Polar Follow-On: NOAA Must Maintain Cost Efficiencies and Refine Launch Strategy for JPSS-3 and JPSS-4 Missions

FINAL REPORT NO. OIG-18-021-A

JULY 9, 2018

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

July 9, 2018

MEMORANDUM FOR: Rear Admiral Tim Gallaudet, Ph.D., USN Ret.
Assistant Secretary of Commerce for Oceans and Atmosphere
and Acting Under Secretary of Commerce for Oceans
and Atmosphere
National Oceanic and Atmospheric Administration

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

SUBJECT: *Polar Follow-On: NOAA Must Maintain Cost Efficiencies and Refine Launch Strategy for JPSS-3 and JPSS-4 Missions*
Final Report No. OIG-18-021-A

Attached is our final audit report on our audit of National Oceanic and Atmospheric Administration's (NOAA's) Polar Follow-On (PFO) program. Our primary objective was to assess the PFO program baselines established in December 2016.

We found that:

- PFO missions' system design depends on program maturing the Joint Polar Satellite System-2 technical baseline and completing plans for a flexible launch strategy;
- NOAA has not provided detailed polar satellite system development costs to Congress; and
- NOAA identified potential future satellite systems and continues to plan its next-generation space architecture, but goals and timelines for new technology insertions are uncertain.

On June 27, 2018, we received NOAA's response to the draft report's findings and recommendations, which we include within the report as appendix C. NOAA agreed with all seven report recommendations, and noted actions it has taken and will take to address them.

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 us by your staff during our audit. If you have any questions or concerns about this report, please contact me at (202) 482-1931 or Kevin Ryan, audit manager, at (202) 695-0791.

Attachment

cc: Ben Friedman, Deputy Under Secretary for Operations, NOAA
Stephen Volz, Assistant Administrator for Satellite and Information Services, NOAA
Mack Cato, Director, Office of Audit and Information Management, NOAA

Report in Brief

July 9, 2018

Background

In December 2016, the Department established cost and schedule baselines for the National Oceanic and Atmospheric Administration's (NOAA's) Polar Follow-On (PFO) program, which funds the Joint Polar Satellite System (JPSS)-3 and JPSS-4 missions. The baselined PFO missions would extend through fiscal year (FY) 2038 at a total life-cycle cost of nearly $7.6 billion. These baselines set forth a strategy to procure the JPSS-3 and JPSS-4 satellites using a block-buy acquisition approach and were intended to make NOAA's polar satellite architecture more resilient such that two on-orbit satellites would need to fail before an actual gap in JPSS data would occur.

However, NOAA's congressional budget submissions for FYs 2018 and 2019 have signaled some uncertainty as to whether the program can fully execute the plans established for the JPSS-3 and JPSS-4 missions.

Why We Did This Review

Our primary objective was to assess the PFO program baselines established in December 2016. More specifically, our objectives were to (1) assess the maturity of PFO missions' system design for indications of cost, schedule or performance issues that would threaten the ability of the JPSS program to execute to its baselines; (2) determine the extent to which NOAA has complied with requirements to report JPSS development costs; and (3) review NOAA efforts to plan for future satellite technologies.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Polar Follow-On: NOAA Must Maintain Cost Efficiencies and Refine Launch Strategy for JPSS-3 and JPSS-4 Missions

OIG-18-021-A

WHAT WE FOUND

We found that (1) PFO missions' system design depends on maturing the JPSS-2 technical baseline and completing plans for a flexible launch strategy; (2) NOAA has not provided detailed polar satellite system development costs to Congress; and (3) NOAA has identified potential future satellite systems and continues to plan its next-generation space architecture, but goals and timelines for technology insertion are uncertain.

WHAT WE RECOMMEND

In order to mitigate the effects of potential reduced annual program budgets and avoid significant cost increases due to prolonged acquisition schedules, we recommend that the NOAA Deputy Under Secretary for Operations ensures that the JPSS program:

1. Includes cost avoidance strategies in its risk management plans, including strategies for prioritizing parts buys, initiating long-lead item purchases, and avoiding parts obsolescence issues.

In order to retain flexibility in the launch strategies for JPSS-3 and JPSS-4, we recommend that the Assistant Administrator for Satellite and Information Services ensures that the JPSS program:

2. Completes storage plans and cost analyses for instruments and integrated satellites.

Further, we recommend that the Assistant Administrator for Satellite and Information Services ensures that the National Environmental Satellite Data and Information Service (NESDIS):

3. Completes policy and plans that will guide polar satellite launch decisions.

In addition, given schedule challenges with heel-to-toe development, we recommend that the Assistant Administrator for Satellite and Information Services ensures that NESDIS uses its polar satellite constellation availability analysis to:

4. Reanalyze scheduled launch dates for JPSS-2, -3, and -4.

To ensure cost and programmatic efficiencies are identified for the Polar Weather Satellites (PWS) program, and therefore put future funds to better use, we recommend that the Assistant Administrator for Satellite and Information Services ensures that NESDIS:

5. Revises and independently assesses the PWS life-cycle cost estimate.

We recommend that the Under Secretary of Commerce for Oceans and Atmosphere:

6. Ensures that NOAA provides Congress with satellite system estimated costs in accordance with requirements for its major satellite programs specified in annual appropriations laws.

We recommend that the NOAA Deputy Under Secretary for Operations ensures NESDIS:

7. Defines goals and timelines for the completion of satellite technology insertion efforts—including the Earth Observing Nanosatellite-Microwave—in order to reduce risk associated with future polar satellite system architectures.

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Cover: Herbert C. Hoover Building main entrance at 14th Street Northwest in Washington, DC. Completed in 1932, the building is named after the former Secretary of Commerce and 31st President of the United States.

Introduction

In December 2016, the Department established cost and schedule baselines for the National Oceanic and Atmospheric Administration's (NOAA's) Polar Follow-On (PFO) program, which funds the Joint Polar Satellite System (JPSS)-3 and JPSS-4 missions. The baselined PFO missions would extend through fiscal year (FY) 2038 at a total life-cycle cost of nearly $7.6 billion. These baselines set forth a strategy to procure the JPSS-3 and JPSS-4 satellites using a block-buy acquisition approach and were intended to make NOAA's polar satellite architecture more resilient such that two on-orbit satellites would need to fail before an actual gap in JPSS data would occur. To do this, the JPSS-3 and JPSS-4 satellites were to be completed and launch-ready years in advance of their scheduled launch dates (2.5 and 5 years before, respectively), so that they could launch earlier—if needed—to restore the on-orbit constellation to a two-failure condition (i.e., with two operational satellites). In addition, PFO plans included a JPSS-3 contingency mission, which would launch the satellite with only microwave and infrared sounders at an even earlier date if a gap condition existed.[1]

Table 1. Polar Follow-On Mission Schedule Baseline

Satellite	Launch Readiness Date	Launch on Schedule Date
JPSS-3 Contingency[a]	Q3 FY 2023	N/A
JPSS-3	Q2 FY 2024	Q4 FY 2026
JPSS-4	Q4 FY 2026	Q4 FY 2031

Source: NOAA polar satellite program documentation

[a] *JPSS-3 Contingency* consists of Advanced Technology Microwave Sounder and Cross-track Infrared Sounder only.

However, NOAA's congressional budget submissions for FYs 2018 and 2019 have signaled some uncertainty as to whether the program can fully execute the plans established for the JPSS-3 and JPSS-4 missions. NOAA's FY 2018 budget submission requested about $180 million for the PFO program, which is only 43 percent of the $419 million in funds its previously established program cost baseline required for FY 2018. In the submission, NOAA proposed to continue development of the JPSS-3 and JPSS-4 missions while it re-planned the PFO program. Re-planning was to involve updating its constellation availability analysis and refining its existing gap analysis to identify new launch dates, in accordance with a to-be-determined budget profile. (NOAA did not provide funding estimates beyond FY 2018 in its budget submission.)

While FY 2018 proceeded under a continuing resolution, however, PFO received funding at an annualized rate of over $326 million. Six months into the fiscal year, the Consolidated Appropriations Act of 2018 set PFO funding at $419 million in accordance with its cost baseline. In February 2018, NOAA's budget submission for FY 2019 introduced the Polar Weather Satellites (PWS) program, which will merge JPSS and PFO into one program. The

[1] For background on JPSS, including a description of instruments, see U.S. Department of Commerce (DOC) Office of Inspector General (OIG), April 26, 2016. *The Joint Polar Satellite System: Further Planning and Executive Decisions Are Needed to Establish a Long-term, Robust Program*, OIG-16-026-I. Washington, DC: DOC OIG, 24–27.

consolidated program combines the life-cycle costs of the JPSS and PFO programs while "allow(ing) NOAA to increase both cost and programmatic efficiencies."[2] Further, the FY 2019 budget indicates that the requested funding "will enable NOAA to maintain the original Launch Readiness Dates for JPSS-3 and JPSS-4."[3]

[2] DOC NOAA, FY 2019. *NOAA FY 2019 Budget Congressional Justification*, FY-19-NOAA-CJ. Washington, DC: NOAA, NESDIS-53.

[3] Ibid, NESDIS-69.

Objectives, Findings, and Recommendations

Our primary objective was to assess the PFO program baselines established in December 2016. During our fieldwork, there was a possibility that NOAA would re-plan the program and revise its baselines. However, the underlying system design, acquisitions, and some aspects of the launch strategy were likely to remain under a revised program plan. Therefore, we assessed risks related to the maturity of the PFO missions' system design and other aspects of the program plan to identify conditions with potential cost, schedule, or performance impacts. Additionally, we audited NOAA's compliance with a requirement to report PFO and JPSS development costs to Congress, and reviewed NOAA's efforts to plan for future satellite technologies in accordance with a previous recommendation. See appendix A for a full description of our objective, scope, and methodology.

We found that (1) PFO missions' system design depends on maturing the JPSS-2 technical baseline and completing plans for a flexible launch strategy; (2) NOAA has not provided detailed polar satellite system development costs to Congress; and (3) NOAA has identified potential future satellite systems and continues to plan its next-generation space architecture, but goals and timelines for technology insertion are uncertain.

I. PFO Missions' System Design Depends on Program Maturing JPSS-2 Technical Baseline and Completing Plans for Flexible Launch Strategy

To reduce technical, cost, and schedule risks, NOAA intends to procure the JPSS-3 and JPSS-4 satellites as virtual copies of JPSS-2. As such, risk to the PFO missions will be reduced as the JPSS-2 components are acquired, integrated, and tested. Beyond the satellites' technical baseline, however, PFO missions also called for early completion, storage, and the ability to be called-up for launch within 1 year.

A. New spacecraft requires modifications to interface with JPSS instruments and the ground system, which will increase costs

In March 2015, the JPSS program competitively awarded a firm-fixed-price contract worth $253 million to Orbital ATK for the JPSS-2 spacecraft. The new contract includes pre-priced options for JPSS-3 and JPSS-4, valued at $130 and $86 million, respectively, which the program exercised on May 25, 2018.

The new JPSS-2, -3, and -4 spacecraft will have a different design from the Suomi NPP and JPSS-1 spacecraft built by Ball Aerospace Technology Corp. The change to a new vendor necessitated updating instrument interface control documents and engineering changes to the new spacecraft's payload interface electronics module to ensure compatibility.

In October 2017, the program and contractor completed a critical design review of the JPSS-2 spacecraft, a key step in the maturation of its technical design. As of December 2017 the program had issued six engineering change proposals for the JPSS-2 spacecraft, resulting in additional costs of approximately $17.6 million, an 8 percent increase in the

value of the contract. During our fieldwork phase, flight project managers told us they wanted to initiate limited contract actions on the JPSS-3 and JPSS-4 options to keep them on the same technical specifications as the JPSS-2 spacecraft, but had not yet been given authority by senior management to do so.

Further, we note that, although the spacecraft for JPSS-3 and JPSS-4 are supposed to be identical to JPSS-2, there is risk that normal product line changes over time can result in the need for additional engineering and cost increases. The cost of the JPSS-1 spacecraft, for example, increased approximately 65 percent from its initial award despite its depiction as a "near-clone" of the Suomi NPP spacecraft. In general, parts obsolescence risks increase as time passes between similar builds. Lowered annual budgets would likely extend acquisition timelines and require the program to manage an increased risk of spacecraft cost growth.

B. Long-term storage plans are not yet complete

As part of the plan to be launch-ready in advance of their scheduled launch dates, the JPSS-3 and JPSS-4 satellites would need to be put in storage until they are needed or otherwise scheduled for launch. According to the program's flight project managers, the JPSS-4 satellite's likely longer storage period of up to 5 years presented the greatest technical challenge. To address the storage needs of both missions, the flight project was developing storage plans in three phases with its instrument and spacecraft vendors. The program planned to complete satellite-level storage plans in late 2018.

It is uncertain to what extent the program can maintain the build-ahead and store approach it had established for the PFO missions. However, it seems likely at least some period of storage would be required for the missions, for either the instruments or fully integrated satellites. As such, the program will need to adjust its storage plans in accordance with any changes to JPSS-3 and JPSS-4 launch plans.

C. Launch policy and program-level plans are under development

NOAA's baselined approach for the PFO missions was intended to make its polar satellite constellation robust by requiring two failures of operational satellites for a gap in data to occur. As we have previously reported, however, this definition of a robust satellite architecture was not part of formal NOAA policy.[4]

As of March 2018, NOAA had not yet developed a policy that would guide polar satellite "launch-on-need" decisions envisioned in the 2016 PFO baseline. To inform a policy, the Office of Systems Architecture and Advanced Planning (OSAAP) is conducting a study of NOAA's satellite observing system architecture (see finding III for more details). A National Academy of Sciences report of its Decadal Survey for Earth Science and Applications from Space—expected in 2018—will also inform NOAA's policy.

[4] See OIG-16-026-I, 19–20. Within OIG-16-026-I, the recommendation to incorporate robust architecture criteria into formal NOAA policy remains resolved but unimplemented (see recommendation 8).

OSAAP conveyed to us that the two-failures-to-a-gap criterion may not make sense for future planning as NOAA's satellite observing system evolves. Further, the JPSS program has identified considerable challenges to implementing a launch-on-need capability and has not been able to identify a government space program that has executed one. NOAA expected to complete its launch policy in 2018.

Beyond policy, JPSS flight project personnel indicated that additional planning for JPSS-3 and JPSS-4 launch-on-need services is needed. The program's study determined that the best approach for the PFO missions would be to contract services for the earliest launch date and then plan to pay (pre-priced) delay penalties until the actual launch date.

D. JPSS-3 early launch readiness dates were at risk due to delays in JPSS-2 development

According to flight project personnel, the development of instruments for JPSS-2, -3, and -4 is scheduled in a "heel-to-toe" fashion, meaning one instrument's development closely follows its predecessor. As a result, development delays in one instrument potentially threaten the completion schedule of the next.

The JPSS-2 instrument development efforts have been challenged by supply chain technical issues and schedule delays beyond what the program expected. A break in time from the manufacture of Suomi NPP and JPSS-1 instruments, a shrinking supplier base, consolidation of the supply chain, and parts obsolescence were factors the project indicated were challenging the JPSS-2 schedule. As a result, flight project managers stated that the JPSS-3 contingency mission early launch readiness date (shown in table 1) was likely not viable.

E. Block-buy cost efficiencies—at risk prior to FY 2018 appropriation—likely maintained, but PWS life-cycle cost needs revision to ensure program identifies additional efficiencies

A Department-led independent cost estimate of the PFO baselines forecast that NOAA could expect to save $585 million as a result of its block-buy approach of the instruments. However, an extension of the procurement schedules would threaten the ability of the program to realize those savings. When the Department established the PFO baselines in 2016, the Deputy Secretary at the time emphasized the need for sufficient annual budget requests to ensure savings were realized.

If realized, the drastic reduction in PFO's FY 2018 budget request would have likely forced the program to significantly revise its procurement schedule for JPSS-3 and JPSS-4 and required the program to manage risks that manifested from the separate procurements of JPSS-1 and JPSS-2. While the program has initiated procurements of JPSS-3 and JPSS-4 instruments, those acquisition timelines would have likely required revisions under a revised budget profile. In addition, spacecraft acquisitions would have been at greater risk of cost growth.

NOAA's FY 2019 budget and the planned consolidation of JPSS and PFO in the PWS program better position the National Environmental Satellite Data and Information Service (NESDIS) to maintain the cost efficiencies it planned for the JPSS-3 and JPSS-4 missions. The FY 2019 budget indicates that NESDIS will identify opportunities to

reduce the life-cycle costs throughout the duration of the PWS program. The current life-cycle cost estimate for PWS, as depicted in the budget, does not yet reflect the cost and programmatic efficiencies NOAA asserts it will gain from the merger of JPSS and PFO. Instead, the PWS life-cycle cost estimate ($18.9 billion) is the sum of the established life-cycle cost baselines of the two separate programs ($11.3 billion for JPSS and $7.6 billion for PFO).

The nearly $8.6 billion of estimated costs to complete the planned PWS program (consisting of $2.1 and $6.5 billion for the current JPSS and PFO programs, respectively), for FYs 2019–2038, should be put to better use through a revision of its life-cycle cost estimate to help identify efficiencies and cost savings NOAA anticipates from the merger of JPSS and PFO (see appendix B).

Recommendations

In order to mitigate the effects of potential reduced annual program budgets and avoid significant cost increases due to prolonged acquisition schedules, we recommend that the NOAA Deputy Under Secretary for Operations ensures that the JPSS program:

1. Includes cost avoidance strategies in its risk management plans, including strategies for prioritizing parts buys, initiating long-lead item purchases, and avoiding parts obsolescence issues.

In order to retain flexibility in the launch strategies for JPSS-3 and JPSS-4, we recommend that the Assistant Administrator for Satellite and Information Services ensures that the JPSS program:

2. Completes storage plans and cost analyses for instruments and integrated satellites.

Further, we recommend that the Assistant Administrator for Satellite and Information Services ensures that NESDIS:

3. Completes policy and plans that will guide polar satellite launch decisions.

In addition, given schedule challenges with heel-to-toe development, we recommend that the Assistant Administrator for Satellite and Information Services ensures that NESDIS uses its polar satellite constellation availability analysis to:

4. Reanalyze scheduled launch dates for JPSS-2, -3, and -4.

To ensure cost and programmatic efficiencies are identified for the PWS program, and therefore put future funds to better use, we recommend that the Assistant Administrator for Satellite and Information Services ensures that NESDIS:

5. Revises and independently assesses the PWS life-cycle cost estimate.

II. NOAA Has Not Provided Detailed Polar Satellite System Development Costs to Congress

Appropriation laws have required NOAA to submit annual reports to Congress for its major satellite programs. The first annual report for a given satellite program—after it has been formally approved for implementation (i.e., its baselines established)—is to include a "baseline report" that, among other things, must include an estimate of the life-cycle cost of the program, with a detailed breakout of the development cost, program reserves, and an estimate of annual costs until development is completed.[5]

For PFO, NOAA has not yet provided Congress with a baseline report due to its prior intention (indicated in the FY 2018 budget request) to re-plan the program. For JPSS, we found that NOAA failed to include a detailed breakout of development costs in the baseline report it submitted for that program. Further, the report did not include an estimate of annual costs until development is completed. While our scope was limited to these polar satellite programs, NOAA may need to provide Congress with additional information for its other major satellite programs if its practices for reporting those cost estimates were similar to JPSS.

The JPSS program baselines were formally established on August 1, 2013. NOAA submitted a baseline report to Congress on November 14, 2014. The report provided an estimate of the life-cycle cost of the program with prior enacted amounts, annual costs for the next 5 years, and a cost to complete. For development costs, the report included the same level of detail—that is, prior enacted and annual figures of the aggregate development costs for the next 5 years and a cost to complete. (See table 2 for program cost-estimate information extracted from NOAA's baseline report to Congress.)

[5] The Consolidated and Further Continuing Appropriations Act, 2012, Public Law No. 112-55, Division B, § 105(c), 125 Stat. 552, 600 (2011), as codified at 33 U.S.C. § 878a(c). This or similar language has been included in other appropriations acts and/or this language has been incorporated by reference in other appropriations acts.

Table 2. JPSS Program Cost Estimates Included in 2014 Baseline Report to Congress (In $ Millions)

	FY 2014 & Prior Enacted	FY 2015	FY 2016[a]	FY 2017[a]	FY 2018[a]	FY 2019[a]	Cost to Complete[a]	Total[b]
Total JPSS and heritage NPOESS[c] Program ($)	5,937.0	916.3	834.0	797.2	710.8	566.7	1,561.4	**$11,323.4**
Development[d] ($)	5,447.1	777.9	704.7	626.0	541.5	377.7	970.8	**$9,431.4**
Operations and Sustainment ($)	489.9	138.4	129.3	171.2	169.3	189.0	590.6	**$1,892.0**
Contingency (%)	—	9	17	20	31	22	13	**12%**

Source: Reproduced from U.S. Department of Commerce NOAA, November 2014. *Joint Polar Satellite System Program Determination of Readiness and Baseline Report to Congress*—Pursuant to section 105(b)(1) and (c)(2) of Public Law No. 112-55, as adopted by reference in section 105 of Public Law No. 113-6 and further adopted by reference in Public Law No. 113-76

[a] Future requests will be determined through the annual budget process. Numbers may not add due to rounding.

[b] OIG has reproduced table 2 with data pulled directly from NOAA's 2014 baseline report to Congress. OIG is aware that the amounts found in the *Total* column of the table do not equate to the sum of the amounts found in the corresponding row.

[c] NPOESS — National Polar-orbiting Operational Environmental Satellite System.

[d] Program Management, Systems Engineering, Mission Assurance, Ground Research and Development, Instrument and Flight Costs are allocated to Development.

The provision of 5 years of aggregated annual development costs and a cost to complete does not constitute a detailed breakout of development costs required by Congress. As indicated in the baseline report itself, a detailed breakout of the development cost figures would specify costs for program management, systems engineering, mission assurance, ground research and development, and instrument and flight (spacecraft and launch services) costs. The program's and independent cost estimates have further breakouts of these allocations. Further, since JPSS development will extend beyond FY 2019, the baseline report did not meet the requirement to provide an estimate of annual costs until development is completed.

Congress needs sufficient information about costs in order to better oversee satellite programs and requires NOAA's Under Secretary to notify congressional committees and take other actions if there is reason to believe development costs will exceed the estimate by 20 percent or more.

Recommendation

We recommend that the Under Secretary of Commerce for Oceans and Atmosphere:

6. Ensures that NOAA provides Congress with satellite system estimated costs in accordance with requirements for its major satellite programs specified in annual appropriations laws.

III. NOAA Identified Potential Future Satellite Systems and Continues to Plan Its Next-Generation Space Architecture but Goals and Timelines for New Technology Insertions Are Uncertain

In our April 2016 report, we recommended that NOAA include new satellite technology insertion as part of its strategic and tactical plans.[6] In early 2017, an independent review team (IRT) found that a lack of adequate time to develop new capabilities required NOAA to procure additional JPSS and GOES-R satellites, unless new technology or commercial solutions can be demonstrated to be equal or better to JPSS and GOES-R performance.[7]

In 2016 and 2017, a NESDIS team led a study of NOAA's satellite observing systems architecture to inform decisions for its space systems beyond the currently planned missions of the JPSS and GOES-R programs. In January 2018, NOAA reported to stakeholders that the study team had identified approximately 100 instrument options for capabilities to meet NOAA's observation needs in the 2030–2050 timeframe. Preliminary conclusions included that hybrid architecture options that combine some traditional missions with new alternatives provide opportunities to meet NOAA's future needs with greater agility and within reasonable costs. NOAA will further refine its study going forward and intends to reconcile its analysis with the National Academy of Sciences Decadal Survey and the Weather Research and Forecasting Innovation Act of 2017.[8]

NOAA has not yet authorized or funded the start of Earth Observing Nanosatellite-Microwave (EON-MW), a potential gap mitigation mission for JPSS observations based on new, small satellite technology. NOAA has studied and made notional plans for EON-MW, which could provide some mitigation for the loss of microwave soundings from JPSS missions. Those plans, according to a NOAA project manager, estimate 30 months from the start of such a project before the satellite would be launch ready.

NOAA efforts to assess weather data provided by commercial sources have been limited thus far due to the immaturity of this sector.[9] In the first round of its Commercial Weather Data Pilot project, NOAA received data from only one provider. However, the data volume was less than expected, leading NOAA to recoup $900 thousand of the original $990 thousand contract award. After releasing a draft request for proposals (RFP) for the second round of its pilot project, in May 2017, NOAA learned that vendors were not ready and postponed its issuance of a final RFP to the third quarter of FY 2018.[10]

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[6] See OIG-16-026-I, finding III.C. and recommendation 9, 19–20.

[7] NOAA National Environmental Satellite, Data, and Information Service. *Independent Review Team Final Report 2017*, slide 12 [online]. https://www.nesdis.noaa.gov/sites/default/files/asset/document/nesdis_irt_report_2017_with_notes.pdf (accessed May 17, 2018).

[8] Pub. L. No. 115-25.

[9] DOC OIG, September 29, 2017. *Top Management and Performance Challenges Facing the Department of Commerce*, OIG-17-033. Washington, DC: DOC OIG, 11.

[10] The first two rounds of NOAA's pilot project intend to assess radio occultation data. Radio occultation involves small satellites that measure distortions caused by the earth's atmosphere in radio signals sent from higher-orbiting Global Position System satellites. These measurements are used to generate "soundings" of atmospheric conditions, including temperature, pressure, density, and water vapor content.

We conclude that goals and timelines for NOAA new satellite technology insertions are uncertain. NOAA's analysis of its future needs continues with assimilation of its own study with the National Academy of Sciences Decadal survey. One effort that could be ready for technology insertion, EON-MW, has consisted of little more than study. Commercial weather data use has not progressed beyond a limited, preliminary study. Meanwhile, the IRT's recommendation for procurements of additional JPSS and GOES-R missions suggests there may be less time than needed to plan new technologies that will meet NOAA's observing requirements. Further, while NOAA's FY 2019 budget request for PWS indicates the program will support risk reduction efforts to support current and future polar data acquisition requirements, the progress of EON-MW suggests more attention to such efforts is needed.

Recommendation

We recommend that the NOAA Deputy Under Secretary for Operations ensures NESDIS:

7. Defines goals and timelines for the completion of satellite technology insertion efforts—including EON-MW—in order to reduce risk associated with future polar satellite system architectures.

Summary of Agency Response and OIG Comments

In response to our draft report, NOAA agreed with all of our recommendations, and described actions it has taken and will take to address them. NOAA also recommended an update regarding the status of the JPSS-3 and -4 spacecraft contract options, which the program has now exercised. NOAA's complete response to our draft report is in appendix C.

We are pleased that NOAA concurs with our recommendations and look forward to reviewing the proposed audit action plan.

Appendix A: Objectives, Scope, and Methodology

Our primary objective was to assess the PFO program baselines established in December 2016. More specifically, our objectives were to (1) assess the maturity of PFO missions' system design for indications of cost, schedule or performance issues that would threaten the ability of the JPSS program to execute to its baselines; (2) determine the extent to which NOAA has complied with requirements to report JPSS development costs; and (3) review NOAA efforts to plan for future satellite technologies.

To assess the maturity of PFO missions' system design, we reviewed the JPSS-2 spacecraft contract to identify key provisions related to design maturity. We interviewed JPSS flight project personnel to understand the JPSS-3 and JPSS-4 contract options, storage plans, and cost increases for the JPSS-2 spacecraft. We attended the JPSS-2 spacecraft critical design review, held October 23–27, 2017, to understand design maturity of the JPSS-2 spacecraft, as well to monitor status of the development and identify risks, potential schedule delays, and cost impacts. We further interviewed NOAA and NASA personnel to understand their assessment of PFO system design maturity. We reviewed the PFO program office estimate and Department's independent cost estimate (ICE) to identify uncertainties in the estimates related to design maturity. We interviewed a cost estimator from the Department's Office of Acquisition Management to understand how the ICE was developed and its determination of cost savings due to block-buy acquisitions. We reviewed a program-commissioned study of launch-on-need, which examined previous efforts to implement such a capability. We interviewed NESDIS leadership and other personnel, including from the Office of Systems Architecture and Advanced Planning, (OSAAP), to understand progress in incorporating "two-failures-to-a-gap" into NOAA policy.

To determine the extent to which NOAA met requirements to report JPSS development costs to Congress, we reviewed the initial JPSS program Baseline Report to Congress, NOAA's major program annual reports for satellites for FY 2014 through 2017, and quarterly reports to Congress. We compared the content of those reports to requirements in Public Law No. 112-55 and other annual appropriation laws since FY 2012. We also interviewed JPSS program officials regarding the program's definition of development costs.

To review NOAA efforts to plan future satellite technologies, we interviewed NESDIS leadership and OSAAP personnel to understand the approach to the NOAA observing system architecture study and reviewed related briefings and reports. We interviewed a NESDIS project manager responsible for EON-MW plans and reviewed a NOAA presentation on its CubeSat-related activities for gap mitigation and future planning. We also interviewed NESDIS leadership, reviewed a NOAA report, and incorporated conclusions from our FY 2018 *Top Management Challenges* report[11] to understand the status and results of the Commercial Weather Data Pilot.

[11] See OIG-17-033, 11.

In addition, we assessed internal control significant within the context of our objectives. This included examining the design of program management controls as documented in NASA procedural requirements. We also assessed the implementation of internal control through document reviews and observations of program and project management life-cycle reviews to determine the program's adherence to its standards, procedures, and plans. In satisfying our objectives, we did not rely on computer-processed data; therefore, we did not test the reliability of NOAA and NASA information technology systems. The findings and recommendations in this report include our assessments of internal control.

Although we could not independently verify the reliability of all the information we collected, we compared it with other available supporting documents to determine data consistency and reasonableness. Based on these efforts, we believe the information we obtained is sufficiently reliable for this report.

We performed our fieldwork from January 2017 to December 2017 at the JPSS program office in Lanham, Maryland; NESDIS offices in Silver Spring, Maryland; National Centers for Environmental Prediction offices in College Park, Maryland; and Orbital ATK's satellite manufacturing facility in Gilbert, Arizona. We conducted this audit under the authority of the Inspector General Act of 1978, as amended, 5 U.S.C. App., and Department Organization Order 10-13, dated April 26, 2013.

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

Appendix B: Potential Monetary Benefits

Table B-1. Polar Follow-On Mission Schedule Baseline

Description	Funds to Be Put to Better Use[a]
Estimated costs to complete PWS program, FYs 2019–2038	$8,579,037,000

Source: OIG, derived from *NOAA Budget Estimates Fiscal Year 2019, Congressional Submission* and the *Consolidated Appropriations Act of 2018*

[a] This includes more efficient use of funds and cost savings that would be identified from a revision of the PWS life-cycle cost estimate as described under finding I.E. and recommendation 5.

Appendix C: Agency Response

UNITED STATES DEPARTMENT OF COMMERCE
The Deputy Under Secretary for Operations
Washington, D.C. 20230

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

FROM: Ben Friedman
Deputy Under Secretary for Operations JUN 27 2018

SUBJECT: *Polar Follow-On: NOAA Must Maintain Cost Efficiencies and Refine Launch Strategy for JPSS-3 and JPSS-4 Missions*
Draft OIG Audit Report

The National Oceanic and Atmospheric Administration (NOAA) is pleased to submit the attached response to the Office of Inspector General's draft report on NOAA's Polar Follow-On program. We agree with all recommendations and included comments in the attached response.

We appreciate the opportunity to review and respond to your draft report. If you have questions, please contact Mack A. Cato, Director, Audit and Information Management Office on (301) 628-0949.

Attachment

Department of Commerce
National Oceanic and Atmospheric Administration
Comments to the OIG Draft Report Entitled
"Polar Follow-On: NOAA Must Maintain Cost Efficiencies and Refine Launch Strategy for JPSS-3 and JPSS-4 Missions"
(May 2018)

General Comments

The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) appreciates the opportunity to review and comment on the Office of Inspector General (OIG) draft report on Polar Weather Satellites (PWS). NOAA has reviewed the report and agrees with all OIG recommendations. The response to each recommendation is provided below.

NOAA also recommends factual and technical changes to the report, which are provided to ensure that the information presented is complete, accurate, and up-to-date.

Recommended Changes for Factual/Technical Information

Page 3, Section A, 1st paragraph and 3rd paragraph, last sentence: The options have now been exercised.

NOAA Response to OIG Recommendations

Recommendation 1: In order to mitigate the effects of potential reduced annual program budgets and to avoid significant cost increases due to prolonged acquisition schedules, we recommend that the NOAA Deputy Under Secretary for Operations ensure that the JPSS Program includes cost avoidance strategies in its risk management plans, including strategies for prioritizing parts buys, initiating long-lead item purchases, and avoiding parts obsolescence issues.

NOAA Response: Concur. This is consistent with the Polar Follow-On (PFO) acquisition approaches proposed. The total JPSS program costs are predicated on the availability of funds as presented in the baseline. Unspecified reductions in annual program budgets will likely have an impact on the total program life cycle cost and could impact the launch schedule, depending on the severity of the reductions.

Recommendation 2: In order to retain flexibility in the launch strategies for JPSS-3 and JPSS-4, we recommend that the Assistant Administrator for Satellite and Information Services ensures that the JPSS Program completes storage plans and cost analyses for instruments and integrated satellites.

NOAA Response: Concur. Actions to refine long term storage plans have been assigned to instrument teams. Liens were applied during the NOAA budget process for fiscal year 2020.

Recommendation 3: We recommend that the Assistant Administrator for Satellite and Information Services ensures that NESDIS completes policy and plans that will guide polar satellite launch decisions.

NOAA Response: Concur. NESDIS is in the process of completing its policy and plans to guide polar launch decisions.

Recommendation 4: Given schedule changes with heel-to-toe development, we recommend that the Assistant Administrator for Satellite and Information Services ensures that NESDIS uses its polar satellite constellation availability analysis to reanalyze schedule launch dates for JPSS-2, -3, and -4.

NOAA Response: Concur. NESDIS will utilize the polar satellite constellation availability analysis to analyze the launch schedules for JPSS-2, -3, and -4 in order to minimize risk across the constellation. Suggested changes in the launch schedule will be coordinated with the decision authority within NOAA and the Department of Commerce.

Recommendation 5: To ensure cost and programmatic efficiencies are identified for the PWS program, and therefore put future funds to better use, we recommend that the Assistant Administrator for Satellite and Information Services ensures that NESDIS revises and independently assesses the PWS life-cycle cost estimate.

NOAA Response: Concur with the recommendation to refine the PWS life-cycle estimate. Maturation of the PFO life-cycle cost estimate will occur as a standard activity as part of the JPSS-3 and -4 mission-level Key Decision Point-C. The PWS life-cycle cost estimate will be independently assessed at this point.

Recommendation 6: We recommend that the Under Secretary of Commerce for Oceans and Atmosphere ensures that NOAA provides Congress with satellite system estimated costs in accordance with requirements for its major satellite programs specified in annual appropriations laws.

NOAA Response: Concur, understanding that this is a standard practice for NOAA satellite systems. NOAA will provide Congress with the life-cycle cost for PFO consistent with requirements for major satellite programs.

Recommendation 7: We recommend the NOAA Deputy Under Secretary for Operations ensures NESDIS defines goals and timelines for the completion of satellite technology insertion efforts---including EON-MW---in order to reduce risk associated with future polar satellite system architectures.

NOAA Response: Concur. NOAA will define its goals and timelines for the completion of satellite technology insertion efforts in support of its architecture studies with a goal to minimize continuity risk.