NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Audit of the Joint Polar Satellite System: To Further Mitigate Risk of Data Gaps, NOAA Must Consider Additional Missions, Determine a Strategy, and Gain Stakeholder Support

FINAL REPORT NO. OIG-14-022-A

JUNE 17, 2014

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

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

June 17, 2014

MEMORANDUM FOR: Dr. Kathryn Sullivan
Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator

FROM: Allen Crawley
Assistant Inspector General for Systems Acquisition and IT Security

SUBJECT: *Audit of the Joint Polar Satellite System: To Further Mitigate Risk of Data Gaps, NOAA Must Consider Additional Missions, Determine a Strategy, and Gain Stakeholder Support*
Final Report No. OIG-14-022-A

Attached is our final report on NOAA's Joint Polar Satellite System (JPSS). Our audit objectives were to (1) monitor NOAA's progress toward establishing JPSS cost, schedule, and performance baselines; (2) assess ongoing development activities; and (3) review efforts to mitigate a potential data gap between Suomi National Polar-orbiting Partnership (Suomi NPP) and JPSS-1 satellites.

We found the following:

- JPSS established its program baselines after the Department and NOAA reduced system capabilities to lower the life-cycle cost and focus its missions—but to further mitigate risk of data gaps, NOAA is likely to plan additional missions beyond JPSS-2. This would effectively increase the overall cost, duration, and robustness of the program.
- The JPSS-1 mission addressed a number of technical and schedule challenges before the integration and test phase of development. This reduced JPSS-1 development risk, but schedule revisions will prolong operational risks from the use of an outdated ground system supporting Suomi NPP until NOAA transitions to an upgraded system prior to JPSS-1 launch.
- NOAA has begun gap mitigation activities but should better quantify the value of JPSS data in order to establish the benefits gained from it, as well as justify further investments in environmental satellite capabilities.

We have summarized NOAA's response to our draft report and included its entire formal response as appendix E. The final report will be posted on OIG's website pursuant to section 8M of the Inspector General Act of 1978, as amended.

In accordance with Department Administrative Order 213-5, please provide us your action plan within 60 days of this memorandum. The plan should outline the actions you propose to take to address each audit recommendation.

Please direct any inquiries regarding this report to me at (202) 482-1855, or Fred Meny, Director, Satellites and Weather Systems, at (202) 482-1931, and refer to the report title in all correspondence.

Attachment

cc: Bruce Andrews, Acting Deputy Secretary
Ellen Herbst, Chief Financial Officer and Assistant Secretary for Administration
VADM Michael S. Devany, Under Secretary for Operations, NOAA
Mary E. Kicza, Assistant Administrator, National Environmental Satellite, Data, and Information Services, NOAA
Harry Cikanek, JPSS Program Director, NOAA
Mack Cato, Director, Office of Audit and Information Management, NOAA

Report In Brief

JUNE 17, 2014

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Background

The Joint Polar Satellite System (JPSS) program was established in 2010 when the Administration chose to restructure the troubled National Polar-orbiting Operational Environmental Satellite System (NPOESS)—a tri-agency partnership among the Department of Defense, NOAA, and NASA—into separate civil and defense programs. JPSS currently supports the operation of one satellite and is developing and launching two, next-generation polar-orbiting satellites (JPSS-1 and JPSS-2) with new, more capable instruments to replace NOAA's legacy polar satellites.

Why We Did This Review

Developing next-generation environmental satellite systems is a top management challenge for the Department and NOAA. Given its national significance and large budget, we have conducted oversight of NOAA's JPSS since the Administration directed its establishment in 2010, after management and technical problems led to cost increases, schedule delays, and capability reductions for its predecessor program, NPOESS. This is our third audit report and fourth oversight product focused on JPSS.

Our objectives were to (1) monitor NOAA's progress toward establishing JPSS cost, schedule, and performance baselines; (2) assess ongoing development activities; and (3) review efforts to mitigate a potential data gap between Suomi National Polar-orbiting Partnership (Suomi NPP) and JPSS-1 satellites.

WHAT WE FOUND

We found that

JPSS Program Baselines Were Established After Department and NOAA Reduced System Capabilities to Lower the Life-Cycle Cost and Focus Its Missions, but Baselines May Be Revised to Mitigate Risk of Data Gaps. Significant changes introduced in NOAA's FY 2014 budget present concerns about coordination with new programs, potential schedule changes, and other cost issues. Also, the program's revised life-cycle cost estimate is more reliable than previous estimates, but opportunities for additional cost savings may arise. Finally, NOAA will evaluate options for additional missions, and the JPSS program will need to revise its formulation.

NOAA Leadership Deemed JPSS-1 Ready for the Next Phase of Development—but Technical, Schedule, and Programmatic Challenges Await. The JPSS-1 flight project currently has adequate schedule margins, but integration and test activities could diminish schedule margins and funding reserves. Delayed facility work complicated the scheduling of ground system upgrades, which added JPSS-1 development risk and resulted in prolonged operational use of inadequate security controls. And, despite master schedule uncertainties, the standing review board recommended approval of a JPSS-1 key decision point.

NOAA Has Begun Gap Mitigation Activities but Should Do More to Help Stakeholders Understand the Consequences of a Gap. The avoidance of gaps will depend upon whether on-orbit satellites continue to operate and the constellation's ability to tolerate unexpected failures. Stakeholders, and the JPSS program, would benefit were NOAA better able to communicate the consequences of an afternoon orbit weather data gap—in terms of the extent of expected forecast degradation, as well as the resulting economic costs.

WHAT WE RECOMMEND

We recommend that the NOAA Administrator

1. Establish reporting metrics to ensure adequate coordination among JPSS, Solar Irradiance, Data and Rescue (SIDAR), and NASA climate instrument programs for review at monthly Program Management Council meetings.
2. Ensure that JPSS-2 operations and sustainment costs beyond FY 2025 are delineated in stakeholder briefing materials about plans for additional missions.
3. Leverage Office of Acquisition Management (OAM)-led cost analysis expertise to explore cost savings opportunities in acquisitions beyond JPSS-2.
4. Ensure that stakeholders are provided formal documentation of NOAA's response to independent review team recommendations and its corresponding acquisition strategy.

We recommend that the NOAA Assistant Administrator for Satellite and Information Services

5. Ensure that stakeholders (including Congress) are provided updated information on the results and confidence level of the JPSS-1 mission's integrated master schedule.

We recommend that the NOAA Deputy Under Secretary for Operations

6. Direct appropriate NOAA entities to explain the effects of a potential afternoon orbit data gap in terms of degraded forecast hours and extrapolated economic costs, or conversely, the contribution to forecast accuracy and the economic benefits of afternoon orbit data.

Contents

Introduction

Developing next-generation environmental satellite systems is a top management challenge for the Department and the National Oceanic and Atmospheric Administration (NOAA). Given its national significance and large budget, we have conducted oversight of NOAA's Joint Polar Satellite System (JPSS) since the Administration directed its establishment, in 2010, after management and technical problems led to cost increases, schedule delays, and capability reductions for its predecessor program, the National Polar-orbiting Operational Environmental Satellite System (NPOESS). This is our third audit report and fourth oversight product focused on JPSS.[1]

One of our prior recommendations, from our September 2012 report,[2] was that NOAA should determine an acquisition strategy for polar satellites beyond the currently defined program—which is limited to developing two satellites, launching 5 years apart, and ends in 2025. In response, NOAA indicated that doing so was dependent upon its negotiations with the Office of Management and Budget (OMB) and Congress and it would work to obtain guidance in fiscal year (FY) 2013 appropriations law. Such guidance did not materialize, however, and NOAA did not address a longer-term acquisition strategy in its FY 2014 budget submission. In November 2013, NOAA's expert independent review team found that the JPSS acquisition strategy was hindered by its current limit of developing just two satellites, which leaves the risk of a gap in polar satellite weather data unacceptably high both in the near term and the foreseeable future.[3] In January 2014, Congress declared that it expected NOAA, with the FY 2015 budget, to provide a strategy that "fully addresses" these issues—and permitted NOAA to use FY 2014 and earlier funds for the procurement of spare instruments and spacecraft.[4]

Prior to the independent review team's findings, on August 1, 2013, the Deputy Secretary approved the program's current cost, schedule, and performance baselines—and the passage of a major milestone signifying the completion of the formulation phase of the program life cycle and the formal start of the implementation phase.[5] The formal establishment of those baselines occurred subsequent to significant changes to the capabilities JPSS will provide, which were introduced in the FY 2014 budget submission and stemmed from the independent review team's initial recommendations for the program, issued in July 2012, and a need to reduce the program's life-cycle cost. (Figure 1, below, provides a timeline of key events in the establishment of the program's baselines.)

[1] See appendix D for a list of our products on JPSS and other NOAA satellite acquisitions.

[2] U.S. Department of Commerce Office of Inspector General, September 27, 2012. *Audit of the Joint Polar Satellite System: Continuing Progress in Establishing Capabilities, Schedules, and Costs Is Needed to Mitigate Data Gaps,* OIG-12-038-A. Washington, DC: DOC OIG.

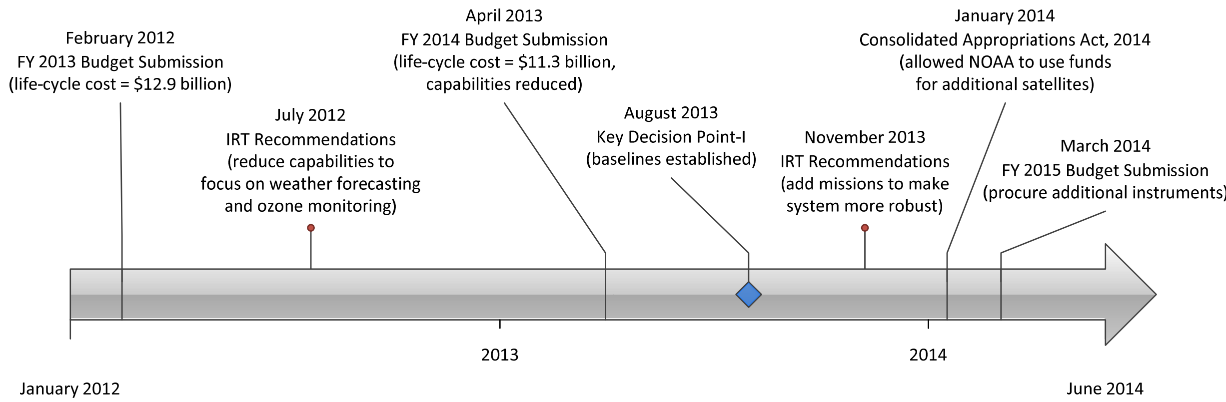
[3] NOAA NESDIS Independent Review Team, November 8, 2013. *Assessment Update One Year Later* [Online] www.nesdis.noaa.gov/news_archives/irt_report_2013.html (accessed November 15, 2013).

[4] 160 Cong. Rec. H510 (daily ed. Jan. 15, 2014) (statement of Rep. Rogers).

[5] In actuality, the program's constituent projects had already been implementing program plans for the acquisition and development of system components.

With additional changes likely to result from the independent review team's November 2013 recommendations, the program will need to re-cycle through formulation and require additional Department-level (as well as OMB and Congressional) approval for what will be significant revisions to its baselines. This will be an opportunity for the program—to better support NOAA's mission and strategic goals for the long term—but will also challenge the ability of leadership to oversee and direct the execution of the JPSS program's recently established baselines, as attention divides between life-cycle phases.

Figure 1. Key Events in the Evolution of JPSS Program Baselines (2012–2014)



Source: OIG, adapted from NOAA budget, legislation, and JPSS program documentation

Appendix B provides more complete background information and context for our findings and recommendations.

Objectives, Findings, and Recommendations

Our objectives were to (1) monitor NOAA's progress toward establishing JPSS cost, schedule, and performance baselines; (2) assess ongoing development activities; and (3) review efforts to mitigate a potential data gap between Suomi National Polar-orbiting Partnership (Suomi NPP) and JPSS-1 satellites. We found that program baselines were established after the Department and NOAA reduced system capabilities to lower the life-cycle cost and focus its missions—but, to further mitigate risk of data gaps, NOAA is likely to plan additional missions beyond JPSS-2. This would effectively increase the overall cost, duration, and robustness of the program. The JPSS-1 mission addressed a number of technical and schedule challenges before the integration and test phase of development. This reduced JPSS-1 development risk, but schedule revisions will prolong operational risks from the use of an outdated ground system supporting Suomi NPP until NOAA transitions to an upgraded system prior to JPSS-1 launch. NOAA has begun gap mitigation activities but should better quantify the value of JPSS data in order to establish the benefits gained from it, and to justify further investments in environmental satellite capabilities. See appendix A for a full discussion of our objectives, scope, and methodology.

I. JPSS Program Baselines Were Established After Department and NOAA Reduced System Capabilities to Lower the Life-Cycle Cost and Focus Its Missions, but Baselines May Be Revised to Mitigate Risk of Data Gaps

With the submission of its FY 2014 budget (see table 1, below), the Department and NOAA proposed a new life-cycle cost of $11.3 billion[6] and a number of changes to the content of the program. These changes were spurred by legislative stakeholders' unfavorable reaction to the FY 2013 proposed life-cycle cost of $12.9 billion and an expert independent review team's recommendations, in July 2012, to remove certain requirements in order to focus JPSS on weather forecasting and ozone monitoring. Program changes were announced in an April 2013 decision memorandum from the Acting Secretary. The late announcement of program changes delayed, by 1 month, the program's system definition review, which was a prerequisite to passing a major program milestone, Key Decision Point-I, and a formal commitment to cost, schedule, and performance (i.e., the scope of system capabilities) baselines. Subsequent findings from NOAA's independent review team, however, have led NOAA to evaluate adding missions and effectively extending the life cycle of JPSS beyond its current planned end in 2025.[7]

[6] See appendix C for a complete history of JPSS program life-cycle cost estimates.

[7] NOAA officials told us that it may be required to fund additional missions under a separate line item in its budget but would manage the missions under the current JPSS program.

Table 1. Comparison of the Program as Defined in FY 2013 and 2014 Budgets

	FY 2013 Budget Submission	FY 2014 Budget Submission	
		JPSS	Non-JPSS
Life-cycle Cost (billions)	$12.9	$11.3[a]	$0.701[b]
End of Program Life Cycle	FY 2028	FY 2025	N/A
Launch Dates	JPSS-1: Q2 FY 2017 JPSS-2: Q1 FY 2022[c]	JPSS-1: NLT Q2 FY 2017 JPSS-2: Q1 FY 2022	N/A
JPSS-1 mission	ATMS, CrIS, VIIRS, OMPS-N, CERES	Unchanged	N/A
JPSS-2 mission	ATMS, CrIS, VIIRS, OMPS-N, OMPS-L, RBI	ATMS, CrIS, VIIRS, OMPS-N	OMPS-L, RBI to NASA (JPSS-2 to host if possible)
Free Flyer-1 mission	TSIS-1, SARSAT,[d] ADCS[d]	Ground system supports Polar Free Flyer	Polar Free Flyer (TSIS-1, SARSAT,[d] ADCS[d])
Free Flyer-2 mission	TSIS-2, SARSAT,[d] ADCS[d]	Cancelled	TSIS-2 to NASA

Source: NOAA budget submissions and JPSS program documentation
[a] Includes $2.5 billion spent under NPOESS, as well as some development and operations support costs for Suomi NPP.
[b] Estimated costs for capabilities removed from JPSS and transferred to other NOAA or NASA programs; Polar Free Flyer's life-cycle cost, estimated at $335 million, was not funded in the FY 2014 omnibus appropriation; life-cycle cost estimate for instruments transferred to NASA was $366 million.
[c] JPSS-2 launch *readiness* date; actual launch date to be determined.
[d] Search and Rescue Satellite Aided Tracking (SARSAT) and Advanced Data Collection System (ADCS) instruments to be supplied by international partners.

A. Significant changes introduced in NOAA's FY 2014 budget present management challenges and concerns

NOAA left unchanged the scope of the JPSS-1 satellite mission, given its advanced stage of development and need to stay on schedule. The most significant program change (1) moved the JPSS free flyer-1 satellite and its instruments to a separate NOAA program called Polar Free Flyer and (2) cancelled the JPSS free flyer-2 satellite mission. Further, NOAA transferred the Ozone Mapping and Profiler Suite-Limb (OMPS-L), Radiation Budget Instrument (RBI), and the second Total Solar Irradiance Sensor (TSIS-2, originally planned for free flyer-2) to NASA for funding and development. JPSS retains responsibility, however, for providing ground system support to Polar Free Flyer. And the JPSS-2 satellite will still host OMPS-L and RBI, if NASA can provide the instruments in time for satellite integration, testing, and launch need dates. Finally, the JPSS life cycle was reduced 3 years, from FY 2028 to FY 2025. These changes raise concerns going forward: (1) JPSS must coordinate with new programs managing capabilities removed from, but still supported by, JPSS; (2) the removed content may lack adequate funding and support, which could have cost and schedule ramifications for JPSS; (3) the scope of JPSS life-cycle cost is inconsistent with the Departmental definition of such cost; and (4) cost reductions from removed capabilities are not the same as cost savings for the government.

1. JPSS must coordinate with new programs established for the removed (but still supported) capabilities. While the FY 2014 changes were intended to focus JPSS on NOAA's weather mission, JPSS will still support nonweather forecasting related capabilities ostensibly removed from the program. This will require interfacing with new programmatic entities established for the transferred capabilities, adding to communication and coordination challenges the program already faces with other entities related to the program.[8] If the new programs experience delays due to funding or development issues, these could affect JPSS costs and schedules given that the JPSS ground system and JPSS-2 satellite will have integrated roles in those missions. Despite NOAA's assurances that OMPS-L and RBI will be accommodated only if they can meet JPSS-2 schedule milestones, in our view there is likely to be pressure to delay JPSS-2 launch if, after significant investment in those instruments, more time is needed before they can be delivered to the program for satellite integration.[9] A JPSS-2 launch delay would increase the potential for another gap in key weather data from the afternoon polar orbit.

2. Removed program content may not have adequate funding or programmatic support. Uncertain funding and programmatic support for the capabilities removed from JPSS could still have cost and schedule ramifications for the program. The Polar Free Flyer and NASA-transferred instruments will compete for resources with other NOAA and NASA programs. Budget sequestration in FY 2013 had already slowed development of the free-flyer mission, and Congress chose not to fund Polar Free Flyer in the FY 2014 omnibus appropriations law. In its FY 2015 budget submission, NOAA renamed the program Solar Irradiance, Data and Rescue (SIDAR), requested $15 million, and planned to revise its acquisition strategy for this capability. The JPSS ground project may need to adjust its contracts and schedules to accommodate changing plans for supporting SIDAR if it retains the requirement to support that program. Further, potential NASA funding shortages for OMPS-L and RBI development projects would add uncertainty to the JPSS-2 integration and test schedule.

[8] See DOC OIG, September 2011. *Audit of the Joint Polar Satellite System: Challenges Must be Met to Minimize Gaps in Polar Environmental Satellite Data*, OIG-11-034-A, Washington, DC: DOC OIG, 4, 7, as well as OIG-12-038-A, 17.
[9] In response to our draft report, NOAA asked that we acknowledge its ongoing development of a formal agreement with NASA to ensure JPSS-2 remains on schedule if OMPS-L and RBI were delayed. According to recent program reporting, however, this agreement is pending a decision by the Department's Milestone Review Board in July 2014. Further, we have not reviewed the agreement, as it was still being drafted during our review period. It remains our view that, even with such an agreement, some degree of this type of risk exists.

3. The shortened program life cycle is not consistent with the Department's definition of life-cycle cost.[10] As currently planned, the JPSS-2 mission's life span of 7 years will extend 3 years beyond the program's life-cycle end date in FY 2025. Therefore, the JPSS cost estimate does not account for the entire life span of the mission. Both JPSS satellites will be designed for a mission life of 7 years, with a 70 percent probability of meeting key performance parameters at 5 years. The second satellite, JPSS-2, is planned to launch in the first quarter of FY 2022. JPSS-2 mission operations and maintenance of the ground system, therefore, would reasonably be expected to continue through FY 2028, if not longer. Even at the 5-year point described above, the mission life would last through FY 2026. JPSS managers had told us that NOAA expected that a follow-on program to JPSS would cover these costs after FY 2025. More recently, program officials told us of plans to cover these expenses under NOAA's Operations, Research, and Facilities appropriation (as opposed to JPSS funds in its Procurement, Acquisition, and Construction account). The Department's acquisition policy, however, does not allow either distinction in determining life-cycle cost, which it defines as inclusive of expected operation and maintenance expenses over the planned life span "without regard to funding source or management control." We recognize, however, that stakeholders were involved in and approved of the decision to shorten the program's life cycle, but we emphasize the need for transparency in cost estimates generated for future missions.

4. Cost reductions from removing program capabilities will not result in an equivalent savings for the government. While JPSS's life-cycle cost estimate is now $1.6 billion less than the prior estimate, it does not represent a savings of that amount to the government, given plans for NOAA and NASA to continue developing the removed capabilities. Accounting for $700 million of the prior JPSS cost estimate, the costs for the removed capabilities will now be borne by other government programs. Budget challenges put the transitioned programs at risk of schedule delays and cost increases.

B. The program's revised life-cycle cost estimate is more reliable than previous estimates; opportunities for additional cost savings may arise

Notwithstanding our concern about the proper duration of the program's life cycle (discussed in I.A.3, above), we conclude that the program's revised life-cycle cost estimate of $11.3 billion is more reliable than previous estimates.[11] The estimate was independently validated by an experienced and well-resourced team led by the Office of Acquisition Management (OAM), which received support from cost analysis experts in

[10] The *Policy on Commerce Acquisition Project Management* (November 6, 2012), on page 3, defines *life-cycle cost* as "the total of the direct, indirect, and nonrecurring costs, including…expenses incurred or estimated to be incurred in the design, development, verification, production, operation, maintenance, support, and retirement of a program or project **over its planned lifespan, without regard to funding source or management control**" (emphasis added).

[11] See DOC OIG, OIG-12-038-A, for our assessment of the program's 2011 cost estimating process and recommendations to ensure future cost estimates were more reliable.

the Air Force, Navy, National Reconnaissance Office, and others. This team obtained better, more comprehensive data than earlier independent and NOAA cost estimators had previously, particularly for ground system and spacecraft contracts. OAM shared the data with NOAA's cost estimator as it separately developed the program office estimate. With $4.3 billion spent prior to FY 2013, OAM's independent cost estimate to completion (FYs 2013–2025) of $7.2 billion was just 1.1 percent more than the program office estimate before the two were fully reconciled.[12]

The JPSS standing review board also performed an independent assessment of the program office estimate and found that the program's approach to developing the estimate was acceptable, the basis of the estimate credible, and the annual phasing of funds appropriate. It assessed somewhat higher levels of uncertainty to instrument and spacecraft costs than the program's cost estimators, which resulted in a 4 percent higher estimate than the program's. The review board deemed this difference acceptable and concluded that the program's life-cycle cost estimate was reasonable.

Prior to the reconciliation of the program office and independent cost estimates, OAM identified risks as well as opportunities for cost savings. As an example, OAM found that mission assurance requirements and associated contract costs for spacecraft and instruments have grown with each successive contract (from NPP through JPSS-2). OAM recommended that further consideration be given to balancing these requirements with affordability.

It also noted that program support costs were about $2 billion, or 28 percent of remaining expenditures (FYs 2013–2025). OAM found this to be in excess of other comparable NASA and Department of Defense space acquisitions. In November 2013, updated analysis presented to NOAA's Program Management Council found the differences to be less dramatic, after normalizing data for more direct comparisons. These costs are driven by acquisition processes, the program scope, and oversight and mission assurance requirements.

Other cost considerations included the JPSS-2 spacecraft acquisition strategy, uncertainty regarding the cost of JPSS-2's launch vehicle, ground system estimates that did not account for costs of transferring development responsibility to NOAA (planned to occur 1 year after JPSS-1 is launched), and management reserves not tied to discrete program risks. The program incorporated these considerations as it reconciled the independent cost estimate with the program office estimate and is working to further examine cost saving efficiencies. OAM will maintain the independent cost estimate to support annual updates and measures of program performance against its baselines.

In our view, OAM (and its distributed independent cost estimating team) has significantly improved the validation of JPSS cost estimates and has raised important considerations

[12] The program's estimate for FYs 2013–2025 was $7.1 billion. Current total cost to completion (FYs 2014–2025) is $6.2 billion.

regarding the affordability of JPSS capabilities. As such, the Department and NOAA would benefit from OAM expertise in evaluating budgets for additional satellite missions.

C. NOAA will evaluate options for additional missions in order to provide a longer-term, more robust constellation of polar satellites, and the JPSS program will need to revise its formulation

On August 1, 2013—after the required oversight boards examined the adequacy of the JPSS program's formulation—the Acting Deputy Secretary, who served as the milestone decision authority, formally approved the program's cost and schedule baseline commitments (shown in tables 2 and 3, below) and authorized the program to proceed with implementation. JPSS has now established its cost, schedule, and performance baselines. However, the program will need to return to the formulation phase and revise its baselines if NOAA chooses—as seems likely—to add missions after NOAA's independent review team found that NOAA's current approach is not sufficiently robust.

Table 2. JPSS Schedule Baseline Commitment

Satellite	Launch Date	NASA Handover to NOAA
JPSS-1	No later than 2nd quarter of FY 2017	Launch + 90 days
JPSS-2	1st quarter of FY 2022	Launch + 90 days

Source: Acting Deputy Secretary Decision Memorandum, August 1, 2013

Table 3. JPSS Cost Baseline Commitment (in $ millions)

Prior	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FYs 2020–2025	Total
5,109.7	824.0	859.4	837.1	800.4	713.9	569.9	1,634.6	11,349

Source: Acting Deputy Secretary Decision Memorandum, August 1, 2013

In November 2013, NOAA's independent review team updated its assessment of NOAA's satellite enterprise and found that the JPSS program's scope as a two-satellite program (beyond the NASA-built Suomi NPP), with launches scheduled approximately 5 years apart, is not sufficiently robust for the nation's weather data needs and compares unfavorably with earlier constellations of polar satellites. The review team's report noted that NOAA's POES[13] satellites, for example, were acquired in block purchases with a new satellite developed, on average, every 1.8 years.[14] Likewise, Department of Defense weather satellites were produced every 1.5 years. Purchasing nearly identical satellites in short succession resulted in cost savings (contractors could more efficiently

[13] NOAA's current operational satellites were developed under the Polar-orbiting Operational Environmental Satellites (POES) program. The last POES satellite was launched February 6, 2009, and designated as NOAA-19.

[14] Our examination of the POES program from 1978 onward found that satellites were launched every 2 years, including both midmorning and afternoon orbit satellites.

produce multiple copies) and more robust development with spare parts available for sharing among instruments and spacecraft at different stages of development. Further, these heritage satellite programs—with multiple, overlapping missions—guarded against unexpected early failures at launch or on-orbit. In such cases, another satellite was ready to launch on relatively short notice. As currently planned, a JPSS satellite failure at launch or before the end of its mission life could result in years without weather data from the afternoon polar orbit (see III.A, below, for discussion of potential data gaps). The independent review team also assessed NOAA's plan to make JPSS-3 and JPSS-4 acquisitions a separate, follow-on program to be inefficient, costly, and insufficiently robust.

To remedy these shortcomings, the review team suggested a change in NOAA's strategic approach so that two failures of polar satellites must occur before a gap in data would emerge. It specifically recommended that NOAA immediately contract at least three units each of ATMS and CrIS instruments from the current suppliers. It also recommended that NOAA initiate a "gap filler" mission, which would consist of a small satellite hosting ATMS and CrIS that could be launched within 3–4 years to ensure the availability of critical weather data before a potential gap in 2017. The additional instruments would be used for JPSS-2 (now in an early stage of development), as well as JPSS-3 and JPSS-4 missions, which the review team argued should be initiated now.

The review team's recommendations are more expansive than one we made in September 2012: that NOAA soon determine its acquisition strategy for JPSS-3 and JPSS-4,[15] in order to give the program adequate time to plan and execute those acquisitions and avoid future gaps in data from the afternoon orbit. JPSS program officials had echoed the need for such decisions and NOAA agreed with our recommendation. Whether for budgetary or other reasons, however, the JPSS program was only able to move forward, in 2013, with the acquisition of JPSS-2.

We view the review team's suggested strategic approach requiring a two-satellite failure before a data gap would be realized to be consistent with NOAA's policy for its other critical environmental satellites in geostationary orbit. NOAA's policy for geostationary satellites calls for an on-orbit backup satellite, which is kept in storage mode, ready to be activated in the event one of its two operational satellites experiences a failure. This policy of fault tolerance has proven useful in recent times as GOES-13 (or GOES-East) anomalies have required the activation of the backup satellite, GOES-14.[16]

NOAA told us its plans in response to the independent review team recommendations will be revealed in appropriations law and budget submissions. In the Consolidated Appropriations Act, 2014, Congress provided NOAA the flexibility to use FY 2014 and prior funds to procure additional spare instruments and spacecraft as needed to ensure

[15] See DOC OIG, OIG-12-038-A, 7, "*Acquisition strategy beyond JPSS-2*," and recommendation 2.

[16] See, for example, Commerce OIG, April 2013. *Audit of Geostationary Operational Environmental Satellite-R Series: Comprehensive Mitigation Approaches, Strong Systems Engineering, and Cost Controls Are Needed to Reduce Risks of Coverage Gaps*, OIG-13-024-A, 1.

continuity of polar satellite observations.[17] In its FY 2015 budget submission, NOAA requested $916.3 million for JPSS, which is $56.9 million more than its established baseline for that fiscal year (see table 3, above). However, the JPSS life-cycle cost remains at $11.3 billion through 2025. NOAA plans to use the funds, in part, to initiate acquisition of additional instruments intended for JPSS-3 and JPSS-4 follow-on missions, as well as spare instruments. On March 28, 2014, the JPSS program conducted a gap filler mission concept review to further study a satellite, hosting ATMS and CrIS only, which could be launched no earlier than the fall of 2019. This mission, if ultimately approved, would be part of a follow-on to the currently defined program. The full extent of NOAA's plans may not be explained until the FY 2016 budget request. We intend to continue monitoring NOAA's efforts in these areas.

The ultimate success of NOAA in acquiring critical polar satellite data is dependent upon the support of stakeholders in the Administration and Congress. Another of our prior JPSS-related recommendations concerned providing executive and legislative decision makers with complete, objective, and understandable data that illustrate the consequences of limiting satellite observational capabilities.[18] To gain stakeholder support, NOAA must provide the outcome of its analysis and full response to the independent review team recommendations, articulated in a formal decision memorandum or acquisition strategy.

Recommendations

We recommend that the NOAA Administrator

1. Establish reporting metrics to ensure adequate coordination among JPSS, SIDAR, and NASA climate instrument programs for review at monthly Program Management Council meetings.

2. Ensure that JPSS-2 operations and sustainment costs beyond FY 2025 are delineated in stakeholder briefing materials about plans for additional missions.

3. Leverage OAM-led cost analysis expertise to explore cost savings opportunities in acquisitions beyond JPSS-2.

4. Ensure that stakeholders are provided formal documentation of NOAA's response to independent review team recommendations and its corresponding acquisition strategy.

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[17] This language can be found in the explanatory statement incorporated by reference into the Consolidated Appropriations Act, 2014. *See*: 160 Cong. Rec. H510 (daily ed. Jan. 15, 2014) (statement of Rep. Rogers).

[18] See recommendation 7 in DOC OIG, September 2011. *Audit of the Joint Polar Satellite System: Challenges Must be Met to Minimize Gaps in Polar Environmental Satellite Data*, OIG-11-034-A, Washington, DC: DOC OIG, 14.

II. NOAA Leadership Deemed JPSS-1 Ready for the Next Phase of Development—but Technical, Schedule, and Programmatic Challenges Await

JPSS-1 satellite development is now undergoing key integration and test activities. The flight project took steps to reduce risks due to a lack of spare parts for key JPSS-1 instruments and its launch vehicle. Scheduling of ground system development was complicated due to issues with construction at the primary and backup facilities. In July 2013, subsequent to the JPSS-1 mission's preliminary design review, the NOAA Administrator approved the project milestone Key Decision Point-C and the project's continuation into the implementation phase. The program's standing review board, however, had concerns with the mission's integrated master schedule—which it planned to further assess once subsystem schedules were completed and fully integrated with the mission schedule.

A. The JPSS-1 flight project currently has adequate schedule margins, but integration and test activities could diminish schedule margins and funding reserves

As of February 2014, the flight project's schedule had a robust 6.5 months of reserve,[19] which was 1.5 months more than what NASA standards required. All of the instruments that will fly on JPSS-1 had been built and some had begun to undergo environmental testing, which involves simulating conditions encountered during launch or flying in space such as vibration, electro-magnetic radiation, and temperature extremes in a thermal vacuum chamber. Such testing (including a subsequent round of environmental testing once the instruments are integrated with the spacecraft) provides mission assurance by rooting out problems that cannot be resolved once the satellite is on-orbit. Spacecraft development, which is currently the primary critical path[20] for the JPSS-1 launch schedule, is on track. However, challenges that the flight project faces include (1) a need for critical spare parts for instrument development, (2) instrument development schedule reserve reduction, and (3) a lack of launch vehicle spare parts.

1. The flight project addressed a need for critical spare parts, which had challenged JPSS-1 instrument development. Development of VIIRS, CrIS, and OMPS, which began under NPOESS, had been at risk because of insufficient critical spare parts, some of which were used to complete the Suomi NPP models of these instruments.

To mitigate the risks, managers told us the flight project identified and ranked critical parts based on a risk assessment. It accelerated parts purchases and was also able to obtain VIIRS parts, in December 2012, that were owned but no longer needed by the Air Force after it cancelled the Defense Weather Satellite System in January of that year. High priority critical spares for all instruments have now been procured, according to

[19] *Schedule reserve* is a separately planned quantity of time above the planned duration estimate reflected in the integrated master schedule. Intended to reduce the impact of missing schedule objectives, schedule reserve is a recommended practice used for future situations that are impossible to predict based on risks and uncertainty.

[20] *Critical path* describes the sequence of tasks in a schedule that represent the longest overall duration from "time now" through project completion. Any slippage of tasks in the critical path will increase the project duration.

project managers, but other spare parts are lacking. With the instruments assembled and functional testing completed, there is less likelihood of damage to critical components. As a result, the JPSS-1 mission has reduced its exposure to this risk. If a problem occurs, a lack of spare parts would delay delivery of an instrument for satellite integration by the time it takes to procure, manufacture, test, and integrate the unavailable parts.

The flight project indicated that acquisition of JPSS-1 spares had occurred mostly at the piece part level, but in some cases component-level parts—detector assemblies, single board computers, and electronic boards—were procured. The project told us that for JPSS-2 instruments, it is procuring spare parts at higher levels of assembly. Unless more copies of instruments (for additional missions) are procured, however, there will continue to be risk associated with lack of spares.

VIIRS is the most technically challenging instrument to fly on JPSS-1. The instrument is undergoing environmental testing and is scheduled to be integrated on the JPSS-1 satellite in April 2015, after which further environmental testing will occur. Spare parts are crucial to resolving anomalies discovered during testing, particularly since VIIRS development is one of the critical paths for the JPSS-1 mission. As of February 2014, VIIRS had 4 months of schedule margin (down from the 6-months margin it held in September), meaning delays greater than 4 months would likely delay the JPSS-1 launch readiness date. Unlike other JPSS-1 instrument developments, the program included an option for a second VIIRS, for JPSS-2, in the contract with Raytheon Space and Airborne Systems. And the development of the JPSS-2 VIIRS flight model has given the flight project some needed flexibility. In one case, the JPSS-2 flight model's Day/Night band timing card was used as a replacement part on the JPSS-1 VIIRS to resolve a digital noise problem encountered during ambient testing. Unfortunately, other JPSS-1 instrument developments do not have this flexibility.

2. The Cross-track Infrared Sounder (CrIS) schedule reserve has been reduced. CrIS development illustrated the type of schedule slip that can occur during integration and testing. Due to anomalies discovered during subsystem integration and testing, CrIS development lost 4 months of schedule reserve between March 2013 and June 2013. In July 2013, a test anomaly led to the discovery of a vacuum leak in the detector cooler module, a CrIS sub-component. In March 2014, the flight project reported that the anomaly, now corrected, had cost $500 thousand and delayed CrIS development by 6 months. On March 21, 2014, an issue with the thermal vacuum test chamber delayed completion of testing and the instrument delivery date by 1 month. The flight project schedule reserve remained within NASA guidelines, in part because it was able to change the order of instruments' integration with the spacecraft.

3. JPSS-1 launch vehicle risk involves potential lack of spare parts. JPSS-1 will be placed into polar orbit by a Delta II rocket, one of only five remaining launch vehicles of this type, which was used to very successfully launch the Suomi NPP satellite. Until recently, JPSS-1's launch vehicle was slated to be near the last of the remaining Delta II rockets to launch. As such, the program identified the launch vehicle and services as a concern due to limited spare parts (which could be further limited as the remaining rockets are launched ahead of JPSS-1). The launch services contractor identified parts that it considered irreplaceable or critical hardware—whose availability, loss, or damage cannot be remedied without serious impact to program cost, schedule, or technical performance—and instituted a quality assurance program over its process controls. In November 2013, as a result of another mission's delay, the program indicated that the JPSS-1 launch vehicle will move ahead to third place in its Delta II production queue, somewhat reducing this risk.

B. Delayed work on facilities complicated the scheduling of ground system upgrades, which added risk to JPSS-1 development and resulted in prolonged operational use of inadequate security controls

The current JPSS ground system—which supports Suomi NPP and was originally designed and partially built under NPOESS—has only a limited backup unit in Aurora, Colorado;[21] includes outdated hardware and software; and lacks required security controls. In order to correct these shortcomings, the program must upgrade the system to support Suomi NPP and the launch of JPSS-1. The management and operations node of the JPSS ground system is housed at the NOAA satellite operations facility (NSOF) in Suitland, Maryland. An alternate processing site (i.e., a full backup unit) is planned for space in a facility located in Fairmont, West Virginia. Before the ground system could be upgraded, power and cooling enhancements were needed at NSOF and space at the planned backup facility had to be leased and furnished with necessary infrastructure and equipment.

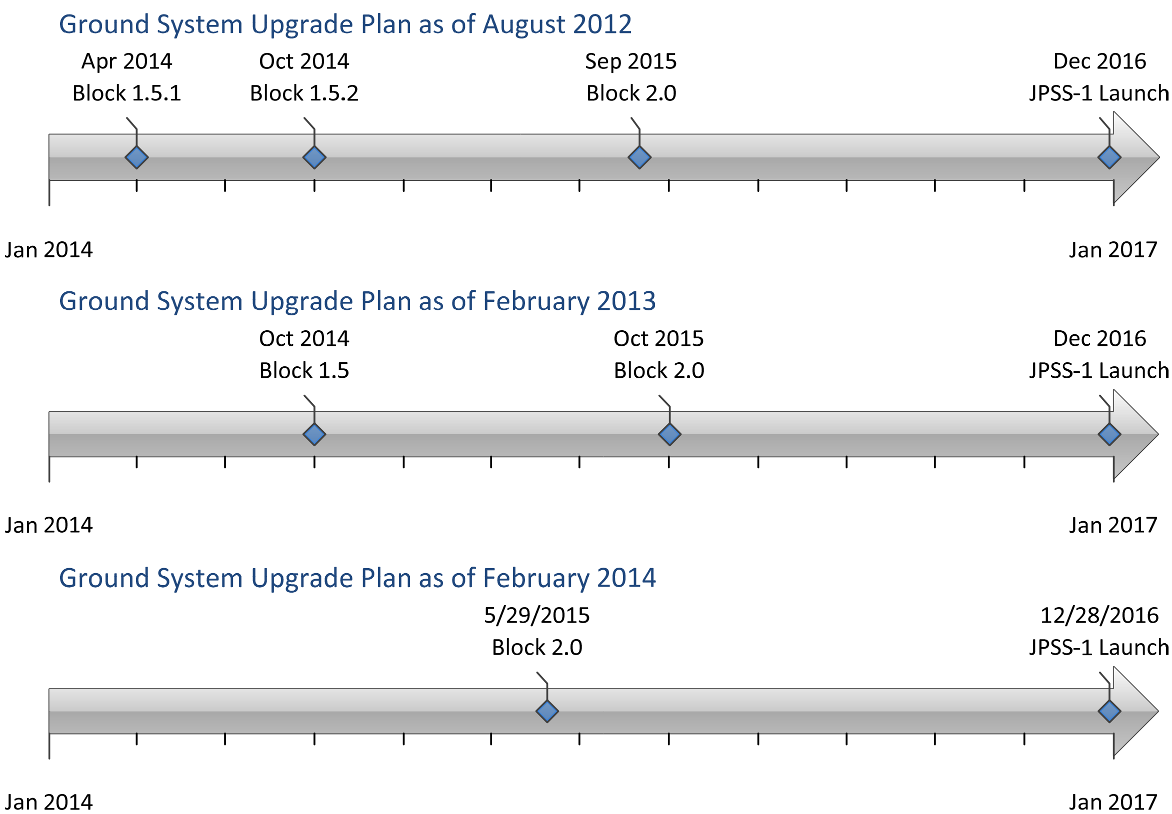
The ground system upgrades were planned to occur in blocks of hardware changes and software releases, with a block to first rectify security weaknesses and make the system more operationally robust for Suomi NPP. A subsequent block would support launch and operation of JPSS-1. In October 2012, a protest of the NSOF renovation contract award caused an automatic 100-day delay of that work. In response, the ground project looked to first install necessary equipment at the backup facility and revised its schedule accordingly.

In early 2013, however, ground project personnel determined that the backup facility construction in Fairmont was not going to be completed in time for its revised plan. This led the program to delay completion of the JPSS-1 mission preliminary design review (it was divided into two parts, 4 months apart) in order to revamp its ground system upgrade plan.

[21] After the satellite was launched, the program built a "stop-gap" backup unit with ability to command Suomi NPP and perform other mission critical functions needed to maintain the satellite in the event the primary command and control node, at NSOF becomes unavailable. The stop gap backup lacks data processing, accounting, and situational awareness capabilities of a full backup. It was built, in part, in response to a recommendation we made in our September 2011 report *Audit of the Joint Polar Satellite System: Challenges Must Be Met to Minimize Gaps in Polar Environmental Satellite Data* (OIG-11-034-A).

The ground project ultimately chose to combine the two blocks into a single major upgrade (see figure 2) and will instead implement some security fixes to the existing infrastructure as part of an extension of the current implementation block. This measure reduces the number of technical reviews the program must conduct with the ground system contractor, thus saving costs. And if it stays on schedule, the program will have a longer period of time to test the ground system and its compatibility with the satellite prior to JPSS-1 launch. In the interim period before the upgrade, however, the program is at greater risk of disruptions to the availability of Suomi NPP data due to the delay in providing a more secure and reliable system for operational use.

Figure 2. Revisions to Schedule of Ground System Upgrades



Source: OIG, from JPSS ground project schedules
Figure shows approximate dates for completion of site acceptance testing, after which the system will be used for JPSS-1 compatibility tests. Operational readiness of the ground system (for use for Suomi NPP and the actual launch of JPSS-1) will be later than shown here. Block 1.5 (initially consisting of two parts, 1.5.1 and 1.5.2) was intended to operationalize the system for Suomi NPP and remedy security weaknesses. Block 2.0 was initially intended to further enhance the system in support of JPSS-1 launch but will now include improvements from Block 1.5. Not shown is an incremental upgrade (Block 1.2.4) to the existing operational ground system, which will provide security-related software patches and other fixes for Suomi NPP operations but will not support JPSS-1.

Management was unable to identify a root cause for the schedule discrepancy between the ground project plans and the backup facility work. One official compared the relatively short amount of time identifying and planning JPSS backup needs with that of the GOES-R program, which had been planning backup facility use for more than 5 years.

Even with senior NOAA management's involvement, the backup unit schedule issue persisted into June 2013, during the second part of the preliminary design review. At that juncture, the program identified three options to work around the schedule conflict. In late October 2013, however, it chose a fourth: to operate the backup unit remotely for scheduled compatibility tests with the JPSS-1 satellite, resolving the schedule conflict, which had persisted for a year.

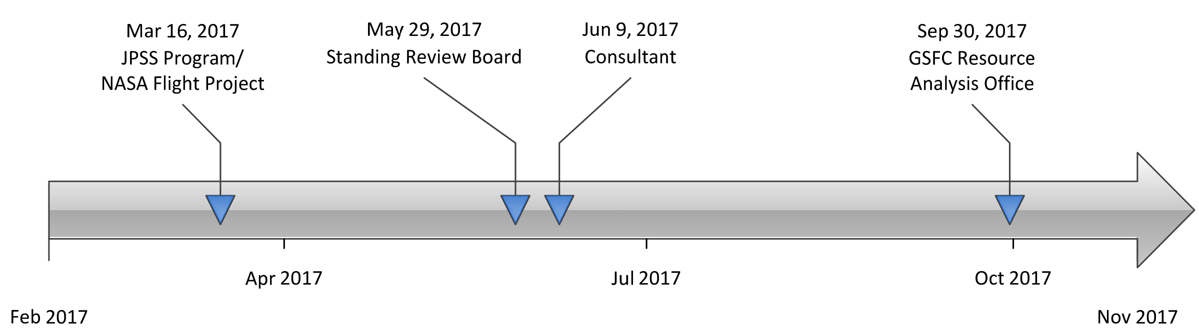
C. Despite uncertainties in the JPSS-1 mission master schedule, the standing review board recommended approval of Key Decision Point-C

At the completion of the JPSS-1 mission preliminary design review in June 2013, the standing review board identified two issues that the program must overcome. First, completion of the backup facility construction was expected approximately 6 months later than what the program needed for its mission schedule. While the program had identified mitigation options to overcome this schedule conflict, it had not determined cost and schedules for the options.

Second, the program's integrated master schedule lacked information from the ground project. A major contract change order for the ground system upgrades was not finalized, and a detailed schedule for the upgrades would not be completed until January 2014. In addition, the schedules for NOAA enterprise systems that further process and distribute JPSS data were not complete and therefore not integrated with the JPSS master schedule. Lacking this information, the board indicated that overall program risk could not be determined. It planned to review the completed schedules as they became available in 2014.

Based on the limited schedule data available for the preliminary design review, however, confidence in the JPSS-1 launch date varied among different entities that independently performed schedule risk analyses (see figure 3, below).

Figure 3. JPSS-1 Launch Dates at 70 Percent Confidence Level



Source: OIG adaptation of JPSS program information presented for Key Decision Point-C

The program had 70 percent confidence that it would be able to launch JPSS-1 by its commitment of no later than the second quarter of FY 2017. The standing review board and a separate consultant each found that a later launch date—in the third quarter of FY 2017—was at the 70 percent confidence level. Yet another NASA assessment—by the Goddard Space Flight Center's Resource Analysis Office—found that 70 percent confidence in a launch date was not achieved until the end (September 30) of FY 2017. The differences were attributed to the various entities assigning higher levels of uncertainty to discrete risks for the spacecraft, instruments, and launch vehicle.

The standing review board also highlighted strengths in the program. Most notably, (a) the JPSS-1 instruments and spacecraft were at a high level of technical maturity for this stage of development; (b) the ground system—while complex and in need of technical upgrades—was a functioning system; and (c) the program was staffed with very capable government employees—in particular, those in program and systems engineering leadership positions. Despite the uncertainty in the JPSS-1 schedule, the review board recommended that NOAA leadership approve Key Decision Point-C, allowing the program to move forward with the next phase of development.

In July 2013, the (acting) Under Secretary for Oceans and Atmosphere and NOAA Administrator approved the JPSS-1 project's (the combined flight and ground project elements constituting the JPSS-1 mission) Key Decision Point-C, transitioning the project to the implementation phase known as final design and fabrication. The decision also commits the project to cost and schedule baselines: a total flight element cost of $1.6 billion (through FY 2022) and a launch date no later than the second quarter of FY 2017.

NOAA's facility issues and the October 2013 federal government shutdown delayed the next series of design reviews—intended to demonstrate that the maturity of system design is appropriate for proceeding with assembly, integration, and test—for the ground project and JPSS-1 mission by approximately 6 and 3 months, respectively. To formally resolve the standing review board's concerns, the program presented a completed integrated master schedule at the JPSS-1 mission's critical design review in April 2014.[22] The mission's launch readiness date had not changed.

Recommendation

We recommend that the NOAA Assistant Administrator for Satellite and Information Services

5. Ensure that stakeholders (including Congress) are provided updated information on the results and confidence level of the JPSS-1 mission's integrated master schedule.

[22] Subsequent to our draft report, a May 16, 2014, program note indicated that the standing review board and NASA's Independent Program Assessment Office "concluded that the JPSS-1 project's cost and schedule analysis results at the mission critical design review were reasonable." We have not reviewed these analyses.

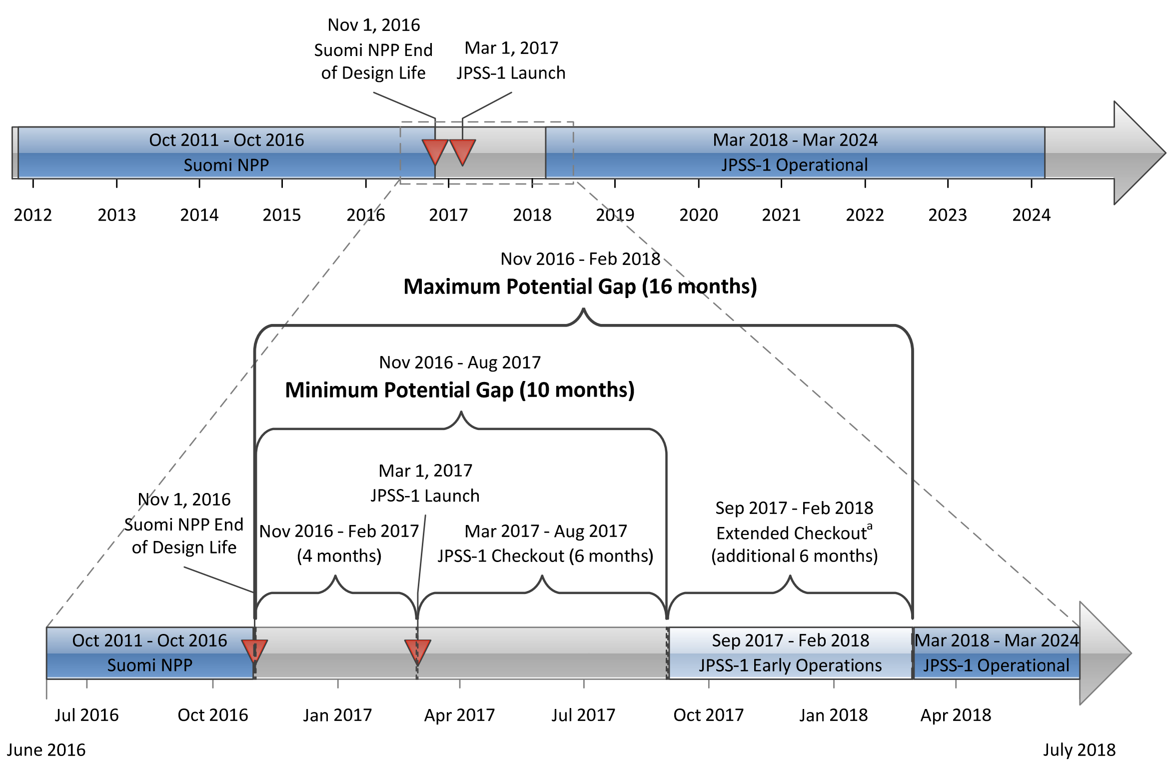
III. NOAA Has Begun Gap Mitigation Activities but Should Do More to Help Stakeholders Understand the Consequences of a Gap

Beginning with our first audit report on JPSS, in September 2011, we have published assessments of the length of potential gaps in polar satellite data from the afternoon orbit. Our current assessment remains consistent with our 2012 projection of a potential 10- to 16-month gap in continuity between Suomi NPP's end of design life and the availability of JPSS-1 operational weather data. NOAA's efforts to mitigate forecast degradation resulting from the potential data gap were funded in an FY 2013 supplemental appropriation. Stakeholders, and thus the JPSS program, would benefit were NOAA better able to communicate the consequences of an afternoon orbit weather data gap—in terms of the extent of expected forecast degradation and, further, the resulting economic costs.

A. The avoidance of gaps will depend upon whether on-orbit satellites continue to operate and the constellation's ability to tolerate unexpected failures

Using informed assumptions of Suomi NPP's operational life, a probable launch date for JPSS-1, and the range of time it will take to calibrate JPSS-1 key instruments (ATMS, CrIS, and VIIRS) and their data or imagery, we find potential for a gap in the continuity of data or imagery lasting 10–16 months as detailed in figure 4 (below).

Figure 4. Potential Gap in Data Continuity Between Suomi NPP and JPSS-1

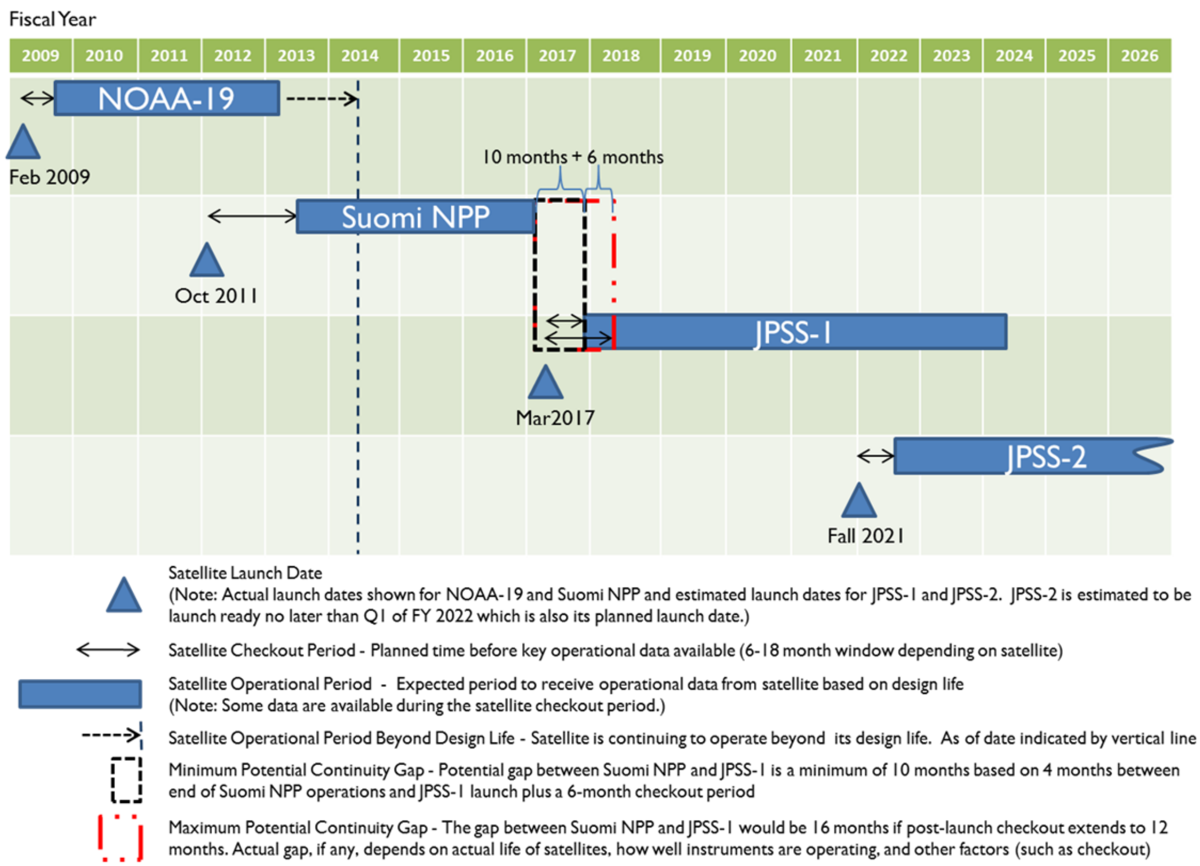


Source: OIG analysis of NOAA data

[a] Various potential problems could extend the amount of time needed to complete calibration and validation.

Our assessment considers the risk of a data continuity gap arising from the aging of Suomi NPP and the scheduled operation of JPSS-1, but we also note the overall fragility of NOAA's polar satellite constellation. NOAA may need to rely, over extended periods of time, on a single polar satellite; a catastrophic launch or early failure of a spacecraft or instruments could significantly increase the duration of time without data from the afternoon orbit. These types of failures were of particular concern for NOAA's independent review team, leading to its recommendations to make the polar constellation more fault-tolerant. Figure 5 (below) depicts the minimal overlap in planned missions, which could leave NOAA at risk from a single satellite failure.

Figure 5. NOAA Afternoon-orbit Polar Satellite Constellation with Potential Continuity Gap



Source: OIG analysis of NOAA data

In FY 2013, the JPSS program analyzed the expected reliability of Suomi NPP based on its on-orbit experience to date and applied various statistical methodologies that led it to conclude that the potential gap had lessened to 3 months or less. In addition, it analyzed legacy afternoon orbit polar satellites that still provide sounder data and imagery (e.g., NOAA's POES and NASA's Aqua satellite still on orbit) that could partially mitigate the loss of JPSS (including Suomi NPP) data or imagery. According to NOAA, these legacy satellites produce lower quality microwave sounder data and imagery than what JPSS instruments provide. And NASA's Aqua satellite, launched in

2002, produces roughly the same quality infrared sounder data as CrIS. The program's updated analysis concludes that, as these legacy satellites age into the late 2010s, they will no longer be able to (partially) mitigate the loss of JPSS data. This suggested that an acceleration of the JPSS-2 satellite's launch would mitigate risk of a premature failure of JPSS-1.

To reduce the likelihood of a gap in the near term, the JPSS program assessed the feasibility of launching JPSS-1 earlier. In a November 2012 report, however, the program concluded that neither the flight or ground projects could accelerate activities to support an earlier launch date. NOAA and the program maintain that attempts to do so would result in increased technical, cost, and schedule risk—and inhibit both projects' ability to respond to development, satellite integration, test, and launch preparation issues. Further, as discussed in section I.C. of this report, NOAA is considering additional missions in response to independent review team recommendations to make its polar satellite constellation able to withstand early or catastrophic failures of a single satellite that would lead to gaps in data.

In October 2012, NOAA commissioned a study to identify and analyze alternatives for mitigating the effects of a loss of data from the afternoon polar orbit. The study report,[23] released in February 2013, made 17 recommendations such as making greater use of currently available data (e.g., from GPS satellites, aircraft, and other observations), data from future sources (e.g., next-generation geostationary satellites currently under development), and improving data assimilation for numerical weather prediction models. In the Disaster Relief Appropriations Act of 2013,[24] NOAA received $105 million (after sequestration) for a weather satellite data mitigation gap reserve fund.[25] NOAA used this fund to begin implementing 12 of the study's recommendations.

B. NOAA has not fully identified the consequences of a data gap

NOAA's gap mitigation plan documents its strategy for preparing for and responding to a potential data gap between Suomi NPP and JPSS-1. More specifically, the data gap it addresses pertains to the potential loss of global microwave and infrared sounder data provided by ATMS and CrIS instruments, respectively, and imagery of the Alaskan region produced by VIIRS. Each is a key performance parameter for the JPSS program.

Polar satellite microwave and infrared sounder data are used to create temperature and moisture profiles of the atmosphere and have a significant positive impact on weather forecast model accuracy relative to other data types.[26] European satellites provide this

[23] Riverside Technology, Inc., February, 15, 2013. *JPSS Gap Mitigation Analysis of Alternatives*, Silver Spring, MD: Riverside Technology.

[24] P.L. 113-2, enacted January 29, 2013.

[25] NOAA received a total of $309.7 million (after sequestration) in the supplemental appropriation, which included the weather satellite data gap mitigation reserve fund, available until September 30, 2015.

[26] For example: we obtained a European Centre for Medium-Range Weather Forecasts (ECMWF) study of the statistical estimation of relative improvement made to operational numerical weather prediction by various

data from the midmorning orbit and NOAA satellites provide this data from the early afternoon. VIIRS imagery allows NOAA to monitor and track weather over Alaska and surrounding oceans, where the availability of other weather data is limited.

While the mitigation plan offers evidence of the importance of polar satellite data in general, it does not provide a clear explanation of the impact the loss of data *from the afternoon orbit* would have on weather forecasting. Along with the independent review teams' November 2013 report, NOAA officials provided a memo indicating that the loss of afternoon orbit data would create a 25 percent chance that forecasts would miss extreme weather events. We believe, however, that NOAA could do more to explain the consequences of a gap—or, conversely, to explain the quantifiable benefits of afternoon orbit data. These explanations may be presented in economic terms; NOAA has economic data for severe weather events as illustrated in figure 6, below.

Figure 6. U.S. Billion-Dollar Weather and Climate Disasters in 2013

Source: www.ncdc.noaa.gov/billions/

In December 2012, NOAA publicized[27] a study that found that the forecast track for Hurricane Sandy would have been significantly less accurate if *all* polar satellite data had been excluded from forecast models.[28] This same study, however, also found that there would have been no significant change in the 5-day forecast for Sandy when numerical

observing systems, using a technique called adjoint model sensitivity. Microwave and infrared sounders were the instruments that contributed most to reducing forecast errors.

[27] http://www.noaanews.noaa.gov/stories2012/20121211_poesandsandy.html

[28] ECMWF, March 2013. *The Role of Satellite Data in Forecasting Hurricane Sandy.* Shinfield Park, Reading, Berkshire RG2 9AX, England: ECMWF.

weather prediction models were denied polar satellite sounder data but provided scatterometer and global positioning system radio occultation data from other satellites. The study did not examine the impact the loss of just afternoon orbit polar satellite sounder data would have had on the Sandy forecast.

NOAA's National Centers for Environmental Prediction (NCEP), however, has previously completed seven data denial case studies of this type. In our 2011 audit report, we discussed data denial studies NOAA had conducted that year, which compared historical forecasts of five significant weather events with simulated forecasts that had been denied data from the afternoon polar orbit. Two of the studies concluded that, without the afternoon orbit polar satellite data, the significant event forecasts at 5, 4, and 3 days were significantly degraded. Subsequently, NOAA completed two additional data denial case studies examining the effect of the loss of afternoon orbit data on the forecasts of two hurricanes (which occurred in August 2011); in one case, the hurricane track forecast was slightly degraded while the other was largely unchanged.

NCEP officials told us that the studies, collectively, underscored the importance of polar satellite data—but that the results could not be used to identify specific weather events or types of events for which forecasts would be most at risk without afternoon orbit data. According to NCEP, different data types contribute more or less to forecast accuracy depending upon the characteristics and timing of a given event. We recommended that NOAA provide stakeholders with better information about the consequences of limited polar satellite observational capabilities.[29]

NOAA's *JPSS Gap Mitigation Analysis of Alternatives* (discussed in this report's section III.A, above) recommended that NOAA conduct an experiment that "replicates the precise conditions expected as part of the potential data gap"—meaning no data from afternoon orbit polar satellites—"and designed in a way that yields better definition regarding which numerical weather prediction parameters will be affected and to what levels." NCEP completed this observing system experiment, spanning a period of 7.5 months, in 2013. The results, however, were not available at the conclusion of our fieldwork.

The lack of a clear, specific explanation of how a gap would affect weather forecasts was a complaint of members of NOAA's independent review team during its discussions with NOAA's satellite programs in August 2013. In response, NOAA issued a statement from the Deputy Under Secretary and the Director, National Weather Service. They concluded, based upon "multiple satellite data denial studies . . . conducted both nationally and internationally," that "a lack of JPSS quality p.m. polar orbiter data would erode everyday weather forecasts and expose the nation to a 25 percent chance of missing extreme event forecasts that matter most."[30] National Weather Service staff told us, however, that the statement was based on the seven data denial case studies

[29] DOC OIG, OIG-11-034-A, 14, recommendation 7.

[30] NOAA NESDIS Independent Review Team, *Assessment Update*, Washington, DC: NOAA NESDIS IRT, 42.

NCEP conducted in 2011 (two of which, or 28 percent of the studies, showed significant forecast degradation). The statement seemingly helped convince the review team that a gap in weather data from the afternoon polar orbit could "have catastrophic national consequences."[31]

NOAA, however, has not yet provided an impact analysis of the loss of just the afternoon orbit data in terms of degraded forecast hours or economic costs. Nor has it quantified the economic benefits of afternoon orbit data. By providing such information, which could better justify investments in environmental satellite capabilities, NOAA would benefit stakeholders' decision-making. Therefore, along with the studies recently completed, NOAA should do more to communicate, in quantifiable terms, the importance of its polar satellite data.[32]

Recommendation

We recommend that the NOAA Deputy Under Secretary for Operations

6. Direct appropriate NOAA entities to explain the effects of a potential afternoon orbit data gap in terms of degraded forecast hours and extrapolated economic costs, or conversely, the contribution to forecast accuracy and the economic benefits of afternoon orbit data.

[31] NOAA NESDIS Independent Review Team, *Assessment Update*, 15.

[32] Relatedly, NOAA's *Analysis of Alternatives* (discussed in part B.) contractor recommended that NOAA establish a dedicated work center with resources to conduct observing system and other experiments to provide quantitative guidance in support of decision-making.

Summary of Agency Response and OIG Comments

In response to our draft report, NOAA concurred with all of our recommendations and reported on some of the activities it has or will take to implement the recommendations. NOAA also included technical comments to the draft report, from which we made changes to the final report where appropriate. We have included NOAA's formal response as appendix E.

Appendix A: Objectives, Scope, and Methodology

This audit was initiated in December 2012 as part of our FY 2013 work plan and in conjunction with our *Top Management Challenges facing the Department of Commerce* (in FY 2013). Our objectives were to

1. monitor NOAA's progress toward establishing JPSS cost, schedule, and performance baselines,

2. assess ongoing development activities, and

3. review efforts to mitigate a projected data gap between Suomi NPP and JPSS-1.

To accomplish our objectives, we interviewed NOAA and NASA program and project managers, as well as National Environmental Satellite, Data, and Information Service (NESDIS) facility managers, regarding progress, issues, and risks in development activities for the JPSS-1 mission and activities supporting the establishment of program baselines. We also interviewed officials and staff with the Department's Office of Acquisition Management, NESDIS, National Weather Service, and the Joint Center for Satellite Data Assimilation. We reviewed extensive program and budget-related documentation. And we attended multiple JPSS program management, life-cycle, and technical reviews, including

- monthly NOAA/NASA Program Management Councils (PMCs),
- monthly ground system contractor program management reviews,
- JPSS-1 delta spacecraft critical design review, December 10–13, 2012,
- JPSS-1 flight delta critical design review, February 13–14, 2013,
- JPSS-1 mission preliminary design review step 1, February 25–28, 2013,
- Ozone Mapping and Profiler Suite (OMPS) pre-environmental review, April 3–4, 2013,
- NOAA satellite conference, April 8–12, 2013,
- JPSS mission preliminary design review step 2, June 18, 2013,
- JPSS program system definition review, June 19–20, 2013,
- NOAA PMC JPSS Program Key Decision Point-I readiness review and JPSS-1 Mission Key Decision Point-C, July 17, 2013, and
- NESDIS presentations for Independent Review Team, August 21–23, 2013.

We reviewed internal controls significant within the context of our audit objectives: NOAA/NASA satellite acquisition program and project management policies and practices, the JPSS Management Control Plan, program schedules, and program reviews. The findings and recommendations in this report are inclusive of this review. In addition, we also reviewed the

Disaster Relief Appropriations Act Internal Control Augmentation Plan but did not test whether the plan had been followed. We detected no incidents of fraud, illegals acts, violations, or abuse within our audit. We did not rely on computer-processed data to perform this audit.

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. From these efforts, we believe the information we obtained is sufficiently reliable for this report.

We performed our work 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.

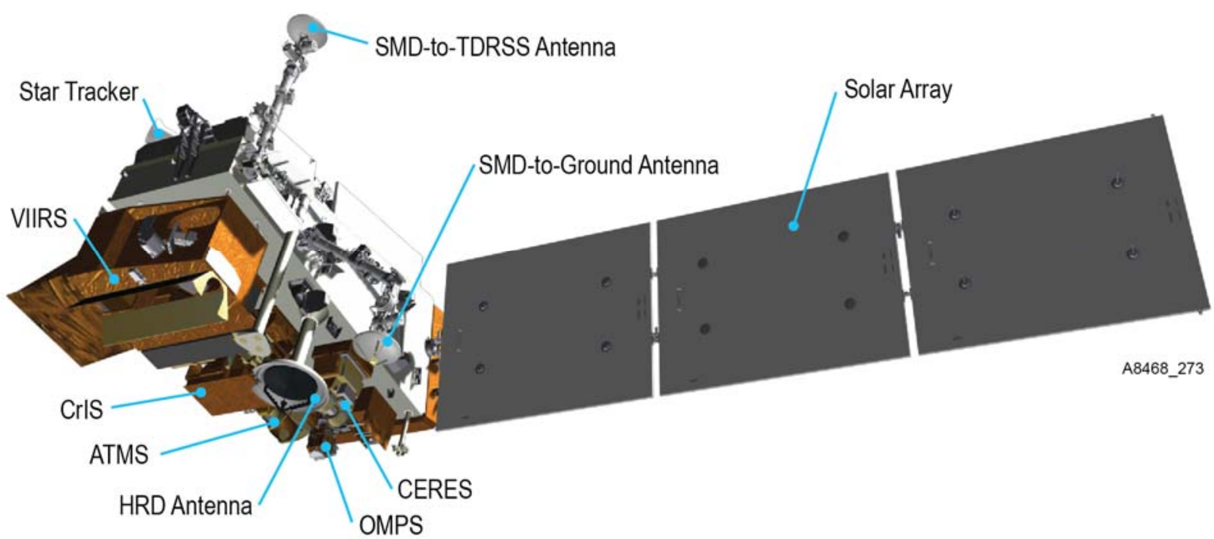
We conducted our review from December 2012 through March 2014 under the authority of the Inspector General Act of 1978, as amended, and Department Organizational Order 10-13. We performed field work at

- NOAA headquarters in Silver Spring, Maryland,
- JPSS program office in Lanham, Maryland,
- Raytheon's facility in Aurora, Colorado,
- Ball Aerospace & Technologies Corporation's facility in Boulder, Colorado, and
- NOAA Center for Weather and Climate Prediction in College Park, Maryland.

Appendix B: JPSS Background

Program origins and the risk of a gap: The Joint Polar Satellite System (JPSS) program was established in 2010 when the Administration chose to restructure the troubled NPOESS—a tri-agency partnership among the Department of Defense, NOAA, and NASA—into separate civil and defense programs. JPSS currently supports the operation of one satellite and is developing and launching two, next-generation polar-orbiting satellites (JPSS-1 and JPSS-2) with new, more capable instruments to replace NOAA's legacy polar satellites. Given delays that began with NPOESS and the aging of NOAA's existing satellites, there is potential for a gap in polar satellite environmental data, some of which have been the most significant contributors to the accuracy of medium-range (3–7 day) forecasts produced by numerical weather prediction models. A degradation of such forecasts could inhibit NOAA's ability to provide emergency managers with information needed to adequately prepare for extreme weather events and protect lives and property.

Figure B-1. JPSS-1 Satellite, Including Instruments and Other Key Components



Source: Ball Aerospace & Technologies Corporation

The afternoon (polar) orbit: NOAA's polar satellites travel in sun-synchronous orbit—crossing a given latitude at the same time of day as the earth rotates underneath—which allows the satellites to collect data over the entire globe. NPOESS was originally intended to provide next-generation satellites for three different polar orbits, identified by the time of day they cross the equator: early morning, midmorning, and early afternoon. In 2006, as a result of NPOESS cost and schedule delays, European satellites were given responsibility for the midmorning orbit. With the restructuring in 2010, the Department of Defense was made responsible for the early morning orbit, and NOAA—partnering with NASA—became responsible for the afternoon orbit, considered the most important for operational weather forecasting.

System capabilities: JPSS has four key performance parameters (system capabilities) that, if not met, "would compromise NOAA's weather mission to provide essential warnings and forecasts to protect lives and property, and would be cause for program reevaluation or cancellation,"[33] including

- Advanced Technology Microwave Sounder (ATMS) data,
- Cross-track Infrared Sounder (CrIS) data,
- Visible Infrared Imaging Radiometer Suite (VIIRS) imagery (in specified channels) for latitudes above 60 degrees North in the Alaskan region, and
- 96 minute data latency (the time period from satellite observation until the data or imagery are available to users at the distribution system) for ATMS, CrIS, and VIIRS key performance parameters

Table B-1. JPSS Instrument Descriptions

Instrument	Description
Advanced Technology Microwave Sounder (ATMS)	*Provides temperature and moisture sounding capabilities by hosting 22 microwave channels.* ATMS and CrIS together provide profiles of atmospheric temperature, moisture, and pressure. The combined ATMS/CrIS sensor suite is called the Cross-track Infrared and Microwave Sounder Suite (CrIMSS).
Cross-track Infrared Sounder (CrIS)	*Measures the three-dimensional structure of atmospheric temperatures, water vapor and trace gases.* CrIS provides over 1,000 infrared spectral channels at an improved horizontal spatial resolution.
Visible Infrared Imaging Radiometer Suite (VIIRS)	*Collects visible and infrared radiometric data of the Earth's atmosphere, ocean, and land surfaces.* Some of the data types include atmospheric parameters, clouds, Earth radiation budget, land/water and sea surface temperature, ocean color, and low light imagery.
Ozone Mapping and Profiler Suite (OMPS)	*Collects data to calculate the vertical and horizontal distribution of ozone in the Earth's atmosphere.* OMPS consists of separate nadir and limb sensors. Measurements from the nadir sensor are used to generate total column ozone measurements, while measurements from the limb sensor generate ozone profiles of the along-track limb scattered solar radiance.
Clouds and the Earth's Radiant Energy System (CERES) and Radiation Budget Instrument (RBI)	*Measures both solar-reflected and Earth-emitted radiation from the top of the atmosphere to the Earth's surface.* CERES is used to observe and understand the role of clouds and the energy cycle in global climate monitoring and prediction. JPSS-2 will host the next generation of this sensor, which will be called the Radiation Budget Instrument (RBI).

Source: JPSS program documentation

[33] National Environmental Satellite, Data, and Information Service, June 27, 2013. *JPSS Level 1 Requirements Document–Final*, version 1.7. Silver Spring, MD: NESDIS, 8.

ATMS and CrIS data together combine to provide what is currently the most important type of data for numerical weather prediction models. VIIRS imagery is used in monitoring and forecasting Alaska weather, where there is a lack of other quality environmental data. The other instruments to be hosted on JPSS satellites are the Ozone Mapping and Profiler Suite (which includes a nadir sensor, designated OMPS-N, and a limb sensor, designated OMPS-L[34]), the Clouds and Earth's Radiant Energy System (CERES), and, on the second JPSS satellite, CERES' follow-on, the Radiation Budget Instrument (RBI). Beyond weather forecasting and situational awareness, JPSS data is used to monitor environmental conditions such as droughts, forest fires, volcanic ash, and ozone levels for treaty compliance. JPSS observations will also be used to monitor other climate variables, continuing more than 30 years of such polar satellite data.

JPSS component projects: The NASA component of the JPSS program currently consists of two interrelated projects: flight (responsible for developing the primary JPSS satellites and supporting Suomi NPP), and ground (responsible for developing the ground system that commands and controls the primary satellites, processes their data, and collects and distributes data from partner organizations' satellites). NOAA is responsible for acquiring other ground system components that further process and distribute data to users. A third project, free flyer, was responsible for developing two smaller satellites that would fly climate, search and rescue, and in situ data collection instruments, but was transferred out of the JPSS program at the start of FY 2014. Flight is currently focused on JPSS-1 development and initial procurement activities for JPSS-2 while the ground project is planning upgrades to refresh, operationalize, and better secure the ground system for Suomi NPP and later, for JPSS satellites.

Suomi NPP bridge mission: An early priority for JPSS was to successfully launch a NASA research and risk reduction satellite, NPOESS Preparatory Project or NPP. This satellite was built by NASA, with some instruments and the ground system largely built under NPOESS. NPP was originally intended to demonstrate the next generation of instruments for NPOESS and continue measurements of NASA's Earth Observation System. The ground system for NPP was not built with the redundancy and high-availability requirements of an operational weather satellite system. In order to prevent a gap in polar satellite data, however, the NPOESS executive committee decided that NPP data should be used operationally. After nearly 2 years of final preparations with the JPSS program, NPP was launched on October 28, 2011, and subsequently renamed Suomi NPP (National Polar-Orbiting Partnership). It has performed well, providing data for operational weather forecast centers and effectively mitigating a potential near-term gap that NOAA was confronting at the time.

Program management and oversight: The JPSS program follows NASA's space flight program and project management requirements[35] and must meet the intent of the Department of Commerce's Scalable Acquisition Project Management Framework, which was instituted in November 2012 after a prolonged effort to improve the Department's management and

[34] OMPS-L is flying on Suomi NPP but is not planned for JPSS-1. JPSS-2 will host OMPS-L if NASA can deliver in time for satellite integration and test need dates.

[35] National Aeronautics and Space Administration, August 2012. *Space Flight Program and Project Management Requirements w/Changes 1-10,* NPR 7120.5E. Washington, DC: NASA.

oversight of acquisitions.[36] NASA revised its standards in August 2012 to emphasize program and project formulation activities. Notable benefits of formulation include the identification and mitigation of high technical, acquisition, cost, and schedule risks—which result in more realistic cost and schedule commitments as programs and projects are approved for implementation.

To help ensure the adequacy of JPSS program and project formulation and implementation, NOAA and NASA leadership are assisted by a standing review board which, with the program, conducts major life-cycle reviews to assess technical and programmatic status and health in advance of major decision points. Separately, NOAA has chartered an independent review team, which includes some members of the JPSS standing review board and aims to maximize the probability of success of NOAA's satellite portfolio through periodic reviews.

[36] See DOC OIG, November 2007. *Successful Oversight of GOES-R Requires Adherence to Accepted Satellite Acquisition Practices,* OSE-18291. Washington, DC: DOC OIG, as well as Inspector General letter to Honorable Darrell Issa on open and unimplemented recommendations, June 28, 2013.

Appendix C: JPSS Cost Estimate History

	2009 Initial Estimate (for FY 2011 President's Budget)	2011 Estimate (not used for President's Budget)	2012 Estimate (for FY 2013 President's Budget)	2013 Estimate (for FY 2014 President's Budget and Program Commitment)
Life-Cycle Cost (in billions)	$11.9	$14.7–16.1[a]	$12.9	$11.3
Life-Cycle End	2024	2028	2028	2025
Satellites	Suomi NPP,[b] JPSS-1, JPSS-2	Suomi NPP,[b] JPSS-1, JPSS-2, and five free flyers	Suomi NPP,[b] JPSS-1, JPSS-2, and two free flyers	Suomi NPP,[b] JPSS-1, JPSS-2
JPSS launch readiness dates	JPSS-1: FY 2015 JPSS-2: FY 2018	JPSS-1: Q1 FY 2017 JPSS-2: Q2 FY 2021	JPSS-1: Q2 FY 2017 JPSS-2: Q1 FY 2022[c]	JPSS-1: Q2 FY 2017[d] JPSS-2: Q1 FY 2022

Source: OIG analysis of data from JPSS program

[a] Cost figures for 2011 represent the program office and independent cost estimates, respectively. These estimates were based on different assumptions (see report number OIG-12-038-A, *Audit of the Joint Polar Satellite System: Continuing Progress in Establishing Capabilities, Schedules, and Costs Is Needed to Mitigate Data Gaps*, issued September 27, 2012). The 2013 program and independent cost estimates were more closely aligned (as discussed in section I.A.3 of this report).

[b] Estimates include some development and all mission support costs for Suomi NPP.

[c] This was the JPSS-2 launch *readiness* date; actual launch date was to be determined.

[d] Current JPSS-1 launch date is *no later than* Q2 of FY 2017.

Appendix D: OIG Products Related to NOAA Satellite Acquisitions

Date Issued	Document Number	Title
March 6, 2014	OIG-14-014M	Memorandum to the Acting Under Secretary for Oceans and Atmosphere, *Audit of NOAA's Geostationary Operational Environmental Satellite–R Series Core Ground System Observations*
November 25, 2013	OIG-14-002	*Top Management Challenges Facing the Department of Commerce in Fiscal Year 2014*: "Challenge 2. Strengthen Oversight of National Oceanic and Atmospheric Administration (NOAA) Programs to Mitigate Potential Satellite Coverage Gaps, Address Control Weaknesses in Accounting for Satellites, and Enhance Fisheries Management"
April 25, 2013	OIG-13-024-A	*Audit of Geostationary Operational Environmental Satellite-R Series: Comprehensive Mitigation Approaches, Strong Systems Engineering, and Cost Controls Are Needed to Reduce Risks of Coverage Gaps*
November 9, 2012	OIG-13-003	*Top Management Challenges Facing the Department of Commerce in Fiscal Year 2013*: "Challenge 5. Reduce Risks of Cost Overruns, Schedule Delays, and Coverage Gaps for NOAA's Satellite Programs"
September 27, 2012	OIG-12-038-A	*Audit of the Joint Polar Satellite System: Continuing Progress in Establishing Capabilities, Schedules, and Costs Is Needed to Mitigate Data Gaps*
October 24, 2011	OIG-12-003	*Top Management Challenges Facing the Department of Commerce in Fiscal Year 2012*: "Challenge 5. Manage the Development and Acquisition of NOAA's Environmental Satellite Systems to Avoid Launch Delays and Coverage Gaps"
September 30, 2011	OIG-11-034-A	*Audit of the Joint Polar Satellite System: Challenges Must Be Met to Minimize Gaps in Polar Environmental Satellite Data*
June 10, 2011	OIG-11-029-M	Memorandum to the Under Secretary of Commerce for Oceans and Atmosphere, *NOAA's Joint Polar Satellite System Audit Observations*
December 20, 2010	OIG-11-015	*Top Management Challenges Facing the Department of Commerce in Fiscal Year 2011*: "Effectively Managing the Development and Acquisition of NOAA's Environmental Satellite Programs"
November 20, 2007	OSE-18291	*Successful Oversight of GOES-R Requires Adherence to Accepted Satellite Acquisition Practices*
May 8, 2006	OIG-17794-6-001	*Poor Management Oversight and Ineffective Incentives Leave NPOESS Program Well Over Budget and Behind Schedule*

Source: www.oig.doc.gov/Pages/Audits-Evaluations.aspx;
www.oig.doc.gov/Pages/National-Oceanic-and-Atmospheric-Administration.aspx

Appendix E: Agency Response

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

6/6/2014

MEMORANDUM FOR: Allen Crawley
Assistant Inspector General for Systems Acquisition and IT Security

FROM: VADM Michael S. Devany
Deputy Under Secretary for Operations

SUBJECT: *Audit of the Joint Polar Satellite System: To Further Mitigate Risk of Data Gaps, NOAA Must Consider Additional Missions, Determine a Strategy, and Gain Stakeholder Support*.
Draft OIG Audit Report

Thank you for the opportunity to comment on the Office of the Inspector General's draft audit report evaluating the Joint Polar Satellite System (JPSS). Working with NASA and our external independent review teams, we believe we have made considerable progress in the development of the JPSS program.

While highlighting some of the challenges that remain, the draft report also reflects the work we have accomplished. Our specific comments on the report's findings and recommendations are attached.

Attachment

Department of Commerce
National Oceanic and Atmospheric Administration Comments to the Draft OIG Report Entitled "Audit of the Joint Polar Satellite System: To Further Mitigate Risk of Data Gaps, NOAA Must Consider Additional Missions, Determine a Strategy, and Gain Stakeholder Support"
(Draft Report)

General Comments

Throughout the document the reference to "additional satellites" and "spare instruments and spacecraft" appears to be used interchangeably. Recommend only using "spare instruments and spacecraft" to avoid confusion with discussions regarding any follow-on to JPSS-2 or gap mitigation concepts.

Recommended Changes for Factual/Technical Information

Page 3,first paragraph, fourth and fifth sentences:
Reference to ". . . but now NOAA relied on the prolonged use of an outdated ground system supporting Suomi NPP." The previous sentence and beginning of this sentence reference JPSS-1 S-NPP Ground System is through Block 1.2. Ground System Block 2.0 is in development to support both the S-NPP and JPSS-1 missions and will be in operation prior to the JPSS- 1 launch. Therefore, reference to an outdated ground system is incorrect. Figure 2 on Page 14 appears to reflect the Block 2.0 for JPSS-1 being put in place prior to JPSS- 1 launch; therefore, the sentence on Page 3 is also inconsistent with Page 14.

Page 5, first paragraph, fourth sentence:
The report should include an acknowledgment of the formal agreement that NOAA and NASA are developing with specific language concerning decision criteria and trigger points to ensure the JPSS-2 spacecraft schedule is not delayed if the OMPS-L and RBI instruments are not delivered per an agreed-to schedule.

Page 6, fourth paragraph, last sentence:
The standing review provided favorable comments regarding the JPSS- 1 IMS and resolution of the issues presented during the Step 2 of the JPSS- 1 Mission PDR in June 2013. This report indicates a period covering December 2012 - March 2014. However, if the reference to the April submission of the JPSS-1 IMS is included, then it would also be appropriate to include the favorable feedback from the review on this item.

Editorial Comments

Page 2, first paragraph, last sentence:
Reference to "...as attention again divides between life-cycle phases." Suggest deletion of word "again" as there is not a reference in the above paragraphs to a problem linked to dividing attention between life cycle phases on JPSS.

Page 6, second paragraph, last sentence:

"Given likely delays due to budget..." This sentence is speculative, not factual. We suggest it be reworded to more of a risk based statement, or removed.

NOAA Response to OIG Recommendations

Recommendation 1: "We recommend that the NOAA Administrator establish reporting metrics to ensure adequate coordination among JPSS, SIDAR, and NASA climate instrument programs for review at monthly Program Management Council meetings."

NOAA Response: NOAA concurs. Using NOAA and NASA approved program/project management processes, cost, schedule, and risk metrics are reviewed on a monthly basis at the Goddard Space Flight Center Monthly Status Review and the Agency PMC.

Recommendation 2: "We recommend that the NOAA Administrator ensure that JPSS-2 operations and sustainment costs beyond FY2025 are delineated in stakeholder briefing materials about plans for additional missions."

NOAA Response: NOAA concurs. The JPSS program will include post-FY2025 sustainment costs into its stake holder briefing materials regarding additional missions.

Recommendation 3: "We recommend that the NOAA Administrator leverage OAM-led cost analysis expertise to explore cost savings opportunities in acquisitions beyond JPSS-2."

NOAA Response: NOAA concurs. NOAA has already engaged with OAM to support the JPSS follow-on activities.

Recommendation 4: "We recommend that the NOAA Administrator ensure that stakeholders are provided formal documentation of NOAA's response to independent review team recommendations and its corresponding acquisition strategy."

NOAA Response: NOAA concurs. NOAA/NESDIS will provide a formal response to the independent review team recommendations and provide that documentation to stakeholders. NOAA has already informally communicated its response on the bulk of the IRT recommendations, but will send a final summary once decisions are made on the polar follow program.

Recommendation 5: "We recommend that the NOAA Assistant Administrator for Satellite and Information Services ensure that stakeholders (including Congress) are provided updated information on the results and confidence level of the JPSS-1 mission's integrated master schedule."

NOAA Response: NOAA concurs. Implementation of this recommendation is already under way. The JPSS-1 Mission Critical Design Review (MCR) was completed successfully in April 2014. The standing review board acknowledged the resolution of the schedule issues presented at Step 2 of the JPSS-1 Mission Preliminary Design Review in June 2013. Analysis from the JPSS-1 MCDR indicates 78% probability of meeting the Launch Readiness Date. The outbrief from the JPSS-1 MCDR will be made available to appropriate stakeholders.

Recommendation 6: "We recommend that the NOAA Deputy Under Secretary for Operations direct appropriate NOAA entities to explain the effects of a potential afternoon orbit data gap in terms of degraded forecast hours and extrapolated economic costs, or conversely, the contribution to forecast accuracy and the economic benefits of afternoon orbit data."

NOAA Response: NOAA concurs. NOAA is and will continue to direct its entities to explain the effects of potential afternoon orbit data gap.

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