Report No. DODIG-2015-111

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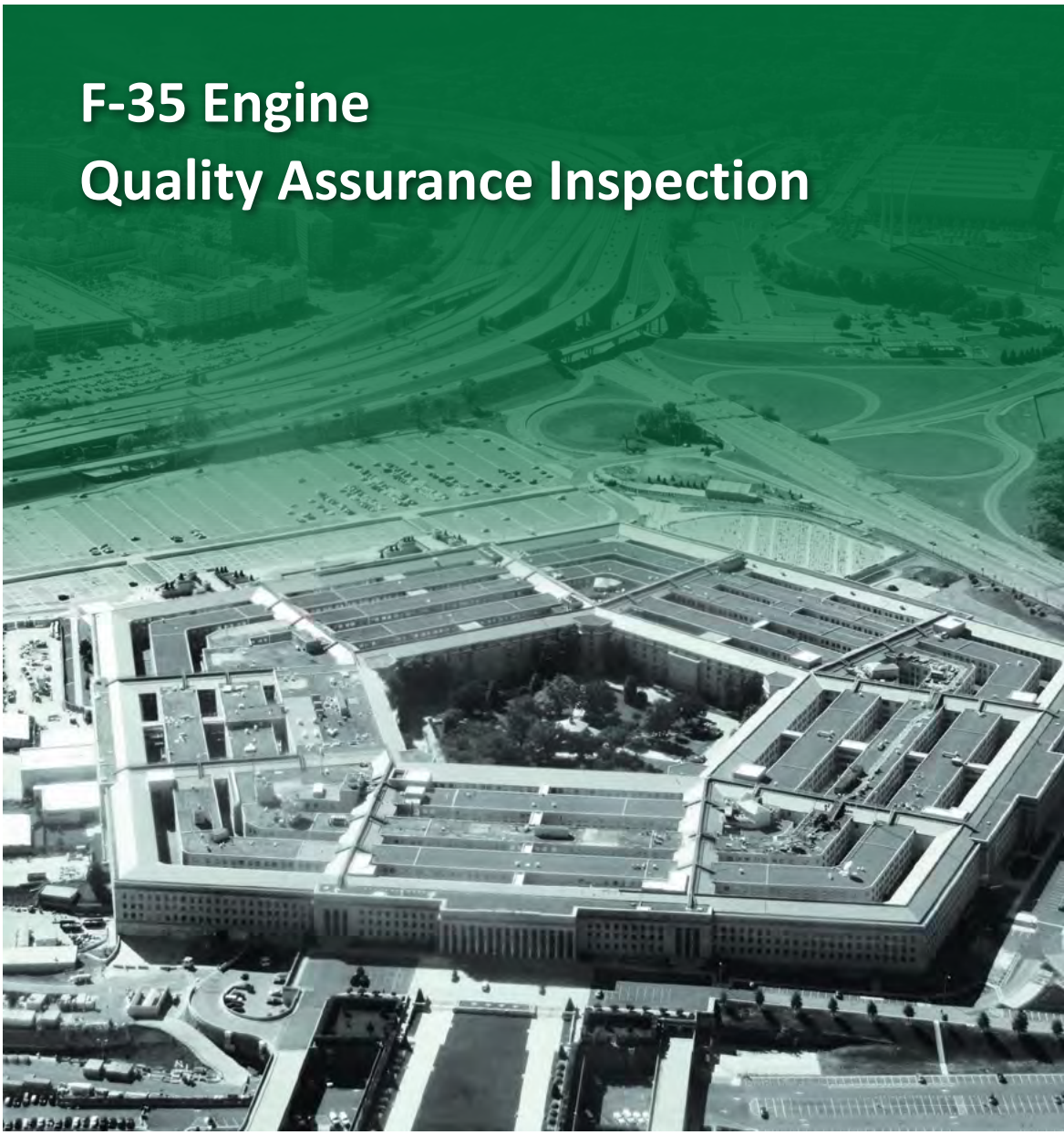
INSPECTOR GENERAL

U.S. Department of Defense

APRIL 27, 2015



F-35 Engine Quality Assurance Inspection

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Results in Brief

F-35 Engine Quality Assurance Inspection

April 27, 2015

Objective

We inspected the F-35 engine (F135) program's quality management system for conformity to contractually required AS9100C, "Quality Management System," statutory and regulatory requirements, DoD policies, and internal quality processes and procedures. F135 engines are procured by the Department of Defense from Pratt & Whitney for the F-35 Lightning II Program.

Findings

A. Additional program management oversight is required by the F-35 Joint Program Office (JPO) and the Defense Contract Management Agency (DCMA), as evidenced by the 61 nonconformities (violations of AS9100C, regulatory requirements, and DoD policies) that we documented during our inspection.

B. The F135 critical safety item (CSI) program did not meet DoD CSI requirements, including requirements for parts identification, critical characteristic identification, part determination methodology, and supplier identification.

C. ~~(FOUO)~~ The F-35 JPO did not establish F135 program quality goals and objectives that were mutually agreed upon by Pratt & Whitney for current contracts. Additionally, Pratt & Whitney metrics did not show improvement in quality assurance, process capability, and [redacted]

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Findings (cont'd)

D. The F-35 JPO did not ensure that Pratt & Whitney proactively identified, elevated, tracked, and managed F135 program risks, in accordance with the F135 risk management plan.

E. The F-35 JPO did not ensure that Pratt & Whitney's supplier selection criteria and management of underperforming suppliers were sufficient.

F. The F-35 JPO did not ensure that Pratt & Whitney demonstrated adequate software quality management practices. Pratt & Whitney had an outdated software development plan, requirements traceability issues, and a software quality assurance organization that did not perform required functions.

Recommendations

A.1.a – A.1.c. We recommend that the F-35 JPO coordinate with DCMA to conduct an effective root cause analysis and implement corrective actions for all 61 nonconformities identified during our inspection; review the contract data requirements list (CDRL) and determine specific items that should require approval; and evaluate open major variance requests to determine whether specification changes are required and if achievable closure plans can be developed.

A.2.a – A.2.c. We recommend that DCMA review CDRL items to identify any deliverables that impact DCMA program surveillance and coordinate with the F-35 JPO to resolve CDRL distribution issues; review and update the Memorandum of Agreement (MOA) with the F-35 JPO to ensure that all DCMA functions to evaluate waivers and deviations are clear and in accordance with the Federal Acquisition Regulation; and ensure that all associated data required to substantiate corrective action closure are accessible, available, and retrievable.

B.1 – B.2. We recommend that the F-35 JPO ensure that contractual flow down of all CSI requirements and Pratt & Whitney's CSI program processes and specifications meet the intent of current DoD CSI requirements and ensure that CSI parts or assemblies for already delivered engines meet current DoD CSI requirements.

Results in Brief

F-35 Engine Quality Assurance Inspection

Recommendations (cont'd)

C.1 – C.3. We recommend that the F-35 JPO establish F135 program quality goals and objectives that are mutually agreed upon by Pratt & Whitney and track Pratt & Whitney's performance against those objectives; ensure that Pratt & Whitney's quality plan meets contractual requirements; and ensure that Pratt & Whitney consistently analyzes and reports key product characteristic process capability index (C_{pk}) data for F135 engine hardware and that performance improvement plans are established.

D. We recommend that the F-35 JPO ensure that Pratt & Whitney identify, elevate, track, and manage all risks that affect the program, including software and supply chain risks.

E.1. We recommend that the F-35 JPO work with DCMA to ensure that Pratt & Whitney clearly defines, documents, and implements minimum baseline criteria for supplier selection and actions to be taken for suppliers that continue to be high risk.

E.2. We recommend that DCMA perform additional surveillance on Pratt & Whitney's corrective action requests issued to suppliers and ensure that they are closed within a reasonable timeframe.

F.1 – F.3. We recommend that the F-35 JPO ensure that Pratt & Whitney resolve nonconformities related to software quality management systems; ensure that Pratt & Whitney's Software Quality Assurance organization conduct audits, reviews, and verification activities of both internally developed and supplier-developed software; and ensure that Pratt & Whitney assess the impact of insufficient software verification on delivered engines.

Management Comments and Our Response

The F-35 JPO and DCMA provided comments on our findings and recommendations. The F-35 JPO agreed with seven recommendations, partially agreed with two recommendations, and disagreed with four recommendations. DCMA agreed with three recommendations and partially agreed with one recommendation.

The F-35 JPO disagreed with evaluating open variance requests, stating that the F135 program is still in development and the F-35 JPO is working to either meet or change the requirements at the end of the system development and demonstration phase. The F-35 JPO partially agreed with our recommendations on CSIs but still plans to align with updated DoD requirements and to work with the contractor to align with DoD requirements by May 2015. For engines already delivered, the F-35 JPO will first determine if significant escapes are discovered while aligning the F135 program with current DoD requirements before taking appropriate action. The F-35 JPO partially agreed with our recommendation on risk management but committed to ensure that Pratt & Whitney identifies, elevates, tracks, and manages all risks that affect the program. The F-35 JPO disagreed with our recommendation on software quality management, stating that software is developed to the correct product software level, the software development plan is not obsolete, and the F135 propulsion system software was properly tested. Comments from the F-35 JPO did not fully address the specifics of our recommendations; therefore, further comments are required.

DCMA partially agreed with our recommendation to document corrective action closures but committed to work on a central repository to maintain corrective action documentation. Comments from DCMA addressed all specifics of the recommendations, and no further comments are required. Please see the Recommendations Table on the next page.

Recommendations Table

Management	Recommendations Requiring Comment	No Additional Comments Required
F-35 Joint Program Office	A.1.c, B.2, C.1, F.1, F.3	A.1.a-b, B.1, C.2, C.3, D, E.1, F.2
Defense Contract Management Agency		A.2.a-c, E.2

Please provide Management Comments by May 29, 2015.

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
4800 MARK CENTER DRIVE
ALEXANDRIA, VIRGINIA 22350-1500

April 27, 2015

MEMORANDUM FOR PROGRAM EXECUTIVE OFFICER JOINT STRIKE FIGHTER
DIRECTOR, DEFENSE CONTRACT MANAGEMENT AGENCY

SUBJECT: F-35 Engine Quality Assurance Inspection (Report No. DODIG-2015-111)

The DoD Office of Inspector General (OIG) conducted an inspection of the F-35 engine (F135) program's quality management system for conformity to contractually required AS9100C, "Quality Management System," statutory and regulatory requirements, DoD policies, and internal quality processes and procedures. F135 engines are procured by the Department of Defense from Pratt & Whitney for the F-35 Lightning II Program.

We conducted this evaluation in accordance with the Council of Inspectors General on Integrity and Efficiency, "Quality Standards for Inspection and Evaluation."

During our inspection, we identified 61 nonconformities that were violations of AS9100C, regulatory requirements, and DoD policies. Based on those nonconformities, we identified systemic findings in the following areas: program management oversight, critical safety item compliance, continuous improvement, risk management, supplier management, and software quality management. By implementing our recommendations, we believe that improvements can be made to these areas.

We considered management comments on the draft of this report when preparing the final report. DoD Instruction 7650.03 requires that recommendations be resolved promptly. Comments from the F-35 Joint Program Office did not fully address the specifics of our recommendations; therefore, we request further comments on Recommendations A.1.c, B.2, C.1, F.1, and F.3 by May 29, 2015. Comments from the Defense Contract Management Agency were fully responsive; therefore, no further comments are required.

Please provide comments that conform to the requirements for DoD Instruction 7650.03. If possible, please send a PDF file containing your comments to [redacted]. Copies of your comments must have the actual signature of the authorizing official for your organization. We cannot accept the /Signed/ symbol in place of the actual signature. If you arrange to send classified comments electronically, you must send them over the SECRET Internet Protocol Router Network (SIPRNET).

We appreciate the courtesies extended to the staff. Please direct questions to [redacted]

Randolph R. Stone
Deputy Inspector General
Policy and Oversight

cc: Under Secretary of Defense for Acquisition, Technology and Logistics
Assistant Secretary of the Air Force (Financial Management and Comptroller)
Naval Inspector General
Auditor General, Department of the Navy

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Introduction

Objectives

Our objective was to inspect the F-35 engine (F135) program's quality management system for conformity to contractually required AS9100C, "Quality Management System," statutory and regulatory requirements, DoD policies, and internal quality processes and procedures. F135 engines are procured by the Department of Defense from Pratt & Whitney for the F-35 Lightning II Program.

Background

The F-35 Lightning II Program is a joint, multiservice, and multinational acquisition to develop and field the next-generation strike fighter aircraft for the Navy, Air Force, Marine Corps, and several international partners and foreign military customers. The F-35 Joint Program Office (JPO) is responsible for the total lifecycle management of the program and uses product-focused integrated product teams to manage and execute program requirements.

The F-35, a single engine aircraft, has three variants; F-35A Conventional Takeoff and Landing (CTOL), F-35B Short Takeoff and Vertical Landing (STOVL), and F-35C Carrier-Suitable Variant (CV). Lockheed Martin is the prime contractor for the air vehicle and Pratt & Whitney is the prime contractor for the engine. Pratt & Whitney produces engines for both commercial and military applications. Their engines are found in the F-15 Eagle, F-16 Fighting Falcon, F-22 Raptor, F-35 Lightning II, C-17 Globemaster III military transport, and Boeing's KC-46 tanker. The F135 engine, which Pratt & Whitney produces for the F-35 Lightning II fighter is the subject of this report.

F135 Engine

There are two engine types for the F-35 aircraft; the F135-PW-100 for the CTOL and CV variants and the F135-PW-600 for the STOVL variant. The F135-PW-100 and F135-PW-600 engines are comprised of five modules: fan module, power module, augmentor module, nozzle module, and gearbox module. These modules, as depicted in Figure 1, can be removed and replaced during maintenance with components and accessories. The F135-PW-600, as depicted in Figure 2, has additional components, including variable area vane box nozzle, lift fan, lift fan clutch, driveshaft, roll posts, and 3-bearing swivel duct. The two major subcontractors for the F135 engine are Rolls-Royce and UTC Aerospace Systems (UTAS). UTAS provides external controls and engine gearbox. Rolls-Royce provides the lift system for the STOVL variant.

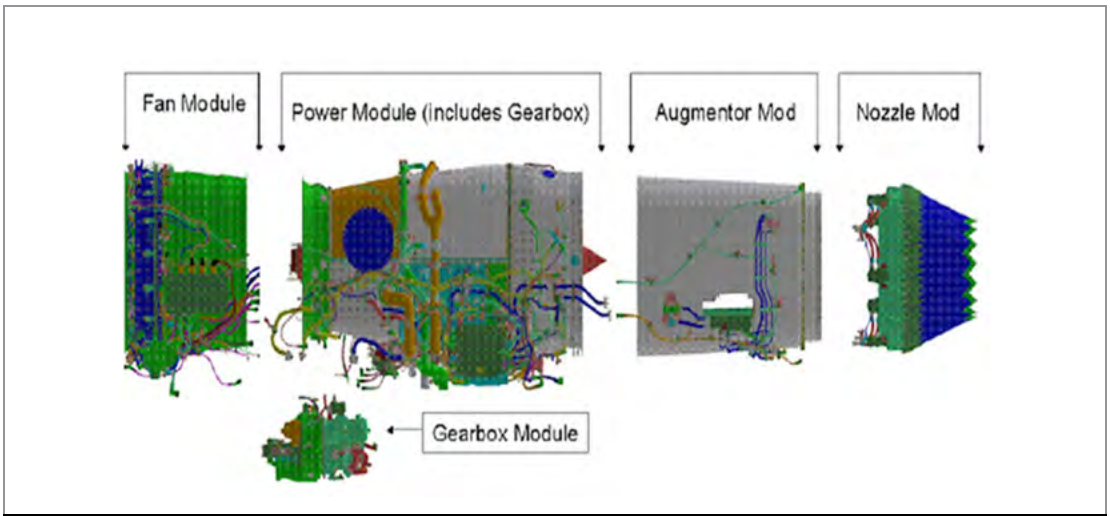


Figure 1. F135 Engine Modules

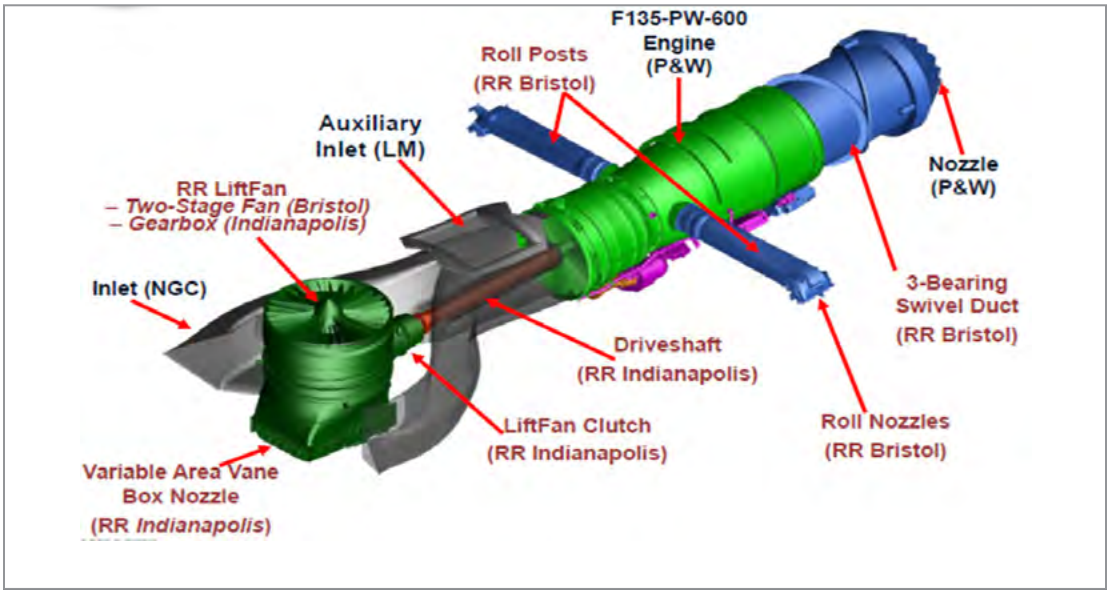


Figure 2. F135-PW-600 Engine for the STOVL Variant

Pratt & Whitney manufactures engine module parts at its East Hartford and Middletown, Connecticut, facilities. The engine assembly and acceptance testing takes place at its Middletown, Connecticut, and West Palm Beach, Florida, facilities. The current build time of an engine is 56 days, which includes approximately 5 days of testing and 12 days of packaging and acceptance. The F-35 JPO purchases complete engines and spare parts. Once manufactured and accepted by the government, complete engines that are slated for aircraft installation are provided to Lockheed Martin as Government-furnished equipment, and complete engine spares and spare parts are stored in depots throughout the country until needed.

F135 Acquisition Strategy

Pratt & Whitney is executing a cost-reimbursement contract for the development, production, qualification, delivery, and flight test support for the system development and demonstration (SDD) phase of F135 program. F135 SDD contract efforts are being performed concurrently with the execution of separate low-rate initial production (LRIP)[1] lot deliveries. Each LRIP lot delivers an increasing level of maturity as additional system capability is achieved. Each LRIP lot has its own contract that establishes engine and spares quantities. The contracting approach for LRIP lots 1 through 3 was cost-plus incentive/award/fixed fee. The contracting approach for LRIP lots 4 through 10 employs a fixed-price-incentive (firm target) type contract for production. The LRIP and full rate production (FRP) contract values and delivery schedule are in Table 1.

Table 1. Contract Values and Delivery

	Total Value	Engine Quantity (installed/spares)	Scheduled Delivery
LRIP 1	$87, 543,741	2 / 2	FY 2010
LRIP2	$508,701,220	12 / 4	FY 2010
LRIP 3	$710,813,914	17 / 3	FY 2011
LRIP 4	$1,158,185,692	32 / 5	FY 2012
LRIP 5	$1,016,351,233	32 / 4	FY 2013
LRIP 6	$1,135, 527,863	36 / 2	FY 2014
LRIP 7	TBD	35*	FY 2015
LRIP 8	TBD	43*	FY 2016
LRIP 9	TBD	57*	FY 2017
LRIP 10	TBD	96*	FY 2018
LRIP 11	TBD	121*	FY 2019
FRP 1	TBD	160*	Starting in FY 2020

* Projected numbers for future orders

[1] LRIP as defined by the Defense Acquisition University is the "effort intended to result in completion of manufacturing development in order to ensure adequate and efficient manufacturing capability and to produce the minimum quantity necessary to provide production or production-representative articles for Initial Operational Test and Evaluation."

~~(FOUO)~~ Quality Management System Inspection

We inspected Pratt & Whitney's quality management system for the F135 program at their East Hartford and Middletown, Connecticut, facilities. We evaluated the quality management system policies, processes, and procedures for compliance to the AS9100C, "Quality Management System," standard. We also evaluated the F-35 JPO and the Defense Contract Management Agency's (DCMA's) program management and oversight of Pratt & Whitney's quality management system for the F135 program.

We identified a total of 61 nonconformities, classified as major or minor, that were considered violations of AS9100C, regulatory requirements, and DoD policies. As defined by the AS9101, "Quality Management Systems Audit Requirements for Aviation, Space, and Defense Organizations," standard, a major nonconformity is a nonfulfillment of a requirement that is likely to result in the failure of the quality management system or reduce its ability to ensure controlled processes or compliant products/services. A minor nonconformity is a nonfulfillment of a requirement that is not likely to result in the failure of the quality management system or reduce its ability to ensure controlled processes or compliant products or services.

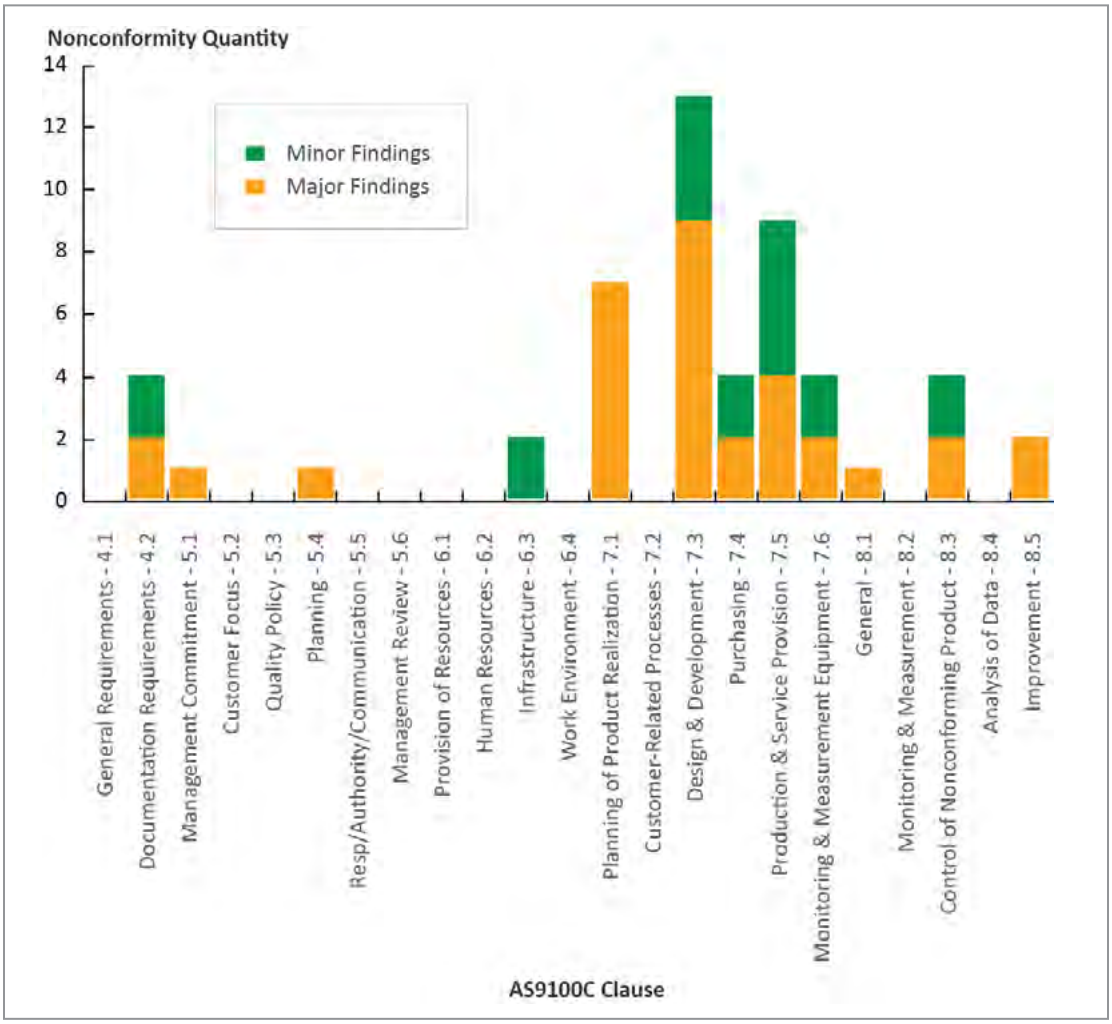
Table 2 shows the breakdown of major and minor nonconformities, and opportunities for improvement (OFIs)[2] found against Pratt & Whitney, the F-35 JPO, and DCMA. Figure 3 shows the nonconformities directed to Pratt & Whitney by AS9100C clause. The following sections discuss major nonconformities only and are organized by its applicable criteria.

Table 2. Major/Minor Nonconformities and OFIs for Each Organization

Organization	Major	Minor	Opportunity for Improvement
Pratt & Whitney	33	19	1
DCMA	3	0	0
F-35 JPO	5	1	1

[2] An OFI is an industry best practice when a specific requirement does not exist.

Figure 3. Pratt & Whitney Nonconformities by AS9100 Clause



~~(FOUO)~~ Results of Pratt & Whitney AS9100C Conformance Inspection

Documentation Requirements (4.2)

Pratt & Whitney did not establish a specific quality program plan that described the management of unique F135 program quality assurance requirements. The SDD contract required that Pratt & Whitney maintain a quality management system and that a quality plan be summarized in the body of the Propulsion System Development Plan (PSDP). In the PSDP, Pratt & Whitney formally requested relief to eliminate the requirement to establish a quality plan for the F135 program; however, the F-35 JPO did not formally relieve Pratt & Whitney of this requirement. The F-35 JPO and Pratt & Whitney agreed to follow Pratt & Whitney's corporate-level quality manual; however, this quality manual described corporate policy on quality assurance and not unique F135 engine's

quality assurance requirements. The SDD contract statement of work (SOW) identified unique program quality assurance requirements that were not addressed by Pratt & Whitney's quality manual such as product specialty engineering discipline elements, critical manufacturing and supporting processes, and technical performance measures. Due to the multi-mission capability requirements of the F-35 and criticality of a single engine design, an F-35 JPO-approved F135 program quality plan is necessary to capture unique quality assurance goals and requirements of the program.

~~(FOUO)~~ *Management Commitment (5.1)*

~~(FOUO)~~ Pratt & Whitney management failed to ensure that process capability (C_{pk})[3] goals are being met, nonconformances per engine and quality escapes are being reduced, and [redacted] Pratt & Whitney identified that 41 percent of all key product characteristics (KPC)[4] do not meet their process certification requirements, which include a C_{pk} of 1.33 or better. A process with a C_{pk} of 1.33 or better is a capable and stable process. Moreover, Pratt & Whitney has not developed process improvement plans for 60 percent of those underperforming KPCs. Given the significant percentage of underperforming KPCs, the F-35 JPO should expect escalating rates of quality escapes and nonconformances per engine, which may impact engine performance, schedule, and cost.

~~(FOUO)~~ [redacted] If Pratt & Whitney does not make continuous improvement top F135 program priorities, then product quality will continue to decline especially with increasing production quantities in the future.

[3] C_{pk}: Capability index that defines the relationships of the "centeredness" (or mean) and "spread" (or standard deviation) of capability to specification limits. C_{pk} measures the accuracy of the process.

[4] KPC: Key Product Characteristics define the unique requirements for associated manufacturing inputs and inspection sampling rates. KPC are applied to certain drawing features and require process control to evaluate inputs, outputs, data collection and control plans to monitor the manufacturing inputs. A process is considered "Certified" when the process output is in control, capable, and has a C_{pk} of 1.33 or better.

Planning (5.4)

Pratt & Whitney is contractually required to establish program objectives and present quality assurance metrics in an open forum with the F-35 JPO during the monthly program reviews (MPRs). Pratt & Whitney has not established program objectives that are mutually agreed upon between Pratt & Whitney and F-35 JPO for the SDD contract. There were program objectives in 2011; however, those program objectives were no longer relevant and no new objectives had been defined. In addition, LRIP Contract SOWs required Pratt & Whitney to report quality assurance metrics such as process variability reduction and nonconformance parts per million at MPRs. Metrics were instead provided electronically at the integrated product team level and may not have received management and interdisciplinary team visibility to ensure that quality assurance metrics were improving. Not reporting program objectives and quality metrics at MPRs or at required intervals limits the ability of the F-35 JPO to make programmatic decisions based upon the latest available data. As of November 2014, the F-35 Program Executive Officer redirected the program to establish F135 specific goals in future production contracts.

Planning of Production Realization (7.1)

Pratt & Whitney personnel did not always follow personal protective equipment (PPE) requirements, putting themselves at significant risk for injury. For example, an acid dipping process, also called "pickling," required that a face mask be worn in the vicinity of the acid tanks. In one instance, an operator was not wearing a face mask while draining a water tank that was near the acid tanks; however, it was unclear whether a face mask was required due to ambiguous designations for the limits of areas requiring PPE. Other examples include personnel not consistently wearing protective gloves at an electrical discharge machine station and personnel not wearing lab coats in the blade vapor coating area. PPE practices must be followed to reduce risk of injury to personnel or contamination of product.

Project Management (7.1.1)

Pratt & Whitney did not track and manage delinquent contract data requirements list (CDRL)[5] items to ensure deliveries occur in accordance with contractual requirements. In addition, Pratt & Whitney contracts management did not have a closed-loop corrective action system for delinquent or rejected CDRLs. Pratt & Whitney had approximately 390 delinquent CDRLs dating to 2000 that were

[5] According to Defense Acquisition University, the CDRL is a "list of authorized data requirements for a specific procurement that forms part of the contract…The CDRL is the standard format for identifying potential data requirements in a solicitation, and deliverable data requirements in a contract."

never delivered to F-35 JPO. If Pratt & Whitney does not ensure CDRLs are tracked, submitted, and managed, then the F-35 JPO may not receive critical, accurate, or relevant program information necessary to verify the design, implementation, and product performance.

Since 2011 and throughout the SDD, LRIP 5, 6, and 7 contracts, the F-35 JPO rejected the Integrated Master Schedules (IMSs)/Integrated Master Plans (IMPs) due to inaccurate and incomplete information. The IMS/IMP did not capture major supplier data, which was critical to capture the total program and meet basic scheduling guidelines. Additionally, there were several open DCMA corrective action requests (CARs) written against Pratt & Whitney and Rolls Royce, noting numerous concerns with the IMS/IMP, including poor quality of subcontractor schedule validation and analysis. The failure of Pratt & Whitney to provide the F-35 JPO with an acceptable IMS/IMP may adversely affect its ability to address schedule risks.

Risk Management (7.1.2)

The risk management program at Pratt & Whitney did not provide management visibility and awareness of risks that can adversely affect the program. Pratt & Whitney's risk management plan stated that F135 Risk and Issues Management Board (RIMB) will review each integrated product team's risk and determine which should be elevated to a program or system level risk. However, we found that the RIMB only discussed technical risks and not production, sustainment, design, or supply chain risks. The risk management database identified 162 active risks; however, the F135 RIMB presentation dated October 21, 2014 only discussed 10 active risks. Additionally, we found insufficient evidence that the required technical leads were present during RIMB to make decisions on ranking risk, risk mitigation plans, and removing risk.

Pratt & Whitney generated software issues at the software development integrated product team level; however, we found no evidence that these issues were analyzed to determine system level risks. For example, there were at least 40 open safety critical technical issues at the integrated product team level without evidence of risk analysis to determine if the issues were potential software risks that should be elevated to the RIMB.

Pratt & Whitney's risk management database was not maintained and did not reflect accurate risk information including risk category, status, mitigation plans, and risk ranking. The risk management procedure defined a structure for identifying and categorizing risks; however, the risk management database did not have the same risk categories. We found that several risks were duplicated in multiple folders of the database where the same risk was open in one category

but already closed in another. Lastly, risk mitigation plans were not developed for production, sustainment, and design risks. If the F-35 JPO does not ensure that Pratt & Whitney maintain an effective risk management program with rigor and discipline to identify, evaluate, and mitigate risks, then significant risks and issues that should be managed and tracked at the system level may be overlooked.

Configuration Management (7.1.3)

The Pratt & Whitney Software Quality Assurance (SQA) organization did not perform physical configuration audits (PCAs) or functional configuration audits (FCAs) on any computer software configuration items (CSCIs) in accordance with internal procedures. A review of SQA records for the main engine, lift system, and boot CSCIs showed no evidence that SQA performed PCAs and FCA activities. Additionally, future SQA audit schedules did not contain PCAs and FCAs. A PCA is a formal examination of the as-built configuration of a CSCI against its technical documentation, to establish the product baseline (as-built vs. as-designed). An FCA verifies that the CSCI meets the requirements documented in the Software Requirements Specification and the Interface Requirements Specification. Not conducting PCAs and FCAs on all CSCIs can result in nonconforming software being integrated into the F-35 aircraft with functionalities that are highly dependent on software.

Design and Development (7.3)

Design and Development Planning (7.3.1)

The F135 Software Development Plan (SDP) did not describe the current software architecture, did not identify all software configuration items, and did not define all applicable product software levels (PSLs).[6] The SDP described an outdated software architecture where the prognostics and health management (PHM) software was a separate CSCI. In the current software architecture, PHM software is embedded into the main engine and lift system CSCIs. The SDP also lacked a description of the boot CSCI.[7] Lastly, the SDP did not define PSL requirements for software designated lower than PSL1 or non-safety critical software.

When the PHM software was designed as its own CSCI, it was designated as a PSL3. Because it is now embedded in the main engine and lift system CSCIs that are both designated as PSL1, the PHM must be developed and tested to PSL1 requirements, unless Pratt & Whitney can demonstrate that their design, development, and

[6] Product software levels (PSLs) are safety critical categories for software products. PSL1, the highest safety critical category, are designated for software whose anomalous behavior would cause or contribute to a failure of a system function and result in a catastrophic failure.

[7] The boot is the software system that provides a starting point in the event that a Full Authority Digital Engine Control or Propulsion Health Area Manager is started or reset.

test processes ensure that lower level PSL-partitioned software won't adversely affect the main engine and lift system software. Flight application software that is not developed and tested in accordance with PSL requirements could impact performance of critical software and could introduce a catastrophic system failure.

Design and Development Outputs (7.3.3)

Software safety requirements were not completely implemented for the boot CSCI as evidenced by 34 safety requirements that were not traceable to software design and test documents. For example, there was no evidence that the safety requirement for the boot software to provide fail-safe recovery from inadvertent instruction jumps was met. There was also no evidence that the safety requirement for operational program loads to not contain unused executable code was met. Incomplete requirements verification for both the main engine and lift fan CSCIs could create a performance and safety risk for the F135 program.

Pratt & Whitney did not identify critical characteristics for many of the critical safety items (CSIs) on the SOW CSI list. Also, the CSI SOW required that Pratt & Whitney ensure all drawings and associated technical data clearly identify that the item is a CSI; however, there were no CSI markings on any drawing or technical data. The purpose of identifying CSIs on drawings and associated technical data is to inform stakeholders that the parts being manufactured, dispositioned, tested, or maintained are critical to the safety of the aircraft and personnel. The failure to identify CSIs decreases the awareness and ability of F135 personnel responsible for design, development, production, test, maintenance, and inspection to ensure that additional CSI controls are implemented for parts that are critical to the safety of the aircraft and personnel.

Design and Development Verification (7.3.5)

The Pratt & Whitney SQA organization did not conduct Software Life Cycle (SLC) audits on critical software suppliers since 2009, even though there have been recent software releases. Pratt & Whitney SQA procedures required SLC audits to be conducted on suppliers for all software released. SLC audits include, but are not limited to, project planning and tracking, requirements, design, code, test plans and procedures, test reports, software documentation, software development tools, configuration management, library controls, shipping, handling, and delivery processes.

The Pratt & Whitney SQA organization could not provide sufficient evidence that they performed software audits in accordance with their software quality assurance procedure. Examples of software audit activities include reviewing change requests, witnessing code and unit testing, and reviewing software release

procedures and packages. If audits are not conducted on Pratt & Whitney- and supplier-developed software, then there is no assurance that quality assurance practices are being implemented for critical software products.

Design and Development Verification and Validation Testing (7.3.6.1)

The F135 Electronics Verification Bench (EVB) laboratory was not formally configuration controlled. Inventory of EVB equipment racks, software change requests, and problem reports were informally managed by e-mails and an excel spreadsheet. In addition, the configuration of the laboratory can be altered or interrupted during formal test by other remote users. The EVB simulates the entire propulsion system while using electronics that are functionally equivalent to flight hardware. The EVB laboratory was used for software configuration item tests, integration tests, failure mode and effects tests, acceptance tests, and system evaluation tests. The SDP required that software test verification uses a configuration controlled set of test assets with test log files, software versions, and configuration of the EVB. Pratt & Whitney's lack of formal configuration management control in the EVB laboratory may invalidate verification test results on critical software verification test activities.

Control of Design and Development Changes (7.3.7)

Pratt & Whitney could not provide evidence of required engineering technical reviews and approvals for specification change requests and component requirement change requests. There was no evidence of integrated product team review and approvals in accordance with the F135 specification change request procedure for approximately 100 records reviewed. There was also no evidence of management approvals for component requirement change requests of Rolls-Royce components. The lack of technical review can lead to specification changes being implemented without adequate analysis on impacts to the product or system.

Purchasing (7.4)

Purchasing Process (7.4.1)

Pratt & Whitney's minimum baseline criteria for selecting suppliers, such as performance/quality history and cost and schedule data, were not clearly documented within its procurement policies and procedures. Pratt & Whitney also did not clearly document the actions to take when a supplier continues to have a poor quality rating or is considered a high risk. Several suppliers had been rated high risk for extended periods of time. We found that one supplier had been considered high risk for 33 consecutive months. If criteria for selection and management of suppliers are not established, clearly documented, and

implemented, Pratt & Whitney cannot provide assurance that their suppliers are qualified to deliver quality products that meet all quality, schedule, cost, and performance requirements.

Production and Service Provision (7.5)

Validation of Processes for Production and Service Provision (7.5.2)

Pratt & Whitney did not recertify Level 3 nondestructive test (NDT)[8] personnel within a five year period in accordance with international standards, such as the National Aerospace Standard 410, "Certification & Qualification of Nondestructive Test Personnel." Several Level 3 personnel were initially certified in the early 1990s; however, they were not recertified within a five year period. We found that Level 3 personnel were initially certified to NDT techniques such as Etch Inspection Method 1979, Florescent Penetration Inspection 1980, Thickness Determination (Ultrasonic) Inspection 1981, Radiographic Inspection 1983, and Eddy Current Testing 1999. If Pratt & Whitney does not ensure that Level 3 personnel are periodically recertified to nationally recognized criteria, then the skills necessary to determine product acceptance using NDT methods may be degraded.

Customer Property (7.5.4)

Pratt & Whitney's handling of electrostatic discharge sensitive (ESDS) Government property did not meet EVB laboratory requirements as evidenced by the lack of the following: equipment ground straps, wrist straps, verification of resistivity in ground and wrist straps, protective coverings for ESDS equipment, and grounding of fixtures that hold critical ESDS components. The EVB laboratory used non-flight full authority digital engine control (FADEC) Government property to perform qualification testing of flight application software. If ESDS protective procedures are not followed, there is a risk of latent defects and damage to Government property and qualification test equipment.

Preservation of Product (7.5.5)

The F135 engine final assembly area was neither adequately identified as foreign object damage (FOD)-controlled area nor protected from common FOD items. The F135 engine final assembly area had FOD signage at the two entry lobbies of the building; however, there were no FOD signage within the engine final assembly areas. Pratt & Whitney FOD procedures also did not prevent common FOD items from entering the engine final assembly area. For example, items such as safety

[8] Level 3 NDT is the highest level of NDT certification. Level NDT personnel are certified in accordance with National Aerospace Standard 410 in one or more NDT methods and shall have a thorough knowledge of the written instructions, codes, specifications and standards used by the employer. He/she shall also have a thorough knowledge of the materials, components, product technologies, NDT methods, and NDT techniques used by the employer.

and tie wire, damaged storage brackets, empty consumable cans (lubricants, cleaners), and packaging materials (styrofoam, plastic wrap, cardboard) were found in the final assembly area. If common FOD items are not restricted from FOD controlled areas, then there is an increased risk of hardware contamination and damage on assembled and delivered engines.

Control of Monitoring and Measuring Equipment (7.6)

Pratt & Whitney did not ensure that calibration equipment records were complete and obsolete equipment calibration labels were removed. Certificates of calibration for coordinate measurement machines (CMMs) were missing critical calibration data such as temperature and relative humidity conditions, measurement uncertainties, and temperature standard. Additionally, CMM limited calibration labels did not reflect actual calibration status of the equipment. In one instance, previous limited calibration labels with obsolete calibration data, such as compensation factors, were still attached to the CMM. CMMs were used to accept and inspect engine components in various stages of assembly and manufacturing. The use of incomplete or outdated calibration measurement data can affect product measurements that are used for product acceptance and increase product rework.

Measurement, Analysis and Improvement – General (8.1)

Pratt & Whitney did not consistently analyze and report KPC C_{pk} data for F135 engine hardware. We found several inconsistencies among C_{pk} values reported from multiple sources for the same KPCs. Furthermore, Pratt & Whitney manufacturing engineers could not identify what analysis or source that was used to support C_{pk} results in the database report. DCMA used the C_{pk} database report to establish a mandatory Government inspection point for all KPCs that have a C_{pk} of less than 1. The F-35 JPO also monitored the data as an indication of technical and program risk. If KPC data are not correctly analyzed and reported, then Pratt & Whitney, F-35 JPO, and DCMA cannot make sound program and resource management decisions, nor determine if engine hardware processes are stable.

Control of Nonconforming Product (8.3)

Pratt & Whitney did not always identify CSI parts, their impacted critical and major characteristics, and the correct disposition status of affected CSIs on major variance requests (MVRs) also known as requests for waivers and deviations. For example, the augmentor fuel pump, contractually identified as a CSI, was not identified as a CSI on an MVR. In addition, Pratt & Whitney combined the definitions of critical and major variances under one category called major variances, which was in violation of contractual requirements. Variance requests

that do not clearly identify items as CSIs may not be reviewed and dispositioned in accordance with CSI program requirements. Furthermore, the misclassification and unclear identification of a CSI or its critical characteristic can lead to errors in processing and dispositioning of associated variance requests.

Improvement (8.5)

Corrective Action (8.5.2)

Pratt & Whitney did not always document root cause and corrective actions for nonconformances. For example, root cause or corrective action details were not documented on three 1st Stage Axial Compressor Rotor Assembly nonconformances, which was in violation of internal procedures. In addition, Pratt & Whitney did not provide timely review and verification of CARs they issued to suppliers. In many cases, the supplier responded with a root cause corrective action plan by the due date; however, Pratt & Whitney did not review and close out the CARs in a reasonable timeframe, including some CARs that were not closed until almost two years later. If the root cause and corrective actions are not documented and reviewed for adequacy in a timely manner, then there is a risk of continued reoccurrence of nonconformances.

Government Quality Assurance Oversight

Performance of the F-35 Joint Program Office

We found nonconformities with the F-35 JPO's quality assurance oversight of the F135 program. Major nonconformities include: insufficient CSI program requirements, inadequate Government contract quality assurance (GCQA) requirements flow down for CSIs, misapplication of the MVR process, and no requirement for approval of CDRL items. Additional quality assurance oversight is required to ensure program cost, schedule, and performance goals are attained.

Critical Safety Item Management

Public Law 108-136, Section 802, "Quality control in procurement of aviation CSIs and related services," requires DoD to prescribe a quality control policy for the procurement of aviation CSIs.[9] The Joint Service CSI Instruction, SECNAVINST 4140.2/AFI20-106, "Management of Aviation Critical Safety Items," dated January 25, 2006 implements Public Law 108-136 and is applicable to

[9] Title 10, Section 2319 of the United Sates Code is the applicable statute that implements aviation CSI requirements of Public Law 108-136, Section 802.

Program Executive Officers, commanders of system acquisition and logistics organizations, program managers, and other agencies that procure, repair, or service aviation materiel. The Joint Service CSI Instruction defines CSI as:

> A part, assembly, installation equipment, launch equipment, recovery equipment, or support equipment for an aircraft or aviation weapons system that contains a characteristic any failure, malfunction, or absence of which could cause a catastrophic or critical failure resulting in the loss or serious damage to the aircraft or weapons system, an unacceptable risk of personal injury or loss of life, or an uncommanded engine shutdown that jeopardizes safety.

CSIs require special handling, engineering, manufacturing, and inspection documentation to control and ensure safety of flight and prevent potential catastrophic or critical consequences of failure. Supplemental guidance for the Joint Service CSI Instruction is provided in the Joint Aeronautical Commanders Group (JACG) Aviation Source Approval and Management Handbook.

The F-35 JPO required Pratt & Whitney to implement a CSI management program according to the CSI SOW. When the CSI SOW was initially developed, the Joint CSI Instruction did not exist to implement Public Law 108-136. The CSI SOW implemented a tailored version of NAVAIR Instruction 4200.25D, "Management of Critical Application Items Including Critical Safety Items," dated June 20, 2002. The CSI SOW was not modified to implement the full scope of the Joint Service CSI Instruction for contracts awarded after the instruction's release date (LRIPs 2 through 7). Nevertheless, we found that the CSI program did not meet NAVAIR Instruction 4200.25D or Joint Service CSI Instruction in several areas. For example,

- CSI parts were identified based on the part's probability of failure rather than the consequence of failure.
- The top level F135 engine assembly is not identified as a CSI on the CSI SOW even though it contains at least one critical safety characteristic.
- CSIs are identified on the CSI SOW by nomenclature (a family of parts) and not by individual part number. Therefore, the list does not specifically identify which parts and assemblies are CSI.
- Not all CSIs on the CSI SOW identify associated critical characteristics. Some identify major characteristics and some have undefined characteristics.
- There was no document that identified prime contractors, original equipment manufacturers, and alternate sources for CSIs.

- There was no evidence that a joint CSI program assessment has been done annually or periodically per the CSI SOW.
- The F-35 JPO did not adequately flow down CSI GCQA oversight requirements for part procurements to DCMA. Per the F-35 JPO/DCMA Memorandum of Agreement (MOA), GCQA is only required for parts containing critical characteristics.

The F135 CSI program's lack of compliance to the NAVAIR Instruction 4200.25D or Joint Service Instruction increases the risk of nonconforming CSI parts being installed on aircraft. It also increases the risk that parts critical to the safety will not be properly handled and controlled by production, test, and maintenance personnel.

Federal Acquisition Regulation 46.407, "Nonconforming Supplies or Services"

The F-35 JPO used the variance process to waive requirements for extended periods of time, which was a misapplication of the variance request process and did not discourage the repeated tender of nonconforming supplies or services in accordance with Federal Acquisition Regulation (FAR) 46.407, "Nonconforming Supplies or Services." As defined by Military Standards MIL-STD-973, "Military Standard Configuration Management," a deviation (or a variance) is,

> A specific written authorization, granted prior to the manufacture of an item, to depart from a particular requirement(s) of an item's current approved configuration documentation for a specific number of units or a specified period of time. (A deviation differs from an engineering change in that an approved engineering change requires corresponding revision of the item's current approved configuration documentation, whereas a deviation does not.)

The F-35 JPO performed a system level F135 FCA that identified 175 major variances to specification requirements; however, the F-35 JPO proceeded to establish the Initial Service Release (ISR) baseline in 2010 with these deficiencies. Currently, twenty percent of the original 175 MVRs remain open. Some MVRs date back to 2009. The five longest open MVRs have closure plans that have been extended multiple times for periods of 1 to 7 years. Additionally, the F-35 JPO and Pratt & Whitney estimate that two percent of those MVRs will be closed by specification changes.

According to the F-35 JPO, reoccurring MVRs are due to the lot-to-lot program concurrency, which has required engine production to proceed in order to meet the aircraft production schedule. Their plan is to close all MVRs by the end of SDD in 2016. The F-35 JPO will continue to accept nonconforming engines if MVR extensions continue to be approved and not resolved.

DoD Directive 5000.01, "The Defense Acquisition System"

The F-35 JPO awarded SDD and LRIP contracts with CDRL items that were delivered for information only, and not for approval. Many of the program planning and schedule CDRL items were removed from current sustainment and production contracts. Examples of plans that were submitted for information only included: Configuration Management Plan, IMS/IMP, Quality Plan, Risk Management Plan, Software Development Plan, System Engineering Management Plan, Engineering Change Proposals, and Variance Requests. According to DoD Directive 5000.01, "The Defense Acquisition System," the program manager has the responsibility for and authority to accomplish program objectives for development, production and sustainment and shall be accountable for credible cost, schedule, and performance. The absence of F-35 JPO approval on program planning and schedule CDRL items limits the ability of the government to provide F135 program direction and oversight.

Performance of DCMA

We documented DCMA nonconformities in three areas: CDRL reviews, corrective action request management and recordkeeping, and variance request evaluation and approval. If DCMA does not provide the required contract administration and quality assurance oversight, then there is additional risk that delivered engines may not meet reliability requirements.

DCMA Instruction 205, "Major Program Support"

DCMA did not adequately review CDRL items that could impact program surveillance activities. DCMA was not included in the distribution lists for several CDRL items on the LRIP 6 and 7 contracts such as the cost data summary report, contract work breakdown structure, engineering change proposal, and variance request. According to DCMA Instruction 205, "Major Program Support", DCMA shall review the CDRLs to identify any deliverables that impact DCMA program surveillance to ensure DCMA is included in the distribution. DCMA Instruction 205 also requires that DCMA contact the F-35 JPO contracting officer to resolve any conflicts between the CDRL distribution and DCMA needs. However, DCMA could not provide evidence that it contacted the F-35 JPO to resolve these CDRL distribution deficiencies. DCMA is required to review CDRLs to ensure that they perform their responsibilities in accordance with the contract. DCMA personnel did not ensure that they receive all necessary CDRL items, which may adversely affect their ability to analyze, identify, and take action to prevent or resolve potential and existing program problems throughout all program phases.

DCMA Instruction 1201, "Corrective Action Process"

DCMA could not provide sufficient evidence of performing activities required in DCMA Instruction 1201, "Corrective Action Process," for 15 of the 16 CARs we reviewed. During our inspection, we did not find supporting information to substantiate activities such as CAR closure, approval of contractor corrective action plans for CARs, verification of corrective actions for CARs, follow up on Level II CARs, and escalation of CARs to the next higher level when corrective actions were deemed ineffective. Without sufficient evidence of adherence to the corrective action process, we do not have confidence that deficiencies were captured, completed, and verified to prevent recurrence of deficiencies in affected products.

Federal Acquisition Regulation 42.302, "Contract Administration Functions"

DCMA could not provide evidence of evaluating and making recommendations for the acceptance or rejection of major and minor waivers and deviations, also referred to as "variances." According to FAR 42.302, "Contract Administration Functions," DCMA is to assist in evaluating and make recommendations for acceptance or rejection of waivers and deviations. The MOA between the F-35 JPO and DCMA did not relieve DCMA of this function. The MOA stated, "This MOA is intended to clarify or add to the normal Contract Administration Services (CAS) functions listed in the Federal Acquisition Regulation (FAR) 42.302 and Defense Federal Acquisition Regulation Supplement (DFARS) 242.302." The MOA also stated that DCMA will review all deviations and waivers in accordance with the F135 Configuration Management Plan. DCMA needs to perform this function to ensure that waivers and deviations are correctly classified, reviewed, and approved.

~~(FOUO)~~ Overall Findings and Recommendations

During our inspection, we noted examples where the F135 program demonstrated sound quality assurance practices. We were impressed with Pratt & Whitney's automated processes, which were implemented to reduce product variation due to human factors and simplify operational task complexity. We noted that shop floor practices were well-controlled with the use of electronic work instructions that could prevent out-of-sequence work. In design and development, we noted well-planned processes that implemented software applications that ensured consistent and controlled workflow. In supplier quality, we found that Pratt & Whitney required its suppliers to be AS9100 certified.

F135 program personnel were knowledgeable of their respective areas and recognized the need for improvements. However, we identified 61 nonconformities that were violations of AS9100C, regulatory requirements, and DoD policies. Based on those nonconformities, we identified the following systemic findings:

- additional program management oversight required,
- critical safety item program not fully compliant,
- contractor shortfalls in continuous improvement,
- insufficient risk management practices,
- insufficient supplier selection criteria and management of underperforming suppliers, and
- inadequate software quality management practices.

The following sections discuss our overall findings and recommendations.

Finding A

Additional Program Management Oversight Required

We found that additional program management oversight is required by F-35 JPO and DCMA, as evidenced by the 61 nonconformities (violations of AS9100C, regulatory requirements, and DoD policy) that we documented during our inspection. F-35 JPO and DCMA oversight is required to prevent adverse program cost, schedule, and performance issues.

Discussion

The F-35 JPO awarded SDD and LRIP contracts with CDRL items that were delivered for information only, and not for approval. We also found that DCMA was not notifying the procuring contracting officer of their absence in the distribution list for CDRLs impacting program surveillance activities. The absence of F-35 JPO approval and DCMA review of CDRL items limits the ability of the government to provide clear direction and guidance to the contractor.

The F-35 JPO used the variance process to waive requirements for extended periods of time, which was a misapplication of the variance request process and did not discourage the repeated tender of nonconforming supplies or services in accordance with FAR 46.407, "Nonconforming Supplies or Services." To date, twenty percent of the original 175 MVRs from the production baseline remain open; approximately two percent could lead to specification changes to meet the performance limitations. The F-35 JPO will continue to accept nonconforming engines if MVR extensions continue to be approved and not resolved.

DCMA could not provide evidence of evaluating and making recommendations for the acceptance or rejection of waivers and deviations. According to FAR 42.302, "Contract Administration Functions," DCMA is to assist in evaluating and make recommendations for acceptance or rejection of waivers and deviations. The MOA between the F-35 JPO and DCMA did not relieve DCMA of this function. DCMA needs to perform this function to ensure that variances are correctly classified, reviewed, and approved.

DCMA could not provide sufficient evidence of supporting information to substantiate closure of CARs, approval of contractor corrective action plans for CARs, verification of corrective actions for CARs, follow-up on Level II CARs, and escalation of CARs to the next higher level when corrective actions were deemed

ineffective. Without sufficient evidence of adherence to the corrective action process, we do not have confidence that deficiencies were captured, completed, and verified to prevent recurrence of deficiencies in affected products.

Management Comments on the Finding and Our Response

F-35 Joint Program Office Comments on Adequacy of Program Management Oversight

The F-35 JPO disagreed and stated that adequate program management oversight is in place. However, the F-35 JPO will address specific issues as it deems necessary to prevent adverse program cost, schedule, and performance issues.

Our Response

Our report identifies gaps in program management oversight of the F135 quality management system. Specifically, nonconformities were documented in the areas of: risk management, CDRL reviews, critical safety item program, supplier management, and establishing program quality assurance goals and objectives. By implementing our recommendations to conduct an effective root cause analysis and implement corrective actions for all 61 nonconformities (violations of AS9100C, regulatory requirements, and DoD policies), the F-35 JPO will address most of the program management oversight shortfalls that we found.

Defense Contract Management Agency Comments on Review of Contract Deliverables

DCMA agreed that the DCMA Aircraft Propulsion Ops (APO) at Pratt & Whitney did not review all CDRLs to identify deliverables that impact DCMA program surveillance. DCMA believes this risk was mitigated based on access to Pratt & Whitney's electronic document storage system where many of the CDRL items can be found and used for program surveillance. Going forward, DCMA APO-Pratt & Whitney will update contract receipt and review process checklists to ensure DCMA is included in the distribution of all CDRLs.

Defense Contract Management Agency Comments on Review of Minor Nonconformances, and Waivers and Deviations

DCMA partially agreed and stated that the F135 LRIP 6 and 7 contracts grant Pratt & Whitney Material Review Board (MRB) authority for disposition of minor nonconformances without Government approval. The F135 MOA with the JPO further states:

> DCMA will monitor minor waivers at the Pratt & Whitney Material Review Board (MRB) by surveillance of the Pratt & Whitney MRB activities, if allowed in the contract. If DCMA questions the clarity or technical content of a MRB action, DCMA will request PW [Pratt & Whitney] to clarify with supporting documentation and DCMA may discuss the condition with the JPO's responsible IPT Lead.

DCMA APO-Pratt & Whitney also has the right to reject engines at final inspection when the Government finds fault with Pratt & Whitney's MRB determination through post-review. DCMA APO-Pratt & Whitney will review and update the MOA with the F-35 JPO to clarify DCMA's functions for evaluating waivers and deviations.

Defense Contract Management Agency Comments on Corrective Action Information

DCMA partially agreed and stated that although DCMA could not provide all requested corrective action data within the timeframe requested, supporting documentation was available. DCMA is working on a central repository to maintain corrective action documentation to ensure it is more readily accessible and retrievable in the future. DCMA agreed that it did not comply with DCMA Instruction 1201, and the Instruction is currently under revision to clarify the CAR elevation process. Upon policy update approval, DCMA APQ-Pratt & Whitney will review all open CARS to determine if any warrant elevation to the next level, as recommended. DCMA APO-Pratt & Whitney will assess all open CARs based on the new policy to identify, analyze, and assess any impacts to F-35 product.

Our Response

We appreciate DCMA's plans to update its CDRL review process and develop a central repository to maintain corrective action documentation. However, DCMA's response on minor nonconformances and waivers and deviations do not align with Federal procurement policy on accepting or rejecting contractor products or services. We contacted the Defense Procurement and Acquisition Policy (DPAP) under the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD(AT&L)) for the Department's official perspective on FAR 46.407, "Nonconforming supplies or services." DPAP referenced the Office of Federal Procurement Policy (OFPP) Policy Letter 11-01, "Performance of Inherently Governmental and Critical Functions," which states that accepting or rejecting contractor products or services is an inherently governmental function.

Recommendations, Management Comments, and Our Response

Recommendation A.1

We recommend that the F-35 Joint Program Office:

a. **Coordinate with the Defense Contract Management Agency to conduct an effective root cause analysis and implement corrective actions for all 61 nonconformities (violations of AS9100C, regulatory requirements, and DoD policies) identified during our inspection.**

F-35 Joint Program Office Comments

The F-35 JPO agreed and stated that it will coordinate with DCMA to conduct an effective root cause analysis and implement corrective actions for all 61 nonconformities by the end of December 2015.

Our Response

The comments from the F-35 JPO meet the intent of our recommendation. No further comments are required.

b. **Review the contract data requirements list and determine specific items that should require approval.**

F-35 Joint Program Office Comments

The F-35 JPO agreed and stated that it will review CDRLs and determine specific items that should require approval. The F-35 JPO also stated that it reviewed CDRL approval determination every year while preparing the annual LRIP request for proposal. The F-35 JPO committed to complete actions for this recommendation by the end of April 2015.

Our Response

The comments from the F-35 JPO meet the intent of our recommendation. No further comments are required.

c. **Evaluate open major variance requests to determine whether specification changes are required and if achievable closure plans can be developed.**

F-35 Joint Program Office Comments

The F-35 JPO disagreed and stated that its process is compliant. The F-35 JPO also stated that the F135 program is still in development and is working to either meet or change the requirements at the end of SDD. All F135 MVRs have achievable closure plans in accordance with the F-35 acquisition strategy.

Our Response

Comments from the F-35 JPO did not address the specifics of the recommendation. According to FAR 46.407, the contracting officer must discourage the repeated tender of nonconforming supplies or services. A review of MVRs for LRIP 7 indicates that the program office is extending the effectivity of existing MVRs to cover entire LRIP 7 units, even though for some of the MVRs, an engineering solution has been identified. Concurrent development should not prevent the F-35 JPO from closing those MVRs not associated with aircraft system-level qualification testing and those MVRs that could lead to specification changes to meet performance limitations before the end of SDD. In addition, engineering documentation changes should be made to identify those components found to have limited life limitations. We request that the F-35 JPO provide additional comments in response to the final report.

Recommendation A.2

We recommend that the Defense Contract Management Agency:

a. Review the contract data requirements list items to identify any deliverables that impact Defense Contract Management Agency's program surveillance and coordinate with the F-35 Joint Program Office to resolve contract data requirements list distribution issues.

Defense Contract Management Agency Comments

DCMA agreed and stated that DCMA APQ-Pratt & Whitney will ensure CDRLs are reviewed as part of the contract receipt and review process to ensure CDRLs required for program surveillance are identified and coordinated with the F-35 JPO and the contractor to ensure proper distribution to DCMA APO-Pratt & Whitney. Contract receipt and review process checklists will be updated to ensure DCMA is included in the distribution of all CDRLs.

Our Response

The comments from DCMA meet the intent of our recommendation. No further comments are required.

b. Review and update the Memorandum of Agreement with the F-35 Joint Program Office to ensure that all Defense Contract Management Agency functions to evaluate waivers and deviations are clear and in accordance with the Federal Acquisition Regulation.

Defense Contract Management Agency Comments

DCMA agreed and stated that DCMA APO Pratt & Whitney will review and update the MOA with the F-35 JPO to clarify DCMA 's functions for evaluating waivers and deviations and ensuring they are clear and in accordance with the FAR.

Our Response

The comments from DCMA meet the intent of our recommendation. No further comments are required but the update to the MOA should incorporate additional information that we received on FAR 46.407. We contacted DPAP for the Department's official perspective on FAR 46.407. DPAP referenced OFPP Policy Letter 11-01, which states that accepting or rejecting contractor products or services is an inherently governmental function. DPAP further stated that,

> Since acceptance of minor non-conformances is an inherently governmental function, delegation should not be allowed. Contractor tasks in this area should be limited to assisting Government personnel in evaluating and making recommendations to accept or reject minor non-conformances.

c. Ensure that all associated data required to substantiate corrective action closure is accessible, available, and retrievable.

Defense Contract Management Agency Comments

DCMA partially agreed and stated that although DCMA could not provide all requested corrective action data within the requested timeframe, documentation is available. DCMA is working on a central repository to maintain corrective action documentation to ensure it is more readily accessible, available, and retrievable.

Our Response

Although data were available during the inspection, we agree with DCMA's approach to create a central repository to maintain corrective action documentation to ensure it is more readily accessible, available, and retrievable. No further comments are required.

Finding B

Critical Safety Item Program Not Fully Compliant

The F135 CSI program did not meet DoD CSI requirements. In addition, Pratt & Whitney did not meet CSI contractual requirements. A CSI program that is not fully compliant with DoD policy inhibits the ability of F135 personnel responsible for design, development, production, test, maintenance, and inspection to perform effective CSI life cycle management.

Discussion

The F-35 JPO required Pratt & Whitney to meet CSI SOW requirements that were based on NAVAIR Instruction 4200.25D, dated June 20, 2002, instead of the Joint Safety Service CSI Instruction, SECNAVINST 4140.2, "Management of Aviation Critical Items," dated January 25, 2006. Nevertheless, we found that the CSI program did not meet either NAVAIR Instruction 4200.25D or Joint Service CSI Instruction in several areas. Areas where the F135 CSI program did not meet DoD requirements include parts identification, critical characteristic identification, part determination methodology, and supplier identification. The lack of compliance with the Joint Service CSI Instruction increases the risk of nonconforming CSI parts being installed on aircraft, which directly affects personnel safety.

Pratt & Whitney processes and specifications did not meet all CSI contractual requirements identified in the CSI SOW. The CSI SOW required that all CSI key product characteristics to be identified and designated as "critical" or "major." However, Pratt & Whitney designated parts on the CSI list with undetermined key product characteristics. Also, Pratt & Whitney did not ensure that all drawings and associated technical data clearly identify that an item was CSI. As a result, DCMA is unable to provide source inspection on all CSI parts as required.

Management Comments on the Finding and Our Response

F-35 Joint Program Office Comments on Critical Safety Item Program Compliance

The F-35 JPO partially agreed and stated that CSI requirements were flowed to the contractor for LRIP1 at which time the F-35/F135 CSJ requirements were still being formulated. Beginning with LRIP 9, the F-35 JPO will include the part number also. The F-35 JPO is working to align with updated DoD requirements.

Our Response

The F-35 JPO's plan to align with updated DoD CSI instructions will address our recommendations on the F135 CSI program.

Recommendations, Management Comments, and Our Response

Recommendation B.1

We recommend that the F-35 Joint Program Office ensure that critical safety item contractual requirements and Pratt & Whitney's critical safety item program processes and specifications meet the intent of the Joint Critical Safety Item Instruction and supplemental guidance of the Joint Aeronautical Commanders Group Aviation Critical Safety Item Management Handbook.

F-35 Joint Program Office Comments

The F-35 JPO partially agreed and stated that CSI requirements were flowed to the contractor for LRIP1 at which time the F-35/F135 CSI requirements were still being formulated. F135 CSI parts are identified by nomenclature, not part number. However, beginning with LRIP 9 the F-35 JPO will include the part number also. The F-35 JPO is working to align with updated DoD requirements and also working with the contractor to document the process to fully align with DoD requirements by May 2015.

Our Response

The F-35 JPO's approach to align with updated DoD requirements meet the intent of our recommendations. However, we want to reiterate that the scope of our recommendation is broader than just addressing nonconformities with part number CSI requirements. No further comments are required.

Recommendation B.2

We recommend that the F-35 Joint Program Office ensure that critical safety items for already delivered engines meet DoD critical safety item requirements such that critical safety items receive proper care and handling during installation, testing, and field maintenance.

F-35 Joint Program Office Comments

The F-35 JPO disagreed and stated that as it is executing actions stated for Recommendation B.1, if the F-35 JPO discovers that a significant escape has occurred, then it will take appropriate action for delivered engines.

Our Response

The F-35 JPO's approach to take appropriate action based on results of implementing recommendation B.1 meet the intent of our recommendation. However, upon alignment with updated DoD CSI instructions, we request that the F-35 JPO provide us with evidence that delivered engines will meet DoD CSI requirements.

~~(FOUO)~~ Finding C

Contractor Shortfalls in Continuous Improvement

~~(FOUO)~~ The F-35 JPO did not establish F135 program quality goals and objectives that were mutually agreed upon by Pratt & Whitney for current contracts. Additionally, Pratt & Whitney metrics did not show improvement in quality assurance, process capability, and [redacted] If the F135 program does not make continuous improvement a top priority, product quality could degrade, especially with increasing production quantities over the next several years.

~~(FOUO)~~ Discussion

There were no established program objectives that were mutually agreed upon between Pratt & Whitney and F-35 JPO for the SDD contract. In addition, Pratt & Whitney did not have an established F135 quality plan that describes unique F135 program quality assurance requirements. Pratt & Whitney formally requested relief to eliminate the requirement to establish a quality plan for the F135 program on the PSDP; however, the F-35 JPO did not provide Pratt & Whitney formal relief from this requirement. Pratt & Whitney has an enterprise-level quality manual; however, this quality manual did not meet the SOW requirements for technical performance measures, product assurance requirements and goals, and critical manufacturing and supporting processes.

~~(FOUO)~~ We documented several nonconformities with Pratt & Whitney's performance measures. For example, Pratt & Whitney did not reduce nonconforming items per engine and quality escapes, and [redacted] Additionally, Pratt & Whitney did not meet process capability (C_{pk}) goals and did not consistently analyze and report KPC C_{pk} data for F135 engine hardware. DCMA relied on this data to establish mandatory Government inspection points. The F-35 JPO also monitored the data as an indication of technical and program risk. If Pratt & Whitney personnel do not correctly analyze and report KPC data, then the F-35 JPO and DCMA cannot make sound program and resource management decisions.

Management Comments on the Finding and Our Response

F-35 Joint Program Office Comments on the F135 Quality Plan

The F-35 JPO partially agreed and stated that it accepted the Pratt & Whitney Company Quality Plan instead of a specific F135 Quality Plan. The F-35 JPO also stated that there is neither a Department nor other defined requirement for a program-specific quality assurance plan. In addition, it is not required by the SOW. The program manager has the responsibility to decide how to proceed based on the size/complexity/risk of the program.

Our Response

The F-35 JPO's plan to ensure that Pratt & Whitney's quality plan meets contractual requirements will address our recommendation.

Recommendations, Management Comments, and Our Response

Recommendation C.1

We recommend that the F-35 Joint Program Office establish F135 program quality goals and objectives that are mutually agreed upon by Pratt & Whitney and track Pratt & Whitney's performance against those objectives.

F-35 Joint Program Office Comments

The F-35 JPO partially agreed and stated that program quality goals and objectives have been established and agreed upon. They are tracked and presented to program management. Since the PEOs November 2014 Quality Update, the program has established F135-specific program goals. The F-35 JPO plans to reflect quality goals and objectives in future production contracts.

Our Response

Although program goals and objectives were not in place at the time of our inspection, we are pleased that the F-35 JPO has since established them in the PEO's November 2014 Quality Update and are planning to reflect those goals and objectives in future production contracts. We request that the F-35 JPO provide us with the updated program quality goals and objectives to determine if it meets the intent of our recommendation.

Recommendation C.2

We recommend that the F-35 Joint Program Office ensure that Pratt & Whitney's quality plan meets contractual requirements.

F-35 Joint Program Office Comments

The F-35 JPO agreed and stated that it will ensure that Pratt & Whitney's quality plan meets contractual requirements as reflected in future production contracts.

Our Response

The comments from the F-35 JPO meet the intent of our recommendation. No further comments are required.

Recommendation C.3

We recommend that the F-35 Joint Program Office ensure that Pratt & Whitney consistently analyzes and reports KPC C_{pk} data for F135 engine hardware and that performance improvement plans are established.

F-35 Joint Program Office Comments

The F-35 JPO agreed and stated that it will ensure that Pratt & Whitney consistently analyzes and reports KPC C_{pk} data for F135 engine hardware and that performance improvement plans are established. The F-35 JPO committed to complete actions for this recommendation by April 2015.

Our Response

The comments from the F-35 JPO meet the intent of our recommendation. No further comments are required.

Finding D

Insufficient Risk Management Practices

The F-35 JPO did not ensure that Pratt & Whitney proactively identify, elevate, track, and manage F135 program risks, in accordance with the F135 risk management plan. As a result, risks that can adversely affect the F135 program may not receive program management visibility and awareness.

Discussion

The risk management program at Pratt & Whitney did not provide program management visibility and awareness of risks that can adversely affect the program. We found that the RIMB only discussed technical risks and not production, sustainment, design, or supply chain risks. There was also insufficient evidence that the required personnel were present during the RIMB to make decisions on risks. Lastly, we found that the Pratt & Whitney's F135 risk management database did not reflect accurate risk information including risk category, status, mitigation plans, and risk ranking.

Pratt & Whitney generated issues at the software development integrated product team level; however, there was no evidence that these issues were analyzed to determine system level risks. For example, there were at least 40 open safety critical technical issues without risk analysis documentation to determine whether the issues were potential software risks that should be elevated to the RIMB.

To effectively perform risk management activities, the DOD risk management guide recommends proactive identification and analyses of risks during all program phases; effective implementation of corrective action; continuous monitoring; and communication, documentation, and coordination.

The F-35 JPO should ensure that Pratt & Whitney maintain an effective risk management program with rigor and discipline to identify, evaluate, and mitigate risks; otherwise, significant risks and issues that should be managed and tracked at the system level may be overlooked.

Management Comments on the Finding and Our Response

F-35 Joint Program Office Comments on Risk Management

The F-35 JPO disagreed and stated that Pratt & Whitney follows standard risk management processes for identification and tracking. The F-35 JPO also stated that high-level risks are discussed by the air system management teams at regular meetings.

Our Response

During our inspection we found nonconformities with Pratt & Whitney's lack of adherence to the F135 risk management process. For example, we found that the RIMB only discussed technical risks, the risk management database was incomplete and inaccurate, and there was insufficient evidence that lower-level risks were analyzed and elevated.

Recommendation, Management Comments, and Our Response

Recommendation D

We recommend that the F-35 Joint Program Office ensure that Pratt & Whitney identify, elevate, track, and manage all risks that affect the program, including software and supply chain risks.

F-35 Joint Program Office Comments

The F-35 JPO partially agreed and stated that it will ensure Pratt & Whitney identify, elevate, track, and manage all risks that affect the program, including software and supply chain risks. The F-35 JPO also clarified that the F135 RIMB is not the only process used and that software system-level risks are already evaluated and documented at the software integrated product team board weekly meeting. Items with significant air system-level impact also receive an Air System Software Problem Anomaly Report (SPAR) Board severity assessment. Issues with a high criticality rank, which impact safety or major program objectives, are treated properly by elevating to program management and taking immediate action to fix the problem.

Our Response

The F-35 JPO's commitment to ensure that Pratt & Whitney identifies, elevates, tracks, and manages all risks that affect the program meet the intent of our recommendations. However, at the time of our inspection, we found that the risk management database at Pratt & Whitney was incomplete and inaccurate, and there was insufficient evidence that the lower component-level software risks were identified, elevated, tracked, and managed. No further comments are required.

Finding E

Insufficient Supplier Selection Criteria and Management of Underperforming Suppliers

The F-35 JPO did not ensure that Pratt & Whitney's supplier selection criteria and management of underperforming suppliers were sufficient. As a result, Pratt & Whitney cannot provide the F-35 JPO assurance that their suppliers are qualified to deliver quality products.

Discussion

Pratt & Whitney's minimum baseline criteria for selecting suppliers, such as performance/quality history, and cost and schedule data, were not well defined within its procurement policies and procedures. We also found that Pratt & Whitney did not adequately define the actions that should be taken when a supplier continues to have a poor quality rating or is considered a high risk. We identified multiple F135 suppliers that were considered high risk for extended periods of time. One supplier was rated as high risk for 33 consecutive months.

Pratt & Whitney did not review and verify CARs issued to its suppliers in a timely manner. In many cases, the supplier responded with a root cause corrective action plan by the due date; however, Pratt & Whitney did not review and close out the CARs within a reasonable timeframe. Some CARs were not closed out until almost 2 years later. If CARs are not closed out in a timely manner, then there is a high risk of continued recurrence of the nonconformance.

Management Comments on the Finding and Our Response

F-35 Joint Program Office Comments on Supplier Management

F-35 JPO partially agreed and stated that supplier selection was sufficient; however, it needs to re-evaluate Pratt & Whitney's management of underperforming suppliers to ensure suppliers are qualified to deliver quality products.

Our Response

The F-35 JPO's plan to work with DCMA to ensure that Pratt & Whitney implements criteria for supplier selection and actions to be taken for suppliers that continue to be high risk will address our recommendations.

Recommendations, Management Comments, and Our Response

Recommendation E.1

We recommend that the F-35 Joint Program Office work with the Defense Contract Management Agency to ensure that Pratt & Whitney clearly defines, documents, and implements minimum baseline criteria for supplier selection and actions to be taken for suppliers that continue to be high risk.

F-35 Joint Program Office Comments

The F-35 JPO agreed and stated that it will work with the DCMA to ensure that Pratt & Whitney clearly defines, documents, and implements minimum baseline criteria for supplier selection and actions to be taken for suppliers that continue to be high risk.

Our Response

The comments from the F-35 JPO meet the intent of our recommendation. No further comments are required.

Recommendation E.2

We recommend that the Defense Contract Management Agency perform additional surveillance on Pratt & Whitney's corrective action requests issued to suppliers to ensure that they are closed within a reasonable timeframe.

Defense Contract Management Agency Comments

DCMA agreed and stated that DCMA APO-Pratt & Whitney will incorporate supplier corrective action into the quality management system surveillance plan to ensure Pratt & Whitney management of supplier corrective action is in compliance with its quality system.

Our Response

The comments from DCMA meet the intent of our recommendation. No further comments are required.

Finding F

Inadequate Software Quality Management Practices

The F-35 JPO did not ensure that Pratt & Whitney demonstrated adequate software quality management practices. Pratt & Whitney had an obsolete SDP and had requirements that were not fully implemented or traceable. Additionally, Pratt & Whitney was not performing required audits and reviews to ensure that software products meet contractual requirements. As a result, there is no assurance that software products meet contractual requirements and there is increased risk to performance of critical software.

Discussion

The F135 SDP did not describe the current software architecture, did not identify all software configuration items, and did not define all applicable PSLs. In addition, boot CSCI software requirements were not implemented or traceable to the software design description, the software test plan, and the software test description. For example, there was no evidence that the safety requirement for the boot software to provide fail-safe recovery from inadvertent instruction jumps was met. Pratt & Whitney was also not developing and testing PHM software at the same PSL of the CSCI that it is embedded in. Incomplete requirements verification and software not developed and tested in accordance with PSL requirements could create a performance and safety risk for critical F135 software.

We found several issues with Pratt & Whitney's SQA organization. For example, the SQA organization did not conduct physical configuration audits and functional configuration audits for the main engine, lift system, and boot CSCIs. For supplier-developed software, the SQA organization did not conduct software lifecycle audits on all software suppliers. Moreover, there was no evidence that the SQA organization verified software change requests, witnessed testing and integration reviews, and reviewed software release packages in accordance with its own internal procedure. The F-35 JPO must ensure that Pratt & Whitney's SQA organization perform its required functions such that quality assurance practices are being implemented for critical software products.

Management Comments on the Finding and Our Response

F-35 Joint Program Office Comments on Software Quality Management

The F-35 JPO disagreed and stated that software quality management practices are in place, and technical reviews have been conducted. The F-35 JPO also stated that the software development plan was in review before our inspection.

Our Response

Pratt & Whitney has processes in place; however, the nonconformities we documented during the inspection pertained to implementation. For example, Pratt & Whitney's SQA organization did not conduct physical configuration audits, functional configuration audits, and software lifecycle audits, and had no evidence that the SQA organization verified software change requests, witnessed testing, or reviewed software release packages. F-35 JPO's response did not provide detail to substantiate its disagreement with our finding discussions.

Recommendations, Management Comments, and Our Response

Recommendation F.1

We recommend that the F-35 Joint Program Office ensure that Pratt & Whitney resolve nonconformities related to software quality management systems, including an obsolete F135 Software Development Plan, lack of software requirements traceability, and software not developed to the appropriate product software level.

F-35 Joint Program Office Comments

The F-35 JPO disagreed and stated that software is developed to the correct PSL. The F-35 JPO also stated that the software development plan is not obsolete but needs only minor updates that were already in work before this inspection. These updates do not invalidate the software flight clearances completed to date as they merely clarify existing processes and procedures.

Our Response

We do not agree that that the software development plan is not obsolete but only needs minor updates. The F135 SDP did not describe the current software architecture, did not identify all software configuration items, and did not define all applicable PSL. An SDP that does not define or reference all software configuration items and their levels of control can lead to conflicting requirements, incorrect design implementation, and rework.

In reference to whether software is developed to the correct PSL, we found that because the PHM software is now embedded in the main engine and lift system, which are designated at the highest PSL, PHM should be developed and tested to the same requirements, unless controls are in place to ensure it won't adversely affect the main engine and lift system software.

Lastly, the F-35 JPO did not provide details or address our recommendation on resolving nonconformities on the lack of software requirements traceability. We request that the F-35 JPO reconsider its position and provide additional comments and substantiating information in response to the final report.

Recommendation F.2

We recommend that the F-35 Joint Program Office ensure that Pratt & Whitney's Software Quality Assurance organization conduct audits, reviews, and verification activities of both internally-developed and supplier-developed software.

F-35 Joint Program Office Comments

The F-35 JPO agreed and stated that it will ensure that Pratt & Whitney's Software Quality Assurance organization conduct audits, reviews, and verification activities of both internally developed and supplier developed software.

Our Response

The comments from the F-35 JPO meet the intent of our recommendation. No further comments are required.

Recommendation F.3

We recommend that the F-35 Joint Program Office ensure Pratt & Whitney assess the impact of insufficient software verification on delivered engines.

F-35 Joint Program Office Comments

The F-35 JPO disagreed and stated that the F135 propulsion system software was properly tested against the standards in the software development plan and work instructions. Multiple flight clearances performed since the beginning of the F135 program are supported by the excellent safety record for software in engine ground test, flight test, and production.

Our Response

Comments from the F-35 JPO did not fully address the specifics of the recommendation. The nonconformities we documented during our inspection identified that there were software requirements for the Boot CSCI and PHM that were not tested or verified. For example, there was no evidence that the safety requirement for the boot software to provide fail-safe recovery from inadvertent instruction jumps was met. We do not dispute the safety record for software in engine ground test, flight test, and production; however, such testing does not guarantee that all software requirements and functionality have been verified. We request that the F-35 JPO reconsider its position and provide additional comments in response to the final report.

Appendix A

Scope and Methodology

We conducted this evaluation from October 2014 through February 2015 in accordance with the Council of Inspectors General on Integrity and Efficiency, "Quality Standards for Inspection and Evaluation." Those standards require that we plan and perform the evaluation to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our evaluation objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our evaluation objectives.

We performed quality assurance inspections at the F-35 JPO in Arlington, Virginia, and Pratt & Whitney facilities in East Hartford and Middletown, Connecticut, to evaluate the F135 quality management system. We also met with DCMA personnel directly involved with the F-35 engine program. Our inspection focused on the following:

- applicable statutory and regulatory requirements,
- contractual quality management system requirements (AS9100C), and
- internal quality assurance processes and procedures.

Statutory and Regulatory Requirements

We inspected the F-35 JPO and Pratt & Whitney implementation of aviation critical safety item requirements. Public Law 108-136, Section 802, "Quality control in procurement of aviation CSIs and related services," requires DoD to prescribe a quality control policy for the procurement of aviation CSIs. Title 10, Section 2319 of the United Sates Code is the applicable statute that implements aviation CSI requirements of Public Law 108-136, Section 802. Joint Service CSI Instruction, "Management of Aviation Critical Safety Items," implements the DOD CSI program and establishes the policies, procedures, and responsibilities to manage CSI. The Joint Aeronautical Commanders Group (JACG), "JACG Aviation Critical Safety Item Handbook," implements the policies in the Joint Service CSI Instruction and describes the technical and quality assurance requirements for a prime contractor CSI program.

Additionally, we evaluated the compliance of applicable requirements in the Federal Acquisition Regulation and DoD Directive 5000.01, "The Defense Acquisition System."

AS9100 Standard

We performed our inspection against the contractually required AS9100C standard.

The AS9100C standard breaks down quality assurance requirements into five major clauses:

- Quality Management System,
- Management Responsibility,
- Resource Management,
- Product Realization, and
- Measurement, Analysis, and Improvement.

The Quality Management System, Management Responsibility, and Resource Management clauses require the organization to have a quality assurance management organization that has all the resources and authority to affect the end-item quality of the product. In addition, it requires the organization to have a quality assurance manual and strict control over all documentation, data, and procedures that affect the quality of the product. Product Realization covers the activities and processes necessary to bring a product into existence.

Product realization is broken down further by the AS9100 standard as follows:

- Planning of Product Realization,
- Customer-Related Processes,
- Design and Development,
- Purchasing,
- Production and Service Provision, and
- Control of Monitoring and Measuring Equipment.

Planning of Product Realization requires the organization to develop processes needed for design and development of product and includes elements such as procedures, quality assurance records, resource requirements, safety and reliability programs, and inspection and test. Customer-Related Process requires the organization to determine customer requirements both specified and derived. These requirements include technical, statutory, and regulatory requirements. Design and Development includes requirements that cover planning, inputs, outputs, review, verification, validation, and control of changes as related to design and development. Purchasing requires the organization to ensure that the purchased product conforms to specified purchase requirements and that all products purchased from suppliers are verified against these requirements. Production and Service Provision requires the organization to ensure that

production is accomplished under controlled conditions using drawings and specifications, work instructions, production tools and software programs, monitoring and measuring equipment, and evidence that all production and inspection/verification operations have been completed as planned. Control of Monitoring and Measuring Equipment requires the organization to ensure that devices used for determining product compliance with performance characteristics are properly maintained to provide assurance of credible measurements.

Measurement, Analysis, and Improvement requires the organization to ensure the product continuously improves. This clause includes customer satisfaction, internal audit, monitoring and measuring processes and product, and control of nonconforming products to ensure continual improvement.

Use of Computer-Processed Data

We did not use computer-processed data to perform this evaluation.

Use of Technical Assistance

We established multi-disciplined teams of engineers, military aviation CSI subject matter experts, and quality assurance subject matter experts who evaluated the F-35 engine program based on the AS9100C quality management standard. Team members were trained and certified in AS9100, with an average of 17 years of quality assurance audit experience. Additionally, our team included two subject matter experts in military aviation CSI.

Appendix B

Prior Coverage

During the last 5 years, the Government Accountability Office (GAO) and the Department of Defense Office of Inspector General (DoD OIG) issued 29 reports discussing the F-35 Joint Strike Fighter. Unrestricted GAO reports can be accessed at http://www.gao.gov. Unrestricted DoD IG reports can be accessed at http://www.dodig.mil/pubs/index.cfm.

GAO

Report No. GAO-14-778, "F-35 Sustainment: Need for Affordable Strategy, Greater Attention to Risks, and Improved Cost Estimates," September 23, 2014

Report No. GAO-14-340SP, "Defense Acquisitions: Assessments of Selected Weapon Programs," March 31, 2014

Report No. GAO-14-468T, "F-35 Joint Strike Fighter: Slower Than Expected Progress in Software Testing May Limit Initial Warfighting Capabilities," March 26, 2014

Report No. GAO-14-322, "F-35 Joint Strike Fighter: Problems Completing Software Testing May Hinder Delivery of Expected Warfighting Capabilities," March 24, 2014

Report No. GAO-13-690T, "F-35 Joint Strike Fighter: Restructuring Has Improved the Program, but Affordability Challenges and Other Risks Remain," June 19, 2013

Report No. GAO-13-500T, "F-35 Joint Strike Fighter: Program Has Improved in Some Areas, but Affordability Challenges and Other Risks Remain," April 17, 2013

Report No. GAO-13-294SP, "Defense Acquisitions: Assessments of Selected Weapon Programs," March 28, 2013

Report No. GAO-13-309, "F-35 Joint Strike Fighter: Current Outlook Is Improved, but Long-Term Affordability Is a Major Concern," March 11, 2013

Report No. GAO-12-437, "Joint Strike Fighter: DOD Actions Needed to Further Enhance Restructuring and Address Affordability Risks," June 14, 2012

Report No. GAO-12-400SP, "Defense Acquisitions: Assessments of Selected Weapon Programs," March 29, 2012

Report No. GAO-12-525T, "Joint Strike Fighter: Restructuring Added Resources and Reduced Risk, but Concurrency Is Still a Major Concern," March 20, 2012

Report No. GAO-11-903R, "Joint Strike Fighter: Implications of Program Restructuring and Other Recent Developments on Key Aspects of DOD's Prior Alternate Engine Analyses," September 14, 2011

Report No. GAO-11-677T, "Joint Strike Fighter: Restructuring Places Program on Firmer Footing, but Progress Is Still Lagging," May 19, 2011

Report No. GAO-11-325, "Joint Strike Fighter: Restructuring Places Program on Firmer Footing, but Progress Still Lags," April 7, 2011

Report No. GAO-11-450T, "Joint Strike Fighter: Restructuring Should Improve Outcomes, but Progress Is Still Lagging Overall," March 15, 2011

Report No. GAO-11-323R, "Tactical Aircraft: Air Force Fighter Force Structure Reports Generally Addressed Congressional Mandates, but Reflected Dated Plans and Guidance, and Limited Analyses," February 24, 2011

Report No. GAO-11-171R, "Defense Management: DOD Needs to Monitor and Assess Corrective Actions Resulting from Its Corrosion Study of the F-35 Joint Strike Fighter," December 16, 2010

Report No. GAO-10-1020R, "Joint Strike Fighter: Assessment of DOD's Funding Projection for the F136 Alternate Engine," September 15, 2010

Report No. GAO-10-789, "Tactical Aircraft: DOD's Ability to Meet Future Requirements is Uncertain, with Key Analyses Needed to Inform Upcoming Investment Decisions," July 29, 2010

Report No. GAO-10-388SP, "Defense Acquisitions: Assessments of Selected Weapon Programs," March 30, 2010

Report No. GAO-10-478T, "Joint Strike Fighter: Significant Challenges and Decisions Ahead," March 24, 2010

Report No. GAO-10-382, "Joint Strike Fighter: Additional Costs and Delays Risk Not Meeting Warfighter Requirements on Time," March 19, 2010

Report No. GAO-10-520T, "Joint Strike Fighter: Significant Challenges Remain as DOD Restructures Program," March 11, 2010

Report No. GAO-09-711T, "Joint Strike Fighter: Strong Risk Management Essential as Program Enters Most Challenging Phase," May 20, 2009

Report No. GAO-09-326SP, "Defense Acquisitions: Assessments of Selected Weapon Programs," March 30, 2009

Report No. GAO-09-303, "Joint Strike Fighter: Accelerating Procurement before Completing Development Increases the Government's Financial Risk," March 12, 2009

DOD OIG

Report No. DODIG-2015-092, "F-35 Lightning II Program Quality Assurance and Corrective Action Evaluation," March 11, 2015

Report No. DODIG-2013-140, "Quality Assurance Assessment of the F-35 Lightning II Program," September 30, 2013

Report No. DODIG-2013-031, "Audit of the F-35 Lightning II Autonomic Logistics Information System (ALIS)," December 10, 2012

Management Comments

F-35 Joint Program Office and Defense Contract Management Agency Comments

F-35 LIGHTNING II JOINT PROGRAM OFFICE
200 12th Street South, Suite 600
Arlington, Virginia 22202-5402

MAR 23 2015

From: Program Executive Officer, F-35 Lightning II Joint Program Office (JPO) and Director, Defense Contract Management Agency (DCMA)

To: Department of Defense (DoD) Deputy Inspector General (IG) for Policy and Oversight

Subj: RESPONSE TO F-35 ENGINE QUALITY ASSURANCE INSPECTION (PROJECT NO. D2014-DT0TAD-0003.000)

Thank you for the opportunity to comment on your draft report, "F-35 Engine Quality Assurance Inspection", dated 25 February 2015.

Both the F-35 Lightning II Joint Program Office (JPO) and the Defense Contract Management Agency (DCMA) take very seriously the findings and recommendations offered in the report. As noted in Enclosure 1, F-35 JPO and DCMA Response to Findings and Recommendations, our team has aggressively addressed DoD IG findings since receipt of the draft report in January 2015. The implementation of these corrective actions has led to significant progress in delivering a quality, timely, and cost-effective weapon system to the United States and its allies.

Enclosure 1 provides a detailed response to each finding and recommendation.

The action officers for this response are [redacted]

CHRISTOPHER C. BOGDAN
Lieutenant General, USAF
Program Executive Officer

WENDY M. MASIELLO
Lieutenant General, USAF
Defense Contract Management Agency

Enclosures:
1. F-35 JPO and DCMA Response to Findings/Recommendations

cc:
Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics
Assistant Secretary of the Navy for Research, Development and Acquisition
Assistant Secretary of the Air Force (Acquisition)

F-35 Joint Program Office and Defense Contract Management Agency Comments (cont'd)

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Combined F-35 JPO and DCMA Responses to DoD IG
F-35 Engine Quality Assurance Inspection Report
Project No. D2014-DT0TAD-0003.000

Finding A

Additional Program Management Oversight Required

We found that additional program management oversight is required by F-35 JPO and DCMA, as evidenced by the 61 nonconformities (violations of AS9100C, regulatory requirements, and DoD policy) that we documented during our inspection. F-35 JPO and DCMA oversight is required to prevent adverse program cost, schedule, and performance issues.

JPO Response: *Disagree. The JPO believes that adequate program management oversight is in place. However, specific issues will be addressed as the JPO deems necessary to prevent adverse program cost, schedule, and performance issues.*

Finding A Discussion

The F-35 JPO awarded SDD and LRIP contracts with CDRL items that were delivered for information only, and not for approval. We also found that DCMA was not notifying the procuring contracting officer of their absence in the distribution list for CDRLs impacting program surveillance activities. The absence of F-35 JPO approval and DCMA review of CDRL items limits the ability of the government to provide clear direction and guidance to the contractor.

DCMA Response: *Agree. DCMA APO-Pratt & Whitney did not review all CDRLs to identify deliverables that impact DCMA program surveillance. DCMA believes this risk was mitigated based on access to Pratt & Whitney's electronic document storage system where many of the CDRL items can be found and utilized for program surveillance. Going forward, DCMA APO-Pratt & Whitney will update Contract receipt and review process checklists to ensure DCMA is included in the distribution of all CDRLs.*

The F-35 JPO used the variance process to waive requirements for extended periods of time, which was a misapplication of the variance request process and did not discourage the repeated tender of nonconforming supplies or services in accordance with FAR 46.407, "Nonconforming Supplies or Services." To date, there are 45 outstanding MVRs of the original 175 MVRs from the production baseline in 2009; approximately 37 MVRs could lead to specification changes to meet the performance limitations. The F-35 JPO will continue to accept nonconforming engines if MVR extensions continue to be approved and not resolved.

DCMA could not provide evidence of evaluating and making recommendations for the acceptance or rejection of waivers and deviations. According to FAR 42.302, "Contract Administration Functions," DCMA is to assist in evaluating and make recommendations for acceptance or rejection of waivers and deviations. The MOA between the F-35 JPO and DCMA did not relieve DCMA of this function. DCMA needs to perform this function to ensure that variances are correctly classified, reviewed, and approved.

DCMA Response: *Partially Agree. FAR 46.407(d) states "If the nonconformance is minor, the cognizant contract administration office may make the determination to accept or reject, except where this authority is withheld by the contracting office of the contracting activity." The F135 LRIP 6 and 7 contracts grant Pratt & Whitney Material Review Board (MRB) authority for disposition of minor nonconformances without government approval. Since the contractor has this authority by virtue of the contract language, DCMA's evaluation and recommendations of acceptance or rejection of waivers or deviations as stated in FAR 42.302(a) (47) is being performed as stated in the contract "Minor non-conformances processed through the contractor's Material Review Board (MRB) are subject to DCMA post review." The F135 MOA with the JPO further states: "DCMA will monitor minor waivers at the Pratt & Whitney Material Review Board (MRB) by surveillance of the PW MRB activities, if allowed in the contract. If DCMA questions the clarity or technical content of a MRB action, DCMA will request PW clarify with supporting documentation and DCMA may discuss the condition with the JPO's responsible IPT Lead." DCMA APO-Pratt & Whitney also has the right to reject engines presented at final inspection to the Government when the Government*

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F-35 Joint Program Office and Defense Contract Management Agency Comments (cont'd)

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finds fault with their MRB determination through post-review. DCMA APO-Pratt & Whitney will review and update the MOA with the F-35 Joint Program Office to clarify DCMA's functions for evaluating waivers and deviations.

DCMA could not provide sufficient evidence of supporting information to substantiate closure of CARs, approval of contractor corrective action plans for CARs, verification of corrective actions for CARs, follow-up on Level II CARs, and escalation of CARs to the next higher level when corrective actions were deemed ineffective. Without sufficient evidence of adherence to the corrective action process, we do not have confidence that deficiencies were captured, completed, and verified to prevent recurrence of deficiencies in affected products.
DCMA Response: *Partially Agree. While DCMA could not provide all requested corrective action data within the time frame desired by the DODIG, documentation supporting CAR/CAP approval, closure and verification is available. DCMA is working on a central repository to maintain corrective action documentation to ensure it is more readily accessible and retrievable in the future. DCMA agrees we did not execute to DCMA Instruction #1201 and that this instruction requires clarification. It is currently under revision to address clarification to the CAR elevation process. DCMA Headquarters will provide an updated policy with an estimated completion date of early 2015. Upon policy update approval, DCMA APO-Pratt & Whitney will review all open CARS to determine if any warrant elevation to the next level as recommended. DCMA APO-Pratt & Whitney will assess all open CARs based on new policy guidance to identify, analyze, and assess any impacts to F-35 product.*

Recommendation A.1
We recommend that the F-35 Joint Program Office:
a) Coordinate with the Defense Contract Management Agency to conduct an effective root cause analysis and implement corrective actions for all 61 nonconformities (violations of AS9100C, regulatory requirements, and DoD policies) identified during our inspection.
JPO Response: *Agree. JPO will coordinate with DCMA to conduct an effective root cause analysis and implement corrective actions for all 61 nonconformities. Complete by end of Dec 2015.*

b) Review the contract data requirements list and determine specific items that should require approval.
JPO Response: *Agree. JPO will review CDRLs and determine specific items that should require approval. The JPO has reviewed CDRL approval determination every year while preparing the annual LRIP RFPs. LRIP 11 RFP will be released later this year. Complete by end of April 2015.*

c) Evaluate open major variance requests to determine whether specification changes are required and if achievable closure plans can be developed.
JPO Response: *Disagree. The JPO variance process is compliant. The F135 Program is still in development and is working to either meet or change the requirements at the end of SDD. All F135 MVRs have achievable closure plans in accordance with the F-35 acquisition strategy.*

Recommendation A.2
We recommend that the Defense Contract Management Agency:
a) Review the contract data requirements list items to identify any deliverables that impact Defense Contract Management Agency's program surveillance and coordinate with the F-35 Joint Program Office to resolve contract data requirements list distribution issues.
DCMA Response: *Agree. DCMA APO-Pratt & Whitney will ensure Contract Data Requirements Lists (CDRLs) are reviewed as part of the contract receipt and review process to ensure CDRLs required for program surveillance are identified and coordinated with the F-35 Joint Program Office and the contractor to ensure proper distribution is made to DCMA APO-Pratt & Whitney. Contract receipt and review process checklists will be updated to ensure DCMA is included in the distribution of all CDRLs.*

b) Review and update the Memorandum of Agreement with the F-35 Joint Program Office to ensure that all Defense Contract Management Agency functions to evaluate waivers and deviations are clear and in accordance with the Federal Acquisition Regulation.

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F-35 Joint Program Office and Defense Contract Management Agency Comments (cont'd)

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DCMA Response: *Agree. DCMA APO-Pratt & Whitney will review and update the MOA with the F-35 Joint Program Office to clarify DCMA's functions for evaluating waivers and deviations and ensuring they are clear and in accordance with the Federal Acquisition Regulation.*

c) Ensure that all associated data required to substantiate corrective action closure is accessible, available, and retrievable.
DCMA Response: *Partially Agree. While DCMA could not provide all requested corrective action data within the time frame desired by the DODIG, documentation is available. DCMA is working on a central repository to maintain corrective action documentation to ensure it is more readily accessible, available and retrievable.*

Finding B

Critical Safety Item Program Not Fully Compliant

The F135 CSI program did not meet DoD CSI requirements. In addition, Pratt & Whitney did not meet CSI contractual requirements. A CSI program that is not fully compliant with DoD policy inhibits the ability of F135 personnel responsible for design, development, production, test, maintenance, and inspection to perform effective CSI life cycle management.
JPO Response: *Partially agree. CSI requirements were flowed to the contractor for LRIP1 at which time the F-35/F135 CSI requirements were still being formulated. Beginning with LRIP 9 the program will include the part number also. The JPO is working to align with updated DoD and department instructions.*

Recommendation B.1
We recommend that the F-35 Joint Program Office ensure that critical safety item contractual requirements and Pratt & Whitney's critical safety item program processes and specifications meet the intent of the Joint Critical Safety Item Instruction and supplemental guidance of the Joint Aeronautical Commanders Group Aviation Critical Safety Item Management Handbook.
JPO Response: *Partially agree. CSI requirements were flowed to the contractor for LRIP1 at which time the F-35/F135 CSI requirements were still being formulated. F135 CSI parts are identified by nomenclature, not part number. However, beginning with LRIP 9 the program will include the part number also. The JPO is working to align with updated DoD and department instructions. JPO is working with the contractor to document the process to allow for full alignment with DOD requirements. Complete by May 2015.*

Recommendation B.2
We recommend that the F-35 Joint Program Office ensure that critical safety items for already delivered engines meet DoD critical safety item requirements such that critical safety items receive proper care and handling during installation, testing, and field maintenance.
JPO Response: *Disagree. During execution of Recommendation of B.1, if it is discovered that a significant escape has occurred, then the JPO will take appropriate action for delivered engines.*

~~(FOUO)~~ Finding C

Contractor Shortfalls in Continuous Improvement

The F-35 JPO did not establish F135 program quality goals and objectives that were mutually agreed upon by Pratt & Whitney for current contracts. Additionally, Pratt & Whitney metrics did not show improvement in quality, process capability, and [redacted] If the F135 program does not make continuous improvement a top priority, product quality could degrade, especially with increasing production quantities over the next several years.
JPO Response: *Partially agree. JPO accepted the P&W Company Quality Plan in lieu of a specific P&W F135 Quality Plan. There is no Department or other defined requirement for a program-specific Quality Plan nor is it required by SOW. The Program Manager has the responsibility to decide how to proceed based upon the size/complexity/risk of the program.*

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F-35 Joint Program Office and Defense Contract Management Agency Comments (cont'd)

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Recommendation C.1
We recommend that the F-35 Joint Program Office establish F135 program quality goals and objectives that are mutually agreed upon by Pratt & Whitney and track Pratt & Whitney's performance against those objectives.
JPO Response: *Partially agree. Program quality goals and objectives have been established and agreed upon. They are tracked and presented to program management. Since the PEOs November 2014 Quality Update the program has established F135 specific program goals. This will be reflected in future production contracts.*

Recommendation C.2
We recommend that the F-35 Joint Program Office ensure that Pratt & Whitney's quality plan meets contractual requirements.
JPO Response: *Agree. JPO will ensure that Pratt & Whitney's quality plan meets contractual requirements as reflected in future production contracts.*

Recommendation C.3
We recommend that the F-35 Joint Program Office ensure that Pratt & Whitney consistently analyzes and reports KPC Cpk data for F135 engine hardware and that performance improvement plans are established.
JPO Response: *Agree. JPO will ensure that Pratt & Whitney consistently analyzes and reports KPC Cpk data for F135 engine hardware and that performance improvement plans are established. Complete by end of April 2015.*

Finding D
Insufficient Risk Management Practices
The F-35 JPO did not ensure that Pratt & Whitney proactively identify, elevate, track, and manage F135 program risks, in accordance with the F135 risk management plan. As a result, risks that can adversely affect the F135 program may not receive program management visibility and awareness.
JPO Response: *Disagree. Contactor follows standard risk management processes for identification and tracking. The team actively work identified risks. High level risks have visibility across the air system management teams at regular meetings.*

Recommendation D
We recommend that the F-35 Joint Program Office ensure that Pratt & Whitney identify, elevate, track, and manage all risks that affect the program, including software and supply chain risks.
JPO Response: *Partially agree. JPO will ensure that Pratt & Whitney identify, elevate, track, and manage all risks that affect the program, including software and supply chain risks. The F135 RIMB is not the only process used by P&W and the JPO. Software system level risks are already evaluated and documented at the software integrated product team board weekly meeting. Items with significant air system level impact will also receive an Air System SPAR Board severity assessment. Those issues with high criticality rank which impact safety or major program objectives are treated properly by elevating to program management and taking immediate action to fix the problem.*

Finding E
Insufficient Supplier Selection Criteria and Management of Underperforming Suppliers
The F-35 JPO did not ensure that Pratt & Whitney's supplier selection criteria and management of underperforming suppliers were sufficient. As a result, Pratt & Whitney cannot provide the F-35 JPO assurance that their suppliers are qualified to deliver quality products.

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F-35 Joint Program Office and Defense Contract Management Agency Comments (cont'd)

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JPO Response: *Partially agree. JPO disagrees that it did not ensure that supplier selection was sufficient; however does agree to re-evaluate PW's management of underperforming suppliers to ensure suppliers are qualified to deliver quality products.*

Recommendation E.1
We recommend that the F-35 Joint Program Office work with the Defense Contract Management Agency to ensure that Pratt & Whitney clearly defines, documents, and implements minimum baseline criteria for supplier selection and actions to be taken for suppliers that continue to be high risk.
JPO Response: *Agree. JPO will work with the DCMA to ensure that Pratt & Whitney clearly defines, documents, and implements minimum baseline criteria for supplier selection and actions to be taken for suppliers that continue to be high risk.*

Recommendation E.2
We recommend that the Defense Contract Management Agency perform additional surveillance on Pratt & Whitney's corrective action requests issued to suppliers to ensure that they are closed within a reasonable timeframe.
DCMA Response: *Agree. DCMA APO-Pratt & Whitney will incorporate supplier corrective action into its Quality Management System (QMS) surveillance plan to ensure Pratt & Whitney management of supplier corrective action is in compliance with their quality system.*

~~(FOUO)~~ Finding F
Inadequate Software Quality Management Practices

The F-35 JPO did not ensure that Pratt & Whitney demonstrated adequate software quality management practices. Pratt & Whitney had an obsolete SDP and had requirements that were not fully implemented or traceable. Additionally, Pratt & Whitney was not performing required audits and reviews to ensure that software products meet contractual requirements. As a result, there is no assurance that software products meet contractual requirements and there is increased risk to performance of critical software.
JPO Response: *Disagree. Software quality management practices are in place and technical reviews have been conducted. SDP was in review for updates prior to the IG audit.*

Recommendation F.1
We recommend that the F-35 Joint Program Office ensure that Pratt & Whitney resolve nonconformities related to software quality management systems, including an obsolete F135 Software Development Plan, lack of software requirements traceability, and software not developed to the appropriate product safety level.
JPO Response: *Disagree. Software is developed to the correct product software level. The software development plan is not obsolete but only needs some minor updates that were already in work prior to the IG Audit. These updates do not invalidate the software flight clearances completed to date as they merely clarify existing processes and procedures.*

Recommendation F.2
We recommend that the F-35 Joint Program Office ensure that Pratt & Whitney's Software Quality Assurance organization conduct audits, reviews, and verification activities of both internally developed and supplier-developed software.
JPO Response: *Agree. JPO will ensure that Pratt & Whitney's Software Quality Assurance organization conduct audits, reviews, and verification activities of both internally developed and supplier-developed software.*

Recommendation F.3
We recommend that the F-35 Joint Program Office ensure Pratt & Whitney assess the impact of insufficient software verification on delivered engines.
JPO Response: *Disagree. The F135 propulsion system software was properly tested against the standards called out in the software development plan and standard work. Multiple flight clearances*

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F-35 Joint Program Office and Defense Contract Management Agency Comments (cont'd)

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performed since the beginning of the F135 program are supported by the excellent safety record for software in engine ground test, flight test and production.

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Acronyms and Abbreviations

APO	Aircraft Propulsion Ops
CAR	Corrective Action Request
CDRL	Contract Data Requirements List
CMM	Coordinate Measurement Machine
[redacted]	
C_{pk}	Process Capability Index
CSCI	Computer Software Configuration Item
CSI	Critical Safety Item
CTOL	Conventional Takeoff and Landing
CV	Carrier-Suitable Variant
DCMA	Defense Contract Management Agency
ESDS	Electrostatic Discharge Sensitive
EVB	Electronics Verification Bench
FAR	Federal Acquisition Regulation
FADEC	Full Authority Digital Engine Control
FCA	Functional Configuration Audit
FOD	Foreign Object Damage
FRP	Full-Rate Production
GCQA	Government Contract Quality Assurance
IMP	Integrated Master Plan
IMS	Integrated Master Schedule
JACG	Joint Aeronautical Commanders Group
JPO	Joint Program Office
KPC	Key Product Characteristics
LRIP	Low-Rate Initial Production
MOA	Memorandum of Agreement
MPR	Monthly Program Review
MVR	Major Variance Request
NDT	Non Destructive Test
OFI	Opportunity for Improvement

Acronyms and Abbreviations (cont'd)

PCA	Physical Configuration Audit
PHM	Prognostics and Health Management
PPE	Personal Protective Equipment
PSDP	Propulsion System Development Plan
PSL	Product Software Level
RIMB	Risk and Issues Management Board
SDD	System Development and Demonstration
SDP	Software Development Plan
SLC	Software Life Cycle
SPAR	Software Problem Anomaly Report
SOW	Statement of Work
SQA	Software Quality Assurance
STOVL	Short Takeoff and Vertical Landing
UTAS	UTC Aerospace Systems

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