ASSESSMENT OF FAA'S RISK-BASED SYSTEM FOR OVERSEEING AIRCRAFT MANUFACTURERS' SUPPLIERS

Federal Aviation Administration

Report Number: AV-2008-026

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Memorandum

U.S. Department of Transportation
Office of the Secretary
of Transportation
Office of Inspector General

Subject: ACTION: Assessment of FAA's Risk-Based System for Overseeing Aircraft Manufacturers' Suppliers Federal Aviation Administration Report Number AV-2008-026

Date: February 26, 2008

From: David A. Dobbs
Principal Assistant Inspector General
for Auditing and Evaluation

Reply to Attn. of: JA-1

To: Acting Federal Aviation Administrator

This report presents the results of our audit of the Federal Aviation Administration's (FAA) oversight of aircraft manufacturers' quality assurance systems for suppliers. Because aircraft and engine manufacturers are increasingly taking an international partnership approach to business, aircraft parts and component suppliers now produce significant parts of U.S.- and foreign-manufactured aircraft. For example, suppliers may ship a completed section of an aircraft body (fuselage), with much of the wiring already completed, to the primary manufacturer who assembles the final units together. U.S. and foreign aircraft and engine manufacturers have opted for this approach because it spreads risk and cost across a network of domestic and foreign partners, speeds up product development, and simplifies assembly procedures.

The audit objective was to evaluate FAA's oversight of aircraft manufacturers' quality assurance systems for domestic and foreign suppliers. Although aviation manufacturers are ultimately responsible for the quality of their products, FAA's Aircraft Certification Service personnel oversee manufacturers' processes for ensuring that the products meet approved design specifications and are in a condition for safe operation. During this review, we worked with personnel from an international air transport consulting firm and performed supplier control audits at companies that supply parts to Boeing, Bombardier/Learjet, General Electric

Aircraft Engines, Rolls-Royce, Pratt & Whitney, and Airbus.[1] We also analyzed FAA's process for identifying and selecting suppliers it audits to determine the effectiveness of manufacturers' supplier oversight systems. Exhibit A details our scope and methodology. Exhibit B lists the entities we visited or contacted.

BACKGROUND

Inspectors in FAA's Manufacturing Inspection District Offices (MIDO) oversee FAA-approved manufacturers[2] in their geographic areas. There are 23 MIDOs[3] and 1 Certificate Management Office,[4] with 195 inspectors to oversee the 1,738 FAA-approved manufacturing facilities in the United States. Although FAA does not approve manufacturers in other countries, U.S. manufacturers use both domestic and foreign suppliers to build their products. FAA is to monitor these suppliers as part of its oversight of FAA-approved manufacturers' quality assurance systems.

Manufacturers are increasingly using domestic and foreign parts and system suppliers to reduce their manufacturing costs and spread risks among multiple partners. Suppliers provide investment capital and assume responsibility for the design and production of systems and sub-systems supplied to prime manufacturers. For example, Boeing's risk-sharing partners in Japan, Italy, and the United States will build composite structures for the Boeing 787, which will include sub-systems that are already certified, tested, and ready for final assembly.

According to a March 2005 study by the U.S. Department of Commerce,[5] the practice of subcontracting major portions of aircraft manufacturing also opens foreign markets for future aircraft sales. Major manufacturers develop agreements with foreign suppliers to produce major segments of their aircraft in exchange for large aircraft orders from the country's carriers. These agreements can amount to billions of dollars in sales for the manufacturer. For example, in order for Boeing to sell Boeing 747s to Air China, at least part of the final product (no matter how small) must be manufactured or assembled in China.

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[1] FAA does not have direct oversight responsibility for Airbus aircraft because they are not produced in the United States. However, according to Boeing representatives, 70 percent of the suppliers used by Airbus are also used by Boeing.

[2] FAA-approved manufacturers are those manufacturers that hold an FAA certificate, such as a production certificate or a parts manufacturer approval.

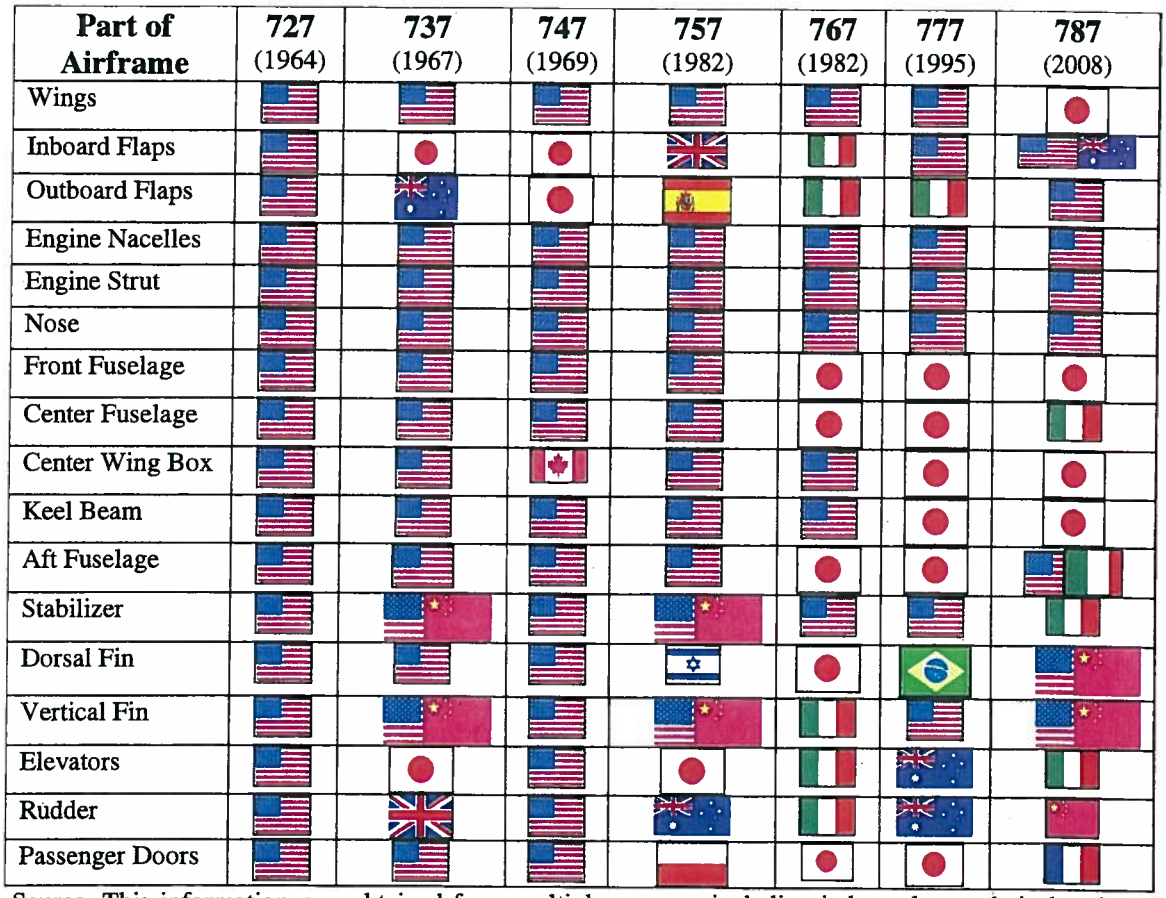
[3] Five offices are Manufacturing Inspection Satellite Offices, which are extensions of nearby MIDOs.

[4] The Certificate Management Office is dedicated to oversight of the Boeing Company. The Certificate Management Office is located in Renton, Washington, with other offices in Everett, Washington (co-located with Boeing production facilities).

[5] "The U.S. Jet Transport Industry: Competition, Regulation, and Global Market Factors Affecting U.S. Producers," U.S. Department of Commerce, International Trade Administration, March 2005.

The evolution of Boeing aircraft over the last 40 years clearly illustrates how manufacturing business models have changed. As shown in figure 1, Boeing's first aircraft were built almost exclusively in the United States. In contrast, the airframe parts for the new Boeing 787 will primarily be manufactured by foreign suppliers.

Figure 1. U.S.- Versus Foreign-Supplied Parts on Boeing Aircraft Models



Source: This information was obtained from multiple sources, including independent technical reviews and manufacturers' and suppliers' websites.

RESULTS IN BRIEF

Since 1998, FAA has worked towards implementing a risk-based oversight system for aviation manufacturers. However, this system was implemented in fiscal year (FY) 2003 and does not take into account the degree to which manufactures now use suppliers to make aviation products. FAA based the new system on historical manufacturing business models, in which manufacturers maintain primary control over the production of their aircraft rather than use suppliers to design and manufacture extensive portions of aircraft.

We found that FAA needs to improve its risk-based oversight system as it does not ensure that manufacturers regularly audit their suppliers. FAA also does not perform enough audits of manufacturers' suppliers (i.e., supplier control audits) to test how well manufacturers' quality assurance systems are working. Rather, FAA requires its inspectors to conduct, at most, four supplier audits regardless of how many suppliers a manufacturer uses. This process is not adequate to determine the risk that a manufacturer will produce substandard parts. FAA's process for supplier audits should be designed to address newer manufacturing business models, which have expanded the number of foreign suppliers, locations where parts are assembled, and the degree of independent manufacturing responsibility suppliers now have.

We also found that the risk assessments FAA inspectors use to evaluate a manufacturer's potential for producing substandard products exclude pertinent information that would aid in evaluating risks. For example, inspectors do not routinely evaluate the results of manufacturers' audits of their suppliers. In our view, manufacturers' assessments of their suppliers, if properly conducted, would provide valuable information that FAA inspectors could use to assess risk and target inspection resources. Risk-based oversight is the right direction for FAA, but it needs to strengthen its system for overseeing aircraft and aircraft part suppliers so that its oversight is effective in today's manufacturing environment.

Finally, we determined that FAA's inspections at supplier facilities were too focused on specific tasks rather than overall quality systems. Using a more uniform approach to supplier audits, our aviation consultants identified widespread deficiencies at supplier facilities used by major aviation manufacturers. We found that some aircraft manufacturers had not designed effective oversight systems for their aircraft part suppliers. Although manufacturers are ultimately responsible for the quality of parts used on their aircraft, three of the five manufacturers we reviewed did not have procedures in place to routinely visit all their critical[6] suppliers and sub-tier suppliers. Consequently, neither manufacturers nor FAA inspectors have provided effective oversight of suppliers; this has allowed substandard parts to enter the aviation supply chain.

We made a series of recommendations designed to enhance FAA's oversight of manufacturers' suppliers. Our full recommendations are listed on page 15.

On December 6, 2007, we met with FAA officials to discuss our draft report issued on November 14, 2007. During this meeting, the manager of the Production and Airworthiness Certification Division stated that FAA generally

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[6] We considered critical parts as those included on FAA's Category Parts List, or parts or part assemblies whose failure could prevent continued safe flight and landing, degrade performance, or cause loss of capability to conduct certain flight operations.

agreed with our recommendations and considered them to be reasonable. In its December 18, 2007, written response to our report, FAA partially concurred with one recommendation and fully concurred with the remaining five. FAA also provided action plans to address each recommendation. FAA's comments and our response are fully discussed on pages 15 through 17.

FINDINGS

We found weaknesses throughout FAA's oversight system for manufacturers and their suppliers. First, FAA has not ensured that manufacturers are providing oversight of their suppliers. Manufacturers are the first line of defense in ensuring the products used on their aircraft meet FAA and manufacturers' standards. Yet, during the 24 months preceding our review, manufacturers had not audited 6 of the 21 critical part suppliers we visited.

Second, FAA does not require inspectors to perform enough audits of suppliers to determine how well manufacturers' quality assurance systems are working. FAA's guidance for overseeing manufacturers' quality assurance systems only requires inspectors to perform, at most, four supplier audits, regardless of how many suppliers the manufacturer uses.

Third, the systemic deficiencies we identified at the 21 supplier facilities we visited indicate that manufacturers and FAA need to strengthen their oversight of these facilities. For example, nearly half (43 percent) of the suppliers had deficiencies in their tool calibration and employee training programs. Deficiencies in these areas could impact the quality of the parts these suppliers produce.

FAA Oversight of Manufacturers' Quality Assurance Systems for Suppliers Needs Improvement

Manufacturers are responsible for ensuring that their aviation products are properly produced. Yet, three of the five major manufacturers we reviewed had not developed requirements to perform regular supplier audits. FAA regulations require manufacturers to have an FAA-approved quality control system. Further, FAA guidance states that this system should include procedures for initial and periodic supplier audits. Although all five manufacturers we reviewed had supplier oversight procedures in their quality assurance manuals, only two had developed requirements to perform regular supplier audits (e.g., once every 2 years). For example, one manufacturer allowed mail-in surveys as an alternative to on-site audits. Another conducted initial supplier audits but established no timeframes for re-evaluation. FAA requires that manufacturers' quality control systems provide a means to determine that supplier-produced components

(e.g., materials, parts, and subassemblies) or services (e.g., special processes, calibration, etc.) conform to FAA-approved design standards and are in condition for safe operation. On-site audits permit manufacturers to verify that the suppliers they use produce parts according to these standards.

FAA Needs To Strengthen Its Risk Assessment Process

The second line of defense for ensuring that only safe aviation products enter the market is FAA's oversight structure for manufacturers and their suppliers. FAA inspectors currently perform risk assessments of each manufacturer to determine how many supplier audits FAA will conduct to test the effectiveness of manufacturers' quality assurance systems. In conducting these audits, FAA inspectors review the suppliers' organizational management structure, procedures for product design control, software quality assurance, manufacturing processes, manufacturing controls (including calibration), and supplier control (how well the suppliers oversee the vendors that supply parts to them).

The results of these audits provide inspectors with information on how well manufacturers are overseeing their suppliers. For example, a series of negative findings at multiple suppliers for a manufacturer would indicate the manufacturer needs to strengthen its quality assurance system or audit processes. Yet, when they perform risk assessments and determine how to target FAA inspections, inspectors do not consider the number of suppliers that manufacturers use or the level of responsibility that suppliers have in producing aviation products.

Additionally, FAA inspectors are not required to evaluate the results of supplier audits conducted by manufacturers. In our view, these results would be a valuable source of information in assessing risk, identifying systemic weaknesses, and determining where to use inspection resources. For example, in one supplier audit we reviewed, a manufacturer found part inspections were not signed off by the supplier's part inspection personnel, operations that were listed incorrectly, and gauges that were not calibrated. In another manufacturer's audit, the auditor identified paperwork differences on the number of items shipped or scrapped and determined there was no evidence of any internal quality audits for a 2-year period. This information could aid inspectors in identifying problem suppliers as well as manufacturers' quality assurance programs that work well and need less oversight. For example, an inspector responsible for engine manufacturing oversight stated that he only reviewed prior audits conducted by the manufacturer about 50 percent of the time.

FAA's risk indicators do not provide inspectors with an effective tool to consistently assess risk. FAA developed 21 risk-based indicators to aid inspectors in assessing manufacturers' quality systems. For example, FAA

determined that events such as key management changes, new manufacturing processes, and workforce reductions were integral to assessing the risk that manufacturers could produce substandard parts.

Although the 21 indicators focused on areas within a manufacturer's operation that might indicate risk, FAA did not consider how individual inspectors could apply those indicators. For example, "reduction in workforce" may or may not have an impact on safety and the potential for producing substandard parts, depending on how, when, and where the staff reduction occurred. Given their institutional knowledge and the room for subjectivity in the risk assessments, each inspector is prone to weigh the 21 criteria differently. To illustrate, we identified an engine manufacturer that was rated differently every year over 4 years by separate inspectors. Although the same 21 areas were evaluated each time, 1 inspector considered the manufacturer a high risk, while another did not.

A sound evaluation of the risk criteria when assessing risk with aviation manufacturers is critical because inspectors rely on the results of these assessments to determine how many supplier audits they will conduct to test the effectiveness of manufacturers' quality assurance systems. That is, the level of risk determined by inspectors dictates the level of oversight inspectors are required to provide at a manufacturer and its supplier facilities. For example:

- A high-risk manufacturer will be inspected every 3 months, and the inspector will have to perform audits of at least four of the manufacturers' suppliers that year.

- A low-risk manufacturer will be inspected once every *3 years,* and the inspector will not have to perform *any* supplier audits.

Other factors may also affect inspectors' application of the risk indicator criteria. For example, because these determinations impact their workload, inspectors may have incentive to lower the risk assessment of the manufacturer for which they have oversight responsibility. The manager for one MIDO agreed that this was a possibility and advised us that his inspector workload had been cut almost in half under the new risk-based system.

We also found that some inspectors' application of the risk assessment process may have been hindered because of their resistance to change. For example, some inspectors disregarded FAA guidance on how to select suppliers for review because they believe the system removes the consideration of the "field knowledge" inspectors possess for the facilities they oversee. Inspectors at three of the five offices we visited judgmentally selected suppliers for review rather than using the prescribed risk-based methodology. Additionally, we identified a manager at one office that changed the results of the statistical sample because he

did not have sufficient travel funds to complete audits of the selected foreign suppliers. The manager instructed inspectors to select suppliers in their local area in place of the foreign suppliers.

FAA's risk indicators overlook the increased role of suppliers. In assessing risks and determining how to target their inspection resources, inspectors do not consider the number of suppliers that manufacturers use and the level of responsibility suppliers have assumed. For example, at the time of our review, FAA had never inspected one critical parts supplier of major structural components, such as landing gear. Additionally, FAA does not maintain a complete universe of manufacturers' foreign, domestic, and sub-tier suppliers to identify inspection priorities.

The increased use of suppliers is not considered in FAA's risk assessment process. This is particularly troubling because, since 2001, FAA has highlighted manufacturers' oversight of suppliers as one of the top six areas in which the manufacturing industry must improve. For example, FAA determined in FY 2005 that 10 percent of the quality assurance system violations inspectors identified at manufacturing facilities were related to supplier oversight. Therefore, FAA's own internal reviews have determined that manufacturers are not providing sufficient oversight of their suppliers.

We acknowledge that it is not FAA's responsibility to provide oversight of manufacturers' suppliers. However, in our view, it is counterintuitive to decrease the number of supplier audits that FAA performs when use of suppliers has steadily increased and FAA has consistently determined that supplier oversight is a problem.

FAA Does Not Require Enough Supplier Control Audits To Assess Manufacturers' Quality Assurance Systems

FAA's supplier selection process results in widely disparate and, in some cases, very limited audit coverage of manufacturers' suppliers. To illustrate, based on FAA guidance, a manufacturer that has 2,000 suppliers and is assessed as a high risk will require the same number of supplier audits as a high-risk manufacturer that has only 20 suppliers. Inspectors are only required to perform, at most, *four* supplier audits regardless of the size of the manufacturer, the number of suppliers used, or the criticality of the part produced. For example, for 2 consecutive years, FAA scheduled the maximum of four supplier audits for a manufacturer of agricultural aircraft (i.e., crop dusters). Conversely, for one of these years, another FAA inspector did not perform any supplier audits for a major engine manufacturer for commercial aircraft.

Supplier control audits are a primary tool that FAA uses to assess how well manufacturers' oversight systems are working. Equally important, these audits function as a second layer of control for preventing improperly produced parts from entering the market. However, as shown in the table below, in each of the last 4 years, FAA has inspected an average of *1 percent* of the total suppliers used by the five manufacturers we reviewed. At FAA's current surveillance rate, it would take inspectors at least 98 years to audit every supplier once. This is particularly troubling because, as discussed previously, manufacturers are not evaluating these suppliers frequently or comprehensively.

Table. Number of Supplier Audits Completed by FAA for Five Major Manufacturers

		Supplier Audits Completed by FAA				
Manufacturer	**No. of Supplier Facilities[a/]**	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**Avg. % Per FY**
A	4,012	2	1	7	4	1%
B[b/]	2,553	31	26	15	27	1%
C	706	5	4	4	6	1%
D	489	5	3	1	2	1%
E	367	0	2	3	2	1%

[a/] Number of supplier facilities based on information obtained for 2004.
[b/] This manufacturer operates seven separate manufacturing divisions. As a result, FAA evaluated the seven divisions separately for risk assessment purposes, which resulted in more supplier control audits.
Source: FAA's National Supplier Control Audit Schedules, FY 2003-2006

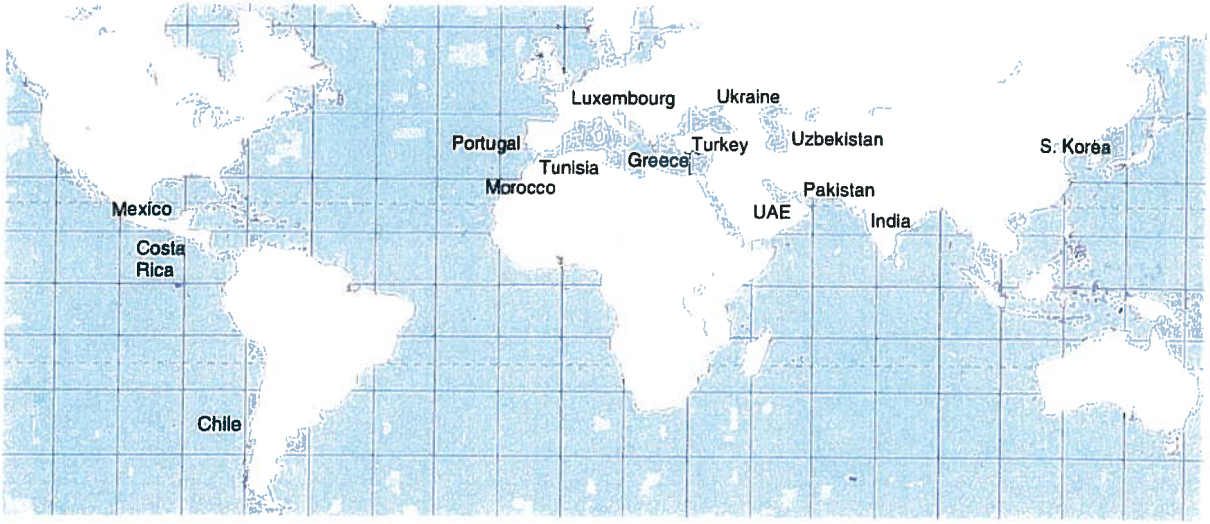
Concerns about supplier oversight are even more serious given the number of countries around the world that produce parts for U.S. aircraft manufacturers without a bilateral agreement with the United States.[7] When entering into a bilateral agreement, the United States agrees to accept the oversight of manufacturers provided by that country's aviation authority, among other things. A fundamental consideration in whether or not to enter into a bilateral agreement is the capacity and ability of the foreign civil aviation authority to oversee aviation manufacturing.

Yet, suppliers in some countries that do not have bilateral agreements with the United States provide significant contributions to the production of U.S. aircraft, such as engine parts and aircraft doors. As shown in figure 2, 15 countries with which the United States does not have a bilateral agreement produce parts for U.S. aircraft manufacturers. For example, one U.S. engine manufacturer has eight suppliers in Mexico, but the United States does not have a bilateral agreement with

[7] A bilateral agreement is a government-to-government agreement with other countries to provide for the reciprocal acceptance of aeronautical products.

this country. Therefore, FAA has no assurance that these countries are providing adequate oversight of the operations of suppliers in their countries.

Figure 2. Countries Without a Bilateral Agreement That Make Parts for U.S. Manufacturers



Source: Manufacturers' supplier lists

Effective oversight of suppliers is essential to ensure that substandard parts do not enter the aviation supply chain. For example, in February 2003, 1 supplier released approximately 5,000 parts that were not manufactured properly for use on landing gear for large commercial passenger aircraft. At least one of these landing gear parts failed while in service. While FAA became aware of this large-scale breakdown at this supplier in 2003, it has not performed a supplier audit at this facility in the last 4 years.

To obtain assurance that manufacturers' quality assurance systems are operating properly, FAA must develop a system of supplier oversight in which the number of suppliers audited more closely correlates to the number of suppliers used and ensure its inspectors follow this system. Given the trend toward increased use of suppliers, FAA must adjust its oversight approach so that its surveillance occurs where the majority of aviation manufacturing takes place: foreign and domestic supplier facilities.

Systemic Weaknesses Identified at Supplier Facilities Indicate That Manufacturers and FAA Must Strengthen Supplier Surveillance

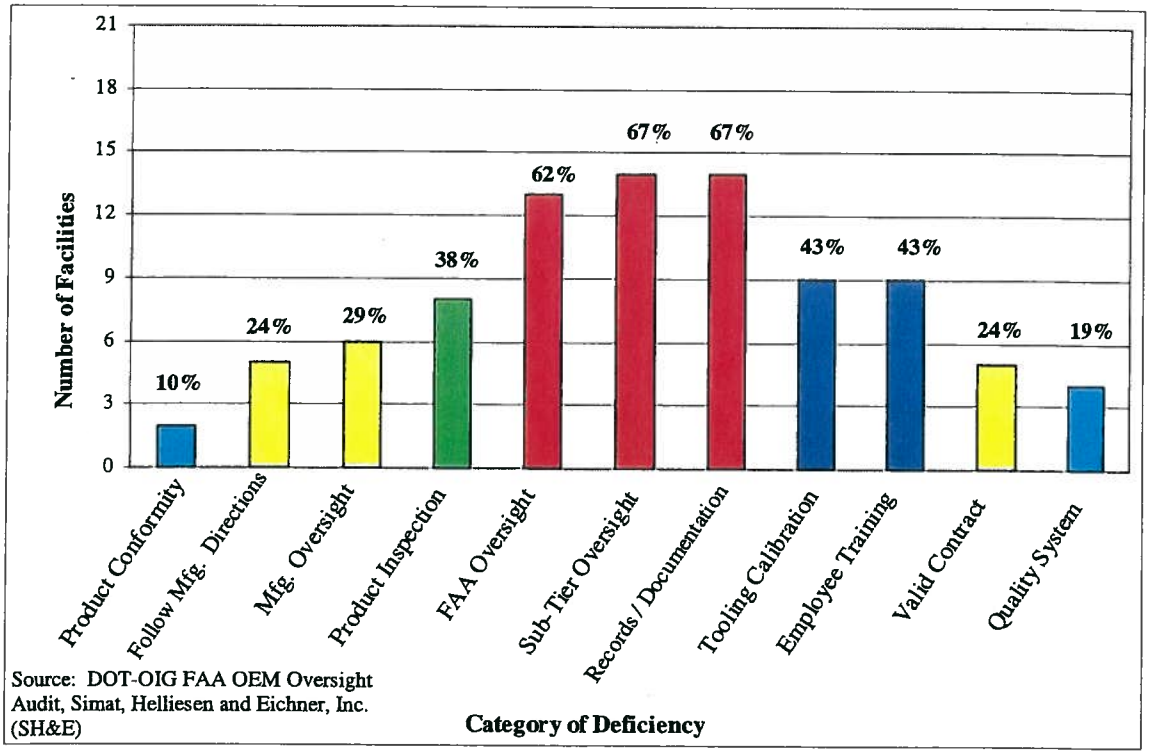
To test manufacturers' and FAA's oversight of supplier facilities, our aviation consultant reviewed operations at 21 foreign and domestic suppliers used by major U.S. and foreign aircraft manufacturers. The suppliers we selected produced key parts for these major manufacturers but had not been inspected by FAA in the

2 years preceding our review. The checklist we used to conduct these audits addressed the same areas that FAA inspectors review when conducting supplier control audits. Our on-site audits covered the supplier's quality system—from the contracts with the manufacturer to the actual parts production, part inspections, facility and production line safety, and shipping.

We identified widespread discrepancies at 20 of the 21 suppliers we reviewed, such as suppliers' inadequate oversight of the part and component suppliers they use (i.e., sub-tier oversight), use of out-of-date tools and equipment, and failure to complete all product testing before shipping parts to the manufacturer. The pervasive nature of the discrepancies we identified indicates that manufacturers and FAA must improve their oversight processes.

While we found incidents of non-compliance in every area audited, we found widespread non-compliance in sub-tier supplier oversight, tooling calibration, employee training, and inspection (see figure 3).

Figure 3. Percentage of Supplier Facilities Where Deficiencies Were Found



Source: DOT-OIG FAA OEM Oversight Audit, Simat, Helliesen and Eichner, Inc. (SH&E)

Of the 21 facilities audited, 6 had little or no recorded oversight by the manufacturer during the 24 months preceding our visit. During the same period, five of the six supplier facilities that had not received oversight by the manufacturer also had not received any oversight by FAA. These six facilities manufacture critical parts, such as aircraft lighting systems, cockpit voice

recorders, and pressure switches and controls. The specific weaknesses we identified are detailed below.

Suppliers did not provide adequate oversight of their part and component sub-tier suppliers. Manufacturers were not verifying that their suppliers were providing effective oversight of the sub-tier suppliers they used to produce parts. This is a critical safety issue, as demonstrated by four engine failures that occurred in FY 2003 due to faulty speed sensors on fuel pumps obtained from a supplier. Three of the engine failures occurred on the ground and one occurred in flight. The part failures were traced to unapproved design changes made by a sub-tier supplier. In all, 152 parts were manufactured in the suspect population.

Examples of the problems we identified in this area include the following:

- For the 2 years prior to our review, 14 of 21 suppliers (67 percent) did not perform regular, on-site evaluations of their sub-tier suppliers. These suppliers relied on mail-in self-evaluations provided by their sub-tier suppliers or relied on an industry standard quality system certification (e.g., ISO 9001) in place of an on-site audit.

- A supplier of passenger service units (the panels above a passenger's seat with the reading light and the panels that open to reveal the emergency oxygen masks) relied on mail-in self-evaluations for its sub-tier suppliers. Any sub-tier supplier that makes the supplier's "10 worst suppliers" list (based on the number of parts rejected during receiving inspections) would receive an on-site audit.

Suppliers did not have effective tool calibration programs. Manufacturers were not ensuring that their suppliers' tools were calibrated accurately. Proper tool calibration ensures that equipment used to perform measurements on parts corresponds to universal industry standards (i.e., tools measure accurately). Examples of problems we identified include the following:

- Nine of 21 suppliers (43 percent) used improperly calibrated tooling in manufacturing and inspection operations.

- One supplier's calibration tracking system showed that approximately 94 percent of the tools were past due for calibration. Some of the tools were out of date for 3 to 4 years. There was no procedure to follow up on out-of-date calibrations and no well-defined procedure to address a product that may be inspected or manufactured using improperly calibrated tooling.

- An employee at another supplier checked the oxygen door on the passenger service unit with an uncalibrated tool that was even marked "uncalibrated."

We found no evidence that these dimensions were checked anywhere else in this production operation.

- At another supplier, an employee used a piece of paper, scotch-taped to the work surface, as a measuring device for a length of wire on an oil and fuel pressure transmitter.

Suppliers' employee training programs were inadequate. We found that manufacturers' suppliers did not always properly train their employees to perform their assigned tasks or document the training in employees' training records. We found the following deficiencies in this area:

- Nine of 21 suppliers (43 percent) did not have adequate control over employee training and training records. We found that (1) employees were inadequately trained for their responsibilities or (2) records proving their training were never created.

- One supplier allowed new, untrained employees to manufacture several components. We witnessed one new employee improperly inspecting a product. A later review of his training record showed that he had not received any formal training in the proper inspection method. This was the same supplier mentioned previously that used a piece of paper as a measuring device for an oil and fuel pressure transmitter.

Suppliers did not have adequate procedures in place to inspect the parts they produced. Suppliers were not properly inspecting their product to ensure they were following the requirements provided by the prime manufacturer. For some suppliers, this is even more critical when they are given the authority to ship the parts they supply directly to another supplier. We identified a failure to follow proper procedures during either the parts in-process or final part inspections at 8 of the 21 suppliers (38 percent).

- We observed one supplier performing *unauthorized, undocumented* re-work of parts. The supplier had experienced problems with panels that allowed emergency oxygen masks to deploy. The quality manager asserted that the panels were manufactured according to the engineering drawings but sometimes did not open properly. To remedy this problem, the supplier used a small grinder to remove some of the material on the panel. This process had not been approved by the prime manufacturer.

- At another supplier, a receiving clerk showed us a part that did not conform to specifications but then placed the non-conforming part back into the original box and forwarded it to inspection. The non-conforming part was not

documented, segregated, tagged, or otherwise communicated to the receiving inspection department.

- At one supplier, records for a weld operation had not been properly approved by the operator. The operator proceeded to sign the records in front of us without conducting the inspections.

The systemic nature of the issues we identified suggests that manufacturers and FAA inspectors are overlooking key areas when they conduct supplier audits. We found that FAA inspectors individually determine how and what to inspect at each supplier facility. FAA inspectors we observed focused on task-specific items, such as the calibration of one tool, rather than on processes or systems in place at the facility. Additionally, inspectors did not follow a standardized inspection process when conducting supplier audits. To supplement their institutional knowledge, FAA inspectors could benefit from additional training on how to conduct comprehensive quality assurance system reviews.

FAA must enhance its oversight of manufacturers' quality assurance systems both for the selection and execution of supplier audits as well as for the number of audits conducted. FAA must also ensure that manufacturers enhance their oversight of suppliers and sub-tier suppliers so that defective parts do not escape supplier facilities for subsequent installation on aircraft.

RECOMMENDATIONS

We recommend that FAA:

1. Require manufacturers to establish criteria for conducting on-site audits for initial supplier approval and conduct periodic audits of suppliers to ensure that quality assurance systems are followed throughout the supply chain.

2. Develop a risk assessment process that emphasizes suppliers of flight-critical parts (e.g., those that manufacture critical and high-volume parts or use large numbers of suppliers, etc.) for passenger aircraft.

3. Develop a risk assessment process that reduces the level of subjectivity in evaluating manufacturers so that inspectors' risk assessments will be more consistent.

4. Require inspectors to review prior manufacturers' audits of suppliers as part of their analysis of risk and determination of resource targeting.

5. Modify its supplier audit requirements so that the number of audits that inspectors are required to conduct more directly correlates with the number of suppliers used by the prime manufacturer.

6. Provide inspectors with training on (a) auditing systems or processes in addition to individual or task-specific elements of a supplier's operations and (b) processes for documenting the results of their reviews.

AGENCY COMMENTS AND OFFICE OF INSPECTOR GENERAL RESPONSE

On December 6, 2007, we met with FAA officials to discuss our November 14, 2007, draft report. In its December 18, 2007, written response, FAA partially concurred with the first recommendation and fully concurred with the remaining five recommendations. FAA provided action plans to address each recommendation. In its response, FAA also stated that it respectfully disagreed with certain statements in our draft report. We incorporated FAA's suggested changes as appropriate. FAA's entire response is included as an appendix to this report.

FAA partially concurred with our recommendation to require manufacturers to perform on-site audits for initial supplier approvals and conduct periodic audits of suppliers thereafter. FAA stated that there is no regulation to implement this

recommendation as a requirement. However, FAA did agree that additional supplier selection criteria would be appropriate.

FAA agreed to revise its manufacturers' guidance on supplier surveillance procedures. The revised guidance would include a process for manufacturers to evaluate and select suppliers for audit based on suppliers' (1) capability to perform all manufacturing activities, inspections, and tests necessary to determine whether parts conform to design data and (2) ability to meet specified requirements. FAA's proposed criteria for selection, evaluation, re-evaluation, and disapproval of suppliers would include initial, ongoing and periodic evaluations of suppliers based on risk.

While FAA's response partly addresses recommendation 1, FAA's proposed changes to Advisory Circular 21-20 appear to be minimal and are not specific enough for us to determine whether the changes will fully address the systemic problems we identified. For example, we question how effectively a new supplier could be evaluated for risk without the manufacturer visiting the supplier's facility. The fact that it is termed an "initial evaluation" would seem to indicate that the manufacturer would not have historical data to use in assessing risk.

While we agree that manufacturers cannot visit every supplier every year, the range of problems we found at suppliers indicates that manufacturers need better FAA guidance to develop an effective quality control system. This system must ensure that suppliers conform to design data and meet specified requirements.

To fully address our recommendation, we believe FAA needs to emphasize on-site reviews of suppliers. The nature and number of discrepancies found at suppliers we visited would not have been identified through records reviews only. For example, a supplier of fuel system parts for a major manufacturer had no record of the manufacturer *ever completing* an on-site audit of their facility. We found numerous deficiencies at this facility, including problems with the calibration program, employee training, and product inspection.

Until FAA can provide more specific information on how it will revise its Advisory Circular, we consider recommendation 1 to be unresolved.

FAA concurred with recommendations 2 through 5. In response, FAA agreed to take the following actions:

- Develop and include as a risk indicator the manufacturer's use of suppliers of flight-critical parts.
- Create and implement metrics to monitor changes to its resource targeting output.

- Develop less subjective risk indicator questions and specific instructional material and incorporate the new questions into its risk based oversight system and database.
- Develop and issue Directive material that will require the review of a sample of manufacturers' supplier audits and use the results of the audits as input for the following year's risk assessment of the manufacturer.
- Develop a supplier control audit quantity approach, develop and implement new Directive material on the approach, and train inspectors on the new Directive.

With the exception of recommendation 1, we consider FAA's planned actions to be responsive. When properly implemented, FAA's actions should significantly enhance its surveillance of manufacturers' quality assurance systems for suppliers. However, the final implementation dates for FAA's proposed actions are projected from 2009 to 2010. We therefore consider recommendations 2 through 5 resolved but open until FAA completes its proposed actions.

ACTIONS REQUIRED

We request that FAA provide additional information detailing the specific changes the Agency will incorporate into the revised Advisory Circular on Supplier Surveillance Procedures. We are satisfied with FAA's planned actions to address recommendations 2 through 5. According to the provisions of DOT Order 8000.1C, we will follow up with FAA to ensure that its corrective actions are consistent with our recommendations.

We appreciate the courtesies and cooperation of Federal Aviation Administration representatives and manufacturers' suppliers during this audit. If you have any questions concerning this report, please contact me at (202) 366-1427 or Lou E. Dixon, Assistant Inspector General for Aviation and Special Program Audits, at (202) 366-0500.

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cc: FAA Associate Administrator for Safety
Director, Aircraft Certification Service
Ron Gill, AVR-1

EXHIBIT A. OBJECTIVE, SCOPE, AND METHODOLOGY

The objective of this audit was to evaluate FAA's oversight of aircraft manufacturers' quality assurance systems for domestic and foreign suppliers. We conducted this audit between February 2004 and November 2007 in accordance with Government Auditing Standards prescribed by the Comptroller General of the United States. We included such tests as necessary to provide reasonable assurance of detecting abuse or illegal acts.

To evaluate FAA oversight of manufacturers' quality assurance systems for suppliers, we visited FAA Headquarters, three Directorates, four FAA Manufacturing Inspection District Offices (MIDO), and the Certificate Management Office that oversees Boeing. In addition, we contacted 5 manufacturers and 21 suppliers to manufacturers, both domestic and foreign. Exhibit B lists the entities we contacted or visited during our review.

We contracted with Simat, Helliesen and Eichner, Inc. (SH&E), an international air transport consulting firm, to assist us in reviewing supplier oversight at 17 domestic and 4 foreign facilities. Additionally, the contractor accompanied us on an FAA supplier control audit of a foreign supplier. To evaluate FAA's oversight, we tracked the number of supplier control audits that FAA performed and determined whether there were trends in the amount of supplier control audits performed from year to year. We also reviewed FAA's resource targeting model and inspectors' ability to use it to perform oversight.

To evaluate manufacturers' quality assurance systems, our contractor compared five manufacturers' quality system manuals with quality system industry standards (e.g., ISO 9001) to determine compliance with FAA guidance. Also, the contractor performed 21 supplier control audits in order to test the quality of FAA and manufacturers' oversight.

To select the suppliers to visit, we compiled a universe of common suppliers among major aircraft and engine manufacturers based on the best information available at that time. We obtained supplier listings from the manufacturers as we visited the various MIDOs overseeing them. From the common universe, we determined which of those suppliers had not been visited by FAA in the 2 years prior to our audit as part of its supplier control audit program. An OIG statistician assisted us in selecting the suppliers.

EXHIBIT B. ENTITIES VISITED OR CONTACTED

FAA

Headquarters:

Aviation Safety (AVS)	Washington, DC
Aircraft Certification Service (AIR)	Washington, DC

Directorates:

Engine and Propeller Directorate	Burlington, MA
Small Airplane Directorate	Kansas City, MO
Transport Airplane Directorate	Renton, WA

Manufacturing Inspection District Offices in:

Renton, WA

Vandalia, OH

Wichita, KS

Windsor Locks, CT

Certificate Management Office for:

The Boeing Company	Renton and Everett, WA

MANUFACTURERS

The Boeing Company	Seattle, WA
Pratt & Whitney	East Hartford, CT
General Electric Aircraft Engines	Cincinnati, OH
Bombardier Aerospace/Learjet	Wichita, KS
Rolls-Royce[8]	Indianapolis, IN

[8] We did not visit the Rolls-Royce facility. Our consultant reviewed Rolls-Royce's quality manuals and interviewed the FAA inspector.

Suppliers to Manufacturers

ALCOA Fastening Systems	Torrance, CA
C.A. Spalding Company	Croydon, PA
Corru-Seals, Inc.	Wallingford, CT
Custom Control Sensors, Inc.	Chatsworth, CA
Eaton Aerospace	Glenolden, PA
Eldec Corporation	Lynnwood, WA
Frisby Aerospace LLC	Clemmons, NC
Goodrich Hella Aerospace Lighting Systems GmbH	Lippstadt, Germany
Honeywell Aerospace Electronic Systems	Redmond, WA
Honeywell International Engines and Systems	Tucson, AZ
Howmet Castings	Dover, NJ
Howmet Corporation	Wichita Falls, TX
Messier-Bugatti Snecma Group	Molsheim Cedex, France
Messier-Bugatti Snecma Group	Velizy-Villacoublay, France
Peco Manufacturing Co. Inc.	Portland, OR
Radial Bearing Corporation	Danbury, CT
Saint Gobain Performance Plastics	Garden Grove, CA
Shultz Steel Company	South Gate, CA
Vibro-Meter, Inc.	Manchester, NH
Vibro-Meter SA	Fribourg, Switzerland
WGI Inc.	Southwick, MA

Industry Associations

National Transportation Safety Board	Washington, DC
General Aviation Manufacturers Association	Washington, DC
Aerospace Industries Association	Arlington, VA
International Association of Machinists and Aerospace Workers	Seattle, WA

Exhibit B. Entities Visited or Contacted

APPENDIX. MANAGEMENT COMMENTS

Federal Aviation Administration

Memorandum

Date: December 18, 2007

To: Robin Hunt, Acting Assistant Inspector General for Aviation and Special Program Audits

From: Ramesh K. Punwani, Assistant Administrator for Financial Services/CFO

Prepared by: Anthony Williams, x79000

Subject: OIG Draft Report: Assessment of FAA's Risk-Based System for Overseeing Aircraft Manufacturers' Suppliers Federal Aviation Administration

Thank you for providing us with the draft report of "Assessment of FAA's Risk-based System for Overseeing Aircraft Manufacturers' Suppliers." We also recognize the ever-changing nature of aircraft manufacturing and we will continue to effectively oversee Production Approval Holder's compliance with the regulations that govern manufacturing of aircraft and related product. As with any system, continuous improvement is essential, and the FAA appreciates your recommendations.

The FAA partially concurs with recommendation 1, and concurs with recommendations 2 through 6. Our responses to the recommendations are listed below. Additionally, we respectfully disagree with certain statements in the draft report, and have previously provided our comments to you.

Recommendation 1: Require manufacturers to establish criteria for conducting on-site audits for initial supplier approval and conduct periodic audits of suppliers to ensure that quality assurance systems are followed throughout the supply chain.

FAA Response: Partially concur. There is no regulation to implement this recommendation as a requirement. However, the FAA agrees that additional supplier selection criteria are appropriate.

FAA Action: Publish criteria in the next revision to Advisory Circular 21-20, Supplier Surveillance, including a process that evaluates and selects suppliers based on their capability to perform all manufacturing activities, inspections, and tests necessary to determine conformity of parts or appliances to the applicable design data and their ability to meet the specified requirements.

The process should include criteria for selection, evaluation, reevaluation, and disapproval of suppliers. These would include the following:

- Initial evaluation of suppliers to determine their capability to meet requirements. The need to conduct initial onsite evaluations to be determined based on risk. The Production Approval Holder (PAH) should make this determination before permitting the supplier to furnish any parts or services.
- Ongoing evaluations to ensure continued adherence to the requirements.
- Periodic onsite evaluation, process reviews, document reviews, or independent product evaluations based on risk.

- June 2008: Create draft material.
- September 2009: Publish Advisory Circular 21-20.

Recommendation 2: Develop a risk assessment process that emphasizes suppliers of flight-critical parts (e.g., those that manufacture critical and high-volume parts or use large numbers of suppliers, etc.) for passenger aircraft.

FAA Response: Concur. In 2007 the FAA developed a new risk assessment tool, Risk Based Resource Targeting (RBRT), which is designed to assign resources based on risk. RBRT will replace the existing Resource Targeting process. The RBRT tool will be applied to several Aircraft Certification Service work processes. The tool has been recently prototyped and is being finalized for deployment. The use of RBRT for the certificate management process (manufacturers with a production approval) is scheduled for FY09. The risk assessment indicator questions, used for determining the number and frequency of supplier control audits, are currently being developed.

FAA Action: Develop and include as a risk indicator the production approval holder's use of suppliers of flight-critical parts (e.g., those that manufacture critical and high-volume parts or use large numbers of suppliers, etc.).

- June 2008: Develop a risk indicator. Coordinate with Field offices.
- September 2008: Incorporate risk indicator into RBRT tool (IT Contractor)
- March 2009: Integrate RBRT into the Certificate Mgt. Information System (IT Rehost).

Recommendation 3: Develop a risk assessment process that reduces the level of subjectivity in evaluating manufacturers so that inspectors' risk assessments will be more consistent.

FAA Response: Concur. The RBRT tool discussed in Recommendation 2 uses a methodology that is standardized across all FAA directorates. Each risk assessment indicator question, used for determining the number and frequency of surveillance activities, is accompanied by instructional material to aid the inspector in answering the questions consistently and correctly. The material is very specific and will reduce the level of subjectivity.

In September 2006 the FAA Aviation Safety organization (A VS) achieved IS09001-2000 Quality Management System Registration. Each trimester an analysis of data, including work process metrics, is conducted from the local office level to the AVS executive level. To further ensure objectivity beyond the new RBRT tool the Aircraft Certification Service will create a new metric to monitor field office changes to the current Resource Targeting output followed by RBRT output.

Appendix. Management Comments

FAA Action:

- December 2007: Create QMS metrics to monitor changes to Resource Targeting output.
- February 2008: Implement QMS metrics to monitor changes to Resource Targeting output.
- June 2008: Develop less subjective RBRT questions and specific instructional material.
- September 2008: Incorporate questions into RBRT tool (IT Contractor)
- March 2009: Integrate RBRT into the Certificate Mgt. Information System (IT Rehost).

Recommendation 4: Require inspectors to review prior manufacturers' audits of suppliers as part of their analysis of risk and determination of resource targeting.

FAA Response: Concur.

FAA Action: The FAA will develop and issue Directive material that will require the review of a sample of PAH's supplier audits during Aircraft Certification System Evaluation Program (ACSEP) and Principal Inspector (PI) evaluations. The review results will be used for two purposes: (1) as a key indicator on how to proceed with the ACSEP or PI evaluation and (2) as input into the following year resource targeting (or RBRT) assessment of the PAH.

- December 2008: Develop new Directive material.
- December 2008: Develop new P AH supplier audit results risk indicator.
- December 2008: Modify resource targeting tool or RBRT.
- January 2009: Implement.

Recommendation 5: Modify its supplier audit requirements so that the number of audits that inspectors are required to conduct more directly correlates with the number of suppliers used by the prime manufacturer.

FAA Response: Concur. The FAA will develop and issue Directive material that will require the number of supplier control audits to more directly correlate with the number of PAH suppliers.

FAA Action:

- March 2008: Develop supplier control audit quantity approach.
- September 2008: Develop new Directive material.
- March 2009: Implement.

Recommendation 6: Provide inspectors with training on (a) auditing systems or processes, (b) individual or task -specific elements of a supplier's operations, and (c) processes for documenting the results of their reviews.

FAA Response: Concur.

FAA Action: The ACSEP training course is scheduled for a thorough content review in FY08. In addition, the AIR Aviation Safety Inspector (ASI) Job Functions course is scheduled for a thorough content review in FY09. This recommendation will be central to the review and follow-on updates of both courses.

- September 2008: Complete ACSEP course content review.
- April 2009: Create new ACSEP Directive material if required.

Appendix. Management Comments

- September 2009: Include changes into the ACSEP Directive.
- September 2009: Include changes into the ACSEP course.
- September 2009: Complete ASI Job Functions course content review.
- April 20 I 0: Create new Certificate Management Directive material if required.
- September 2010: Include changes into the Certificate Management Directive.
- September 2010: Include changes into the ASI Job Functions course.

Appendix. Management Comments