**Before the Committee on Transportation and Infrastructure**
**Subcommittee on Aviation**
**United States House of Representatives**

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# FAA's Certification of the Eclipse EA-500 Very Light Jet


**Statement of**
**The Honorable Calvin L. Scovel III**
**Inspector General**
**U.S. Department of Transportation**



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Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to testify today regarding the Eclipse EA-500 very light jet. Our testimony today is based on the initial results of our investigation of the Federal Aviation Administration's (FAA) process used to certify the EA-500. It is important to emphasize that we did not assess the safety of the aircraft itself. Further, our investigation was limited to the Eclipse certification only; we did not examine FAA's process for certifying and overseeing the aircraft manufacturing industry in general.

As this Subcommittee is aware, safety is a shared responsibility among FAA, aircraft manufacturers, airlines, and airports. Together, these form a series of overlapping controls to keep the system safe. The United States has achieved an impressive safety record—a remarkable accomplishment given all the changes occurring within the industry.

Over the past several years, multiple manufacturers have been designing a new class of aircraft called very light jets or VLJs. VLJs are small aircraft with advanced technologies that cost less than other business jets. Aviation forecasters predict that thousands of VLJs will enter the National Airspace System over the next 2 decades.

Eclipse EA-500
Source: Aviation Business Index

Experts also predict that VLJs will be targeted towards private general aviation users as well as on-demand, point-to-point air taxi operators. In 2006, FAA certified the first VLJs—one of which was the Eclipse EA-500, a six-seat jet aircraft, which featured advanced avionics and better fuel efficiency. Eclipse Aviation was formed in 1998 with the intent of introducing new technology to the aviation industry.

When a manufacturer embarks on building a new aircraft, it must receive two separate approvals from FAA before the aircraft can be mass produced: (1) a design certification (approving the design of the aircraft) and (2) a production certification (approving the manufacturer to begin mass production of the aircraft). FAA issued the design certificate for the Eclipse EA-500 on September 30, 2006, and the production certificate on April 26, 2007. It is important to note, however, that even after a manufacturer has received certification approval, FAA is responsible for ensuring that each aircraft manufactured under its design certificate meets the approved design and is in condition for safe operation.

While the industry was generally excited about the introduction of the technologically advanced jet, some FAA employees were concerned that it was "pushed through" the certification process too quickly. In March 2007, our office received a complaint concerning the certification process for the Eclipse EA-500. The complainant alleged that senior FAA officials prevented FAA inspectors from properly inspecting the production of the Eclipse jet by, among other things, reassigning the inspectors who had identified numerous deficiencies with the aircraft's production and prohibiting the new inspection team from looking under the aircraft floorboards during final inspection.

During our ongoing investigation of the allegations, other FAA employees raised additional concerns that senior officials in FAA's Aircraft Certification Service short-cut both the design and production certification processes. The complaints alleged that those officials may have compromised safety by (1) certifying Eclipse's design despite knowledge of Eclipse's failure to meet certification requirements for avionics software, stall warnings, flaps, and cockpit screens and (2) rushing approvals required for Eclipse to mass produce its jet.

Mr. Chairman, a significant issue overshadowing FAA's certification of the EA-500 is the inherent risks associated with a new aircraft utilizing new technology, produced by a new manufacturer, and marketed with a new business model for its use. Because of these factors, we would have expected FAA to exercise heightened scrutiny in certifying the aircraft. In addition, because the EA-500 has advanced avionics and turbine engine technology typical of large transport aircraft combined with the light weight of smaller, private aircraft, it did not easily fit into FAA's existing certification framework.

FAA chose to certify the EA-500 and other VLJs using certification requirements for general aviation aircraft rather than the more stringent certification requirements for larger transport aircraft. However, in a post-design certification, "lessons-learned" internal review of the Eclipse project, FAA managers acknowledged that the general aviation certification requirements were "inadequate to address the advanced concepts introduced on this aircraft." We understand that FAA is developing a Notice of Proposed Rulemaking (NPRM) to clarify certification requirements for VLJs. Given the issues surrounding the EA-500 certification, FAA should expedite the NPRM to allay future concerns with this expanding industry segment.

In certifying the EA-500, FAA asserts that it met all pertinent certification regulations. However, our initial investigation results show a combination of FAA actions and inactions indicating that the Agency expedited the certification processes for the EA-500 to meet a September 2006 deadline in the Aviation Safety line of business fiscal year (FY) 2006 Performance Plan.

Specifically, FAA allowed Eclipse to use alternate means of compliance to meet design certification requirements despite unresolved design problems identified during testing. Those alternate actions may have contributed to problems that are still reported by Eclipse users today. FAA also awarded Eclipse a production certificate even though there were known deficiencies in its supplier and quality control systems. In addition, the company experienced significant problems replicating its approved design. We are also concerned that the priority designation of the EA-500 may have affected FAA's relationship with and oversight of Eclipse as it quickly moved this new aircraft through the certification process.

My remarks today will focus on the three following points.

### FAA Allowed Eclipse To Use Alternate Means of Compliance To Meet Design Certification Requirements Despite Unresolved Design Problems—Users Continued To Report Similar Problems After Certification

During the design certification of the EA-500, Eclipse applied and FAA approved alternate means of compliance for the aircraft's avionics software and airspeed and altitude indicator (pitot-static system). More importantly, recent events reported by Eclipse aircraft users indicate that other problems identified during the design certification continued after the design was approved, including erroneous stall warnings, cockpit display failures, and flap movement problems. Further, users are still reporting that the aircraft is experiencing a high rate of tire failure.

In addition, our analysis of two safety problem reporting systems disclosed numerous issues similar to those encountered during the design certification process; many of these problems have been reported with the EA-500 over the last year. For example, Service Difficulty Reports (SDRs)[1] disclosed that between June 2007 and July 2008, the largest user of the EA-500 submitted 84 SDRs for 28 Eclipse aircraft. While SDRs are to be expected with any new aircraft, the fact that many of those reported for the EA-500 appear to relate back to design issues is troubling.

**A recent incident involving the EA-500 has heightened attention regarding the aircraft's design certification.** On June 5, 2008, an EA-500 on approach to Chicago Midway airport experienced a throttle failure that resulted in an uncontrollable maximum power thrust from its engines. After consulting the emergency procedures, the pilots shut down one of the engines; however, this action caused the second engine to roll back to idle power and be unresponsive to the throttle. The pilots declared an emergency and were able to land the plane without injury to the two pilots or two passengers.

During its investigation into the incident, the National Transportation Safety Board (NTSB) expressed concern about the reliability of an assembly that failed after

[1] SDRs are submitted by operators when a failure or defect occurs in the aircraft structure or is detected if that failure or defect has endangered or may endanger the safe operation of an aircraft.

accumulating only 238 hours and 192 cycles. The NTSB also raised concerns that the problem could be due to flaws in the design logic for the software that controls the engines and issued two recommendations to FAA requiring (1) immediate inspection of all EA-500 engine throttles and (2) an emergency procedure to address dual engine control failure.

On June 12, 2008, FAA issued an Airworthiness Directive (AD)[2] that requires operators to examine throttle controls for identified faults and replace assemblies as necessary. Since awarding the design certificate to Eclipse, FAA has issued a total of six ADs for various components of the EA-500.

As a result of this incident, FAA engineers re-examined the software that controls the engines and discovered software logic flaws that should have been resolved before design certification. At the end of June 2008, the local FAA certification manager sent a memorandum to the manufacturer requiring Eclipse to develop an approach to bring the aircraft design into certification compliance for that system. Eclipse is currently addressing FAA's requirement.

### FAA Awarded Eclipse a Production Certificate Despite Known Deficiencies in the Company's Supplier and Quality Control Systems

FAA granted Eclipse a production certificate on April 26, 2007. A production certificate is FAA's approval that the manufacturer has demonstrated the ability to manufacture aircraft using an FAA-approved design without further FAA airworthiness inspections. To obtain a production certificate, however, manufacturers are required to undergo FAA quality control reviews and an FAA Production Certification Board review to determine if they have complied with all regulations. FAA's quality control reviews, which began in July 2006, identified numerous deficiencies, with 42 serious deficiencies (including 4 involving software) identified as late as February 2007.

The Production Certification Board completed its review on April 26, 2007—the same day the production certification was granted—and identified two serious, overarching deficiency issues. First, the Board found that Eclipse had not completed the requirement to show that it had established and could maintain a quality control system. Second, the Board found significant issues associated with Eclipse's controls over its suppliers. Despite the impact that these issues could have on the production process, FAA awarded the production certification to Eclipse with 13 specific production problems.

Additionally, before it received its production certification, Eclipse encountered numerous problems replicating its own aircraft design on the factory floor. A significant concern was that manufacturing deficiencies were not identified by Eclipse

[2] FAA issues an Airworthiness Directive when it finds that an unsafe condition exists and that the condition is likely to exist in other products of the same design.

inspectors designated to certify aircraft airworthiness. For example, in one instance, Eclipse presented an aircraft to FAA for airworthiness certification with approximately 20 airworthiness deficiencies, even though an FAA-approved Eclipse inspector had previously inspected the aircraft for airworthiness and found no non-conformities.

### FAA's Desire To Promote the Use of VLJs May Have Contributed to Its Decision To Accelerate the Eclipse Certification Process

A significant concern surrounding this issue, Mr. Chairman, is that FAA designated the Eclipse EA-500 VLJ as a priority project for certification in its FY 2006 Performance Plan for the Aviation Safety line of business. In this plan, FAA stated that it would certify the aircraft design by September 2006. Although FAA met this deadline, the specific designation as a priority certification may have resulted in reduced vigilance on the Agency's part during the aircraft's design and production certification processes. We identified four other FAA actions that raise concern regarding the Agency's safety oversight focus in this matter:

- **FAA granted Eclipse Organizational Designated Airworthiness Representative (ODAR) authority to certify its own aircraft for airworthiness 4 years before Eclipse obtained a design certificate.** This authority allowed Eclipse to approve and document parts as they were manufactured, with Eclipse inspectors overseeing manufacturing processes on FAA's behalf. However, it is unclear to us why FAA determined that Eclipse met the qualifications to perform its own inspections since Eclipse was a new manufacturer with no history of manufacturing an aircraft or shepherding a design through the design certification process. Further, FAA inspectors found numerous deficiencies on planes that had been accepted and approved by Eclipse inspectors.

- **FAA granted single-pilot operation certification for the EA-500 despite FAA Flight Standardization Board[3] concerns.** Eclipse originally envisioned that the EA-500 would be marketed to individual owners. However, because of the many in-flight problems reported by pilots, the Board determined that the aircraft required a two-pilot crew. On December 15, 2006, Eclipse initiated a customer service complaint to protest the Board's recommendation. FAA subsequently rescinded the two-pilot recommendation on January 29, 2007.

- **FAA replaced the inspection team that had identified deficiencies at Eclipse and restricted the new team's inspection activities.** After FAA removed the original inspection team, it assigned the former FAA Headquarters Deputy Director of Aircraft Certification responsibility for the Eclipse certification project. This individual assembled a new team of inspectors and developed a

[3] The FAA Flight Standardization Board is a group of FAA pilots who test-fly the new aircraft to determine readiness for users.

policy that limited the inspectors' ability to fully inspect the aircraft for airworthiness.

- **FAA allowed one of its engineers formerly assigned to the Eclipse project to take a high-level position at Eclipse without a "cooling-off" period.** While at FAA, the engineer evaluated and approved Eclipse's proposed methods for meeting FAA's certification requirements for the design phase of the aircraft. When he left FAA, he immediately began working at Eclipse as Director of Certification, serving as the focal point between Eclipse and FAA concerning the company's compliance with FAA's certification requirements.

Mr. Chairman, the results of our investigation and those of the NTSB, as well as concerns expressed by EA-500 users and FAA employees, clearly underscore the need for FAA to take immediate actions to ensure that existing problems reported by Eclipse users are quickly resolved. At our recommendation, FAA established a Special Certification Review Team last month to verify that Eclipse corrects design and production problems associated with the EA-500 and determine that the aircraft is in condition for safe operations. The team concluded the certification of the EA-500 was appropriate because it met FAA requirements for the focus areas reviewed. We received a copy of the team's report on Saturday and are reviewing its findings and recommendations.

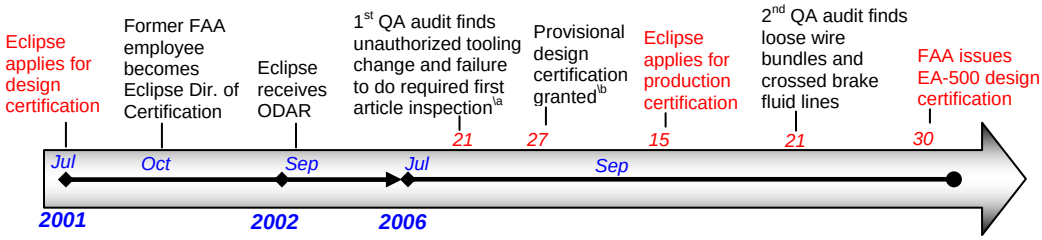
However, based on our interim results, we are recommending that FAA take several immediate actions. Those include expediting its NPRM to clarify certification requirements for the expanding VLJ industry segment; refraining from granting new, inexperienced manufacturers authority to certify the airworthiness of their own aircraft prior to design certification; and verifying that the certification process for single-pilot operations of the EA-500 was appropriate.

I would now like to discuss these issues in further detail.

## FAA Allowed Eclipse To Use Alternate Means of Compliance To Meet Design Certification Requirements Despite Unresolved Design Problems—Users Continued To Report Similar Problems After Certification

We found that in certifying the EA-500 design, Eclipse used and FAA approved an alternate means of compliance. While FAA regulations permit alternate means of compliance, we are particularly concerned that FAA applied a less stringent standard to the avionics software design, which the aircraft heavily relies upon for operation. Users have since reported problems directly related to the EA-500 software, such as cockpit display failures. In addition, other problems with the aircraft design have surfaced, such as airspeed and altitude indicator (pitot-static system) discrepancies, erroneous stall warnings, and tire failures. The timeline below shows key dates leading up to the design certification for the EA-500.

***Figure 1. Eclipse Design Certification***




\a First article inspection: A required inspection of a newly produced or revised part, assembly, or product.
\b Provisional design certification: An approval of the aircraft design that allows for limited flight and operational testing of the aircraft.
Source: OIG analysis of FAA data

**The Eclipse EA-500 relies extensively on software to operate.** The Eclipse EA-500 is a technologically advanced aircraft with an integrated avionics system that controls several of the aircraft's crucial systems and displays, sensor data processing, and subsystem monitoring. For example, this system enables the flight crew to control landing gear, cabin pressurization, lighting, trim, and electrical systems.

This integrated system also handles key data that flows to the aircraft's flight management system, such as global positioning (GPS), altitude, direction, and velocity data. The EA-500's avionics system is solely computer-based; it does not have stand-by instruments to monitor flight-critical information (other VLJs like the Cessna Mustang have back-up [analogue] systems; see figure 2 below).

***Figure 2. Comparison of Cessna and Eclipse Cockpit Systems***

**Cessna Mustang cockpit has analogue instrumentation (gauges) in addition to a computer screen display**

**EA-500 cockpit relies exclusively on a computer-based system**

During the EA-500 design certification, Eclipse applied and FAA approved alternate means of compliance for the aircraft's avionics software. Given the EA-500's dependence on its avionics software, we would have expected FAA to perform rigorous analysis and testing prior to design certification. We found, however, that FAA did not require this software to be approved to the accepted industry standard before certification. Instead, FAA accepted an "IOU" from Eclipse, which stated that the aircraft would meet the accepted industry standard at a later date. In exchange, Eclipse agreed to maintain control of the aircraft—meaning that it would not be released to customers.

While FAA guidance concerning this process allows for deviation from normal accepted practices, we are concerned about the level of review that FAA conducted in certifying the software. Specifically, FAA Advisory Circular 20-115B states the following:

> An applicant for an [FAA design certification] for any electronic equipment or systems employing digital computer technology may use the considerations outlined in RTCA document DO-178B [industry standards] as a means but not the only means to secure FAA approval of the digital computer software.

FAA software technical specialists we spoke with told us that the RTCA document was essentially the "de-facto standard" for software approval. We also spoke with FAA inspectors (who routinely approved aircraft software applications) who stated that FAA's proposed actions of accepting an IOU from the manufacturer were so contrary to its long-established business practices that they did not meet the safety standards normally required of other applicants.

The IOU from Eclipse addressed tests that its software supplier needed to complete to meet industry standards for the software driving the avionics system. However, when

FAA issued the design certificate, Eclipse's software supplier had only completed 23 of the 65 tests. The supplier subsequently completed all 65 tests by June 2007; however, EA-500 users continued to report problems with the cockpit instrumentation as recently as May 2008. For example, our analysis of SDRs submitted between June 2007 and July 2008 by the largest user of the EA-500 shows 22 malfunctions of the instrument display, including faulty airspeed readings that caused aborted take-offs and autopilot malfunctions.

In a post-design certification, "lessons-learned" internal review of the Eclipse project, FAA managers acknowledged that "FAA supported flight testing without completing software validation" even though Eclipse had a "significant software vendor integration issue." This review also noted that "FAA created innovative processes to support [the] program [but] there are risks associated with not following documented processes."

In fact, even the local FAA manager who approved the Eclipse design certification has since expressed concerns over the process used for certifying the aircraft software. In a July 16, 2007, memorandum to the Director of the Aircraft Certification Service this manager stated the following:

> During the TC [design certification], we accepted a lesser level of validation and consequently the FAA ended up doing a great deal of developmental flying with Eclipse, a task that the company should accomplish prior to FAA TIA [preliminary aircraft] testing. In conducting a lessons learned review after the initial TC [design certification], we identified the level of software certification as an issue we would treat differently on subsequent certifications.

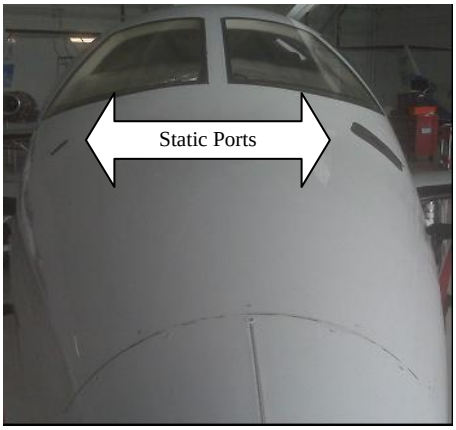
**A specific concern related to the avionics software was that the cockpit screen was blanking or freezing both before and after design certification.** FAA regulations state that the electronic display indicators must be designed so that if one display fails, another display would remain available to the crew without the need for immediate action by the pilot for continued safe operation. The cockpit display is critical instrumentation for the pilot; it displays vital information such as airspeed, altitude, flap position, and rate of climb. In the case of the EA-500, the cockpit display is even more critical because there is no back-up, analogue instrumentation.

In order to award the design certificate, FAA permitted Eclipse to fix the software "bug" that caused the screen blanking after the design certification was issued. However, Eclipse was not able to do so until January 18, 2007—nearly 4 months after the design certification was awarded. While this fix appeared to address the software "bug," our analysis of SDRs reported by the largest user of the EA-500 between June 2007 and July 2008 disclosed one instance of cockpit screen blanking that occurred during the final approach for landing.

**During the design certification process for the EA-500, Eclipse applied and FAA approved alternate means of compliance to certify the aircraft's system that controls airspeed and altitude indicators.** The Eclipse EA-500 design for the pitot-static system (which indicates airspeed, altitude, and rate of climb) did not include a drainage system for excess moisture, unlike the typical design for other aircraft. Eclipse developed and initially tested the EA-500 pitot-static system and reported no early significant problems. However, it is important to note that this initial testing took place in Albuquerque, New Mexico—an extremely dry climate with little rainfall. Once the aircraft was brought into more humid climates, such as Florida, problems began occurring with airspeed and altitude cockpit indicators.

The source of these problems was eventually traced to moisture build-up inside the pitot-static system. This occurred due to the unusual placement of the static ports on the top of the aircraft nose (see figure 3 below) and the lack of drainage; the static ports are normally located on the sides of the aircraft to mitigate moisture.

***Figure 3. EA-500 Nose Pitot-Static Ports***




Source: OIG

Federal aviation regulations require that "the design and installation of each air speed indicating system must provide positive drainage of moisture from the pitot-static system." However, FAA can approve a non-typical design by granting the manufacturer an "Equivalent Level of Safety" (ELOS) exemption. In this instance, FAA granted an ELOS for the EA-500 pitot-static tube as proposed by the manufacturer. The ELOS was based on Eclipse's assertion that the pitot-static system included a heating system designed to dry any moisture that might accumulate.

According to FAA inspectors we spoke with at the Fort Worth FAA certification office (the office responsible for Eclipse certification), they were uncomfortable that the pitot-static design lacked sufficient drainage and declined to approve the ELOS, even with the heating system. To overcome these objections, FAA referred the ELOS approval to the Kansas City Small Airplane Directorate, which agreed to approve it.

In response to the pitot-static system problem, FAA issued an AD on June 14, 2007, limiting operations of the aircraft to two-pilot operations only and only under visual flight rule conditions.[4] FAA issued a second AD that was effective on February 26, 2008. This AD lifted the restrictions for those aircraft whose owners had installed the design modification for the pitot-static system developed by Eclipse for existing aircraft. However, users we spoke with told us that while the modification required by the AD has helped reduce the number of incidents, it has not eliminated the problem.

For example, as recently as April 2008, the pilot of an EA-500 experienced a warning signal that the two instruments measuring airspeed did not agree during take-off. The pilot then aborted the take-off and returned the aircraft for maintenance inspection. Subsequent inspection of the aircraft revealed moisture build up in the pitot-static system; after draining out the moisture, the aircraft returned to normal service without problems.

**Eclipse aircraft users continued to report other post-design certification problems with the EA-500, including erroneous stall warnings, flap movement failures, and a high rate of tire failure.**

- Erroneous Stall Warnings: The EA-500 experienced erroneous stall warnings before and after the design certificate was awarded. FAA regulations state ". . . the stall warning must not occur during takeoff with all engines operating, a takeoff continued with one engine inoperative, or during an approach to landing." These stall warnings continued to occur after Eclipse received its design certificate on September 30, 2006. According to FAA pilots we spoke with, erroneous stall warnings can be extremely hazardous, particularly when landing. For example, they may cause pilots to either take urgent actions that can prove dangerous based on the belief that they are experiencing a stall or ignore them because they have proven to be erroneous in the past.

  Nearly 3 months after the design certification was issued, FAA was able to attribute some of the stall warnings to flying the aircraft at inappropriate speeds. However, pilots have recently reported this problem with the EA-500 through SDRs and a voluntary, anonymous safety reporting system, the Aviation Safety Reporting System. At least three additional reports regarding stall warnings have been reported through these two systems between June 2007 and July 2008. All three involved problems on take-off.

[4] Flying under visual flight rules (VFR) requires that the pilot (or pilots) have enough forward visibility and clearance from clouds to safely operate the aircraft without referring to cockpit instruments.

- Flap Movement Failures: FAA regulations state that the main wing flaps must be designed so that the occurrence of flap failure is "extremely improbable." However, both before and after the design certificate was awarded, the aircraft had problems with flaps sticking in position. The impact of this on the aircraft is that a "flaps up" landing can require up to 100 percent more landing distance. This landing length may not be available for every general aviation pilot who flies the EA-500, which is not equipped with anti-skid brakes. During testing of the aircraft in December 2006, FAA's Flight Standardization Board recommended that it be restricted to two-pilot operations stating:

  > The immediate issue that has caused the Board to reach this conclusion is the repeated flap failures that have occurred during recent flights. These failures are now approaching a frequency of one flap failure for every 10 attempts to operate the flaps. The flight control problem affects safety of flight and acceptable operational reliability.

  FAA Headquarters officials overruled the Board's recommendation and approved it for single-pilot operations in January 2007 after receiving a customer service complaint from Eclipse. While only 1 instance of flap failure was reported through an SDR after design certification, our analysis of SDRs from the largest EA-500 user between June 2007 and July 2008 disclosed 21 reports of other flight control part malfunctions (i.e., rudder, flaps, aileron, and elevator).

- High Rate of Tire Failure: During our site visits to the largest user of the EA-500, pilots we spoke with raised other issues that were not identified during the design certification of the aircraft. For example, they expressed concerns about a high frequency of tire failure associated with the aircraft. In subsequent discussions with these and other EA-500 users, they told us that the high rate of tire failure was likely due to the fact that the aircraft was initially designed for use on "soft fields" (i.e., dirt and grass). However, it is now being used almost exclusively on standard, paved airport runways.

  Since the tires were meant for soft field use, they are softer and less durable than the harder, longer-lasting aircraft tires commonly used on standard, paved runways. As a result, the aircraft requires an even higher degree of speed control and precision upon landing to prevent tire "blow-outs" during landing, which places additional workload on the pilots. Because pilots continued to report tire failures with the EA-500, Eclipse has submitted the required data to FAA to obtain certification for a more durable tire.

  Pilots also expressed concerns that the tires on the aircraft were wearing excessively because the landing gear was designed with a slight inclination inwards, towards the fuselage. As a result, the entire surface of the tires was not contacting the runway evenly, thus causing excessive wear on the exposed sides of

the tires. We understand that Eclipse is modifying the aircraft's design to correct this problem.

**According to FAA, none of the problems experienced by users today were identified during the design certification.** FAA asserts that none of the current problems experienced by EA-500 users were identified during the design certification. However, in our opinion, there is sufficient evidence that these problems were occurring during that period and that FAA *should have* known about them.

For example, in the 2 weeks preceding award of the design certification on September 30, 2006, Eclipse test-flew the aircraft for 100 hours as a pre-condition for receiving the certification. During those flights, the pilots experienced (1) at least 4 erroneous stall warnings during landing, (2) 10 instances of cockpit screen freezing or blanking, and (3) 18 cases of actual flap failure or flap-failure messages on the cockpit display. All of these are problems that users continued to report after design certification. Table 1 shows the design problems that occurred before and after FAA awarded Eclipse its design certification.

***Table 1. Eclipse EA-500 Design Discrepancies Found Before and After Design Certification***

| Issue Found[\a] | Pre-Design Certification | | Post-Design Certification | | |
|---|---|---|---|---|---|
| | Joint FAA & Eclipse Flight Testing[\b] | Flight Standardization Board[\b] | Flight Standardization Board | Service Difficulty Reports | Aviation Safety Reporting System |
| *Erroneous Stall Warnings* | 4 | 9 | 10 | 2 | 1 |
| *Screen Blanking* | 10 | 2 | None Documented | 1 | None Documented |
| *Flap Malfunctions* | 18 | None Documented | 8 | 1 | 1 |
| *Airspeed Disagrees* | 1 | None Documented | None Documented | 13 | 2 |
| *Air Data Computer Failures* | 20 | None Documented | 1 | 1 | None Documented |
| *Autopilot Failures* | 7 | None Documented | None Documented | 3 | 2 |

\a Number of instances based on documentation obtained currently; more instances may exist.
\b Joint FAA & Eclipse Flight Testing accomplished by Aircraft Certification Office (ACO) Pilots; Flight Standardization Board testing conducted by separate group of FAA pilots.
Source: OIG analysis of FAA data

Based on the results of our investigation to date, the conclusions in FAA's lessons-learned review, and—most importantly—the problems that continue to impact pilots, we believe that FAA should have exercised greater diligence in certifying the EA-500 design. Going forward, FAA must ensure that the approval of aircraft involving so

many unknowns (e.g., new technology and new manufacturer) is subjected to close scrutiny and thorough risk analysis.

Last month, at our recommendation, FAA established a Special Certification Review Team to verify that Eclipse corrects design and production problems associated with the EA-500 and determine that the aircraft is in condition for safe operations. The team completed its assessment last week and concluded the EA-500 met applicable certification requirements for the issue areas reviewed. We received a copy of the team's report on Saturday and are reviewing its findings and recommendations.

## FAA Awarded Eclipse a Production Certificate Even Though It Knew of Deficiencies in Eclipse's Quality Control and Supplier Control Systems

FAA granted Eclipse a production certificate on April 26, 2007. A production certificate is FAA's approval to manufacture aircraft using an FAA-approved design. Prior to obtaining a production certificate, every aircraft manufactured by Eclipse was required to receive an FAA inspection and certificate of airworthiness before it could be released to a customer. Once Eclipse received its production certificate, however, it could mass produce and certify its own aircraft for airworthiness without FAA inspection approval.

Before receiving a production certificate, manufacturers are required to undergo two steps: (1) FAA quality control audits and (2) an FAA Production Certification Board review. Once FAA completes its quality control audits and the manufacturer has corrected all findings, FAA will convene the Board to consider a manufacturer's application for production certification. The purpose of this review is to determine if the manufacturer has complied with all regulations required to obtain a production certificate.

A key issue for the Board is to ensure that corrective actions for any non-satisfactory conditions of non-compliance have been addressed *prior to issuing a production certificate*. In the case of the EA-500, however, we found that FAA issued the production certification before Eclipse corrected identified deficiencies. Further, FAA audits of Eclipse supplier controls, which were conducted post-production certification, found that significant deficiencies continued to occur.

Beginning in July 2006, FAA safety inspectors who specialize in aircraft manufacturing conducted three quality control audits of Eclipse. Each of these audits identified numerous deficiencies, including improperly manufactured parts and uncalibrated, unmarked tools. For example, one review conducted by FAA in February 2007 identified 42 deficiencies, including 4 involving software used for aircraft operations (e.g., pilot displays).

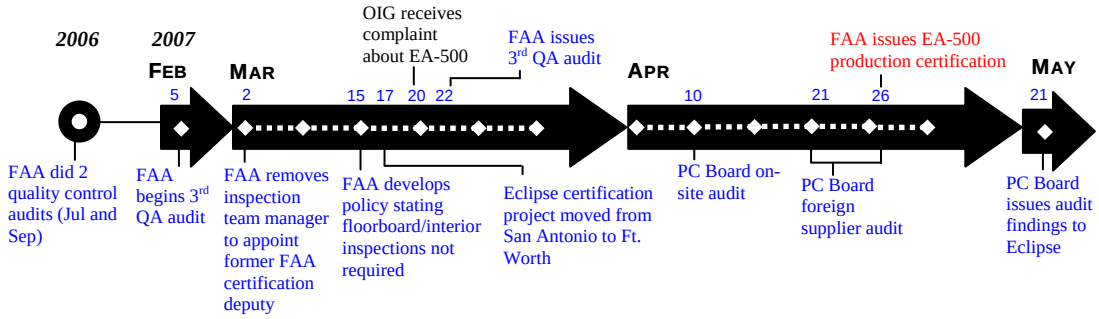
On April 10, 2007, when the Production Certification Board was convened, only 29 of the 42 deficiencies identified in FAA's quality control audits had been corrected. Despite the 13 uncorrected deficiencies, the Board finalized the on-site (in New Mexico) portion of its review of Eclipse quality control on April 12, 2007.

On April 21, 2007, the Board arrived in Japan to review one of Eclipse's foreign suppliers. It completed this portion of the review on April 26, 2007—the same day that FAA awarded Eclipse its production certification. When the Board finalized its review and transmitted its findings to Eclipse on May 21, 2007, (almost a month after Eclipse had the production certification) it identified two serious, overarching non-conformities with Eclipse production.

First, the Board concluded that Eclipse had not completed the requirement to show that it had established and could maintain a quality control system. Second, based on its review in Japan, the Board concluded that Eclipse had significant issues with control over its suppliers.

Despite the impact that these non-conformities could have on the production process, FAA awarded the production certification to Eclipse on April 26, 2007, with a total of 13 known, unresolved production problems (primarily associated with Eclipse supplier and quality control systems). The Board did not close out its open review items until February 2008. The following timeline shows key dates leading up to the production certification for the EA-500.

***Figure 4. Eclipse Production Certification***




Source: OIG analysis of FAA data

**Three months after FAA issued the production certification, the 13 unresolved action items remained open.** We are concerned because FAA was aware of unresolved deficiencies that continued after it granted Eclipse its production certification. In a July 16, 2007, memo to the Director of Aircraft Certification, the local certification office manager stated the following:

> Thirty-two airplanes have received Standard Airworthiness certificates. Twenty-one of these have been since the Production Certificate was [issued] on April 26, 2007. There are 13 action items on the Project Certification Plan that completes the [production certificate]. Some of these action items are complete and some are behind schedule. Eclipse is scheduled to complete the action items by the end of the year.

The 13 remaining findings included requirements addressing Eclipse's oversight of its suppliers and adherence to its own quality assurance processes. For example, corrective actions to address these 13 findings included the following:

- Establish new procedures for Eclipse to inspect its suppliers on site.
- Establish new procedures to inspect parts received from foreign suppliers.
- Develop and submit a "shelf-life" policy to determine when certain aircraft parts have expired (e.g., sealants, engine oil, and fluid compounds).
- Develop procedures to protect parts vulnerable to damage from electrostatic discharge (i.e., parts/software that could be damaged by power surges and other electrical shock).
- Perform an internal audit of its quality assurance processes.

**Additionally, before Eclipse received its production certification, it encountered numerous problems replicating its own aircraft design on the factory floor.** A significant concern was that manufacturing deficiencies were not identified by Eclipse's ODAR inspectors designated to certify aircraft airworthiness. For example, in one instance, Eclipse presented an aircraft to FAA for airworthiness certification with approximately 20 airworthiness deficiencies, even though an FAA-approved ODAR inspector had previously inspected the aircraft for airworthiness and found no non-conformities.

Other examples of deficiencies FAA identified included improperly installed fasteners on the wings, oxygen lines routed across control cables, and wires chafed by the airframe. Aircraft also failed functional test procedures for critical systems such as landing gear, communications, flaps, pitch trim, fire protection, and transponders.

FAA inspectors told us that Eclipse repeatedly submitted aircraft for airworthiness certification with previously identified discrepancies that had still not been corrected, and they expressed frustration over the time and resources spent inspecting aircraft that were clearly not ready for inspection. For example, on the first aircraft, FAA inspectors found deficiencies associated with the landing gear on eight separate inspections. Table 2 below shows discrepancies that FAA inspectors identified on the first three EA-500 aircraft *after* they were certified by Eclipse inspectors.

### *Table 2. Manufacturing Deficiencies Found by FAA Inspectors After Eclipse Inspectors Certified the Aircraft*

| Discrepancy | Aircraft 1 | Aircraft 2 | Aircraft 3 |
|---|---|---|---|
| ***Failed Functional Tests*** | | | |
| Landing Gear Rigging | 8 times | | |
| Landing Gear on Extension During Flight Test | | 2 times | |
| Aileron Trim | 2 times | | |
| Bleed Air Supply Subsystem (BASS) | 4 times | | |
| Cabin Pressurization | 5 times | | |
| Electrical Power Distribution System | 2 times | | |
| Pitot-Static System | | 2 times | 3 times |
| Transponder | 2 times | | |
| Airspeed Measuring System/Air Data System | 3 times | 2 times | |
| Oxygen Mask Drop | | | 2 times |
| ***Wire Chafing*** | | | |
| Numerous wire bundles on aircraft structure behind instrument panel | | 3 times | |
| Engine Bleed Valve Line on insulation | 1 time | | |
| Starter Generator cables assembly | 1 time | | |
| Multi-Functional Display Wires on the aircraft structure, both sides | | 1 time | |
| ***Loose Wiring*** | | | |
| Engine wiring harness to BASS module | 1 time | | |
| Canon Plug and Wire Harnesses | 1 time | | |
| Electrical connectors where the wings attach to the fuselage, left and right sides | | 1 time | |
| ***Weight & Balance*** | | | |
| Human Calculation Errors | 2 times | 1 time | |
| ***Rivets/Grommets/Fasteners*** | | | |
| Engine grommet misaligned | 1 time | | |
| Fasteners and rivets improperly installed | | 2 times | 1 time |

Source: OIG analysis of FAA data

**After granting the production certification, FAA audits of Eclipse supplier controls found significant deficiencies occurring that should have been corrected.** During our investigation, we found that FAA inspectors conducting audits of Eclipse's supplier quality control between February and August of 2008 identified multiple issues that should have been corrected. FAA initiated enforcement actions for seven out of the seven Eclipse suppliers it audited. That is, during the audits, the FAA inspectors identified serious non-conformities associated with aircraft parts, materials, or manufacturing processes used for the EA-500 by Eclipse suppliers. These included the following:

- Receiving or Accepting Non-Conforming Parts or Tools: Suppliers were not performing receiving inspections for parts or materials received from *their* suppliers. In addition, suppliers were producing parts using design specifications that were either unapproved or outdated. Suppliers also received, accepted, and used non-conforming materials from *their* suppliers.

- Parts Not Properly Stored or Marked: Non-conforming/deficient parts were found on the suppliers' shop-room floors that were not marked as deficient, which meant that technicians could not determine if they passed or failed a receiving inspection; therefore, they could have been mistakenly used in production.

- Failure To Follow Manual Procedures: Work instructions at one foreign supplier were not written in English, which meant that inspectors from both the manufacturer and FAA could not verify that the work instructions were written as required. Supplier personnel were also using outdated instructions to perform weight and balance calculations of flight control surfaces (i.e., flaps, ailerons, etc.). In addition, suppliers' certificates of conformance (a tag confirming that the part conforms to requirements) did not contain process specifications as required by the engineering documentation.

- Uncalibrated Tools: Several gauges that require strict calibration were found uncalibrated. Further, these tools were not included in the database that tracks tool calibration (this system ensures that tools requiring calibration meet required specifications within required timeframes). Calibrated tools are highly sensitive and used in safety-critical manufactured components, such as the wing assembly or the actuators that control flight surfaces (i.e., flaps, ailerons, etc.).

- Revisions to Tooling and Procedures Without Approval From Eclipse: FAA inspectors observed technicians hand-trimming hinge and access covers for the elevator (which controls aircraft pitch) without any documentation or engineering authorizations. In addition, one supplier revised supplier manuals, material specifications, process specifications, and workmanship standards with no evidence that the changes had been approved by Eclipse or FAA.

Additionally, at the largest user of the EA-500, mechanics found problems with Eclipse supplier-manufactured parts on 26 of the 28 EA-500 aircraft operated by the company. Specifically, Eclipse supplier-manufactured bell cranks (which control aileron movement) were corroding, causing excessive friction during operation resulting in severe degradation and limited functionality. As a result, all 26 aircraft had to have their bell cranks replaced—some on more than 1 occasion. In one instance, an aircraft's bell crank had to be replaced only 6 weeks after that aircraft's airworthiness certificate was issued.

The fact that these issues continued to occur post-production raises questions about FAA's ability to maintain proper oversight when advancing the production of new

aviation technology. FAA has established good steps to oversee this process, but those steps were rendered ineffective since FAA treated them as mere formalities rather than prerequisites to certification.

## FAA's Desire To Promote the Use of VLJs May Have Contributed to Its Decision To Accelerate the Eclipse Certification Process

A significant concern surrounding this issue, Mr. Chairman, is that FAA specifically designated the Eclipse EA-500 VLJ as a priority project for certification. In FAA's Aviation Safety line of business FY 2006 Performance Plan, FAA identified Eclipse as a priority certification activity, stating that it would support the operation of VLJs in the National Airspace System by issuing:

> . . . a [design certification] for a new small airplane by September 2006. Eclipse Aviation will obtain [a design certification] for small jet powered by P&W [Pratt and Whitney] 610 engines and using extensive new technology avionics.

We are concerned that the specific designation of Eclipse as a priority certification may have resulted in undue pressure to meet the deadline, thereby resulting in reduced vigilance from FAA during the aircraft's design and production certification processes. In FAA's post-design certification, lessons-learned review of the Eclipse project, FAA managers acknowledged that "FAA supported an aggressive certification schedule" and that it expended "32,000 hours; $2.0 million (salary, travel, and overtime costs); and hundreds of hours of [compensatory] time," indicating that they believed these efforts were inappropriate.

In fact, with authorization from FAA managers, three inspectors exceeded the number of overtime hours allowed by Federal regulations in their attempt to ensure Eclipse received its design certification by the September 2006 deadline. In addition, as a pre-condition to receiving design certification, FAA flew the test plane for 30 flights, encompassing 100 flight hours over the 2-week period preceding the September 30, 2006, issuance of the design certificate.

An important point, Mr. Chairman, is that FAA met its Performance Plan deadline and awarded the design certification to Eclipse on Saturday, September 30, 2006.

With the significant risks posed by a new aircraft utilizing new technology and produced by a new manufacturer, we would have expected that FAA would have exercised greater scrutiny in certifying the aircraft. In addition, because the EA-500 has advanced avionics and turbine engine technology typical of large transport aircraft combined with the light weight of smaller, private aircraft, it did not easily fit into FAA's existing certification framework.

FAA chose to certify the aircraft and other VLJs using certification requirements for general aviation aircraft rather than more stringent certification requirements for larger transport aircraft. However, in FAA's post-design certification, lessons-learned review of the Eclipse project, FAA managers acknowledged that the general aviation certification requirements were "inadequate to address the advanced concepts introduced on this aircraft." We understand that FAA is developing an NPRM to clarify certification requirements for VLJs. Given the issues surrounding the EA-500 certification, FAA should expedite the NPRM to allay future concerns with this expanding industry segment.

In addition to the priority certification, we identified four issues that raise concern regarding FAA's safety oversight focus in this matter: (1) FAA granted Eclipse an ODAR appointment much earlier in the process than it has for other manufacturers, (2) FAA granted single-pilot operation certification for the EA-500 despite concerns from the FAA Flight Standardization Board and users, (3) FAA replaced the inspection team overseeing Eclipse and restricted the new team's inspection activities, and (4) a former FAA engineer assigned to the Eclipse project took a position as Director of Certification for Eclipse.

**FAA granted Eclipse authority to certify its aircraft for airworthiness before approving the design, which is far earlier than it has for other manufacturers.** FAA granted Eclipse an ODAR appointment on September 3, 2002. The ODAR designation allowed the company to approve and document parts as they were manufactured, with internal Eclipse inspectors overseeing manufacturing processes on FAA's behalf. To receive an ODAR designation, FAA regulations require the organization to have proven experience to perform the functions for which the authorization was requested.

FAA does not typically grant ODAR authority before an aircraft company obtains its design certification. However, FAA guidance allows for this if the organization has a "high probability of obtaining a production certificate." In the case of Eclipse, FAA granted ODAR designation to the manufacturer 4 years before the company obtained a design certificate for its aircraft and 5 years before it obtained its production certification.

Given that FAA must have known that Eclipse was several years away from obtaining design certification, we question how FAA determined the company had a "high probability" of receiving its production certificate. FAA has granted ODAR authorization prior to issuing a design certification for only one other new VLJ manufacturer, Adam Aircraft; however, this manufacturer is in bankruptcy. In fact, as shown in table 3 below, Eclipse is the only operating manufacturer to receive its ODAR authorization *before* the aircraft design was approved by FAA.

### *Table 3. FAA Approvals for Other New Manufacturers of VLJs*

| Manufacturer | Design Certificate Issued | Production Certificate Issued | ODAR issued |
|---|---|---|---|
| **Eclipse** | September 30, 2006 | April 26, 2007 | September 3, 2002 |
| **Cirrus** | October 23, 1998 | June 12, 2000 | September 8, 2006 |
| **Liberty Aircraft** | February 19, 2004 | April 6, 2006 | November 18, 2006 |
| **Adam Aircraft** | May 11, 2005 | None (Company bankrupt) | May 17, 2002 |
| **Sino Swearingen*** | October 27, 2005 | None | None |

* The small jet from this manufacturer was not classified as a VLJ because of its weight, but it is often used for comparison purposes to the Eclipse certification because it was design certified by the same FAA office during the same time period.
Source: OIG analysis of FAA data

It is unclear why FAA determined that Eclipse met the qualifications to perform its own inspections since Eclipse was a new manufacturer with no history of manufacturing an aircraft or shepherding a design through the design certification process. In our view, these facts should have raised questions regarding Eclipse's ability to perform this function. As discussed earlier, FAA inspectors found numerous deficiencies on planes that had been inspected and approved by Eclipse inspectors with ODAR designations. This would indicate that FAA granted early ODAR authority in an attempt to expedite the certification process, rather than granting it as a result of diligent and thorough oversight.

We also found evidence indicating that the individuals selected for the Eclipse ODAR may not have been fully qualified to perform inspection tasks. For example, when one FAA principal inspector showed improperly installed fasteners to Eclipse ODAR authorized representatives, they could not articulate how to inspect for proper installation. The FAA inspector expressed significant concerns that the ODAR representatives lacked sufficient knowledge to certificate the airworthiness of aircraft.

In our opinion, FAA should carefully evaluate the propriety of granting ODAR authority for new, inexperienced manufacturers prior to design certification, especially in the case of light-weight aircraft that rely heavily on new technology. Further, FAA's ODAR designation process should more thoroughly evaluate designees' skill level and experience and ensure that the company designees are allowed to conduct their inspections properly and without interference from the manufacturer. In the case of Eclipse, FAA's post-design certification, lessons-learned review noted that [ODAR] designees "reported pressure by the company to make submittals before data was *[sic]* complete."

**FAA granted single-pilot certification for the EA-500 despite concerns from the Flight Standardization Board and users:** Eclipse originally envisioned and designed the EA-500 as a single-pilot aircraft with the goal of marketing it to individual owners. However, pilots reported in-flight concerns (e.g., complexity of new software, cockpit display "freezing," discrepancies with airspeed and altitude indicators, and a minimally effective autopilot system) that could create an undue burden on a single pilot. Because of these factors and the level of the aircraft's functionality at the time, FAA's Flight Standardization Board determined on December 13, 2006, that the aircraft required a two-pilot crew.

Despite the concerns raised by FAA's Flight Standardization Board, the President and Chief Executive Officer of Eclipse initiated a customer service complaint on December 15, 2006, against the Board to protest its two-pilot recommendation for the aircraft. In a December 21, 2006, response to Eclipse, the Director of Flight Standards Service agreed with the company's assertions without additional testing or information, stating that he "wanted to assure [Eclipse] that Flight Standards will do everything possible to work with Eclipse Aviation in assuring a successful conclusion to our efforts."

An important point, Mr. Chairman is that on January 29, 2007, FAA rescinded the recommendation and determined that a single pilot could operate the aircraft at the aircraft's existing level of functionality.

Yet, the overseas equivalent to FAA, the European Aviation Safety Agency (EASA), has declined to certify the EA-500 for operation in Europe. EASA's primary concern is that single-pilot operation is unsafe due to the lack of normally required equipment on the aircraft, such as a robust autopilot system. Conversely, EASA certified the Cessna Mustang VLJ, which had the necessary equipment to meet its level of certification, with no additional requirements.

We spoke with pilots at the largest operator of Eclipse aircraft, one of whom stated that he "lacked confidence that the aircraft could be operated safely by a single pilot." These concerns are even more significant considering that the pilots we spoke with have considerable amounts of commercial flying time. Further, they work for a company that has well-organized flight operations and dedicated maintenance support and uses *two-pilot flight operations* with the EA-500. This company also worked closely with the manufacturer to develop its own solutions for problems discovered in its fleet of purchased Eclipse aircraft. By contrast, a single pilot or owner is likely to have less flight experience and no dedicated maintenance or flight operations support.

**FAA replaced the inspection team that had identified deficiencies at Eclipse and limited inspection activities.** We found that FAA replaced the original FAA inspectors on the Eclipse project and limited the replacement team from thoroughly inspecting the aircraft. At this point, in March 2007, Eclipse had received the design certification, and its aircraft were undergoing FAA airworthiness inspections. These were required as the company had not yet received its production certification. Upon receipt of this certification, the company would be able to mass produce the aircraft without FAA certifying the airworthiness of each individual aircraft.

After multiple incidents of aircraft being presented to FAA for airworthiness certifications when numerous deficiencies existed, the manager of the FAA manufacturing inspection office sent an e-mail to Eclipse on February 26, 2007, with the approval of his supervisor.

In the e-mail, he detailed all of the steps that Eclipse needed to complete to comply with FAA requirements for obtaining an airworthiness certificate. According to FAA officials we spoke with, Eclipse senior management believed these requirements exceeded the FAA regulations and complained to officials within FAA Headquarters. In March 2007, FAA Headquarters officials removed the FAA manager who sent the e-mail from the project, stating that he had stepped outside his authority in laying out the regulatory requirements to the manufacturer.

We spoke with other FAA managers, including the supervisor of the removed manager, and they stated that the steps outlined in the e-mail *were* appropriate because FAA is ultimately responsible for certifying the airworthiness of each new aircraft. Specifically, FAA Order 8130.2F places the responsibility on FAA to ensure that each aircraft manufactured under its design certificate meets the approved design and is in condition for safe operation.

FAA Headquarters officials also removed the Directorate Manager in charge of both the manufacturing inspection and design certification offices from the Eclipse project. In a six-page letter of reprimand, FAA officials stated that the Directorate Manager failed to meet expectations associated with meeting its customer service initiatives. Specifically, the letter stated that he needed to "build relationships with our customers and achieve operational results." The letter further stated "your personal relationship with the Eclipse Executives is deficient. As [Eclipse is] one of your major customers we expect you to work to improve the relationship."

In fact, FAA Headquarters officials required the Directorate Manager to undergo a peer appraisal, consisting of a 360° review (i.e., a process for collecting observations from multiple sources about individual performance) and invited the Chief Operating Officer of Eclipse to be one of the individuals appraising his performance in certifying the EA-500. While the Directorate Manager's supervisors were the group

that rated him lowest, the Directorate Manager's customers were the group that rated him the highest.

With the removal of the local inspection manager, the Directorate Manager, and other FAA inspectors who repeatedly identified discrepancies, the FAA Headquarters Director of Aircraft Certification at FAA Headquarters assigned his former deputy responsibility for managing oversight of the Eclipse certification project. The deputy assembled a new team of inspectors and developed a policy that limited the inspectors' ability to fully inspect the aircraft for airworthiness. The deputy was also selected as a member of the FAA Special Certification Review Team, which recently concluded that the design certification of the EA-500 met FAA standards.

Specifically, FAA's Production Certification Plan did not require Eclipse employees to remove floorboards or interior panels for FAA inspectors. Before this policy was established, FAA inspectors had found numerous deficiencies on planes that had already been inspected and certified by ODAR-designated Eclipse inspectors.

In FAA's post-design certification, lessons-learned review of the Eclipse project, FAA managers acknowledged that "issues were not worked at the appropriate levels in the organization." In our view, FAA's actions in this instance present a troubling picture of the production certification process for the EA-500 and underscore our concerns that the Agency focused primarily on promoting new aviation technology rather than ensuring proper safety oversight.

**A former FAA engineer assigned to the Eclipse project became Eclipse's certification director.** During our review, we were concerned about an unusual set of circumstances surrounding the former FAA project officer on the Eclipse certification project. The engineer worked on the Eclipse certification project from January 2000 until October 2001. In his capacity as the project officer for FAA, the engineer evaluated and approved Eclipse's proposed methods for meeting FAA's certification requirements for the design phase of the aircraft.

When he left FAA, he immediately went to work at Eclipse as the Director of Certification. In his new role with Eclipse, he served as the focal point between Eclipse and FAA regarding the company's compliance with FAA's certification requirements. Essentially, he performed the same function for the company as he did under FAA, with no consideration given to any potential conflicts of interest.

We have previously recommended that FAA revise its post-employment guidance for aviation safety inspectors to require a "cooling-off" period when an FAA inspector is hired at an air carrier he or she previously inspected. To avoid potential conflicts of interest, FAA should also consider applying this requirement when aircraft certification inspectors or engineers leave the Agency for employment with private aviation companies that they previously regulated.

## FAA Must Take Immediate Actions To Ensure That Continuing Problems Reported by Eclipse Users Are Quickly Resolved

Mr. Chairman, the results of our investigation and those of the NTSB, as well as concerns expressed by EA-500 users and FAA employees, clearly underscore the need for FAA to take immediate actions to ensure that existing problems reported by Eclipse users are quickly resolved.

Last month, at our recommendation, FAA established a Special Certification Review Team to verify that Eclipse corrects design and production problems associated with the EA-500 and determine that the aircraft is in condition for safe operations. The team completed its assessment last week and concluded that the certification of the EA-500 was appropriate for the areas reviewed. We received a copy of the team's report on Saturday and are reviewing its findings and recommendations. However, based on the interim results of our investigation, we are recommending that FAA take the following actions:

1. In view of the problems we have identified, FAA must reassess the propriety of its single-pilot certification for the EA-500.

2. FAA must expedite its NPRM to clarify certification requirements for the expanding VLJ industry segment given the differences between certification requirements for large transport and general aviation aircraft.

3. FAA should carefully evaluate the propriety of granting ODAR authority to new, inexperienced manufacturers prior to design certification. Further, FAA's ODAR designation process must more thoroughly evaluate designees' skill level and experience and ensure that the company designees are allowed to conduct their inspections properly and without interference from the manufacturer.

4. FAA must discontinue prioritizing specific manufacturers' programs in its Performance Plan for special attention to prevent any appearance of favoritism or the perception of diminished vigilance in its oversight mission.

5. FAA must implement a "cooling-off" period for its aircraft certification safety inspectors and engineers before allowing them to accept positions with the manufacturers they formerly regulated.

That concludes my testimony, Mr. Chairman. I would be happy to answer any questions you or other Members of the Subcommittee may have.

The following pages contain textual versions of the graphs and charts included in this document. These pages were not in the original document but have been added here to accommodate assistive technology.

**FAA's Certification of the Eclipse EA-500 Very Light Jet**
**Section 508 Compliant Presentation**

**Figure 1. Eclipse Design Certification Timeline**

- July 2001: Eclipse applies for design certification.
- October 2001: Former FAA employee becomes Eclipse Director of Certification.
- September 2002: Eclipse receives Organizational Designated Airworthiness Representative (or ODAR) authority.
- July 21, 2006: First quality assurance audit finds unauthorized tooling change and failure to do first article inspection. (Note: a first article inspection is a required inspection of a newly produced or revised part, assembly, or product).
- July 27, 2006: Provisional design certification granted. (Note: a provisional design certification is an approval of the aircraft design that allows for limited flight and operational testing of the aircraft).
- September 15, 2006: Eclipse applies for production certification.
- September 21, 2006: Second quality assurance audit finds loose wire bundles and crossed brake fluid lines.
- September 30, 2006: FAA issues EA-500 design certification.

Source: OIG analysis of FAA data

**Figure 2. Comparison of Cessna and Eclipse Cockpit Systems**

Figure shows side-by-side photographs of the Eclipse EA-500 and Cessna Mustang cockpit systems. The figure notes that the Cessna Mustang cockpit has analogue instrumentation (gauges) in addition to a computer screen display while the EA-500 cockpit relies exclusively on a computer-based system.

**Figure 3. EA-500 Nose Pitot-Static Ports**
Photograph of the nose of the EA-500 aircraft. Arrows point to the pitot-static ports located on top of the aircraft nose.

**Table 1. Eclipse EA-500 Design Discrepancies Found Before and After Design Certification**

Table 1 shows the design problems that occurred before and after FAA awarded Eclipse its design certification.

1. Erroneous Stall Warnings: Before design certification, joint FAA and Eclipse flight testing reported 4 instances and the FAA Flight Standardization Board reported 9 instances. After design certification, the FAA Flight Standardization Board reported 10 instances, Service Difficulty Reports disclosed 2 instances, and the Aviation Safety Reporting System disclosed 1 instance.

2. Screen Blanking: Before design certification, joint FAA and Eclipse flight testing reported 10 instances and the FAA Flight Standardization Board reported 2 instances. After design certification, the FAA Flight Standardization Board had no documented instances, Service Difficulty Reports disclosed 1 instance, and the Aviation Safety Reporting System had no documented instances.

3. Flap Malfunctions: Before design certification, joint FAA and Eclipse flight testing reported 18 instances and the FAA Flight Standardization Board had no documented instances. After design certification, the FAA Flight Standardization Board reported 8 instances, Service Difficulty Reports disclosed 1 instance, and the Aviation Safety Reporting System disclosed 1 instance.

4. Airspeed Disagrees: Before design certification, joint FAA and Eclipse flight testing reported 1 instance and the FAA Flight Standardization Board had no documented instances. After design certification, the FAA Flight Standardization Board had no documented instances, Service Difficulty reports disclosed 13 instances, and the Aviation Safety Reporting System disclosed 2 instances.

5. Air Data Computer Failures: Before design certification, joint FAA and Eclipse flight testing reported 20 instances and the FAA Flight Standardization Board had no documented instances. After design certification, the FAA Flight Standardization Board reported 1 instance, Service Difficulty Reports disclosed 1 instance, and the Aviation Safety Reporting System had no documented instances.

6. Autopilot Failures: Before design certification, joint FAA and Eclipse flight testing reported 7 instances and the FAA Flight Standardization Board had no documented instances. After design certification, the FAA Flight

Standardization Board had no documented instances, Service Difficulty Reports disclosed 3 instances, and the Aviation Safety Reporting System disclosed 2 instances.

Note A: The number of instances shown in table 1 is based on documentation obtained currently; more instances may exist.

Note B: Joint FAA and Eclipse Flight Testing accomplished by Aircraft Certification Office Pilots; Flight Standardization Board testing conducted by a separate group of FAA pilots.

Source: OIG analysis of FAA data

**Figure 4. Eclipse Production Certification Timeline**

- 2006: FAA did 2 quality control audits in July and September.
- February 5, 2007: FAA begins third quality assurance audit.
- March 2, 2007: FAA removes inspection team manager to appoint former FAA certification deputy.
- March 15, 2007: FAA develops policy stating that floorboard/interior inspections are not required.
- March 17, 2007: Eclipse certification project moved from San Antonio to Fort Worth.
- March 20, 2007: Office of Inspector General receives complaint about EA-500.
- March 22, 2007: FAA issues third quality assurance audit.
- April 10, 2007: Production Certification Board begins on-site audit.
- April 21, 2007: Production Certification Board begins foreign supplier audit.
- April 26, 2007: Production Certification Board completes foreign supplier audit.
- April 26, 2007: FAA issues EA-500 production certification.
- May 21, 2007: Production Certification Board issues audit findings to Eclipse.

Source: OIG analysis of FAA data

**Table 2. Manufacturing Deficiencies Found by FAA Inspectors After Eclipse Inspectors Certified the Aircraft**

Landing Gear Rigging: failed functional test on first aircraft 8 times.

Landing Gear on Extension During Flight Test: failed functional test on second aircraft 2 times.

Aileron Trim: failed functional test on first aircraft 2 times.

Bleed Air Supply Subsystem (BASS): failed functional test on first aircraft 4 times.

Cabin Pressurization: failed functional test on first aircraft 5 times.

Electrical Power Distribution System**:** failed functional test on first aircraft 2 times.

Pitot-Static System: failed functional test on second aircraft 2 times. On third aircraft, it failed functional tests 3 times.

Transponder: failed functional test on first aircraft 2 times.

Airspeed Measuring System/Air Data System: failed functional test on first aircraft 3 times. On second aircraft, it failed functional tests 2 times.

Oxygen Mask Drop: failed functional test on third aircraft 2 times.

Wire chafing found with numerous wire bundles on aircraft structure behind instrument panel; this problem was found on the second aircraft 3 times.

Wire chafing found with engine bleed valve line on insulation. This problem was found 1 time on the first aircraft.

Wire chafing found with starter generator cables assembly. This problem was found 1 time on the first aircraft.

Wire chafing found with multi-functional display wires on the aircraft structure, both sides. This problem was found 1 time on the second aircraft.

Loose wiring found with Engine wiring harness to Bleed Air Supply Subsystem module. This problem was found 1 time on the first aircraft.

Loose wiring found with canon plug and wire harnesses. This problem was found 1 time on the first aircraft.

Loose wiring found with Electrical connectors where the wings attach to the fuselage, left and right sides. This problem was found 1 time on the second aircraft.

Weight and balance discrepancies due to human calculation errors were found 2 times on the first aircraft and 1 time on the second aircraft.

Engine grommet was found to be misaligned 1 time on the first aircraft.

Fasteners and rivets were found to be improperly installed 2 times on the second aircraft and 1 time on the third aircraft.

Source: OIG analysis of FAA data

**Table 3. FAA Approvals for Other New Manufacturers of Very Light Jets**

Note: Table 3 shows that Eclipse is the only operating manufacturer to receive its ODAR authorization *before* the aircraft design was approved by FAA.

**Eclipse:** Design certificate issued September 30, 2006. Production certificate issued April 26, 2007. ODAR authority was issued on September 3, 2002.

**Cirrus:** Design certificate issued October 23, 1998. Production certificate issued June 12, 2000. ODAR authority issued on September 8, 2006.

**Liberty Aircraft:** Design certificate issued February 19, 2004. Production certificate issued April 6, 2006. ODAR authority issued on November 18, 2006.

**Adam Aircraft:** Design certificate issued May 11, 2005. No production certificate issued since the company went bankrupt. ODAR authority was issued on May 17, 2002.

**Sino Swearingen:** Design certificate issued October 27, 2005. No production certificate issued. No ODAR authority issued. (Note: The small jet from this manufacturer was not classified as a VLJ because of its weight, but it is often used for comparison purposes to the Eclipse certification because it was design certified by the same FAA office during the same time period.)

Source: OIG analysis of FAA data