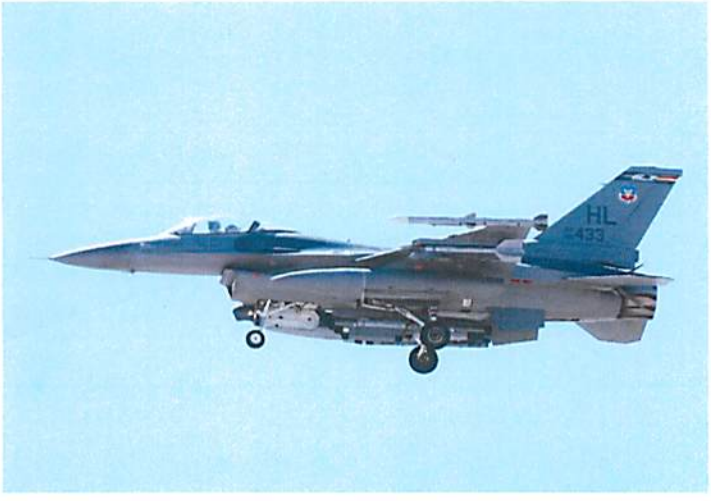
# UNITED STATES AIR FORCE
# AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

**F-16C, T/N 88-0433**

**421st FIGHTER SQUADRON**
**388th FIGHTER WING**
**HILL AIR FORCE BASE, UTAH**



**LOCATION: UTAH TEST AND TRAINING RANGE, UTAH**

**DATE OF ACCIDENT: 4 MAY 2012**

**BOARD PRESIDENT: LIEUTENANT COLONEL THOMAS R. OLSEN, JR.**

**CONDUCTED IAW AIR FORCE INSTRUCTION 51-503**

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR COMBAT COMMAND
JOINT BASE LANGLEY-EUSTIS VA

OFFICE OF THE VICE COMMANDER
205 DODD BOULEVARD SUITE 203
JOINT BASE LANGLEY-EUSTIS VA 23665-2788

04 FEB 2013

# ADDENDUM TO THE

# ACTION OF THE CONVENING AUTHORITY

**The Addendum to the Report of the Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 4 May 2012 mishap near Hill AFB, UT, involving F-16C, T/N 88-0433, assigned to the 388 FW, Hill AFB, UT, complies with applicable regulatory and statutory guidance and on that basis is approved.**

//SIGNED//

**WILLIAM J. REW**
**Lieutenant General, USAF**
**Vice Commander**

**ADDENDUM TO**

**AIRCRAFT ACCIDENT INVESTIGATION**

**F-16C, T/N 88-0433**
**Utah Test and Training Range (Near Hill AFB, UT)**
**4 May 2012**

# 1. AUTHORITY AND PURPOSE

## a. Authority

On 15 October 2012, Lieutenant General William J. Rew, Vice Commander, Air Combat Command (ACC), directed Lieutenant Colonel Thomas R. Olsen, Jr. to re-open the accident investigation conducted under Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations* concerning the 4 May 2012 mishap of an F-16C aircraft, tail number (T/N) 88-0433. Based on additional evidence that came to light after completing the investigation, Lt Col Olsen reexamined Contributing Factor #2 of the original report's "Statement of Opinion" concerning the anomaly on fan blade 17. Lt Col Olsen was to answer the specific question of "whether the anomaly should have been detected during the installation inspection process at Tinker AFB in April, 2004?" (Tab Y-5) The additional investigation was conducted at Ellsworth AFB, South Dakota, and by telephone conferencing, from 16 October 2012 to 21 December 2012. The following board members participated in the additional investigation: a legal advisor (LA) and a recorder (REC).

## b. Purpose

This is a legal investigation convened to inquire into the facts surrounding the aircraft or aerospace accident, to prepare a publicly-releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes.

# 2. FINDINGS

Testimony and new evidence indicates the forge anomaly on the aft portion of the number 17 first-stage fan blade was a surface discrepancy. However, it may not have been completely visible due to the possibility of material transfer or smearing during machining. This could have led to the discrepancy being obscured from visual detection during any inspection conducted during installation at Tinker. The testimony indicates that an anomaly of the magnitude indicated by the General Electric (GE) Metallurgical Investigation Report was "large enough to be seen." (Tab V-10.1 and Tab J-34) Additionally, the 0.215 inch by 0.641 inch by 0.739 inch triangular-shaped anomaly on the blade 17 dovetail section was most likely present from the time of its manufacture, would have been possible to detect during a visual inspection despite any coatings or smearing, (Tab V-11.1 and Tab J-34) and would have been visible during a feature-by-feature inspection. (Tab V-13.1)

There was conflicting testimony on how new fan blades are inspected at the blade build-up facility and just how much of the surface of the blade's dovetail section would be covered by material transfer or smearing during machining. However all the witnesses agree that at least some of the surface portion of the anomaly was probably obscured from visual detection. Additionally, the witnesses with personal knowledge of the build-up process stated new fan blades are only looked at for damage that might have occurred during transportation, either inside or outside of the building. (V-16.1 and V-10.1)

During the original investigation, witnesses indicated that when fan blades are received for fan rotor assembly it is not known if they are new or refurbished. They also indicated that all fan blades received for engine build-up were subjected to a visual inspection as specified in Technical Order (T.O.) 2JF110-3-5. WP 018 00, Sections 8 and 9. (Tab V-7.10) (Tabs V-9.3 through V-9.8 and V-9.11 and U-19 through U-20) However, follow-on testimony indicates that Fan Rotor Assembly Mechanics would know, by markings or tags, whether a blade was new or refurbished, and that new blades are only given a general inspection for induced damage from transport and only have technical order guidance applied if obvious damage is noted. (V-14.1) There is no technical order procedure for the inspection. These inspections are based on common sense and the experience of the technician. The witnesses also indicated that these procedures have not changed since 2004. (V-16.1)

## 3. STATEMENT OF OPINION CONCERNING CONTRIBUTING FACTOR #2

Photos of fan blade 17 clearly show an anomaly on the surface of the dovetail. The testimony indicates the possibility of this anomaly being present as a 0.215 inch by 0.641 inch by 0.739 inch triangular-shaped surface at the time of installation. In addition, the anomaly would have been visible during pre-build up inspections despite the presence of coatings or smearing.

Based on the metallurgical investigation and the additional testimony, I find the evidence does not indicate the anomaly "should" have been detected. However I find, by a preponderance of the evidence, that the anomaly could have been detected during the installation inspection process at Tinker AFB in April 2004. The probability of detection was limited due to the possibility of material transfer or smearing during machining and that feature-by-feature inspections of new blades were deemed not necessary.

//SIGNED//

28 DECEMBER 2012

THOMAS R. OLSEN, JR., LT COL, USAF
President, Accident Investigation Board

## SUMMARIZED TESTIMONY OF PCE

I, PCE , a Propulsion Chief Engineer at Tinker Air Force Base, Oklahoma, after being placed under affirmation, hereby state that before my interview, the difference between the nature of an accident investigation board (AIB) under AFI 51-503 and a safety investigation board (SIB) under AFI 91-204 was explained to me. An AIB is a legal investigation convened to inquire into the facts surrounding aircraft or aerospace accidents, to prepare a publicly-releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes. I understand the difference between an AIB and SIB. I understand that my AIB testimony may be used for any purpose and can be released to the public.

I am the Division level engineer for the propulsion systems managed out of Tinker AFB including 17 different types of model engines. I ensure the engineering staff has established processes involving safety and reliability issues and are following them and the processes are as efficient as possible. I am not really certain what qualifications are required for the personnel in the assembly shops. I have a Masters Degree in Engineering and Technology Management as well as mishap training and engine design training.

What I know about the tech orders that specify how F-110 engine parts are inspected comes directly from the people that work for me. Specifically, my GS-13-level engineering supervisor and a GS-12-level who works for him. I do not specifically know what happens in the shop, as I don't have direct oversight of the personnel that execute the tech orders. I don't have first-hand knowledge of exactly how the technicians assemble the engine parts.

When a new fan blade comes in through central receiving and out of the warehouses, they go to a "kitting area" where all the parts are placed to put the fan rotor together. The maintenance shop will lay out all those parts and get them ready to install. While they are getting them ready to install they are required to do a basic visual inspection for any damage. They look for damage that might have occurred during transportation, either inside or outside of the building. In most cases, they do not have the drawings of the part so it is unlikely they would find a manufacturing defect unless it was really prominent. If they find transportation damage or there is a dimensional issue, they will handle that deficiency by writing it up. I do not know what type of training the technicians have for doing the inspections. A 0.215" x 0.641" crack is large enough to be seen. However, due to the coating that is placed on the fan blade, half of the crack was covered. It would be hard to miss if there was a saw cut in the slug. FPI is Florescent Penetrate Inspection is a process of putting the florescent penetrate on the part and expose it to a specific type of light and that will show a crack if it is there. They have FPI there and perform it on repairs but do not do it on new parts. We don't over inspect new parts except in rare circumstances. Assemblers are supposed to look at the parts to make sure there is not any obvious damage but they are not trained to look at the level of detail it would have taken to see the black line that was partly covered by coating and to have registered that is bad. A new blade does not get the same level of inspection.

//SIGNED//

PCE

Signed and sworn before me this 19 day of Dec 2012.

//SIGNED//

THOMAS R. OLSEN, Lt Col, USAF

**SUMMARIZED TESTIMONY OF** SSE

I, SSE , a supervisory aerospace engineer at Tinker Air Force Base, Oklahoma, after being placed under affirmation, hereby state that before my interview, the difference between the nature of an accident investigation board (AIB) under AFI 51-503 and a safety investigation board (SIB) under AFI 91-204 was explained to me. An AIB is a legal investigation convened to inquire into the facts surrounding aircraft or aerospace accidents, to prepare a publicly-releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes. I understand the difference between an AIB and SIB. I understand that my AIB testimony may be used for any purpose and can be released to the public.

I am the supervisor of 12 engineers. We have engineering authority over the F-110 and F-118-101 jet engine fleets that go into the F-16 and U-2 aircraft. I have a Bachelor of Science degree in Mechanical Engineering.

When the maintenance technicians receive the fan blades, they will unpack the box and install them. They do not clean or inspect them prior to installation when they are brand new. They will only inspect brand new fan blades if the box appears to be damaged. Technicians are not trained in inspecting new fan blades. I am aware of the technical orders that govern this process. A fan blade is only inspected when the aircraft engine comes to Depot after being flown. At that time the blade is cleaned, the coating is stripped off and the blade is inspected using the fluorescent penetrant inspection process. It is my opinion that since half of the 0.215" x 0.641" crack was covered by the coating, it is unlikely that the maintenance technician would have seen this defect; however, not impossible. The technician would not be able to see this anomaly and is not looking for it unless there is obvious transportation damage. It is my opinion that the anomaly would have been present when it was delivered to Tinker AFB.

//SIGNED//

SSE

Signed and sworn before me this 27th day of December 2012.

//SIGNED//

THOMAS R. OLSEN, Lt Col, USAF

**SUMMARIZED TESTIMONY OF** ENG

I, ENG , an F-110 engineer at Tinker Air Force Base, Oklahoma, after being placed under affirmation, hereby state that before my interview, the difference between the nature of an accident investigation board (AIB) under AFI 51-503 and a safety investigation board (SIB) under AFI 91-204 was explained to me. An AIB is a legal investigation convened to inquire into the facts surrounding aircraft or aerospace accidents, to prepare a publicly-releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes. I understand the difference between an AIB and SIB. I understand that my AIB testimony may be used for any purpose and can be released to the public.

My primary duty is to provide field and acquisition support for the F-110 engine. My education includes an engineering degree and various classes involving engine specific classes, mishap prevention and reoccurring on the job training.

Maintenance technicians do not know if the fan blade they are receiving is brand new or re-serviced. The blades are not inspected prior to assembly by the maintenance technician if it is a serviceable fan blade. Most cracks are not visible with the naked eye. A fan blade will receive additional inspection if the box it arrived in is damaged.

//SIGNED//

ENG

Signed and sworn before me this 21ST day of DECEMBER 2012.

//SIGNED//

THOMAS R. OLSEN, Lt Col, USAF

**SUMMARIZED TESTIMONY OF** EPM

I, EPM , an F-110 Program Manager for GE Aviation in Cincinnati, Ohio, after being placed under affirmation, hereby state that before my interview, the difference between the nature of an accident investigation board (AIB) under AFI 51-503 and a safety investigation board (SIB) under AFI 91-204 was explained to me. An AIB is a legal investigation convened to inquire into the facts surrounding aircraft or aerospace accidents, to prepare a publicly-releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes. I understand the difference between an AIB and SIB. I understand that my AIB testimony may be used for any purpose and can be released to the public.

I am responsible for sales and support of the F-110 engine that powers the F-15 and F-16. My primary customer is the United States Air Force. I have worked for GE for 30 years and have held a number of positions in product and field support and project management.

I am familiar with the Technical Order process. It is my understanding that there are two scenarios for when a technician puts a part into an engine. The first, a part has a green serviceable tag. If the part has this tag, it can be assumed by the technician that the part has been inspected already and the technician only needs to look for handling damage. I have no knowledge if a new part received from the Original Equipment Manufacturer would have a green serviceable tag, or be treated as if it had a green serviceable tag. The second scenario is there is no tag placed on the part, the technician would need to get the appropriate Technical Order and do a feature by feature inspection that would be required for that particular part. I believe the Technical Order requires an FPI inspection on every blade that goes through depot; however, not every blade at Tinker AFB is there for a depot level inspection. There are instances where we will direct technicians to pay particular attention to a particular area of a part if we've had past history of failures originating out of that area. I have not seen or been a part of the inspection process at Tinker AFB.

In this particular case, it is my opinion that the entire anomaly would not have been visible prior to the fan blade failing. A crack would have been visible instead of a triangular notch. GE believes that the risk is minimal that this same problem will be seen in other fan blades and it is not necessary to inspect them prior to the normal time for depot inspection. GE does not believe this is a widespread problem. If the technicians did a feature by feature inspection pursuant to the technical order, then I believe the anomaly probably would have been detectable. However, if the technicians did not perform a feature by feature inspection, then I do not believe the anomaly would have been detectable.

//SIGNED//
EPM

Signed and sworn before me this 27TH day of DECEMBER 2012.

//SIGNED//

THOMAS R. OLSEN, Lt Col, USAF

**SUMMARIZED TESTIMONY OF** ETL

I, ETL , the F-110 team lead for the F-110 Engine at Tinker Air Force Base, Oklahoma, after being placed under affirmation, hereby state that before my interview, the difference between the nature of an accident investigation board (AIB) under AFI 51-503 and a safety investigation board (SIB) under AFI 91-204 was explained to me. An AIB is a legal investigation convened to inquire into the facts surrounding aircraft or aerospace accidents, to prepare a publicly-releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes. I understand the difference between an AIB and SIB. I understand that my AIB testimony may be used for any purpose and can be released to the public.

I am an F-110 Engine Equipment Specialist and the team lead for the F-110 Engine, the engine in the mishap aircraft.

The person receiving the fan blades to install them into the fan rotor assembly will know if the blade is a new or a refurbished blade. There is a tag or marking that indicates that the blade is new or refurbished.

The assembly mechanic is not required to inspect the blade itself. It has already been through a process to inspect it. The only inspection on a new blade is to see if it is nicked, dented, or chipped or if there has been some other type of handling damage done to it. If you find a defect then you would inspect that defect to the limits defined in the tech order. T.O. 2J F-110 -3-5 work package 18 is the applicable tech order that defines those limits.

There is no inspection required at Tinker on a new blade. This visual inspection is not actually required by tech order; it is a mechanic's practice. Actual inspections are done by someone qualified and certified to do a Tech Order inspection.

I have never worked in the rotor shop. I have not actually observed the process in the rotor shop.

The procedures for installing fan blades on a fan rotor assembly have not changed since 2004 when the mishap blade was installed.

//SIGNED//
ETL

Signed and sworn before me this 27th day of December 2012.

//SIGNED//
THOMAS R. OLSEN, Lt Col, USAF

**SUMMARIZED TESTIMONY OF** JEI

I, JEI , a Jet Engine Inspector at Tinker Air Force Base, Oklahoma, after being placed under affirmation, hereby state that before my interview, the difference between the nature of an accident investigation board (AIB) under AFI 51-503 and a safety investigation board (SIB) under AFI 91-204 was explained to me. An AIB is a legal investigation convened to inquire into the facts surrounding aircraft or aerospace accidents, to prepare a publicly-releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes. I understand the difference between an AIB and SIB. I understand that my AIB testimony may be used for any purpose and can be released to the public.

I am a Jet Engine Inspector and have been employed by the U.S Military for 23 years. I inspect engines in the GE jet engine shop including the F-110 Engine, the engine in the mishap aircraft.

I have been a crew chief on F-16s and F-117s and have been taught on-the-job by many experienced people over the years.

When new fan blades are received for installation into an F-110 engine they are received in a box, or from the blade building where they inspect them, and they are installed on the first stage fan disc in the rotor shop. That is the TO 2JF110-3-7 that drives fan rotor assembly. TO 2JF110-3-5 provides guidance for blade inspections.

The person installing the blades will know if they are new or refurbished. The person who installs the blades will not inspect them according to any Tech Order. Inspections are done in the blade building. A crack would probably be obscured by a coating. The assembly mechanic would probably not see a small defect. If the assembly mechanic saw a defect in a fan blade, he would condemn the blade and get another blade. However there is no requirement that they inspect the blade. The Tech Order 3-7 tells the assembly mechanic how to install the blade. It says nothing about inspecting the blade.

//SIGNED//

JEI

Signed and sworn before me this 21 day of Dec 2012.

//SIGNED//

THOMAS R. OLSEN, Lt Col, USAF

**SUMMARIZED TESTIMONY OF** RS

I, RS , Rework Supervisor at the Blade Repair Facility at Tinker Air Force Base, Oklahoma, after being placed under affirmation, hereby state that before my interview, the difference between the nature of an accident investigation board (AIB) under AFI 51-503 and a safety investigation board (SIB) under AFI 91-204 was explained to me. An AIB is a legal investigation convened to inquire into the facts surrounding aircraft or aerospace accidents, to prepare a publicly-releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes. I understand the difference between an AIB and SIB. I understand that my AIB testimony may be used for any purpose and can be released to the public.

I am the Rework Supervisor at the Blade Repair Facility at Tinker Air Force Base Oklahoma since 2010. I supervise about 18 employees and they do the rework of aircraft blades. We mainly deal with reworked blades. However all new blades go through my shop before they go to the rotor shop.

For new blades, we get them from supply in the box. To my knowledge, no one else at Tinker inspects new blades before they come to my shop. When new blades are taken out of the box, they are looked over by the technician. However it is only a cursory visual inspection that is not required or defined by Tech Order. If there is obvious damage, the technician will return them to the Production Management Technician (PMT) and they will do a quality deficiency report on them. We put the serviceable blades in sets based on weight, before they are either sent to the rotor shop, or back to a supply warehouse until they are needed. To my knowledge the procedures for handling fan blades in the Blade Repair Facility have not changed since 2004.

//SIGNED//
RS

Signed and sworn before me this 27th day of December 2012.

//SIGNED//
THOMAS R. OLSEN, Lt Col, USAF

DEPARTMENT OF THE AIR FORCE
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205 DODD BOULEVARD SUITE 203
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12 OCT 2012

MEMORANDUM FOR LT COL THOMAS R. OLSEN, JR.

SUBJECT: AFI 51-503, Accident investigation Board Report, F-16C, T/N 88-0433, 388th Fighter Wing, Hill AFB, Utah, 4 May 2012

**In reference to Contributing Factor #2 of your report, additional evidence concerning the anomaly on fan blade 17 has come to my attention which may impact your report. As a result, I am returning the report to you to reexamine Contributing Factor #2 – specifically, whether the anomaly should have been detected during the installation inspection process at Tinker AFB in April, 2004. You will reconvene necessary members of your board, collect additional evidence and conduct any appropriate additional interviews to examine this issue. You have 30 days to produce an updated report.**

//SIGNED//
WILLIAM J. REW
Lieutenant General, USAF
Vice Commander