NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

May 16, 2003

AIRWORTHINESS GROUP CHAIRMAN'S FACTUAL REPORT

NTSB No: LAX-02-GA-201

A. ACCIDENT

Location: Walker, California
Date: June 17, 2002
Time: 1445 Pacific Daylight Time
Aircraft: United States Department of Agriculture Forest Service Lockheed C-130A "Hercules", N130HP

B. AIRWORTHINESS GROUP

Group Chairman: Jean-Pierre Scarfo
National Transportation Safety Board
Washington, D.C.

Member: Michael Weber
Rolls-Royce
Indianapolis, Indiana

Member: Carl Meyer
Hawkins & Powers Aviation, Inc.
Greybull, Wyoming

Member: Bill Bulger
United States Department of Agriculture Forest Service
Portland, Oregon

Member: William Kunger
Federal Aviation Administration
Reno, Nevada

Member: George James
Lockheed Martin Aeronautics Company
Marietta, Georgia

C. SUMMARY

On June 17, 2002, about 1445 Pacific daylight time, a Lockheed C-130A “Hercules”, N130HP, broke apart in-flight while executing a fire retardant delivery near Walker, California. The three flight crew members were fatally injured and the airplane was destroyed. A company flight plan had been filed and visual meteorological conditions prevailed. The airplane was operated by the United States Department of Agriculture Forest Service (subsequently referred to in this report as the Forest Service) for the public use fire fighting. The airplane was registered to Hawkins and Powers Aviation, Inc. (H&P), Greybull, Wyoming.

A witness to the accident video taped N130HP starting at the top of the ridgeline to a point after the wings separated; however, no video footage was captured of the ground impact. From the video, N130HP proceeded down the east side of the drainage valley and proceed to make a ½ salvo fire retardant drop. Just prior to the completion of the drop, the nose of the airplane appeared to rise and the airplane consequently started to initially arrest its descend and to level out. The nose of the airplane then continued to rise towards a nose-up attitude and almost at the completion of the ½ salvo fire retardant drop, the airplane’s wings folded upwards and detached from the fuselage at the center wing box beam-to-fuselage attachment location. When the wings departed the fuselage, all four engines were still attached. Close examination of the video revealed that the right wing folded upwards first followed immediately (slightly less than a ¼ of a second later) by the left wing. After the wings separated from the airplane, the fuselage continued to travel in the general direction of the intended flight path, the nose pitched down, and the fuselage rolled to the left (counterclockwise) becoming inverted until the airplane was out of camera shot.

Examination of the wreckage site revealed that the majority of the airplane came to rest east of Highway 395 spread over two distinct debris fields. The more southerly debris field was where the engines, the propeller assemblies, the outer wings, and the majority of the recovered center wing pieces came to rest. The trees, shrubs, and bushes within this debris field exhibited fire damage and the soil was scorched. The more northerly debris field was where the cockpit, fuselage, and empennage came to rest. The trees, shrubs, bushes, and soil within this debris field exhibited little signs of fire damage and were covered with the red fire retardant slurry.

The entire center wing lower surface was recovered with the exception of approximately the right outboard 167-inches (fractured at center wing station 53 right (CWS 53R)) and was found down side up. Fire damage and blistering of the paint was observed throughout the inside of the lower surface with the most intense fire damage observed in the vicinity of the fuel cross-feed manifold. The center wing lower surface was cut chordwise (longitudinally) at approximately CWS 41R just inboard of the fracture line at CWS 53R and was sent to Folwer Inc., Gardena, California for metallurgical examination.

Metallurgical examination of the fracture surface along CWS 53R revealed chordwise fatigue cracks initiating from rivet holes from two separate stringers. These two cracks progressed along the skin itself and through both stringers in which the cracks initiated and eventually linked up across a skin panel joint to create a crack slightly over 12-inches in length. The lower skin is constructed of three skin panels flush lap joined. The material for the lower skin and stringers were confirmed to be those specified by the original manufacturer (Lockheed) and a scanning electron microscope examination of the skin panels and stringers revealed no indication of inter-granular fracture associated with stress corrosion.

The center wing inspections that were being performed by Hawkins & Powers (H&P) were based on inspections provided from various United States Air Force (USAF) Technical Orders (T.O.s). Review of the *IPG-182* and the USAF T.O. 1C-130A-36 Nondestructive Inspection Procedures found that there was no specific inspection requirement for cracks in the fastener holes beneath the doublers located at either CWS 53L or 53R; however, several tasks were identified in both documents that provided crack inspection instructions in the general area of those doublers. These inspections called out various visual, eddy current, and fluorescent penetrant inspection inspections in the skin panel seams and stringers at the fastener hole locations. Further review of USAF T.O. 1C-130A-36 manual revealed that x-ray inspection CW 30 of the skin panel and stringers beneath the doublers located outboard of CWS 61 while the doubler was still installed and, if cracks were detected, then the doubler would be removed and a back up eddy current inspection would be performed. For the C-130A model only, there are a set of two doublers on either side of BL 61L and 61R. C-130 models B through E have only those doublers located outboard of 61L and 61R. The outboard doubler inspection called for in USAF T.O. 1C-130A-36 was not included in the set of center wings inspection called out in *IPG-182*.

D. DETAILS OF INVESTIGATION

1.0 ON-SITE INVESTIGATION

1.1 AIRPLANE ORIENTATION

All position references to left/right or clockwise/counterclockwise are made aft looking forward (ALF). Directional orientation (longitudinal, lateral, and vertical) for referencing airplane and powerplants components are provided in Figure 1. References to inboard and outboard are made from the longitudinal centerline of the airplane. The engines and propellers rotate clockwise ALF.

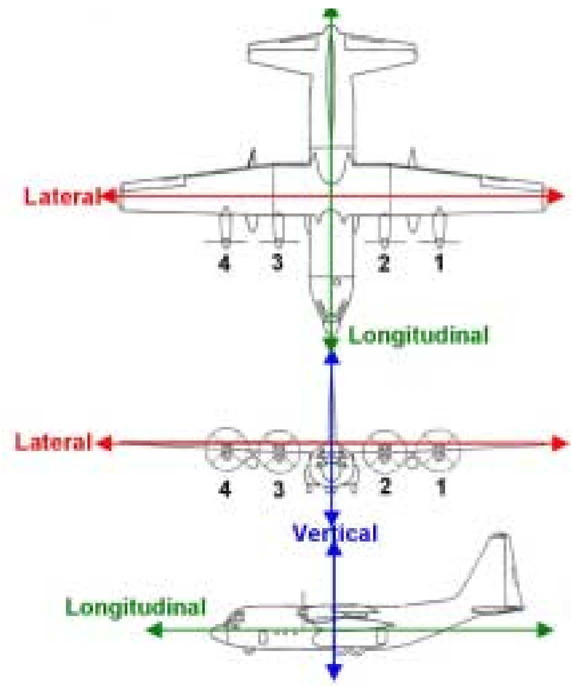


FIGURE 1: AIRPLANE ORIENTATION

The airplane is dimensionally referenced longitudinally by fuselage stations (FS) at 1-inch intervals starting at a datum point in front of the airplane nose and increasing in magnitude towards the tail. The nose of the airplane is at FS 30.4. Dimensionally the airplane is referenced laterally by wing stations (WS) : longitudinal centerline, butt line (BL) 0.0, and increasing i The center wing is referenced from BL 0.0 to center wing station 220 right (CWS 220R). The outer wings are refere at the CWS220L (OWS 0.0L) wing joint line and outer win 0.0R) wing joint line.

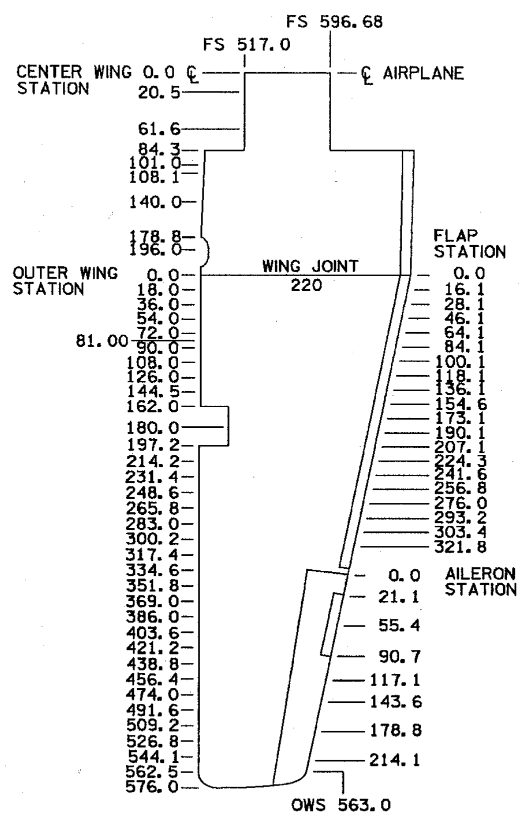


FIGURE 2: WING STATIONS

1.2 AIRPLANE ACCIDENT SEQUENCE

The accident flight started with the airplane number N130HP, serial number (SN) 56-0538 (also know Base, Minden, Nevada, for loading of fire retardant. Accor Record sheet, dated June 17, 2002, tanker T130 was loaded was added. Tanker T130 departed Minden at 14:29 local t drop of the day and proceeded directly to the Cannon Although the aircrew of tanker T130 had already made f tanker T130, the sixth drop was to be their first run on an all made on a north/south course. Before the run, tanker direction of the intended drop. The intended run requ perpendicular over a ridgeline and down a steep drainage v Tactical Group Supervisor (ATGS) and other pilots partic particular run was judged moderately difficult. Approxima drop, a Lockheed Martin P-3A "Orion" airplane made a pe to the intended fire retardant drop course of tanker T130, wind conditions. The USFS ATGS requested that tanker T130 make a level 6 drop. This is the second highest coverage level in terms of coverage (6 gallons per 100 square feet) and flow rate (601 – 800 gallons per second).

A witness to the accident video taped the accident sequence starting with T130 at the top of the ridgeline to a point after the wings had separated from the airplane, but due to the location of the witness and trees obscuring the video recorders view, the airplane impacting the ground was not recorded (Attachment 1). The following account of the accident sequence is based on the video footage. Tanker T130 proceeded down the east side of the drainage valley and proceed to make a ½ salvo fire retardant drop. Just prior to the completion of the drop, the nose of the airplane appeared to rise and the airplane consequently started to initially arrest its descent and to level out. The nose of the airplane then continued to rise towards a nose-up attitude and almost at the completion of the ½ salvo fire retardant drop, the airplane's wings folded upwards and detached from the fuselage at the center wing box beam-to-fuselage attachment location. When the wings departed the fuselage, all four engines were still attached. Close examination of the video revealed that the right wing folded upwards first followed immediately (slightly less than a ¼ of a second later) by the left wing. After the wings separated from the airplane, the fuselage continued to travel in the general direction of the intended flight path, the nose pitched down, and the fuselage rolled to the left (counterclockwise) becoming inverted until the airplane was out of camera shot.

1.3 Wreckage Location and Diagram

Using a hand held Global Positioning Satellite (GPS) receiver, the location of the crash site was determined to be at a latitude of 38° 31′ 13.53″ N (north) and longitude of 119° 28′ 53.33″ W (west) at a field elevation of 5,350 feet mean sea level. The majority of the airplane came to rest east of Highway 395 spread over two distinct debris fields (DF), DF (1) and DF (2), that were divided by a property fence line (Photo 1). The more southerly debris field, DF (1), was where the engines, the propeller assemblies, the outer wings, and the majority of the recovered center wing pieces came to rest. The trees, shrubs, and bushes within DF (1) exhibited fire damage and the soil was scorched. The more northerly debris field, DF (2), was where the cockpit, fuselage, and empennage came to rest. The tress, shrubs, bushes, and soil within DF (2) exhibited little signs of fire damage and were covered with the red fire retardant slurry. No large pieces of the fuselage or cockpit area were recovered except for a section cargo of flooring identified to have been located just aft of the cockpit.

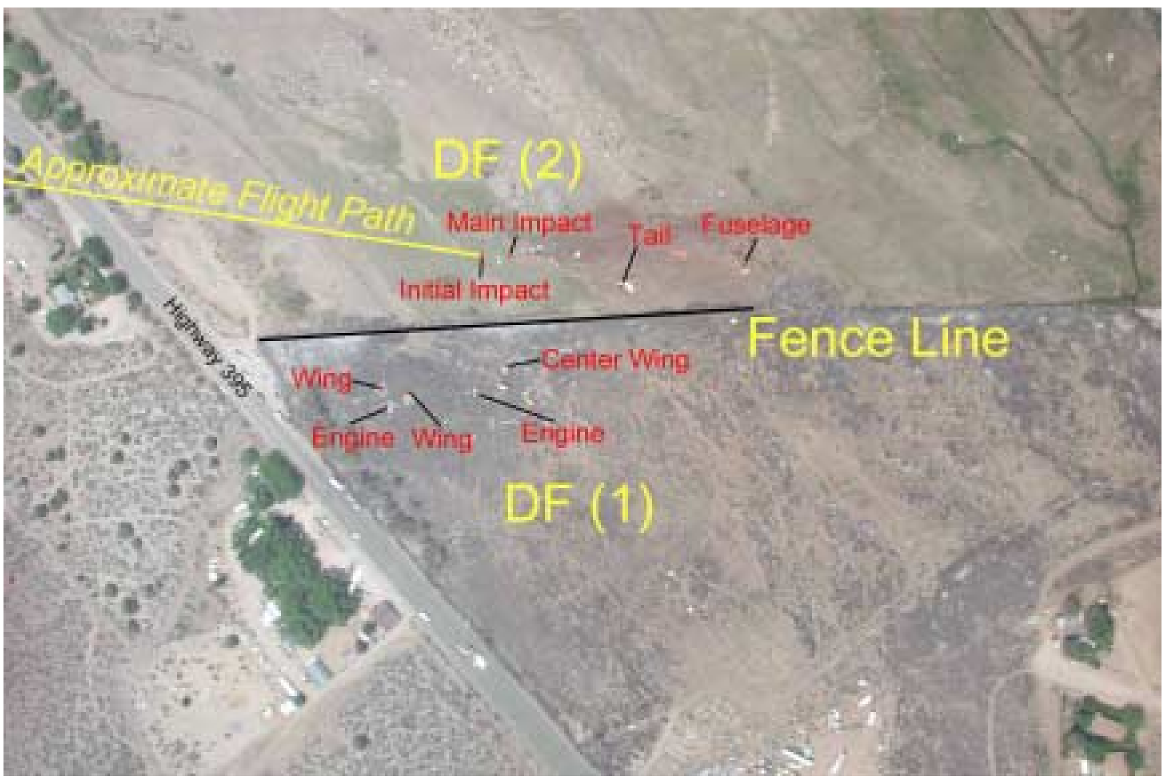
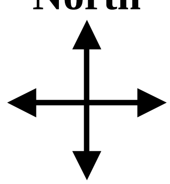


Photo 1: Aerial View of Wreckage Site — Debris Fields (1) and (2)

North



Several pieces of the airplane came to rest outside either of the two debris fields. Pieces were found in the brush on both side of Highway 395, including on the highway itself, along the general flight path of the airplane. The two largest pieces that were recovered outside either of the two main DFs were pieces of the center wing box beam upper skin.[1] The largest piece came to rest on Highway 395 (Photo 2) and measured approximately 277-inch laterally x 44-inch longitudinally with a maximum of six stringers still attached. Examination of this piece revealed that it was comprised of 2½ panels and that the outboard section of the piece was significantly curled upwards. The other significant piece was found in the brush east of Highway 395. This piece of upper center wing skin measured approximately 93-inch laterally x 13-inches longitudinally and was comprised of a piece from two different skin panels with no stringers still attached.

PHOTO 2: CENTER WING UPPER SKIN

One piece of airplane structure was recovered high up on the eastern side of the drainage valley along the general flight path were the airplane had made its fire retardant drop. The piece measured 5 x 7 x 2-inches and was comprised of several layers joined together by Hi-Lok fasteners (Photo 3). The piece was sent to Lockheed for metallurgical examination as well as part identification (See section 4.2 Airplane Structure Found in Drainage Valley of this report for details of the metallurgical examination). No part numbers were on any of the pieces to help identify the piece of recovered airplane structure. Lockheed compared the geometry and material comprised of the entire piece as well as the individual layers with know C-130 structural members. Lockheed concluded that this part was not a production designed C-130 part, nor was it part of any known Lockheed designed retrofit. After Lockheed completed its metallurgical analysis of the airplane structure, it was sent to H&P were it was identified as coming from the under the left wheel well (Photo 4) of a similarly modified H&P tanker C-130 aircraft.

PHOTO 3: RECOVERED PART

PHOTO 4: PART LOCATION

Attachment 2 is the wreckage diagram showing were significant pieces of the airplanes and powerplants came to rest and impact site features. DF (1) is comprised of GPS point 1 though 16 while DF (2) is comprised of GPS point 17 though 38. Throughout the remainder of this report, any references to parts found at a particular GPS point can be referenced back to their location on the wreckage diagram in Attachment 2.

[1] The center wing box beam structure is interchangeably and synonymously referred to as the center wing for the remainder of this report.

1.4 WRECKAGE DOCUMENTATION

1.4.1 Debris Field (1)

At GPS point 1, the right wing outer flap and flap track, two flap jackscrews, numerous small pieces of the center wing spar caps and stringers, a center wing-to-outer wing (rainbow) fitting, pieces of the outer wing, and an outer wing rainbow fitting were recovered. One of the recovered jackscrews was found still attached to the flap with the jackscrew nut located visually at approximately the center of the jackscrew length (50% jackscrew length). The other jackscrew was found detached from its' respective flap with the jackscrew nut also located visually at approximately the center of the jackscrew length.

At GPS point 9, the left outer wing was recovered with the outer wing rainbow fitting still attached. The wing was found right side up and consumed by fire.

At GPS point 12, the entire center wing lower surface was recovered, with the exception of approximately the right outboard 167-inches and two pieces of the center wing upper surface (Photo 5).[2] The center wing lower surface was found down side up, lower skin facing upwards. Still attached to the center wing lower skin was the No. 2 engine (left inboard) pylon and approximately 39-inch lateral section of the outer left wing. Fire damage and blistering of the paint was observed throughout the inside of the lower surface with the most intense fire damage observed in the vicinity of the fuel cross-feed manifold. Two center wing upper skin pieces were also recovered. One piece measured approximately 150-inches laterally x 79-inches with 11 stringers still attached with an approximately 30-inch longitudinal section of the outer wing was still attached. The other piece measured approximately 130-inches laterally x 38-inches chordwise with five stringers still attached.

PHOTO 5: CENTER WING LOWER SKIN

At GPS point 16, the right outer wing with the rainbow fitting still attached, the right wing flap and flap tracks, and the No. 4 engine (right outboard) pylon were recovered. The outer wing was found upside down with the engine pylon still attached but the flap and flap tracks had become separated from the wing. Extensive fire damage was observed over the entire outer wing with some areas completely consumed by fire. The outer wing data plate was still affixed to the right outer wing. The SN on the data plate was 3095L.

[2] The center wing is comprised of a upper and lower surface connected to a front and rear beam by four spar caps that run the entire length of the center wing. The upper surface is constructed of four panels comprised of 11 stringers and the upper wing skin, while the lower surface is constructed of three panels comprised of 13 stringers and the lower wing skin.

1.4.2 Debris Field (2)

The empennage/tail section was found separated from the rest of the airplane and was lying on its' right side (Photo 6). The empennage/tail section had separated in-line with the upper escape hatch attachment. Both the cargo door and the ramp were found detached from the airplane structure. The right horizontal stabilizer was fractured at the root of the vertical stabilizer while the left horizontal stabilizer remained intact, with the counterweight still attached, but the outer tip exhibited impact damage (Photo 7). The entire left horizontal stabilizer tip was bent downwards and the leading edge of the outer tip was bent aft and the skin was compressed. The vertical tail was intact but exhibited some impact damage. A hole was observed on the right side near the middle of the rudder; however, the hole did not pass though to the left side. The lower rudder surface near the horizontal stabilizers was pushed forward and deformed. Still attached to the empennage were the two elevator and rudder boost packs.

PHOTO 6: EMPENNAGE/TAIL SECTION

PHOTO 7: EMPENNAGE/TAIL SECTION

1.5 WING SECTIONS LAYOUT AND RECONSTRUCTION

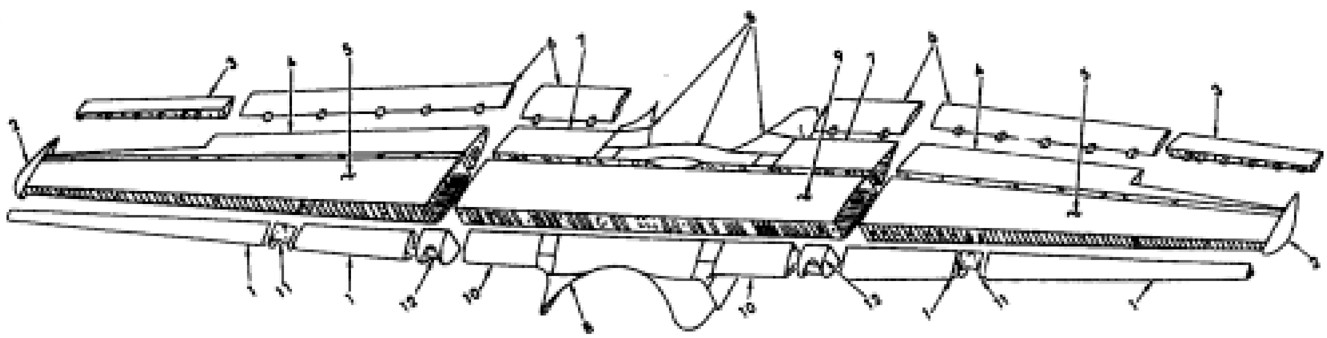
All the recovered pieces of the center wing box beam structure, vertical main landing gear beams/frames, wing spar caps, fuselage longerons and wing-to-fuselage attachment angles were transported to a nearby Marine hanger in Bridgeport, California for reconstruction and evaluation.

1.5.1 Wing Sections Description

The wing group consists of the center wing, outer wings, ailerons, flaps and associated hardware. Joining of the center wing to the fuselage is accomplished by lockbolts that attach the main landing gear frame/beam assembly (See Figure 4) to the front and rear wing beams at CWS 62L and 62R and fuselage at Butt Line (BL) 62. The outer wing is attached to the center wing by bolts through the wing joint (also called the rainbow fitting) and beam cap corner fittings in each box beam structure. There are eight such rainbow fittings, one attached to the upper and lower skin of the center wing as well as a mating fitting attached to the lower and upper skin of the outer wing. Each center and outer wing assembly consists of a box beam, leading edge, trailing edge, and flap assemblies. In addition, each wing assembly includes a wing leading edge-to-nacelle fairing.

The wing-to-fuselage fairings consist of formed fillets and panels. The wing fillets are shaped aluminum panels that attached to the wing center section and to the fuselage. These panels extend from wing leading edge to wing trailing edge across the bottom of the wing. The underwing fillets extending from FS 517 to FS 597 and from FS 617 to FS 667 and are attached to the airplane with countersunk washers and o-rings.

The center wing box beam structure is a semi-monocoque type, in that skin panels are load carrying members. The center wing consists of front and rear beam assemblies, four upper skin panels, three lower skin panels, and ten rib installations. Each skin panel is approximately 36-feet long and is flush lap joined to the adjacent panel with fasteners. Each flush lap includes a faying surface seal. Eleven hat sections (also commonly referred to as stringers) are attached spanwise (laterally) on the upper skin panels and thirteen are attached spanwise to the lower skin panels to stiffen spanwise the wing surfaces. The center wing box beam extends from CWS 220L to CWS 220R and from FS 517 to FS 597 (Figure 3).



Index	Nomenclature
1	Outer wing leading edge skin and structure
2	Wing tip skin and structure
3	Aileron skin and structure
4	Outer wing trailing edge skin and structure
5	Outer wing box beam skin and structure
6	Center and outer wing flap skin and structure
7	Center wing trailing edge skin and structure
8	Wing-to-fuselage fairing skin and structure
9	Center wing box beam skin and structure
10	Center wing leading edge skin and structure
11	Outer wing to outbd engine nacelle fairing
12	Center wing to inbd engine fairing

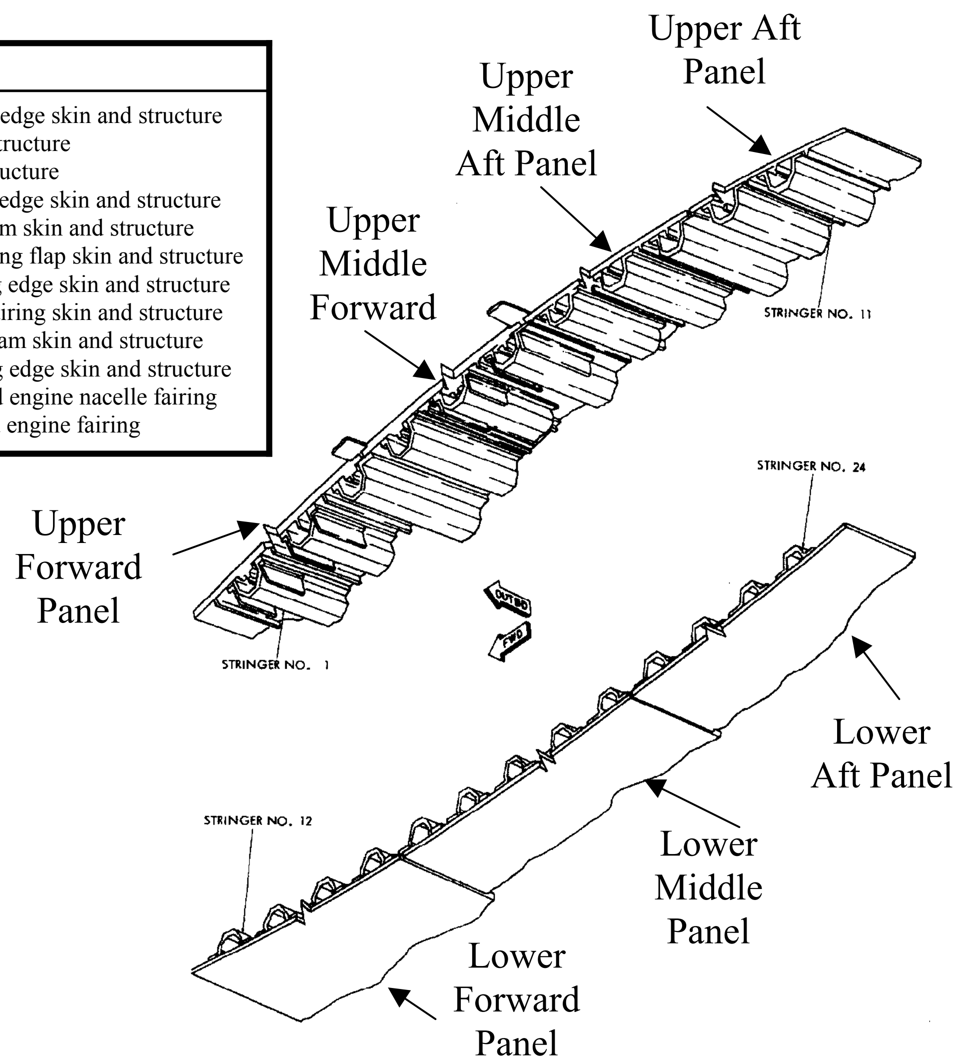


FIGURE 3: CENTER WING SECTIONS

1.5.2 Center Wing Box Beam Lower Wing Surface Layout

PHOTO 8: CENTER WING LOWER SURFACE

The entire lower surface of the center wing was recovered except for approximately the right outermost 167-inches (approximately CWS 53R to CWS 220R) (Photo 8). All thirteen stringers were attached to the center wing lower surface. No pieces of the aft beam or aft spar cap remained attached to the center wing lower surface except for a small piece of the left aft corner fitting. Approximately 134-inches of the forward beam (CWS 220L to CWS 86L) and approximately 62-inches of the forward lower spar cap remained attached to the center wing lower surface. The part of the forward beam that remained attached exhibited heat damage and melting. The forward lower spar cap pieces that remained attached to the center wing lower surface were within the area of the attached forward beam. Rainbow fittings and the corresponding corner fittings for the center wing left lower surface and the left outer wing lower surface were all intact. All the bolts that join outer wing to the center wing through the rainbow and corner fittings were also intact. The entire bottom of the center wing lower surface exhibited fire damage.

Examination of the right outer wing revealed that a section of the center wing lower surface right rainbow fitting was still joined to the outer right wing lower surface rainbow fitting. Neither the center nor the outer right wing lower surface rainbow fittings were intact nor were they complete. Both fittings measured approximately 41-inches in length with 7 complete nodes and with their respective rear corner fittings still attached. A complete lower surface rainbow fitting is comprised of 13 nodes plus two corner fittings and measures approximately 80-inches in length (FS 517 to FS 597).

An additional piece of joined rainbow fittings was found separate from any wing structure and was identified as the center wing lower surface right rainbow fitting attached to the outer right wing lower surface rainbow fitting; however, but the corners fittings were missing. This piece of rainbow fitting measured approximately 38.5-inches in length with 6 nodes. Separate from any wing structure was found two joined corner fitting which were identified as the center wing lower right forward joined to the outer right wing lower left forward. The entire center wing and outer right wing lower surface rainbow fitting were recovered.

1.5.3 Center Wing Box Beam Upper Wing Surface

Five large and several smaller pieces of the center wing box beam upper wing surface were pieced together to create the upper wing surface measuring approximately 30-feet laterally by approximately 6-feet longitudinally. The largest upper skin piece had attached to it the entire center wing upper surface left rainbow fitting, the entire outer wing upper surface left rainbow fitting and a section of the left outer wing upper skin. Although none of the four corner fittings were still attached to the rainbow fittings on this piece of upper skin, two were found separated and identified as being part of the this upper skin piece. One was identified as being a the left upper surface outer wing corner fitting while the other was identified as the center wing upper surface corner fitting. This largest piece of upper skin piece exhibited blistered paint, melted skin, and heavy sooting on the top of the upper skin from the center wing left upper rainbow fitting to approximately 13-feet laterally right, towards the middle of the wing. Two smaller but still significant in size pieces that mate with the largest piece described above also exhibited fire damage; however, no fire damage was observed on any of those recovered upper skin pieces that were laterally to right of the these two smaller pieces. It should be noted that except for the large pieces with the fire damage, all the other upper skin pieces were recovered either away from the fire damaged pieces or outside of the two debris fields. Those upper wing pieces that were located on the right side of the center wing box centerline, WS 0, were noticeable curled upwards. No pieces of the forward or aft beams or any of the spar caps remained attached to any of the upper wing skin pieces recovered.

Two rainbow fitting pieces were found separated from the wings but were identified as being part of the center wing upper surface right rainbow fitting. One piece measured approximately 30-inches in length with 5 nodes and the other pieces measured approximately 38-inches in length with 6 nodes. The entire center wing upper surface right rainbow fitting was accounted for (all 11 nodes).[3]

Two rainbow fitting pieces were found separated from the wings but were identified as being part of the outer wing supper surface right rainbow fitting. One piece measured approximately 37.5-inches in length with 5 nodes while the other measured approximately 39-inches in length with 6 nodes. The entire outer wing upper surface rainbow fitting was accounted for (all 11 nodes). A single corner fitting was found separate from any identifying attaching hardware.

1.5.4 Center Wing Box Beam Spar Caps, Fuselage Longerons, and Main Landing Gear Beams

There are four spar caps — an upper and lower on both the front and rear beam — each measuring approximately 440-inches (LWS 220 to RWS 220) in length. Numerous pieces of the center wing box spar caps were recovered and their overall length measured approximately 1072-inches, approximately 60% of the total length of the approximately 1,760-inches. All the spar cap fracture surfaces exhibited features consistent with either overload or else the fracture surface was damage so that no determination could have been made. No corrosion was observed on any of the facture surfaces.

Three pieces of the center fuselage upper skin longerons were recovered. One piece was identified as a right forward butt-line (BL) BL 20 longeron (measured 95-inches in length) while another was identified as a left forward BL 20 longeron (measured 83-inches in length). The remaining center fuselage upper skin longeron piece was identified as an aft BL 20 longeron but it could not be determined whether it was part of the right or left BL 20 longeron.

[3] A total of 11 out of 16 corner fittings were recovered.

Two separate pieces of the center wing beams were recovered detached from the rest of the wing. One piece was identified as a center wing beam measured approximately 100-inches in length. Approximately a total of 180-inches of spar caps, upper and lower, were attached to this piece. The other piece of the center wing beam was identified as a center wing left forward and measured approximately 100-inches from LWS 61 to LWS 161 with a portion of the wing attach vertical beam still attached at the LWS 61 location. Approximately 32-inches of upper spar cap was still attached.

A center wing aft beam left side from LWS 210 to LWS 100 was recovered. Approximately 220-inches of spar cap remained attached to the beam, 110-inches of forward and aft spar. Still attached to the beam were flaps, both flap tracks, but both jackscrew were missing.

1.5.5 Center Wing Box Beam-to-Fuselage Attach Angles

Three pieces of the left center wing box beam-to-fuselage attach angles, BL 61 were recovered. Two of the three pieces were identified as part of the aft attach angles at FS 597 while the other angle was identified as part of the forward attach angle at FS 517. The two pieces of the aft attach angles measured 22-inches and 57-inches longitudinally respectively. The lone forward piece of the attach angle measured 45-inches longitudinally. Examination of the attach angle fracture surfaces revealed no signs of corrosion or fatigue.

One piece of the left center wing box beam-to-fuselage attach angle, BL 61 was recovered and identified as part of the attachment at FS 617. The piece measured 35-inches longitudinally. Another piece of the center wing box beam-to-fuselage attach angle, BL 61, was identified as being from the right side at attachment FS 617.

1.5.6 Vertical Main Landing Gear Beams Vertical Beam/Frame Assemblies

Three large sections of main landing gear (MLG) vertical frame/beam assemblies were recovered (Figure 4). All three were positively identified as being from the left side of the airplane and consisted of parts of the vertical frame (main beam), sidewall panel, vertical beams (intermediate bow beams), horizontal braces, and landing gear tracks. Two of the sections were identified as part of the forward MLG vertical frame/beam assembly at FS 517 while the third one was identified as a piece of the aft MLG vertical frame /beam assembly at FS 597. The two forward vertical frame/beam assemblies measured approximately 46-inches and 65-inches vertically respectively. The shorter of the two forward sections had part of the FS 517 vertical attachment and part of one main landing gear track still attached. The longer of the two forward sections had parts of both main landing gear tracks still attached and the section of web between the two vertical beams (intermediate beams) where the jackscrew access panel is located. The aft vertical frame/beam assembly measured approximately 93-inches vertically and had two vertical beams (intermediate beams) along with web area with the jackscrew access panel and the pillow block still attached.

A piece of the MLG vertical frame/beam assembly-to-center wing box beam spar was identified as being from the left side of the airplane at the FS 517. The spar measured approximately 34-inches longitudinally on both sides and the vertical beam height measured 29-inches from the top where it would have mated with the center wing box beam. Another piece of the MLG vertical frame/beam assembly-to-center wing box beam spar was identified as being from the right side at FS 597. The spar cap measured 22-inches laterally and the vertical height of the beam measured 25-inches. Fracture surfaces of all the vertical beams were examined and they all exhibited features indicative of overload.

1.5.7 Main Landing Gear Retracting Mechanism Shelf Bracket Assemblies

All four MLG lower retracting mechanism shelf bracket assemblies (referred to in this section as the bracket assembly) were recovered intact and identified as to their location within the airplane. The vertical frame (main beam) attachment lugs (2) along with a section of the vertical frame itself were attached to the right aft bracket assembly. Similar to the right aft bracket assembly, the vertical frame attachment lugs remained attached to the right forward bracket assembly; however, the MLG jackscrew was still installed within the bracket assembly and the bracket assembly was still attached to the floor bulkhead end fittings.

Both the left aft and forward bracket assemblies had the vertical frame lugs still attached to them but in the case of the left aft bracket assembly, the bracket assembly remained attached to the longitudinal retardant tank reinforcing plates located along the cargo floor installed as part of the retardant tank installation and airplane modification. All the fracture surfaces of the vertical beam attached to the bracket assemblies were examined and exhibited featured indicative of overload.

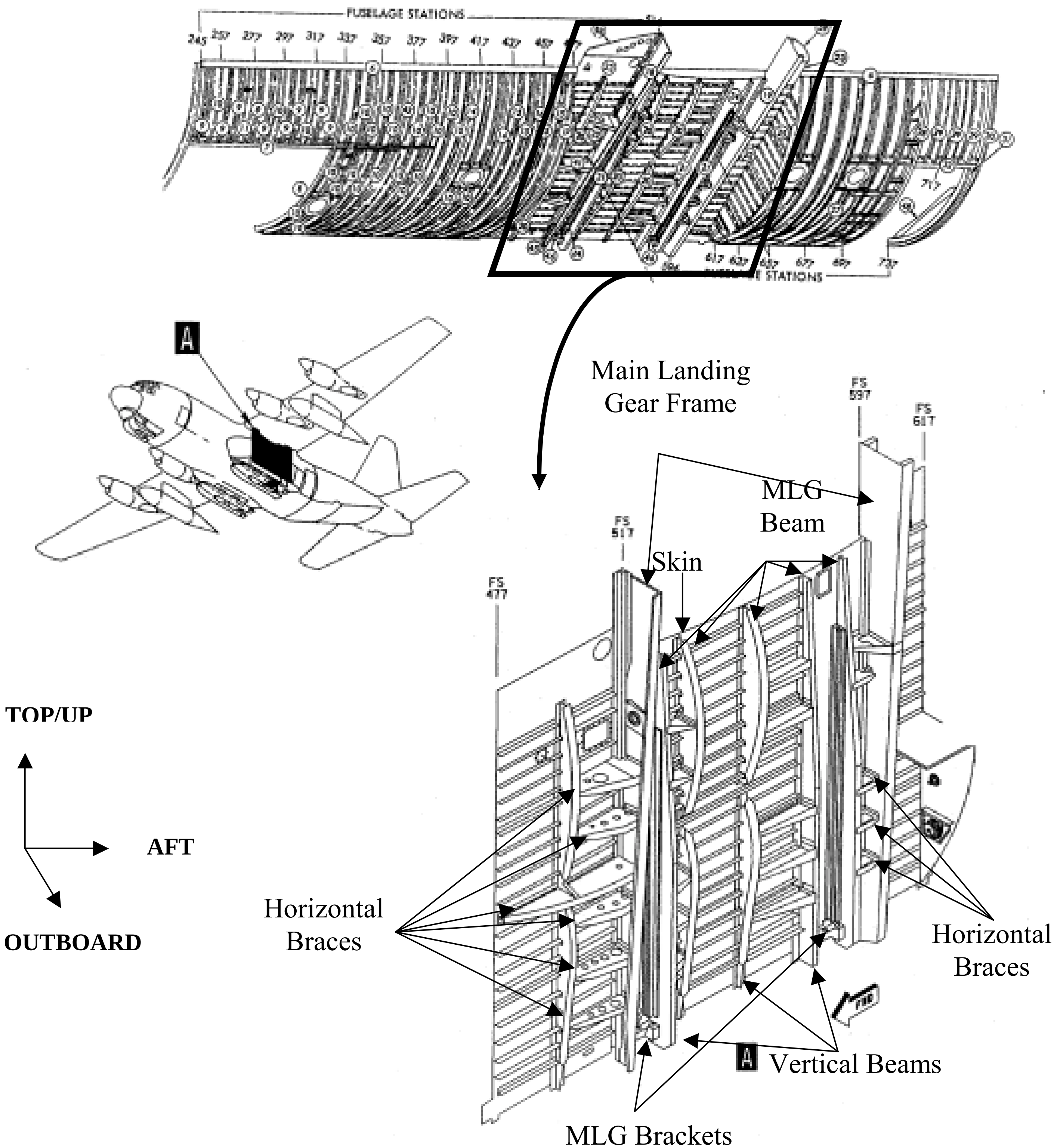


FIGURE 4: WING-TO-FUSELAGE ATTACHMENT AREA

1.6 POWERPLANTS

1.6.1 Engine Description

The Allison T56A-9D turboshaft engine is comprised of two basic sections: a power section and a gas turbine section. The power section consists of a 14-stage single spool axial flow compressor coupled to a 4-stage axial flow turbine through a single shaft, with a through flow can–annular combustor with six combustion burners, an accessory drive housing, and oil, fuel, electrical, control, bleed air, and cooling air systems. The gas turbine section is connected by a torquemeter and anti-icing shroud unit assembly to a reduction gear unit assembly having a single propeller shaft. Engine operation is controlled by coordinated operation of the fuel, electrical, and control systems. A negative torque signal system is incorporated in the reduction gear assembly. This system sends the propeller towards feather when negative shaft torque exceeds a predetermined value. A safety coupling decouples the reduction gear unit if negative torque exceeds a maximum limit. An engine breather is located on the front end of the power section unit assembly and vents the internal area of the engine without loss of oil. The engine produces 4,591 effective shaft horsepower (ESHP) that includes 320 shaft horsepower (SHP) from 797 pounds of thrust.

1.6.2 General Engine Information

All four Allison T56A-9D turboshaft engines were found in DF (1). The engine data plate for three of the four engines was readable while the data plate for the remaining engine exhibited extensive fire damage precluding a visual confirmation of the engine SN and/or part number (PN).[4] The engine positions were determined by comparing the engine SN on the legible data plate with the recorded installation position of each engine in the maintenance records.

1.6.3 Engine No. 1

Engine No. 1, SN AE100843, PN 6846583[5], was determined to be located at GPS point 11 in the wreckage diagram (Attachment 1). The engine remained attached to the nacelle and was covered in soot forward of the heat shield but remained relatively clean aft of the heatshield. Fire damage and blistering of the nacelle paint was noted. Both the inlet duct and torquemeter were separated from the engine inlet case. The torquemeter was intact and still located within the inlet duct. Still attached to the torquemeter were the reduction gearbox assembly's pinion & accessory spur gearshaft assembly (pinion gear) and a small fractured piece of the reduction gearbox rear housing. A large fractured section of the reduction gearbox rear housing, with the reduction gear main studding diaphragm assembly and accessory gears still attached, was found lying next to the torquemeter. All the reduction gears, plus the pinion gear, appeared to be intact. The reduction gear-to-power section struts were still attached to the large section of reduction gearbox rear housing found next to the torquemeter.

[4] The numbering convention for the engines and propellers is from left to right ALF. The data plate for engines No. 1, 2, and 3 were legible but was destroyed for engine No. 4.
[5] The engine PN is for the entire engine assembly includes the following sections: power, turbine, torquemeter, and reduction gearbox.

The bottom of the engine was not visible; however, examination of the engine from the 7:00 to 4:00 o'clock positions showed no breaches of any of the external engine cases. The accessory gearbox housing had become detached from the engine and the housings were fractured exposing the internal gears. All the gears appeared to be intact. All the 1st-stage compressor blades were intact and none exhibited any bending. Visual examination of the turbine section was precluded by nacelle and airplane debris obstruction of the exhaust.

1.6.4 Engine No. 2

Engine No. 2, SN AE101504, PN 6897151, was determined to be located at GPS point 12 in the wreckage diagram. The engine remained attached to the nacelle and was covered in soot forward of the heat shield. Fire damage and blistering of the nacelle paint was noted. With the cowling still installed, no determination of the condition of the engine aft of the heat shield could be made. Both the torquemeter and the inlet duct were separated from the engine inlet case. A large fractured portion of the reduction gearbox rear housing, with the reduction gear main studding diaphragm assembly and accessory gears still attached, was found lying next to the engine. All the reduction gears appeared to be intact.

Examination of the 1st-stage compressor blades and the 4th-stage turbine blades revealed that all the blades were intact and that the blade tips were slightly bent in the direction opposite rotation. The accessory gearbox remained attached to the engine; however, the left side of the accessory gearbox were fractured exposing the accessory gears. All the exposed gears appeared to be intact.

1.6.5 Engine No. 3

Engine No. 3, SN AE101267, PN 6897151, was determined to be located at GPS point 8 in the wreckage diagram. The engine remained attached to the nacelle and was covered in soot forward of the heat shield but remained relatively clean aft of the heatshield. No signs of fire damage were observed on the engine itself but fire damage and blistering of the nacelle paint was noted. The torquemeter was intact but was found separated from the inlet housing and the inlet duct. Still attached to the torquemeter were the pinion gear and a small fractured section of the reduction gearbox rear housing. A large fractured portion of the reduction gearbox housing, with the some of the accessory gears still attached, was found near the torquemeter. All the visible reduction gears, plus the pinion gear, appeared to be intact. One of the reduction gear-to-power section struts was still attached to a portion of the reduction gearbox and to the inlet case.

The bottom of the engine was not visible; however, examination of the engine from the 7:00 to 4:00 o'clock positions showed no breaches of any of the external engine cases. All the 1st-stage compressor blades were intact and some, not all, were bent in the direction opposite rotation. Those compressor blades that were not bent remained straight. Engine orientation precluded a visual examination of the turbine blades.

1.6.6 Engine No. 4

Engine No. 4, SN A100814, PN 6897151, was determined to be located at GPS point 10 in the wreckage diagram. The engine was still attached to the nacelle and no fire damage was observed aft of the heat shield; however, the inlet housing, accessory gearbox, and reduction gearbox were all consumed by the fire.

The 1^{st}- and 2^{nd}-stage compressor blades were easily examined in-situ. Both stages were heavily bent in the direction opposite rotation to the point that the blades were laying one on top of the other and were covered with a white soft powder (Photo 9). Examination of the 4^{th}-stage turbine blades revealed that they were bent slightly over in the direction opposite rotation considerably less than what was observed in the compressor stages. The bottom of the engine was not visible; however, examination of the engine from the 7:00 to 4:00 o'clock positions showed no breaches of any of the external engine cases.

Photo 9: Bent 1^{st}- & 2^{nd}-Stage Compressor Blades

1.7 Propellers

1.7.1 Propeller Description

The Hamilton Standard propeller assembly, 54H60-91, is a variable pitch constant speed four metal bladed hydromatic propeller model. The main assemblies of the propeller consist of the barrel, dome, low pitch stop, pitchlock regulator, electrical contact ring, and the four blades.

1.7.2 General Propeller Information

All four Hamilton Standard propeller assemblies (subsequently called propeller), model 54H60-91 were found in DF (1) and were all separated from their respective engines. Unlike the engines, each propeller could not be identified in-situ as to their installation position. Therefore, the propeller numbering in the following propeller sections corresponds to the order in which they were examined which also corresponds to their position within the wreckage field. Propeller 1 is the most western in DF (1), closest to Highway 395, while propeller 4 is the most eastern in DF (1), farthest from Highway 395.

From the collection of the whole and fractured pieces of the propeller blades still attached to the propeller hub, and the detached blades scattered in and around the general area were the wings, engines, and propeller were found, it appears that a majority of each of the sixteen propeller blades were recovered. All the propeller blades and blade fragments that were found separated from the propeller hub exhibited varying degrees of damage which included tip fractures, multiple airfoil fractures, twisted airfoils, airfoil impact marks, airfoil scrape marks, dented leading edges, and blade butt fractures. The vast majority of the propeller blades were found imbedded into the soil. Some of the propeller blades exhibited fire damage to the de-icing boot and/or were covered with soot. Three of the propeller blades found separated from their respective propeller assemblies had numbers on the airfoil. Those number were N231, N239471, and N239471.

1.7.3 Propeller 1

Propeller 1 was found at GPS point 7 in the wreckage diagram resting on its reduction gearbox and a single propeller blade with the dome assembly was pointing upwards. The dome assembly and the hub appeared to be intact while the hub mounting bulkhead assembly and the control ring deicer holder assembly were damaged. Two propeller blade airfoils remained attached to the hub. One propeller blade airfoil was found near the flat pitch (airfoil chord perpendicular to the centerline of the engine) blade pitch angle. This propeller blade was essentially intact and was bent aft creating almost an "L" shape. The other propeller blade was found at a very high blade pitch angle towards feather (airfoil chord is parallel to centerline of the engine). Unlike the other "L" shaped propeller blade airfoil, this blade was not intact, instead it was missing approximately half of the blade tip and it exhibited no significant bending. Both propeller blade airfoils exhibited fire and heat damage to the de-icing boots and were covered with soot. The butt end of the two fractured blade airfoils were found installed in the hub. The reduction gear front and rear housing were heavily fractured and essentially missing, exposing the ring gear and the reduction gear main drive gear assembly. Both gears appeared to be intact.

1.7.4 Propeller 2

Propeller 2 was found at GPS point 9 in the wreckage diagram lying on its side. The dome assembly and the hub appeared to be intact. Two propeller blade airfoils remained attached to the hub. One propeller blade airfoil was found near the feathered position and was missing approximately the outer third of the blade tip while the other propeller blade airfoil appeared also to be near the feathered position and only the inner-most 8-inches remained. Both these propeller blade airfoils exhibited fire and heat damage to the de-icing boots and were covered with soot. On the two other propeller blades, only one butt end remained installed in the hub while the other blade was missing entirely, airfoil and blade butt. The reduction gear front housing assembly was heavily fractured with only about half of it still attached, while the rear housing assembly was completely missing exposing the ring gear and reduction gear main drive gear assembly. Both gears appeared to be intact. Fire damage and heavy sooting was noted in the reduction gearbox area

1.7.5 Propeller 3

Propeller 3 was found at GPS point 13 in the wreckage diagram on its nose - resting vertically on the dome assembly. The dome assembly and the hub appeared to be intact while the control ring deicer holder assembly was damaged. Two propeller blade airfoils remained attached to the hub and the de-icier boots on both were melted. One propeller blade airfoil was intact and found towards the "flat pitch" blade pitch angle while the other propeller blade airfoil was fractured approximately 1.5-feet outboard of the blade butt and this blade was found towards the reverse blade pitch angle. Both these propeller blade airfoils exhibited fire and heat damage. On the two other propeller blades, only one butt end remained installed in the hub while the other blade was missing entirely, airfoil and blade butt. The reduction gear front housing assembly was completely fractured with only a few pieces of the front flange still attached, while the rear housing assembly was completely missing, exposing the ring ear and the reduction gear main drive gear assembly. Both gears appeared to be intact.

1.7.6 Propeller 4

Propeller 4 was found at GPS point 15 in the wreckage diagram on its side. The dome appeared to be intact but the hub was fractured and part of it was consumed by the fire. Two propeller blade airfoils remained attached to the hub with one of the propeller blades intact and bent aft while the other was fractured approximately 6-inches outboard from the blade butt. Both propeller blade airfoils were found at a blade pitch angle that was relatively at "flat pitch." On the two other propeller blades, the butt end of both blades remained installed in the hub and the rest of the blade airfoil had fractured. The reduction gear front housing assembly was almost completely consumed exposing the ring gear. The ring gear appeared to be intact. No part of the rear housing assembly itself, the gears in the rear housing assembly, the main studding diagram assembly, or the gears in the front housing assembly remained. The forward section of the propeller shaft appeared to be connected to the propeller but was fractured just aft of the propeller roller bearing.

2.0 DETAILED CENTER WING LOWER SURFACE EXAMINATION

After the completion of the on-site portion of the investigation at Walker and Bridgeport, the entire wreckage was transported to the "Plain Part" storage facility in Pleasant Grove, California. The Airworthiness Group meet at "Plain Part" from September 17 – 19, 2002 to perform additional examination of the wreckage and inspections on the center wing lower surface. Before the arrival of the Airworthiness Group, the center wing lower surface had been previously cut chordwise at approximately CWS 41R just inboard of the fracture line at CWS 53R and was sent to Fowler Inc., Gardena, California for metallurgical examination. See Section 4.0 entitled *Metallurgical Examination* for details on the Fowler report findings.

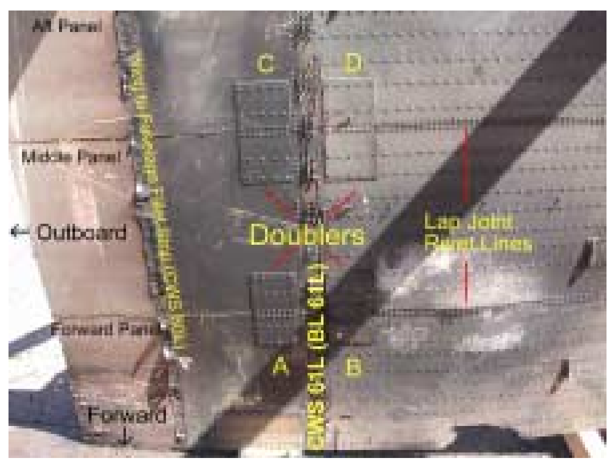


PHOTO 10: CW LOWER SURFACE - LEFT

The remainder of the center wing lower surface was cut longitudinally at CWS 101L and CWS 157L in the presence of the Airworthiness Group to facilitate on-site visual and non-destructive inspection (NDI) examination of: 1) the four center wing lower skin doublers at the BL 61L longeron (Photo 10), 2) the area around and underneath the No. 2 engine drag angle CWS 213L and, 3) the area of the wing-to-fuselage fillet panel CWS 80L.

On the forward skin panel of the center wing lower skin just outboard of CWS 178L (approximately CWS 180L) a crack was noted emanating from the first fastener hole aft of the beam cap attachment. A section of the center wing lower skin around CWS 178L was cut out to facilitate a visual inspection. The initial visual inspection revealed features indicative of fatigue. This section was sent to the Safety Board's Material Laboratory, Washington, D.C. for a detailed metallurgical examination. See Section 4.0 entitled *METALLURGICAL EXAMINATION* for details of the metallurgical finding. A second crack located inboard of CWS 220L was noted starting from the leading edge of the forward panel progressing aft. Initial visual examination of this crack revealed features indicative of an overload failure and no additional metallurgical work was performed.

2.1 Doublers at CWS 61L Lower Skin

Four rectangular doublers plates were installed on the center wing lower skin, two each on either side of the BL 61L longeron. The forward two doublers (A & B) lapped over the forward and middle lower skin panels and the aft two doublers (C & D) lapped over the middle and aft lower skin panels. Dimensionally, each doublers measured approximately 12-inches longitudinally x 6-inches laterally axis and were centered longitudinally over the lower skin panel lap joint fastener lines. Lockheed indicated that the doublers were installed during production of the center wing.

All four doublers were visually examined and no cracks were noted. Multiple x-rays were then taken of and around each doubler using a photographic film strip measuring 14- x 17-inches affixed on top of the each doubler. Examination of the x-rays in that area revealed three chordwise (longitudinal) cracks measuring approximately 0.300, 0.450, and 0.350-inches respectively, all originating from a different fastener holes in different doublers.

After all the doublers had been x-rayed, the doublers were removed and the fastener holes were Fluorescent Penetrant Inspected (FPI) using a Type III (visible and fluorescent) Method A (water washable), Level 1 (low sensitivity). Five chordwise cracks were found originating from fastener holes using the FPI. The cracks measured approximately 0.120, 0.100, 0.350, 0.035, and 0.050-inches respectively. Only one of the three cracks detected by x-ray was confirmed by FPI and four of the 5 cracks found during the FPI were not detected by x-ray. Of the seven cracks discovered by x-ray and FPI, three were in the inboard doublers while four were in the outboard doublers.

2.2 Center Wing Station 61 Left (BL 61L)

The BL 61L fastener pins were removed and the entire length of the BL 61L was inspected using FPI. No crack indications were found.

2.3 No. 2 Engine Drag Angle Located CWS 213L

The aft nacelle fairing for engine No. 2 (CWS 213L – CWS 178L) was cut to expose the underside of the center wing skin. A repair doubler plate was noted on the bottom of the center wing forward panel. The doubler panel measured approximately 20-inches chordwise x 13-inches spanwise and was located approximately 13.5-inches inboard of CWS 220 (CWS 206.5L – CWS 186.5L) and 12-inches aft from the leading edge of the front panel. No NDI inspections were performed on the doubler.

Removal of the engine fairing also revealed a lower skin doubler repair was along the CWS 213L engine truss attachment (drag angle). The doubler was located approximately 4.5-inches inboard of the CWS 220L rainbow fitting and extended approximately 3-feet longitudinally from the leading edge of the front panel to approximately the middle of the second panel and measured approximately 6.5-inches wide. An x-ray was taken on either side of WS 213L (engine drag angle) from the front panel leading edge back approximately 36-inches. No x-rays were taken through the stringer but instead in-between stringers. Three cracks were discovered with two oriented chordwise while the third was at a 45° angle from the chordline (See Figure 8, Attachment 3). The two chordwise cracks were identified as skin cracks and measured approximately 0.200 and 0.120-inches respectively. The third crack which started off at a 45° angle and then turned chordwise was identified as a drag angle flange crack. This crack measured approximately 0.450-inches

2.4 Wing-to-Fuselage Fillet strip (CWS 80L)

All the fasters (screws and anchor nuts) from the wing-to-fuselage fillet strip (CWS 80L) were removed and a FPI was conducted along the entire area. No crack indications were found.

2.5 Forward Panel Leading Edge Doubler Repair

The center wing lower surface forward panel exhibited a leading edge spar cap doubler repair outboard of CWS 61L longeron. The doubler plate spanned from approximately CWS 63L - CWS 76L. No FPI or x-ray inspection was performed on this piece.

3.0 COCKPIT GAUGES

3.1 Main Fuel Control Panel and Fuel Quantity Gauges

The main fuel control panel (Figure 4) was recovered heavily damaged with many of the gauges and switches missing and/or broken. The main fuel control panel is located on the cockpit overhead control panel. Fuel quantity gauges for the auxiliary tanks (external) are installed across the top of the panel. This airplane did not have any auxiliary tanks installed; therefore, the gauges were in-operative (covered). The fuel quantity gauges for the four main fuel tanks, the internal tanks, are installed across the bottom of the panel. There are four internal tanks, one tank located outboard of each engine. The tanks are integral units of the wings, using the upper and lower skin surface as tank walls. Each one of these main tank fuel quantity gauges are operative. The large gauge in the center of the main fuel control panel is the fuel totalize for the main fuel tanks. Table 1 lists the fuel quantity gauges still installed in the main fuel control panel and the quantity indicated. All the glass covers for those gauges that remained installed in the panel were either missing or broken.

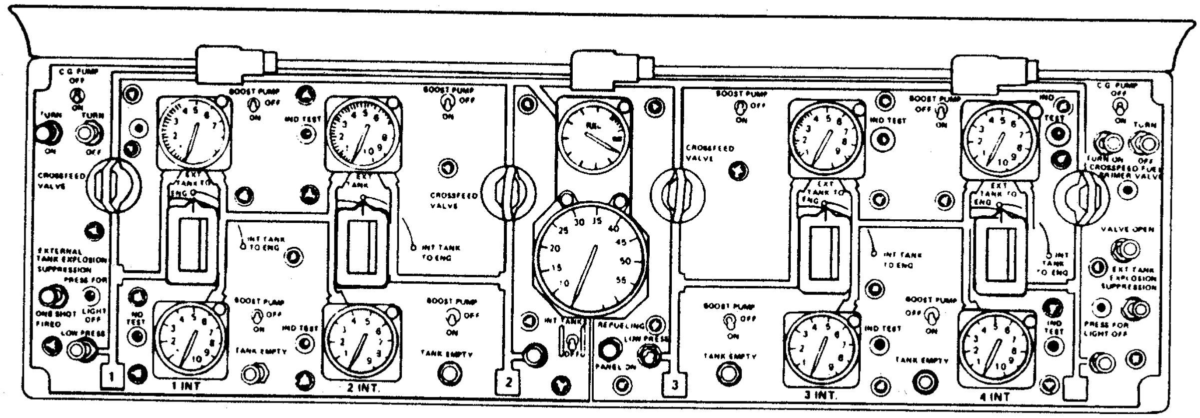


FIGURE 4: MAIN FUEL CONTROL PANEL

TABLE 1: MAIN FUEL CONTROL PANEL GAUGES

	TOP ROW				**MIDDLE**	**BOTTOM ROW**			
	Left Aux External	Left Aux Internal	Right Aux Internal	Right Aux External	Fuel Totalized	No. 1 Internal	No. 2 Internal	No. 3 Internal	No. 4 Internal
INSTALLED	YES	YES	YES	NO	YES	NO	NO	NO	NO
READING	0	2,000	7,000	-	2,000	-	-	-	-

Along with the main fuel control panel, there is a single point refueling control panel located in the right wheel fairing, that consists of the same auxiliary and main tank fuel quantity gauges as those installed on the main fuel control panel.

Face plates of all the fuel quantities gauges for the auxiliary tanks are in an in-operative condition (covered) and are marked 0 – 5 x 1000 lbs. Face plates for all the fuel quantity gauges for the main tanks are in an operative condition and are marked 0 – 9 x 1000 lbs for the <u>inboard</u> tanks (No. 2 and No. 3 tanks) and 0 – 10 x 1000 lbs for the <u>outboard</u> tanks (No. 1 and No. 4 tanks). Ten fuel quantity gauges were recovered separated from either of the two fuel control panels and each one had the glass cover also broken and/or missing.

Three fuel quantity gauges were determined to be main inboard tank gauges (face plate marked to 0 – 9 x 1000 lbs) and they read 0, 0, and 7,000 lbs respectively. Three other fuel quantity gauges were determined to be auxiliary tank gauges (face plate marked to 0 – 5 x 1000 lbs) and they read 0, 3,000, and 5,000 lbs respectively. One fuel quantity was determined to be an outboard gauge, face plate marked 0 – 10 x 1000 lbs) and read 2,800 lbs. Three fuel quantity gauges did not have the face plate nor pointer still installed and their position within the control panels could not be determined and three of the 16 total fuel quantities gauges were not recovered.

The No. 1 and No. 2 main tank cross-feed switches were the only cross-feed switches with their knob still attached. In both cases, the knob was in the CLOSED position. Cross-feed switches for the No. 3 and 4 tanks did not have the knob still attached. Comparing the knob set screw positions on the

No. 1 and No. 2 tanks cross-feed switch knobs with the set screw positions of the No. 3 and 4 tanks, it was determined that the No. 3 tank was in the CLOSED position and the No. 4 was in the ON (cross-feed position). The knob set screw is on the left side of the post when the knob is in the CLOSED position.

3.2 Altimeter and Cabin Pressure

The pilot's altimeter was recovered and the altimeter setting was 30.12 inches of mercury and the altitude read 600 feet MSL. A co-pilot's altimeter was recovered separate from the instrument panel and separate of its protective housing. The altimeter setting was 30.11 inches of mercury and the altitude indicated 565 feet MSL. A cabin pressure gauge was recovered with the indicator needle broken as well as the glass cover. The cabin pressure control gauge was recovered still attached to the control panels, the glass cover was intact, and the needle still installed. The altitude needle in the cabin pressure control gauges was pointed towards 550-feet MSL.

3.3 Acceleration Meter

The acceleration meter (g-meter) was recovered still installed in the pilot's instrument panel. The glass cover was broken but both pointers were still attached. The maximum acceleration needle was pointing towards 4Gs while the instantaneous needle was pointed towards 1.25Gs.

4.0 METALLURGICAL EXAMINATION

4.1 Center Wing Box Beam Lower Surface Examination

Metallurgical examination of the fracture surface at CWS 53R by Fowler Inc. revealed fatigue in the forward and middle lower skin panels and in stringers 16 and 17 (Attachment 4). Binocular examination revealed that the primarily areas of fatigue initiation were at two adjacent rivet holes, where stringers 16 and 17 attach to the lower skin panel (See Attachment 4, Figure 6), along the second to last longitudinal row of rivets holes of the forward inboard doubler (See Photo 11)[6].

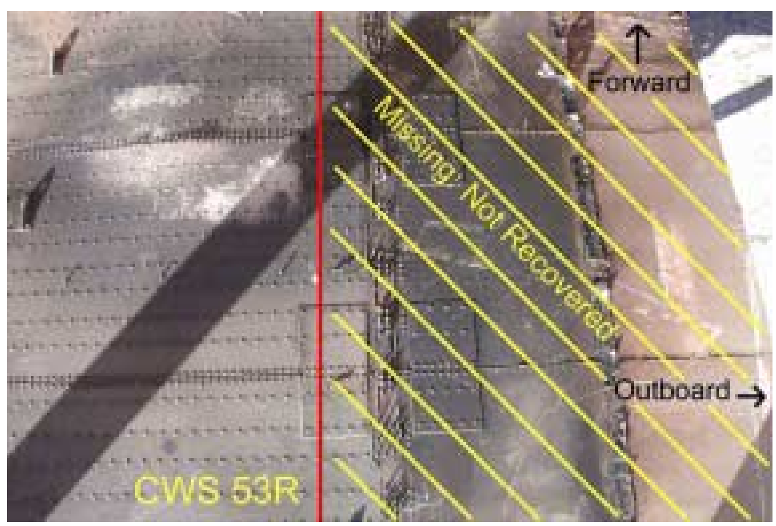


Photo 11: CW Lower Surface

[6] Photo 11 is of the center wing left side depicting the fracture location on the center wing right side.

Lower skin panel fatigue cracks were found to have initiated at the aft rivet hole of stringer 16 and the forward rivet hole of stringer 17 (See Attachment 4, Figures 9 & 10). At both the stringer 16 and 17 locations, the lower skin panel exhibited a fatigue crack propagating from the forward and aft sides of the rivet holes. The skin panel cracks that propagate from the stringer 16 rivet hole grew approximately 2.2-inches forward and approximately 0.75-inches aft, joining the forward crack from the stinger 17 rivet hole. The forward propagating crack from stinger 16 spanned across the middle skin panel to the forward skin panel. The skin cracks that propagated from stinger 17 holes grew approximately 1.08-inches forward, joining with the aft crack from stringer 16, and approximately 6-inches aft. The total length of the cracks from stringers 16 and 17, after they linked-up, measure 12.2-inches. Several other smaller crack initiation sites were noted along the fracture line as well as at other doubler rivet hole locations (See Attachment 4, Table 1 for additional details).

Fatigue cracks were also noted in stringers 16 and 17 themselves. The cracks initiated in the stringer flanges, above the area the primary skin panel cracks originated, and propagated into the upper surface of the respective stringers (See Attachment 4, Figures 9 & 10).

Hi-Lok fasteners are used to join the lower the skin panels. The Hi-Lok fasteners on the aft edge of the forward lower skin panel were sheared due to overload principally in the aft direction. Rivets that attached stringers 12, 23, and 24 to the lower skin as well as rivets that attach the forward spar cap to the lower skin were also sheared due to overload.

A scanning electron microscope (SEM) examination of the skin panel at the forward rivet hole in stringer 17 revealed clear visible fatigue striations on the fracture surface and that the crack initiation was at the lower corner of the rivet hole. The origin was partially rubbed on both sides of the rivet hole eliminating identifiable fracture features. Examination of the corresponding rivet hole in the stinger 17 revealed multiple small fatigue cracks initiating from the rivet hole and adjacent areas on the lower surface of the stringer. SEM examination of the lower skin panel forward rivet hole in stringer 16 revealed that fatigue cracks had initiated on both sides of the Hi-Lok fastener hole. No indication of inter-granular fracture associated with stress corrosion cracking was found at the fatigue origin sites.

Sections of the lower skin panel and stringer 16 and 17 were cut in preparation for metallography and for a chemical analysis from an independent laboratory. The manufacturing specifications call for the center wing lower surface panels to be made of rolled 7075-T6; stringers 12 – 15, 17 – 19, and 21 – 24 to be made of extruded 7075-T6; and stringers 16 and 20 (panel lap joint stingers) to be made of extruded 7075-T6511.[7] The microstructure of the lower surface panels and the stringers revealed that they were all consistent with the specified material. Chemical analysis of the lower skin panels and the stingers also indicated that the parts had conformed to the material specification. Conductively and hardness measurements indicated that the lower skin panel and the stringers had been heat treated to the T6 temper.

[7] 7075 is a wrought aluminum composition alloy with zinc. This alloy is composed of (max weight percent unless shown as range): .40Si, .50Fe, 1.2-2.0Cu, .3Mn, 2.1-2.9Mg, .18-.28Cr, 5.1-6.1Zn, .2Ti, .20other, remainder Al. T6 is the designation for the heat treatment required which also specifies the conductively and hardness levels required.

4.2 AIRPLANE STRUCTURE FOUND IN DRAINAGE VALLEY

The airplane structure was sent to the Lockheed materials laboratory in Marietta, GA, to determine the material composition and its possible origin and application. The structure was comprised of three thinner sheets and a larger thick piece, which Lockheed calls a "bathtub fitting", joined by Hi-Lok fasteners. A chemical analysis of the "bathtub fitting" fitting and the various sheets of the structure were performed using a SEM. Although Lockheed could not positively identify the either the bathtub fitting or layered sheet as being any one specific alloy, the "bathtub fitting" was determined to be an aluminum part containing copper alloy, possibly 2024[8], one layer sheet was determined to be aluminum with zinc 7021[9], and two sheets were aluminum with both copper and zinc, possibility 7075[10]. All the fractures were determined to be due to overstress. A small corrosion crack, less than 0.010-inches, was noted in a large hole of the "bathtub fitting" (Attachment 5).

4.3 EVALUATION OF THE SEALANT FOUND AROUND THE STRINGERS ON THE CENTER WING

Sealant was removed from between the stringers and the low skin panel of the center wing and sent to Lockheed materials laboratory in Marietta Georgia to determine the material composition and, if possible, based on the material composition, date when the center wing was constructed. While the material composition of the sealant was being analyzed, a review of the original C130A center wing build specification along with all subsequent build changes and refurbishment specifications was being conducted by Lockheed. Lockheed's Material &Processes Engineering determined that all C-130A airplane center wings were manufactured prior to the use of fay surface sealant, and concluded that "the center wing on subject aircraft [T130, SN56-0538] has been disassembled and rebuilt sometime after delivery to the USAF and it is likely that the skins and stringers are not original parts." (See the Performance Study for the residual strength analysis report)

4.4 LOCKHEED RESIDUAL STRENGTH ANALYSIS

At the request of the Safety Board, Lockheed performed a residual strength analysis to identify the vertical load factor that would have caused the center wing lower surface to fail based on the know fatigue damage documented in the Fowler metallurgical report. Lockheed constructed a generalized Finite Element Model of the C-130A center wing lower surface to represent the three skin panels, the thirteen stringers, and two beam caps that represent the primary load carrying members along with fastener elements attaching the stringers to the skin. Various failure scenarios were represented in the model including the cracks in the lower skin, and in the stringers (See the Performance Study for the complete residual strength analysis report).

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[8] 2024 is a wrought aluminum composition alloy with copper. This alloy is composed of (max weight percent unless shown as range): .50Si, .50Fe, 3.8-4.9Cu, .3-.9Mn, 1.2-1.8Mg, .10Cr, .25Zn, .15Ti, .20other, remainder Al.

[9] 7021 is a wrought aluminum composition alloy with zinc. This alloy is composed of (max weight percent unless shown as range): .25Si, .40Fe, .25Cu, .10Mn, 1.2-1.8Mg, .05Cr, 5.0-6.0Zn, .1Ti, .08-.018Zr, 20other, remainder Al.

[10] 7075 is a wrought aluminum composition alloy with zinc. This alloy is composed of (max weight percent unless shown as range): .40Si, .50Fe, 1.2-2.0Cu, .3Mn, 2.1-2.9Mg, .18-.28Cr, 5.1-6.1Zn, .2Ti, .20other, remainder Al.

Lockheed concluded from the analysis that:

> The center wing failed at a load that was approximately 30% of the design ultimate strength of the center wing and that the presence of fatigue cracks at multiple locations and in multiple structural elements reduced the residual strength to approximately 50% of design limit load and compromised the fail-safe capability of the structure. Failure was likely caused by a symmetric maneuver load exceeding 2.0g during the final drop of fire retardant.

Furthermore, Lockheed concluded that:

> Non-destructive inspection methods could have detected the existing fatigue cracks in the wing lower surface skin panel before this accident occurred. Although crack sizes at design limit load are substantially smaller than those found on this wing, a directed radiographic inspection in the area of each lower surface doubler is capable of detecting fatigue cracks in order of 0.50 to 0.75 inches with high confidence providing skilled inspectors are used. Inspection intervals appropriate for this detectable crack size can be determined from a damage tolerance crack growth analysis; however, this requires an extensive knowledge of the operational loads environment and internal stresses of the C-130A wing. C-130 Operational Loads Recording Programs has shown the fire fighting missions to be substantially more severe than typical military logistics operations and consequently, aircraft operated in this role would require inspection intervals as much as 12 times more frequently than typical military transport usage for meeting damage tolerance requirements.

5.0 AIRCRAFT OWNERSHIP, REGISTRATION AND AIRWORTHINESS HISTORY

The accident airplane was delivered to the United States Air Force (USAF) in December 1957 as a Lockheed Aircraft Corporation C-130A Hercules, SN 56-0538, Lockheed SN 3146 (Photo 12), and was retired from military service in 1986 when it was put into storage at the Aerospace Maintenance and Regeneration Center (AMARC) at Davis Monthan Air Force Base, Arizona. The airplane stayed in storage until May of 1988. On May 24, 1988, the Forest Service acquired SN 56-0538, along with six other C-130A airplanes, from the General Services Administration (GSA) (Attachment 6) and on August 24, 1988 the airplane was released from storage and transferred to the Forest Service. According to the GSA transfer order, the total time on airplane SN 56-0538 was 19,546.8 hours time since new (TSN). The USFS on August 12, 1988, sold SN 56-0538 to Hemet Valley Flying Service, Hemet California, (subsequently referred to as Hemet Valley) along with five other recently acquired C-130A airplanes, for installation of retardant tanks (Attachment 7). Before the final sale of airplane SN 56-0538 to Hemet Valley, Hemet Valley applied for a United States Identification Number (Registration Number) of N134FF for airplane SN 56-0538 on July 19, 1988 (Attachment 8). According to the Aircraft Bill of Sale, stamped December 5, 1988, Hemet Valley then sold airplane SN 56-0538, N134FF, to Hawkins & Power Aviation Inc. (subsequently know as H&P) (Attachment 9).

On December 10, 1988, H&P issued a *Statement of Conformity*, FAA Form 8130-9, in accordance with *14 Code of Federal Regulations* (CFR) Part 21.53,[11] certifying that airplane SN 56-0538, registration number N134FF, complied with 14 CFR Part 21.33 and Type Certificate (TC) A15NM, revision 2 (Attachment 10). That same day, H&P also applied to the FAA for a *Special Airworthiness Certificate*, in accordance with 14 CFR Part 21.175(b),[12] for Restricted Category for the purpose of Carriage of Cargo for aircraft SN 56-0538 based on conformance with TC A15NM, revision 2. On December 15, 1988, the FAA's Phoenix Manufacturing Inspection Satellite Office (MISO) issued H&P a *Special Airworthiness Certificate* in accordance with 14 CFR Part 21.185(b)[13] (Attachment 11). On December 15, 1988, along with the *Special Airworthiness Certificate*, the FAA's Phoenix MISO also issued the *Operating Limitations* for SN 56-0538, registration number N134FF. The *Operating Limitations* required that the airplane operate in accordance with USAF Technical Order (T.O.) 1C-130A-1 (USAF Series C-130A airplane flight manual) and that the airplane must be serviced and maintained in compliance with USAF T.O. 1C-130A-2-1 through 1C-130A-2-13 (Attachment 12).

PHOTO 12: AIRPLANE DATA PLATE

On December 28, 1988, H&P applied for an aircraft registration change for SN 56-0538, and on January 23, 1989, the FAA issued an *Assignment of Special Registration Number* changing the registration number of SN 56-0538 from N134FF to N130HP (Attachment 13). After the registration of SN 56-0538 was changed to N130HP, the *Operating Limitation – Restricted Category* sheet was reissued by the FAA's Flight Standards District Office (FSDO) in Helena, Montana on August 8, 1989, to address specifically airplane N130HP. The reissued *Operating Limitation – Restricted Category* sheet required the airplane to comply with the same operational, service, and maintenance USAF T.Os. as previously required while the airplane was registered as N134FF (Attachment 14). The FAA's Helena FSDO issued

[11] 14 CFR Part 21.53 reads as follows:
(a) Each applicant must submit a statement of conformity (FAA Form 317) to the Administrator for each aircraft engine and propeller presented to the Administrator for type certification. This statement of conformity must include a statement that the aircraft engine or propeller conforms to the type design therefore.
(b) Each applicant must submit a statement of conformity to the Administrator for each aircraft or part thereof presented to the Administrator for tests. This statement of conformity must include a statement that the applicant has complied with § 21.33(a) (unless otherwise authorized under that paragraph).

[12] 14 CFR Part 121.175(b) reads as follows: Special airworthiness certificates are primary, restricted, limited, and provisional airworthiness certificates, special flight permits, and experimental certificates.

[13] 14 CFR Part 121.185(b) reads as follows: (b) Other aircraft. An applicant for a restricted category airworthiness certificate for an aircraft type certificated in the restricted category, that was either a surplus aircraft of the Armed Forces or previously type certificated in another category, is entitled to an airworthiness certificate if the aircraft has been inspected by the Administrator and found by him to be in a good state of preservation and repair and in a condition for safe operation.

a Restricted Category for the purpose of Carriage of Cargo *Special Airworthiness Certificate* for SN 56-0538, N130HP on August 8, 1989 (Attachment 15).

The FAA's Northwest Mountain Region Flight Standards Field Office (FSFO) in Casper, Wyoming rescinded the *Special Airworthiness Certificate* that was issued on August 8, 1989, and issued on June 1, 1998, a *Restricted category Special Airworthiness Certificate* with the purpose of the certificate was for in 14 CFR Part 21.25(b)(1)(2)(3)(7)(other) operations (Attachment 16).

Along with the new *Special Airworthiness Certificate* issued to H&P on June 1, 1998, for SN 56-0538, N130HP, the FAA's Casper FSFO also issued a *Special Operating Limitation* sheet. This new *Special Operating Limitation* sheet required compliance with all the same operational, service, and maintenance required USAF T.Os. as previously required but also required the use of H&P HP-C-130A *Inspection Guide* (Attachment 17).

6.0 TYPE CERTIFICATE (TC) HISTORY

6.1 TYPE CERTIFICATE HISTORY FOR C-130A, SN 56-0538

In accordance with the requirements in 14 CFR Part 21.53, H&P issued a *Statement of Conformity*, dated December 10, 1988, stating that SN 56-0538 conformed to 14 CFR Part 21.33 and to the Type Certificate (TC) A15NM, revision 2. 14 CFR Part 21.33(b) requires that each applicant must make all inspections and tests necessary to determine compliance with the applicable airworthiness, aircraft noise, fuel venting, and exhaust emission requirements; that materials and products conform to the specifications in the type design; that parts of the products conform to the drawings in the type design; and that the manufacturing processes, construction, and assembly conform to those specified in the type design.

According to 14 CFR Part 21.41, a TC is considered to include the type design, the operating limitations, the certificate data sheet, the applicable regulations pertaining to records compliance, and any other conditions or limitations prescribed for the product. The Forest Service had listed SN 56-0538 on TC A15NM, revision 2 when T130 was first registered and an airworthiness certificate issued. The Safety Board was unable to obtain a copy of TC A15NM, revision 2; therefore, the date of issuance and the exact requirements outlined in the type certificate data sheet (TCDS) is unknown. However, the *Operating Limitations - Restricted Category* sheet that accompanied the original *Airworthiness Certificate* for SN 56-0538, dated December 15, 1988 (See Attachment 12), outlined the operating, service, and maintenance requirements much like what would be listed in the TCDS. According to this *Operating Limitations - Restricted Category* sheet, the airplane must be operated in accordance with USAF T.O. 1C-130A-1-1 flight manual and; maintenance and serviced in accordance with T.Os. 1C-130A-2-1 through 1C-130A-2-13. Table 2 provides a description of each manual.

TABLE 2: USAF TECHNICAL ORDER MANUALS

USAF TECHNICAL ORDERS	TECHNICAL ORDER TITLES
1C-130A-2-1	General Airplane
1C-130A-2-2	Ground Handling, Servicing, and Airframe
1C-130A-2-3	Hydraulics Systems
1C-130A-2-4	Power Plant
1C-130A-2-5	Fuel Systems
1C-130A-2-6	Instruments
1C-130A-2-7	Electrical Systems
1C-130A-2-8	Radio, Communications, and Navigation Systems
1C-130A-2-9	Flight Control Systems
1C-130A-2-10	Utility Systems
1C-130A-2-11	Propeller
1C-130A-2-12	Landing Gear
1C-130A-2-13	Airplane Wiring Diagrams
1C-130A-1	Flight Manual
1C-130A-1-1	Flight Manual, Appendix 1 Performance Data

The TCDS applicable to SN 56-0538 at the time of the accident was A15NM, revision 4, (Attachment 18). The Safety Board was unable to obtain a copy of TCDS A15NM, revision 3, to develop a chronology of changes from the original TCDS that SN 56-0538 was certificated under, revision 2, and the TC that was applicable at the time for the accident, revision 4. TCDS A15NM, revision 4, indicates that the certification basis was per the restricted category aircraft issue of type certificate 14 CFR Part 21.25(a)(2).[14]. A review of TC A15NM, revision 4, revealed that of the six NOTES at the end of the TCDS, NOTE 1 stated that aircraft approved under the TC may only be used as a fire fighting aircraft, NOTE 3 requires the airplane to be operated in accordance with USAF T.O. 1C-130A-1 and USAF T.O. 1C-130A-1-1 (USAF Series C-130A, C-130D, & C-130D-6 airplane flight manual performance index), and NOTE 4 pertained to the continuing maintenance procedures. NOTE 4 states that the airplane must be maintenance and serviced in accordance with USAF T.O. 1C-130A-2-1 through 1C-130A-2-13 as maintenance directives, but did not include future programs, updates, or any continuous airworthiness engineering support. Furthermore, the TCDS did not however require the use of the USAF T.O. 1C-130A-6 *Aircraft Scheduled Inspection and Maintenance Instruction* manual for developing the appropriate inspection intervals. The –6 manual provides detailed instructions on when particular parts of the aircraft require inspections (usually based on a calendar year), what type of inspections are to be performed, and what critical features are to be inspected.

6.2 TYPE CERTIFICATES FOR OTHER C-130A AIRPLANES

Search of the FAA TCDS data base revealed seven different TCDSs for the C-130A model and one for the L-382, civil version of the C-130E model: Table 3 provides the listing of the TCDSs. A review of TCDS A30NM, held by H&P, revealed that SN 56-0538 was also not only listed on this as well as Forest Service TCDS A15NM. The maintenance and service requirements outlined in A15NM, NOTE

[14] 14 CFR Part 21.25(a)(2) reads as follows: Is of a type that has been manufactured in accordance with the requirements of and accepted for use by, an Armed Force of the United States and has been later modified for a special purpose.

4, are the same requirements listed in A30NM. Reviews of all the C130A TCDS revealed that the conformity requirements were essentially identical except for the NOTES at the end of the each sheet that provides specific and/or unique operating and maintenance requirements. TCDS TQ3CH (Attachment 19), held by Snow Aviation International, Inc., Columbus, Ohio, contains ten NOTES and is the newest TCDS of the seven examined. This TCDS has the most comprehensive maintenance program description of all the C130A TCDSs and provides for future changes when available from the FAA, Department of Defense agencies, or any other source (such as the manufacturer). These were not listed in the Forest Service TSCD A15NM. Furthermore, it also contains listings of applicable airframe airworthiness directives, powerplant and propeller airworthiness directives, and time compliance technical orders.

During November and December 2002, Safety Board investigators met with representatives from the FAA aircraft certification department to review their current policies regarding updates to TCDS. Because of the meetings, the FAA agreed to review their process of revising TCDS for the C130 aircraft and will require that all type certificate holders revise and update to their respective TCDS to confirm with a standard that the FAA is currently developing.

TABLE 3: C-130 TYPE CERTIFICATES

TCDS NUMBER	REVISION NO. DATE	AIRCRAFT MODEL	TCDS OWNER	FAA OFFICE	NOTES
A15NM	REV 4 7/16/90	C130A	FOREST SERVICE	LOS ANGELES ACO[15]	1 THRU 6
A30NM	REV 1 02/18/93	C130A	H&P	DENVER ACO	1 THRU 6
A31NM	BASIC 01/31/90	C130A	HEMET VALLEY	LOS ANGELES ACO	1 THRU 5
A33NM	BASIC 05/22/90	C130A	WESTERN INTERNATIONAL	LOS ANGELES ACO	1 THRU 5
A34SO	BASIC 03/30/90	C130A	LESEA	ATLANTA ACO	1 THRU 5

TABLE CONTINUED ON NEXT PAGE

[15] ACO stands for Aircraft Certification Office.

TABLE 3: C-130 TYPE CERTIFICATES			Continued		
A39CE	REV 2 08/15/96	C130A	CENTRAL AIR SERVICES	WICHITA ACO	1 THRU 7
TQ3CH	REV 1 03/10/2000	C130A	SNOW AVIATION	CHICAGO ACO	1 THRU 10
A1SO	REV 15 10/25/2001	382, 382B, 382E, 382F, 382G, & 382J	LOCKHEED MARTIN CORP.	ATLANTA ACO	1 THRU 10
A35NM	REV 1 8/6/2002	C130B	HEAVYLIFT HELICOPTERS INC.	LOS ANGELES ACO	1 THRU 5

7.0 SUPPLEMENTAL TYPE CERTIFICATE (STC) HISTORY FOR C-130A, SN 56-0538

On August 11, 1989, Hemet Valley applied for a Supplemental Type Certificate (STC) for installation of retardant tanks for the special purpose of Forest and Wildlife Conversation in Restricted Category C-130 airplanes. On January 31, 1990, the FAA's Los Angeles ACO approved STC, number SA4835NM, for that purpose (Attachment 20). The Los Angeles ACO, by issuing the STC, determined that the installation of the retardant tanks adhered to 14 CFR Part 21.113 and did not alter the C-130 product by introducing a major change in type design, great enough to require a new application for a type certificate under 14 CFR Part 21. 19(a) and that the proposed change in design, power, thrust, or weight was not so extensive that a substantially complete investigation of compliance with the applicable regulations was required.

On March 26, 1990, H&P issued *Major Repair and Alternation* FAA Form 337, for alternation of SN 56-0538, registration number N130HP, in accordance with the requirements of Hemet Valley STC SA4835NM (Attachment 21). Although H&P issued FAA Form 337 for the incorporation of STC SA4835NM, Hemet Valley performed the modification to SN 56-0538.

8.0 RETARDANT TANK OPERATIONS AND LOADS

8.1 GENERAL DESCRIPTION OF RETARDANT TANK SYSTEM AND OPERATION

The Hemet Valley retardant tank system consists of two separate tanks (a forward and aft tank) capable of holding 3,000 gallons of retardant. According to the Forest Service, the retardant weight is defined as 9.0 pounds per gallon and the Operating Limits in the FAA approved airplane flight manual supplement, dated January 30, 1990, restrict the maximum weight capacity of any one tank to 13,650 pounds. Each tank is filled from the rear of the airplane though a dual quick disconnect fitting located adjacent to the rear personnel doors. Retardant quantity received is indicated to both the ground crew and pilot by the Engineer Load/Master.

Each tank is divided into four compartments and the compartments are independently operated; therefore, several retardant release options are available: 1) one door at a time, 2) two doors at a time, 3) four doors at a time (½ salvo), 4) eight doors at a time (full salvo). Each tank door is opened and closed by hydraulic actuators using the airplane's 3,000 PSI hydraulic system and is controlled electrically through a 24-Volt relay system.

The drop system control panel is located on the aft portion of the center instrument pedestal and includes a drop system arming switch, door position lights, door selector dial & switch, automatic or manual mode selection switch, sequence timer, restrictor ON/OFF switch, and a push-to-test button. There is an amber colored door position light for each of the eight compartments and each position light will illuminate when its respective door is in the OPEN position and will continue to illuminate until the door is in the CLOSED position actuating a limit switch in the fully closed and locked position.

With the AUTO or MANUAL mode switch in the MANUAL position, the DROP BUTTON must be depressed to OPEN the door(s) and released to CLOSE the door(s). When in the AUTO position, the DROP BUTTON only needs to be depressed once and held to cycle automatically through the pre-selected sequence. When the DROP BUTTON is depressed in the AUTO mode, the drop selector will automatically rotate clockwise to the next drop selection until all the tank doors have been opened and the retardant has been drop. Release of the DROP BUTTON in the AUTO mode, just as in the Manual mode, will close the doors after the time delay interval, incorporated into the operating cycle, has passed — approximately three seconds after the DROP BUTTON is released. The time interval between drops in the selected drop sequence is determined by the setting of the sequence timer.

Located on the annunciator panel on top of the pilot's glare shield is a green GO light which is illuminated to show that the system is ready. In order to illuminate the GO light, the arming switch must be on the ON position, the drop selector must be in a position other that SAFE, and the airplane hydraulic system must be at least 1,500 PSI. The SAFE position on the drop selector is a lock-out feature that prevents inadvertent drops. For, example, in the SAFE positions, the tank doors will not open when the DROP BUTTON is depressed and the Drop Selector will not automatically advance when the DROP BUTTON is released.

8.2 Retardant Load Drop

According to the Minden Tanker Base, Minden, Nevada, Air Tanker Dispatch/Flight Record for tanker T-130, the last retardant load of 3,000 gallons was loaded on board at 14:29 local time. Based on the estimates of the retardant weight of 9 pounds per gallon, the airplane departed Minden with 27,000 pounds of retardant on board. For additional airplane weight and performance information, see C-130A Aircraft Performance Study.

9.0 C-130A MAINTENANCE PROGRAM

9.1 USAF C-130A Testing, Restrictions, and Inspection Program

In the late 1970s, Lockheed performed a series of service life analyses[16] on major components of the C-130 aircraft, one of which was the center wing of the C-130A and, in 1978 delivered

[16] The baseline aircraft structure was for a C-130A with all modifications up to January 1977.

their findings to the USAF. With respect to the C-130A center wing, three main areas were considered for analysis, each one constituting a major discontinuity in the center wing — fuselage longeron carry thru at CWS 20L/R, fuselage-to-wing joint at BL 61, and outer-to-inner wing point CWS 220. Each location was analyzed using utilization and endurance criteria in flight hours based on the current mission profiles and environmental data at that time. The analysis results were considered valid only if there was no change to the future mission definitions, mission utilizations, annual flying rates, and structural status of the fleet. The results of the service life calculations were that the service life endurance point and the structural action point for the center wing were 19,384 and 11,910 flight hours respectively (Attachment 22).[17] During a hydrostatic fatigue test on a C-130A fuselage, the center wing failed catastrophically at BL 61 at 13,203 cycles with an applied load of 62% limit design. Inspection of the failed area revealed multiple site fatigue damage in the lower skin panels in the vicinity of BL 61. Photos, although of poor quality, seem to indicate that the cracks ran through and/or along the lower skin doublers inboard of BL 61. Based on these findings, Lockheed recommended that the C-130A fleet be inspected for cracks in the vicinity of WS 61 center wing lower surface with the initial inspection to be performed at 12,000 flight hours and a recurring inspection every 2,500 flight hours (Attachment 23).

USAF T.O. 00-25-4 *DEPOT MAINTENANCE OF AEROSPACE VEHICLES AND TRAINING EQUIPMENT* outlines the types and scope of program depot maintenance (PDM)[18] support, and establishes procedures for scheduling aerospace vehicles and training equipment for depot maintenance. PDM is based on data from reliability centered maintenance (RCM) programs (MSG-3)[19], the maintenance data collection system, requirements submitted by owning activities and other reliability and maintenance data sources, such as Aircraft Structural Integrity Program (ASIP),[20] Analytical Condition Inspection (ACI),[21] and Airframe Condition Evaluation (ACE).[22] The USAF feeds back into the RCM process each of these maintenance data sources to continuously identify maintenance task that must be performed and on a scheduled basis to ensure the inherent reliability of the airplane. The RCM process is continuously evolving throughout the life of the airplane.

[17] The structural action point was defined as that point where 10% of the center wings would be expected to have major repair or replacement due to fatigue cracks and the service life endurance point was defined as that point where 50% of the center wings would be expected to have major report or replacement due to fatigue cracks.

[18] PDM is a set of inspection requiring skills, equipment, or facilities not normally possessed by operating locations. It is the highest level of maintenance performed by the military and is similar to a "D" check performed by an air carrier.

[19] Reliability-Centered Maintenance (RCM) is a maintenance concept that has the objective of achieving the inherent, or designed-in, reliability of a system. The concept is a derivative of the airline/manufacture maintenance planning document MSG-2 and MSG-3, published under the auspices of the Air Transport Association.

[20] The ASIP is time-phased set of required actions performed at the optimum time during the life cycle (design through phase-out) of an aircraft system to ensure the structural integrity (strength, rigidity, damage tolerance, durability and service life capability) of the aircraft. The results of the ASIP, i.e., fatigue analysis, damage tolerance analysis, fatigue test results, individual aircraft tracking program, etc., are used in the RCM analysis of structurally significant items. These analyses and tests identify critical areas, inspection tasks, and frequencies.

[21] The ACI is the systematic disassembly and inspection of a representative sample of aircraft to uncover hidden defects, deteriorating conditions, corrosion, fatigue, overstress, and other deficiencies in the aircraft structure or systems not detectable though normal inspection programs, typically over and above those inspections specified in a T.O. or PDM work specifications. ACIs generate data for engineering and technical evaluation of the relative condition of the aircraft and adequate nondestructive inspection techniques to be used to insure that the types and sizes of flaws suspected to be found can be reliably detected.

[22] ACE is similar to the ACI in that it generates deficiency data for engineering and technical evaluation based on the same conditions listed for the ACI but that the ACE inspection is conducted by field teams at the activity where the aircraft is located, instead of at the DEPOT, and the data is used to establish DEPOT level threshold for On Condition Maintenance.

Within T.O. 00-25-4, Tables 1 and 2 lists aircraft scheduled for PDM on a cyclic interval with the cycle time stated in months. The PDM interval is measured from the output date of the last PDM to the input date of the next due PDM. To assist in scheduling PDM, the USAF allows up to a 90-day plus or minus variance from the PDM due date. The USAF has changed the PDM interval for the C-130A and its variants several times throughout the model "A" history. The most recent version of T.O. 00-25-4, dated 30 June 2002 lists the PDM interval for the NC-130A airplane at 60 months, and the June 15, 1995 version has the AC-130A at 36 months.

On December 16, 1988, Hemet Valley received a letter from the Department of the Air Force Warner Robins Air Logistic Center (WR-ALC), regarding flight restriction status of C-130A aircraft SN 56-0538 (Attachment 24). The USAF considered SN 56-0538 on a Level II flight restricted status if the airplane was still in the active USAF inventory. On February 1, 1989, Hemet Valley Flying Service received another letter from WR-ALC explaining and clarifying the differences between Level I and II restriction categories and the requirements necessary to remove the restrictions (Attachment 25). Both levels of flight restrictions were based on whether or not repairs were performed to the outer wing. According to WR-ALC, no such flight restrictions were imposed on any of the C-130A airplanes based on center wing repairs or rehabilitation.

WR-ALC sent a correspondence to Hemet Valley on March 14, 1996, again providing restriction levels, if any, on a list of C-130A greater in number than what was listed in the December 1988 letter. Tanker T130, SN 56-0538 was once again listed on this most recent correspondence but with no restriction information available.

9.2 HAWKINS & POWERS GENERAL C-130A AIRPLANE MAINTENANCE

The *Special Operating Limitations - Restricted Category* sheet that accompanied the original *Special Airworthiness Certificate* for T130 back in December 1988 required that maintenance and servicing be performed in accordance with USAF T.O. 1C-130A-2-1 through 1C-130A-2-13 and operated in accordance with USAF T.O. 1C-130A-1 and 1C-130A-1-1. The latest revision to tanker T130's *Operating Limitation* sheet, dated June 1, 1998, requires that the airplane be maintained and serviced in according with the same USAF T.O. 1C-130A-2 manuals as the previous *Operating Limitation* sheet except for the additional requirement of servicing and maintaining the airplane in accordance with manual *H&P HP-C-130A Inspection Guide*. The *H&P HP-C-130A Inspection Guide* referenced in the operating limitations sheet, dated March 1, 1995, has the same inspection requirements is the *Inspection Planning Guide (IPG-182). IPG-182* was FAA-approved by the Long Beach Aircraft Evaluation Group on March 22, 1995. *IPG-182* for the C-130A aircraft is based on the information in USAF T.O. 1C-130A-6 *Aircraft Scheduled Inspection and Maintenance Instruction*. At the time of the accident, the current version of T.O. 1C-130A-6 was published 15 May 2000 (basic) with change No. 3, dated June 2002.

IPG-182 divides the airplane inspection into three separate basic checks ("A" – "C") plus special inspections. An "A" check is performed every 7 calendar days and consists of a visual inspection of the aircraft for obvious defects, operational checks of certain systems, and security and condition of specified structure. A "B" check is performed every 300 flying hours or 12 calendar months, whichever occurs first, after a preceding "B" or "C" check, and consists of structural integrity inspections, operation checks, troubleshooting, adjustment procedures, servicing, and visual security and condition of specified structure. A "C" check is performed every 600 flying hours or 36 calendar months, whichever occurs first, after the preceding "C" check and consists of the same types of inspection performed in the "B" check, but those inspection are performed in greater detail. In addition, the "C" check includes structural inspection.

IPG-182 lists the following additional USAF T.Os. to be used in when performing inspection and maintenance: 1C-130A-3 (*Structural Repair Instructions*), 1C-130A-23 (*System Peculiar Corrosion Control*), and 1C-130A-36 (*Nondestructive Inspection Procedures*). At the time of the accident, the most recent revision of the TCDS, revision 4, had not been updated to included the *IPG-182* or the additional maintenance manuals called out in the *IPG-182*.

9.3 HAWKINS AND POWERS C-130A CENTER WING INSPECTIONS

General visual inspection of the wings occur at every check and a detailed visual inspection is performed every "C" check in accordance with eth H&P HP-C-130A *Inspection Guide*; however, no detailed non-destructive inspections of the wings are covered in "A", "B", "C" checks of the H&P HP-C-130A *Inspection Guide*. Inspections for the wings are cover under zonal inspections 500 (left wing) and 600 (right wing). Twelve separate detailed center wing inspections are called out in the Section III *Structural Inspection Program* of *IPG-182* and in the H&P HP-C-130A *Inspection Guide* with an inspection frequency of 2,400 flight hours or 48 months depending on the specific inspection (Attachment 26).

The origin of the fatigue cracks found in the lower surface skin panel were determined to be beneath the forward doubler at CWS 53R at the stringers 16 and 17 location. These cracks not only propagated past the area where they would have been covered by the doubler but they also propagated into the stringers beneath the doubler and across the lap joint between the middle skin panel and the forward skin panel. Review of the *IPG-182* manual and the USAF T.O. 1C-130A-36[23] found that there was no unique inspection requirement for cracks in the fastener holes beneath the doublers located at either CWS 53L or 53R; however, several tasks were identified in both documents that provide crack inspection instructions in the general area of those doublers. Inspections CW 11 and CW 21 in USAF T.O. 1C-130A-36 call for inspections of the skin panels, stringers, and lap joints. Inspection CW 11 entitled *ALL SKIN PANELS SEAMS, UPPER AND LOWER, CWS 220 LEFT T.O. CWS 220 RIGHT* calls for an initial visual crack inspection using a mirror and flashlight and a confirmatory inspection if cracks are suspected using a Fluorescent Penetrant Inspection (FPI) technique (Attachment 27). CW 21 entitled *CENTER WING LOWER SKIN PANEL LAP JOINTS, CWS 220 T.O. 220 L/R* calls for an eddy current of the fastener holes in the skin lap areas with the fasteners still installed and a backup of a visual or FPI if a crack is suspected. According to the CW 21 crack inspection requirements, if a doubler exists[24], a scan around the edges is called out for any cracks emanating in the covered wing panel. Figure 4-21 of CW 21 provides an illustration of the doubler and instructions for additional inspections of the stringers and skin

[23] T.O. 1C-130A-36 basic issue date of 1 December 1984, change 33 dated 30 January 2000.

[24] T.O. 1C-130A-36 manual used by H&P covers the C-130 models A through E. The C-130 models B through E had the doublers installed only outboard of BL 61L and 61R. The C-130J has no lower skin doublers at all. Lockheed issued SB 382-57-55 & 82-557 on February 27, 1985, to remove the doublers from the center wing lower surface CWS 62 to CWS 68 Left/Right for the 130B/E model aircrafts. The USAF followed the Lockheed SB with T.O. 1C-130-1256, dated 9 April 1987, directing the same requirements outlined in the SBs.

panels if cracks are detected. Inspection CW 21 is specifically called out in section III of *IPG-182*, wings zonal 500 & 600, as inspection No. 5 (Attachment 28) while CW 11 is not. However, parts of the CW 11 inspection, such as a visual inspection of interior and exterior center wing box beam lower surface panels from BL 61L to 61R, are incorporated into the wings zonal 500 & 600 inspection No. 8 but not all, such as inspection of the stringers.

Further review of USAF T.O. 1C-130A-36 manual revealed an inspection, CW 30, that calls out a crack inspection in the fastener holes for the doublers located outboard of CWS 61 (Attachment 29). Remember, for the C-130A model only, there are a set of two doublers on either side of BL 61L and 61R. Inspection CW 30 entitled *CENTER WING LOWER SURFACE PANELS UNDER DOUBLERS CWS 61.5 T.O. 80 L/R*, provides a detailed preliminary nondestructive inspection (NDI) of the lower skin doubler with the doubler still installed using a portable x-ray unit. If cracks are detected using the x-ray the doubler is removed and a back up eddy current inspection is performed. The outboard doubler inspection called for in CW 30 is not included in the set of center wings inspection called out in *IPG-182*.

9.4 LOCKHEED L-382 CENTER WING INSPECTION

The inspection of the skin panel in the area of the external doubler is called out in USAF T.O. 1C-130A-36, CW 30, an x-ray inspection procedure for cracks eminating from the stringer attachment fasteners holes. The Lockheed L-382 center wing, although different in many aspects from the C-130A center wing, does have doublers installed on the lower skin, but only outboard of BL 61. The Lockheed procedure calls for an primary x-ray inspection and a backup eddy current inspection if cracks are suspected because of the x-ray. In both the case of the C-130A and the L-382, the doublers are left installed during the x-ray and, if a crack is detected during the primary inspection, a backup eddy current inspection with the doubler removed is then performed.

10.0 AIRPLANE MAINTENANCE RECORDS FOR C-130A, SN 56-0538

10.1 USAF & LOCKHEED CENTER WING INSPECTION RECORDS

On October 30, 1967, a center wing inspection was completed in accordance with time compliance technical orders (TCTO) 1C-130-798. No additional information was recorded on the Technical Instruction compliance record sheet to indicate the findings of the inspection. On September 9, 1981, a lower center wing corrosion inspection was completed in accordance with TCTO 1C-130-1070. Similar to the previous center wing inspection, no additional information was recorded to indicate the findings of the inspection.

According to USAF maintenance and contract documents, the center wing of SN 56-0538 was refurbished between the years 1983 and 1984. According to airplane induction paperwork, airplane SN 56-0538 arrived at Aero Corporation located in Lake City, Florida on May 3, 1983 for basic Programmed Depot Maintenance (PDM) inspection and a center wing rehabilitation under contract F0903-80-C-1227. The airplane and the center wing had accumulated 18,624.4 flight hours when inducted at Aero Corporation. The center wing was rehabilitated and installed by Aero Corporation on March 7, 1984 (Attachment 30). The Safety Board was unable to find any documentation indicating that

SN 56-0538 had ever had another center wing other than the one discussed above. Thus, at the time of the accident, the total time on the center wing since rehabilitation was 3,239 flight hours.

10.2 HAWKINS & POWERS AIRPLANE RECORDS

At the time of the accident, T130 had accumulated 21,863 hours time since new (TSN), 45 flight hour since last "A" check, 168 flight hours since last "B" check, and 462 flight hours since last "C" check. The last "A", "B", and "C" checks were all performed by H&P and the inspections were completed on June 2, 2002 (Work Order (WO) 15111), September 1, 2001 (WO 13311C), and March 8, 2001 (WO 11027C), respectively. The total aircraft flight time at the last "A", "B", and "C" checks were 21,818 hours, 21,695 hours, and 21,401 hours respectively. According to the aircraft Logbook for SN 56-0538, the last detailed 2,400 hour inspection (WO 96-0030) was completed as part of the June 21, 1996 "C" check (WO 96-0035). The total airplane flight time at this "C" check was 20,417 flight hours (Attachment 31).

10.3 HAWKINS & POWERS WING INSPECTION AND REPAIR RECORDS

In section 9.3 of this report, *Hawkins and Powers C-130A Center Wing Inspections*, the detailed center wing inspections were discussed. The inspection frequency of the center wing from the *Structural Inspection Program* (SIP) section of *IPG-182* was stated to be either 2,400 flight hours or 48 months depending on the specific inspection (See Attachment 26). Inspection No. 5, sheet 13, that corresponded to T.O. 1C-130A-36 CW 21 entitled *CENTER WING LOWER SKIN PANEL LAP JOINTS, CWS 220 T.O. 220 L/R,* provides the overall inspection of the center wing lower surface. The frequency for this inspection is every 2,400 flight hours. Since the center wing rehabilitation was performed when the airplane total time was 18,624 flight hours, this inspection (Inspection No. 5, sheet 13) was due when the airplane had accumulated 21,024 flight hours. H&P maintenance records indicated that the center wing inspection was performed in December 1999, WO 8080 (Attachment 32), when the airplane had accumulated 21,090 flight hours. No defects were recorded on either the H&P signoff sheet or on the nondestructive testing sheet. Review of the airplane logbook indicated that the last two "C" inspections occurred in April 1999 and March 2001. The Safety Board could find no paperwork to link the center wing inspection to any particular "C" check or special inspection; however, the aircraft log book did indicate that the two center wing repairs were performed, WO 8005C. Details of the repairs are provided in the following paragraphs.

H&P's maintenance records indicate that the left hand outer wing was removed and replaced with a rehabilitated wing. According to the H&P's Work Order (WO) 4487, dated May 20, 1998, the left hand outer wing, SN 3093, was removed and replaced with a rehabilitated outer wing SN 3096L during a "C" check (Attachment 33). The total aircraft flight time on T130 was 20,762 flight hours when the rehabilitated left hand outer wing was installed. The USAF's AFTO Form 95 shows that the outer wing SN 3096L was rehabilitated by Hayes International Corporation, Birmingham, Alabama, on December 6, 1985 and was previously installed by Aero Corporation, Lake City, Florida on C-130A, SN 57-0459 (Attachment 33).

Review of the H&P maintenance records for documentation of the doubler repairs discussed in section 2.1 *Doubler at CWS 61L Lower Skin* and section 2.3 *No. 2 Engine Drag Angle Location CWS 213L* revealed that both repairs were performed in April 2000 based on cracks found during a "C" check, WO 8005C. The doubler repair in the drag angle location at CWS 213L and the lower skin repair at BL 61L were performed in accordance with approved FAA data on FAA Form 8110-3 *Statement of Compliance* with the Federation Aviation Regulations, identification number EO031000HP1230BH and EO032000HP1700BH, respectively. The airplane had accumulated 20,891 flight hours when these two "C" checks and the repairs were performed. Again, the center wing was not inspected in accordance with the SIP because the airplane flight time had not reached the scheduled center wing inspection due time.

According to the H&P's WO 11027C, dated March 8, 2001, the right hand outer wing, SN 3224, was removed and replaced with a rehabilitated outer wing SN 3095R during the last "C" check of T130 before the accident (Attachment 34). The total aircraft flight time on T130 was 21,401 flight hours when the rehabilitated right hand outer wing was installed. The USAF's AFTO Form 95 shows that the outer wing SN 3095R was both rehabilitated by Hayes International Corporation, Birmingham, Alabama, on December 6, 1985 and were previously installed by Aero Corporation, Lake City, Florida on C-130A, SN 57-0459 (Attachment 34).

10.2 FAA SERVICE DIFFICULTY REPORTS

A review of the FAA's Service Difficulty Report (SDR) data base for Lockheed C-130A airplanes revealed that one SDR was submitted for N130HP back in April 1998. The reported structural difficulty was two chordwise cracks found in the lower skin at the outer wing station 33. No other SDRs were submitted for N130HP and none of the submitted C-130A SDRs documented a previous history of center wing lower surface cracking.

In an internal USFS letter, dated May 21, 1998, the USFS was informed of the cracks found in the outer wing (the one described in the above mentioned SDR report) during a USFS site visit to H&P on April 27 – 28, 1998. The letter stated that H&P had notified other Forest Service C-130A contractors and another C-130A operator of the defect, as well as the FAA so that other operators of C-130A aircraft could be notified. The letter goes on to state that all Forest Service and Department of Interior inspectors would be made aware of the defect found and the approved repair performed.

10.3 USFS AVIATION MISHAP INFORMATION SYSTEM

The Aviation Management part of the Forest Service has developed a reporting system called the Aviation Mishap Information System (AMIS) which is an electronic data base encompassing all aspects of aviation mishap reporting within the Forest Service. Categories of reports include aircraft mishaps, aviation hazards, aircraft maintenance deficiencies, and airspace intrusions. The system uses the SAFECOM (Safety Communiqué) form to report any condition, observance, act, maintenance problem, or circumstance, which has potential to cause an aviation-related mishap. The Department of Interior (DOI) and the Forest Service both use this common reporting form for incident, hazard, and maintenance deficiency reporting. A review of the SAFECOM for C-130A airplane between January 1, 1988 to June 17, 2001 revealed a total of 11 SafeComs with two for N130HP. None of the SAFECOMs for either

N130HP or the other C-130As were directly or indirectly related to any safety issues regarding the wings or any damage to the wings.

11.0 POWERPLANTS MAINTENANCE RECORDS FOR C-130A, SN 56-0538

11.1 ENGINES

Table 4 provides maintenance history for the four Allison T56A-9D engines. Maintenance checks "A", "B", and "C" are performed every 50 hours/21 days, 300 hours/36 months, and 600 hours/48 months, respectively.

TABLE 4: ENGINE MAINTENANCE INFORMATION

	ENGINE 1	ENGINE 2	ENGINE 3	ENGINE 4
SERIAL NUMBER	AE100843	AE101504	AE101267	A100814
PART NUMBER	6846583	6897151	6897151	6897151
TOTAL TIME SINCE NEW (TSN) - HOURS	10,090.76	9,933.83	10,875.03	Unknown
TIME SINCE OVERHAUL (TSO) - HOURS	1,747.56	3,792.83	2,420.03	2,603.03
DATE INSTALLED ON N130HP	**4/20/1994**	**7/21/2000**	**9/13/1996**	**4/8/2002**
TSN WHEN INSTALLED ON N130HP	8,887	9,289.96	9,618.8	Unknown
TSO WHEN INSTALLED ON N130HP	545.4	3,148.96	1,163.8	2,500
DATE LAST "C" CHECK	**4/15/1999**	**3/8/2001**	**3/8/2001**	**4/8/2002**
ENGINE TSN AT LAST "C" CHECK	9,594.91	9,598.77	10,385.68	Unknown
ENGINE TSO AT LAST "C" CHECK	1,253.31	3,331.08	1,952.73	2,500
DATE LAST "B" CHECK	**9/1/2001**	**9/1/2001**	**9/1/2001**	**N/A**
ENGINE TSN AT LAST "B" CHECK	9,921.69	9,893.05	10,679.96	-
ENGINE TSO AT LAST "B" CHECK	1,580.09	3,625.36	2,247.01	-
DATE LAST "A" CHECK	**6/2/2002**	**6/2/2002**	**6/2/2002**	**6/2/2002**
ENGINE TSN AT LAST "A" CHECK	10,044.82	10,016.18	10,842.84	Unknown
ENGINE TSO AT LAST "A" CHECK	1,703.22	3,748.49	2,375.69	2,558.69
DATE LAST MAINTENANCE	**9/17/1999**	**3/29/2002**	**3/29/2002**	**4/12/2002**
ENGINE TSN AT LAST MAINTENANCE	9,824.37	9,830.8	10,772	Unknown
ENGINE TSO AT LAST MAINTENANCE	1,482.77	3,677.65	2,304.85	2,500
LAST MAINTENANCE PROVIDER	H&P	H&P	H&P	H&P

11.2 PROPELLER

Table 5 provides maintenance history for the four Hamilton Standard model 54H60-91 propellers. Maintenance checks "A", "B", and "C" are performed every 50 hours/21 days, 300 hours/36 months, and 600 hours/48 months, respectively.

TABLE 5: PROPELLER ASSEMBLY MAINTENANCE INFORMATION

	PROPELLER 1	PROPELLER 2	PROPELLER 3	PROPELLER 4
SERIAL NUMBER – HUB	N232783	N222259	N231490	N239471
TIME SINCE OVERHAUL (TSO) – HOURS	2,075.58	2,373.77	3,976.35	2,110.99
DATE INSTALLED ON N130HP	**11/12/2002**	**7/22/2000**	**10/25/2000**	**1/22/2002**
TSO WHEN INSTALLED ON N130HP	1,937.1	1,795.77	3,512.8	1,978.38
DATE LAST "C" CHECK	**7/26/2000**	**3/8/2001**	**3/8/2001**	**6/4/2001**
ENGINE TSO AT LAST "C" CHECK	1,804.39	2,012.02	3,729.05	1,894.57
DATE LAST "B" CHECK	**7/20/2000**	**9/1/2001**	**9/1/2001**	**7/29/1999**
ENGINE TSO AT LAST "B" CHECK	1,769.82	2,306.3	4,023.33	1,511.7
DATE LAST "A" CHECK	**6/2/2002**	**6/2/2002**	**6/2/2002**	**6/2/2002**
ENGINE TSO AT LAST "A" CHECK	2,034.51	2,332.7	3,935.28	2,062.1
DATE LAST MAINTENANCE	**1/22/2002**	**3/20/2001**	**10/19/2000**	**8/12/2000**
ENGINE TSO AT LAST MAINTENANCE	1,937.1	2,038.22	3,512.8	1,786.27
LAST MAINTENANCE PROVIDER	H&P	H&P	H&P	H&P
LAST OVERHAUL DATE (MON/YR)	10/1987	8/1984	12/1997	2/1985

12.0 C-130A CERTIFICATION, AIRWORTHINESS & MAINTENANCE ISSUES

In 1991, during inspections into the operation of large surplus United States military aircraft certificated in the restricted category, the FAA discovered that some confusion existed as to under what circumstances persons or property may be carried. The FAA addressed this issued with a letter to the United States Department of Agriculture (USDA), dated July 1, 1991, in which the letter outlined the operating limitation of restricted category aircraft, but the letter went on to address airworthiness standards as well by stating that:

> Because of the special nature of the intended use of the restricted category civil aircraft, their airworthiness certification standards are not designed to provide the same level of safety that is required for aircraft certificated under standard category airworthiness standards.

As it pertains to the certification of aircraft, category means a grouping of aircraft based upon intended use or operating limitations, for example: transport, normal, utility, acrobatic, limited, restricted, and provisional. The Federal Aviation Regulations (FARs) provide airworthiness standards for normal, utility, acrobatic and commuter under Part 23, and airworthiness standards for transport category aircraft under Part 25 but no such airworthiness standards exists in the FARs for restricted category aircraft.

During a 1991 contract pre-aware on-site evaluation of T&G Aviation Inc., the DOI's Office of Aircraft Services (OAS) inspectors identified inadequacies with the certification, maintenance, and use of Lockheed C-130A airplanes and was concerned that the identified problems may extend throughout the airtanker industry. The OAS inspectors found that the FAA had certified for civilian use a T&G C-130A aircraft after its military inspection program requirement had lapsed, which the OAS inspectors felt was in conflict with the TCDS requirement of compliance with all T.O.s. Additional research into the military and FAA records for other Forest Service carded airtankers conducted by the OAS investigators revealed that other airtankers, including the H&P N130HP, had been certified without the aircraft complying with all the T.O.s that affect airworthiness, just as the T&G aircraft. On March 26, 1992, an internal memorandum from the DOI's Alaskan Regional Director of the OAS in Anchorage to the DOI's Director of the OAS in Boise, Idaho provided the details of the T&G site visit plus it included the following concerns (Attachment 35):

> Our experience with the C-130A and the varying approaches to maintenance and the various FAA-approved programs leave us questioning the aircraft's current airworthiness. Our reviews have involved discussions with both military and civilian personnel knowledgeable in the operation of this aircraft. They advised us against using these aircraft without the proper inspections and maintenance being performed. This included the PDM, (depot level) inspection and maintenance as well as adherence to life-limited and/or calendar maintenance requirements. Along with the Alaska Fire Service we have elected not to renew T&G's contract during the Government's option period; therefore averting a dispute.
>
> Our concern manifests itself in whether the airtanker industry can furnish the Government the level of maintenance required for this type aircraft. Our findings in the cited examples leave us questioning the safety of our joint use of these aircraft.
>
> The position of both Chiefs, Division of Technical Services, is that C-130A aircraft not be operated for the Department of the Interior (DOI) beyond an inspection, or component overhaul/replacement requirement identified in that aircraft's military maintenance program. The basis for their position is supported and shared by the U.S. Air Force's C-130 System Program Engineers from Robins Air Force Base. They advised against using these aircraft if beyond an inspection or maintenance requirement.
>
> As part of the March 26, 1992 internal memorandum, OAS recommended the following:
>
> 1. Notify the FAA of our findings and solicit their assistance in resolving what would appear to be airworthiness problem. Their assistance should also focus in on the varying approaches to maintenance for this type aircraft and provide some standardization among operators.
>
> 2. The DOI's use of these C-130A aircraft should be based upon an inspection and maintenance program that incorporates all the inspection life-limited component overhauls/replacement and maintenance requirement for continued airworthiness. This should be based either upon the Lockheed L-382 or the U.S. Air Force maintenance programs. Suggest similar requirements be required of all surplus military aircraft, such as the OV-1O and C-23.
>
> 3. Notify the U.S. Forest Service of our findings and request that they support these recommendations.

DOI solicited the FAA's assistance in resolving the C-130A certification and maintenance issues addressed in the internal DOI memorandum discussed above. FAA personal from the Aircraft Certification Service (AIR) and Flight Standards Service (AFS), along with National Aviation Safety

Inspection Program (NASIP) members, meet to review DOI's C-130A concerns and on October 26, 1992, the FAA sent a reply letter stating that they felt that in the case of the T&G C-130A, that the aircraft records were sufficient for certification and that standardized maintenance program for the C-130A airplane was not practical and that in some cases might degrade the level of safety rather than improved it based on different operating requirements and environments (Attachment 36).

An internal DOI information paper written some time after the FAA's response to DOI's request for assistance (no date on the information paper), continues to raise the issue of what is the minimum and acceptable certification and maintenance requirements for C-130A aircraft (Attachment 37). The following excerpts from the information letter convey the DOI's concerns and recommendations:

> There is less than universal agreement on what constitutes required maintenance of C-130A surplus military aircraft. The basis of the confusion appears to be a) a lack of common and continuous interpretation of the language provided in the Note portion of the Type Certificate, and b) a process that does not require critical PDM items to be accomplished in a civilian operating environment.
>
> In summary, it appears the current C-130A surplus military aircraft maintenance standards to which commercial operators are being held are not equivalent to <u>minimum essential</u> PDM inspection items and TBO items necessary to sustain an aircraft in an airworthiness condition regardless of the flight environment in which the aircraft is operated. The program should be systematized to ensure a level of inspection and maintenance consistent with operating requirements.

On January 14, 1993, representatives from the FAA and the DOI met to discuss C-130A certification and maintenance issues. Stemming from this meeting, several action items were suggested to enhance the FAA certification and inspection program of C-130A aircraft (Attachment 38). Each action item was assigned a time frame for completion – immediate (1- 3 months), medium (3-9 months), long (9-18 months), and ongoing (continuous). The suggested action items and completion times (in parenthesis) were as follows:

- Aircraft Certification Service (AIR) will ensure future issuances of TCDS clearly define what USAF T.O.s are applicable (medium /ongoing)
- Maintain close AFS/AIR coordination on the certification and inspection program approval of surplus military aircraft (immediate/ongoing)
- Flight Standards should issue an Advisory Circular specific to C-130A inspection program approval requirements (long)
- AIR should establish an USAF/FAA liaison relationship for C-130A airworthiness necessary to establish a "core" list of T.O.s of the Programmed Depot Maintenance (PDM) inspection items (immediate/ongoing)
- Flight Standards should issue a bulletin to FAA Field Offices on approval of C-130A inspection programs to ensure that the minimum "core" items are incorporated (immediate)
- AIR should issue Airworthiness Directive specific to the C-130A as appropriate (ongoing)

Action item No. 5 tasked Flight Standards to issue a bulletin to FAA field offices on approval of C-130A inspection programs to ensure that the minimum "core" items of the PDM are incorporated. Warner Robins Aviation Logistic Center (WR-ALC) PDM provided the DOI's OAS a list of the "core" tasks which the USAF felt were required to maintain the airworthiness of the C-130A aircraft (Attachment 39). FAA's AFS-510 issued a briefing paper on February 11, 1993, discussing the regulatory requirements for incorporation of these "core" inspection items. The FAA recognizes that the issue of how the FAA will be informed of future revisions or changes to the "core" inspection items must still be addressed but no specific solutions were identified (Attachment 40).

In a memorandum, dated February 26, 1993, from the OAS Deputy Director to the OAS Director, options were discussed on how to handle the concerns regarding C-130A PDM inspection requirements and the FAA's proposed corrective actions. The memorandum proposes that a policy be issued that **no** C-130A airtankers will be dispatched on DOI fires, pending compliance with new FAA directives pertaining to "core" PDM inspection and time change items, and that the C-130A airtanker issues should be elevated to the Secretaries of the Interior and Agriculture level to resolve the problems associated with interagency standards (Attachment 41).

In a memorandum from the DOI Director of Program Services to Directors of the Bureau of Land Management, Fish & Wildlife Service, National Park Service, and the Assistant Commissioner for Indian Affairs, dated May 10, 1993, concerns over C-130A maintenance and inspection were highlighted and brought to the attention of the FAA, the Department of Justice (DOJ), and the Forest Service, well as several other bureaus within the DOI. Although the Forest Service had activated early the contract with Hemet Valley to provide C-130A airtanker services, the DOI believed

> … that the risks associated with the use of current fleet of C-130A aircraft are too great to allow use in association with the Department of the Interior wildlife suppression activates, not withstanding the Federal Aviation Administration's issuance of airworthiness certificates. Thus, until further notice, use of C-130A airtankers on Fires on Department of the Interior lands being managed by a Department of Interior agency is prohibited. No employees of the Department of the Interior nor its bureaus shall dispatch any C-130A airtankers, regardless of the location of the fire or the agency managing the fire. (Attachment 42).

On May 20, 1993, WR-ALC sent a letter to the FAA outlining the C-130A integrated maintenance plan that the USAF uses to ensure the airworthiness of the aircraft (Attachment 43). In this letter, the USAF stated that the PDM interval was every 12 months ± 3months and that:

> We [USAF] strongly recommend that those C-130A aircraft that are operated in civilian use, under the rules and regulations of the FAA, be required to accomplish the entire C-130A maintenance plan, which includes PDM, to assure the continued airworthiness of the aircraft.

The FAA, DOI, USFS, USAF, FAA, and the DOJ all meet on May 14, 1993, to discuss the concerns as to the airworthiness of C-130A surplus military aircraft. The FAA during the meeting agreed to evaluate the requirements of the FAA-approved inspection programs for the C-130A aircraft under Part 91 of the FAR and compare those requirements to the military technical publications and a summary report following the evaluation. After the meeting, the FAA wrote a letter to the DOI Director of Program Service, dated May 28, 1993, outlining what the FAA intended to do in addressing the concerns of the DOI. Included with this letter was the FAA's action plan which included additional items beyond what was recommended by the FAA back in January 1993 such as establishing a working group to evaluate the C-130A maintenance program and to make revisions to the C-130A TCDS if necessary (Attachment 44).

On May 28, 1993, the DOI Director of Program Services issued a memorandum to rescind the policy issued on May 10, 1993 prohibiting the use of C-130A airtankers on fires on DOI lands being managed by a DOI agency. The DOI resided the prohibition for use of C-130A airplanes based on the FAA's action plan and the FAA's opinion that the C-130A airworthiness certification would remain in effect as long as the maintenance and alternation are properly performed by the operators as set forth in the FAR (Attachment 45).

On June 14, 1993, the Flight Standard National Field Office (AFS-500) sponsored a joint C-130 AFS and AIR working group (Attachment 46).[25] The working group, which consisted of the PMI for each of the four operators, safety inspectors for the Atlanta FSDO, and representatives from AFS-300 and AFS-500, convened to provide the following:

- Guidance to be used in approving inspection programs submitted in accordance with 14 CFR Part 91.409(f)(4) of the FAR for C-130A aircraft.
- Recommendations to the AIR concerning what, if any, ADs should be issued for the C-130A aircraft, engines, and/or propellers.
- Recommendations to AIR concerning what, if any, revisions to the C-130A TCDS
- Review existing approved inspection programs of the C-130A aircraft and recommend to the PMI what revisions are needed for continued adequacy of the program provided by 14 CFR Part 91.415(a) of the FAR.

Also, priority was to be given to corresponding with the applicable C-130A operator regarding any revisions that are need to its inspection program and a review of the ramp and records inspections shall be accomplished to access the impact of any changes that have to be made to the operator's inspection program.

During early August[26], the FAA released a joint AFS and AIR C-130A airworthiness working group report to provide recommendations in accordance with previously outlined FAA action plan task items in Attachment 46 entitled *Issues Raised Concerning Aircraft Airworthiness* (Attachment 47). Sixteen recommendations were proposed by the FAA on such C-130A specific topics as guidance for approving inspection programs submitted in accordance with 14 CFR Part 91.409, for issuance of ADs on what life limited parts should be designated, and changes to be made to the TCDS. Furthermore, three additional recommendations were proposed that were not C-130A specific but dealt with such topics as reevaluating assigned principle inspectors job for continued surveillance of large, multiengine, turbine powered aircraft; prior to issuing any TC for surplus military aircraft, determine the applicably of any AD and establish instructions for continued airworthiness; and establish procedures between the Department of Defense (DOD) and FAA for exchange of data concerning surplus military aircraft.

On August 12, 1993, the FAA issued a short and long term action plan outlining the tasks to be taken by the Joint Flight Standards and AIR Working Group to address the recommendations received from the C-130A inspection working group (Attachment 48). The short term actions were made up of a

[25] Although this document has no date, other documents (Attachments 47, 48, and 49) refer to the entitled meeting.
[26] Although the document has no date, another FAA document, dated August 12, 1993 (Attachment 48) indicates that this meeting was on August 9, 1993.

series of meeting between the representatives of the AFS, AIR, DOI, Forest Service, operators of the C-130A, and the Aerial Firefighting Industry Association to discuss the implementation of the PDM "core" requirements and their resulting impact to the operators: the execution of the implementation schedule for the PDM "core" items prior to September 15, 1993 and tracking of it incorporation; review ADs issued for the civil version of the C-130, the L-382, to determine their applicability to the C-130A; and to review time compliance technical orders (TCTO) issued by the USAF since the C-130A was TC in 1988 for possible issuance of ADs.

On August 23, 1993, representatives from the FAA, USAF, Forest Service, and C-130A operators attended a FAA-sponsored C-130 airworthiness meeting held at AFS-500 at Dulles Virginia. Attachment 49 is a recap of the meets minutes taken at this August 23, 1993 meeting by Reston Support Services, Inc. The various participating parties voiced their concerns and opinions relating to the continued airworthiness of the C-130A. According to the minutes of the meeting, AFS-500 was concerned that there were a number of ex-military C-130As in a variety of civilian uses but no standardized inspection program and no continuing airworthiness program. AFS-500 felt it was more important to address the scope of the inspections, what is inspected, rather than on the frequency of those inspection. The minutes also go on to reflect the USAF (WR-ALC) concerns over the lack of the operators performing the PDM items and that an accident was waiting to happen. AIR-200 stated that the FAA policy was not to go back and requiring testing once a TC has been issued but to correct design problems or safety defects with ADs. Operators of the C-130A expressed their concern of additional inspection requirements that incorporating the PDM "core" items may have on their operations and that the PDM requirements would be put off as long as possible then retire the airplane without complying. The Forest Service disagreed with the USAF position and stated that the current programs appear adequate and that rather than applying new requirements in bits and pieces, that the FAA should apply new standards to all aircraft across the entire industry.

The recommendations that came from the June 14, 1993, Flight Standard National Field Office meeting resulted in several initiatives to clarify, define, and standardize FAA policy as it pertains to the maintenance requirements of restricted category surplus military airplanes. In response to the recommendations, AFS published Flight Standards Information Bulletin for Airworthiness (FSAW) 93-57. FSAW 93-57 clarified AFS policy concerning inspection standards and approval of inspection programs. In addition, AIR undertook several initiatives concerning the C-130A including the establishment of a focal ACO and clarification of FAA policy concerning instructions for continued airworthiness, AD, and life limited parts. With the experience gained from the C-130A, in the early 1990, the FAA issued Flight Standards Handbook Bulletin for Airworthiness (HBAW) 95-13A (Amended), effective date of October 23, 1995, to replace FSAW 93057 and provide a uniform policy concerning the maintenance of all restricted category surplus military airplanes.

HBAW 95-13A states "The inspection frequency and program structure established by the military may not be appropriate for use in a civilian environment. Therefore, inspection frequency and program structure may be adjusted to meet an individual operators requirement." In addition it states that ASIs (Aviation Safety Inspectors) should review existing approved inspection programs to ensure that the scope and detail of the programs provides at least an equivalent level of safety as provided in this bulletin."

13.0 CORRECTIVE ACTION

13.1 FAA AIRWORTHINESS DIRECTIVES

The FAA issued an Airworthiness Directive (AD) 2002-19-14, with an effective date of September 26, 2002, to inspect for fatigue cracking in the center wing lower skin panels and stringers applicable to any Lockheed C-130A airplanes type certificated in the restricted category or any other surplus military C-130A airplanes.

The AD requires inspections of the lower center wing skin panels and stringers between CWS 41L and 71L and CWS 41R and 71R to detect cracks in the fastener holes using a method sufficiently reliable to determine the location and orientation of cracks that are small, perhaps less than 0.010-inches in length. Along with this initial inspection, the AD also required that a repetitive inspection interval be developed to prevent cracks growth from exceeding the minimum residual strength required to support ultimate load on the affected structure and that the repetitive inspection intervals must be based on damage-tolerance assessment of wing panels and stringers. As already mentioned in the Maintenance Program Section, the USAF T.O. 1C-130A-36 "Nondestructive Inspection Manual" calls out a preliminary x-ray inspection of the fastener holes and a back-up eddy current inspection if cracks are suspected when performing the x-ray.

If a crack was detected, the AD allowed the cracked part to be either replaced with a new part or repaired, and in either case, different additional requirements are added. If the part is replaced then the AD requires that the inspection be performed again and if the part is repaired then the repair must include a damage tolerance assessment in addition to an analysis showing static strength capability in compliance with the certification basis of the airplane and to develop a new inspection interval based on the damage-tolerance assessment.

A reporting requirement was also included as part of compliance with AD 2002-19-14. Within 10 days after accomplishing the initial inspection, a report of the inspection results (both positive and negative) was to be submitted to the Manger of the Atlanta ACO. As of the issuance of this report, three operators have developed inspection procedures to detect the cracks like those found on the T130 and have also conducted a damage tolerance analysis in accordance with the requirements of the AD. To date, three C-130As have been inspected and in each case, no cracks were found.

13.2 USAF TIME COMPLIANCE TECHNICAL ORDER

On October 2, 2002, the USAF issued TCTO 1C-130-1830 requiring inspection of C-130A center wing lower skin panels for cracks. The compliance period for the TCTO is no later than 90 days after receipt or before the next flight, which ever may occur first. The TCTO specifies out that all the four center wing lower skin doublers be removed and that a surface scan for cracks be performed using eddy current in the area under and near the removed doublers.

13.3 DEPARTMENT OF AGRICULTURE AND DEPARTMENT OF THE INTERIOR

In response to the Lockheed C-130A accident in Walker California on June 17, 2002, and the Consolidated Vultee P4Y accident on July 18, 2002 in Estes Park, Colorado, the Forest Service and DOI Bureau of Land Management (BLM) jointly established an independent, five-member Blue Ribbon Commission to identify essential information for planning a safe and effective future aviation program. On August 15, 2002, the Chief of the Forest Service and Director of the BLM asked the panel to identify weaknesses and fail points in the current aviation program, focusing on safety, operational effectiveness, costs, sustainability, and strategic guidance. The Blue Ribbon Commission issued their findings in a report released on December 6, 2002. On December 6, 2002, the National Interagency Fire Center (NIFC)[27], which is the nation's support center for wild land firefighting, issued a press release that based on the findings of the Blue Ribbon Commission, the USDA Forest Service and USDOI Bureau of Land Management will no longer contract for the C- 130A or PB4-Y aircraft as airtankers. The agencies will be consulting with the FAA to develop a rigorous inspection and maintenance program for the other models of heavy airtankers to provide a greater margin of safety. Aircraft that pass the inspection and follow the maintenance program will continue to be used.

13.4 OPERATORS/OWNERS

In light of the recent fire fighting airtanker accidents that occurred during the summer of 2002, TBM Inc. and International Air Response have engaged Celeris Aerospace Canada, a scientific/engineering software development and consulting located in Ontario, Canada, to assist them to developing and implementing a Structural Health and Usage Monitoring program for large airtankers engaged in the firebombing role. In December 2002, Celeris Aerospace Canada issued report No. CAC/TR/02-004 outlining the initial and continuing activities tasks that needed to be addressed when implementing such a program.

Celeris Aerospace Canada proposed two short-term recommendations. The first recommendation was to establish the current health of the large airtanker fleet. The proposed approach would identify critical structural locations for each airtanker fleet based on past aircraft history, maintenance, and inspection records and any engineering data that may be available. From this data a fatigue and damage tolerance analysis of these critical structural areas would be used to define the "initial health status" of each airtanker fleet. This information would then be the basis to establish an inspection and maintenance intervals for critical locations of each aircraft type. The second recommendation was to define the actual loads experienced by the airtankers so that safe and realistic operational and inspection/maintenance procedures can be defined. Once the "initial health status" of the individual aircraft has been established, those considered viable to operate will be equipped with a recording system that will monitor the actual loads they experience at critical structural locations. The data gathered from the recording system would be downloaded from each airtanker on preset basis to rapidly identify any unusually harsh or severe usage so that the appropriate maintenance and inspection actions can be implemented immediately and to quantify the actual loads and operating conditions experienced by the airtankers operating in the firefighting role. Over time, this will allow the initially fatigue and damage tolerance assessments of critical structural locations to be refined and realistic inspection and maintenance intervals established. A long term recommendation was also proposed in the Celeris report. They

[27] The seven agencies at NIFC are the Bureau of Land Management, National Park Service, Fish and Wildlife Service, and Bureau of Indian Affairs, all in the Department of the Interior; and the Forest Service, in the Department of Agriculture.

proposed to develop criteria that can be used to evaluate the suitability of future aircraft that may be considered for the firefighting, before them being incorporated into the fleet.

On December 4, 2002, the Aerial Firefighting Industry Association[28] issued a bulletin on their website (www.afia.com) expressing the firefighting industry's plan to address safety issues resulting from a two day special meeting held in October 2002 to address the C-130A and P4Y accidents. Some of the actions that the attendees of this special meeting agreed to undertake are as follows:

- Review current FAA-approved airtanker inspection programs with the assistance of independent non-destructive inspection (NDI) laboratories, structural engineering firms and the FAA, to determine what, if any, changes are required to ensure all critical structural areas are inspected at intervals necessary to ensure safety of flight. Target date for completion is January 1, 2003.
- Explore the use of structural data recording equipment that will allow them to monitor the health of their aircraft on a continuing basis, adjust their maintenance and inspection intervals as appropriate, and signal the need for overstress inspections when severe flight conditions have been encountered.
- Training for flight crews in examining critical structural areas during pre-flight inspections will be reemphasized in company training programs.

Although the Safety Board has only seen the proposal from Celeris Aerospace for TBM and International Air Response, the Safety Board is aware that as part of the actions agreed upon at the December 2002 AFIA meeting, that other airtanker operators are working in cooperation with the Forest Service and Sandia National Laboratories in Albuquerque, New Mexico, on similar programs.

14.0 AIRTANKERS STUDIES

Requests for information to the Forest Service, USAF, Lockheed, and National Aeronautics and Space Administration (NASA) on any testing of the C-130A relating to the fire fighting mission turned-up no findings. However, the Safety Board did find studies performed in the early 1970s by NASA on the Lockheed P2V and the Douglas DC-6 that examined the effects of the low level firefighting mission on these converted surplus military airplanes plus a Canadian study on civilian Fokker F27 also converted to the firefighting mission. The data for the P2V study was gathered by NASA and analyzed by an independent aviation firm. The results of the P2V study indicated that no adverse effects to the airframe structure due to the tank installation and the mission flown. The data for the DC-6 study (NASA Report number TM X-72622, dated November 1974) was both gathered and analyzed by NASA and drew conclusions that indicated that, unlike the P2V study, that the firefighting mission did impact the structural life of the airplane. The report concluded that: "The severity of maneuver load applications, in

[28] The Aerial Firefighting Industry Association (AFIA) is a nonprofit trade association organized for promoting and advancing the common interests and welfare of companies engaged in forest and wildland firefighting utilizing multi-engine airtankers, heli-tankers, and single engine airtankers. Association membership includes nine multi-engine airtanker companies, two heavy lift heli-tanker companies, two single engine airtanker (SEATS) company, and six sustaining members. AFIA activities involve communicating, educating, and representing industry interests to federal and state firefighting agencies and Congressional staffs, and coordinating the two-way dissemination of information to improve the safety and effectiveness of airtanker operations.

both magnitude and frequency of occurrence, is such that significant shortening of the structural life of the aircraft should be expected."

In the 1990's Conair Aviation LTD[29], Abbotsford, British Columbia, Canada analyzed the F27 Firefighting aircraft as part of the Canadian Airworthiness Manual Chapter 511.609, Instruction for Continued Airworthiness. Conair Aviation's Supplemental Structural Inspection Document (SSID)-535 provided the results of a Fokker F27 Firefighter aircraft in the firefighting mission evaluation.[30] The SSID-535 stated that:

> The F27 firefighting aircraft operated in a firefighting role is exposed to a harsher loading environment than initially intended for a typical transport role aircraft. The increase severity of the loading environment is accounted for by the introducing a 'Damage Rate Factor' (DRF). The airframe time that the aircraft accumulates in the firefighting role is multiplied by the Damage Rate Factor, thereby increasing the accumulated airframe time compared to a typical transport aircraft… For the F27 Firefighting, the time spent in the firefighting role is 5.7 times more severe that the typical Fokker transport role operation.

Because of these findings, the inspection intervals, limitations, mandatory replacement times, and remaining airframe life limits for the Fokker F27 fire fighting aircraft were modified.

15.0 PUBLIC AIRCRAFT

The accident airtanker, T130, was operating as a "public aircraft" under 14 *Code of Federal Regulations* Part 91. The status of an aircraft as "public" or "civil" depends on its use in government service and the type of operation that the aircraft is conducting at the time. On October 9, 1994, Congress passed the Independent Safety Board Act Amendments, Public Law (P.L.) 103-411, which changed the definition of the term "public aircraft." Title 49 United States Code Section 40102(a)(37) incorporated the changes specified in P.L. 103-411 and reads as follows:

(37) "public aircraft"—

(A) means an aircraft—

(i) used only for the United States Government;

or

(ii) owned and operated (except for commercial purposes), or exclusively leased for at least 90 continuous days, by a government (except the United States Government), including a State, the District of Columbia, or a territory or possession of the United States, or a political subdivision of that government; but

(B) does not include a government-owned aircraft transporting passengers or property for commercial purposes

[29] Conair Aviation, the fixed-wing operations division of Conair Group Inc. is a Canadian operator of a fleet of 40 fixed-wing aircraft specializes in fire management services and products for forest protection agencies.

[30] Firefighting is defined as aircraft operations that occur below 2,000 feet above ground level excluding take-offs and landings. The firefighting segment of the profile constitutes the flight time during which the aircraft is subjected to a harsher loading environment.

On April 19, 1995, the FAA issued Advisor Circular (AC) 00-1.1 entitled *Government Aircraft Operations* to provide guidance on whether particular government aircraft operations are “public” aircraft operations or “civil” aircraft operations under the new statutory definition of “public” aircraft under P.L. 103-411. Within the AC, “Firefighting” operations, which the FAA defines as including dispensing of water or fire retardants on a fire and the transport of firefighters and equipment to a fire or to a base camp from which they would be dispersed to conduct the firefighting activities, would be included as a governmental function and therefore classified as “public” aircraft activity. On December 10, 1988, the accident airplane was issued a Special Airworthiness Certificate for restricted category in accordance with 14 CFR Parts 21.175(b) and 21.185(B) with the “special purpose” of agriculture, forest and wildlife conservation, aerial surveying, and other operation specified by the Administrator. Along with the special purpose listed above, for restricted category airplanes “special purpose” also includes patrolling, weather control and aerial advertising.

On April 5, 2000, Congress passed P.L. 106-181 cited as the “Wendell H. Ford Aviation Investment and Reform Act for the 21st Century” to amended Title 49 United States Code Section 40102(a)(37) to read as follows:

(37) “public aircraft” means any of the following:

(A) Except with respect to an aircraft described in subparagraph (E), an aircraft used only for the United States Government, except as provided in section 40125(b).

(B) An aircraft owned by the Government and operated by any person for purposes related to crew training, equipment development, or demonstration, except as provided in section 40125(b).

(C) An aircraft owned and operated by the government of a State, the District of Columbia, or a territory or possession of the United States or a political subdivision of one of these governments, except as provided in section 40125(b).

(D) An aircraft exclusively leased for at least 90 continuous days by the government of a State, the District of Columbia, or a territory or possession of the United States or a political subdivision of one of these governments, except as provided in section 40125(b).

(E) An aircraft owned or operated by the armed forces or chartered to provide transportation to the armed forces under the conditions specified by section 40125(c).

Title 49 United States Code, Section 40125 reads as follows:

Section 40125: Qualifications for public aircraft status

(a) Definitions. In this section, the following definitions apply:

(1) Commercial purposes. The term “commercial purposes” means the transportation of persons or property for compensation or hire, but does not include the operation of an aircraft by the armed forces for reimbursement when that reimbursement is required by any Federal statute, regulation, or directive, in effect on November 1, 1999, or by one government on behalf of another government under a cost reimbursement agreement if the government on whose behalf the operation is conducted certifies to the Administrator of the Federal Aviation Administration that the operation is necessary to respond to a significant and imminent threat to life or property (including natural resources) and that no service by a private operator is reasonably available to meet the threat.

(2) Governmental function. The term “governmental function” means an activity undertaken by a government, such as national defense, intelligence missions, firefighting, search and

rescue, law enforcement (including transport of prisoners, detainees, and illegal aliens), aeronautical research, or biological or geological resource management.

(3) Qualified non-crewmember. The term "qualified non-crewmember" means an individual, other than a member of the crew, aboard an aircraft--

(A) operated by the armed forces or an intelligence agency of the United States Government; or

(B) whose presence is required to perform, or is associated with the performance of, a governmental function.

(4) Armed forces. The term "armed forces" has the meaning given such term by section 101 of title 10.

(b) Aircraft owned by governments. An aircraft described in subparagraph (A), (B), (C), or (D) of section 40102(a)(37) does not qualify as a public aircraft under such section when the aircraft is used for commercial purposes or to carry an individual other than a crewmember or a qualified non-crewmember.

(c) Aircraft owned or operated by the Armed Forces.

(1) In general. Subject to paragraph (2), an aircraft described in section 40102(a)(37)(E) qualifies as a public aircraft if--

(A) the aircraft is operated in accordance with title 10;

(B) the aircraft is operated in the performance of a governmental function under title 14, 31, 32, or 50 and the aircraft is not used for commercial purposes; or

(C) the aircraft is chartered to provide transportation to the armed forces and the Secretary of Defense (or the Secretary of the Department in which the Coast Guard is operating) designates the operation of the aircraft as being required in the national interest.

(2) Limitation. An aircraft that meets the criteria set forth in paragraph (1) and that is owned or operated by the National Guard of a State, the District of Columbia, or any territory or possession of the United States, qualifies as a public aircraft only to the extent that it is operated under the direct control of the Department of Defense.

The FAA issued a Joint Flight Standards Handbook Bulletin for Airworthiness (HBAW), Air Transportation (HBAT), and General Aviation (HBGA), bulletin numbers HBAW 95-04, HBAT 95-06, and HBGA 95-02 entitled *Government Aircraft Operations; Public Aircraft Operations Versus Civil Aircraft Operations* in June 1995. The purpose of the handbook bulletins was to provide information and guidance to be used by FAA ASIs when working with government-owned aircraft operators. The bulletin states "FSDO managers must ensure that a site visit is held with each governmental agency in their geographical area….Additionally, the FSDO's should provide the maximum assistance and advice to agencies which, while conducting public aircraft operations, desire to operate in accordance with the FAR." In terms of surveillance, the bulletins states that

> Government-owned aircraft operators, holding any type of FAA certification, will be included in the normal surveillance activities such as, spot inspections of the aircraft and aircraft records. This includes any aircraft exclusively leased to the Federal government. Any aircraft or operation certified by the FAA is subject to this surveillance regardless of whether they are operating as "public or civil." For example, if an operator's operation is considered "public" and they hold an airworthiness certificate, their maintenance records are eligible for review.

> Government-owned aircraft operators who are conducting public aircraft operations must be included in the FSDO's annual planned surveillance actives to ensure that their status remains unchanged.

The surveillance guidance and responsibility provided in the above listed aviation safety inspector bulletins is provided in the following inspector handbooks: 1) Order 8400.10 *Air Transportation Operations Inspector's Handbook* in Chapter 4 Section 8 entitled *Public Aircraft Operations* under paragraph 267 *Government Aircraft operator Surveillance* and 2) Order 8700.10 *General Aviation Operation Inspector's Handbook* in Chapter 47 entitles *Issue a Certificate of Waiver for Restricted Category Civil Aircraft* Section 1 paragraph 7 *Surveillance Activities*.

16.0 INSPECTION AND OVERSIGHT OF PUBLIC AIRCRAFT – FOREST SERVICE, FAA, GSA

16.1 INTERAGENCY AVIATION INSPECTION STUDY

Under the Federal Crop Insurance Reform and Department of Agriculture Reorganization Act of 1994 (Section 306 of Public Law 103-354), Congress mandated the Secretaries of Agriculture and Transportation to study and report to Congress perceived duplication of aviation inspections between the USDA and the FAA and cost effectiveness or eliminating or reducing those inspections. To accomplish this, the Act mandated that a joint USDA and Department of Transportation (DOT) study be conducted of

> "the inspection specifications and procedures by which aircraft and pilots contracted by the Department are certified to determine the cost efficiencies of eliminating duplicative Department inspection requirements and transferring some or all inspection requirements to the Federal Aviation Administration, while ensuring that neither aircraft, nor pilot safety is reduced and that mission preparedness is maintained."

In May 1995, the USDA and the DOT issued *Interagency Aviation Inspection: A joint USDA/DOT Study* to present to Congress their findings and recommendations. One of the objectives of the study was to determine if and how the FAA might assume some or all responsibility for performing inspection of USDA contractee to USDA standards and provide recommendations for consideration.

The study noted that both the USDA and FAA currently have responsibilities for inspecting aviation activities but that their missions differed. The USDA inspections are limited to contractees and are focused on contract compliance while the FAA inspections are focused on compliance with the FARs. Another difference noted was between the FAA's and USFS's inspection requirements. The FAA's National Program Guidelines (NPG) for FSDO inspectors outlines minimum aircraft inspections, including ramp inspections or spot inspections for a certain percentage of operators that hold 14 CFR Part 137 operating certificates; however, for those operators with no operating certificate and operate under 14 CFR 91, the NPC prescribes no minimum level of coverage. The FAA's minimum allowable level of coverage contrast with the USDS's contract inspection requirements in that the USDA inspects all contractee aircraft annually, regardless of the operating certificate or lack of certificate the operate may hold.

The study looked at several different alternatives to the current status quo, one including that the FAA assume all USDA contract inspecting responsibilities. The study concluded that the status quo was the only alternative that fully satisfied the mission preparedness and safety oversight criteria and was the most cost-effective, particularly considering the potential cost of transition of some or all of the inspection responsibilities to the FAA. In addition, it was concluded that there was a minimal of duplication between the USDA and the FAA inspections. Even though the status quo was determined to be the best solution, the study did recommend a series of correct actions for the current system. Those recommendations are listed below.

- Developing joint electronic access to contractee inspection records;
- Informing USDA and FAA of each other's inspection findings on USDA's contractees; and
- Designating national and regional point(s) of contact within both FAA and USDA;
- Notifying FAA FSDOs or USDA Regions of an impending visit and potentially coordinating inspection activities to minimize impacts on operators;
- Providing USDA the names of FAA inspectors who visit USDA contractees;
- Inviting FAA representatives to USDA meetings;

16.2 UNITED STATES GENERAL SERVICES ADMINISTRATION (GSA)

In terms of aviation, the United States General Services Administration (GSA) works with the civilian Federal agencies to develop policy for acquiring, using, and disposing of aircraft as well as fostering safe, effective, and efficient aviation in U.S. Government agencies through the Aircraft Management Policy Division (AMPD). The AMPD accomplishes its mission by sponsoring programs such as the Interagency Committee for Aviation Policy (ICAP) and Safety Standards Guidelines for Federal Flight Programs. At the direction of the Office of Management and Budget, GSA established the ICAP in 1989. ICAP advises AMPD on technical and operational issues related to aviation management and is comprised of aviation managers from 18 Federal agencies[31] that own or hire aircraft to accomplish their missions.

GSA and members of ICAP developed and adopted a set of common Safety Standards Guidelines for Federal Flight Programs. The ICAP member-agencies agreed to write and enforce their own agency specific flight program standards based on those guidelines. Each agency uses these guidelines to develop, implement, and maintain agency-specific aviation flight program standards that identify the risks that may not be addressed under the Federal Aviation Regulations (FAR), but which are associated with government flight operations. Where FAR or military standards apply, Federal agencies would meet or exceed those standards. Where FAR or military standards do not apply, Federal agencies will use risk management techniques to create the highest standards for themselves based on the Safety Standards Guidelines. Along with Safety Standards Guidelines for Federal Flight Programs publication, guides on such topics as aviation operations, aircraft operations, maintenance manual, and conducting

[31] Members of ICAP: Department of Agriculture, Department of Commerce, Department of Defense, Department of Health and Human Services, Department of Justice, Department of State, Department of the Interior, Department of the Treasury, Department of Transportation, Department of Veterans' Affairs, Environmental Protection Agency, Federal Aviation Administration, Federal Emergency Management Agency, General Services Administration, National Aeronautics and Space Administration, National Science Foundation, National Transportation Safety Board, and Tennessee Valley Authority.

Aviation Resource Management Surveys (ARMS)[32] to are also provided help member-agency and as well as members of the public aviation community to assist in developing comprehensive aviation programs

ICAP provides a service to its member-agency called an ARMS. The ARMS audits are voluntary and require that each member-agency make a request for that ICAP service. An ARMS inspection is comprised of a team of aviation experts that review the records and operation of an aviation organization and publish their findings and recommendations to that organization and their chain of command. The last conducted ARMS audit of the Forest Service was in 1991, before the C-130A utilization as a fire fighting platform.

17.0 FOREST SERVICE AND DEPARTMENT OF INTERIOR OPERATION AND FLIGHT STANDARDS

The 2002 National Airtanker Service Contract (subsequently referred to as the Contract) issued by the USDA Forest Service stated that the mandatory availability period of T-130 was from June 28 to October 15. In Section C of the Contract (Attachment 50), general requirements are outlined which include the following:

- Contractors must be certified under FAR Part 137
- Aircraft have Standard or Restricted Airworthiness Certificates
- Aircraft certified as Airtankers must be licensed under a restricted Type Certificated for the aircraft
- Airtankers which are configured from former military aircraft which have FAA TCs based upon military operations in lieu of a manufacture's TC must have all applicable TCTO's or Navy Service Bulletins. This includes any directives that refer to later models of the same type that were issued after the earlier models had left the military inventory.
- All maintenance shall be performed in accordance with the manufacturer's recommendations and all applicable FARs pertaining to civil aircraft.
- All aircraft inspections shall be performed in accordance with an FAA-accepted inspection or continuous maintenance program applicable to the aircraft at the start of the contract.
- Compliance with mandatory manufacturer's bulletins, FAA ADs as applicable, and the correction of maintenance deficiencies shall be accomplished before the start and during the period of the contract performance.
- Aircraft shall be operated in accordance with the requirements of FAR Part 91 and 137 governing all civil aircraft (FAR 137.29(d), notwithstanding), other Federal Regulations stated in the contact and the air regulations of the States in which the aircraft may operate under this contract.

According to the Contract, the mandatory availability period of T-130 was from June 28, 2002 to October 15, 2002 (94 days). The Government may, at its option, order service on a day-to-day basis during the 45-day calendar period following the mandatory availability period. This optional time period is known as the Post-Season. After the T-130 accident, all the C-130A's post-season options were never exercised and the Forest Service issued a stop-work order.

[32] An ARMS inspection is comprised of a team of aviation experts that review the records and operation of an aviation organization and publish their findings and recommendations to that organization and their chain of command.

The DOI's Bureau of Land Management (BLM), Fish and Wildlife Services (FWS), and the DOA's Forest Service developed an interagency document entitled *Standards for Fire and Aviation Operations 2002*. Chapter 12 of *Standards for Fire and Aviation Operations 2002* provides policy and standards for aviation operations for each of the agencies listed above and defines airtankers as a national resource that is to be operated by commercial vendors in accordance with FAR Part 137.

18.0 NATIONAL AIRTANKER STUDY (NATS)

In 1994, a National Airtanker Study (NATS) was under taken by the Forest Service in conjunction with representations from the DOI Bureau of Land Management and State Wildlife suppression agencies. The study was to be completed in two phases. Phase I was to define the Forest Service and DOI's needs for large airtankers for the 1996-1998 fires seasons. The Phase I report was completed in March 1995. Phase II was to provide recommendations to provide support for both agencies long term airtanker needs (1999-2020) and was to be the basis for large airtanker contract solicitations. The Phase II report was completed in November 1996.

The Phase I report determined that the National fleet size of 41 large airtankers was needed. In the Phase II report, a variety of aircraft (excess military, commercial, and turbine upgrades) were considered as potential large airtanker platforms of the future. These future airtankers were restricted to multi-engine turbine powered capable of delivering over 1,000 gallons of retardant. Amongst these airtankers for future consideration was the civilian L-382G, C-130E and military surplus C-130A, C-130B and C-130E. The Phase II report recommended that the procurement of excess military aircraft was the most cost effective way to acquire airtanker platforms and although C-130A aircraft were acceptable no additional aircraft be sought except as parts sources for existing aircraft. To fulfill this need for 41 large airtankers, the report went on to suggest a fleet composition and a proposed acquisition and transition plan. A future fleet consisting of twenty P-3A aircraft, ten C-130B aircraft and 11 C-130E aircraft was suggested with a proposed transition of 4 C-130Bs in 1999, 2002, 2008 with 6 in 2005. The proposed transition of C-130Es was 3 in 2002 and 4 each in 2005 and 2008.

In a decision memorandum from the Secretary of Agriculture, the recommendation was made to adopt a method by which the contractor would own, operate, and maintain airtankers acquired through the sale of surplus military aircraft. Implementation of this plan required legislation that was passed on October 14, 1996 entitled *The Wildlife Aircraft Transfer Act (S.2078, PL104-307). The Wildlife Aircraft Transfer Act of 1996* states that the Secretary of Defense, during the period beginning on October 1, 1996, and ending September 30, 2005, sell aircraft and aircraft parts to persons or entitles that contract with the Federal Government for the delivery of fire retardant by air in order to suppress wildfires and that the condition of sale is that the airplanes may only be used for the provision of airtanker services for wildfire suppression purposes and that they may not be removed from the United States unless dispatched by the National Interagency Fire Center in support of international agreement to assist in wildfire suppression efforts or for purposes jointly approved by the Secretary of Defense and Agriculture in writing in advance.

On June 1, 1999, the Defense Logistic Agency (DLA) — the DOD agency responsible for implementing regulations concerning the sale of aircraft to the Forest Service — put into the Federal

Registry an interim final rule prescribing the regulations relating to the sale of aircraft and aircraft parts under *The Wildlife Aircraft Transfer Act of 1996.*

In December 1999, the Forest Service and the Bureau of Land Management issued the Phase II implementation plan which lists the recommendations, outlined in the Phase II, the responsible party for ensuring that the recommendation is performed, and the action required by the responsible party to ensure that the recommendation is performed. Since it was recommended in the Phase II report that procurement of excess military aircraft was the most effective manner in which to acquire airtankers, and *The Wildlife Aircraft Transfer Act of 1996* established the vehicle to do so, the implementation plan tasked the Forest Service Acquisition Management staff to develop implementation guidance or a Memorandum of Understand between the USDA and DOD and confirm commitments from the DOD to provide aircraft. The target date for completing this task was March 2000.

According to the Forest Service, the Forest Service solicited responses from parties interested in being eligible for the initial sale of the surplus aircraft and in May 2001, the Secretary of Agriculture approved a candidate list. After developing an desired inventory of aircraft and aircraft parts needed by the eligible firms, the Secretary of Agriculture in January 2002 forwarded this request along with a request that the sale of surplus military be conducted. As of the issuance of this report, the DoD had not acted upon the Secretary of Agriculture's request.

Jean-Pierre Scarfo
Aerospace Engineer
Airworthiness Group Chairman

ATTACHMENTS

1.	Video of C-130A, N130HP, Wing Separation
2.	Wreckage Diagram
3.	Nondestructive Testing Inspection Report of Lower Skins by CEDTECH Testing
4.	Metallurgical Report on Center Wing Lower surface from Fowler Inc.
5.	Lockheed Metallurgical Report, No. ET066134, dated August 6, 2002
6.	Excess Personal Property Report & Transfer Order for SN 56-0538, dated May 24, 1988,
7.	Aircraft Bill of Sale for SN 56-0538, dated August 18, 1988
8.	Hemet Valley request for registration for SN 56-0538, dated July 19, 1988
9.	Aircraft Bill of Sale for SN 56-0538, dated December 5, 1988
10.	Statement of Conformity, FAA from 8130-9 for SN 56-0538, dated December 10, 1988
11.	Application for Airworthiness Certificate for SN 56-0538, dated December 12, 1988 and Airworthiness Certificate for SN56-0538, December 12, 1988
12.	Operating Limitations for SN 56-0538, dated December 15, 1988
13.	Application and assignment of new registry for SN 56-0538
14.	Reissued Operating Limitation – Restricted Category sheet
15.	Restricted Category for the purpose of Carriage of Cargo Special Airworthiness Certificate for SN 56-0538, N130HP dated August 8, 1989
16.	Restricted category Special Airworthiness Certificate for SN 56-0538, dated June 1, 1998
17.	Special Operating Limitation sheet for SN 56-0538, dated June 1, 1998
18.	TCDS A15NM, revision 4, dated July 16, 1990 for the C-130A owned by USFS
19.	TCDS TQ3CH, dated March 10, 2000 for the C-130A owned by Snow Aviation
20.	FAA Approval of STC SA4835NM, dated January 31, 1990
21.	FAA Form 337, Major Repair and Alternation, for alternation of SN 56-0538, in accordance with the requirements of Hemet Valley STC SA4835NM
22.	Lockheed C-130 Service Life Analysis, Report LG78ER0029, Vol III, Section 5.4, 1/30/78
23.	Lockheed C-130 Service Life Analysis, Report LG78ER0020, Vol III, Section 5.4, 9/1/78
24.	Letter from the USAF to Hemet dated December 16, 1988, on C-130A restrictions
25.	Letter from the USAF to Hemet dated February 1, 1989, on C-130A historical data
26.	IPG-182 inspection frequency for the wings, dated 1 March 1995
27.	USAF T.O. 1C-130A-36 CW 11 entitled *ALL SKIN PANELS SEAMS, UPPER AND LOWER, CWS 220 LEFT T.O. CWS 220 RIGHT*
28.	USAF T.O. 1C-130A-36 CW 21 entitled *CENTER WING LOWER SKIN PANEL LAP JOINTS, CWS 220 T.O. 220 L/R*
29.	USAF T.O. 1C-130A-36 CW 30 entitled *CENTER WING LOWER SURFACE PANELS UNDER DOUBLERS CWS 61.5 TO 80 L/R*
30.	Air Force Work Document for center wing replacement, dated May 2, 1983
31.	C-130A, SN 56-0538 Airplane Log Book sheets
32.	H&P WO 8080, dated April 18, 2000, center wing inspection
33.	H&P's WO 4487, dated May 20, 1998, for replacement of the left outer wing & USAF's Form AFTO 95 for the rehabilitation/installation of left outer wings

34.	H&P's WO 11027C, dated March 8, 2001, for replacement of the right outer wing & USAF's Form AFTO 95 for the rehabilitation/installation of right outer wings
35.	Memorandum from DOI's Alaskan Regional Director of the OAS in Anchorage to the DOI's Director of the OAS in Boise, Idaho, dated March 26, 1992
36.	FAA letter to DOI, dated October 26, 1992
37.	DOI Information Paper on C-130A Certification and Maintenance Concerns
38.	Briefing Paper on DOI/FAA C-130A Certification and Maintenance Meeting, Dated Jan 14, 1993
39.	WR-ALC list of PDM "core" tasks, dated November 17, 1992
40.	FAA Briefing Paper on C-130A Certification and Maintenance, dated February 11, 1993
41.	DOI letter addressed to the Director of OAS on C-130A issues dated February 1993
42.	DOI letter addressed to the DOI/Forest Service Directors prohibiting the use of the C-130A dated May 10, 1993
43.	WR-ALC letter to FAA on C-130A continued airworthiness dated May 20, 1993
44.	FAA letter to DOI discussing C-130A inspection program dated May 28, 1993
45.	DOI letter addressed to the DOI/Forest Service Directors rescinding prohibiting the use of the C-130A dated May 28, 1993
46	FAA Action Plan document entitled "Issues Raised Concerning Aircraft Airworthiness"
47.	Joint AFS and AIR C-130 Airworthiness working group report
48.	FAA Action Plan Document entitled "Actions to be Taken to Address the Recommendations Received form the C-130A Inspection Group", dated August 12, 1993
49.	Recap of the meets minutes taken at this August 23, 1993 meeting by Reston Support Services, Inc.
50.	2002 National Airtanker Service Contract