

## **NTSB REPORT (FTW02FA003)**

**American Airlines F-100 N1448A**

**Dallas-Fort Worth 03 October 2001 -Nose collapsed whilst being towed to gate**

### **HISTORY OF FLIGHT**

On October 3, 2001, at 0836 central daylight time, a Fokker F28 Mk 0100 (F-100) airplane, N1448A, operating as American Airline's (AA) flight 535, was substantially damaged while being towed to the gate at the Dallas-Fort Worth International Airport (DFW), DFW Airport, Texas. The airplane was registered to and operated by American Airlines Inc., of Fort Worth, Texas. The captain, who held an airline transport pilot certificate, the first officer, who also held an airline transport pilot certificate, two cabin attendants, and 82 passengers were not injured. Visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed for the 14 Code of Federal Regulations Part 121 scheduled passenger flight. The flight originated from the Tulsa International Airport, Tulsa, Oklahoma, at 0712, and was destined for DFW.

According to AA, the flight was the first flight following a light "C" maintenance check. According to the captain, while on final approach to runway 13R at DFW he received an unsafe nose landing gear indication on the multi function display unit (MFDU) in the cockpit. The captain abandoned the approach and "recycled the gear per procedures to no avail." Air Traffic Control (ATC) requested that another airplane, a King Air, check the condition of the F-100's nose landing gear. The King Air's flightcrew reported the landing gear appeared to be extended. Subsequently, the airplane landed on runway 13R, rolled out, and came to a stop on the runway. An evacuation of the airplane was not initiated.

According to a AA maintenance personnel and the captain, a maintenance crew met the airplane on the runway, placed locking pins in each of the landing gears, connected the towbar, and prepared to tow the airplane to the gate. Prior to commencing the tow, the captain asked the maintenance crew for clarification regarding "strapping" of the nose landing gear prior to towing. A conversation between the maintenance crew at the airplane and the supervisor, who was located a separate location on the airport, via handheld radio ensued. The supervisor informed the maintenance crew he did not see anything regarding strapping of the nose gear in the maintenance manuals. Meanwhile, a maintenance crew chief, located at another location, contacted the captain and informed him that strapping of the nose gear prior to towing the airplane was required. The captain then contacted the supervisor again, and asked if the gear needed to be strapped. The supervisor responded that he was referencing the manuals and would respond in 2-3 minutes. Two minutes later, the supervisor informed the maintenance crew the gear did not need to be strapped. Subsequently, the captain released the airplane brakes, the maintenance crew placed the tug vehicle into low gear, and the nose landing gear collapsed. The nose of the airplane came to rest on the towbar.

The maintenance crew reported the tug vehicle did not move forward; the gear collapsed when the brakes were released and the tug vehicle was placed into low gear. Following the maintenance supervisor's communication with the maintenance crew, he was contacted by the maintenance crew chief and was informed that strapping of the nose landing gear was

required; however, the strap was not available at DFW. The passengers were deplaned and transported to the terminal by bus. The nose landing gear was removed from the airplane for further examination.

### **PERSONNEL INFORMATION**

On January 5, 2000, the captain was issued an airline transport pilot certificate. He was type rated in the F-100 and had accumulated a total of 7,109.0 flight hours, of which 5,286.4 hours were in the F-100. On February 6, 2001, he underwent his most recent FAR Part 121 proficiency check.

On August 11, 1997, the first officer was issued an airline transport pilot certificate. He was type rated in the F-100 and had accumulated a total of 413.27 flight hours, all of which were in the F-100. On October 24, 2000, he underwent his most recent FAR Part 121 proficiency check.

### **AIRCRAFT INFORMATION**

The Fokker F28 Mk 0100 airplane (serial number 11457) was delivered new to American Airlines, and had accumulated a total of 20,758 flight hours at the time of the accident. The airplane was maintained in accordance with American Airline's FAA approved airworthiness inspection program (AAIP).

The nose landing gear (NLG) is an oleo-pneumatic shock-absorber, which absorbs loads and gives support to the airplane's nose. The NLG folds forward (toward the direction of flight) when it is retracted. When the landing gear lever in the cockpit is moved to the up (retract) position, a mechanical linkage acts to retract a down-lock plunger from a down-lock bracket in the nose landing gear bay, therefore releasing the nose landing gear from the down-and-locked position.

The airplane's most recent light "C" maintenance check was completed on October 3, 2003, 1.1 hours prior to the accident. A review of the repair items, that were accomplished during the check, revealed the down-lock plunger would not fully extend into the down-lock bracket (therefore the NLG was not down-and-locked). Maintenance personnel noted the down-lock plunger clearance was greater than 0.02 inches (acceptable clearance is 0.003 - 0.02 inches). Maintenance personnel accomplished adjustments per the maintenance manual, which consisted of removing an unknown number of down-lock thrust shim plates. It should be noted that removal of the shims would further increase the clearance. However, subsequently the NLG was operated (retracted and extended 2-3 times) and the down-lock plunger was able to fully extend.

The Fokker 100 maintenance manual (towing maintenance procedures) outlines steps to follow when towing the airplane with a NLG unsafe indication. The maintenance manual sets forth 4 different methods for towing; 1. Tow the aircraft from the nose landing gear 2. Tow the aircraft from the main landing gear 3. Tow the aircraft by main gear driving 4. Tow the aircraft from the nose landing gear with a towless towing vehicle. Each of these procedures contains a caution statement consisting of the following:

DO NOT TOW THE AIRCRAFT IF A NOSE GEAR UNSAFE CONDITION IS GIVEN. THE DOWNLOCK PLUNGER IS NOT FULLY ENGAGED. THE NOSE LANDING GEAR CAN RETRACT. The manual states that a towing bridle (including straps) and tow bar must be available. The procedures further require the bridle be secured to the airplane prior to commencing the tow.

The following warning is stated in American Airline's F-100 Operating Manual (Gear Up/Unsafe Ldg Procedure): "If nose gear unsafe indication is still present after landing, do not tow the airplane. Installation of the nose gear locking pin does not protect against nose gear collapse in this condition."

### **DAMAGE TO AIRCRAFT**

Examination of the airplane, by the NTSB Investigator-In-Charge (IIC), revealed a semi-circular indentation (consistent with the dimensions of the tow bar) which initiated at the nose landing gear wheel well and extended forward, toward the direction of flight. The pressure bulkhead (item 260, according to the Fokker 100 structural repair manual), located forward of the nose landing gear wheel well, was wrinkled and ruptured. Additionally, the forward avionics door and an area of the fuselage, aft of the nose radome, were damaged.

### **AERODROME INFORMATION**

The DFW Airport is located at north 32 degrees 47.042 minutes latitude and west 097 degrees 15.205 minutes longitude, and at an elevation of 602 feet msl. The airport has two parallel runways on the west side of the airport and three parallel runways on the east side of the airport that are oriented north-south. DFW also has two parallel runways oriented northwest-southeast. Runway 13R is concrete-grooved, and 9,301 feet long and 150 feet wide.

### **METEOROLOGICAL INFORMATION**

At 0856, the weather observation facility located at DFW reported the following weather conditions: scattered clouds at 30,000 feet, visibility 8 statute miles, temperature 64 degrees Fahrenheit, dew point 61 degrees Fahrenheit, wind from 190 degrees at 8 knots and an altimeter setting of 30.10 inches of Mercury.

### **TESTS AND RESEARCH**

The nose landing gear was initially examined at an American Airline's hangar at DFW. The down-lock plunger was observed not engaged; and was extended 0.75 inches (approximately 0.25 inches from being fully engaged in the gear down-and-locked position). The retract actuator and linkage associated with the actuator was not binding. A gear swing was performed and the operation of the down-lock plunger was observed. The nose landing gear retracted and the down-lock plunger fully retracted. However, as the gear was then extended, the down-lock plunger extended approximately 0.25 inches and stopped. Attempts to manually release the plunger were unsuccessful. The gear was then removed from the airplane, and transported to an American Airline's maintenance facility in Tulsa, Oklahoma, for further examination. No roughness or galling of the down-lock plunger was observed.

The nose landing gear was examined, with the presence of the NTSB IIC, in Tulsa. The down-lock plunger extension was again measured (after transport) and found to be extended 0.920 inches (.080 inches from being fully engaged in the gear down-and-locked position). The down-lock plunger assembly (includes O-ring, lower seal ring, rod bushing, copper spring, cadmium bolt, and cadmium washer) was removed and displayed an adequate amount of lubrication. The down-lock plunger assembly was disassembled. It was noted that the assembly's O-ring in the rod bushing was torn and the lower seal ring on the rod was swelled. According to AA, the damaged O-ring in the rod bushing would not be a factor in preventing the plunger from engaging. However, the swelled seal accounts for the plunger not fully engaging by .080 inch, which would be sufficient to prevent the gear from collapsing. As previously mentioned, when the gear was on the airframe, the plunger travel was deficient by 0.75 inch.

The NTSB received reports that, under certain circumstances, the down-lock plunger assembly bolt may interfere with the down-lock plunger assembly's spring (the tip of the bolt may enter the space between the spring coils), and limit movement of the down-lock plunger. The assemblies copper spring exhibited various witness marks between adjacent spring coils and surface marks on the outside diameter of three consecutive coils. The cadmium plated down-lock plunger bolt exhibited marks on the sides at the tip end, 180 degrees apart. The spring and down-lock plunger bolt and washer were sent to the NTSB Materials Laboratory in Washington, D.C. for further examination.

The NTSB examination revealed thirty-five pairs of witness marks were noted between adjacent spring coils. Energy dispersive spectrometer (EDS) analysis of the witness marks between the spring coils and of the surface marks on the outside diameter of the coils revealed only copper, and no cadmium, consistent with the coils making contact with each other. The diameter of the down-lock plunger bolt was 0.249 inches (within specification) and no significant surface disturbances were observed. EDS analysis of the down-lock plunger bolt revealed no evidence of copper. The thickness of the down-lock plunger bolt washer was measured at 0.1055/0.1060 inches (within specification).

The down-lock thrust plates and shims (mounted on the NLG) and down-lock stop plates (mounted on the airframe) were also examined at the NTSB Laboratory in Washington, D.C. The down-lock thrust plates and down-lock stop plates met design dimensions. The thrust plates and stop plates displayed mechanical damage and wear marks, consistent with the stop plates and thrust plates impacting each other. The orientation of the features on the thrust plates is consistent with the thrust plate, at some time, being installed inverted. A witness mark was noted on the thrust plate and stop plate, which was consistent with the size and shape of a nut. The witness marks and impact features were analyzed; however, there was no evidence that they would have restricted the down-lock plunger.

#### **ADDITIONAL INFORMATION**

On June 19, 1990, Fokker issued a service bulletin (SBF100-11-013), which recommended a placard be installed on the right nose landing gear door that stated: "WARNING: If NLG indicates UNSAFE: DO NOT TOW Follow AMM chapter 9-10 procedure. Groundlock pin does NOT protect in this case". This service bulletin was the result of inadvertent retraction of the NLG during tow operations, even with the groundlock pin installed. The service bulletin had been complied with on the accident airplane.

On October 15, 2001, American Airline's published an account of the accident in a bi-weekly Operations Safety newsletter. The purpose of the publishing the account was to raise awareness of the circumstances of the accident.

In November 2001, American Airline's issued a Maintenance & Engineering Bulletin. The bulletin outlined procedures regarding towing of the F28 Mk 0100 with an unsafe gear indication and clarified, with color photographs, the location and position of the down-lock plunger when it is fully engaged.

On March 20, 2002, American Airline's developed an additional warning placard to install adjacent to the tow switch on the F28 Mk 0100s. The placard warns against towing the airplane with an unsafe gear indication.

American Airline's developed an alternate strapping system. On August 30, 2002, the strapping system was approved and implemented.

Fokker Services revised the F-100 aircraft maintenance manual (AMM) 31-12-01-400-834, subtask 32-21-01-220-024-A00) to include the following:

1. Before removal of the thrust plate mark the top side of the plate.
2. After removal of the thrust plate, check for excessive damage such as cracks. Replace as required.
3. During installation the mechanic must ensure that the thrust plate is installed with the marked side up.
4. In case a new thrust is installed, identify the top side by checking the location of the radius on the corners. The top corners have a radius of 3 to 4 mm and the lower corners have sharp edges.

[http://www.ntsb.gov/aviationquery/brief2.aspx?ev\\_id=20011022X02123&ntsbno=FTW02FA003&akey=1](http://www.ntsb.gov/aviationquery/brief2.aspx?ev_id=20011022X02123&ntsbno=FTW02FA003&akey=1)



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