Landing gear collapse, Aircraft Accident Report, New York Airways, Inc. Sikorsky S-61L, N619PA, Pan Am Building Heliport, New York, New York, May 16, 1977

Micro-summary: **The landing gear of this helicopter collapsed while the engine was running.**

Event Date: **1977-05-16 at 1735 EDT**

Investigative Body: **National Transportation Safety Board (NTSB), USA**

Investigative Body's Web Site: **http://www.ntsb.gov/**

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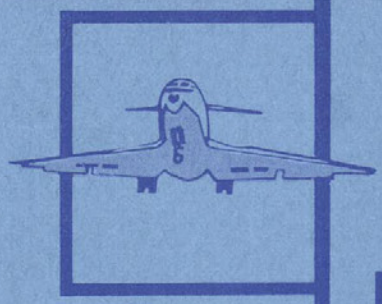

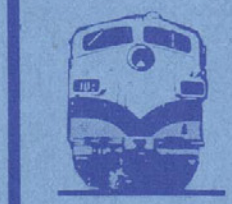

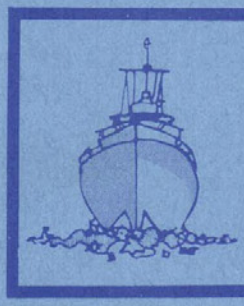

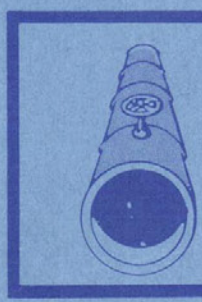

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

NEW YORK AIRWAYS, INC.,
SIKORSKY S-61L, N619PA

PAN AM BUILDING HELIPORT

NEW YORK, NEW YORK

MAY 16, 1977

REPORT NUMBER: NTSB-AAR-77-9

UNITED STATES GOVERNMENT

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NATIONAL TRANSPORTATION SAFETY BOARD
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AIRCRAFT ACCIDENT REPORT

Adopted: October 13, 1977

NEW YORK AIRWAYS, INC.
SIKORSKY S-61L, N619PA
PAN AM BUILDING HELIPORT
NEW YORK, NEW YORK
MAY 16, 1977

SYNOPSIS

About 1735 e.d.t. on May 16, 1977, the right landing gear of a New York Airways, Inc., Sikorsky Model S-61L helicopter, N619PA, failed while the aircraft was parked, with rotors turning, on the rooftop heliport of the Pan Am Building in New York, New York. The aircraft rolled over on its right side and was substantially damaged. Four passengers had boarded the aircraft and other passengers were in the process of boarding. The passengers and the three crewmembers onboard received either minor or no injuries; however, four passengers who were still outside the aircraft and were waiting to board were killed and one was seriously injured. One pedestrian on the corner of Madison Avenue and 43rd Street was killed and another was seriously injured when they were struck by a separated portion of one of the main rotor blades of the aircraft.

The National Transportation Safety Board determines that the probable cause of the accident was the fatigue failure of the upper right forward fitting of the right main landing gear tube assembly. Fatigue originated from a small surface pit of undetermined source. All fatalities were caused by the operating rotor blades as a result of the collapse of the landing gear.

1. INVESTIGATION

1.1 History of the Flight

On May 16, 1977, New York Airways, Inc. (NYA) Flight 972, a Sikorsky S-61L, N619PA, was being operated as a regularly scheduled passenger flight from the rooftop heliport (JPB) of the Pan American Building at 200 Park Avenue, Manhattan, New York, to John F. Kennedy International Airport (JFK), New York, New York.

The flight originated as Flight 971 from JFK Airport and landed at the heliport at about 1732. 1/ There were 20 passengers and a crew of 3 aboard.

After approaching from the northeast and landing, the aircraft was taxied to the boarding gate, which required a 180° turn to the left and a short taxi of 10 to 20 feet to position the aircraft properly. The captain stated that he used the tailrotor instead of his brakes to assist in taxiing. He set his brakes and left the tail wheel unlocked, which was a normal procedure. The aircraft was chocked and passengers began to deplane. According to witnesses and passengers, the landing had been smooth and gentle.

The captain remained in his seat with his hands on the controls. The collective was bottomed (negative pitch) and torque was about 18 percent on each engine. The engine speed controls (ESC) were positioned to maintain 100 percent rotor speed (N_R) and the automatic flight control system was on with all controls centered--a normal operating procedure. The first officer stated that as he filled out the flightlog, he had his knee against the collective to insure that it was bottomed.

The captain estimated that they had been sitting on the heliport for 1 to 2 minutes. Passengers had deplaned and the outbound passengers were boarding. He heard a "faint noise," which he believed to have come from the rotor system, followed immediately by a "crumpling, crunching noise" and a buckling sound. The crumpling sound was accompanied by a settling and yawing motion, followed by a roll of the aircraft to the right.

As he heard the first "faint noise," the captain reached for the ESC's to shut the engines down. He pulled them back immediately to the ground idle detent and then into the engine shutoff position before the aircraft rolled beyond its 45° position. When the ESC's are in the shutoff position, fuel is shut off in the engine fuel control units. The captain stated that when the blades struck the concrete they were not being powered by the engines.

1/ All times herein are eastern daylight, based on the 24-hour clock.

The first officer stated that he felt the aircraft settle slightly to the right and heard a crunching noise, followed immediately by a "gentle smooth roll" to the right.

After hearing the first sound, the first officer looked to his right at the captain who was in the right cockpit seat and saw the captain reach for the ESC's. He also saw the blade tip path plane rotating with the aircraft. The relationship of this tip path remained constant, from the upright position, throughout the entire roll. He reached up to help the captain pull the ESC's but the captain already had his hands on them; he stated that the whole sequence happened quickly.

With the ESC's in the shutoff position, the aircraft continued the roll and the main rotor blades struck the heliport concrete surface. The captain heard the breaking of plexiglass as the blades struck the first officer's overhead window. When the aircraft stopped the captain completed the procedure to shut down the aircraft. All switches were turned off.

The captain stated that it did not occur to him to use the rotor brake after the aircraft began to roll; the events developed too rapidly to allow the rotor brake to be effective.

At the time of the accident, inbound passengers had deplaned and four outbound passengers had boarded or were boarding the aircraft; one passenger was approaching the first step of the airstair door. The flight attendant, who was positioned inside the aircraft at the entrance door stated that, as a woman passenger was coming up the airstair she heard a "loud metallic crumbling sound," which she believed to be coming from the right underside of the aircraft. She noticed a vibration which was followed immediately by the aircraft tilting to its right side. As the aircraft continued its roll to the right, she heard the engines stop. She stated that the woman on the airstair door and a passenger who had just boarded fell backward against the door. She braced herself so she would not fall as the door closed when the aircraft came to rest on its right side. After the motion stopped, the flight attendant inquired about the safety of the four passengers who were inside the aircraft and upon ascertaining that they were alright, she began to give instructions regarding evacuation.

A passenger who was approaching the airstair door at the time of the accident stated that as he placed his left foot on the first step of the airstair, he heard a loud noise like an engine backfire and then he noticed the aircraft moving laterally first and then begin to tilt toward him. He said that he stepped back as the helicopter tilted further toward him and he began moving toward the front of the aircraft while keeping his hands on the aircraft's side. In the few seconds that it took the aircraft to stop, he had moved forward to a position adjacent to the cockpit. He was not injured.

The accident occurred during daylight hours at latitude 40° 45' north and longitude 73° 58' west. The elevation of the accident site is 855.23 feet m.s.l.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	0	4	1
Serious	0	1	1
Minor/None	3	17	2

1.3 Damage to Aircraft

The aircraft was substantially damaged.

1.4 Other Damage

Two automobiles located on the streets below the accident site were damaged by separated main rotor blade leading edge counterweights. An office on the 36th floor of the west side of the Pan Am Building was extensively damaged when an 11-foot section of a main rotor blade penetrated a window. The New York Airways passenger waiting/control tower area located in the east corner of the heliport had five windows shattered and a light fixture knocked from its structure. A 6-foot section of the rooftop edge railing on the north side was penetrated and bent outward by a main blade section.

1.5 Personnel Information

The three crewmembers were properly certificated and qualified for the flight. (See Appendix B.)

1.6 Aircraft Information

The aircraft was certificated, equipped, and maintained in accordance with Federal Aviation Administration (FAA) requirements and New York Airways procedures.

The records of maintenance and inspection from June to December 1976, were examined. There were no notable patterns of malfunctions or items of malfunction related to the failure of the right landing gear. The program of inspection and recording was comprehensive and complete. The program calls for: (1) A daily preflight. (2) A "safety inspection" every 40 hours--an in-depth inspection to discover any irregularities. The entire aircraft is opened up and additional functional tests are performed. (3) A phase check. One of five phases is performed every 70 hours. All five phases are completed within 350 hours. The type of inspection and corrective maintenance is progressive. Selected items and AD compliance work, if any, are performed during these checks.

At the time of the accident, the landing gear had a total time of 6,913:15 hours. There was no service life limit on the landing gear or on its components. Overhaul was required every 9,900 hours. The gross weight and c.g. were within prescribed limits for both takeoff and landing. About 950 lbs of Jet A-1 fuel were onboard, and the aircraft weighed about 17,668 lbs when the accident occurred. (See Appendix C.)

1.7 Meteorological Information

At the time of the accident, surface weather observations for the heliport were as follows: Broken clouds at 1,500 ft, visibility--15 mi, temperature--71° F, wind--260° at 12 kn, altimeter setting--30.26 in Hg.

1.8 Aids to Navigation

Not applicable

1.9 Communications

Not applicable

1.10 Aerodrome Information

The heliport is located on top of the Pan American Building, at 200 Park Avenue, New York. The heliport is operated by New York Airways, Inc., and was certificated under an airport operating certificate issued by the Federal Aviation Administration on January 3, 1977, with an effective date of February 1, 1977. It is an Index A heliport based on the requirements of 14 CFR 139, with no exemptions. The heliport is owned by the Grand Central Corporation and leased to New York Airways, Inc. New York Airways is responsible for the administration, operation, and maintenance of the heliport.

The heliport is located at an elevation of 855.23 feet m.s.l. and has an effective landing area of 131 feet by 131 feet. Only VFR and special VFR operations are authorized. Approach and departure routes for the heliport are specified in the certification manual for the heliport. The heliport pavement is of reinforced concrete. A lighted windsock is located at the northwest corner and another at the extreme northeast corner of the heliport.

1.11 Flight Recorders

N619PA was equipped with a Fairchild A-100 cockpit voice recorder (CVR), Serial No. 4129. The recording was complete from landing at JFK Airport through the landing on the Pan Am Building heliport to the accident event.

Two minutes and twenty-one seconds following the landing, the cockpit area microphone recorded a "cracking" sound and banging sound as the blades contact the roof. There was no recorded crew conversation for the period that N619PA was on the roof.

The aircraft was not equipped, nor was it required to be equipped, with a flight data recorder.

1.12 Wreckage and Impact Information

1.12.1 General Examination

Aircraft damage was limited to the main rotor blades, the main rotor system, the copilot's enclosure (fuselage station (F.S.) 72, water line (W.L.) 170), the right side of the fuselage just forward of the right main landing gear attachment points (F.S. 209.5, W.L. 89 and 156), the right main landing gear supports (F.S. 221), and the horizontal stabilizer mounted on the right side of the tail rotor pylon (F.S. 704.5, W.L. 191). All access panels and fairings were in place and attached, except for the nose battery compartment access door which had been opened after the rollover to disconnect the battery.

The five color coded main rotor blades had been damaged exclusively. Each blade was 28 feet 10 inches long and weighed 209.3 lbs. All blades had bent upward along their span, and heavy surface contact smears were located on their bottom surfaces beginning at midspan and continuing outward toward the tip.

The only parts of the helicopter that were thrown from the heliport were outboard sections of these five rotor blades. The longest distance traversed by the blade portions was four blocks north and one block west of the Pan American Building.

The outboard sections of the five main rotor blades, including the tip caps, were recovered in the area below the heliport on the roofs of lower buildings or at street level. (See Appendix D.)

There was no preimpact damage noted to any of the aircraft's systems or powerplants. The fuel tanks, which were located in the lower fuselage tub structure beneath the passenger cabin floor, were intact with no evidence of fuel leakage. About 120 gallons of fuel was removed from the aircraft after the accident.

1.12.2 Landing Gear Examination

Examination of the landing gear showed that the left main gear assembly was intact with no visual damage. The right main landing gear had separated from its upper (F.S. 221, W.L. 164) and lower (F.S. 221 and 243.5, W.L. 106) fuselage attachment fittings and was lying beneath the aircraft. The aircraft was righted, and the right landing gear and lower fuselage were examined.

The two tires, axle, and main oleo strut were intact. Both tires were fully inflated; the tires were removed and the axle examined. Visual examination disclosed no evidence of damage. The oleo was fully extended. The energy absorbing strut, which angles from the upper fuselage attachment fitting (F.S. 221, W.L. 164) outboard to the oleo strut's upper attachment fitting, had separated through its lugs at both the upper and lower ends.

The lower landing gear supports consist of two sets of upper and lower tube assemblies which form two "V's"; the apex of each "V" attaches to the upper and lower ends of the main oleo strut (outboard) and to the fuselage attachment fittings (inboard). The forward upper and lower tubes (F.S. 221, W.L. 106) attach to the forward fuselage attachment fitting through P/N 6125 - 50333 - 22 fitting which is bolted and bonded to the forward upper tube. The aft upper and lower tubes attach to the aft fuselage fitting (F.S. 243.5, W.L. 106) in a similar manner. (See figures 1 and 2, Appendix E.) The lower attachment tube was bent downward and had broken adjacent to the inboard tube assemblies fitting. The forward upper tube assembly had separated at the main oleo strut attachment fitting. The complete tube was still attached to the P/N 6125-50333-22 fitting. However, this fitting, which also has a lug to which the lower tube attaches had fractured.

The fractured areas were examined in the Safety Board's metallurgical laboratory and under the Safety Board's control at Sikorsky Aircraft/United Technologies' laboratories.

1.13 Medical and Pathological Information

No occupants of the aircraft were seriously injured. Post-mortem examination of the four passengers that had not yet boarded the aircraft and the one pedestrian revealed that they died as the result of impact trauma caused by strikes from the main rotor blades and separated portions of those blades. The cause of death of the four passengers was found to be multiple lacerations, fractures, and internal injuries. The cause of death of the pedestrian was found to be fractures of the skull and lacerations of the brain.

A review of the cockpit crew's medical records disclosed no evidence of pre-existing physical problems which could have affected their judgment or performance.

1.14 Fire

There was no fire; however, foam was laid over the area in the immediate vicinity of the aircraft as a precautionary measure.

1.15 Survival Aspects

This was a survivable accident for the aircraft occupants. When the aircraft came to rest on its right side the first officer, who was in the left seat, was hanging in his harness. The captain looked back and saw that the cockpit door, which is a two-panel sliding door, was partially open and was jammed. This door was fully open before the accident. Although the captain's emergency evacuation station was in the cabin, he realized that he could not enter the cabin through the door. The captain unbuckled the first officer; the first officer then opened his emergency exit, which is the window on his side, and exited by pushing the window free and climbing out on top of the aircraft.

The first officer climbed off the aircraft on the bottom side. He did not see anyone moving on the heliport. He went around the tail section to the other side of the aircraft at the rotor head area and saw what he believed to be transmission fluid on the ground. Two cargo personnel were there and he told them to put foam down. He went back to the (bottom side) of the aircraft, pushed a cargo cart closer and climbed back up onto the aircraft.

The captain followed the first officer out the left emergency exit. He walked back toward the tail section on the now horizontal left side of the aircraft, opened the left rear emergency door, and climbed down into the aircraft. There were three male and one female passengers inside of the cabin and a flight attendant at the front of the cabin. All were calm; there was no panic. The captain told them to come to the rear exit. The three male passengers climbed out by themselves. The first officer then escorted each passenger back to the baggage cart and they climbed down. The woman who had been on the airstair when the aircraft began to roll over had injured one of her hands. The flight attendant was attempting to give first aid and the captain began to assist; however, after looking at the injuries briefly they assisted her in leaving the aircraft. The flight attendant then deplaned followed by the captain.

The New York Police Department (NYPD) received a call to respond to Madison Avenue and 43rd Street for a "jumper" 2/ who hit a pedestrian. Then a detective unit and a fire department unit arrived, at which time a call over the radio said that a helicopter had hit the Pan American Building. A detective said he saw a body and a 6-foot length of rotor blade at the Madison Avenue location. He then walked to the Pan American Building and went up an elevator with some firemen. About 4 minutes elapsed from the initial response until the detective was on the elevator.

2/ A person who had committed suicide by jumping from a building.

When the detective and the firemen arrived at the 50th floor, the elevator went back down to the bottom. The Fire Department key was then used to take command of the elevators. When the detective arrived at the top some other fireman were already there.

The NYPD personnel stated that initial confusion existed in getting to the roof because the elevators remained in automatic operation immediately after the accident. When the fire service arrived they operated the elevators manually with the fire service keys until building personnel arrived to operate the manual controls.

At 1738, the New York Fire Department (NYFD) received a special call to send the rescue unit to the Pan American Building. This was immediately followed by a call for a full response--all units from the fire battalion--to that location. Because of the difficulty encountered with the automatic elevator operation, foam was not applied until 1745 or 1750 when the first fire department units arrived on the roof.

The crash/fire/rescue (CFR) procedures outlined for the heliport were contained in the heliport operations manual. The procedures were valid and clearly stated for each employee. Some of the station personnel were not completely familiar with the contents of the CFR portion of the manual. However, the primary firefighters, which were the two cargo handlers, were aware of their CFR duties and performed their duties as dictated by the manual. One cargo handler had received no formal CFR training. The foam hoses were deployed immediately and most of the emergency procedures went into effect.

The most significant shortcomings of the CFR activities were: (1) The alarm box to the City/Building fire alarm system was not activated. (2) Foam was not applied to the aircraft immediately although CO_2 was applied. (3) There was no NYA employee who immediately took charge of the accident site to insure the CFR emergency plan was implemented properly.

1.16 Tests and Research

The Safety Board's metallurgical laboratory examined the right forward main landing gear tube assembly (P/N S6125-50338-2) 3/ and the right aft inboard main landing gear fitting with a portion of the tube.

Examination of the right forward main landing gear P/N S6125-50333-22 fitting showed that it fractured near where the end of the tube assembly is located within the fitting (See figure 2, Appendix F). This was near the bottom of a 1.498/1.500-inch diameter hole which is drilled in the fitting to accommodate the tube. Fractography of the fractured features indicated that a fatigue crack had begun along the 0.12-inch radius near the bottom of the hole where the hole changes from a cylindrical to a conical shaped section. (See figure 4, Appendix F.)

3/ The S6125-50338-2 tube assembly includes the S6125-50333-22 fitting.

Examination of the fracture using a scanning electron microscope (SEM) disclosed fracture features typical of high cycle fatigue propagation from these origin areas. Fatigue had propagated down and through the bottom of the fitting and out. (See Figure 4, Appendix F.) Approximately 40 percent of the fractured cross sectional area of the fitting appeared cracked. The remaining sections of fracture away from this fatigue region were typical of overload separations.

Some areas were missing along the fracture line that corresponded to the overload portion of the separation. These missing areas suggested that the fitting opposite the fatigue region and near its forward side had broken in compression since compression breaks tend to fragment the fracture.

The missing area on the forward side was seen by comparing the mating fracture halves and noting that the fracture on the inboard half went through the small hole used to locate the tube in the fitting while on the outboard half the fracture in the same area progressed through the bolt hole. (See Figure 3, Appendix F.)

Detailed examination of the fracture origin area disclosed two origin sites, both of which appeared to be at discontinuities in the radius (See Figures 5 and 6, Appendix F). The two origins produced two planes of fatigue fracture slightly offset from one another. The two fatigue cracks grew into one large crack a short distance out from the radius. Because of the extent and symmetry of the crack arrest markings and the locations of the origins with respect to a ratchet mark (step-like portion of the fracture connecting the fatigue planes), one origin was considered secondary and the other was considered the main origin. A substance was found which completely filled the discontinuity at the secondary origin and partially filled the discontinuity at the main origin. (See Figures 5 and 6, Appendix F.) Energy dispersive X-ray analysis of the substance at the main origin area disclosed elements normally associated with the fitting alloy system along with an appreciable amount of sulfur and small amounts of calcium and potassium all of which are foreign elements. The silicon energy peak was strong indicating silicon as a primary element of the substance; the fitting alloy normally contains less than 0.4 by percent weight of silicon.

The radius in the origin area was mostly covered by an adhesive (EC-2214) used during fabrication of the assembly. Analysis of this adhesive material indicated that it was high in aluminum and silicon with some sulfur, chlorine, potassium and calcium.

Hardness and electrical conductivity measurements of the fitting gave values averaging Rockwell "B" 83 and 40 percent International Annealed Copper Standard, respectively. These measurements, as well as the microstructural characteristics, appeared normal for 7075 aluminum alloy heat treated to the T73 condition (specified material and heat treatment).

Examination of the right-hand aft main landing gear fitting and tube assembly showed fractures that were all typical of an overload separation. No evidence of fatigue or other type of pre-existent cracking was found on this assembly.

1.17 Additional Information

1.17.1 History of Heliport Operation

Heliport operations began in 1965 from the Pan Am Building with New York Airways operating Boeing Vertol 107 equipment. There was public pressure against the NYA petition because of noise and safety reasons. Hearings were held and the operation was approved. A 5-year permit from the NYC Planning Commission was issued for the period 1964 through 1969. The NYC Department of Marine and Aviation then issued an Air Facility Permit for 1 year, which was later renewed for another 1-year term.

In February 1968, NYA ceased operations from the heliport because of a contractual disagreement between Pan American World Airways and Trans World Airlines. During the disagreement, the facility permit for the heliport expired. Shortly before the expiration date NYA requested a renewal. The Department of Marine and Aviation refused to renew the permit because (1) NYA was not operating onto the roof heliport currently, (2) NYA presented no plans in the renewal petition to begin operations at a set date, (3) public pressure was such that a hearing should be held. Since NYA was not operating to the roof, the city determined that there was no point in renewing the permit at that time. No further petitions were presented, and in 1969 the NYC Planning Commission permit expired.

On November 24, 1976, the New York City Planning Commission held a public hearing to consider the application of New York Airways, Inc., for a resumption of scheduled helicopter operations from the roof top heliport on the Pan American Building. Before the hearing, local community planning boards 5 and 6, representing the neighborhoods most directly affected by the proposed operation, gave their approval of the granting of an operational permit after an extensive review of the facility. The operation was then approved by the New York City Board of Estimate, the Department of Marine and Aviation, and by the Federal Aviation Administration.

The resolution by the Board of Estimate, City of New York, to grant a permit to operate the Pan American Building Heliport was approved December 6, 1976, and adopted January 20, 1977. The special permit was for a 3-year period.

On January 27, 1977, New York Airways, Inc., applied to the Department of Marine and Aviation for an Air Facility License for the operation of a heliport on the roof of the Pan American Building. This license was granted on January 31, 1977, for 1 year. Operations began on February 1, 1977, and were conducted without incident until this accident. During this period New York Airways conducted 7,240 helicopter operations from the rooftop heliport.

1.17.2 History of S-61L Forward Lower Landing Gear to Fuselage Attachment Fitting Failures

On July 15, 1963, a forward lower landing gear to fuselage attachment fitting failed when a Los Angeles Airways S-61L, N300Y, was parked with rotors turning at the American Airlines gate area, Los Angeles International Airport. While ground personnel loaded mail aboard the aircraft, a snapping noise was heard, and the helicopter tipped to the right and rolled over on its right side. Outboard sections of the five main rotor blades contacted the ramp surface and separated. One person on the ground was injured and windows in the airline terminal building were broken.

Investigation revealed that forward lower landing gear fitting, P/N S6125-50312-22, had failed in fatigue and had separated, allowing the right main landing gear to collapse. This part had a total time of 1912:43 hours.

As a result of this occurrence, the manufacturer redesigned the forward and aft fittings, both left and right, as follows:

1. Forging material was changed from 7079T6 aluminum alloy to 7075T73 aluminum alloy.

2. Wall thickness of the tube portion of the fitting was increased from .120 to .160 inches.

3. The internally machined radius was increased to .12 inches.

The redesigned fittings were installed on all existing S-61L models (four at that time) per Sikorsky Service Bulletin 61 B25-1 dated September 18, 1963. Appropriate engineering drawings were changed requiring installation of the improved fittings. (PN's 6125-50333-21-22 and PN's 6125-50334-21-22).

Subsequently, all S-61L model aircraft, including those purchased by New York Airways, Inc., had the improved fittings installed. This accident resulted from the first failure since the redesigned fittings had been installed.

1.17.3 Normal Helicopter Operating Procedures

Experience has shown that the overall safety of helicopter operations is enhanced by operating the engines and rotor system during the frequent passenger enplaning and deplaning of normal scheduled operations. Dynamic components of a helicopter's main rotor system are not designed for frequent stops; therefore, rotor shutdown at each stop would shorten the service life of these components which are critical to safety of flight and would increase the possibility of component fatigue.

The stability of a helicopter is increased when the rotor blades are turning during high and variable wind conditions. Also, blade flapping at low rotor RPM during such wind conditions increased the possibility of blade damage to the aircraft's airframe.

1.18 New Investigation Techniques

None

2. ANALYSIS

The aircraft was certificated, equipped, and maintained according to applicable regulations. The aircraft's powerplants and systems were not factors in the accident. The gross weight and c.g. were within prescribed limits. The flightcrew was properly certificated and each crewmember had received the training and off-duty time prescribed by applicable regulations.

According to the flightcrew, passengers, and other witnesses, the landing on the heliport was gentle. The aircraft was taxied to the normal position without incident, and approved procedures were followed for passenger operations. The fact that the engines were operating, and the rotor was turning had no bearing on the failure of the landing gear. No control input was made which could have overloaded the part which failed.

The captain stated that he had his hands on the controls, and that the collective was bottomed, which would produce minimum torque on the engines. This setting was verified by the first officer. The cyclic was in the neutral position according to the captain and the first officer. The first officer stated that as the aircraft began to roll, he saw the blade tip path rotate with the aircraft and remain constant in the windshield in relation to the fuselage. The constant relationship shows that no cyclic input was induced which in turn would have tilted the rotorhead and the blade tip path plane.

The Safety Board reviewed the actions taken by the crew from the first sound of failure until the blades struck the heliport surface and concluded that the actions taken by the crew--to close the ESC's--were correct. The location of the aircraft and the number of people

around the helicopter, coupled with an unexpected noise from an area initially believed by the captain to be the rotor system, dictated that the engines be shut down immediately. The fact that both ESC's were shut down so quickly probably prevented further damage and injury and possibly prevented a fire.

The pilot's reaction of not applying the rotor brake was also correct. The rotor brake is not designed to stop a rotor head turning at 100 percent N_R quickly. It is designed to stop the rotor blades once N_R is below 40 percent. For an emergency shutdown the lever may be forced forward into the full on position, after closing the engine RPM control with a delay time of 5 seconds. Since the captain barely had time to close the ESC's before the blades struck the ground, the Safety Board concludes that he could not have used the rotor brake for an emergency stop of the rotor blades. At 100 percent N_R, the application of the rotor brake will cause the brake to heat up and possibly burn out, thereby creating a fire hazard.

The Safety Board, therefore, concludes that the failure of the gear was not the result of a pilot input.

The fracture of the right hand landing gear forward fitting, P/N S6125-5033-22, stemmed from a fatigue crack through 40 percent of the cross section.

The crack location in the bottom portion of the fitting suggested that bending stresses, which compressed the top of the fitting and placed tension on the bottom, had caused the fracture to begin and propagate. Planar orientation of the crack was diagonally downward and inboard through the support rib between the fuselage and lower diagonal tube attachment. Since fatigue cracks tend to propagate in a plane perpendicular to the direction of principle tension stress, a tension force along the diagonal tube may also have contributed to the crack propagation.

The material properties of the fitting, including the chemical composition, were considered normal for 7075-T73. Originally the fitting was designed using the alloy 7079-T6 (P/N S6125-50312). However, problems with stress corrosion cracking warranted changing the material to 7075-T73 (T73 condition is highly resistant to stress corrosion).

The radius showed no appreciable attack from corrosion, indicating this area was adequately protected against it. There was no indication of stress corrosion on the fracture surface although pitting of the fracture was noted. This pitting, however, was much more intense in the latter stages of fatigue propagation, indicating that the corrosion medium may have entered when the crack opened to the atmosphere (breaking through the support rib and lower portion of the fitting).

Two holes, however, did enter into the interior of the tube. These holes were located along the inboard edge of the adhesive just inboard of the tube end and were open between the external and internal radius of the fitting. An access, therefore, existed for water or other mediums to penetrate into the interior and collect along the lower portion of the radius. If the adhesive in the radius area contained minute holes through its thickness, then corrosion attack would have been highly localized, and would have produced discontinuities such as those found on the failed fitting.

The discontinuities found could also have been produced by normal microconstituent particles or phases in the material which were exposed to the surface. The sizes of the discontinuities, however, were much larger than the compound phases or particles found in the microsections which would mean that the discontinuities would have to be unusually large particles or groupings of second phase particles.

The substance found in the cavities of the discontinuities is believed to be the adhesive used in the assembly. It is not known whether the adhesive entered the cavity before or after the fracture.

The Safety Board, therefore, concludes that the fracture of the right main landing gear was the result of fatigue originating from a small surface pit of undetermined source.

Although, in this case, the rotating main rotor blades resulted in fatalities when the right landing gear failed, there is a good possibility that similar fatalities could have occurred if gear failure had occurred during shutdown or starting procedures. In considering all of the safety aspects of continued rotor rotation during enplaning and deplaning operations versus frequent rotor shutdowns, the Safety Board concludes that continued rotor rotation during such operations is, in most cases, safer. This conclusion is based on the fact that, (1) frequent rotor shutdowns shorten the service life of the rotor components and the engine by introducing more fatigue cycles thereby reducing the overall safety of operations, (2) potential safety hazards such as rotor brake fires, engine acceleration malfunctions, and main blade to fuselage contact due to excessive flapping at low rotor RPM are introduced by repeated rotor brake applications, and (3) the stability of the helicopter is increased due to the gyroscopic effects resulting from the rotating blades. Continued rotation is especially important for safety during variable, high wind conditions.

The heliport was certificated properly under 14 CFR 139. All the equipment which was required to meet the crash fire rescue (CFR) criteria was met or exceeded. The personnel requirements, as stated in the heliport manual, were met or exceeded.

The Safety Board also concludes that, although some confusion existed and some misunderstanding of CFR responsibilities were apparent, the CFR activities were effective for the situation.

The Safety Board recommends that the cockpit cabin door of the aircraft remain open. Helicopters operated under 14 CFR 127 are not required to have the cockpit door closed and locked as are aircraft operated under 14 CFR 121. Since the door is not usually used in normal operations, the Safety Board believes that it is unnecessary and could become an obstruction between the cockpit and cabin during emergency conditions.

3. CONCLUSIONS

3.1 Findings

1. The aircraft was certificated and maintained according to approved procedures.

2. All crewmembers were certificated and qualified for the flight.

3. The airport was properly certificated under 14 CFR 139, without exemptions.

4. The fracture of the right main landing gear forward fitting resulted from a fatigue crack.

5. The fatigue crack had initiated along the 0.12 inch internal radius near the bottom of one of the two location holes where the hole changes from a cylindrical to a conical shape.

6. Fracture features were typical of high cycle fatigue propagation from the origin areas and propagation down and through the bottom of the fitting.

7. All fractures outside the vicinity of the fatigue origin regions resulted from overload separations.

8. Hardness and electrical conductivity measurements of the failed fitting gave values normal for 7075 aluminum alloy heat treated to the T73 condition.

9. The failure of the landing gear did not result from any pilot inputs or operational overloads.

10. The flightcrew's decision to close the ESC's after a malfunction was suspected was proper.

11. The rotor brake could not have been used effectively to halt the rotor system in the short time interval between failure of the landing gear and rotor blade impact.

12. The CFR procedures for the heliport were adequate for the emergency.

13. New York Airways personnel accomplished effectively the CFR duties, although there was some confusion concerning overall supervision of specific duties.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the fatigue failure of the upper right forward fitting of the right main landing gear tube assembly. Fatigue originated from a small surface pit of undetermined source. All fatalities were caused by the operating rotor blades as the result of the collapse of the landing gear.

4. SAFETY RECOMMENDATIONS

As a result of this accident, on May 18, 1977, the National Transportation Safety Board issued the following recommendations to the Federal Aviation Administration:

> "Issue an Airworthiness Directive to require an immediate one-time inspection by an approved method on both the forward and aft main landing gear attachment fittings, right and left, on all Sikorsky Model 61L series helicopters having similar installations. (Class I - Urgent Followup) (A-77-32)
>
> "Reevaluate the current inspection interval and issue requirements for more frequent periodic inspections if necessary to insure continued safe operation. The inspection interval could be based on a set number of operating cycles instead of an established operating time. (Class II - Priority Followup) (A-77-33)"

Upon receipt of these recommendations, the Federal Aviation Administration issued a telegraphic airworthiness directive which:

(1) Required, prior to next flight, a fluorescent penetrant inspection of the forward and aft main landing gear attachment fittings, right and left, on all affected Sikorsky Model 61 series helicopters. In addition, a visual inspection was required prior to the first flight of each day.

(2) Required the reevaluation of the current inspection interval and issue requirements for more frequent periodic inspections if necessary to insure continued safe operation. The inspection interval could be based on a set number of operating cycles instead of an established operating time.

As a result of the cockpit door of the S-61L sliding almost closed and jamming, on July 13, 1977, the Safety Board subsequently recommended that the Federal Aviation Administration:

"Require that the sliding cockpit door on the Sikorsky S-61L helicopter be removed or retained open so that it cannot obstruct the entrance from the cockpit to the cabin area. (Class II-Priority Followup) (A-77-51)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ KAY BAILEY
Acting Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ WILLIAM R. HALEY
Member

October 13, 1977

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was notified of the accident about 1745 on May 16, 1977. The investigation team went immediately to the scene. Working groups were established for operations/weather/airports/air traffic control, human factors, witnesses, structures/systems, powerplants/maintenance records, and cockpit voice recorder.

Participants in the on-scene investigation included representatives of the Federal Aviation Administration, Sikorsky Aircraft, New York Airways, Inc., New York City Transportation Department, Air Lines Pilots Association, and Association of Flight Attendants.

2. Hearing

A public hearing was not held.

APPENDIX B

PERSONNEL INFORMATION

Captain Lee G. Richmond

Captain Lee G. Richmond, 46, was employed by NYA on February 24, 1964, as a first officer. He was qualified initially in the S61N on March 22, 1964, and upgraded to Captain on November 17, 1970. His initial Category-A Edge qualification was on April 23, 1971.

Captain Richmond's last line check was on June 28, 1976. He had completed proficiency checks/recurrent training on January 12, 1977, and July 13, 1976. He received an Edge Procedure Checkout and Line Check on February 1, 1977. This period also included a 1 hour ground school on edge procedures.

Captain Richmond holds Airlines Transport Pilot Certificate No. 644892 dated November 11, 1970, with the following ratings: Rotorcraft - Helicopter BV-107-II (VFR only) SK-61; Commercial Privileges airplane single-engine, land and sea; airplane multi-engine land, glider, instruments.

His first-class medical certificate was dated April 21, 1977. It had no limitations.

Captain Richmond had about 11,721 total hours of flight time at the time of the accident, 9,000 of which were in helicopters. He had about 2,200 hours in S61 helicopters. In the previous 30 days he had recorded 50:30 hours as a S61 helicopter captain and 9:20 hours other helicopter time.

In the 24-hours before the accident he had recorded 3:48 hours rotor time as an S61 captain.

First Officer John F. Flanagan

First Officer (F/O) John F. Flanagan, 31, was hired by New York Airways on April 8, 1977. His initial S61 qualifications was on April 16, 1977, and his Edge Procedure Qualification was completed on April 15, 1977.

First Officer Flanagan holds Commercial Certificate No. 1987361 with the following ratings: Airplane single-engine land, rotorcraft-helicopter instruments including helicopter. The date of his certificate was January 6, 1970. His second-class medical certificate was dated August 26, 1976, and had no limitations.

First Officer Flanagan had a total of 1,768.4 hours of flying time, with 1,339.2 hours recorded in helicopters. His total S61 time was 61 hours, all flown in the 30 days prior to the accident. He had recorded 3:48 hours rotor time in the 24 hours before the accident.

The day of the accident was the fourth consecutive day that each pilot had flown. On the first day of this sequence they did not fly together. However, they flew together on the second and third days, and the day of the accident. They reported for duty at JFK at 1402 on the day of the accident. Each had been off duty since 2117 the previous day. At the time of the accident each pilot had been on duty 3:33 hours.

Flight Attendant Lammie Chevalier

Flight Attendant Chevalier was employed by New York Airways in 1973. She was current and qualified to perform her prescribed duties.

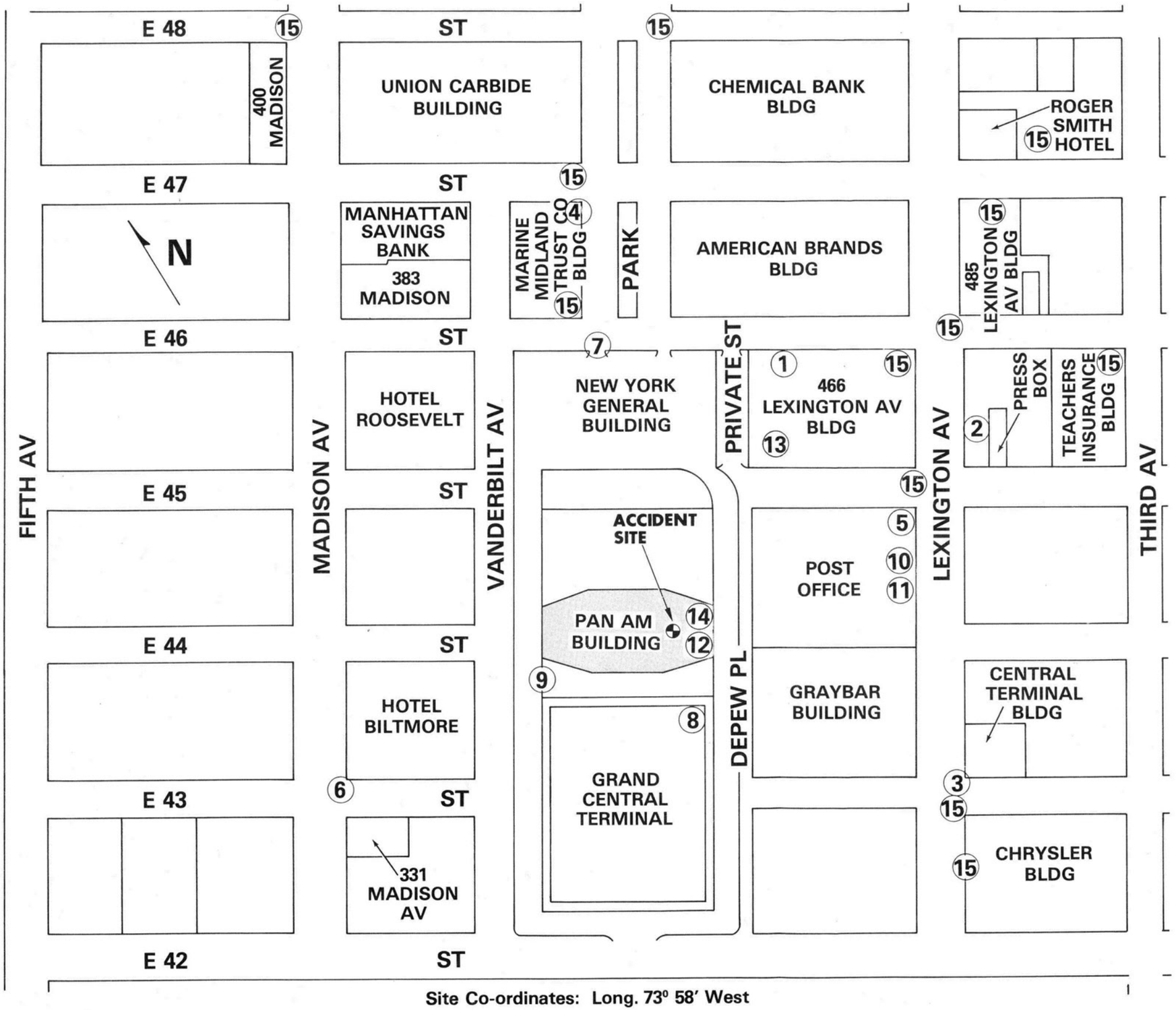
APPENDIX C

AIRCRAFT INFORMATION

Sikorsky S-61L, N619PA (S/N 61427) was manufactured in June 1968. It was owned by the General Electric Credit Corporation of Georgia and operated by New York Airways, Inc. It was certificated and maintained according to procedures approved by the FAA. At the time of the accident the aircraft had accumulated about 6,913:15 flight hours and 7:22 flight hours since its last major inspection.

The aircraft was equipped with two General Electric CT58-140-2 engines. Engine serial numbers and times are as follows:

Position	Serial No.	Total Time
1	295063C	7,201:44
2	295069C	6,517:52



Site Co-ordinates: Long. 73° 58′ West
Lat. 40° 45′ North

APPENDIX 'D'

LEGEND:

1. 4′-5″ Outboard Section — Main Blade Spar
2. 4′-6″ Spar Section — Outboard End Tip
3. 4′-1″ Spar Section — Outboard End Tip
4. 4′-0″ Spar Section — Outboard End Tip
5. 0′-11″ Spar Section — Outboard End Tip
6. 2′-3″ Spar Section — Outboard End Tip
7. 4′-2″ Outboard Section — Main Blade Spar
8. 2 Twelve Inch Wide Trailing Edge Pockets
9. 10′-6″ Center Section — Main Blade Spar (Penetrated Window of Office 36th Floor)
10. 2′-4″ Outboard Section — Main Blade Spar
11. 1 Twelve Inch Wide Trailing Edge Pocket
12. 3′-6″ Outboard Section — Main Blade Spar (On Heliport)
13. 4′-2″ Outboard Section - Main Blade Spar (Outside Room 369-466 Lexington Ave.)
14. 19′-2″ Center Section — Main Blade Spar (On Heliport Just Forward of Aircraft Nose)
15. Miscellaneous Blade Parts — Pockets, Leading Edge Counterweights (11 Locations)

Helicopter Location

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

Wreckage Distribution Chart
New York Airways Inc.
Sikorsky S-61L N619PA
Pan Am Building Rooftop Heliport
Manhattan, New York
May 16, 1977

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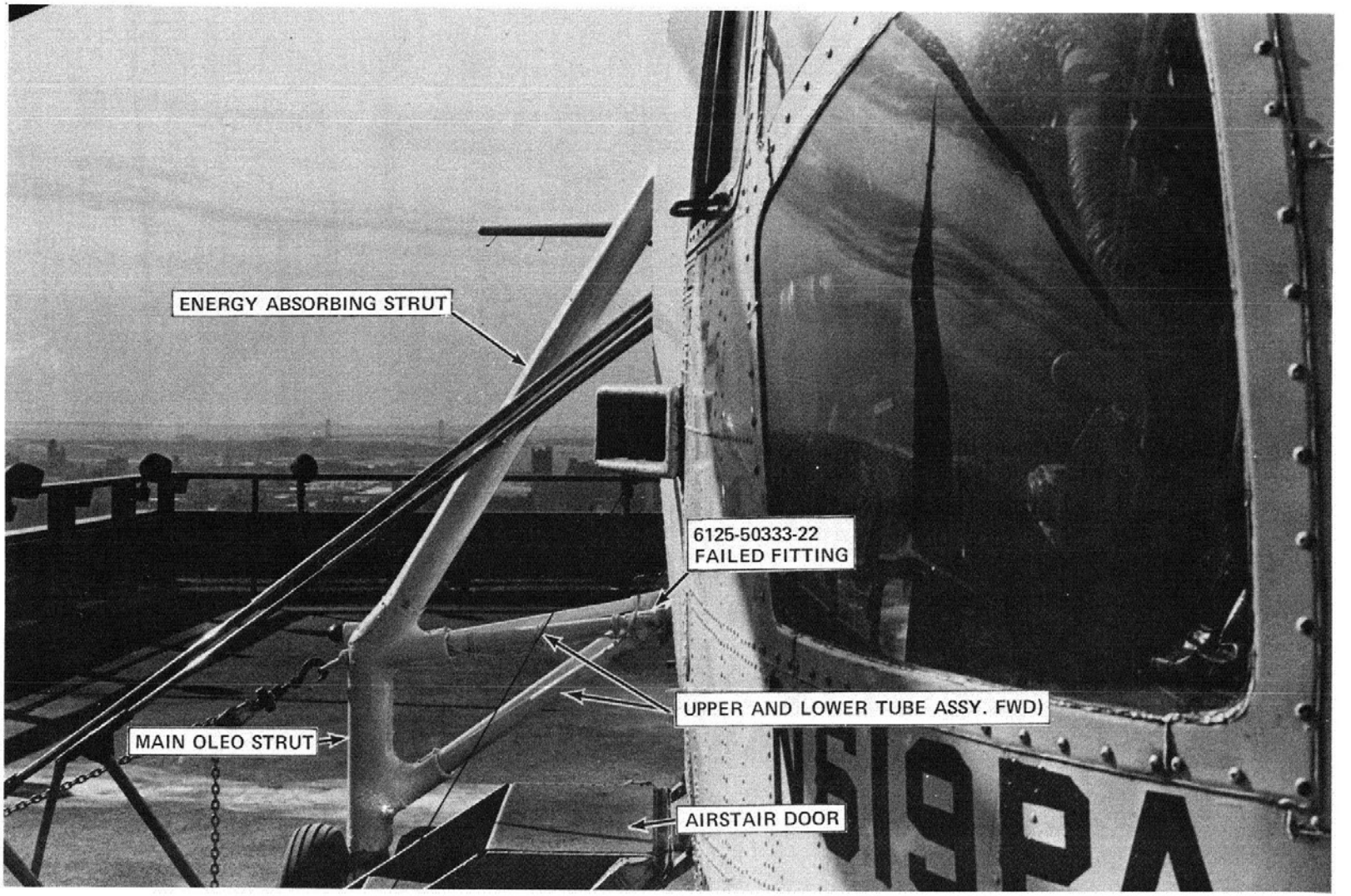
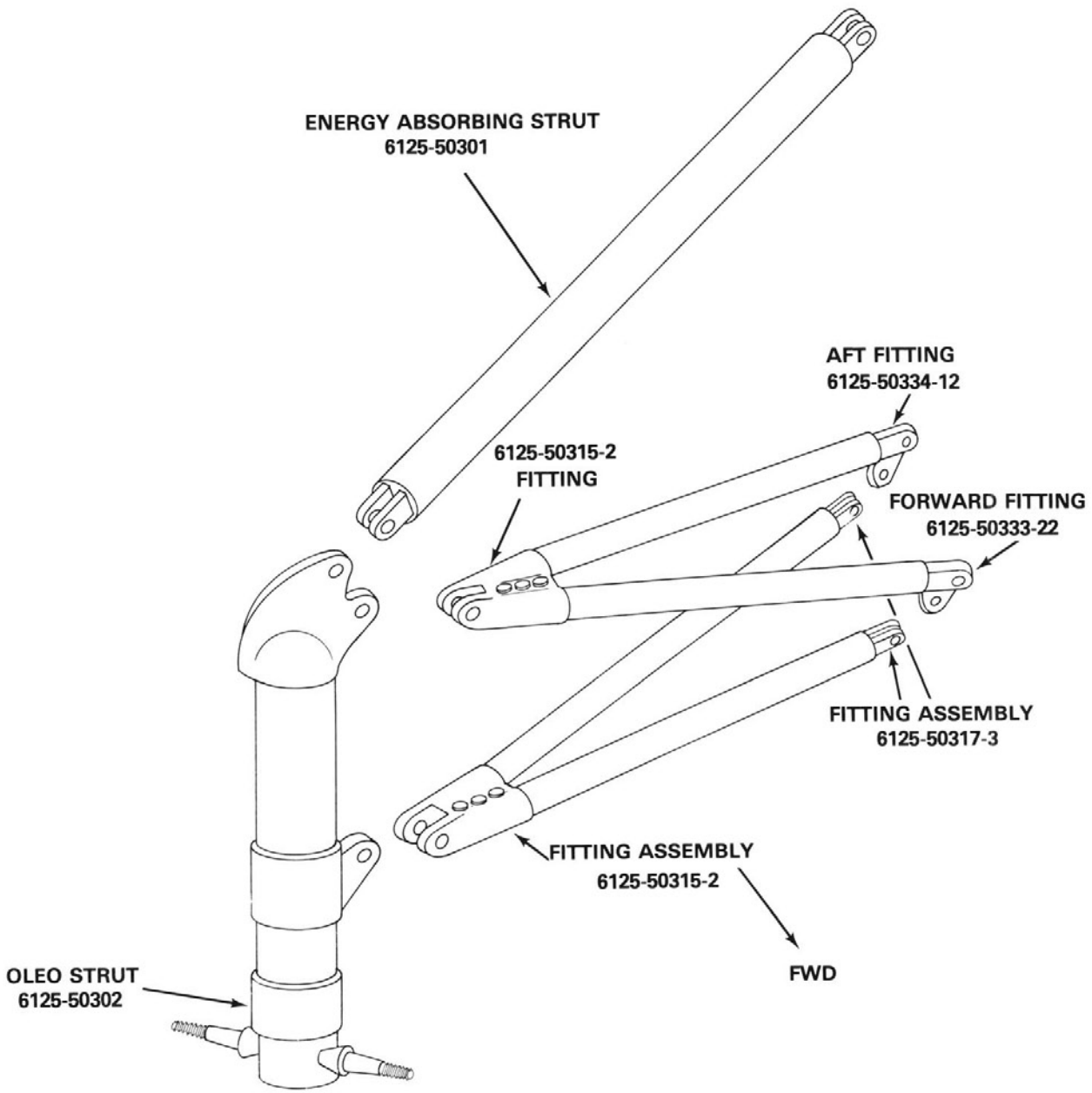


Right main landing gear - S-61L-N619PA photographed on
Pan Am Building rooftop heliport (prior to May 16, 1977 accident date)



S-61L MAIN LANDING GEAR

APPENDIX F

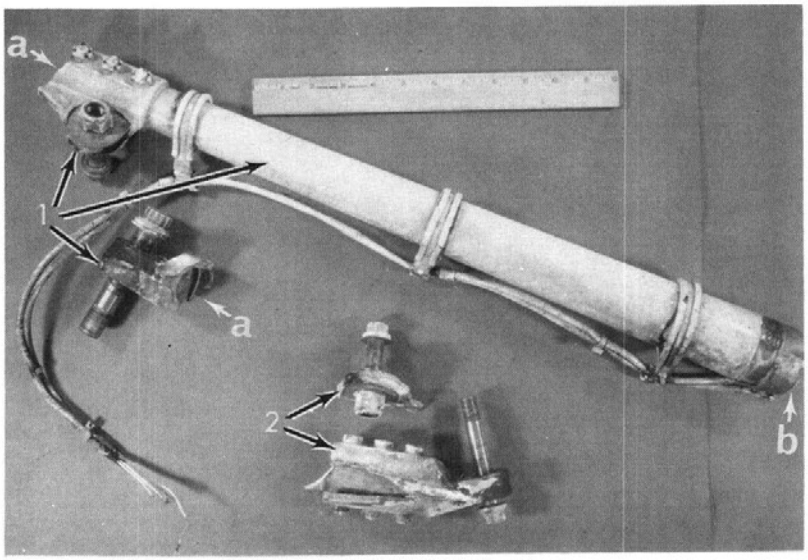


Figure 1. Overall view of the components, as received. 1.) Forward main landing gear fitting and tube assembly. 2.) Aft main landing gear inboard fitting with portion of tube.

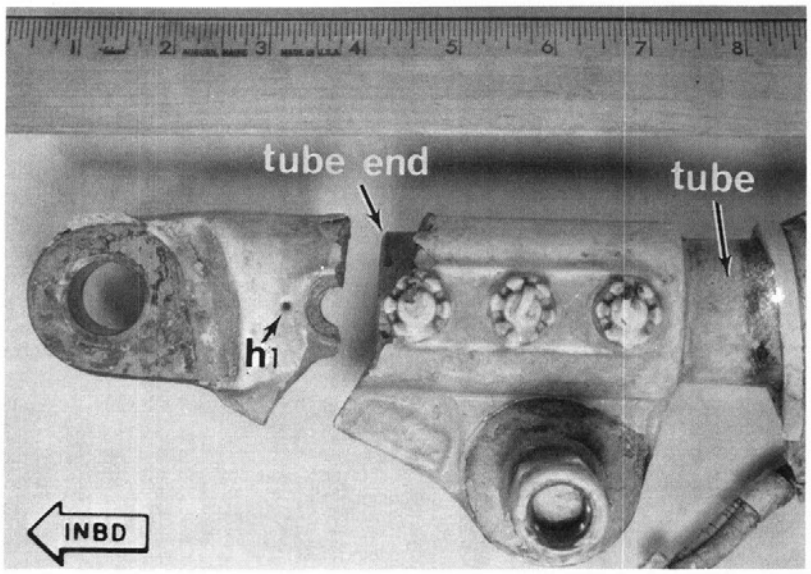
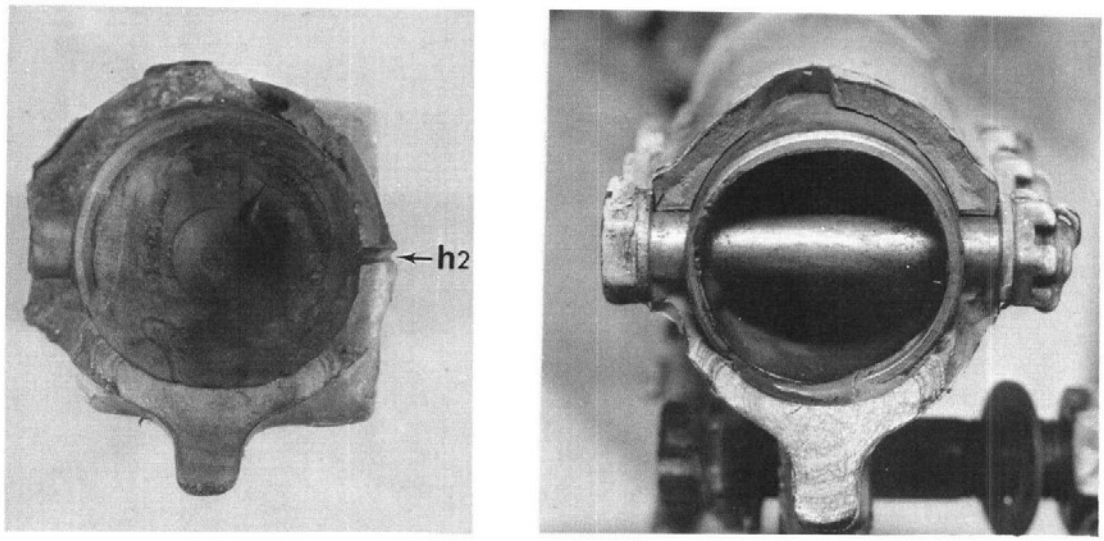


Figure 2. Right hand main landing gear fitting (P/N S6125-50333-2) with the fractures (arrows "a" figure 1) placed relative to each other as if intact. Inboard attachment bolt was removed from the hole.



Looking Inboard Looking Outboard

Figure 3. Mating fracture surfaces on the P/N S6125-50333-2 fitting. Both photographs approximately X1 1/4

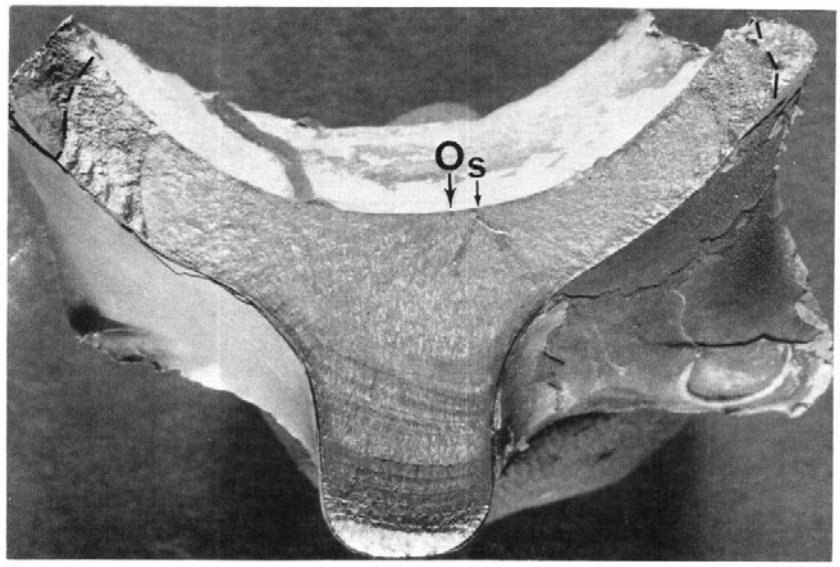


Figure 4. Portion of inboard fracture surface removed for detailed fractographic examination. Arrow "O" denotes main origin and arrow "S" locates secondary origin while dashed lines indicate approximate extent of fatigue propagation from these origins.

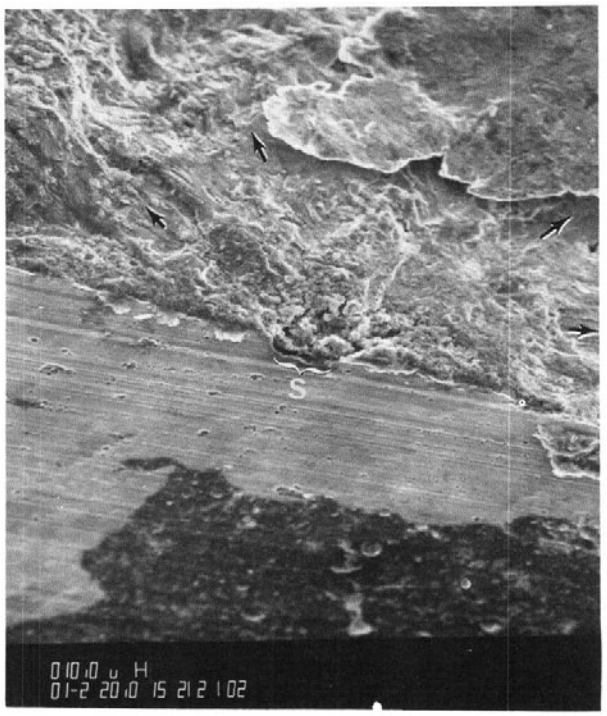


Figure 5. SEM photograph showing secondary origin bracket "S" (see arrow "S" in figure 4 for location). Fracture surface is above origin and hole radius is below. Arrowheads depict fatigue propagation direction. X100

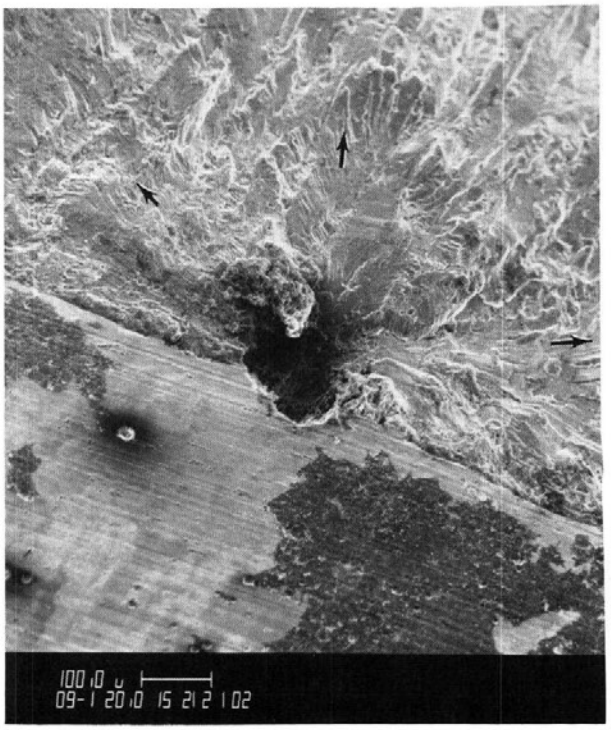


Figure 6. SEM photograph of main fatigue origin area (see arrow "O" figure 4 for location). Arrowheads indicate fatigue propagation directions. X90

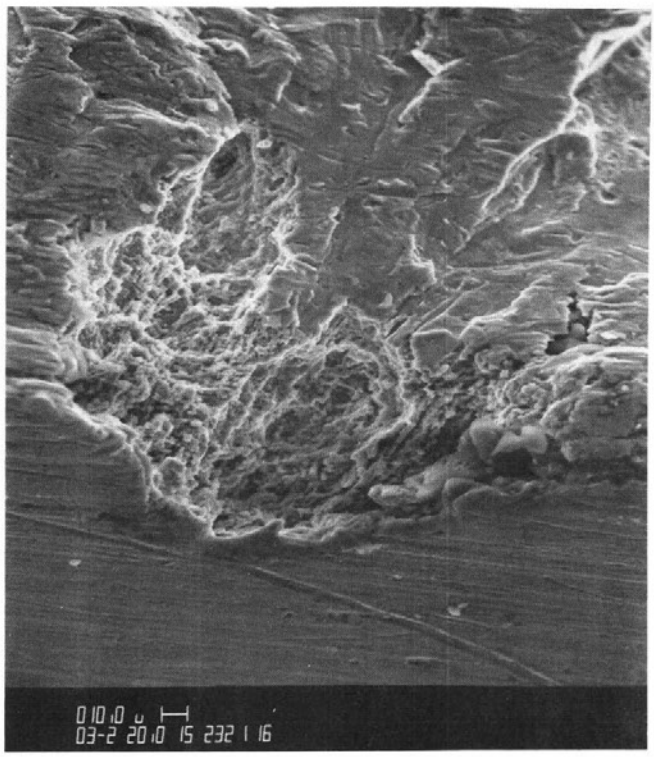


Figure 7 Main origin area shown in figure 6 after extensive cleaning by replication. X300

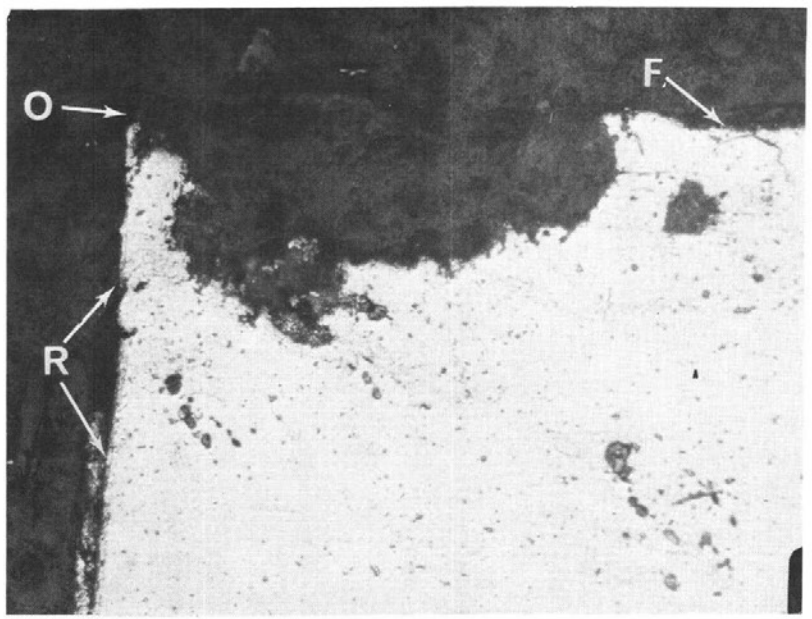


Figure 8. Longitudinal metallographic microsection through the main origin area showing the discontinuity in profile. Arrows "R" and "F" indicate the radius and fracture profile respectively. X375 Kellers etch

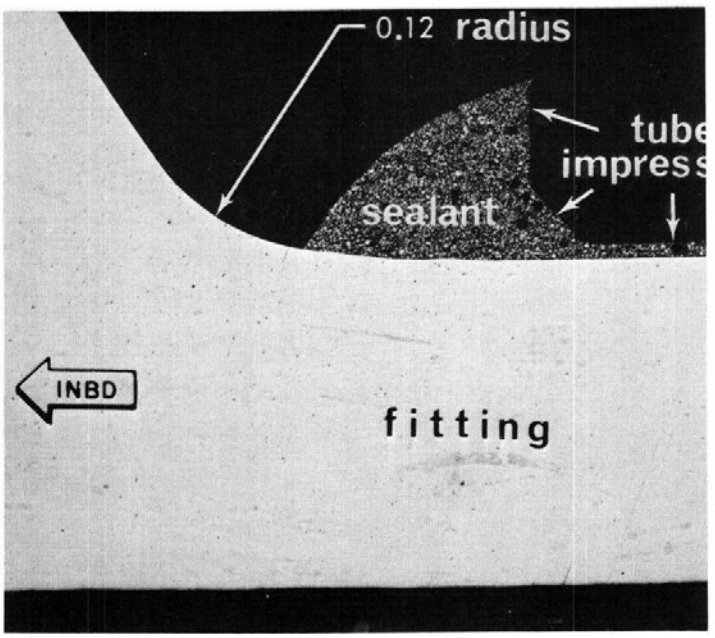


Figure 9. Longitudinal section through the fitting radius at a location diametrically opposite the fatigue origin. X10 unetched

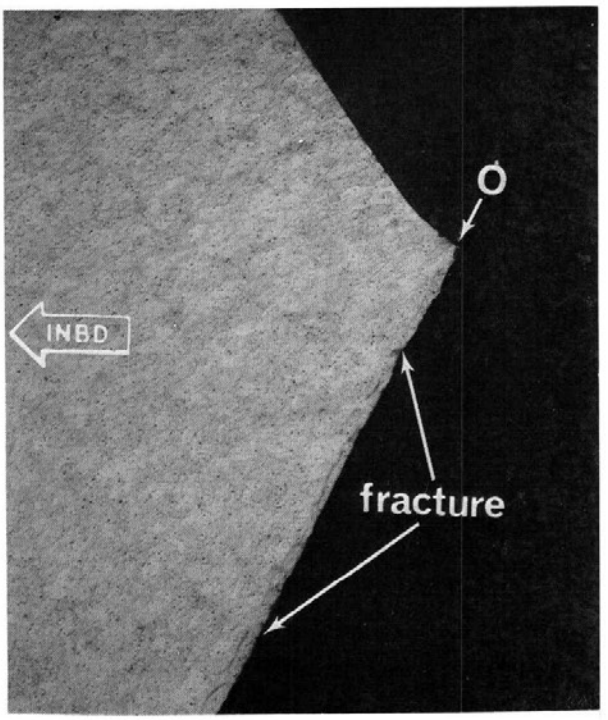


Figure 10. Longitudinal section through the main fatigue origin area. Arrow "0" indicates same area depicted by arrow "0" in figure 8. X10 nital etched

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