~1955

FJ-3 "Fury"

≈55

FJ-3, F-1C

The design of a new Fury version, the NA-194, began in March of 1952. The engine of the NA-194 was to be the Wright J65-W-2, a license-built version of the British-designed Armstrong-Siddeley Sapphire turbojet. The thrust of the J65 was 7800 pounds, as against the 6000 pounds offered by the J47-GE-2 of the FJ-2. The higher thrust provided by the J65 offered the Navy the possibility of markedly enhanced performance, and a contract for 289 examples of the NA-194 was given to the Columbus plant on April 18, 1952. The designation FJ-3 was assigned by the Navy. Serials were BuNos 135774 through 136162.

In order to serve as a testbed for the FJ-3, the fifth FJ-2 (BuNo 131931) was fitted with a J65-W-2 engine. The NAA designation NA-196 was assigned to this project, and the modified FJ-2 flew for the first time on July 3, 1953.

The modified FJ-2 (131931) had retained the original nose intake of the stock FJ-2, but it was discovered during flight tests that the increased power offered by the J65 required that the nose air intake be made somewhat larger. Consequently, the production FJ-3 was provided with a larger nose intake to provide more air. However, the slatted wings and the hydraulic power-operated horizontal tail and ailerons of the FJ-2 were retained. Four 20-mm cannon were provided, with 648 rounds of ammunition. Cockpit armor included a 52-pound back plate and an 88-pound plate in front of the instrument panel.

The first production FJ-3 (BuNo 135774) rolled out of the Columbus factory and flew for the first time on December 11, 1953. William Ingram was the pilot. The engine was the 7650 lb.st. J65-W-4.

By July of 1954, twenty-four FJ-3s had been delivered, and the aircraft began its Fleet Introduction Program at the Naval Air Testing Center (NATC) at Patuxent, Maryland. The flavor of the test flying environment at Patuxent during the mid-1950s was described very well by Tom Wolfe in his book *The Right Stuff.* Most of the early Navy jets had lots of quirks and were often quite dangerous to fly, and there were numerous accidents. I lived just across the Chesapeake Bay from Patuxent at that time, and scarcely a month would go by without at least one crash of a jet fighter being tested there. However, by the standards of the day, the FJ-3 went through its test program with relatively few problems being uncovered, although 135785 (#12) did manage to explode in midair and crash because of the ingestion of a foreign object, and the pilot of 135786 #13 got himself lost, ran out of fuel, and had to ditch in the Patuxent River.

Navy Squadron VF-173 based at Jacksonville, Florida was first to receive the FJ-3, becoming active with the fighter in September of 1954. The FJ-3 made its first carrier landings aboard the USS *Bennington* (CVA-20) on May 8, 1955. On January 4, 1956, an FJ-3 flown by Cdr. Ralph L. Werner of VF-21 became the first aircraft to land aboard the USS *Forrestal*, the first of the new class of post-war giant carriers.

During the mid 1950s, the US Navy developed a mirror system to replace (at least partially) the paddle-waving LSO in guiding a pilot's approach to a carrier landing. The first mirror landing was made by Cdr. Robert D. Dose on August 22, 1955, when he landed his FJ-3 aboard the USS *Bennington.*

On July 1, 1955, the Navy abandoned the deep blue color scheme that had been used throughout the Korean War, and adopted a color scheme in which the upper surfaces were dull grey and the undersurfaces were white.

The early FJ-3s had wing slats. On later FJ-3s, the wing slats were abandoned in favor of extended wing leading edges with a leading edge fence on each wing. The wing area went from 287.9 to 302.3 square feet. Space in these wing leading edges was used to accommodate 124 gallons of additional fuel, and many earlier FJ-3s were retrofitted with this extended wing leading edge.

12/07/1955
&
11/09/1956

XP6M
"Seamaster"
Flying Boat

12/07/55

Martin XP6M "Seamaster" Flight Test Accidents

In the early 1950s the US launched a very large program to complement the USAF long range bombers. A long range, high speed, low level interdiction naval aircraft was envisioned. There were strong disputes between the AF and Navy over this program, so the airplane was the center of controversy before it ever flew. There is a good amount of info available on this airplane.

The P6M was an advanced airplane for its day. It was one of the first with all hydraulically powered flight controls. It featured an all-flying tail, with elevators geared to the horizontal stab. One of the main missions was low altitude (read Sea Level) penetration and mine laying at 0.9Mn. The P6M was a large (over 150,000lbs) airplane with a +3.8/-1.8G design load factor. Using "q times load factor" as a measure of required structural "beefiness" it was quite a design challenge. If gross weight is considered a multiplier for complexity then the design challenge is even greater.

Part 1 - The first XP6M airplane suffered a catastrophic accident on December 7th, 1955. First flight had occurred in July of that year, with some 37 flight hours and 42 taxi hours accumulated over some 23 airborne flights and 16 "non-airborne" flights.* Due to the controversial nature of the program, an early Navy "preliminary evaluation" was scheduled. Four flights with two Navy pilots were planned. The standard test crew of four would be on-board with one Navy pilot, a Martin pilot as PIC with a Martin Flight Engineer and Test Conductor completing the crew. Due to low clouds the test plan had to broken up into packets. A non-airborne flight with the first Navy pilot had been conducted the previous day, with an airborne flight with that pilot conducted first on Dec 7th. The subject flight was the first with the second Navy pilot and the second of the day. A "change-of-pilot" turnaround was accomplished. This was the second two-airborne-flight day of the program, and possibly the first "quick-turnaround" (ie; no ground inspection) airborne-flight day of the program.

*Note that "rollout" occurred in Dec 1954.

"Weather conditions were not unusual" – report quote. Winds were low, cloud cover at 10-12kft, with OAT of 36deg F. Takeoff was at 3:05PM with the accident occurring some 13 minutes later. The test plan called for a series of static longitudinal stability test points to be accomplished first. These were planned for low altitude and moderately high speed (~10k ft and 0.85Mn – the interim "Vmax"). Observers reported seeing the AC in a shallow descent with an exhaust trail. A composite of their observations was put together. At about 3k to 6k ft a minor explosion or breakup occurred accompanied by a puff of white smoke or vapor. The only onboard date retrieved was a photorecorder film frame about two minutes before the breakup.

The accident report states the exact cause was not determined, but is believed to be a runaway stabilizer. Seven possible causes of stab movement were considered, with three deemed "unlikely". The four most likely causes are:

A) Explosion in wing stub or fwd plumbing area;
B) Broken or snagged cable;
C) Loss of pilot's elevator load feel System;
D) Loss of one hydraulic system.

Inflight measurement of loads/moments had not been accomplished as yet due to instrumentation problems and schedule. A longitudinal control anomaly was reported on the previous flight that day. This was the first flight in the A/C for the Navy pilot. There was no radio following, chase A/C, nor T/M. The intercom "wire" recording was found jammed from previous landing. Chase coverage had been planned. A Navy chase was down for a maintenance problem. A USAF chase had run out of fuel, and the second Navy chase was not yet serviced for flight. The protocol as to whether a chase was required was not mentioned in the report.

The Navy "evaluation" was to be within the contractor tested envelope. As the full flight envelope had not been cleared the airplane was operating under a set of "interim" flight restrictions. The nature and formality of these was not spoken to in the report. Rime ice had been noted on the flaps on previous flight of day. Ice Protection use was not mentioned anyplace in report even though the departure OAT was just above freezing.

The airplane was equipped with four ejection seats. The sequence was to be FE, FTE, C/P and lastly pilot. The FE & FTE ejected, but did not survive. The pilot (Navy) and C/P (Martin) stayed with the A/C. The FTE had not attached the automatic opening lanyard of his parachute. The FE had done so, and his chute opened. Both he and the FTE ~~were~~ may have been rendered unconscious during the ejection. The FE did not have an automatic inflating Mae West (none of the crew did), and so drowned.

A thorough and wide ranging investigation was conducted. It was hampered by the fact that no onboard recorded data was retrieved. Digital data recording systems were coming into use as was telemetry, but these were not in use on this airplane. Most of airplane was salvaged from the water. So the conclusions had to be based on investigation of the recovered structure/equipment.

Reconstruction of the nature/timing of the inflight break-up led to conclusion that the airplane essentially conducted the first part of an outside loop. This in turn led to investigation as to why, and to "highly likely" cause of movement of horizontal stabilizer in "leading edge up" direction. At the high "q'" condition that existed, analysis yielded a result that two degrees of movement were needed to produce the motion needed. Recall that the elevator is geared to the stabilizer so that the elevator panels would have also produced a nose down moment. The investigation then focused on what would have produced such motion. This resulted in the seven possible causes with the four most likely mentioned previously.

A good portion of the report speaks to horizontal tail hinge moments. The horizontal stabilizer is moved by a hydraulic actuator powered by two hydraulic systems which act in tandem (ie; if one system is depressurized then the force output of the actuator is reduced). This was done as the ability to predict hinge moments during the design phase was admitted to be somewhat imprecise. The flight tests to measure/determine them had <u>not</u> been done at the time of the accident. The report states that if a hydraulic system had failed, the hinge moments (load) imposed on the actuator would have been reasonably close to its capability. The accident report for the 2nd aircraft also speaks to this subject in detail. It states that an error existed in computing the horizontal hinge moments from different wind tunnel tests during the design phase, but that the revised levels were not so large as to be the cause for this accident on this airplane, except in the case of a failed hydraulic system. However the accident report for this airplane does not speak to this finding.

An airplane level "shaking" had been reported on contractor flights while at the higher Mns at lower altitudes. It was also noted on the first Navy evaluation flight.

So; several questions and lessons learned can be raised/gleaned.

(1) The installation of ejection seats certainly shows the willingness to provide significant (ie; costly) safety devices for the program. The 2nd airplane was not going to have them installed.
(2) Since the ejection seats had been installed and the test program was by definition over water, the lack of self-inflating Mae-Wests can be called into question.
(3) The fact that one crewmember had not attached his auto-deploy lanyard indicates that a pre-test-point checklist was not used.
(4) The unnoticed failure of the intercom recording devise on the previous flight indicates there was no preflight check of it done or in-place. To be fair, this was a "quick turnaround" for pilot change only.
(5) The lack of a chase airplane is a subject open to debate.
(6) As this was an advanced airplane, one can argue a procedure should have been in place requiring every flight to have a chase. However it can be argued that since the "Navy Evaluation" was to be within the cleared envelope and to be non-hazardous maneuvers, requiring a chase would not be warranted. Ed – upon reading the entire report I am struck with similarity to own experience in that early flights on a new airplane are filled with myriad "anomalies" not related to the test points of the day. Leaks, trailing vapor, loose parts, etc are all every day situations. This was the case here. A chase adds an additional means of confirmation that an anomaly is serious or not, or even exists.
(7) The fact that the 1st navy pilot reported a longitudinal control system anomaly (the column jerked forward ~2 inches and then returned to neutral) on the first flight of the day, and this did not prompt a ground check prior to committing to a next flight might be subject to critique. But I suspect many of us have been on "demo" flights where the guest pilot reports something not seen by the main test team, and his input is given somewhat short shrift. Also without doubt, the desire to get the "evaluation" completed was strong. Of note; the anomaly occurred at essentially the same flight condition as the accident pitchover
(8) The lack of periodic radio contact/following could be subject for critique, although the flight was only 13 minutes from takeoff.
(9) Whether the basic criteria that the "preliminary evaluation" was to be conducted within the previously tested contractor envelope was followed can be debated. While individual test point variables (GW, CG, Speed/Mn) were within previously test points, the combination that existed on the subject flight had <u>not</u> been previously tested (Ed determination from report). As example; the airplane was loaded to 160,000 lbs. at 38% MAC (Aft) CG. These were the <u>maximums</u> flown

by the contractor on previous flights, but not on the same flight. The static long stab tests scheduled had been conducted at the scheduled speed and CG, but not as low an altitude as scheduled nor at as heavy a weight as scheduled. To be fair, speed and CG are considered the most important variables, and were kept "not outside" previous tests. The intercom transcript of the previous flight (the first navy eval flight) reveals an inflight discussion, just prior to test point conduct, about the amount of aileron control to use for a roll rate test at the interim Vmax of 0.85Mn. Deliberate and repeated flying into the regime where the "shaking" occurred can also be questioned. Again, to be fair, a favorable evaluation by the Navy was critical to Martin, and they would certainly want to show as much of the airplane's capability as possible.

DJH~2011

Part 2 - To be added

12/7/55
11/9/56

Martin 270, 275

P6M SeaMaster

In its last major aircraft design, Martin returned to an earlier concept of the flying boat as a bomber. By the end of the 1940's the Soviet Union had tested a nuclear bomb, and the Cold War was in full swing. The newly created Air Force was busy buying and deploying long-range bombers to deliver nuclear weapons, a monopoly viewed by the Navy as unacceptable. Noting the inherent limitations of its force of short-range carrier attack and maritime patrol aircraft, the Navy looked at several means of joining the Air Force as in strategic deterrent. A super-carrier (the United States) was designed to handle larger propeller and jet aircraft then under design. The United States ran afoul of military budget limitations and vehement opposition from the Air Force "bomber lobby." The Navy Bureau of Aeronautics then developed the concept of a "Seaplane Striking Force" centered around the development of large jet-powered seaplanes that could offer performance equal to that of land-based jets. Capable of operating from most of the earth's surface, a small number of these seaplanes could perform mining, conventional and nuclear strike, and photo reconnaissance missions that would complement those of the new Strategic Air Command. With only a tender or submarine needed for re-arming and re-fueling, the SSF promised an economical means of force projection.

Requests to industry were let in April 1951. After a short but fierce design competition with Convair, Martin was awarded contracts for two prototype XP6M-1's, six pre-production service-test YP6M-1's, and up to 24 production P6M-2's. Martin named the SSF aircraft the SeaMaster. The Navy was now in the bomber business.

Design specifications for the SeaMaster were demanding. Required to carry 30,000 pounds of payload to a target 1,500 miles away, the plane was also required to be capable of a high-speed dash at .9 Mach at low altitude. Its hull had to be stressed for open-ocean operations. Design Engineer George Trimble, hydrodynamicist J.D. Pierson, and aerodynamicist J.L. Decker led the design team. Refining work already done on the Marlin's hull design, they adopted a new length-to-beam ratio of 15 to 1 as most efficient in both air and water. The XP5M-1 airframe was rebuilt to test the new hull, redesignated Martin Model 270. Hydroflaps like those on the Marlin were fitted for dual use as air brakes.

A compound turbo/ramjet from Curtiss-Wright was initially designated as the SeaMaster powerplant. After several failures in testing, this engine was dropped in favor of modified Allison J71's, mounted in tandem overwing nacelles. The P6M had the same variable-incidence "flying" T-tail and spoiler ailerons as the XB-51, and its payload was carried in a rotating bomb-bay, pneumatically sealed to be watertight. Swept wings with slight anhedral drooped close enough to the water for wingtip tanks to serve as stabilizing floats, without the drag of struts. The overall result was an airplane with proportions so sleek and simple that they could be described as classic.

The first prototype was rolled out in secrecy on December 21, 1954, and after several months of load-verification tests the XP6M-1 finally took to the air on July 14, 1955, flown by Martin chief test pilot George Rodney. Initial tests revealed only one major problem that required a "fix": the design of the nacelles allowed the afterburner exhaust to scorch and sonically fatigue the rear fuselage. After keeping the plane's development secret, the Navy invited the press for the roll-out in November of the second prototype, which was outfitted with a complete set of navigation and bombing equipment.

All went well with the testing program until December 7, 1955 (two days after the death of Glenn L. Martin), when the first XP6M-1 prototype crashed into the Chesapeake Bay during a routine check ride for the first Navy pilot. All four members of the crew were lost. With no onboard data recorders to help, the accident-investigation team was unable to find a specific fault. Months were lost re-configuring the second prototype with test instrumentation and ejection seats for all the crew. It was not until May, 1956, that flight testing resumed with Ship #2.

By autumn, solutions were being sought for a frequent airframe buzz that plagued both prototypes. One "fix" involved locking the elevators together with the variable-incidence "flying tail." A test flight on November 9 verified that improvement in the vibration, however, in recovering from a shallow dive at high speed, pilot Bob Turner lost pitch control of the aircraft, which started a violent outside loop. The crew ejected safely as the airframe broke up. Information from the flight data recorders indicated that the modified tail configuration had been overpowered by dynamic forces at high speed, due to a previously undiscovered mathematical error in calculating loads for the hydraulic control actuators.

Even at this low point in the program the Navy BuAer still saw promise in the concept and optimistically continued funding for the SeaMaster and a number of expensive "options." A beaching cradle was designed that allowed SeaMasters to taxi in and out of the water on their own power. Two old amphibious-warfare dock ships and two conventional seaplane tenders began shipyard conversions as support ships for the SSF. The submarine U.S.S. Guavina, redesignated as an AO(SS) "oiler," was equipped to refuel SeaMasters at secret seadromes. There were also plans to use an old escort carrier equipped with a retractable rear ramp for "beaching" P6M's, which were too heavy to be hoisted aboard by cranes. Finally, an auxiliary naval air station was refurbished to serve as the SeaMasters' home base; it occupied 1,265 acres at NAS Harvey Point, near Elizabeth City, N.C.

Meanwhile service-test YP's were completed with "fixes" for the problems encountered in the prototypes. Engine nacelles were canted out five degrees from the fuselage and the intakes moved back from the wings' leading edges. Hydraulic control systems were upgraded in the tails. A year after the second crash, the first YP6M-1 was rolled out and flight testing resumed in January 1958. Five other YP's joined the program during 1958, and tests were carried out at a feverish pace. Mine-laying and navigation systems were qualified even though standard Navy mines could not yet withstand sea impact when dropped at high speed. Conventional and "special-weapon" (nuclear) practice shapes were successfully dropped from the rotary bomb-bay, and night and day photo reconnaissance pods were tested.

Early in 1959 production P6M-2's began to emerge from the Martin plant, and the full potential of the design was realized. Installation of newly developed Pratt and Whitney J75 engines gave the P6M-2's nearly 12,000 more pounds of static thrust. This allowed the gross weight to be increased to 195,000 pounds from 171,000 pounds in the YP's. Increased weight meant a greater draft for the hull, which in turn necessitated raising the wing anhedral to zero degrees. Other improvements included full-visibility canopies and transistorized Sperry navigation and bombing systems. Production P6M-2's were equipped with midair refueling probes, and "buddy-pack" refueling kits were designed to fit inside SeaMaster bomb-bays, allowing fast conversion into tankers.

Pilots reported that the planes handled well and were capable of flying Mach .89 "on the deck." This was important, as the development of radar-guided surface-to-air missiles had made low-level flying an essential part of strategic penetration missions. The SeaMaster's wings were especially strong for the extra stress of high speeds through thick air; the aluminum skin at the wing roots was an inch thick. By contrast, the Air Force's B-47 could only manage about Mach .58 at low altitude, the newer B-52 only .55.

By the summer of 1959 all-Navy crews had begun flying three P6M-2's completed so far, and it appeared that operations could begin by early 1960. Rising costs, however, had led to two cutbacks, reducing the number of production items to eighteen, then eight. Then the bottom dropped out altogether. Citing "unforeseen technical difficulties," the Navy cancelled the entire program on August 21.

The decision was and still is highly controversial. More than $400 million had been spent on equipping the SSF, but during its long gestation period newer technologies had emerged. The development of the Polaris ballistic missile and submarine had finally given the Navy its strategic deterrent. Further, the atomic powered carrier Enterprise was going into service with long range nuclear capable strike aircraft, namely, the A3D Skywarriors and supersonic A3J Vigilantes.

Stunned, Martin engineers and executives tried to generate interest in an eight-jet transport version of the P6M, whimsically dubbed the SeaMistress, a huge nuclear-powered flying boat, and a supersonic seaplane somewhat resembling the Air Force Canberra. But there were no takers. Martin Chairman George Bunker announced that the company was now in the missile and electronics business. Fifty years of aircraft design and production was at an end.

Of the SeaMaster program little remains. The aircraft languished on the D Building ramp at Middle River for over a year after the cancellation before being scrapped. The "flying tails" and two rear fuselage sections were sent to Navy test facilities, while two sets of wing floats were used by a Martin supervisor to build a catamaran. Two tails, one fuselage section, and wing floats now belong to the Glenn L. Martin Aviation Museum.

Complete Model Specifications

Please remember to credit the Glenn L. Martin Museum Aviation Museum when quoting or utilizing any of the information contained herin.

carry a small General Electric reactor. The reactor was simply for radiation and systems tests and did not, in fact, operate any of the plane's systems. The company removed the nose of the plane and replaced it with a special lead-shielded pressurized capsule for a five-man test crew; the cockpit glass varied from nine to eleven inches thick. The new plane, designated the NB-36H, first flew in September 1955, and completed about a hundred flights before project termination. Convair project pilot Fred Petty and his test crew spent long hours droning across the Atomic Energy Commission's southwest test sites, avoiding bad weather and being tailed by a C-119 chase plane carrying a load of paramedics to secure the crash site for radiation hazards, in the event that the test plane cratered itself in the desert. A planned follow-on program, the X-6, whereby a B-36 would have had reactor-driven aircraft systems, did not get beyond the planning stage. And so ended actual flight tests of nuclear aircraft technology. The project itself lasted until 1963, when it finally collapsed, the victim of rising costs, lack of interest, and growing criticism.

THE "ULTIMATE" SEAPLANES

The post-World War II years witnessed the decline of the seaplane in civil and military applications. Long-range "DC-4 generation" transports replaced it on transoceanic service, and shore- and carrier-based aircraft replaced military seaplanes for patrol and antishipping duties. Nevertheless, the Navy retained some interest in seaplanes during the 1950s, actively pursuing development of both a water-borne seaplane fighter, the Convair XF2Y-1 Sea Dart (a twin-jet delta design), and the large Martin XP6M-1 Seamaster patrol flying boat. Both represented promising concepts. Convair test pilot Sam Shannon completed the Sea Dart's maiden flight at San Diego in April 1953. A more powerful version flew the next year and accomplished a unique "first" for sea-borne aircraft by exceeding Mach 1 in a dive in August 1954, piloted by Charles Richbourg. Unfortunately, during a press demonstration, this aircraft broke up from a "diverging" longitudinal pitching at low altitude near the speed of sound, killing Richbourg. The remaining two Sea Darts flew on into 1957 on a variety of tests, but the program died from lack of funding and genuine operational need.

The XP6M-1 Seamaster, a large, four-engine flying boat, was canceled because it threatened to draw funding away from carrier-based aircraft projects and seemed overtaken as a strategic concept by the first of the Polaris-equipped ballistic missile submarines. In fact, this most impressive

ircraft almost certainly should have been proceeded with, for it was, as hief project pilot George Rodney has recalled, ". . . truly a Mach 1 airraft, with all the other performance characteristics of comparable landased aircraft."19 Testing of the XP6M-1 began in July 1955 at Martin's Middle River, Maryland plant and continued at Patuxent River. Unfortunately, one major accident claimed the lives of four crewmen in December 1955, and although the exact cause was never precisely determined, investigators believed a runaway powered control system failure ent the plane into a violent pitchover during testing off St. Mary's iver. A second accident traced to engineering design error caused another prototype to go into a violent loop during testing off Delaware. ortunately, this time pilot Bob Turner and his test crew were able to ject safely as the plane began breaking up. Despite these two accidents, owever, the Seamaster proved an excellent aircraft, capable of a variety f operational uses ranging from mine laying to nuclear bombing, and it as a sad day when the Pentagon's defense planners canceled development of this promising design. The remaining six preproduction and ten oduction Seamasters completed were eventually scrapped.

CLASSY SPY FROM LOCKHEED

e acute need for reliable intelligence information concerning the abilities of the Soviet Union led to many reconnaissance aircraft proms. Bell, for example, undertook development of the so-called X-16 ld Eagle," but this twin-engine long-span aircraft never got off the wing board, for an even more ambitious design, Kelly Johnson's ed U-2, had already flown. The U-2 represented essentially the ld's most refined powered glider. At first, Johnson had envisioned an 04 fuselage joined to a broad-span, high-aspect-ratio, sailplane-like g. The final aircraft, of course, represented a very different design, Tony Le Vier completed its first flight in August 1955.

he U-2 presented some unique challenges, as Tony Le Vier discov on its first flight. Attempts to land it like a conventional sailplane ed unsuccessful; the U-2 simply would not quit flying. Johnson, in gned tones, advised Le Vier finally to climb to altitude and abandon prototype. At that point, Le Vier summoned up all his years of expece and decided to land the plane, which had a unique bicycle-like ing gear, like any "tail dragger." And it came in smoothly and gracey. Future U-2 pilots learned to stall the plane just off the ground be touchdown, otherwise it would coast and coast down the runway. had ...

THE MARTIN P6M SEAMASTER

In the post-World War II period, the US Air Force built up the "Strategic Air Command", a nuclear strike force of long-range bombers. The US Navy realized that the strategic nuclear mission was now of overwhelming importance, all the more so because defense budgets were being cut, and wanted to build up their own nuclear strike capability to prevent them from being overshadowed by the Air Force / SAC. Proposals to build a "super carrier", the USS UNITED STATES, as a floating base for Navy strategic bombers were shot down in 1949, and so the Naval Bureau of Aeronautics came up with another scheme, the "Seaplane Striking Force SSF)". The SSF envisioned a fleet of big, jet-powered seaplanes that would not only be capable of long-range nuclear strike, but would also be useful for conventional bombing, reconnaissance, and mining. Laying mines was seen as particularly important, since to reach the open seas the Soviet Navy had to pass through a number of "bottlenecks" that could be blocked by mining. The seaplanes would be able to operate from advanced areas, supported by a seaplane tender or even a submarine.

The Navy issued a request to industry in April 1951. The SSF seaplane was to carry 13,600 kilograms (30,000 pounds) of war load to a target over 2,400 kilometers (1,500 miles) from the seaplane's aquatic "base". The aircraft was to be capable of a Mach 0.9 dash at low altitude. Convair and Martin submitted proposals, with Martin winning the competition. On 31 October 1952, the Navy awarded Martin a contract for two prototypes, with the company designation of "Model 275" and the Navy designation of "XP6M-1", plus a static test article. This initial order would presently lead to further contracts for six pre-production service evaluation machines, with the designation of "YP6M-1", and up to 24 full-production machines, with the designation of "P6M-2". Martin gave the aircraft the name "SeaMaster". Apparently, the company had run out of names starting with "Mar". The Martin design team was led by George Trimble, an aeronautical engineer who as head of the Martin advanced design department; J.D. Pierson, a hydrodynamicist; and J.L. Decker, a aerodynamicist. Using the P5M Marlin flying boat as a starting point, they developed a revised hull design, with a length-to-beam ratio of 15:1, which was felt to offer the best efficiency in both air and water. The XP5M-1 Marlin flying boat prototype was rebuilt to test the new hull design, with this test aircraft designated the "Martin Model 270".

The original powerplant was supposed to have been a Curtis-Wright turbo-ramjet engine, but the engine development program ran into trouble, and so the decision was made to fit the SeaMaster with four Allison J71-A-4 turbojet engines with 57.87 kN (5,900 kgp / 13,000 lbf) afterburning thrust each, mounted in pairs in nacelles above the wing near the wing roots. The J71 was a derivative of the J35 axial-flow turbojet, used on the Republic F-84 Thunderjet, and originally developed by General Electric as the TG-180 but passed on to Allison for full production.

The wings featured a sweepback of 40 degrees and ended in wingtip tanks that served as floats. The wingtip floats were also fitted with gear to help dock the aircraft. The SeaMaster was to have a pressurized cockpit and crew of four, including pilot, copilot, navigator / radio operator, and flight engineer. The SeaMaster leveraged off Martin's advanced XB-51 attack bomber design, with features such as an "all flying" tee tail and a rotating bomb bay. The bomb bay flipped over in flight to expose munitions or camera payloads, and was pneumatically sealed to keep it watertight. The sole defensive armament was a remote-controlled tail turret with twin 20-millimeter cannon.

The first SeaMaster prototype was rolled out in secret on 21 December 1954, and performed its first flight on 14 July 1955, with Martin test pilot George Rodney at the controls. The flight test program revealed only one serious flaw: the engines scorched the rear fuselage, and so the use of afterburner had to be limited.

The Navy publicly announced the SeaMaster in November 1955, inviting the press to witness the rollout of the second XP6M-1 prototype. Unlike the first prototype, the second prototype was fitted with operational navigation and bombing gear. The test program continued smoothly until 7 December 1955, two days after the death of Glenn L. Martin. During a routine check flight for the first Navy pilot, the initial SeaMaster prototype crashed into Chesapeake Bay, killing all four aircrew on board. The post-mortem revealed a control-system fault that caused the aircraft to pitch nose down, bending its wings down and ripping them off. The second SeaMaster prototype was refitted with new flight instrumentation and ejection seats. Test flights finally resumed in May 1956. Unfortunately, the second prototype went out of control on 9 November 1956 during a flight test of a modified tail configuration. The aircraft broke up, but the crew were able to eject safely. The problem was traced down to an error in the design calculations for the tail control system.

Despite the loss of both prototypes, the Navy still remained enthusiastic about the SeaMaster. A beaching cradle was designed to allow SeaMasters to taxi in and out of the water, and two LSDs (landing ship docks), two seaplane tenders, and the submarine USS GUAVINA were sent to shipyards to fit them as SeaMaster support vessels. A home base was set up at Naval Air Station Harvey Point, near Elizabeth City, North Carolina.

The first pre-production YP6M-1 was rolled out in November 1957, with flight tests resuming in January 1958. It featured afterburning Allison J71-A-6 engines, which were visibly "toed out" to reduce the effect of exhaust blast on the rear fuselage. The engine inlets were also moved back from the leading edge of the wing, presumably to reduce water ingestion. Five more YP6M-1s were built in 1958 and participated in an extensive flight test program, performing practice drops of conventional and (dummy) nuclear munitions, and evaluating day and night photoreconnaissance pallets.

* The first production P6M-2 was rolled out in early 1959. The production SeaMaster featured more powerful non-afterburning Pratt & Whitney J75-P-2 turbojet engines with 77.89 kN (7,940 kgp / 17,500 lbf) max thrust each, providing a total increase of 53.36 kN (5,440 kgp / 12,000 lbf) thrust, and permitting a substantial increase in gross weight. The engine installation was visibly different: the engine exhausts in the XP6M-1 and YP6M-2 had been staggered, but they were parallel in the P6M-2.

MARTIN P6M-2 SEAMASTER:

spec	metric	english
wingspan	31.37 meters	102 feet 11 inches
wing area	176 sq_meters	1,900 sq_feet
length	40.84 meters	134 feet
height	9.88 meters	32 feet 5 inches
empty weight	41,400 kilograms	91,285 pounds
max loaded weight	80,000 kilograms	176,400 pounds
maximum speed	1,010 KPH	630 MPH / 550 KT
service ceiling	12,200 meters	40,000 feet
range	3,200 kilometers	2,000 MI / 1,740 NMI

The increased gross weight meant the production SeaMasters sat lower in the water, and so the wing anhedral was eliminated. The P6M-2 was fitted with a new canopy with large overhead panels for improved visibility; solid-state Sperry navigation and bombing systems; and a mid-air refueling probe. A probe-and-drogue tanker kit was also developed that could be plugged into the SeaMaster's bomb bay, allowing it to be quickly converted into a tanker. The SeaMaster was a futuristic aircraft, and its performance demonstrated that it wasn't just a pretty toy. The wings were built very strong for low altitude operation, with aluminum 2.5 centimeters (an inch) thick at the wing roots, and the SeaMaster was able to attain the Mach 0.9 requirement for "on the deck" flight. In contrast, the Boeing B-52 was only capable of Mach 0.55 at low altitude.

Three production P6M-2s had been completed by the summer of 1959, with all-Navy crews moving them through operational conversion for service introduction in early 1960. Five more were in construction. However, the Navy had been steadily cutting back the number of production aircraft, from 24, to 18, and then to 8, and then on 21 August 1959 cancelled the SeaMaster program completely.

There were loud protests, since the program had cost about $400 million USD and the machine was certainly whizzy, but in truth the SeaMaster was an obsolete concept. The Navy was already moving full steam ahead to a much more effective nuclear deterrent capability in the form of the Polaris ballistic missile submarine.

Martin tried to promote other seaplane designs, such as an eight-engine airliner version of the SeaMaster that was informally called the "SeaMistress", but the writing was on the wall. Martin formally abandoned the aircraft business to focus on missiles and defense electronics. The SeaMasters that had been built sat idle for over a year and were then scrapped, and sadly only bits and pieces of them survive.

AL. RAITHEL

ER 8250

XP6M-1
ACCIDENT INVESTIGATION

VOLUME 1 SUMMARY

—

VOLUME 2 ANALYSIS

APRIL 1956

MARTIN
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XP6M-1

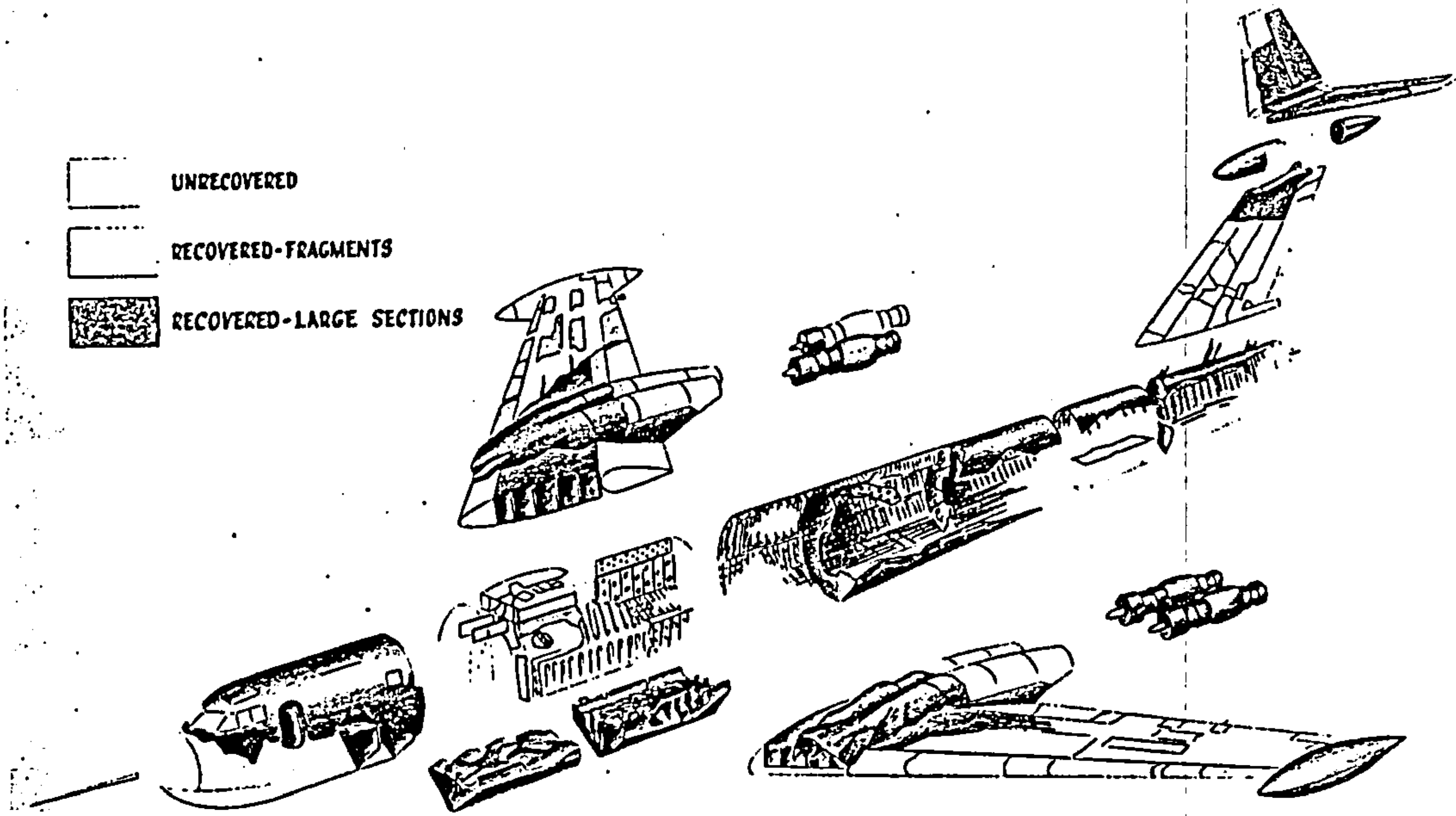
ACCIDENT INVESTIGATION

VOLUME 1 SUMMARY

APRIL 1956

MARTIN
BALTIMORE

XP6M-1 SALVAGE



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FOREWORD

This report summarizes the activities, findings, and recommendations of a special committee charged with investigating the accident of the XP6M-1 SeaMaster on December 7, 1955.

The investigating committee was composed primarily of engineers and specialists from the Martin Company. Special assistance was provided, however, by Captain R. F. Kane, the Bureau of Aeronautics Representative (BAR) in Baltimore, and by other members of his office who participated directly in all activities of the committee. Representatives of the Allison Engine Company and the Naval Air Safety Center also assisted. In addition, valuable consulting services were provided by the following agencies:

United States Air Force Directorate of Flight Safety

National Advisory Committee for Aeronautics, Langley and Lewis Laboratories

Aluminum Company of America, Research Laboratory

Civil Aeronautics Board

The accident investigation is recorded in two separate volumes. This report (Volume I: Summary) is limited to a brief account of the final solution and of the major factors directly concerned with the accident. The second report (Volume II: Analysis) covers in detail the supporting data and the special studies made during the investigation.

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SUMMARY

During a test flight on December 7, 1955, the first XP6M-1 Sea-Master became disabled in the air, broke up, and plunged into the mouth of the Potomac River. An intensive investigation of the accident resulted in the following major findings and conclusions:

1) There was no evidence that excess speed, abnormal aerodynamic forces, or aeroelastic effects contributed to the accident.

2) There was no evidence of powerplant malfunction as an initiating cause.

3) There was no evidence that wing or tail flutter was a contributing factor.

4) Both flight deck crew members ejected successfully, but they were killed by subsequent injuries. The pilot and copilot apparently had insufficient time to eject.

5) The primary structural failure of the wings occurred in negative bending after a severe nose-down pitch of the aircraft.

6) The stabilizer appears to have failed after the initial wing failure.

7) Most of the fires and explosions reported by witnesses and found as evidence on the wreckage occurred after structural break-up. A limited fire or explosion could have existed before break-up.

8) The cause of the severe nose-down pitch which resulted in structural break-up was attributed to a malfunction or difficulty in the longitudinal control system.

There was insufficient evidence to derive a single, indisputable, most probable cause of the accident. The investigation considered and eliminated many possibilities on the basis of available evidence. The following items remained as possible initiating factors:

1) A minor explosion that damaged the control system;

2) A broken or snagged control cable;

3) A malfunction in the feel-force system;

4) The loss of one hydraulic system in combination with possibly excessive stabilizer hinge moments;

5) A malfunction or improper use of the hydraulic by-pass valve for the stabilizer control system;

6) Possible pilot error in handling the controls.

These cases could be neither proved nor disproved from the evidence at hand. Corrective action has been taken on the second XP6M-1 for cases 1) through 5).

I. INTRODUCTION

From June 23, 1955, to December 7, 1955, the XP6M-1 SeaMaster (Bureau Number 138827) was flight tested in prototype at the Middle River facilities of the Martin Company. In satisfying pre-demonstration requirements, the aircraft accumulated 37.6 airborne hours and 42.3 taxi hours during 39 flights. Qualitative flight characteristics were established up to Mach 0.945 and a calibrated airspeed of 522 knots. A preliminary flight test evaluation under the cognizance of the Contractor was being conducted by a series of Naval Aviators, one on each flight, when the fatal accident occurred on December 7.

A. FINAL TEST FLIGHT

On its final flight, the XP6M-1 departed Middle River at 15:05 EST for general test and familiarization. The crew, except for the pilot, Lieutenant Commander V. Utgoff, consisted of Martin personnel: M. B. Bernhard, copilot, J. O. Hentschel, flight test engineer, and H. D. Scudder, flight engineer. Weather conditions were not unusual. The wind was ten knots at 090 degrees, and the barometer reading was 29.99 inches Hg. The ceiling was 12,000 feet estimated; visibility was 12 miles. Outside air temperature at sea level was 36 degrees Fahrenheit.

The last photo-panel record (estimated to have been taken 15 seconds to two minutes before the accident) showed engines at 98 percent rpm, an altitude of 8750 feet, a corrected IAS of 490 knots, and a corrected Mach Number of 0.853. The conditions of the scheduled tests were within the envelope of previous flights.

B. DESCRIPTION OF ACCIDENT

At approximately 1519, the airplane became disabled or exploded in flight east of St. Georges Island, Maryland, and plunged into the water near the mouth of the Potomac River adjacent to Buoy Number 6. All four crew members were killed.

Several Naval aircraft and helicopters were in the vicinity. They circled the scene for survivors and directed small boats to pick up pieces of the aircraft and the body of the flight test engineer. Rescue operations continued until darkness.

Thirty-seven witnesses to the accident were interviewed and written statements were taken. This information was combined into the following composite eyewitness statement:

"The aircraft was first seen in relatively level flight at an altitude of 7500 to 9000 feet on a southerly heading. An exhaust trail from the aircraft was noticed. An apparently controlled and gradual descent was observed.

"At 3000 to 6000 feet the aircraft was seen in the vicinity of Webster Field. When the aircraft was east of St. Georges Island, a minor explosion or visual break-up accompanied by a puff of white smoke or vapor was observed. Minor debris fell from the aircraft. Fire followed immediately and the descent steepened. Two explosions in rapid sequence were seen and heard and the major break-up occurred. Fire increased in intensity as the aircraft, broken into two or three major pieces and many smaller components, fell rapidly in a steep descent. Secondary explosions were noted in some large pieces as they descended. When the largest piece struck the water, audible explosion or impact concussion was heard. Fire continued on the water for two to seven minutes around a large section of hull which floated for 10 to 12 minutes.

"A parachute was observed, fully blossomed, above the falling aircraft at an estimated altitude of 500 to 600 feet. This chute sank rapidly after entering the water."

C. ORGANIZATION OF INVESTIGATION

The accident did not produce a few significant facts or clues which quickly revealed its cause. In this case, certain important information was missing:

1) There were no survivors.

2) There was no chase plane. It had been deemed unnecessary because the flight plan included nothing which had not been checked in previous flights.

3) There was no wire recording. The wire was recovered but it had become stuck in the recording head during the last landing.

4) There was no radio contact.

Information from any of these sources might have narrowed the scope and shortened the time of the investigation. As a further complication, most of the wreckage was on the bottom of the Potomac River under 50 to 70 feet of water.

By agreement, the United States Navy salvaged the wreckage and provided a work and storage area at the Naval Air Test Center, Patuxent. The Martin Company accepted responsibility for reconstructing the wreckage, analyzing the evidence, and presenting the findings and recommendations. It was necessary, therefore, to organize a special project at Martin. Its purpose was to:

1) Recover, identify, and reconstruct the wreckage;

2) Obtain evidence from the wreckage to show sequences of structural failure, fire and explosion damage, and system and equipment functioning or failure;

3) Review the structure of each component system for evidence in design, testing, inspection, and service history which might lead to a suspicion of possible trouble;

4) Integrate all the seemingly unimportant bits of information into a pattern to determine the most probable cause of the accident.

A basic sixteen-man committee, composed of experts from various departments, directed the efforts of approximately 100 people (Fig. 1). The services of these people were retained as long as they were needed--in some cases, for two weeks, and in others, for the full investigation period of four months. The committee also consulted numerous representatives from outside agencies.

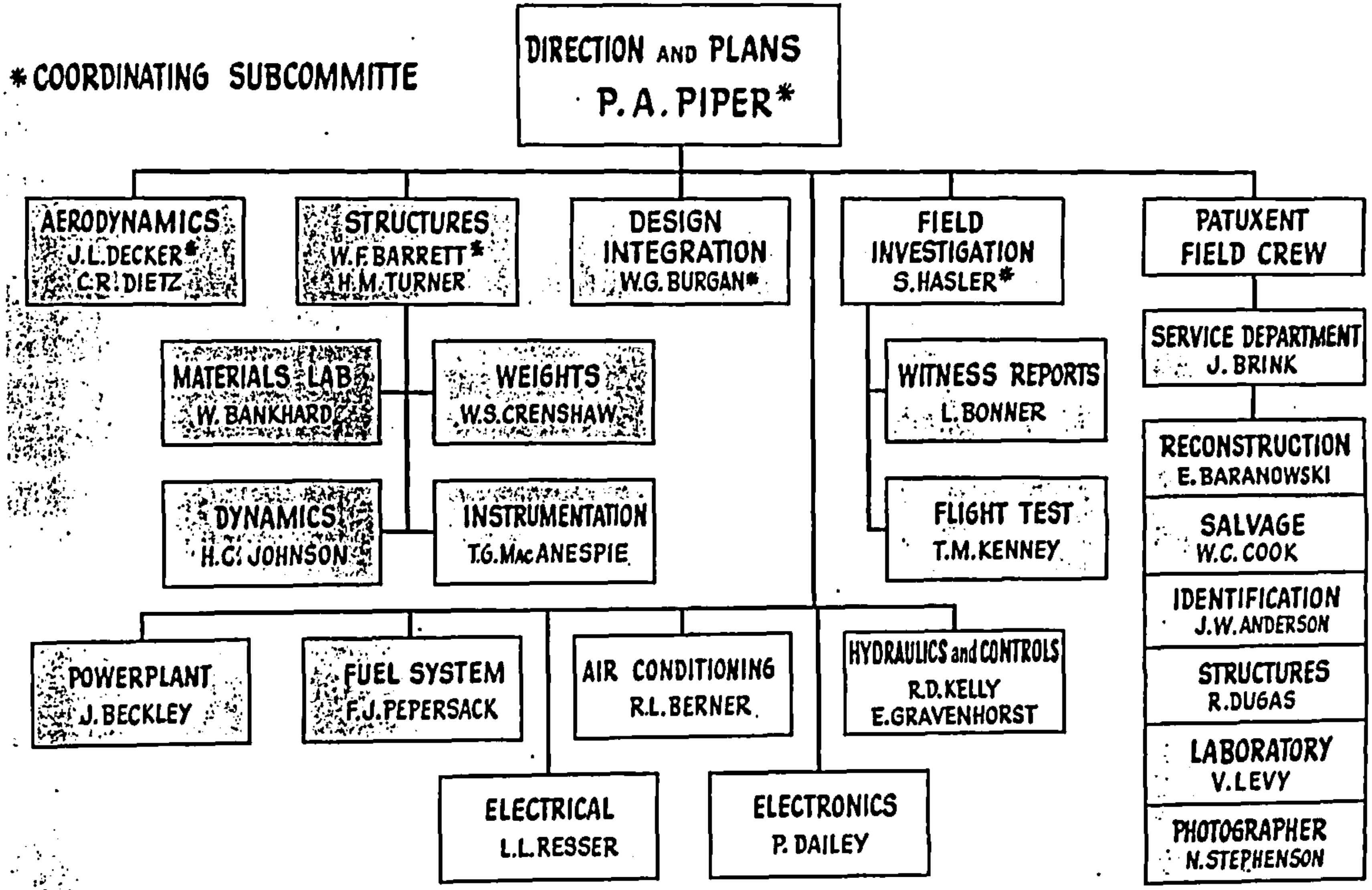

Fig. 1. Accident Investigating Committee

II. BASIC FACTUAL DATA

During the various studies of the investigation, many theories and suppositions were proposed and rejected. Those that remain, the most important facts and the strongest deductions, are noted in summary in this section.

A. SOURCES

Several basic sources of information contribute to the establishment of an accident envelope.

1. Witness Statements

Eyewitness statements are subject to error in detail, and perhaps some of the details of the composite statement are not correct. For instance, the quoted altitudes, which are highly pertinent to the accident, are subject to variation. One military pilot first observed fire at 9000 feet; two others reported it at 4000 feet. Nevertheless, the important facts are:

1) A general agreement on the location of the accident with no external indications of trouble except in an area very close to the actual salvage area;

2) Apparently no unusual maneuvers before breakup, fire, or explosion, but simply level flight or a controlled glide.

2. Salvage Recovery

The United States Navy had a salvage fleet in operation almost continuously from December 7 to March 2 (Fig. 2). Considerable difficulty was experienced in obtaining wreckage because of the depth of water in the channel (40 to 70 feet) and the silty condition of the bottom. Sonar search, underwater television, and diving operations were successful in locating major pieces of wreckage. Extreme care was used in plotting the location of each piece so that a fall pattern could be constructed (Fig. 3). During the later period, dragging operations were used to recover smaller pieces. It is estimated that about 85 to 90 per cent of the structure and equipment was recovered.

There were three primary areas of wreckage location:

1) Main area from which hull parts, inner wings, and nacelle parts were recovered;

2) Forward area (approximately one mile from wreckage center) where Engines 1, 2, and 3 were found;

3) Aft area (approximately one mile from wreckage center) where portions of tail surfaces, outer wing fragments, and other light structure were found.

In addition to the areas of successful wreckage recovery, a much larger area was thoroughly searched to be sure that there were no parts which had fallen off earlier during the flight. Helicopter search of shore areas, radio announcements, and local newspaper ads were used in an attempt to locate such pieces. None were found outside the salvage area. A reasonable assumption is that break-up occurred rapidly and over a relatively short distance.

3. Fall Pattern Trajectories

By using the recovery locations of major pieces of wreckage, it was possible to compute fall trajectories and to obtain an approximate idea of the altitude and distance from the crash point where these items left the airplane (Fig. 4). Trajectory studies also establish a general flight path during the period of break-up and fall-out.

The many variables of trajectory calculations make it fruitless to attempt an exact sequence of break-up part by part.

All the trajectories show, however, that the break-up took place over a distance of about 3000 feet at an altitude of 3000 to 6000 feet within a time period for total break-up of probably five to ten seconds or less.

4. Instruments and Equipment

The study of equipment recovered from the wreckage gave some important indications (Fig. 5):

Photo Panel.- The last reading was taken at 15:18:28. Initial explosion occurred at 15:19. Because of an inconsistency in time records, the reading is believed to have been taken no earlier than two minutes before major break-up and may have been within 15 seconds. Other data show the aircraft to be flying at 490 knots IAS, Mach Number 0.853, 8750-foot altitude, and a power setting of 98 percent rpm. There was no indication of anything abnormal at this time.

Stabilizer Variable "Q" Feel Actuator.- This actuator was positioned at a stroke of 2.92 inch, corresponding to a "q" of 1020 pounds per square foot (psf) at the time of break-up or power interruption. This would indicate that the ship did not reach a speed much in excess of that last speed recorded on the photo panel. It indicates that the speed before break-up was not in excess of previously tested values.

5. Medical Autopsy

Autopsy findings and a complete medical report were submitted by Dr. Russell S. Fisher, Chief Medical Examiner for Maryland. These findings are summarized in a later section.

There was no evidence of toxic effects from CO, CO_2, or fuel fumes. The flight engineer and flight test engineer ejected at a low altitude after major break-up. The copilot and pilot made no attempt to eject. These results appear to be due to the lack of time. They indicate a quick onset of trouble with high acceleration forces during break-up.

B. ACCIDENT PROFILE

In spite of the incompleteness of information, the basic factual data can be combined to form a flight profile which envelopes the general nature of the accident (Fig. 6). These basic facts and primary deductions have been useful in eliminating many types of initiating causes, and they have narrowed the field to a few possibilities which will be discussed in the technical summaries.

These are the conditions which must be satisfied by any theory of accident cause.

1. Location

Eyewitness accounts place the ship in a definitely limited area when there was visible evidence of trouble. This is substantiated by the fall pattern trajectories. The ship was not breaking up and shedding parts over a considerable span of time and distance.

2. Nature of Flight

The ship was engaged in static stability runs, taking check points in slight dives and climbs between 7000 and 10,000 feet. The last photo panel record was taken 15 seconds to 2 minutes before break-up. It is considered unlikely that the test was terminated or that the ship went to a lower altitude to start a different test.

3. Descent from Initial Altitude

Altitude determination is inexact. Onset of trouble, followed by break-up and fire, may have started directly from one of the test runs without previous knowledge by the crew.

If there was an intentional dive from 9000 to 6000 feet, the "q" feel actuator indicates that it was probably at high speed. An emergency descent might be caused by knowledge of fuel or hydraulic leaks, fumes, or fire.

Speed reached during the dive was within flight envelopes already tested, and there should have been no flutter or stability or control difficulties.

No abrupt maneuvers or gyrations were observed prior to the initial break-up. There was simply a controlled glide, white puffs of smoke, a steeper dive, and an explosion or break-up with increasing dive angle.

4. Ejection and Lack of Radio Contact

The sudden onset and rapid development of break-up allowed no time for ejection at altitude.

A knowledge of fuel leaks (with the pilot attempting an emergency landing) would have made him avoid operating radio switches because of the ignition hazard.

5. Fire

There was a large amount of fire damage on the right side of the hull, and lesser fires in the wings and nacelles. From witness accounts, it appears that most, if not all, of the fire occurred after the initial break-up during the fall to the water. Statements concerning trails of black smoke are interpreted to mean normal engine exhaust. However, there remains the possibility of a limited fire as the initial factor.

6. Technical Investigations

The technical investigation shows, fundamentally, that major structural break-up of the wing and center hull resulted from a severe nose-down pitch. The center wing failed in negative bending. The fire in the Number 4 hull tank area and along the left side of the hull lasted a minimum of 15 to 30 seconds. This presents a possibility but not a certainty that fire occurred before structural break-up.

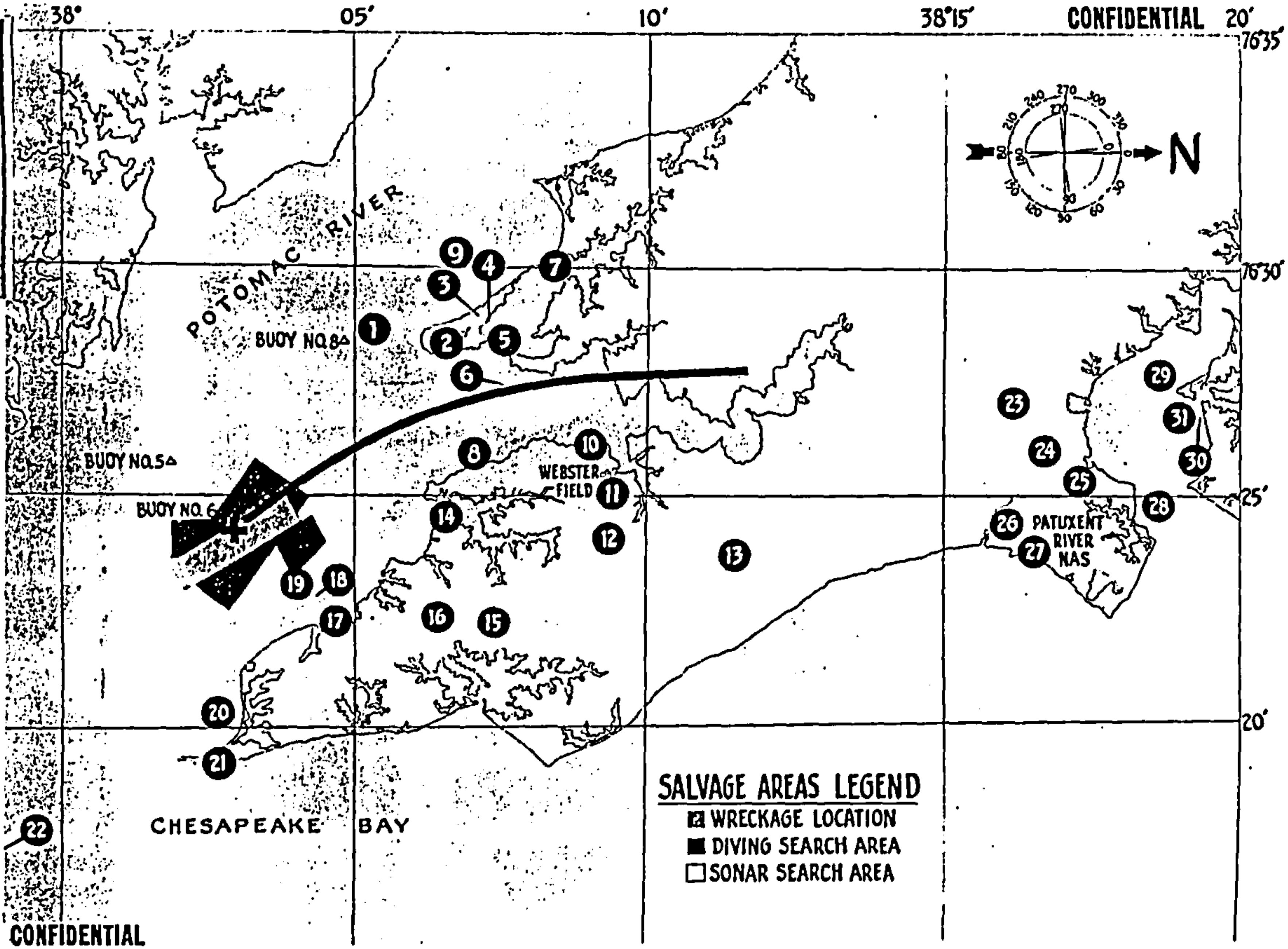

Fig. 2. Witness Locations and Salvage Operations

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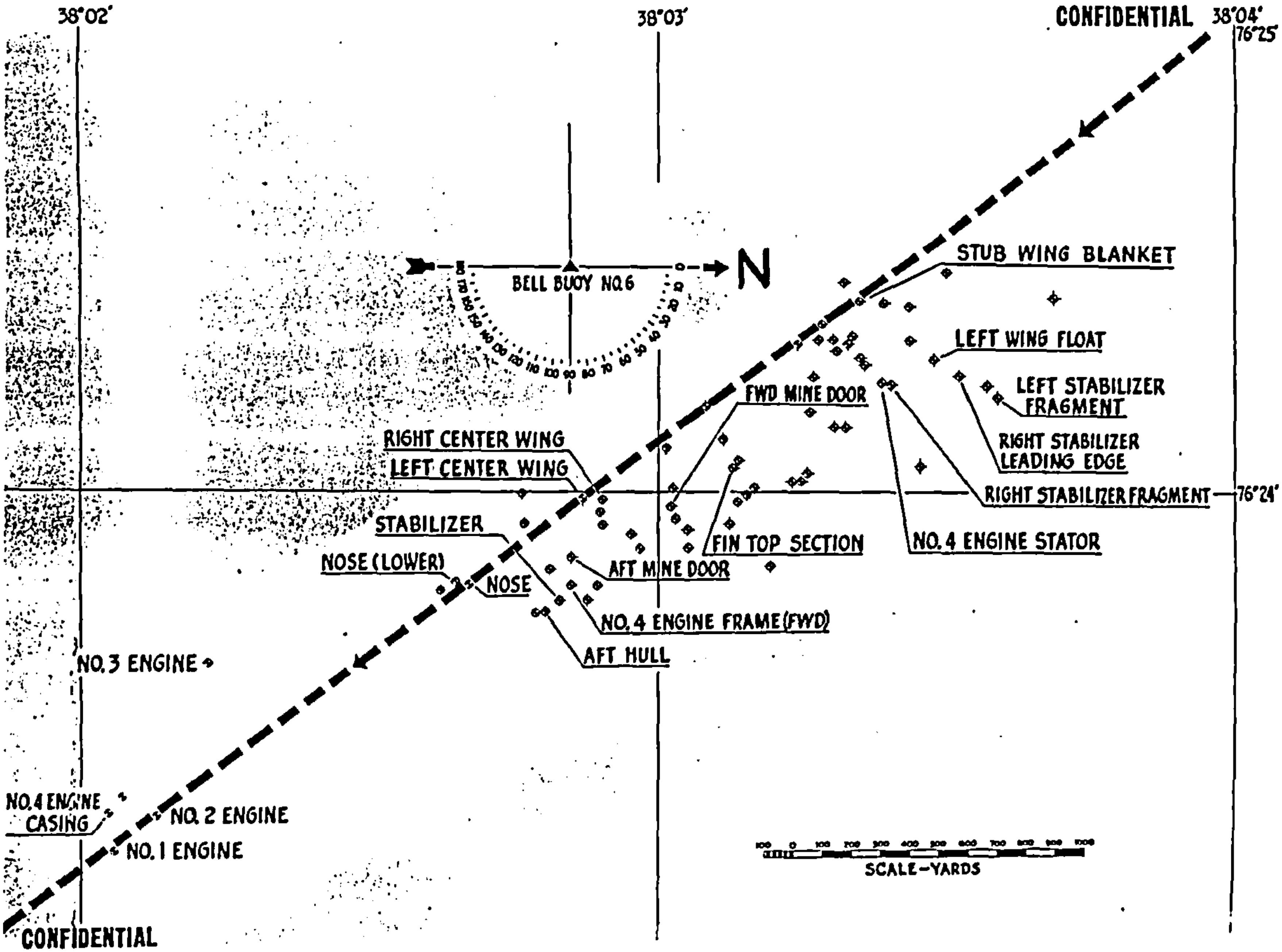

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Fig. 3. Salvage Recovery Pattern

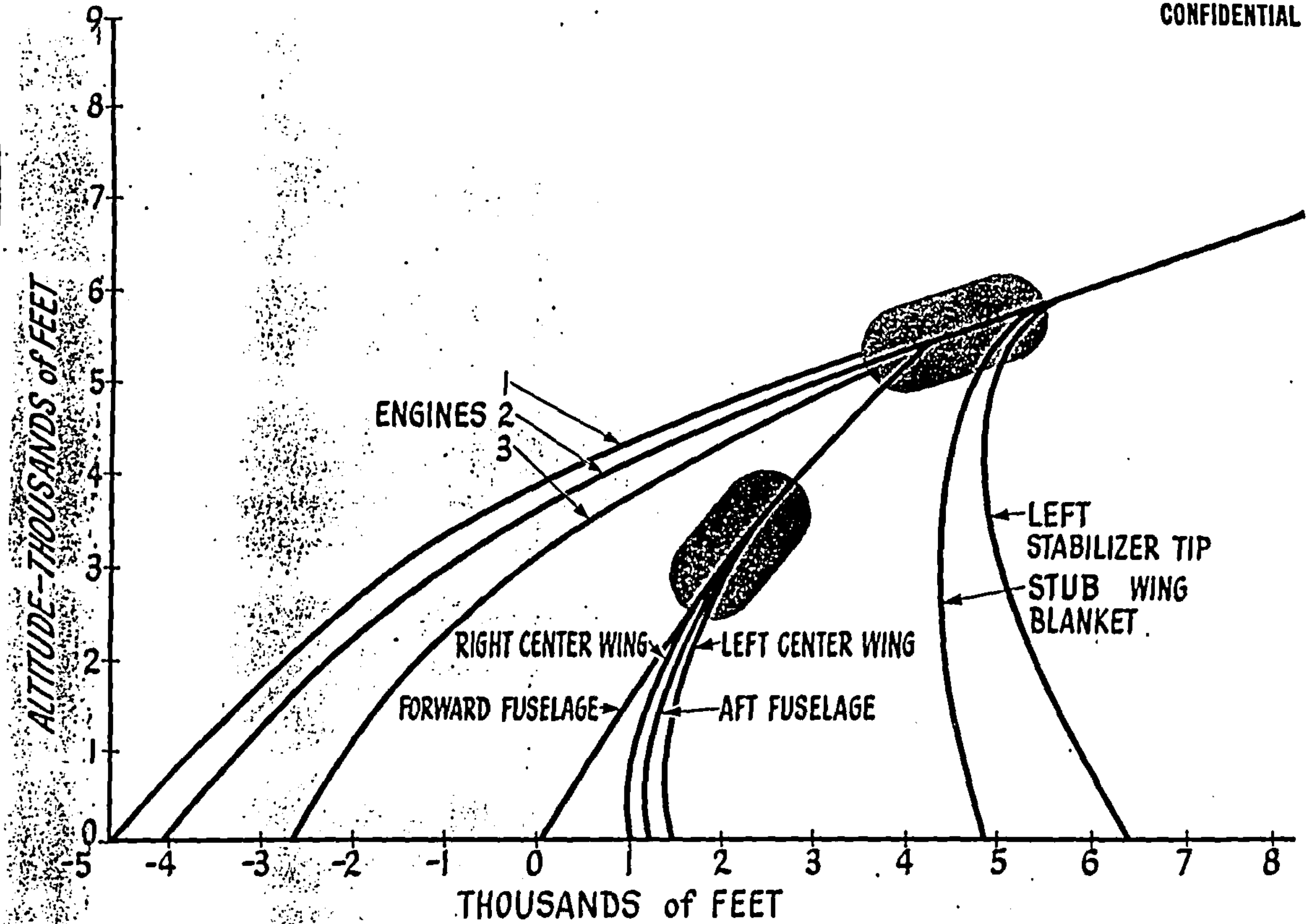

Fig. 4. Trajectory Pattern

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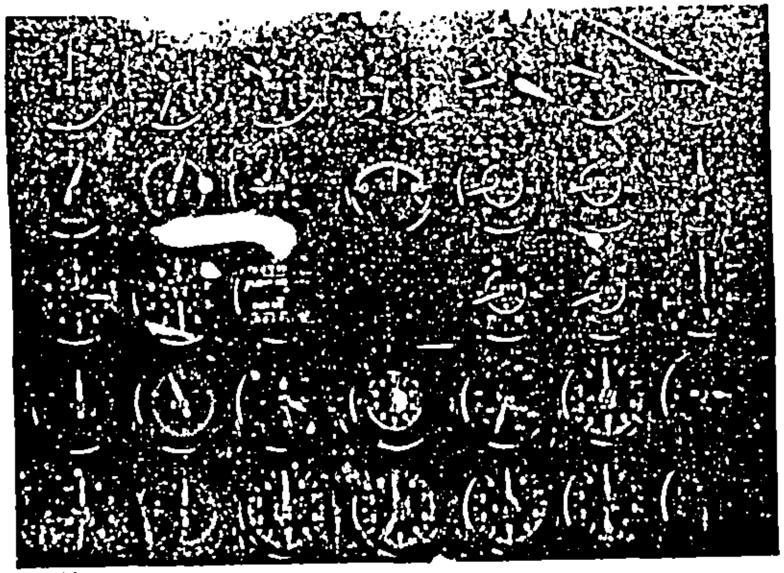

PHOTO PANEL

= NORMAL FLIGHT CONDITIONS

SPEED = 490 KT (M=0.853)
ALTITUDE = 8750 FT
POWER = 98% RPM

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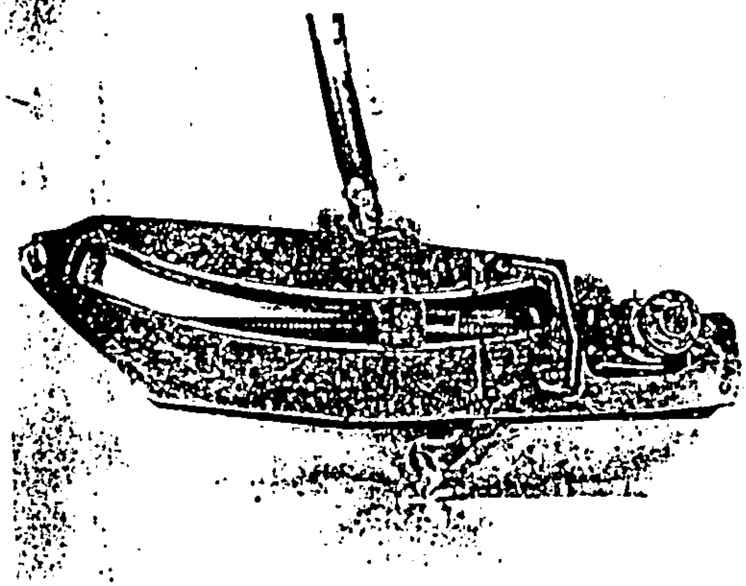

"Q" FEEL POSITION
HORIZONTAL STABILIZER

= MACH NO. of 0.85 AT BREAK-UP

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Fig. 5. Important Evidence

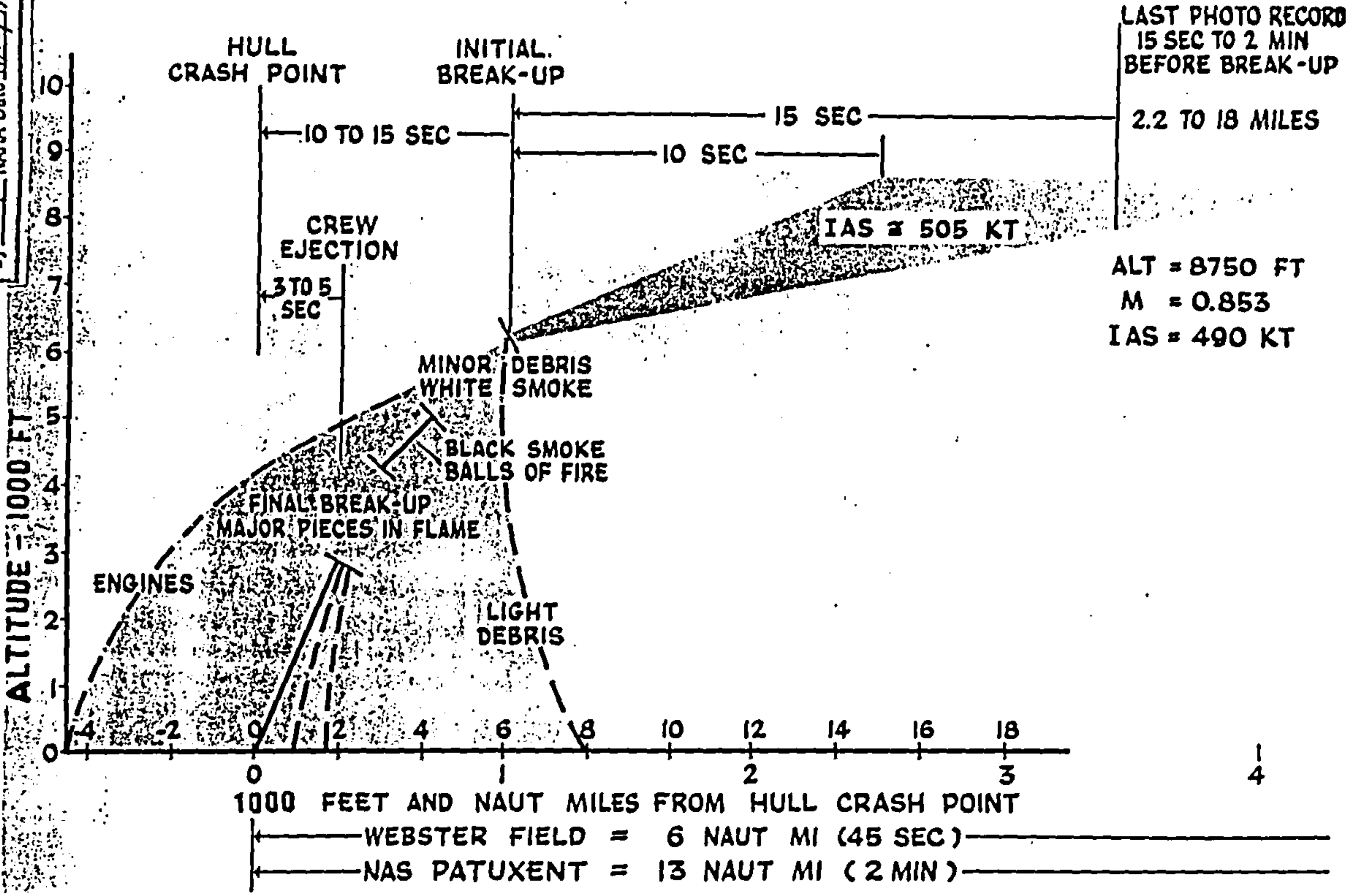

Fig. 6. Accident Envelope

III. SUMMARY ANALYSIS

Within the flight profile envelope of the accident, pertinent technical data from the investigation were used to determine a sequence of events and to make an analysis of possible causes.

A. SEQUENCE OF EVENTS

After careful consideration of all available evidence, the investigating committee established a sequence of events. The entire sequence, from the initial pitch-down until impact of the forward hull with the water, is estimated to have taken 10 to 15 seconds.

1. Initial Descent

The initial action was a descent from 9000 to 6000 feet. The descent may have been an intentional high-speed dive after the pilot became aware of some difficulty. The possible difficulties which have been considered are:

1) Limited fire or explosion;

2) Fuel leak or fumes;

3) Hydraulic leak or loss of hydraulic pressure.

It is equally possible that the accident sequence may have started from level flight or a slight dive in one of the longitudinal stability test runs at an altitude of 7000 to 8000 feet. Altitude determination from witness statements and fall pattern trajectories is not precise enough to preclude either possibility from consideration.

2. Wing Failure in Negative Bending

A severe nose-down pitch caused the wings to fail in negative bending. This event is considered basic to the sequence and is supported by uncontestable evidence in the wreckage. There are three types of abnormality which could cause an unwanted pitching of the aircraft:

1) An increase in stabilizer incidence of two degrees or more;

2) A complete loss of the stabilizer;

3) A change in stabilizer incidence or rig from a partial failure or reduction in hull stiffness.

These classes of possible initiating causes are discussed in Part B of this Chapter.

3. Structural Break-Up

The wing stub failed in negative bending, and the wings rotated down around the sides of the hull and crushed the bulkheads and upper longerons. The engines were thrown from the wings by a combination of inertia loads and wing rotational acceleration. After losing wing lift, the hull yawed; the stabilizer reached a high angle of attack and developed a large up and aft load. Under the influence of this load, the stabilizer separated from the fin and the hull broke into two major sections. Separation occurred in the minebay area just forward of the mine-latch frames.

This estimated sequence of break-up is supported by analysis and interpretation of a multitude of individual fractures. The preponderance of evidence indicates the tail was on the aircraft at the time of wing failure.

4. Fires and Explosions

Most of the extensive fires and explosions noted by observers and evident on the wreckage appear to have occurred after break-up and to have continued during the fall to the water. Some limited fire in the Number 4 hull tank area may have existed earlier but the evidence indicates that it did not. A flash fire, originating in the air lock and sweeping forward into the flight deck, lasted about five seconds and occurred after break-up.

5. Crew Ejection

The flight engineer and flight test engineer ejected after break-up and after being burned by the flash fire. After their ejection there was insufficient time for the pilot and copilot to eject.

B. ANALYSIS OF POSSIBLE CAUSES

Although much wreckage was available for examination and study, many of the pieces had suffered severe impact or fire damage and many key parts or pieces of structure were missing. This made it impossible to derive a single, undisputable, most probable cause of the accident. Many possibilities were considered and eliminated on the basis of available evidence. The following items, however, remain as possible initiating factors in the accident:

1. Increase in Stabilizer Incidence

An unwanted increase in stabilizer incidence of two degrees or more could have originated from several sources.

Explosion in Wing Stub or Forward Plumbing Area.- Only a few fragments of the structure and equipment were recovered from this area. The door to the minebay was found open, and this would have prevented a normal flow of ventilating air through the wing stub area. There are several potential sources of fuel leaks which could have produced an explosive concentration of fumes. There are potential sources of ignition in electrical, electronic, and instrumentation equipment. This assumed explosion, however, was not of sufficient intensity to cause significant structural damage. It is conceivable, nevertheless, that one of several pieces of equipment may have been propelled in a manner to cut or snag control cables or to short to 28 volts positive the electrical circuit to the hydraulic by-pass valves. Any of these conditions could initiate trouble in the longitudinal control system. An explosion in the wing stub or forward plumbing area is considered a possible cause of the accident. Possible explosions in other areas of the aircraft are not considered likely sources of trouble.

Broken or Snagged Cable System.- Parts of the cable system could have been broken or snagged by loose brackets or a loose object fouling them. Such a difficulty might have been related to the control incident reported by Lieutenant Commander E. Horrell, who was pilot on the flight immediately preceding the accident. No evidence of this nature was found in the wreckage. The possibility cannot be ruled out, however, because the complete cable system and structure were not recovered.

Loss of Feel System.- Experiments with the control system mock-up indicate that a sudden loss of feel force would result in a sufficient movement of the controls by the pilot to fail the wings in the manner of the accident. It has been reasoned that one hydraulic system and the complete mechanical circuit (from the actuator valve through the feel force system and the trim actuator) were operative at the time the stabilizer was torn off the aircraft. This reasoning is based on the observation that the actuator cylinder returned to a normal trim position after the top end of the cylinder had been broken off in the fully extended position. Although this interpretation of one piece of evidence is considered valid, there is no other supporting evidence. The trim actuator and essential parts of the feel system have not been recovered. It may be conceded that there could be a different explanation for the final position of the stabilizer actuator. Therefore, the loss of feel force remains as a possible initiating cause.

Loss of One Hydraulic System.- No positive evidence has been found to indicate that either hydraulic system was inoperative. It has been possible, however, to examine and pressure test only about 40 per cent of the hydraulic tubing and fittings. If one system was out, it is possible that stabilizer hinge moments exceeded the capacity of the remaining system. Calculated hinge moments show at least a ten per cent positive margin, but a possible error in rigging the elevators might tend to increase the actual hinge moment. A loss of portions of the stabilizer bullet fairing could adversely affect the hinge moments or tail loads. There is still the possibility that excess hinge moments overpowered the stabilizer actuator if one system was inoperative.

Hydraulic By-Pass Valves.- Examination of switches, one valve, and recovered portions of the electrical wiring indicates no malfunction in the system. If the pilot suspected trouble in one system he may have attempted to operate the by-pass and inadvertently shut off the good system. Such action could initiate the trouble and must be considered as a possible cause.

Adverse Pilot Action.- Although the pilots were experienced and the feel forces may have been quite normal, this was the first flight in the XP6M-1 for one pilot. Adverse control manipulation is considered unlikely, but it remains a possibility.

Malfunction of Stabilizer Control Valve.- The stabilizer control valve was recovered in good working order, and the only malfunction considered in the investigation was high valve-spool friction due to "silting" oil contamination. This silting action on the valve could result in a control system movement similar to that reported by LCDR Horrell.

Control mock-up tests have proved that the amount of valve sticking attained with a very high contamination would not result in an unstable or unflyable airplane. The difficulty is considered quite unlikely as a possible cause of the accident.

2. Loss of Stabilizer

A structural analysis of the available wreckage has led to the conclusion that the tail was still intact at the time of wing failure. If it is argued that this sequence of tail break-up is in error, then it is possible that the stabilizer could be removed by:

1) Tail flutter;

2) Impact with some heavy piece;

3) Rudder or elevator hinge failure with subsequent damage to the fin or stabilizer.

The available structural evidence, however, has been interpreted to rule out these factors as possible causes.

3. Reduction in Hull Stiffness

A partial failure or reduction in hull stiffness could have produced a change in stabilizer incidence or ring. Nevertheless, there is sufficient evidence to eliminate these factors as possible causes. Studies of recovered wreckage give no indication of early failure in fin attachments or bulkheads which might have affected the rig of the stabilizer. REAC investigations indicate that a 60 per cent reduction in hull vertical bending stiffness would be required to produce unstable pitch oscillations. There is no evidence of such damage prior to break-up.

IV. BACKGROUND OF ACCIDENT

From June 23, 1955, through December 7, 1955, the XP6M-1 (Bureau Number 138827) was flight tested at the Martin Company. The predemonstration requirements had been accomplished: pilot familiarization, hydrodynamic investigation, airspeed calibration, bail-out chute tests, preliminary CO survey, powerplant installation and preliminary vent survey, windshield wiper tests, preliminary mine drop tests, and engine nacelle duct measurements. Instrumentation malfunctions and aircraft unavailability made it impossible to obtain flap loads and hinge moment data.

The airplane had accumulated 37.6 flight hours and 42.3 taxi hours during a total of 39 flights. There were actually only 23 airborne flights out of 39 official flights because some flights were aborted after the aircraft taxied to the take-off area and experienced equipment failures. Qualitative flight characteristics had been established up to Mach 0.945 and calibrated indicated airspeeds to 522 knots.

Pilots had expressed satisfaction with the aircraft and with its longitudinal and directional control. They reported that lateral control was oversensitive for small wheel throws, and the system has been modified in the second aircraft. A ''stick shaker' unit was also installed on the second aircraft to provide adequate stall warning. An airframe shake, which the pilots noted in the first aircraft, will be thoroughly investigated if it exists on the second XP6M-1. With the possible exception of the shake, none of these items are considered to be factors in the accident.

A. LAST TEST FLIGHT

During the period in which the final flight was made, the XP6M-1 airplane was undergoing preliminary evaluation by a team of Navy pilots. The tests were being conducted from the Martin Company's facilities. The airplane was entirely under the maintenance of the Contractor and all crew members except the pilot were Martin personnel.

Navy representatives, together with Martin personnel from Aerodynamics and Flight Test, had detailed a flight test program commensurate with previous tests performed by the contractor and with flight test time available before a scheduled change of Engine Number 1. It was explicitly understood that the Navy preliminary flight test evaluation would encompass only tests previously performed by the Contractor. In some instances, the proposed tests did not exactly duplicate the Contractor's tests, but there were few items programmed which had not been previously demonstrated to an essential degree.

The original program was to be flown by four Navy pilots on two flights. The first half of each flight was to consist of tests at high altitudes; the airplane would then land, a new Navy pilot would go aboard, and the second half of the flight would cover tests at lower altitudes.

1. Flight 39-1A

Adverse weather conditions and difficulty with the operation of the afterburners made it impossible to adhere to the original program. Instead, on Flight 38-1, only taxi tests were made; no airborne flight was accomplished. The next day, December 7, 1955, a 10,000 to 12,000-foot ceiling precluded tests at high altitude, and it was decided that Flight 39-1 would follow the programs of Flights II and IV. Because of the low ceiling, it was agreed to eliminate the stall tests. Accordingly, on Flight 39-1A, the tests under Flight II were performed with Lieutenant Commander E. Horrell as pilot and the same Martin personnel as on Flight 38-1. No noticeable discrepancies were reported in the flying qualities of the airplane under the conditions tested. LCDR Horrell commented, however, that the gage monitoring the utility system hydraulic pressure was erratic and reading high. Two inflight inspections by the flight engineer established that the gage was in error and that the system was functioning properly. LCDR Horrell also reported that while flying at Mach 0.845 indicated at 468 knots (swivel IAS) in a shallow dive at 10,000 feet in slightly turbulent air, the control column moved forward about two inches and then came back to its initial position. The action of the column was discounted as being due to rough air and the tests were continued with no further incidents. A landing was then made to change pilots. After landing, Engines 1, 2, and 3 were shut down and Number 4 throttled.

2. Flight 39-1B

Lieutenant Commander V. Utgoff went aboard for Flight 39-1B and LCDR Horrell disembarked. Recovered film shows the take-off on Flight 39-1B, a level flight trim point at 8700 feet with normal rated thrust on all engines, and two additional points: one in a climb at Mach 0.742 and the other in a dive at Mach 0.853. The recorded data on the photo-panel film are compatible with the program outlined under Flight IV. The program required, in part:

1) Take-off with 40 percent cg and fixed stick;

2) Static longitudinal stability tests at 10,000 feet with 40 per cent cg (a trim at V_{max} for Normal Rated Thrust and then stabilization at three speeds above and below trim at increments of Mach 0.03).

The recovered film indicated the following:

1) Normal take-off and climb;

2) Level flight trim at 8700 feet, Normal Rated Thrust, Mach 0.805;

3) Low speed trim at 10,150 feet, Normal Rated Thrust, Mach 0.742;

4) High speed trim at 8750 feet, Normal Rated Thrust, Mach 0.853.

Approximately 11 minutes after take-off, the film record stops. An investigation of many factors leading to the establishment of time has led to the conclusion that the aircraft was airborne for no longer than two more minutes.

3. Other Data

These records and the statements of witnesses provided the basic information. Other sources were not available:

1) There was no chase plane. The FJ-2 was not up. An Air Force chase plane which was being used had returned because of low fuel. Another Air Force chase plane which was to relieve the first was not yet serviced.

2) The wire recorder was inoperative.

3) There were no radio transmissions. Later investigation revealed both radios operative, but only one was turned on. This is not normal procedure.

4) There were no survivors.

Some witnesses were interviewed immediately to pinpoint the wreckage area and to develop a general idea of the events of the accident. All possible witnesses (37 in all) were interrogated during the next few days. In many cases, they were interviewed several more times, and fairly good witness coverage was gained. Individual witness statements are not generally reliable in detail, but when several are correlated they offer a coherent story. An average or composite narrative was prepared from these statements. The narrative and the statements of particular witnesses whose attention was drawn by curiosity to the aircraft prior to any difficulty were particularly helpful in describing the events just preceding the accident.

B. MEDICAL FINDINGS

Immediately after the accident, the body of the flight test engineer who had been in the aft port seat was found floating on the surface with his parachute partially streamed. He had been subjected to a flash fire (high temperature for a short duration) while still in the aircraft. These flash burns correspond to a definite flame pattern. Minor throat injuries were incurred during his subjection to high acceleration forces during break-up or high velocity air stream during ejection. The injuries correspond to the position of the helmet chin strap. At least ten seconds later, he received severe fore and aft impact concussion across the back and head which produced his immediate death. This was caused by impact with the water. The failure of his parachute to open was undoubtedly due to lack of time to pull the ripcord and to his failure to attach the automatic opening device.

The bodies of the pilot and copilot were recovered on December 18, 1955, in the forward flight deck debris. They had received multiple extreme injuries from impact of the forward flight deck with the water. Injuries indicate that they were still seated in their respective seats with their feet on the rudder pedals in a normal flight position. It appeared that there was no time for an attempt to eject.

The flight engineer's body, seen in the fully blossomed parachute, was recovered March 20, 1956. His death was due to drowning. His body also showed evidence of flash burns corresponding to the flame pattern. His one injury, a fracture of the tail bone, occurred at least 15 seconds prior to death. It was undoubtedly due to ejection or high acceleration forces during break-up. He was recovered in his parachute, straps still fastened, and had presumably made no attempt to free himself. His Mae West was under his flight jacket and had not been inflated. He was probably unconscious upon entering water. It can be assumed that unconsciousness was due to severe pain of the tail bone fracture or to high-acceleration forces during his subjection to the high-velocity airstream. One of the burned straps of his parachute harness had been rent by air blast.

V. EJECTION

The ejection seats in the XP6M-1 airplane are standard Navy configurations which use the face curtain to start and sequence the operation. The four seat systems in the airplane are completely separate; the flight deck systems differ from the pilots only in that there is no provision for control column freeing and snatching. Normal face curtain ejection is accomplished as follows:

1) The occupant places his feet in the seat stirrups;

2) He pulls the face curtain;

3) The curtain releases the overhead hatch and frees and snatches the control column;

4) The curtain fires the seat catapult about one-sixth of a second after hatch release;

5) A lanyard attached on the hull releases the seat belt two seconds after ejection;

6) Two seconds later, an automatic (aneroid) release opens the parachute.

Test seats and hatches identical to those used in the airplane were thoroughly tested prior to first flight both at the Naval Air Medical Center in Philadelphia and at the Martin Company. All tests were successfully passed.

The recovered systems were bread-boarded and subjected to detailed examination by Martin specialists and then by technicians from Frankford Arsenal and Pittman-Dunn Laboratories, the developers of the cartridge devices. No evidence of malfunction or failure was found.

Further investigation of escape activities included studies of the recovered hull nose section, examinations and autopsies of bodies, and trajectory plots of the hull nose section and the ejected hatches and seats.

A. CONCLUSIONS

The findings from the ejection studies are summarized:

1) Both flight deck crew members ejected, and their seat and hatch systems functioned in a normal manner;

2) Both ejections took place after the separation of the nose section and after the subsequent flash fire;

3) The parachute of the flight test engineer, who was unconscious or injured from an aerial collision with debris, did not open because he had not attached the auto-release lanyard to his seat belt;

4) The parachute of the flight engineer opened normally; he was probably unconscious when he entered the water and had worn his life vest under his flight jacket.

5) The pilots made no attempt to eject, literally flying the nose section into the water.

The procedure for escape in this aircraft follows this crew sequence: flight engineer (starboard aft), flight test engineer (port aft), copilot (starboard forward), and pilot (port forward). It appears that the sequence was being followed, but there was insufficient time for successful ejection because of the quick onset of trouble and the high acceleration forces during break-up.

B. RECOMMENDATIONS

As a result of the ejection studies, the following recommendations are made:

1) Provide ejection seats for all crew members;

2) Keep both airlock hatch doors closed during flight by crew training or by installation of a microswitch and crew warning light to prevent the spread of fumes or fire;

3) Provide rear view mirrors or periscopes for the crew as a means to inspect the aft hull and tail in flight for minor fires or structural failures;

4) Provide automatically inflated life vests for crew members;

5) Provide cold weather survival suits for crew members.

VI. AERODYNAMICS

The purpose of the aerodynamics investigation was to determine whether a fault in the flying qualities of the aircraft could have contributed to the accident. A thorough review was made of the aerodynamic design, the aircraft's flight history, and particularly its stability and control characteristics.

A. BASIC AIRCRAFT DESIGN

The mission requirements of the XP6M-1, an intruder capable of 600 knots at sea level, exerted a profound influence upon the aircraft design. The high-speed dash requirement, part of a normal minelaying profile, corresponds to a Mach number of 0.908 and a dynamic pressure of 1200 psf. As a result of these speeds and high dynamic pressures, compressibility and elastic deformation have significant effects on aircraft stability and airloads.

A comparison of the P6M design requirements with those of other aircraft illustrates the problem. For example, the design dynamic pressure of the B-47 is approximately 500 psf. Fighter aircraft such as the F-86, having design "q" values approximately that of the XP6M-1, are designed for limit load factors of 7.5g. The design limit load factor of the XP6M-1 is 3.8g. The structure of the smaller aircraft, therefore, is better adapted for flight at high values of dynamic pressure.

To solve the problem of stability and control created by compressibility, aerolastic effects, and the aircraft's size and speed, the P6M-1 was designed with an all-movable power-operated stabilizer. The elevator is geared to the stabilizer in a fashion that adds to stabilizer effectiveness. An elevator is a relatively poor high-speed control for an aircraft of this type since its effectiveness is somewhat reduced by compressibility and seriously reduced by aeroelastic effects. Therefore, the gearing between the elevator and stabilizer is such that small amounts of elevator deflection are used at high speed. Stabilizer control is obtained by a dual hydraulic control system; the cable runs, hydraulic pumps, cylinders, and valves are duplicated to form two completely independent systems.

With the powered-operated system, longitudinal control feel must be obtained synthetically. The basic element of the synthetic feel system of the P6M-1 is conventional. It provides a column force proportional to compressible dynamic pressure and stabilizer incidence increment from trim position. In addition, a bobweight supplies a stick force of eight pounds per g. One unique feature of the feel system adds a force stability which compensates with speed for the adverse effects of aeroelasticity and the normal transonic tuck-under. This speed compensation is accomplished through a cam which changes the mechanical advantage of the pilot over the feel system.

B. LONGITUDINAL STABILITY AND CONTROL

The aircraft was accomplishing a static longitudinal stability program at the time of its loss. Because of this, it is relevant to review the longitudinal stability and control characteristics of the airplane as they have been obtained from flight tests. Three general areas will be considered:

1) Longitudinal stability in level flight;

2) Maneuvering control force characteristics;

3) Stabilizer hinge moments.

1. Speed and Dynamic Pressure

During its last test, the airplane was trimmed at Mach 0.805 with a gross weight of 116,000 pounds. The center of gravity was at 40 per cent MAC. Three points of the test had been obtained and the last run on the photo panel record was at Mach 0.853 at an altitude of 8750 feet. In previous flights the aircraft had exceeded the Mach number and the dynamic pressure which existed in the break-up condition. Figure 7 compares the estimated speed at break-up with values which were previously obtained during the flight program. It is possible to establish the dynamic pressure at the break-up point from the position of the "q"-feel screw jack in the longitudinal control system. The screw jack indicated a compressible dynamic pressure of 1020 psf. The 1020-psf dynamic pressure corresponds to Mach 0.845 at 6000 feet, which are considered to be the break-up speed and altitude. On Flight 30-1 a compressible "q" of 1077 psf was reached at an altitude of 3500 feet. The maximum Mach number was obtained during Flight 26-1 when Mach 0.949 was reached at 26,500 feet. The most aft center of gravity, 40.9 per cent MAC, was obtained on Flight 36-1. It is apparent, therefore, that the flight condition at break-up was significanlty within previously demonstrated limits.

2. Control Forces

The static longitudinal stability of the aircraft in level flight has been investigated at altitudes of 15,000 and 28,000 feet (Fig. 8). These runs were trimmed at Mach 0.81 and Mach 0.94. Although slightly unstable gradients of stabilizer position versus speed are indicated above Mach 0.76, stick forces were stable throughout the speed range for both tests. Since pilots fly almost exclusively by force feel in the high speed range, the aircraft is considered to possess satisfactory longitudinal stability characteristics in one-g flight. Pilots' comments have been quite favorable with regard to these flying qualities. The stable control force characteristics are due to the speed-feel compensation which has been incorporated in the synthetic feel system. Flight test results and the predictions from wind tunnel data compare very favorably.

Some testing had been completed relative to the maneuvering control force characteristics of the aircraft. The maneuvering control forces of the XP6M-1 and the P5M are compared in Fig. 9. The column force required to achieve limit load factor is plotted against the cg position (relative to the design aft cg). Although the XP6M-1 control forces are lighter than the P5M, they are within specifications. Flight results indicate that 67 pounds are required to develop limit factor at a cg of 38.5 per cent MAC at 440 knots. This is well above the specification minimum of 45 pounds.

C. STABILIZER HINGE MOMENTS

The horizontal tail was designed to limit loads of 75,000 pounds down and 50,000 pounds up. The calculated tail load at the time of the accident was 21,700 pounds down. This down load is obtained with a stabilizer incidence of minus 1.4 degrees and an elevator deflection of minus two degrees. The load was well within the design capability of the horizontal tail.

The all-movable horizontal tail is actuated by a hydraulic power system which is capable of producing 69,000 foot-pounds of hinge moment to drive the stabilizer leading edge down and 13,000 foot-pounds to drive the leading edge up. Half of the hinge moments are available if one hydraulic system fails. During flight testing of the first aircraft, no hinge data were obtained from flight. Estimates from wind tunnel data, however, show a hinge moment of 31,500 foot-pounds for the break-up flight condition. This is within the capacity of one hydraulic system, which produces 34,500 pounds of hinge moment. The hinge moment coefficients were obtained from the University of Maryland, the Cooperative Wind Tunnel at the California Institute of Technology, the Cornell Aeronautical Laboratory, and the Wright Aeronautical Development Center. This information covers the range from Mach 0.20 to Mach 0.94. Any inconsistences in the data were interpreted to increase the stabilizer hinge moment, and the calculations therefore are conservative. Stabilizer hinge moments will be determined in flight tests of the second aircraft to make an effective check of the calculated results.

The comparison of the predicted stabilizer incidence required to trim and the actual flight test results is very good. A stabilizer incidence of minus 1.4 degrees was predicted for level flight trim at the break-up speed; flight test results indicate that a minus 1.6 degrees was used. This agreement is considered excellent.

The calculated elevator deflection at break-up was two degrees up. Flight tests showed a deflection of 0.5 degrees up. The hinge moment per degree of elevator deflection in the break-up condition is 14,300 foot-pounds, whereas the hinge moment per degree of incidence is only 300 foot-pounds. Thus, the elevator contributes more than 90 percent of the stabilizer hinge moment at Mach 0.845. The difference between calculated and flight test elevator deflections represents a very large change in the total hinge moment. If the flight test elevator deflection is used, a total hinge moment of 8000 foot-pounds is estimated. With the calculated deflection it is 31,500 foot-pounds. Clearly, the calculated hinge moments are much more conservative than those predicted directly from flight data. It is concluded, therefore, that the airplane would have been flyable in the break-up flight condition if one of the two boost systems, each capable of delivering 34,500 foot-pounds, had failed.

It is important to consider the consequences of aerodynamic hinge moments overpowering the stabilizer cylinder. This condition results in one of two types of eventual aircraft structural failure. In either case, the stabilizer would assume the position at which the cylinder output equalled the aerodynamic hinge moment. The aircraft would first undergo a transient disturbance as the adjustment took place. If the change in incidence were small, this adjustment would involve a small transient disturbance in acceleration followed by an increase in aircraft speed because the trim load factor became less than one g. The end result would be ultimate structural failure in flutter due to excessive aircraft speed. If the stabilizer hinge moment were sufficiently high to create an incidence change of approximately two degrees or more, the transient disturbance in normal acceleration associated with the stabilizer motion would produce sufficiently large load factors to fail the wings in negative bending.

Pertinent to the accident, the stabilizer hinge moment would have had to exceed 48,500 foot pounds in order to develop enough negative g's to fail the wings.(Fig. 9a). However, the stabilizer "q"-feel screw jack position indicates that the aircraft probably did not build up excessive speed. It may be theorized, therefore, that an overpowering of the stabilizer of small magnitude did not occur. In order for the severe overpowering of one cylinder to occur, the hinge moments would need to be at least 50 percent above the conservative estimates. This is not considered to be probable although mis-rigging of the elevator could contribute significant hinge moment changes. Unless there was a significant mis-rigging, it is unlikely that the loss of one hydraulic system was associated with the accident sequence.

D. LATERAL AND DIRECTIONAL STABILITY

Pilots commented upon over-sensitive lateral control during taxi, take-off, and landing tests (due to high effectiveness of the Martin spoiler in the flaps-down configuration), but they were satisfied with the roll rate and control response at higher speeds. On Flight 26-1 the spoilers deflected at high Mach numbers (Mach 0.95 at 30,000 feet) -- an abnormal condition -- but this effect was traced to a leak in the pneumatic hold-down system on the right outboard spoiler. Significantly, the main indication to the pilot was through his instrumentation. The airplane still remained in trim even though there was some lag in spoiler response as the wheel was moved to achieve a wing level condition.

Directionally, the airplane was demonstrated to possess positive stability during steady sideslip tests. High-speed sideslips revealed that high pedal forces and restricted actuating cylinder power limited the deflections and sideslip angles. These are characteristics of the design to ensure small asymmetrical airloads on the vertical and horizontal tails.

There is conclusive evidence from the reconstructed wreckage that the wings failed in negative bending and that the failure was essentially a symmetrical one. Although there is some evidence of asymmetric loads on the empennage, the accident sequence places the tail failure after the wing failure. During failure of the wings, it is likely that some rolling and yawing developed to give asymmetric tail loads. There was, however, a predominantly longitudinal motion during the accident.

E. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions have been made:

1) Longitudinal stability and control of the XP6M-1 are satisfactory and therefore do not appear to be a contributing factor in the accident. Flight tests showed that the flying qualities of the XP6M-1 were good, and the pilots commented favorably upon them.

2) Stabilizer hinge moments required to trim in the flight condition at break-up were estimated to be 10 to 20 per cent below the output of one cylinder. It is possible but improbable that the horizontal tail could overpower one hydraulic actuating system after malfunction of the other system.

3) Directional and lateral stability and control characteristics were not contributing factors in the accident.

As a result of the accident investigation, two revisions to the aircraft are recommended:

1) Change the elevator linkage to reduce by about one degree the up-elevator deflections at stabilizer incidences of high-speed flight;

2) Increase the power of the stabilizer hydraulic actuating cylinder at least 25 per cent to ensure trim in all level flight conditions after a failure of one system and to give adequate maneuverability over the entire speed, load factor, and altitude range.

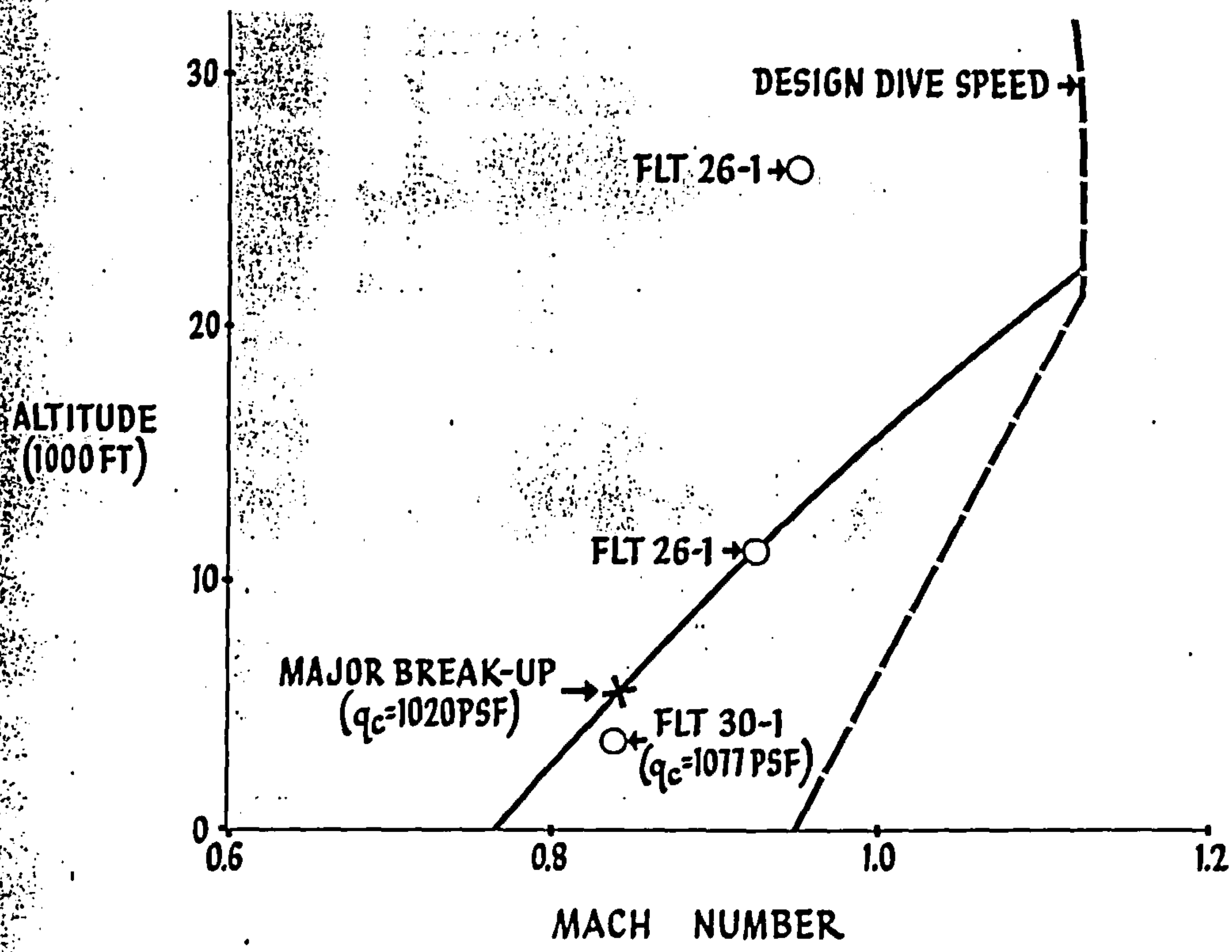

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Fig. 7. Flight Test and Break-Up Speeds

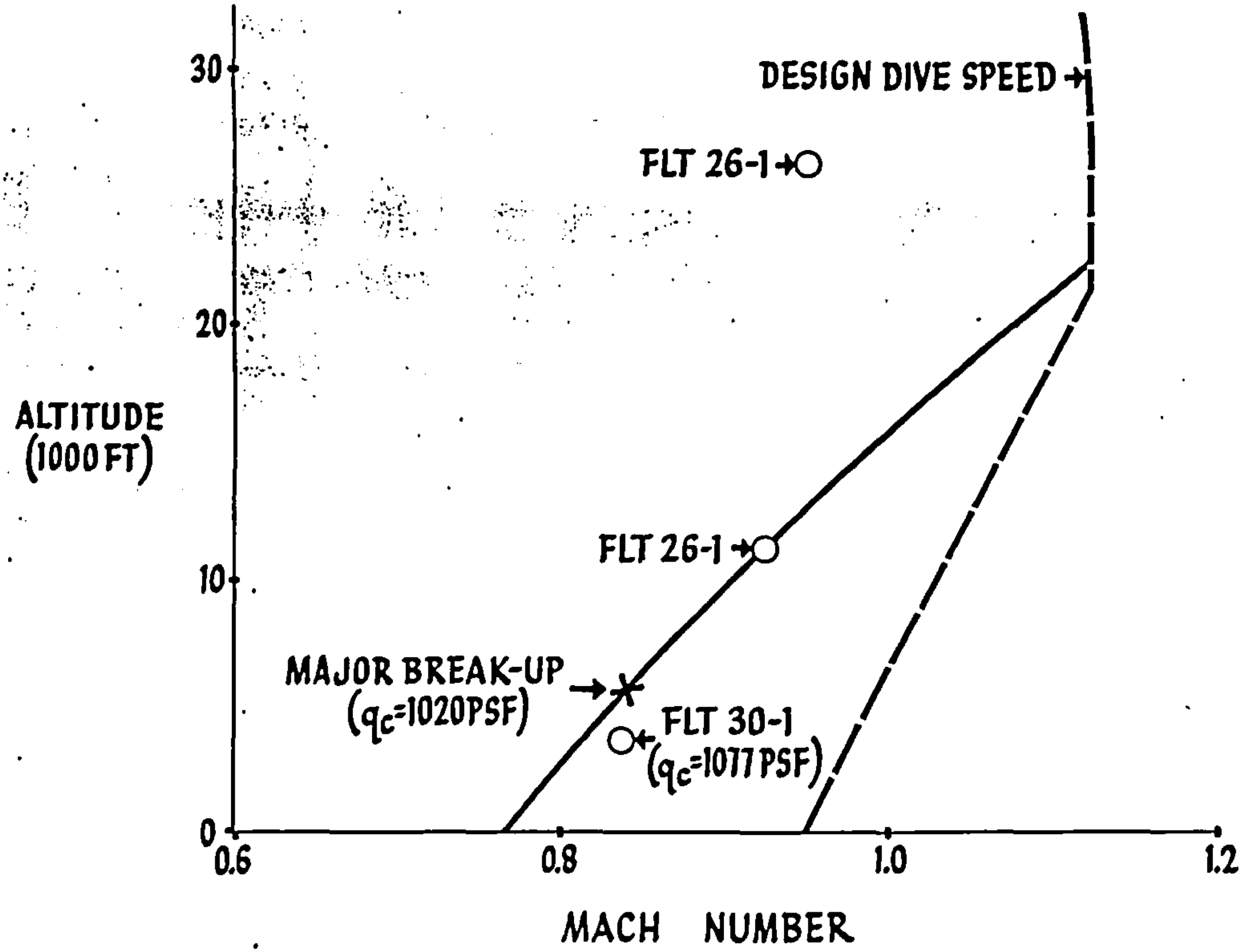

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Fig. 7. Flight Test and Break-Up Speeds

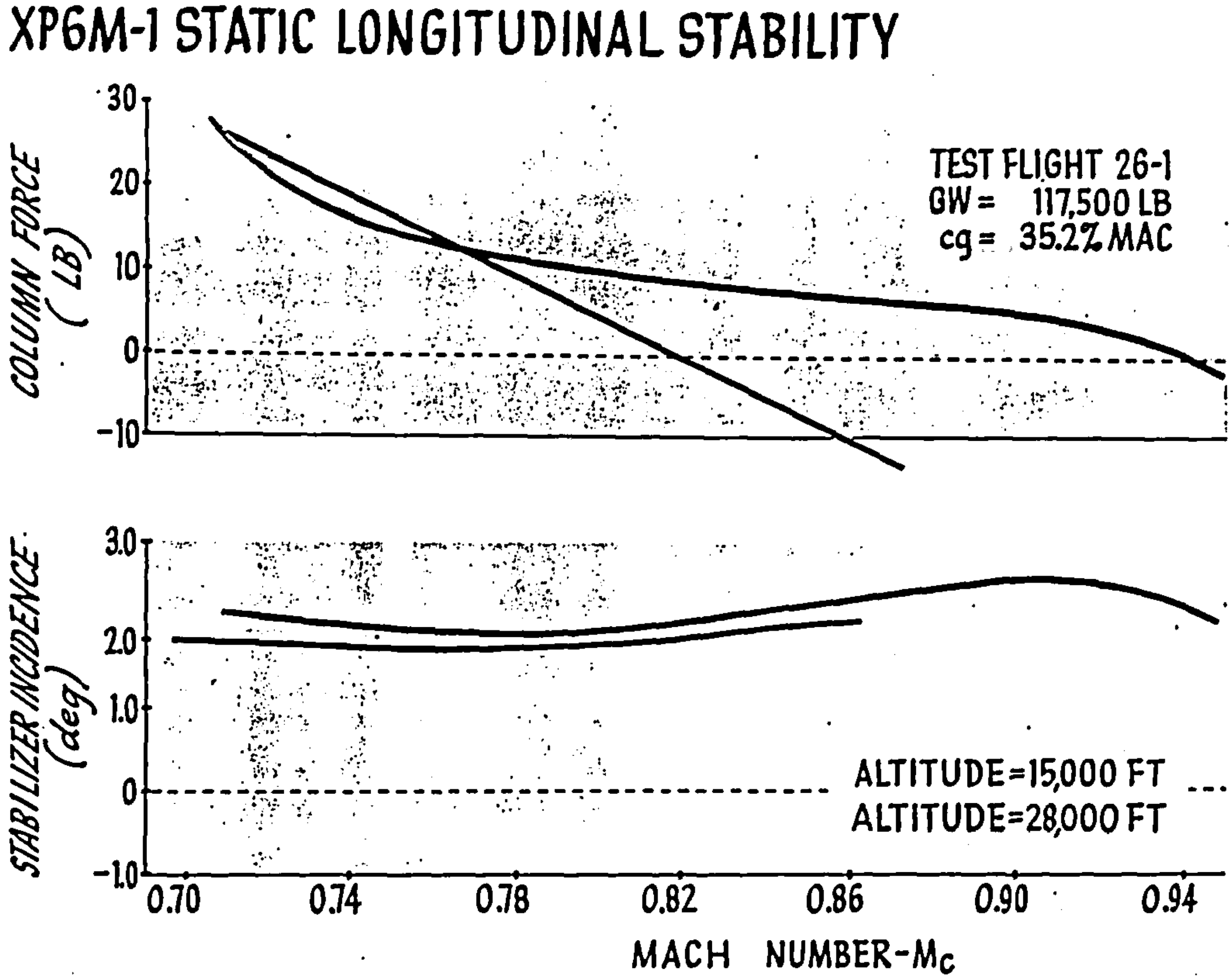

Fig. 8. Static Longitudinal Stability

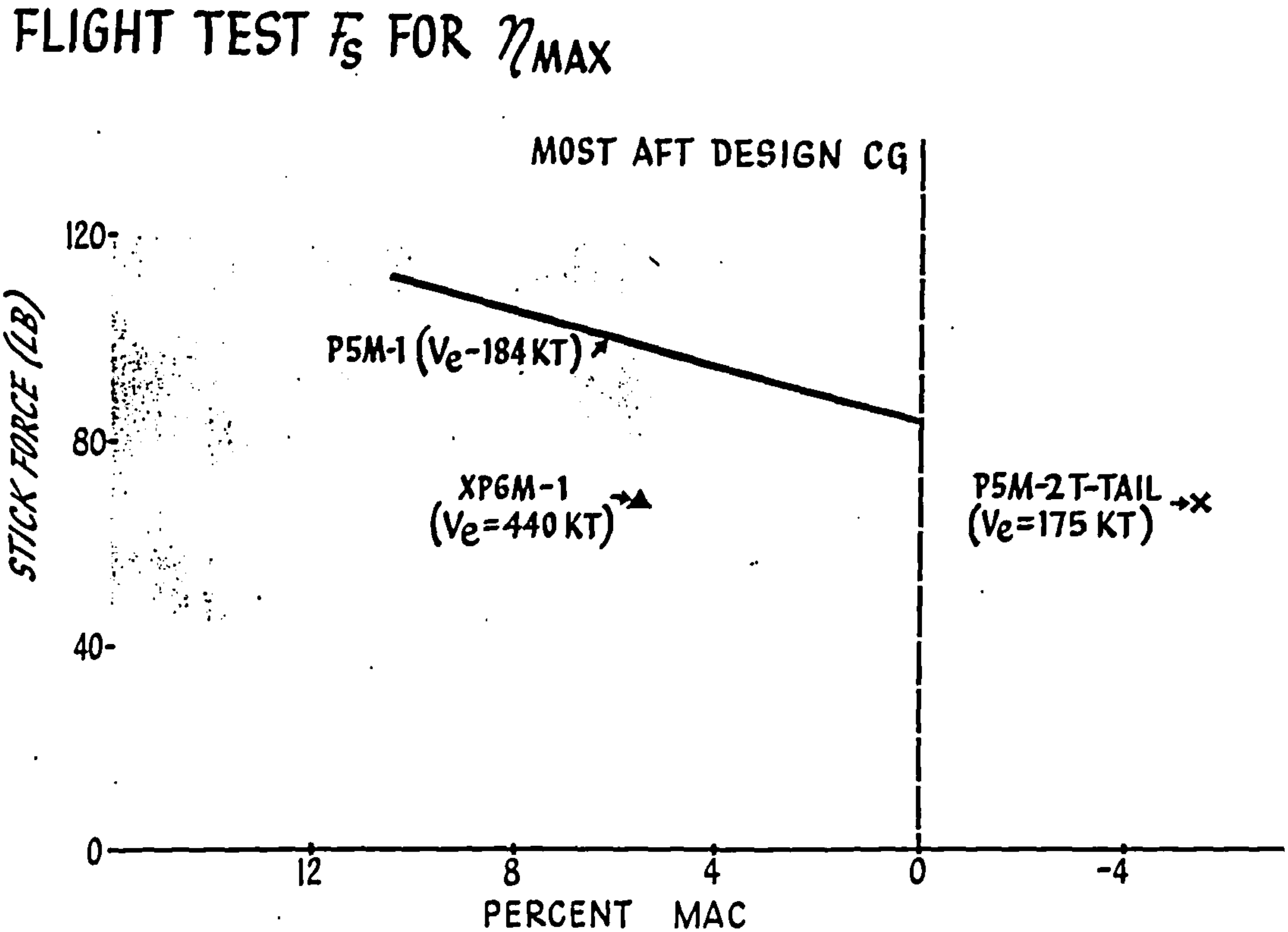

Fig. 9. Maneuvering Control Forces

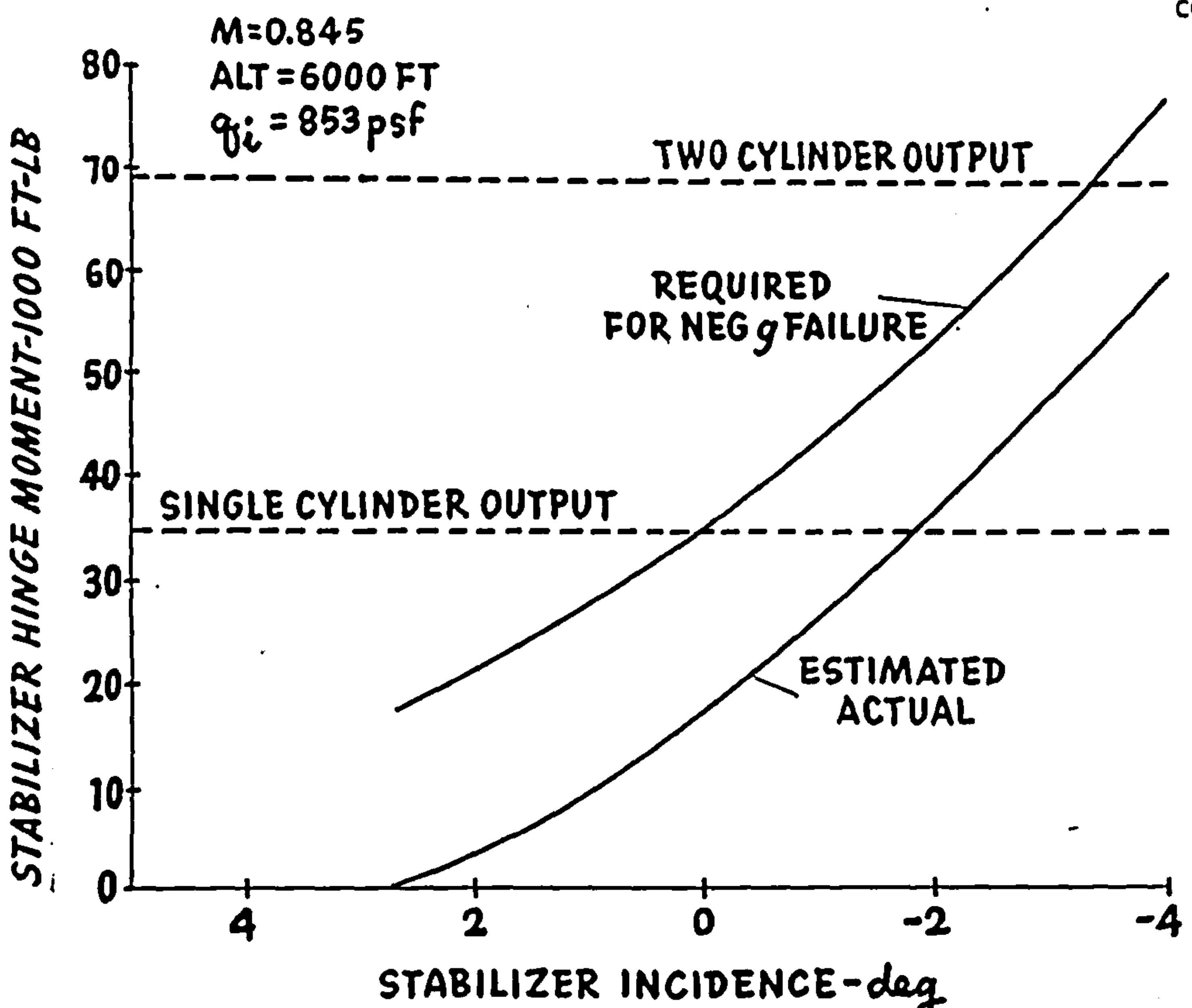

Fig. 9a. Stabilizer Hinge Moments for Negative-g Break-Up

VII. POWERPLANT

Allison YJ71-A-4 engines were used on the XP6M-1. The J71 engine program, with a total of 60,000 hours operation and 10,000 actual flight hours, provides an excellent background for these engines. Parts ahead of the rear turbine flange are the same on the J71-A-9 and J71-A-4 engines except for afterburner and assembly parts. The A-9 and the similar A-11 engines are used in the Douglas B-66 and RB-66 with a high degree of reliability. Further backup is provided by the J71-A-2 engines of the McDonnell F3H which have basically the same compressor, burner, and turbine as the A-4 engines. The A-9, A-11, and A-2 engines are qualified for 150 hours and currently operate 300 hours between overhaul. Having the same rotating parts as these engines gives the J71-A-4 inherently more reliability than the 50-hour flight rating test that is customary for experimental engines. Outside of a minor afterburner problem during take-off, the operation of the A-4 engines in the XP6M-1 airplanes was highly successful and required only routine attention from the pilot.

A. ENGINE RECOVERY

Photo-panel records show that the engines were operating at approximately 98 percent rpm before the accident. Indications are that they were throttled back possibly to idle for the controlled descent, and between 5000 and 6000 feet they were thrown out by a violent nose-down pitch of the aircraft. Some parts of the engines were recovered in the major wreckage area. The engines must have suffered partial break-up due to the action of the engine removal doors and to the many hoses attached to the gear cases. Three afterburners were found near the engines, indicating that they broke off upon impact with the water.

A thorough examination of Engines 1, 2, and 3 and their nacelles showed no sign of engine failure. These engines suffered severe impact damage, the majority of which was caused by collision with the water. Engine Number 4 has not been found, but the Engine 4 nacelle, including the complete firewall between Engines 3 and 4, shows no sign of fire. or possible engine or accessory failure. None of the nacelles gives evidence of flying objects which may have come from the engines or accessories. The arrangement of Engine 3 and 4 nacelles and the possible path of dislodged engine rotating parts is diagramed in Fig. 10. The rotating accessories of Engine 3 are not adjacent to the hole in the side of the hull at the Number 4 fuel tank. The Engine 3 compressor was recovered intact except for impact damage.

B. ENGINE SUPPORT FAILURE

The three recovered engines and the Engine 4 nacelle show that all four engine mounts failed in a similar manner. The engines left the aircraft in an upward direction and went through the engine removal doors on top of the nacelles. Failures of the fittings are clean, and there is no sign of the engines or their components being loose in the nacelles. Although only a few nacelle doors were recovered, there is no sign of an explosion which could have blown a door off the airplane prior to the accident.

C. FIRE

When the fire extinguisher system is operated, it shuts off all hydraulic oil and fuel to the affected nacelle. The hydraulic valves in Engines 1 and 2 and the fuel shut-off valves in Engines 1 and 4 were found in the open position. This indicates that the fire extinguisher system was not used in any of these nacelles while d-c power was available. The XP6M-1 fire extinguisher and detector systems have been completely tested and declared satisfactory by CAA Technical Development and Evaluation Center in Indianapolis.

Fires did occur in Engine 2 and 3 nacelles. Examination showed, however, that these fires occurred after the engine left the nacelles and the fires were not large enough to cause the accident. Several small pieces of the nacelle removal and access doors were found burned and about an equal number were found unburned. The nacelle beam and beavertail between the hull and Engine 3 were recovered and showed no sign of fire or flying objects which could have caused the fire in the Number 4 fuel tank.

The Auxiliary Power Unit was not recovered but there was no evidence of fire or damage from flying objects in the area where it was installed. There is no requiremnt for operating the unit in flight except in an emergency when one engine generator does not function. Indications are that the unit was not operating at the time of the accident and therefore was not a contributing cause in the accident.

D. CONCLUSIONS AND RECOMMENDATIONS

The numerous consulting experts who joined the investigation concurred with the conclusion that powerplant trouble was extremely remote as a possible cause of the accident.

As a result of the studies, however, several recommendations not entirely relevant to the accident are made:

1) Adopt a more thorough procedure for engine inspection.

2) Simplify the fire extinguisher system operation by eliminating the nacelle selector switch. This reduces the number of operations necessary to fire a bottle and makes the system more reliable by eliminating four relays.

3) Ground test the fire extinguisher and detector systems by firing bottles and using heat on the detector elements.

4) Install improved fire detector system control boxes.

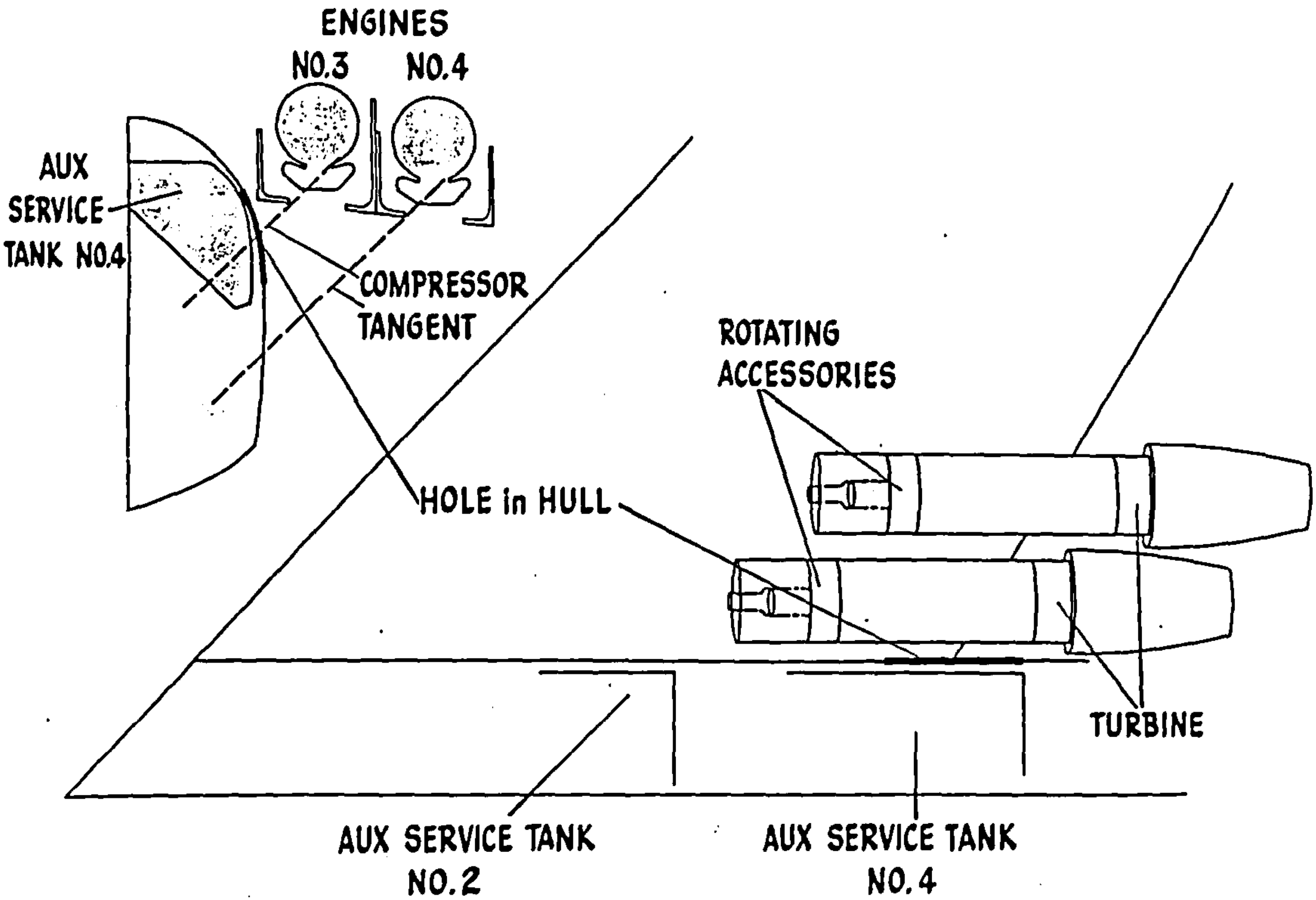

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Fig. 10. Tangents of Engine Rotating Parts

VIII. STRUCTURES

The XP6M-1 aircraft is designed to withstand flight maneuver load factors of 3.8g positive and 1.8g negative at a gross weight of 140,000 pounds. The airplane was static tested to 110 percent of the positive design limit load which was critical for the horizontal tail, the aft hull, and portions of the wing. Because no ultimate static test airplane was available, the flight airplane was restricted to two-thirds of these load factors, or 2.53g positive and 1.2g negative. The gross weight of the airplane at the time of the accident was approximately 115,000 pounds, and the load factor during the stability runs, according to the flight plan, would be plus 1g with variations of not more than plus - or - minus 0.2g.

The sequence of structural break-up, indicated by an investigation of the wreckage, is probably the following:

1) Upward motion of the stabilizer leading edge;

2) Violent nose-down pitch of airplane;

3) Failure of the wings in negative bending after an original stability failure of the lower cover of the hull stub in compression (Fig. 11).

4) Destruction of the primary tension-carrying material in the upper hull as the wings collapsed against the hull side (Fig. 12);

5) Horizontal tail failure from excessive angle of attack originating at the stabilizer hinge fittings.

The tail load for the flight condition last noted on the photo panel was 21,700 pounds down. A two-degree nose-up movement of the stabilizer at this speed would create sufficient load factor (minus 3.9g at this weight) to fail the wing in negative bending with a relatively small load on the tail.

The significant structural failures can be best analyzed by concentrating on the areas of failure origination and eliminating as unimportant certain large regions of the airplane. The most significant areas are the center hull section from Station 407 to 749, the hull stub from LBL 56 the RBL 56, and the tail structure.

A. ELIMINATED ORIGINS OF FAILURE

The forward hull from Station 407 forward, the aft hull from Station 749 aft, and the wings from BL 56 outboard can be eliminated as origins of failure.

1. Forward Hull Section

The area forward of Station 407 was one of the least probable origins of failure:

1) Practically all damage was caused by water impact.

2) The damage to Bulkhead 407 and to the mine door drag struts was caused by the mine door leaving the airplane. Because the struts are critical for a fully loaded door, their failure could not be primary.

3) Shrapnel damage to Bulkhead 407 occurred prior to the fire in the pressure lock.

4) The wing leading edge failed prior to the fire in the pressure lock.

5) Both crew hatches show fire damage and give no indication of striking other structure. The fire occurred after break-up.

2. Aft Hull Section

Consistent water damage to the bottom and left side of the hull from Station 647 aft indicates this piece to have been together upon impact with the water. Damage to hull skin on the right side near Station 700 coincides with the position of the flap hinge bracket when the wing rotated into the hull (Fig. 13). Since this section is still an integral part of the aft hull, it can be assumed that the aft hull was in one piece when the wings failed.

3. Outboard Wings

The outboard wings failed in positive bending just outboard of the nacelles by inertia forces and by slapping together under the hull. The symmetry of failure of the wing through a section which is not a minimum section indicates that the hull side destroyed the lower cover along this section. The possibility of an explosion in the wing is remote because of the symmetry of failure.

B. CENTER HULL SECTION

The center hull section is an area of significant structural failure. The general structure in this area consists of:

1) Three bulkheads (front and rear spar wing bulkheads and an aft hull tank bulkhead);

2) An upper and lower longeron;

3) A crown stringer which becomes integral with a wing rib;

4) Hull skin;

5) A torque box which stabilizes the lower longeron;

6) Fuel tank support structure which carries vertical shear and torsion loads only.

1. Wings

All of the failures in the center hull section are consistent with a negative bending failure of the wing.

The front-spar bulkhead hammerhead fittings failed from tension on the upper chord, and the lower chord failed from compression. The rear spar bulkhead and the hull fuel tank bulkhead failed in a manner that indicates the wing folded down. Heavy brinelling marks on the closing rib and the lower chord of the wing rear spar coincide with marks on the hammerhead fitting. These marks show that the wings hinged about the intersection of the closing rib and the wing upper chord. Failure of the bulkhead side and inner chords and damage to the mine door indicate that the mine door was in place when the wing was destroyed. Failures of the longerons, crown stringers and the wing covers in the hull stub are also consistent with a failure of the wing in negative bending. The upper cover failed in tension and the lower cover failed in compression (Fig. 14).

2. Hull Side Skin

The most significant evidence in this area is that pieces of the hull side skin and mine latch frames were found inside the center sections in both wings. Damage to the lower blanket of the center wings (near the front spar between BL 105 and BL 155) coincides with the latch frame position when the wing is rotated downward. Damage to the hull side skin in the torque box area coincides with the inner flap hinge bracket when the wings fold inward.

3. Fire

The Number 4 fuel tank door shows evidence of failing from an explosive force in the tank cavity between the door and the fuel cell. However, lack of fire damage to the mine door indicates that the explosion occurred after break-up.

The fire in the Number 4 hull tank area and the fire along the right side of the hull, which was fed by fuel from the Number 4 cell, occurred in the air. The burning time was from 15 to 30 seconds in the air and from two to three minutes on the water. Fractures in this area show that the fire occurred after failure. All other fires occurred after break-up either in the air or on the water (Fig. 15).

C. TAIL

The other area of significant structural failure is the tail. All fractures were examined in the laboratory for evidence of fatigue, and hardness tests were made of all major pieces. In no case was there evidence of fatigue or material deficiency.

Both the fin and stabilizer are constructed of three main spars with honeycomb blankets. The structure of the leading edge is conventional. The stabilizer is attached to the fin at the rear spar and hinges about this point. The stabilizer actuating cylinder is attached to the front spar lower chord at the ship centerline to react vertical loads. The center of pressure for a down load on the tail occurs aft of the hinge point and puts tension loads in the actuating cylinder. A scissors fitting attaches to the fin front spar and the stabilizer front spar at the upper chord. The scissors fitting reacts side loads only. The elevators are slaved to the stabilizer and are actuated through a set of push-pull rods and bell cranks.

1. Stabilizer

The original failure, resulting from an up and aft load on the stabilizer, was in the stabilizer hinge fittings (Fig. 16). There is no indication of an unsymmetrical load on these fittings. The elevator push-pull fitting, located between the stabilizer center spar and rear spar on the ship centerline, failed in tension with evidence of an upward and rightward movement of the stabilizer. The actuating cylinder failed in tension and bending at two places -- through the attaching lug and 16 inches below the stabilizer attaching point. This failure occurred when the actuator was fully extended and when it was five inches aft of its normal position. The actuator impinged upon the fin closing rib at this point from an aft and rightward movement of the stabilizer.

The scissors fitting failed with compression on the upper left arm and with tension on the fin attachment fitting of the upper right arm. This is consistent with a side load to the right on the stabilizer.

The outer third of each stabilizer failed in negative bending. This structure, probably weakened by the pulling of the outer hinge bracket from the stabilizer by the elevators, failed at water impact. The aft stabilizer leading edge was struck by an object while still an integral part of the airplane. Indentations and scrape marks on the upper cover indicate a direction parallel to the flight path. This object was most likely an engine access door. The final disintegration of the tail indicates that the failure did not propagate from this impact.

2. Elevators and Fin

The damage to the elevator and its hinges shows that the right elevator exceeded its travel limits in an upward direction and failed from aft and downward loads. Indications are that the outer hinge failed first. The left elevator exceeded its travel limits in a downward direction and failed from upward and aft loads (Fig. 17). It is again evident that the outer hinges failed before the centerline hinge. It would be necessary for the stabilizer to leave the airplane before the elevator could exceed the limits noted.

The fin failures occurred after break-up either in the air or at water impact. The force required to separate the stabilizer from the fin is such that the fin must remain an integral part of the airplane to react it. All fin failures, therefore, are secondary.

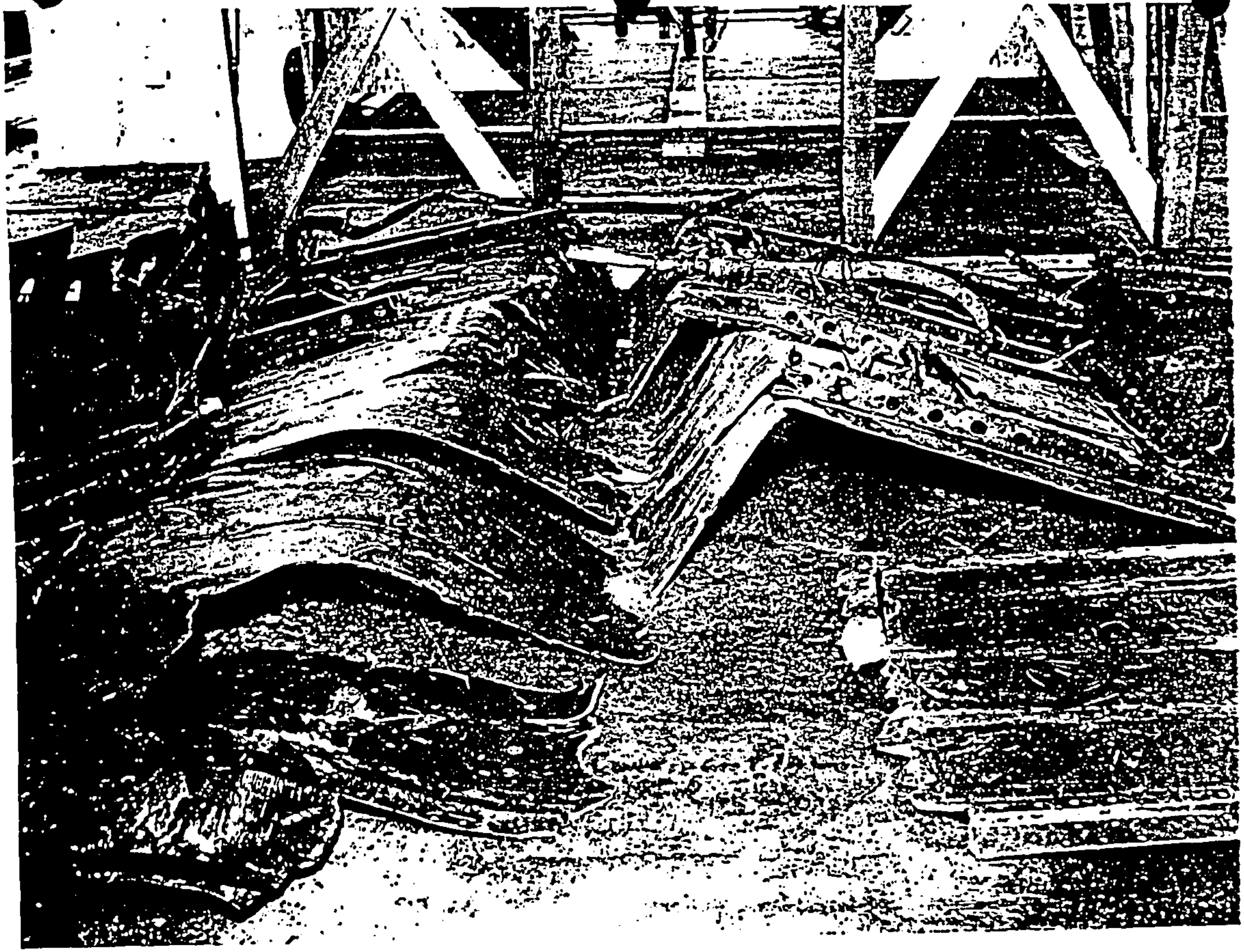

Fig. 14. Lower Wing Cover

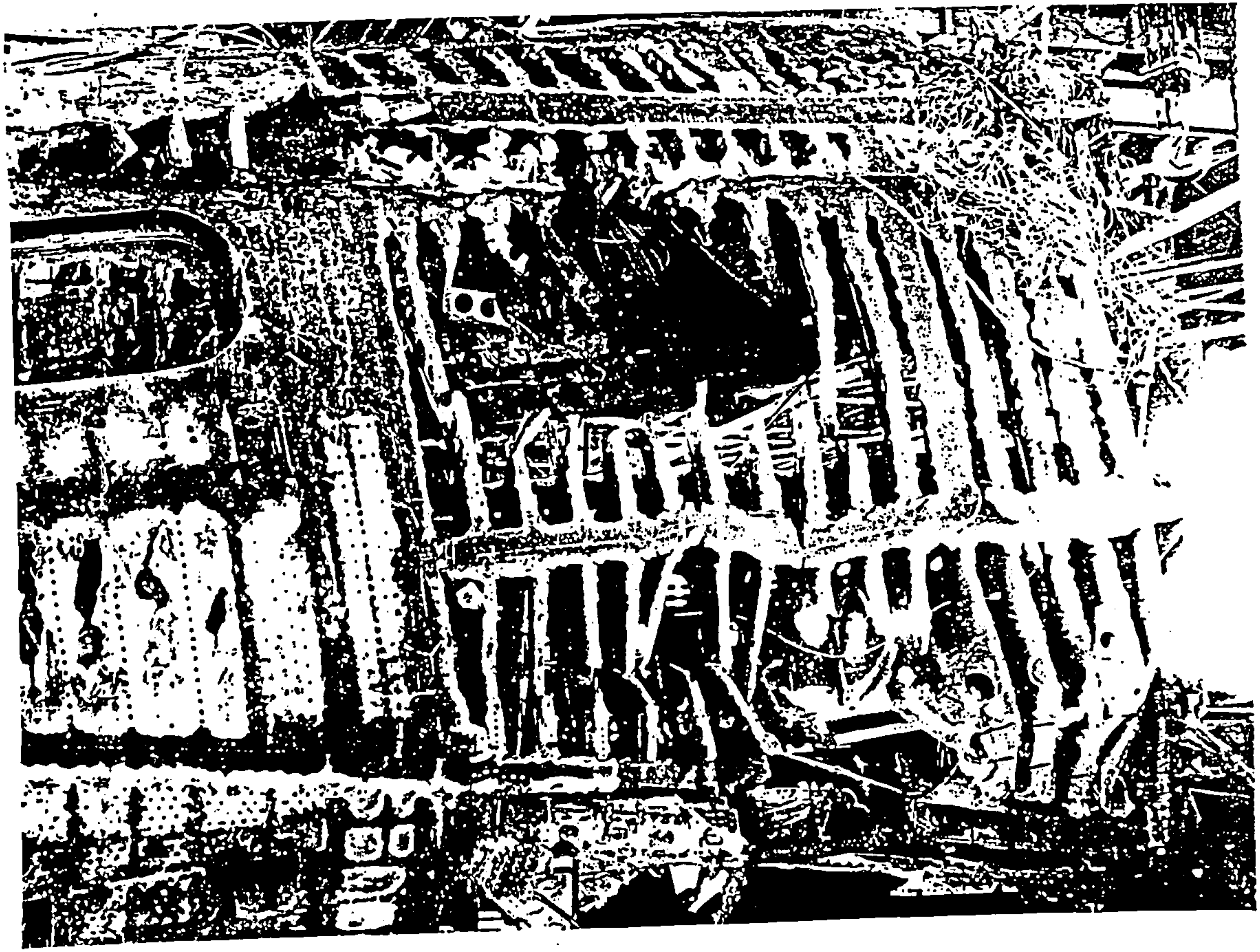

Fig. 13. Damage to Hull, Right Side

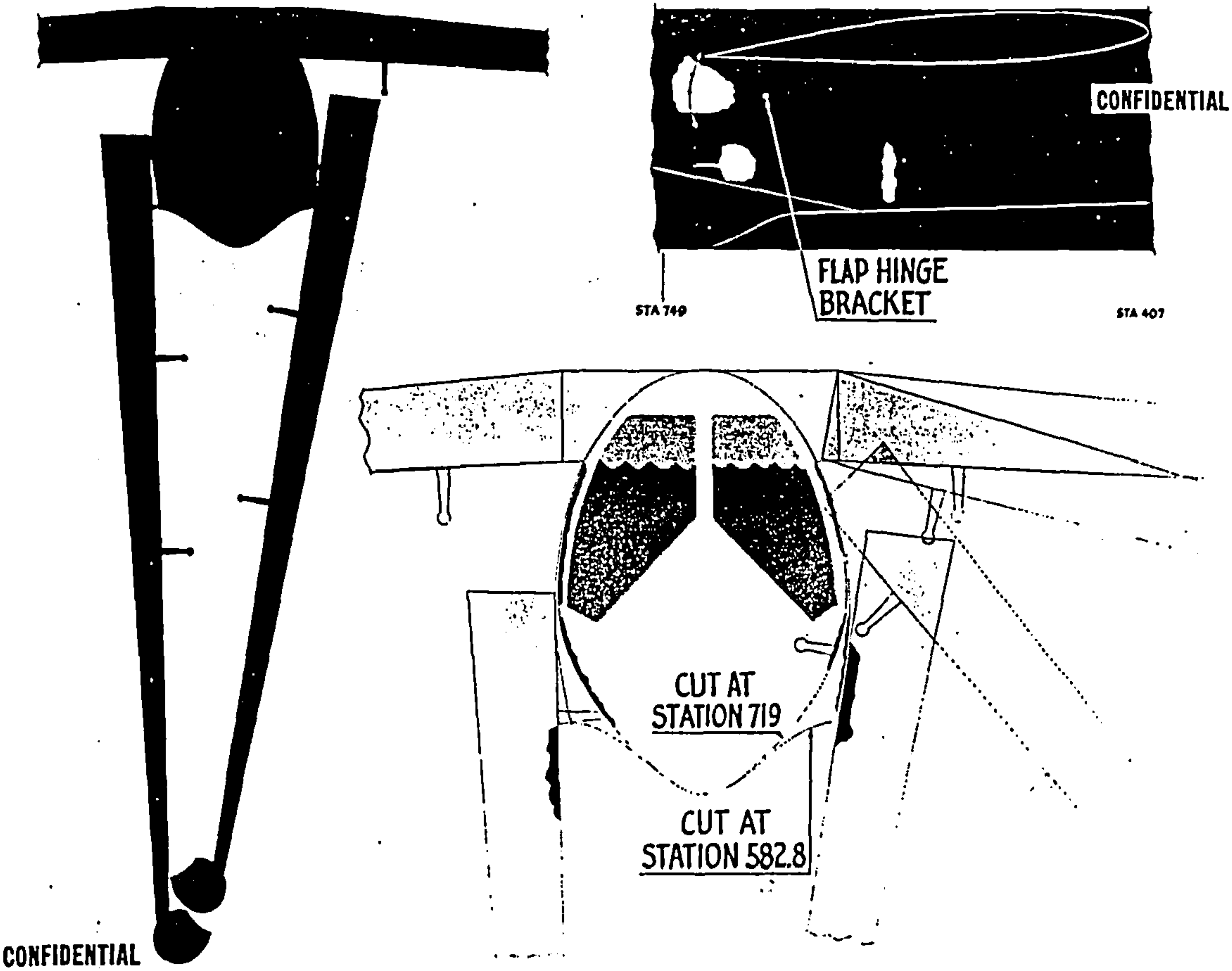

Fig. 11. Wing Failure

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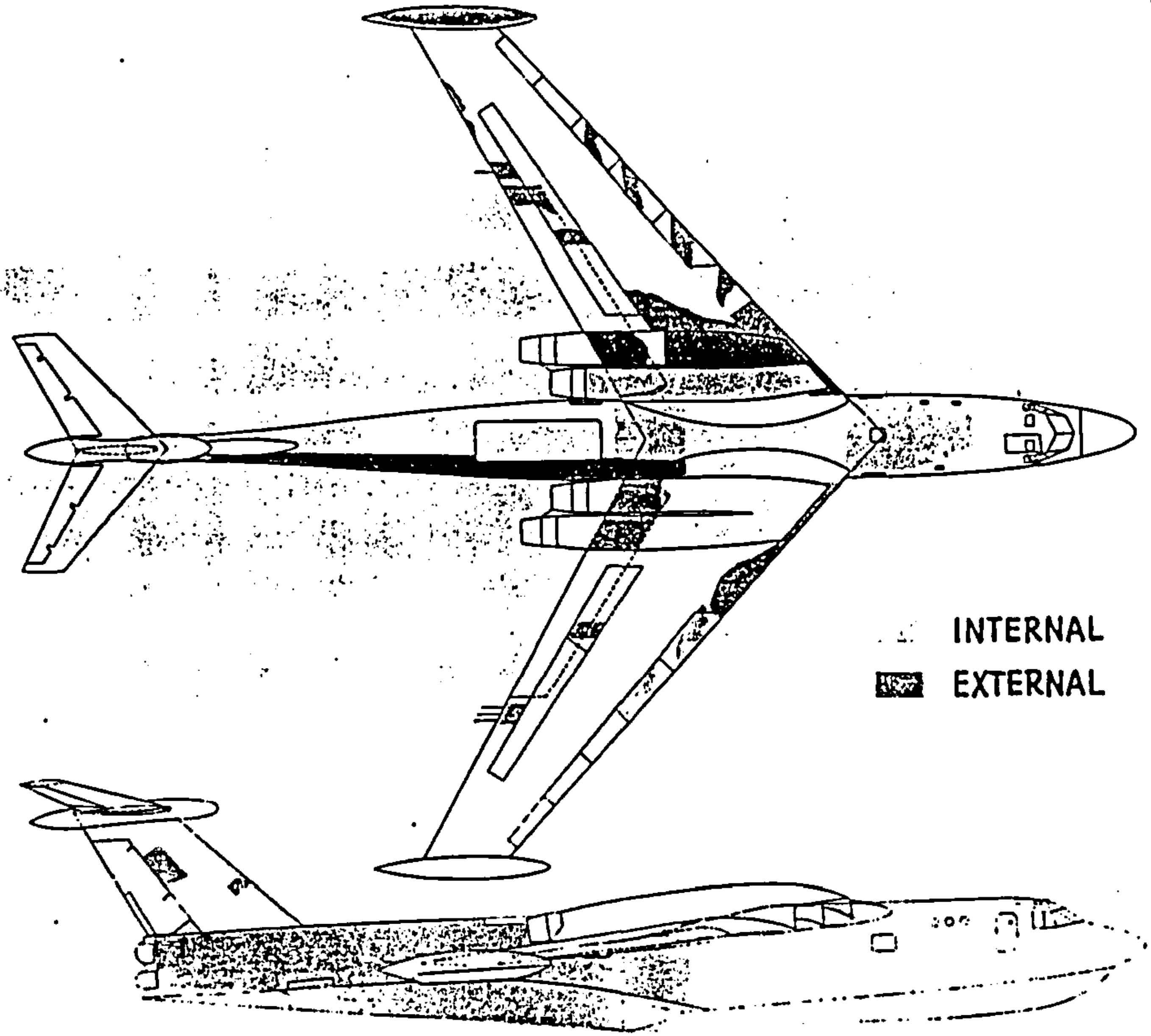

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Fig. 15. Fire Pattern

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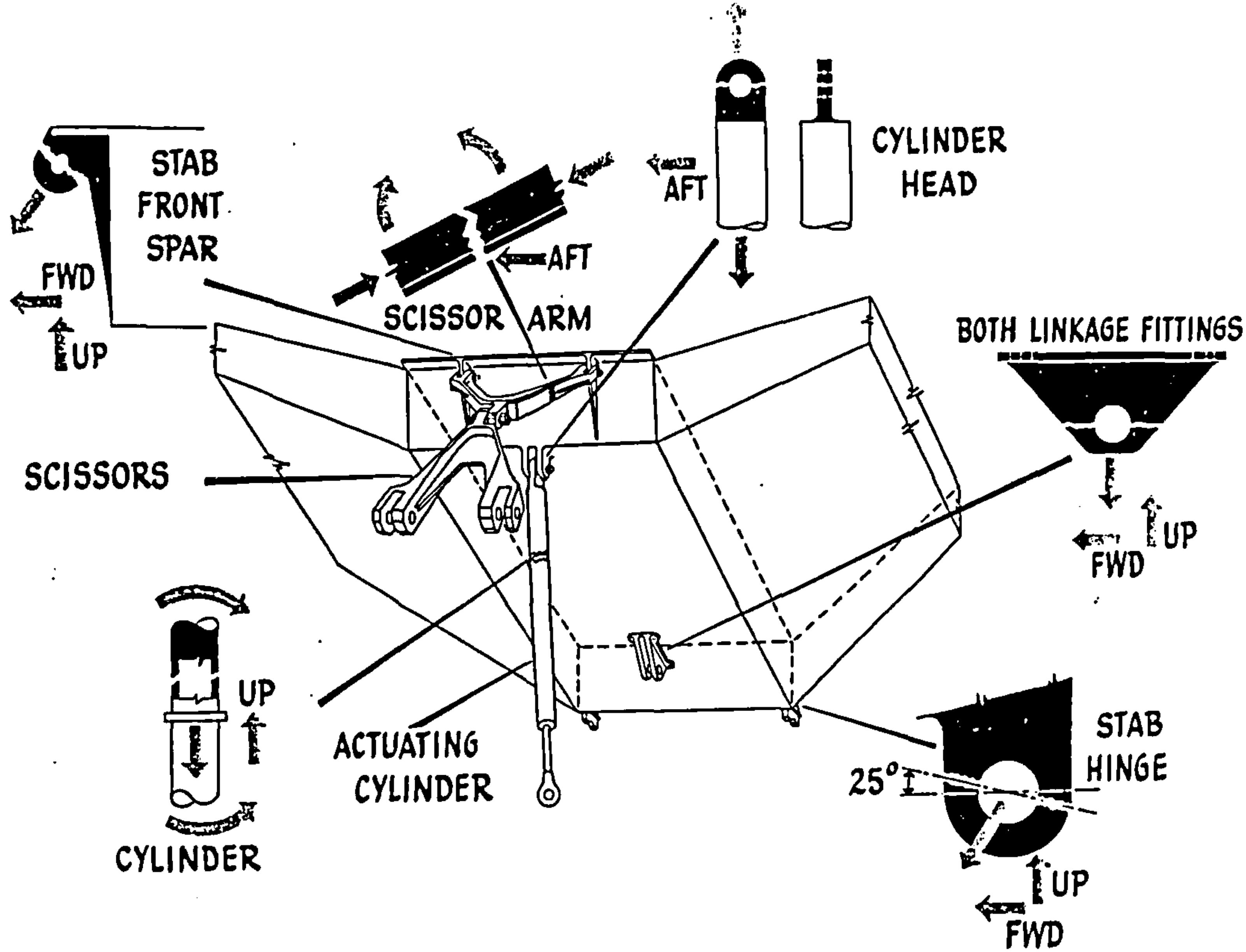

Fig. 16. Stabilizer Failures

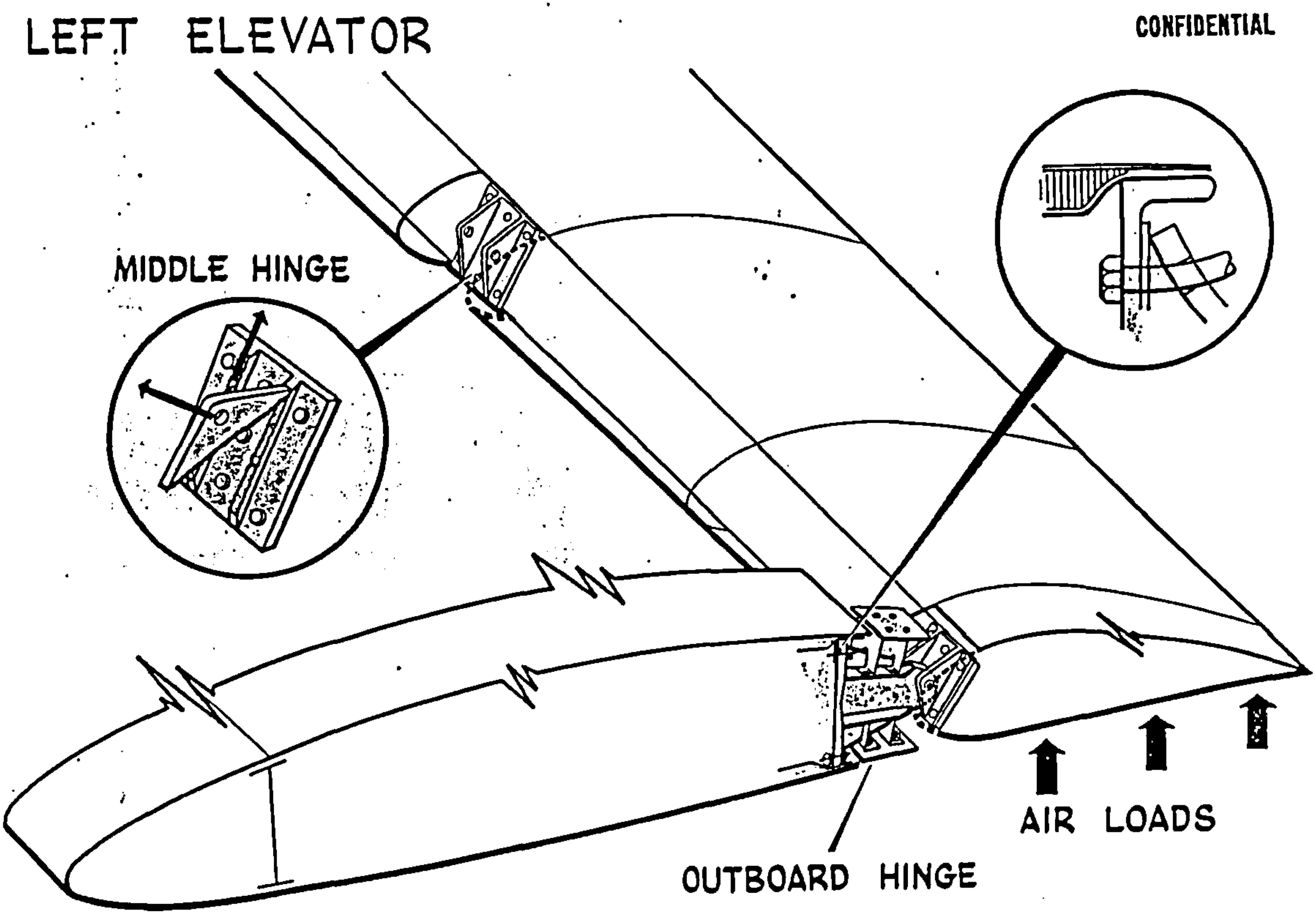

Fig. 17. Left Elevator Failures

IX. DYNAMICS

Flutter is a self-excited oscillation which occurs if the airplane surpasses its critical speed. Below this speed, excitations from gusts and other sources die out without damage to the airplane. The possibility that flutter might have played a part in the accident was carefully explored. The following sources of information were available:

1) Past flight records;

2) Analytical studies and wind tunnel model tests;

3) Wreckage examination.

Analytical and model test investigations do not supply sufficient evidence to fix the flutter speed accurately. Although it might have been lower than specification requirements, the examination of the wreckage and a study of past flight records of higher speeds show that flutter did not occur and cannot be considered a contributing cause of the accident.

A. PAST FLIGHT RECORDS

Test flights were monitored by accelerometers fixed at various points on the aircraft. None of the records gave any indication that the airplane was in danger of flutter within its flight limitations (Fig. 18).

The most significant record was obtained during Flight 30: 1077 psf dynamic pressure (compared with 1020 psf for the accident), 3420 feet altitude, Mach 0.835, and 522 knots CAS. This record was taken during operation of the rotary minebay door so that the whole aircraft was shaken. The oscillograph record properly indicates this shaking but gives no indication of low damping for any of the frequencies that would be connected with flutter.

In an examination of the record, the frequency connected with antisymmetric T-tail flutter (about four cps) was of particular interest. This frequency was indicated at two or three places in the record with a maximum amplitude of about plus-or-minus 0.2 degrees (torsional motion of the upper fin closing rib), but each time it was damped out within two or three cycles. The following conclusions have to be drawn:

1) The recording gave a suitable indication of the required oscillations.

2) The behaviour of the airplane, interpreted on the basis of test experience, indicated a flight speed substantially below the flutter speed.

3) The parameter "q" (larger for this record than for the accident), rather than the parameters V, M and ρ , is critical for this type of flutter.

In general, the past flight records definitely show that the aircraft, if no other damage occurred beforehand, was substantially below the speed for any type of destructive flutter.

B. ANALYSES AND WIND TUNNEL MODEL TESTS

The original flutter investigation of the airplane was based on extensive analytical investigation and on low-speed wind tunnel tests. Doubts still existed regarding the possibility of T-tail flutter at transonic speeds. Flight limitations were set accordingly, and a high-speed wind tunnel investigation was well under way at the time of the accident.

In connection with the accident the following conditions were reviewed:

1) Wing -- tip floats partially filled with water or ice;

2) Flap -- a) a loss of pinch-up in the system,

b) an abnormal amount of ice in the flaps;

c) a loss of hydraulic actuators;

3) T-tail flutter;

4) Elevator -- a) a loss of actuator rods,

b) water or ice in the trailing edge;

5) Rudder -- a) a loss of mass balance,

b) a loss of the actuator,

c) a broken top rudder hinge.

In cases 2) c) and 4) a), relatively mild flutter was indicated in speed ranges below the accident speed. The results of 4) a) may be significant in interpretating the wreckage because the elevators would flutter after the stabilizer as a whole had left the airplane. The possibility of 5)c) is still being investigated, although a preliminary check does not indicate flutter. Such a failure could be of considerable interest in that fracture of the rudder bracket would damage the hydraulic lines to the stabilizer actuator. With the exception of T-tail flutter, all remaining cases have been eliminated.

High speed tests and further analytical investigations of T-tail flutter have been completed. The nature of this flutter has been explored: it is a violent antisymmetric flutter involving mainly fin torsion with stabilizer yawing and rolling motions.

The critical speed of this flutter is determined by so many parameters not accurately known (including those of the hull and the wing) that analytical and experimental results are subject to various possible interpretations. A conservative interpretation yields a small margin (about five per cent) above accident speed. A larger margin, however, is by no means excluded. Thus, a firm conclusion that T-tail flutter did not cause the accident cannot be drawn from analytical and test investigations. On the other hand, this possibility is excluded by past flight records and by an examination of the wreckage.

C. WRECKAGE EXAMINATION

With regard to antisymmetric T-tail flutter, the wreckage examination revealed:

1) Stabilizer failures were remarkably symmetric; the middle two-thirds was recovered in one piece. Both stabilizer trunnion fittings show a clean fracture from high vertical tension load and show no other damage. Flutter would produce high fore and aft loads on these fittings, a different mode of failure.

2) High antisymmetrical loads would overload the critical connection of the stabilizer center section blanket to the rear spar. This connection was intact and showed no sign of distress.

3) T-tail flutter would put large torsional loads on the fin. No permanent torsional shear wrinkles were found in the fin leading edge, nor were permanent shear buckles found in the fin blanket panels.

4) T-tail flutter, either kinematically or inertially, cannot cause extension of the stabilizer actuating cylinder (which failed in its fully extended position).

Other possibilities of flutter were eliminated by an examination of the wreckage.

1) Wing flutter would be antisymmetric. The failure of the wing, like that of the tail, was remarkably symmetric.

2) Flap flutter could be caused by loss of the actuating cylinder but it would be evidenced by damage to the top of the flap and to the adjacent bottom of the beavertail on the nacelles. No such damage was found.

3) Elevator flutter might be indicated by damage at both up and down stops but could not have happened before the actuator rods broke; it could have occurred after the break-up.

D. FIN STIFFNESS

For the second XP6M-1 and the YP6M's, a new fin is being designed to provide an increase of approximately 80 per cent in torsional stiffness (Fig. 19). This new design will replace the honeycomb panels with relatively heavy aluminum sheet, increase the fin thickness of the upper end, and effect a redesign of the bullet fairing. A substantial increase in critical T-tail flutter speed is expected from this change. Until the new fin is available, flight speeds for the second airplane will be restricted to Mach 0.7 at sea level, varying linearly to Mach 0.95 at 21,500 feet. Analytical and model test investigations will be continued.

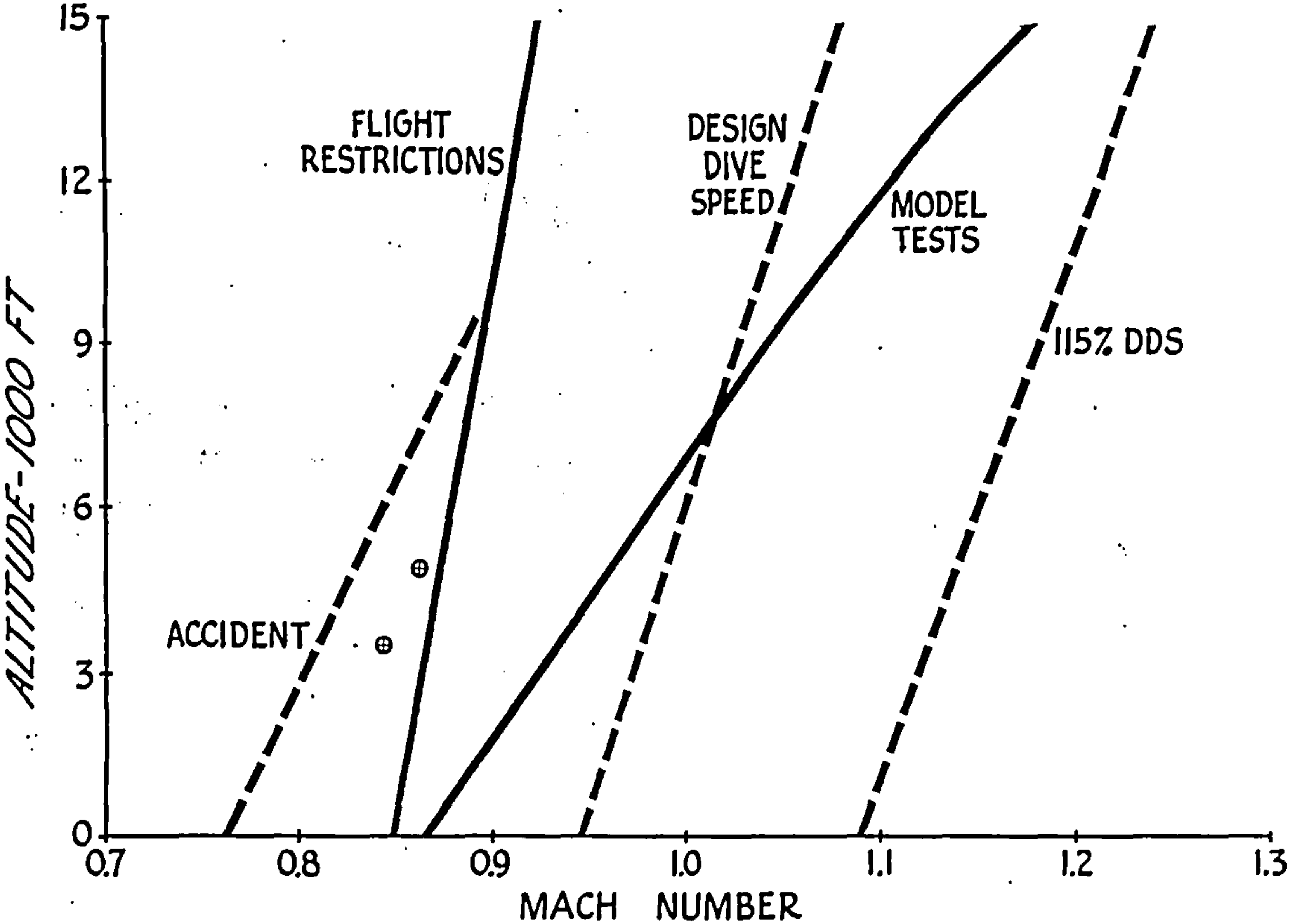

Fig. 18. Flutter Limits

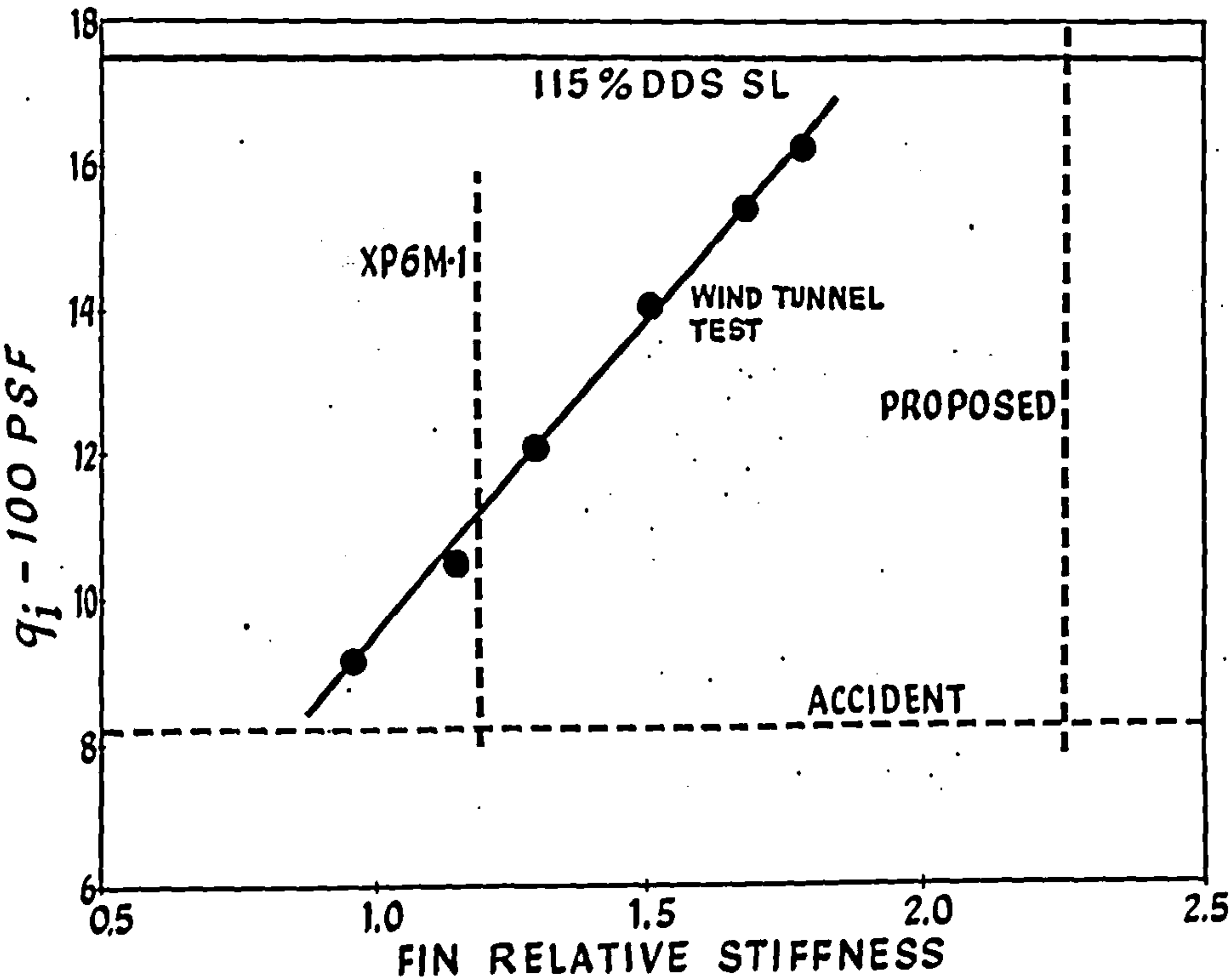

Fig. 19. Fin Stiffness

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X. CONTROLS

The flight path of the XP6M-1 during the accident suggests an excessive stabilizer nose-up movement that caused a high-g nose-down pitch of the aircraft and subsequent break-up. There are two broad areas of possible cause for this excessive nose-up stabilizer movement:

1) Forces external to the hydraulic or mechanical control system;

2) Forces internal to these systems.

Although all hydraulic and mechanical control systems have been investigated, the nature of the accident -- violent nose-down pitching of the airplane with little or no roll or yaw -- indicates that major effort should be devoted to an analysis of the pitch control system (Fig. 20).

A. DESIGN HISTORY

The complete design history of the pitch control system is not germane to the accident investigation. Nevertheless, a few of the most pertinent facts should be mentioned here:

1) The aerodynamics of the airplane necessitated full power-control of the stabilizer.

2) Full power-control of the stabilizer in turn dictated the use of some type of synthetic feel system.

3) The response requirements of the stabilizer control system made it necessary to use hydraulic power as the driving force.

4) In the system there are dual mechanical control runs from the control column aft to the feel system linkage and from this linkage to the stabilizer-valve operating crank.

5) Two completely independent hydraulic systems are used to power the control sufaces. Each of these systems is used to power one section of a tandem hydraulic cylinder that actuates the stabilizer.

6) A full-scale control system mock-up was used for the stability test program. Subsequent to the stability tests, a life test of over six million cycles was run on the pitch control system.

B. INVESTIGATIONS

Many reports, investigations, tests, and studies were made by the electro-mechanical department to determine possible causes of the accident. A few of these will be mentioned to indicate the types of investigations:

1) The stability study mock-up was used to ascertain the response characteristics of the stabilizer under various types of hydraulic system failure or malfunction.

2) Recovered components were examined for possible areas of malfunction.

3) Failed tubing, pulley brackets, cables, etc., were examined to determine what type of failure occurred.

4) Tests were run to study the effect of valve "silting" on valve spool friction. The stability study mock-up was used to evaluate the effect of valve friction on over-all airplane stability.

Several significant facts developed as a result of the investigation:

1) There was no evidence of initiating structural failure in either the control system or the hydraulic system.

2) There was no visible evidence of contamination or galling in the stabilizer control valves.

3) The "q" portion of the feel system was recovered and found to be in a position corresponding to the estimated airplane speed at the time of the accident.

4) The stabilizer cylinder failed in the fully extended (stabilizer nose-up) position. The failure was a combination tension and bending failure of the upper cylinder barrel (Fig. 21).

5) After failure of the upper portion of the stabilizer cylinder, the lower portion of the cylinder (including the control valves and associated linkages) returned to the same trim position that was recorded on the last photo-panel exposure.

C. POSSIBLE CAUSES

The hydraulic and mechanical control system could have caused the accident through an unwanted signal entering the controls or through the loss of a hydraulic system. Although there is some evidence that these major possibilities were not the actual cause, they must still be considered. The facts of the investigation indicate several possible origins of an undesired stabilizer movement.

1. Unwanted Signal

An unwanted or undesired signal in the control system may have caused the stabilizer to assume an excessive nose-up attitude that resulted in structural failure of the wings through negative bending.

Pilot Error.- The simplest explanation may be that the signal was produced by the pilot in error. Although both were experienced aviators, this was the first flight in the XP6M-1 for one pilot.

Jammed or Broken Mechanical Controls .- A jammed or broken mechanical control system is another possible origin of excessive stabilizer movement. A jammed cable, a push rod, or a broken cable that has snagged on structure might cause the pilot to overcontrol if it suddenly broke loose while he was attempting to free the system. It is believed, however, that if such a condition did exist, the pilot would have reduced speed immediately and attempted to trim the ship with the stabilizer trim actuator. The position of the q-feel device and the trim of the system indicates that no such action was taken. It may be noted that a broken cable could result in some movement in the control system similar to that experienced by LCDR Horrell in the previous flight.

Loose Object.- A loose object or structural component in certain critical areas could overpower the feel system and cause excessive stabilizer movement. Due to the nature of the wreckage it is impossible to say conclusively whether this did or did not occur.

Loss of Feel.- Sudden loss of feel could prompt an overcorrection by the pilot, but the fact that the stabilizer cylinder returned to its trim position indicates that the feel system was probably intact at the time of the accident. Marks on the crank arms attached to the feel spring show that the electric trim actuator was attached to the spring when the aircraft broke up.

2. Hydraulic System Malfunction

Within the hydraulic system itself--irrespective of external forc es --there are other possible origins of an excessive stabilizer movement.

Loss of One System.- The loss of one hydraulic system, coupled with stabilizer hinge movements in excess of the load capabilities of the other system, would allow the stabilizer to assume a nose-up position. Because stabilizer hinge movements were never determined in flight tests, the possibility that these loads are above calculated values does exist. The loss of a system could result from many factors, and this retains a degree of probability in spite of the record of no failures during previous tests and flights. Two independent systems were specified for the airplane because of the very fact that hydraulic systems can and do fail. Failure of one hydraulic system could be caused by:

1) Leakage of fittings, tubing, or components to allow a loss of oil and pressure;

2) Bypassing of oil through a faulty component to produce a pressure loss;

3) Pump failure;

4) Malfunction or inadvertent operation of a bypass valve, accessible to the pilot for test purposes, that can dump the pressure in one stabilizer hydraulic system (perhaps the wrong one).

Loss of Two Systems.- The loss of two hydraulic systems could result from any combination of the causes that might produce failure in one system. Nevertheless, the fact that the recovered half of the stabilizer cylinder returned to its proper trim indicates that this system was operating at the trim position of break-up. Loss of both systems is not considered a probability.

Stabilizer Control Valve.- Malfunction of the stabilizer control valve could cause excessive movement of the stabilizer. The stabilizer control valve was recovered in good working condition, however, and the only type of malfunction that can be considered is high valve-spool friction due to "silting". High friction will cause hunting of the stabilizer surface; the amount of hunting depends upon the setting of the q-feel system and the amount of friction. Tests have been made to indicate that the maximum "silting" friction from a valve spool is 40 pounds. The time required to obtain this friction with no valve motion was two minutes. This corresponds to a hysteresis of less than 0.25 degrees of stabilizer movement. These tests indicate that spool friction as high as 90 pounds does not produce an unflyable airplane. It should be noted that "silting" could result in some control system movement which might be related to that experienced by LCDR Horrell in the previous flight.

D. RECOMMENDATIONS

As a result of the investigations, changes are being incorporated in the second XP6M-1. These and many other changes are being made in an attempt to increase the safety and reliability of the aircraft.

1) A larger stabilizer cylinder, whose capacity is approximately 25 per cent greater than that of the present one, is being designed.

2) The bypass valve on the Number 1 stabilizer hydraulic system will be disconnected except on particular test flights that require single-system operation.

3) The bypass valve on Number 2 stabilizer hydraulic system will be removed.

4) The feel system is being strengthened.

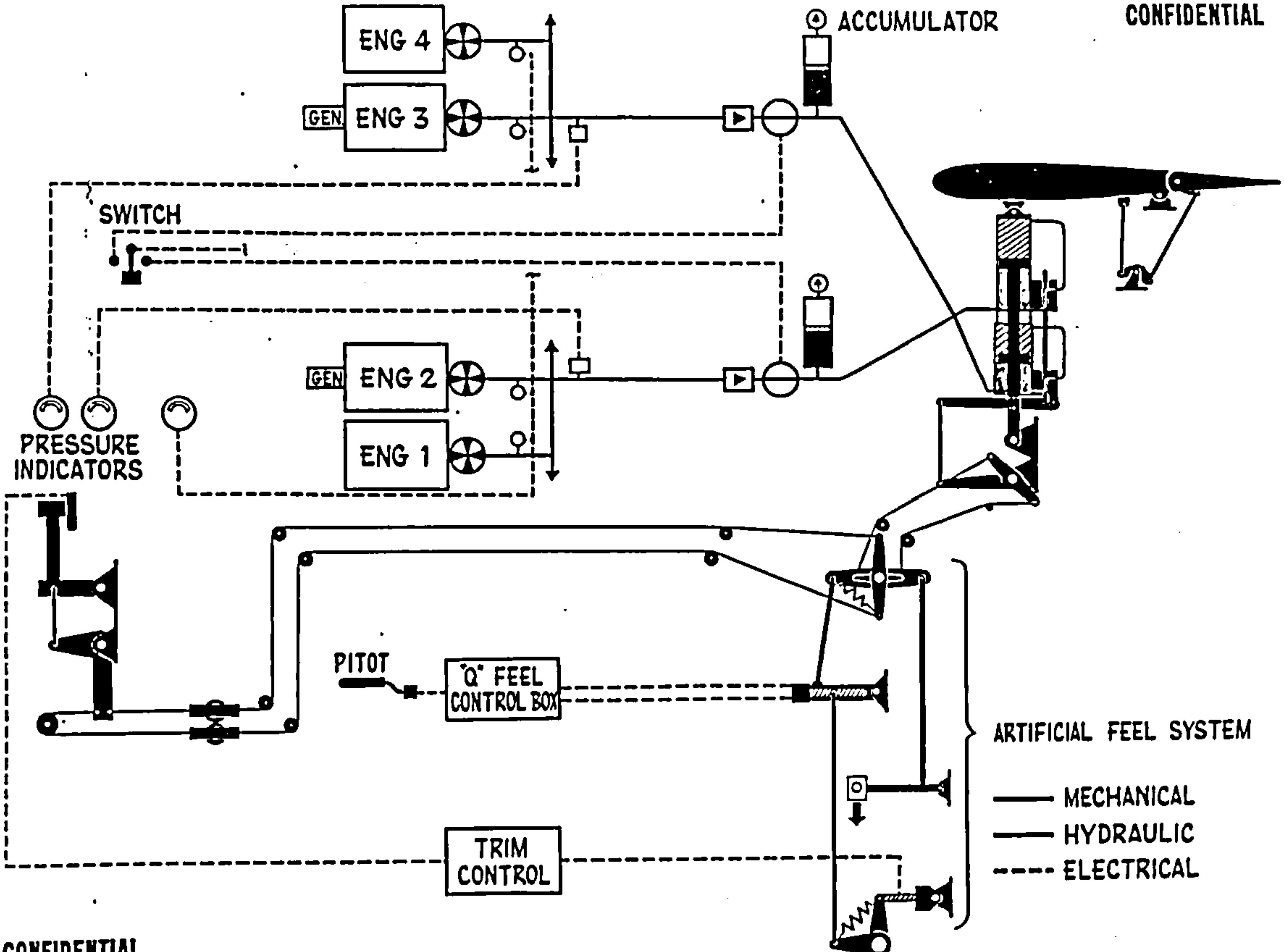

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Fig. 20. Longitudinal Control System Schematic

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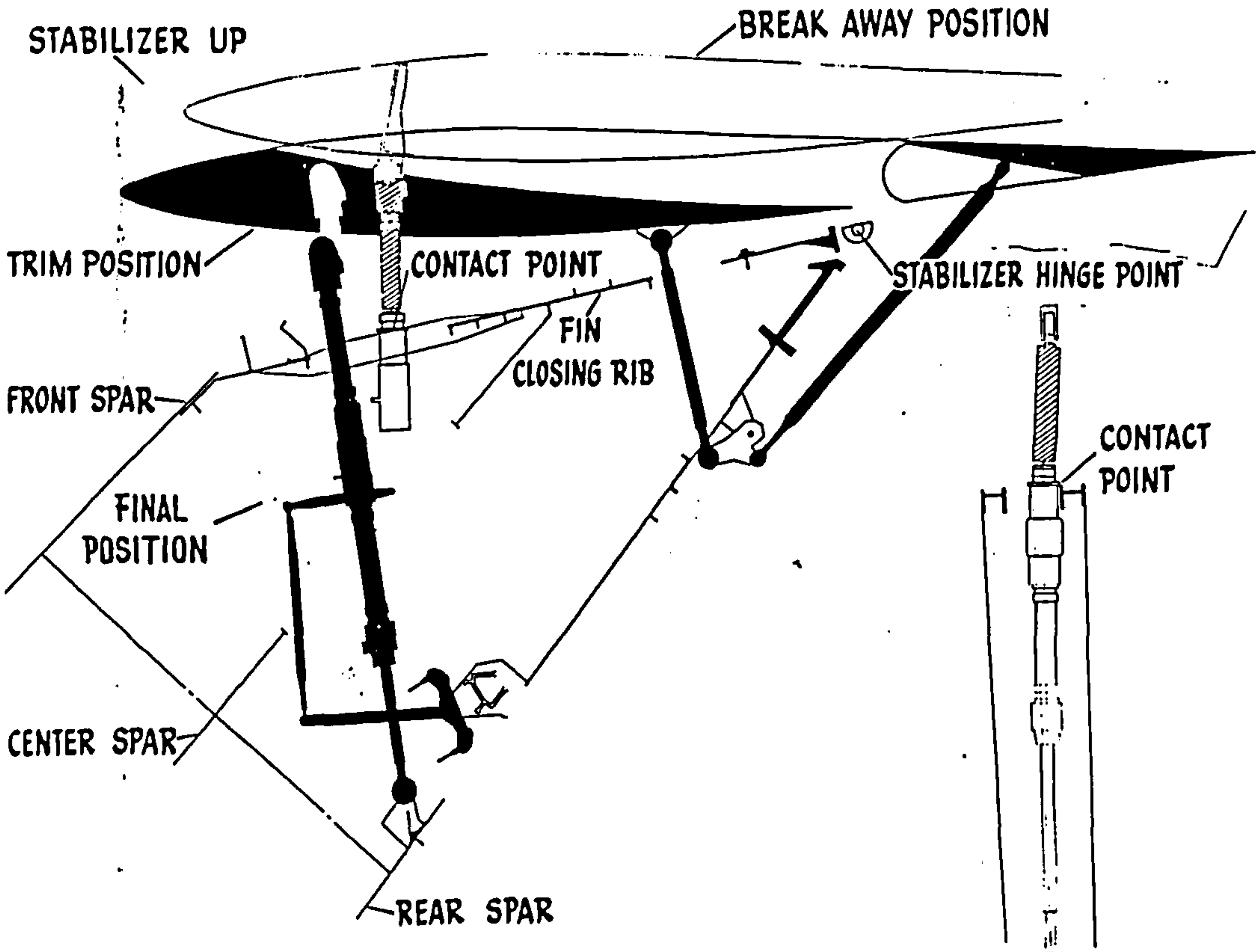

Fig. 21. Sequence of Stabilizer Failure

XI. FUEL SYSTEM

The XP6M-1 carries JP4 fuel in four flexible-cell hull tanks above the minebay area and in two integral wing tanks. The hull service tanks Numbers 1 and 3, forward and aft on the port side, are self-sealing. The hull auxiliary tanks Numbers 2 and 4, on the starboard side, are self-sealing and non-tear. Each of the hull cells has a full capacity of more than 5200 pounds, and each of the wing tanks contains more than 25,000 pounds.

A. FUEL MANAGEMENT

Management of the fuel system is accomplished through two visual-flow fuel control panels: one accessible to the pilot and copilot in the cockpit, and an auxiliary panel accessible to the flight engineer at the radio operator's station (Fig. 22). In normal management the two outboard Engines 1 and 4 are fed from the forward service tank, and the two inboard Engines 2 and 3 are fed from the aft service tank. Control of fuel feed to the engines is possible only from the pilot's panel, but he can delegate to the auxiliary panel the transfer of auxiliary fuel to the service tanks.

The rotary switches on the pilot's control panel are fairly reliable indicators of the switch position in flight. From the recovered panel the switch positions are:

1) Boost pumps on;

2) Engine fuel feed valves closed;

3) Auxiliary fuel transfer relegated to the auxiliary control panel.

The auxiliary control panel contains toggle switches for the various transfer pumps and fuel valves. These switches do not give a reliable indication of their actual position in flight. Therefore, it was necessary to inspect the actual fuel valves to establish fuel management. These d-c motor-operated, gate-type valves employ a gear train and lever to actuate the valve gate, and their recovered position is indicative of the inflight setting. Twelve of the fourteen valves were recovered. The two missing are the shut-off valves for Engines 2 and 3 fuel feed.

The fuel-shut-off valves from Engines 1 and 4 were recovered in an open position. This indicates that the pilot's movement of the switch to a closed position occurred after the loss of d-c power, and that the fire extinguisher had not fired to these engines. The forward and aft service tank valves were recovered closed, but this was an automatic and temporary position. Glide attitudes of 7-1/2 degrees or more will cause an automatic shut-off of the valves if the tanks contain as much fuel as indicated on the recovered panel. A sustained negative g would also cause automatic shut-off. Another valve, recovered closed, revealed that the pressure fueling manifold extending into the airlock did not contain fuel under pressure. A test of the recovered valve verified that there was no leakage.

The fact that the Number 1 transfer, Number 2 transfer, cross-feed, and cross-fuel valves controlled from the auxiliary fuel panel were recovered closed indicates that no attempt was made to use emergency fuel controls. Therefore, the actual valve positions as recovered confirm that there was normal fuel management. The auxiliary tank fuel levels further substantiate this fact.

B. IGNITION SOURCES

The interiors of the three recovered hull cells show no evidence of burning. The exterior of the Number 4 cell, however, is scorched over a large area. Extensive burning on the outside starboard hull forward and aft from an opening in Number 4 cell shows that the fire in this cavity burned in flight.

The fire was fed from the Number 4 hull tank, and it is possible that loss of fuel from this tank was the white cloud reported by witnesses. Examination of the damaged Number 4 tank door, which was blown loose, revealed a type of failure that could be caused by excessive uniform pressure, possibly an explosion. Like the opening in the starboard hull, loss of this door would have a negligible effect on the longitudinal hull stiffness, flight characteristics, and structural strength of the aircraft.

A separate plot of all recovered equipment, tubing, and connections, which were part of the fuel and vent systems, did not reveal any specific area where concentrated burning took place. One 1-1/4-inch diameter tube appeared to have an explosive, bursting type of failure. It was examined and duplication tests were conducted. The results showed that the tube contained fuel which was heated by an external fire. The tube subsequently burst under pressure--an effect, not a cause.

Other scorched areas within the wing tanks were examined and found to have been burned after break-up.

Operation of the cabin conditioning system was interrupted prior to the flash fire which developed in the airlock after break-up started.

The system was operating normally except that it did not provide stub wing box ventillation because the doors at each end of the airlock were open.

1. Fuel Leakage

Tank, fuel, or vent system leakages are possible sources of combustible fuel or vapor. Figure 23 --showing all pressurized and unpressurized fuel and vent system equipment and connections--was constructed to establish points of possible leakage and ignition. Points where leaks were discovered at some time after the original installation in the airplane are circled.

Repetitive leakage areas were the cross-feed fuel line, pressure feeding manifold, and vent system connections. They have been corrected. The cross-feed fuel line (a metal tube) was replaced with a flexible hose prior to the last flight. The pressure fueling manifold has been redesigned to incorporate a flexible hose with multibolt, flanged connections rather than the large nut-type coupling originally used. All of the flexible couplings throughout the vent system are being eliminated and replaced with standard metal tubes and flexible hoses with standard end fittings.

2. Ignition Points

Electrical, electronic, and instrumentation installations are possible ignition points for fuel or vapor leakage. The hot air duct, however, revealed under test that it is not an ignition source. In the test chamber a temperature up to 710 degrees on the duct metal failed to ignite fuel vapor or insulation spontaneously, but firing a spark plug within the chamber resulted in immediate ignition, assuring an explosive mixture. Calculated engine air bleed temperature during flight is 590 degrees Fahrenheit.

The electronic, electrical, and instrumentation wires that pass through the minebay area are continuous except where they terminate at equipment. A physical break or disconnection of the wiring, with subsequent short circuiting on the structure, is a possible ignition source. Brown recorder stepping switches of the VGTA unit are possible instrumentation sources of ignition.

Electrically operated fuel valves have explosion-proof motors, and limit switches such is those on the mine door are hermetically sealed. Toggle switches and interphone jack boxes in the minebay area become a hazard only when a crew member operates them, or if a loose wire short circuits to structure.

The possibility of a static electrical charge resulting from motion of the fuel cell against its non-metallic backing board is being investigated as an ignition source. A full-scale tank-slosh test specimen is being instrumented to evaluate the problem. It has been concluded that the most probable ignition source for fire in the minebay area is a broken electrical wire short circuiting on the aircraft structure.

3. Possible Causes

There are a number of possible fuel and ignition sources in the stub wing box area. With the airlock doors open, no positive venting of this structure was available, and the possibility of an explosion definitely existed. Both sets of stabilizer control cables pass through the wing box. An explosion in the area, by propelling instrumentation and other units into the lines or cables, could have caused a loss of longitudinal control.

Calculations have shown that an explosion in the pressure box of 25 psi would have failed the fasteners to the blankets, resulting in a positive bending failure of the wing. Such failure, of course, did not occur. The recovered parts of the structure did not show that they were subjected to pressure; however, they are of such heavy gages that low pressures would not have deformed them permanently. The possibility remains that this accident was caused by a loss of longitudinal control resulting from a relatively low-pressure explosion in the stub wing box.

4. Eliminated Causes

Fuel cell failure, usually associated with a swelling sealant or splits in the inner liner, has been a serious concern with other aircraft. Nevertheless, the fuel cell liners of Hull Tanks 1, 3, and 4 gave evidence of no flaws, and there was no trace of sealant rubber in the three filters recovered. The XP6M-1 cells had completed 25-hour slosh-leakage, accelerated-load, and gunfire tests without failure. At present, a 100-hour slosh test of a typical self-sealing cell (Hull Tank 3) is being made to find if weak areas exist in the installation.

Malfunctions of the fuel quantity and vent systems were also eliminated as possible ignition sources. Manufacturer's reports show that instrumentation energy levels in the fuel quantity system were kept too low to create an explosion hazard even with open or short-circuited wiring. Furthermore, a vent system malfunction did not cause excessive tank pressures. Readings of recovered pressure gages from the fatal flight agree with those of previous flights.

Other possible ignition sources were found inapplicable:

1) A typical, welded, tubular fuel manifold failed under test at 380 psi. System operating pressure is 60 psi and proof pressure is 120 psi.

2) Recovered fuel pumps showed no evidence of overheating, fire, or explosion. The hull tank pumps were below the fuel level when the accident occurred.

3) Service tank fuel levels and a closed valve in the transfer line rule out the possibility of an overfilled service tank.

C. RECOMMENDATIONS

The findings of the accident investigation have prompted many recommendations for improving the fuel system. Corrective measures involve items possibly related to the accident and others that concern general safety. Of the former items, the following are recommended:

1) Improve the sealing of hull tank cavities, and conduct water tests to ensure liquid tightness in the lower cavity areas.

2) Eliminate flexible couplings from the vent system and replace them with metal lines and flexible hoses with metal end fittings.

3) Incorporate a fume-tight enclosure for the hot air duct and all wiring in the fuel tank cavities.

4) Provide positive venting of the stub wing box.

5) Ensure that all equipment and wiring in non-safe areas is explosion-proof and that all switches are hermetically sealed.

6) Install a continuous hose for the hull-cavity vent line where it passes through the wing tank in place of the original metal tubing sections with interconnecting couplings.

7) Replace existing fuel valves (standard in industry) with an improved type to avoid the possibility of fuel leakage from over-torqued flange bolt attachments.

8) Replace all energized instrumentation units with explosion-proof types.

The following recommendations involve items for general improvement:

1) Increase the size of the fuel transfer lines from the wing tanks (Rib 56) to the service tanks to reduce the time required to refill service tanks after use of the afterburners.

2) Identify all fuel systems control valves with readily visible decals to facilitate manual operation in the event of 28-volt electrical failure.

3) Relocate the pressure fueling unit aft of the airlock to eliminate possible fuel or vapor leaks in the airlock compartment.

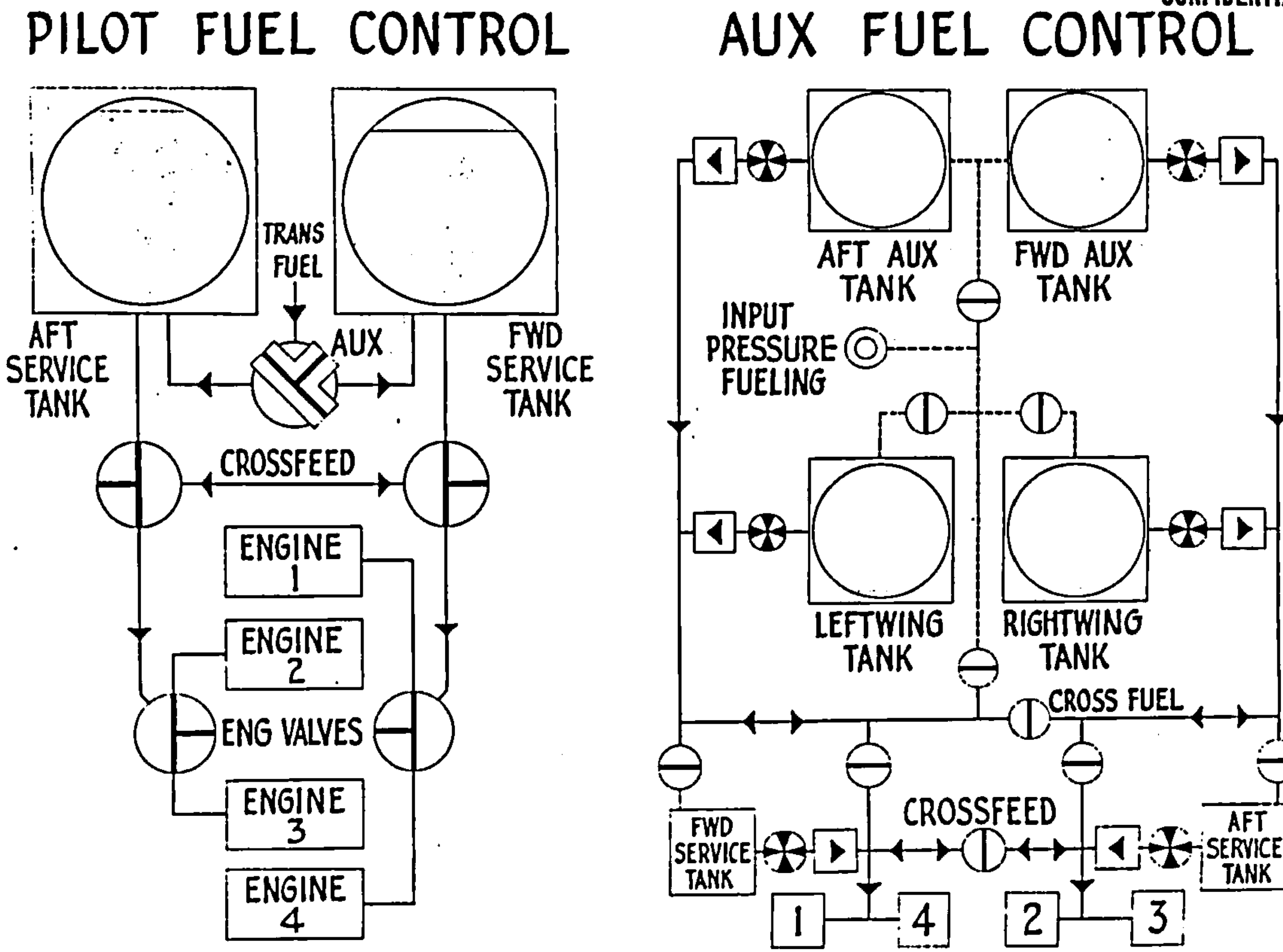

Fig. 22. Fuel Control Panels

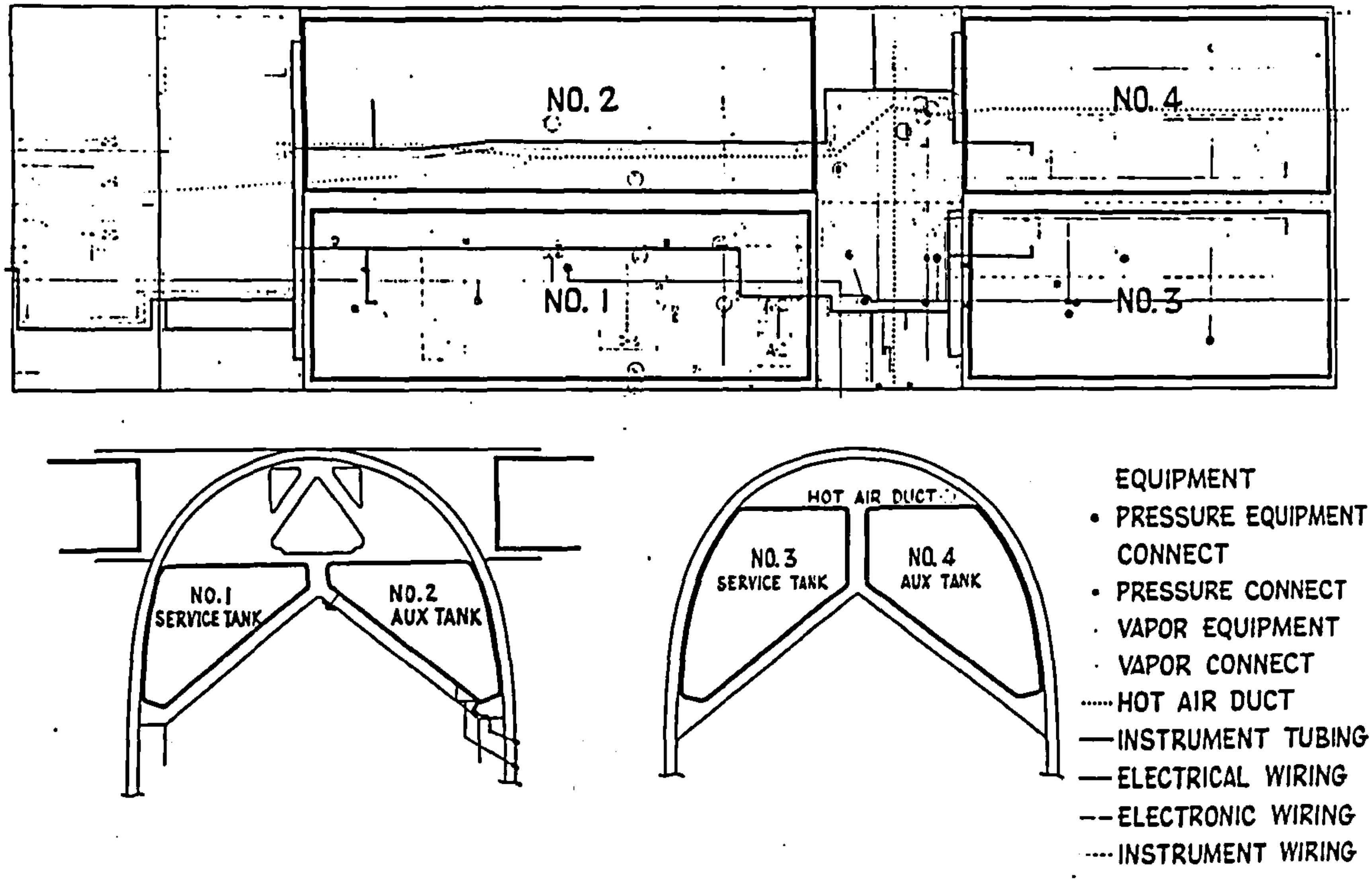

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Fig. 23. Fuel Equipment and Wiring, Hull Tank Region

XII. OTHER SYSTEMS

The electrical power systems and utilization circuits in the XP6M-1 airplane were not found to be the initiating factor in the accident. The circuitry and wiring, however, may have been a contributing factor in that chafing or physical damage to wiring or equipment could result in an ignition source. This ignition source, in conjunction with the proper mixture of fuel and air, could have initiated an explosion or fire. There was no evidence available to verify this premise.

Photo panel records proved that there was electrical power at 1518:28 PM. Alternating-current and direct-current power were available afterwards to change the position of the stabilizer feel actuator and to close the service tank shut-off valves in the fuel system. The exact time that electrical power ceased to exist could not be determined, but no evidence was found to indicate that power was not available until the engines left the aircraft at break-up.

Other aircraft systems - instrumentation, electronics, and cabin conditioning - are discussed in detail in Volume II of the Accident Investigation.

XIII. REVISIONS TO AIRCRAFT

When the first XP6M-1 was lost, the second aircraft was in ground test status, scheduled to fly about six weeks later. At that time it was equipped as a prototype. All normal equipment except the turret and navigation system were installed, equipment and powerplant were instrumented for demonstrations, and provisions for a five-man crew were completed. The pilot was provided with an ejection seat, but the remainder of the crew would use an escape chute leading down from the flight deck floor.

It was decided that this aircraft must be removed from ground test status and reworked to provide ejection seats for four crew members and instrumentation to permit it to accomplish the tests planned for both the first and second aircraft. In general, the added instrumentation was for aerodynamic stability and control, performance, and structural loads and vibration data.

A. SHIP NUMBER 2 CHANGES

All engineering departments were requested to review the airplane design and recommend changes, studies, or tests of systems or components wherever they appeared hazardous or questionable. Out of some 200 recommendations that were considered carefully, approximately 40 changes were selected for incorporation prior to flight. These changes fell into four categories from which typical examples will be noted (Fig. 24):

1) All pending engineering changes:

   Beef-up of hull side skins,

   Revision of engine anti-icing system,

   Beef-up of stabilizer bullet and door,

   Provisions for slat bearing greasing:

2) Pilot recommendations:

   Relocation and simplification of fire extinguisher;

   Revision of rudder toe-pedal travel,

   Revision of spoiler control linkage,

   Addition of knee guard over long trim whell;

3) Possible flight hazards revealed by the investigation:

Removal of inflammables from forward beaching gear compartment or airlock,

Installation of rear view mirrors,

Removal of rubber Teck fittings from vent system,

Increase of fuel transfer rate, wing to service tanks,

Provision of fumetight enclosure for ducts and wiring in tank cavities,

Removal of stabilizer shut-off valves,

Use of latest type flight gear for crew,

Addition of telemetering for continuous ground monitoring;

4) Nuisance items:

Addition of door to stabilizer bullet-fin junction,

Beef-up of stabilizer bullet structure,

Beef-up of hydroflaps,

Beef-up of APU inlet and exhaust ducts,

Replacement of all frame-to-longeron gussets in aft hull.

In addition to these changes, approximately 40 design areas were reviewed or inspected on the airplane, 25 studies were made of various aspects of the airplane design, and 20 new tests were authorized to be made prior to or during the initial flights of the second airplane. Two changes, now in progress but not completed, will be made later. They are the installation of a new fin and a larger stabilizer cylinder.

The airplane has been returned to ground test status, and release for flight has been requested. It is planned to treat the airplane as a new untested prototype. The airplane will be flown at first with severe restrictions which will be lifted as flight test data indicate such expansions of the envelope are safe.

B. FLIGHT RESTRICTIONS

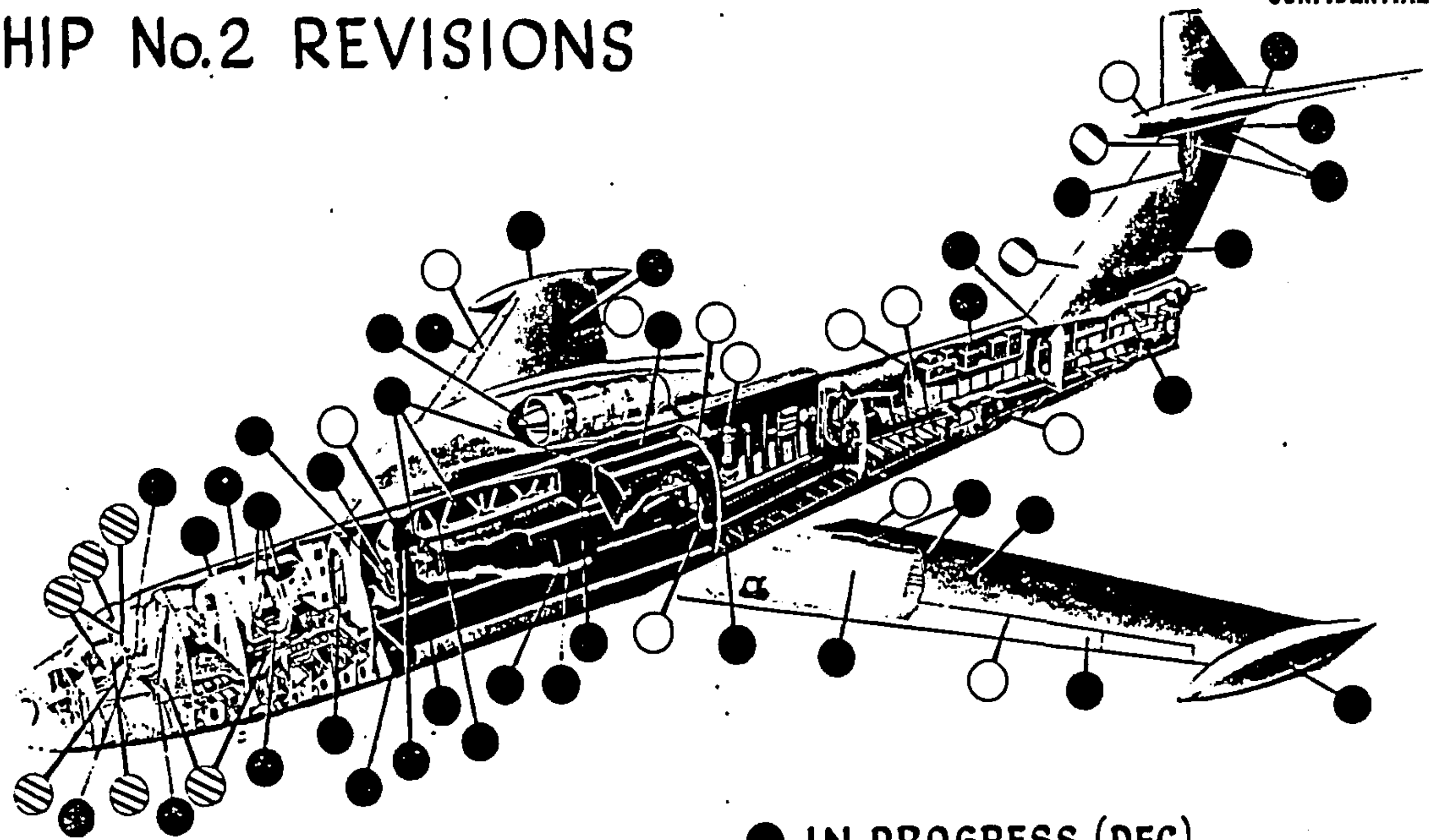
A flutter limit of Mach 0.70 at sea level, varying linearly to Mach 1.0 at 21,500 feet and above, will be observed until the new fin is installed on the airplane (Fig. 25).

To determine stabilizer hinge moments in flight, a placard of Mach 0.75 at sea level, varying linearly to Mach 0.80 at 10,000 feet and above, will be followed initially. Flight test data obtained at speeds up to Mach 0.8 will be extrapolated in accordance with stabilizer hinge moment curves from wind tunnel tests to predict hinge moments at higher speeds. Flights at higher speeds will follow a step by step procedure to assure a known safe margin of pitch control power. A minimum of three flights to test stabilizer hinge moments will be necessary before Mach 0.95 is achieved at high altitudes.

The original flight restrictions for the first aircraft were Mach 0.85 at sea level, varying linearly to Mach 0.95 at 21,500 feet and above. This restriction was imposed primarily because of questionable flap and wing trailing edge strength at higher Mach numbers. After it is shown that ample pitch control is available to fly to these limits, flap loads in flight will be obtained to determine the adequacy of the flaps. After flap strength is proven, the airplane will be restricted only by the flutter limit.

Because of questionable longitudinal stability at extreme aft cg positions at high speed and low altitude, the aft cg, (normally 44 per-cent MAC) will be limited to 40 per cent for speeds in excess of Mach 0.7 at 5000 feet and Mach 0.92 at 13,000 feet. No limiting speed for full aft cg is necessary above 13,000 feet. When longitudinal stability margins are determined at 40 per cent MAC at high speed and low altitude and at 44 per cent MAC outside the placarded region, it is expected that this limit will be lifted without modification to the airplane. When all of the limits noted above are removed, the airplane will be flown without restrictions.

SHIP No.2 REVISIONS



- ● IN PROGRESS (DEC)
- ◍ RECOMMENDED
- ○ NUISANCE ITEMS
- ● INVESTIGATION RESULT
- ◐ PLANNED

Fig. 24. Revisions to Second XP6M-1

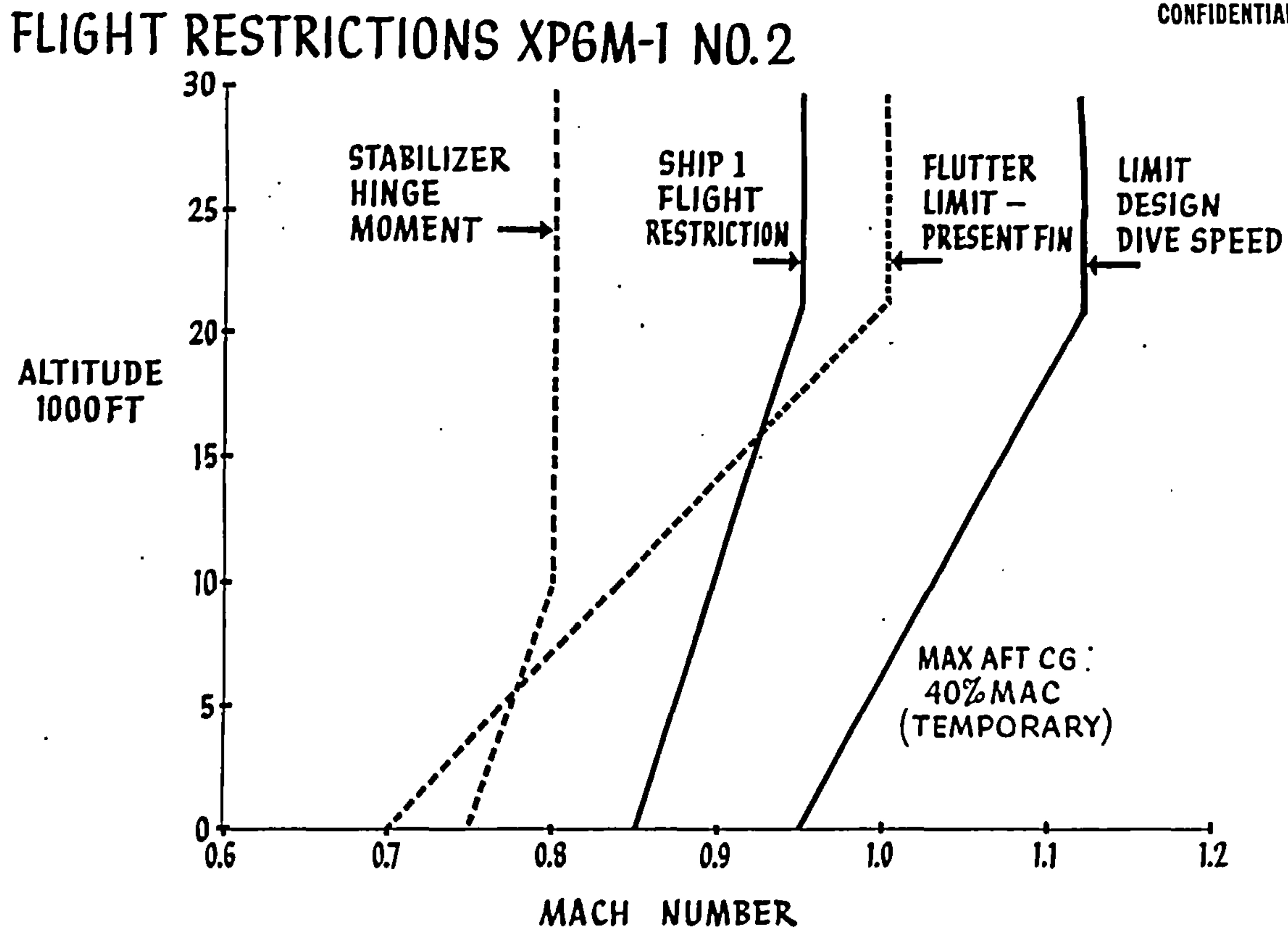


Fig. 25. Flight Restrictions of Second XP6M-1

XIV. ADDENDA AND ERRATA

New data still being accumulated will be added to this report if they prove to be of critical relevance to the accident or its discussion.

Pages 1 and 19:

Taxi tests of the first XP6M-1 were begun on June 23, 1955. The first airborne flight was made on July 14, 1955.

ER 8250

XP6M-1

ACCIDENT INVESTIGATION

VOLUME 2 ANALYSIS

APRIL 1956

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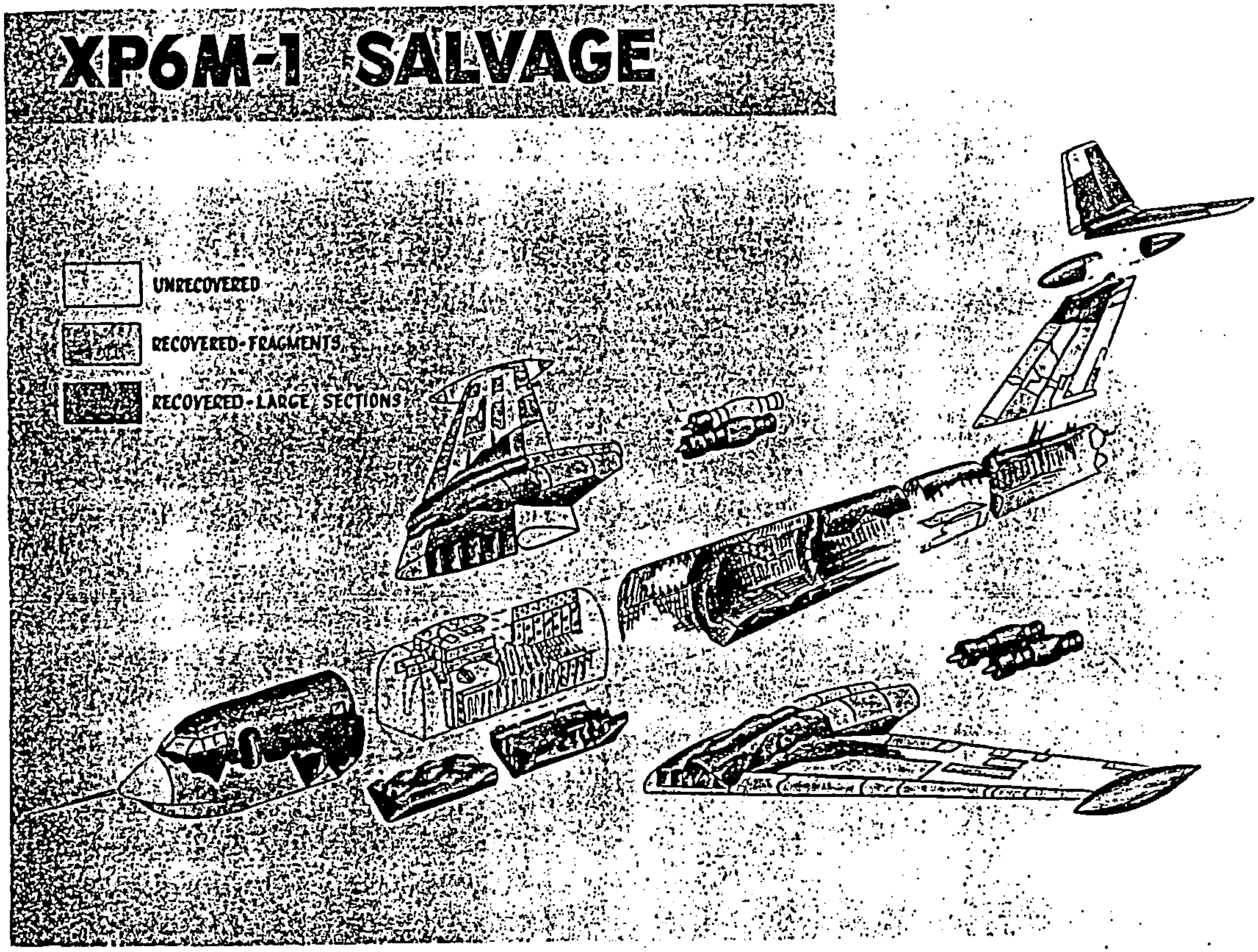

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FOREWORD

This is Volume II of the findings of the XP6M-1 accident investigation committee. Volume I (Summary) was limited to a brief account of the major factors directly concerned with the accident. Volume II covers in detail the supporting data and special studies made during the investigation.

Determination of the cause of an accident is often simplified by the availability of a few significant facts or clues which quickly lead to the solution. In this accident, certain information was missing:

1) There were no survivors;

2) There was no chase plane -- it had been deemed unnecessary because the flight plan included nothing which had not been checked in previous flights;

3) There was no wire recording -- the wire was recovered but it had become stuck in the recording head at the time of the last landing;

4) There was no radio contact.

Information from any of these sources might have narrowed the scope and shortened time of the investigation. As a further complication, most of the wreckage was on the bottom of the Potomac River under fifty to seventy feet of water.

Therefore, it was necessary to organize a special project to:

1) Recover, identify and reconstruct the wreckage;

2) Obtain evidence from the wreckage to show sequences of structural failure, fire and explosion damage, systems and equipment functioning or failure;

3) Review the structure and each component system for evidences in design, test program, inspection, and service history which might lead to clues of possible troubles;

4) Integrate all the seemingly unimportant scraps of information into a pattern which permitted determination of the most possible cause.

Organization

The organization chart indicates the groupings and key people of the accident investigation committee. The best men were picked for the particular job in hand. In some cases, XP6M-1 Group Engineers were selected for their intimate knowledge of the airplane. In others, staff design engineers and even section heads were detached from their regular duties in order to provide a wider range of knowledge and experience. A basic sixteen man committee directed the efforts of approximately 100 technical people. These people were retained as long as their services were needed -- in some cases, one or two weeks, and in others for the full period of four months. In addition there were others from Engineering, Manufacturing, Service, etc. not directly assigned but who provided data, services and advice to the committee.

Method of Operation

Each committee member organized the efforts of his own group, and manpower was apportioned between Patuxent and Middle River as required by the several investigations. To maintain unity of effort between the two locations, Martin airplanes were used for four or five weekly trips during the first two months and two trips per week thereafter.

A meeting of the entire committee was held every week where each specialist discussed the progress of his investigations and submitted his conclusions and suppositions to the entire committee. This procedure assured dissemination of the factual information to the entire group and prevented digression or compartmented thinking. Most important, it subjected each expert to critical and independent questioning of his program, conclusions, and suppositions by all the other members. Conscious efforts were made at all times to maintain an independent and objective viewpoint.

Outside Consultants

Other means taken to assure the effectiveness of the program and the validity of the conclusions included the participation of independent outside groups and agencies.

The head of the BAR office and four of his engineering staff participated directly in the daily work of the committee. Officers from Naval Air Safety Center attended most of committee meetings. Representatives from Allison Engine Company also participated as full members of the committee.

Mr. Sydney D. Berman of the Air Force Directorate of Flight Safety spent two weeks on the job. His written report is a part of this foreword. Dr. Russell S. Fisher has supplied very significant information

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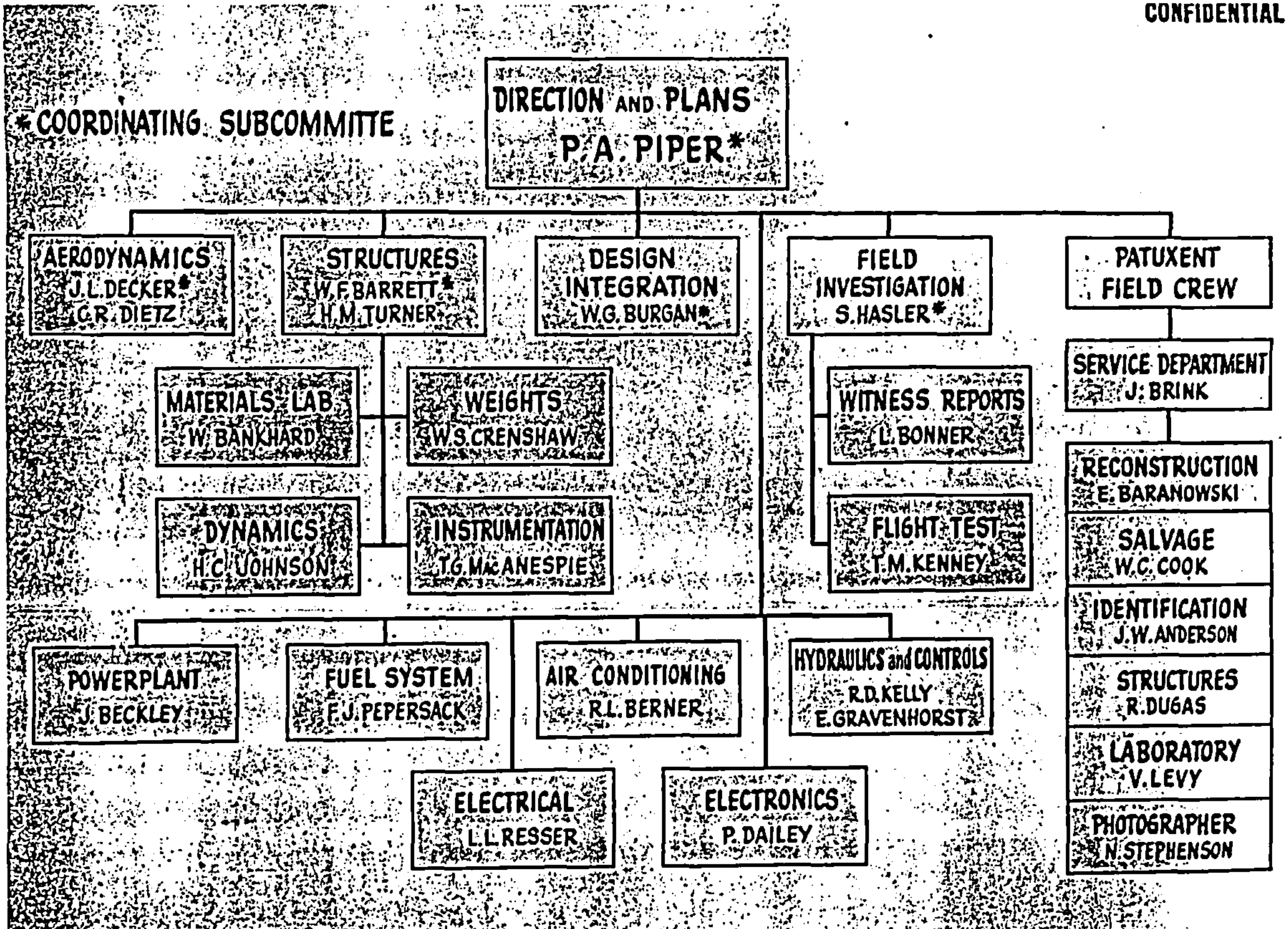

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in his autopsies on the crew members. There have been several conferences, visits and discussions with specialists from the Civil Aeronautics Board, NACA Langley and NACA, Cleveland.

Metallurgical questions were discussed with representatives of the Naval Research Laboratory and the Aluminum Company Research Laboratory. Mr. J. Ludwig of Chance Vought came to Baltimore for a thorough discussion of control system problems. Valuable information on gasoline explosions was obtained from U.S. Army Ordnance at Aberdeen Proving Grounds.

Grateful acknowledgement is made to these associated consultants. In some cases, their suggestions have stimulated new considerations or a shifting of emphasis on work already started. Most important is the independent checks which these associates have given to the committee work.

Associated Consultants

BuAer Representatives

Capt. R.F. Kane
Mr. J. Neuner
Mr. H. Chandler
Mr. P. Sicardi

Aluminum Research Laboratory

Mr. M.S. Hunter
(Asst. Chief Metallography)
and others at New Kensington

Naval Air Safety Ctr., Norfolk

Cdr. W.E. Carver
Lt. Cdr. H.N. Moore
and other officers

Naval Research Laboratory

Dr. G. Erwin
Mr. J.E. Kies

Allison Engine Co.

Mr. D. Steeg
Mr. L.O. Nolan, Jr.
Mr. R. Meentz

Civil Aeronautics Board

Mr. M.V. Clarke
(Structures)
Mr. A.B. Hallman
(Propulsion)

U.S. Air Force Directorate of Flight Safety

Mr. S. Berman

Chief Medical Examiner State of Maryland

Dr. Russell S. Fisher

Associated Consultants (con't)

NACA, Langley, Virginia

Mr. H.A. Soule, Asst. Director
Mr. Melvin Gough, Flight Research
Mr. D.J. Martin, Vibration and Flutter
Mr. R.A. Anderson, Structures
Mr. B.P. Brown, Stability and Control
and others

NACA, Lewis Laboratory

Mr. G.M. Ault, Propulsion

Chance Vought Aircraft

Mr. J. Ludwig

Army Ordnance, Aberdeen

Mr. H. Rosenberg
Mr. Bernier
Mr. M. Smith

Frankford Arsenal, Philadelphia

Mr. S. Rolle
Mr. C. Johnson
Mr. L. Miller

REPORT OF MR. SYDNEY B. BERMAN

Special Aircraft Accident Investigation of Model XP6M-1

Potomac River, Maryland on December 7, 1955

The Accident

Model XP6M-1 manufactured by The Glenn L. Martin Company took off from Patuxent Naval Air Station, Maryland on a general test and familiarization flight at 1505 on 7 December 1955. Approximately 14 minutes later, the aircraft disintegrated in flight. All four crew members suffered fatal injuries.

History of Flight

The aircraft had just completed a flight of approximately 1 hour 30 minutes duration. It had landed to enable a change of flight test pilot personnel. No servicing was accomplished. Approximately 14 minutes after take-off, the concensus of the considered more reliable witnesses observed the aircraft to descent rather steeply from approximately 10,000 feet to approximately 3500 feet. White smoke, black smoke, fire and structural disintegrations was observed. One parachute was seen to blossom at a low altitude.

Investigation and Analysis

The aircraft had accumulated approximately 50 hours of air and water time. The program being flown at the time of the accident was to perform static longitudinal stability runs. All other flights were covered with a chase plane; however, on this flight the chase plane had returned to base for refueling and hence, the fatal flight was not covered. In addition, although the aircraft wire recorder was recovered, it unfortunately had malfunctioned at the beginning of the flight and hence, could not provide any information pertaining to the accident. There were two photopanel cameras installed, one of which was recovered. The film recorded the time of flight, altitude, airspeed, Mach No. and engine R.P.M.

The wreckage fell in the Potomac River in an area approximately 3-1/2 nautical miles long and 1/2 mile wide. The general location is east of St. Georges Island, Maryland in the vicinity of Buoy No. 6. Sonar detection equipment was used with remarkable success in locating pieces of wreckage. There developed three primary areas of wreckage recovery.

a. The main area from which hull parts, minor wing and nacelle items were recovered.

b. Forward area (approximately one mile from center of main area) where engines No. 1, 2, and 3 were found.

c. Aft area (approximately one mile from center of main area) where portions of tail surfaces, outer wing fragments and other light structure were found.

Generally, about 90% of the aircraft structure was recovered. These consisted essentially of: the forward hull to bulkhead No. 407 (station forward of mine door); the aft hull from No. 647 (station forward of No. 3 and No. 4 hull tank area) rearward to stern; numbers 1, 2, and 3 engine; parts of No. 4 engine; right and left elevator; outer forward portions of stabilizer; nearly all of the fin; inner and outer portions of right and left wing; and parts of outermost portions of right and left wing; wing parts in hull area; rear spar hull bulkhead; portions of the front spar hull bulkhead and hull structural members between front and rear spar bulkheads; and the mine door in two pieces. Essential parts still to be recovered are: the central portion of the stabilizer, the rudder, portions of flaps, several fuel valves, etc.

On the flight immediately preceding the fatal flight, the pilot on the controls experienced a sudden forward snatch movement of approximately 2 inches travel. It immediately returned to its original position. No noticeable effect on aircraft pitch or trim was apparent. A gust load acting on the stabilizer and slave elevator was not the cause due to the irreversibility of the control system. Endeavors are still being made to isolate and evaluate the particular item which the pilot experienced.

A detailed examination of the wreckage by the writer revealed the following observations and evaluations:

a. The number 4 hull fuel tank door had separated from the adjacent hull structure due to forces generated by a fuel air mixture explosion. This door is approximately 102 inches long by 64 inches wide. The door is attached in the hull such that one end of the long side is hinged to the lower side of the hull center beam, and the other end of the long side is fixed to the top of the hull lower chine. The variation in height of the door attachments is such that the door supports the fuel tank on a 45 degree plane. Parallel to the edge of the short side running beamwise across the panel are 16 "Zee" section channels fabricated of sheet aluminum alloy. The 820 gallon tank rests on a plastic insulating material which in turn rests on the top of these "Zee" channels. It was noted that all of these channels had compression failures in the upper flange portion of the channels. These failures were of a uniform nature and were approximately equal in distance from the ends of the door. The failure of the door around the entire attachment to the structure was in downward direction. The entire failure pattern of the stiffness (Zee channels) and of the door attachment is indicative of a uniform pressure acting perpendicular to the inside face of the door. The requirements necessary for an explosion are readily available. The fuel is obtained by leakage of the tank or its plumbing. The ignition could be one of several sources. One of these probable sources is a bundle of wires in this region that is continually being energized since they feed the fuel transfer pumps. The tank contained approximately 2/3 fuel. The likelihood that excessive "g" forces acting on the fuel failed the door as described exists but is improbable. In order for the weight augmented by the forces of acceleration to deform and free the door the airplane would have had to be rotated through 45° at the moment of application of the load. Any angular variation within reasonable limits other than 45° would not result in the uniform compression buckling of the upper part of the "Z" channels as occurred. The door was recovered approximately one mile back along the flight path from the structure to which it is attached;

b. The interiors of the flight crew compartment (Station 228 to Station 353) and of the air lock compartment (Station 353 to Station 407) had been subjected to short duration fire of the flash type variety. This fire was more intense in the region of the left rear floor area of the air lock compartment. A general burning was also evident in the fire-retardant sound proofing material in each compartment as well as darkening and blistering of paint. The plywood cover on the sea chart on the floor of the crew compartment was charred. The writer's evaluation is that the fire in these compartments is incidental to something having already been catastrophic to the aircraft. Observation of bulkhead No. 407 revealed several holes punctured in the web. The direction of the missiles was from the rear piercing the web in a jagged pattern inward or forward. The holes averaged from two to four inches wide. The fire mentioned earlier in the air lock compartment flared out of these openings in the web. This was apparent since the rear side of the web around the holes was smoked. The only inflammable matter that could cause the fire damage as described in each, the hell hole and crew compartment is JP-4 fuel escaping from the single point fueling line. It was determined that under a certain routine in fuel management 6 to 8 gallons of fuel would be trapped. It is possible that while the airplane was undergoing some unorthodox maneuver, the fuel was thrown out from the fueling line. When structural disintegration of the hull area between the wing spars bulkheads occurred, the web of bulkhead No. 407 was pierced, however, before the fire occurred.

c. The right and left side of the wings failed in a strikingly similar nature. The outboard portions failed due to positive acceleration. Each of the engines separated from the wing in an upward direction. Each wing at the hull attachment failed in a downward or negative direction. The bottom and top wing cover skins between spars in the area of the hull failed in compression and tension respectively which is synonymous with the negative direction of failure of the wings at the hull sides. Although fire damage was apparent on both wings, this fire again occurred after structural break-up. This conclusion was readily apparent by rebuilding parts of the wing structure and ascertaining the relationship of burned and clean pieces adjacent to each other.

d. The bomb door extending in the bottom of the hull from bulkheads No. 407 to 749 had broken into two pieces, the fracture occurring just forward of rear spar bulkhead No. 604. Examination of the fractures around the bottom and sides of the door revealed that the separation was due to a tension load. The retention of the door in the hull is accomplished by a huge trunnion type of fitting at the aft end, supported by bulkhead No. 749. This trunnion is so designed that it can transmit only vertical load but no drag load. At the rear spar bulkhead No. 604, two large hooks clamp onto two oblong handles attached to the door. These hooks can transmit both drag and vertical loads. The forward part of the door is attached to the operating trunnion at bulkhead No. 407. This trunnion can take drag and vertical loads. In order to release and break the bomb door it is apparent that a large tension load had to exist in the lower part of the hull as well as a large load acting vertically downward through the wing spar bulkheads. Except for slight scorching at the aft right corner of the door, the entire door was clean of fire indication.

e. The rear spar wing hull bulkhead was recovered essentially in one piece. The skin adjacent to the structural box housing the hinge hooks for the clamping of the bomb door had failed in tension due to drag loads. This entire structural member had no sign whatsoever of having been subjected to heat, smoke or fire.

f. Only small pieces were recovered of the front spar bulkhead as well as of the hull structure between the front and rear bulkheads. These pieces again are similar to the rear spar bulkhead in that they are clean without any evidence of smoke or fire damage.

g. The hull from Station No. 647 (forward of the hull rear tank area) clear aft to the stern (Station 1443) was recovered more or less in one piece. The entire right side was severely burned such that almost no side skin remained and in large areas even the ribs were burned out. The left side suffered no fire damage but did sustain severe distortion. This distortion was in an inward direction as would be the case upon hitting the water on the left side. Examination of the right side burned area indicated burning both in flight and on the water. This was indicated by burned side skin being blown free by slip stream effect as well as driplets and puddles of molten aluminum alloy deposited on ribs in a direction perpendicular to the skin. The point the writer wishes to emphasize is that no fire occurred in this entire rear hull area while the aircraft was a sound body. The reason for this statement is that the rear spar bulkhead at Station 604 and adjacent hull skin as already mentioned were clean of all fire indications, whereas there exists severe fire damage of the immediate adjacent skin and bulkhead No. 647. Hence, it is obvious that while the airplane was intact, there was no fire; otherwise, the rear spar bulkhead and adjacent skin would also show signs of fire. An explanation of the source of the fuel that fed the fire which demolished the entire right side of the hull aft of bulkhead No. 647 is presented. When the structural explosion and disintegration occurred in the hull structure between the spar bulkheads, the structural integrity of the hull and the aircraft no longer existed and the aft part of the hull was now a free body. Upon separation, the No. 2 hull tank located between the wing spars and containing approximately 500 gallons of fuel could have been thrown out and impinged upon the forward part of bulkhead No. 647.

g. Examination of the skin on the right side of the hull directly beneath the fin indicate that an abnormal high up load was imposed in this region sufficient to create permanent tension field distortions. This load was imposed prior to the fire as indicated by the fact that the high spots of the distorted skin were attacked by the fire. The heavy plate of the fin on the right side had failed in tension due to an up load on the right stabilizer, whereas there is indication of a compression failure or of down load on the left side of the fin. This type of failure is indicative of either flutter in the empennage or of an unusually high unsymmetrical horizontal tail load creating a rolling moment from right to left. Again to be noted is that fire damage on portions of the fin with clean portions of the fin in consonance with fire damage on the hull structure beneath the fin indicate that the disintegration of the fin occurred before the fire.

h. Examination of numbers 1, 2, and 3 engines indicate they were not involved in the accident. Only parts of number 4 engine were recovered. However, the cowling of this engine was recovered which was in fair condition.

i. Since no logical sequence of events could be developed, none are presented.

Conclusions

1. There was no fire in flight before structural disintegration.

2. The number 4 hull tank door was subjected to an explosion which freed it from the structure.

3. Examination revealed that there are no "g" limiters in the stabilizer control system and that approximately 100 pounds of pilot effort if suddenly applied could result in wing structural failure

4. Information is that limiting flutter speed is marginal and that the spread from the actual flight speeds are not within the regulations.

5. Since nothing but small pieces of the hull between the spar bulkheads were recovered, a possibility exists of a high intensity fuel tank explosion in this area.

Recommendations

1. That entire control systems be reevaluated.

2. That the structural analysis and flutter design be reviewed and aircraft be modified if necessary.

3. That the hull section between spar bulkheads be rebuilt when sufficient parts are recovered in order to determine whether disintegration was due to release of energy as a result of structural loads or fuel explosion.

4. That outer tip portions of the wings be rebuilt since there exists diverse opinions as to the direction of load which caused failure. This is important in establishing a sequence.

5. That aircraft be studied to reveal all probable items that may be considered as hazards to flight safety.

I. BACKGROUND OF ACCIDENT

A. FLIGHT HISTORY OF AIRCRAFT

During the period 23 June through 7 December 1955 the XP6M-1 (BuNo 138821) was flight tested at the Middle River facilities of the Glenn L. Martin Company in accordance with Pre-Part I and Part I Demonstration Requirements (Ref. I-1). The pre-demonstration requirements (pilot familiarization, hydrodynamic investigation, airspeed calibration, bail-out chute tests, preliminary CO survey, powerplant installation and preliminary vent survey, flap loads and hinge moment tests, windshield wiper tests, preliminary mine drop tests, and engine nacelle duct measurements) had all been accomplished except that instrumentation malfunctions or unavailability precluded obtaining data of flap loads and hinge moments.

The Part I Demonstration of the XP6M-1 was in progress although no single item under investigation had been completely tested as yet. The airplane had accumulated 37-2/3 flight hours and 42-1/3 taxi hours during a total of 39 flights. A flight is so designated when the airplane has been signed off and is taxied to the take-off area. If there are equipment failures at this time, the flight is aborted although it is still officially recorded as a "flight". Thus there were actually only 23 airborne flights out of 39 official flights. Table I-1 presents a log of all the flights with a resume of the purpose or highlight of each flight as well as a tabulation of the pilots and the take-off gross weights and centers of gravity.

Reference I-2 fully defines all the tests, and presents the data collected and their resulting analysis for the flights of the XP6M-1. Qualitative flight characteristics of the airplane had been established up to Mach 0.949 and calibrated indicated airspeeds up to 522 knots. Complete quantitative data was lacking because, while considerable testing had been accomplished at mid cg, few tests had been made at extreme ranges of cg (28.8 per cent MAC forward and 44 per cent MAC aft).

In general, the pilots had expressed satisfaction with the longitudinal and directional control of the airplane. However, the lateral control was over-sensitive for small wheel throws, an intermittent airframe shake was present, and there was no stall warning. None of these three items are considered to be factors in the accident, with the possible exception of the shake. The lateral control system has already been modified for the second XP6M-1 by changing the mechanical linkage between the aileron wheel and the spoilers. This modification results in more wheel throw for small spoiler deflections. A "stick shaker" unit was also to be installed on this plane to provide adequate stall warning. Also the airframe shake will be thoroughly investigated if it exists on the second XP6M-1.

B. EVENTS ASSOCIATED WITH AND DETAILS OF LAST TEST FLIGHT

During the period in which the final flight was made, the XP6M-1 airplane was undergoing preliminary evaluation by a team of Navy pilots. The tests were being conducted from The Glenn L. Martin Company's facilities at Middle River, Maryland. The airplane was entirely under the maintenance of the Contractor and all crew members excepting the pilot were Martin personnel.

The Navy representatives, together with Martin personnel from Aerodynamics and Flight Test, had detailed a flight test program commensurate with previous tests performed by the Contractor and with flight test time available before a scheduled change of Engine 1. It was explicitly understood that the Navy preliminary flight test evaluation would only encompass tests previously performed by the Contractor. In some instances, the proposed tests did not duplicate exactly the Contractor's tests, but it was clearly evident that there were few items programmed which had not been previously demonstrated to an essential degree.

The original program, reproduced herein as Table I-2, was to be flown by three Navy pilots on two flights. The first half of each flight was to consist of tests at high altitudes; then the airplane would land, a new Navy pilot would go aboard, and the second half of the flight would cover tests at lower altitudes. Thus, the first evaluation flight would follow the programs listed in Table I-2 under "Flight I" and "Flight II" while the second evaluation flight would adhere to "Flight III" and "Flight IV".

Adverse weather conditions and difficulty with the operation of the afterburners made it impossible to adhere to the original program. Instead, on Flight 38-1, only taxi tests were made; no airborne flight being accomplished. This flight was made by Cdr. Weart with Martin personnel M. Bernhard (copilot), H. Scudder (flight engineer), and J. Hentschel (Flight test engineer). The next day, (Dec. 7, 1955), a 10,000 to 12,000 foot ceiling precluded tests at high altitude. Consequently, it was decided that Flight 39-1 would follow the programs given in Table I-2 under "Flight II" and "Flight IV". Because of the low ceiling, it was agreed to eliminate the stall tests.

Accordingly, on Flight 39-1A, the tests under "Flight II" were performed with LCdr. E. Horrell as pilot and the same Martin personnel as on Flight 38-1. The loading for this flight was Martin loading 16 (gross weight = 159,789 pounds; cg = 37.7 per cent MAC). From LCdr. Horrell's comments, there were no noticeable discrepancies in the flying qualities of the airplane under the conditions tested. The film from Photopanel 1 was recovered and the tests of Flight 39-1A have been plotted. The analysis of these data is given in Ref. I-3 as well as in Ref. I-2. LCdr. Horrell did comment that the gage monitoring the utility system hydraulic pressure was erratic and reading high, but two in-flight inspections by the flight engineer established that the gage was in error and the system was functioning properly. Also, LCdr. Horrell reported that, while flying at Mach 0.853 at 483 knots (swivel CIAS) in a shallow dive at 9200 feet in slightly turbulent air, the control column jerked forward about two inches and then came back to its initial position. Mr. Bernhard discounted the action of the column as merely being caused by rough air and the testing was continued with no further incidents. A landing was then made to change pilots.

After landing, Engines 1, 2, and 3 were shut down and Engine 4 throttled. As the speed boat approached with the next Navy pilot, the boat crew informed the XP6M-1 crew that smoke was coming from Engine 2. Mr. Bernhard, noticing the Engine 2 exhaust gas temperature read 400°C quickly motored this engine and the temperature immediately dropped to 200°C as the smoke disappeared.

LCdr. V. Utgoff went aboard for Flight 39-1B and LCdr. Horrell disembarked. The recovered film includes the take-off on Flight 39-1B, a level flight trim point at 8700 feet with normal rated thrust on all engines, and two additional points, one in a climb at Mach 0.742 and the other in a dive at Mach 0.853. The data are included as Table I-3 of this report. A stenographic transcript of the salvaged wire recording is presented in the Appendix to this chapter. The recorded data are compatible with the planned program as outlined under "Flight IV" of Table I-2.

The time history of the take-off, given in Figure I-1, shows a normal pattern. The airplane was airborne at 15:07:13 (time on photopanel No. 1). A climb was then made and, at 8700 feet, the airplane was trimmed in level flight in the clean configuration with normal rated thrust on all engines at 15:15:12 for the beginning of the static longitudinal stability tests. The speed was then reduced by the use of a pull force on the column (engine rpm being held constant) and a film record was made at 10,150 feet altitude and at Mach 0.742. Then the airplane was nosed over into a shallow dive and a film record made at 15:18:28 at Mach 0.853 at 8750 feet. The film is severed on the second frame of this run. A detailed analysis of the photopanel film record has been made and may be found in Chapter VIII of this report.

C. CREW

The crew on the fatal flight were Martin personnel except for the Navy evaluation pilot. All members of the crew except the Navy pilot were the regularly assigned aircraft crew, had flown in the XP6M-1 on most of the preceding flights, and had been assigned to the XP6M project (flight test) since prior to first flight. The Navy pilot on this flight had not flown in the XP6M before. Brief biographies follow:

1. Pilot

Lt. Commander Victor Utgoff, age 40, had approximately 5000 hours total flight time of which 1200 were in heavy sea planes. Previously he had flown for Naval Air Transport Ferry Squadron during WWII. He was a member of VP-47 from May 1947 to August 1949 and was assigned to VP-40 from June 1951 through July 1953.

2. Copilot

Maurice B. Bernhard, age 35, was a project test pilot for the Martin Company assigned to the XP6M and had been with the Company as a test pilot since 1953. Before coming to the Company he had been a test pilot for the CAA in New York; a test pilot in the Navy at Patuxent River, Maryland; and a Navy pilot during World War II. An engineering graduate, he was copilot on the first flight of the XP6M-1.

3. Flight Test Engineer

James O. Hentchel, age 29, was employed by the Martin Company in May 1952 and became associated with the Flight Test Department in March 1955. He was assigned to the XP6M-1 as Flight Test Engineer. A graduate of Towson State Teachers College he served in the U.S. Maritime Service from October 1944 to May 1946.

4. Flight Engineer

Herbert D. Scudder, age 41, became a flight engineer copilot with Flight Test Department of the Martin Company in July 1950. He was assigned to the XP6M-1 as flight engineer and perfomed this duty on the first flight as well as on subsequent flights. He was also a crew member on the first flight of the P5M.

D. PROCEDURE AFTER ACCIDENT

The first indication of the possibility of the XP6M-1 accident was a message overheard by the Martin Company tower through their CAA phone line that an aircraft had exploded in flight in the vicinity of Patuxent River. The tower immediately attempted to contact the XP6M-1, and when it could not, notified George Rodney, Chief, Experimental Flight Test. As information became available and further transmissions by the tower failed to raise the XP6M-1, it was assumed that it was the crashed aircraft, although original radio messages from airborne observers indicated that the aircraft in question was an A3D.

Mr. Rodney and Donald McCusker, another test pilot of the company, took off immediately for the area of the crash and at the same time, our rescue sea plane was dispatched there also. Succeeding communication verified the crashed aircraft as the XP6M-1. Mr. Rodney continued to the scene but sent our rescue aircraft back to Middle River because Navy aircraft and rescue helicopters were already in the area. These Navy craft remained in the area until darkness, directing small boats in the search for survivors and salvage of small pieces of wreckage.

Mr. Rodney spent the rest of the night at Patuxent interviewing witnesses to the accident to determine the exact location of the crash area. Liaison was set up with NAS Patuxent for establishing procedures for the impending field investigation, and coordinating efforts for salvage, reconstruction, and initial analysis.

TABLE I-1
Flight Number Index
XP6M-1 BuNo. 138821

Flight No.	Date	Flight Time Hr:Min	Taxi Time Hr:Min	Total Flight Time Hr:Min	Total Taxi Time Hr:Min	Take-Off Gross Weight (lb)	Take-Off C.G. % MAC	Pilot*	Remarks
1-1	6-23-55	0	0:20	0	0:20	133675	34.6	R	Initial taxi investigation
2-1	6-27-55	0	1:46	0	2:06	133675	34.5	R	Initial taxi investigation
3-1	6-30-55	0	1:20	0	3:26	133675	34.5	R	Initial taxi investigation
4-1	7-6-55	0	1:15	0	4:41	133675	34.5	R	Hydrodynamics investigation
5-1	7-7-55	0	1:41	0	6:22	133675	34.5	R	Hydrodynamics investigation
6-1	7-14-55	1:45	0:55	1:45	7:17	133675	34.6	R	First flight - preliminary flight evaluation
7-1	7-18-55	0	1:0	1:45	8:17	133675	34.6	R	
8-1	7-19-55	1:23	0:43	3:08	9:00	134285	34.8		Preliminary aerodynamics - rolls, yaws, approach to stall, hydro-flap blow-back
9-1	7-21-55	1:50	0:35	4:58	9:35	139285	34.5		Rolls, extended dive brakes
10-1	7-25-55	2:10	0:25	7:08	10:00	139285	34.5	R	Airspeed calibration, steady turns, rolls
11-1	7-28-55	2:00	0:50	9:08	10:50	139285	34.5	R	Engine performance stall approach, rolls
12-1	8-11-55	0	1:15	9:08	12:05	140178	34.0		Hydryflap blowback
13-1	8-15-55	1:37	1:21	10:45	13:26	140178	34.0		Airspeed calibration, rolls, drag deceleration
14-1	8-24-55	1:20	1:15	12:05	14:41	145178	33.5	B	Shake investigation, airspeed calibration
15-1	8-26-55	0	1:37	12:05	16:18	145178	33.5	B	Afterburner trouble
16-1	8-29-55	0	0:50	12:05	17:08	145178	33.5	B	Afterburner trouble
17-1	9-1-55	1:47	0:44	13:52	17:52	145178	32.0	B	Rolls, airspeed calibration

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TABLE I-1 (CONTINUED)

Flight No.	Date	Flight Time Hr:Min	Taxi Time Hr:Min	Total Flight Time Hr:Min	Total Taxi Time Hr:Min	Take-Off Gross Weight (lb)	Take-Off C.G. % MAC	Pilot*	Remarks
18-1	9-7-55	1:55	0:50	15:47	18:42	147782	29.8		Airspeed calibration, drag deceleration
19-1	9-26-55	1:10	1:35	16:57	20:17	152874	29.4	R	Empty mine door rotation
20-1	9-28-55	1:49	1:01	18:46	21:18	152874	36.4	B	Locked throttle climb, static longitudinal stability, drag deceleration
21-1	9-29-55	1:37	0:40	20:23	21:58	155369	29.2	B	Airspeed calibration
22-1	10-3-55	0:05	1:09	20:28	23:07	156265	31.3	B	Flight aborted due to fire warning light
23-1	10-5-55	2:20	0:51	22:48	23:58	156265	31.3	B	Escape chute tests
24-1	10-11-55	1:50	1:30	24:38	25:28	155369	31.5	B	Empty mine door rotation, rolls, airspeed calibration
25-1	10-13-55	0	1:32	24:38	27:00	155369	32.2	B	
26-1	10-15-55	2:35	1:54	27:13	28:54	155369	32.2	R	Empty mine door rotations, rolls, airspeed calibration, static longitudinal stability, flap hysteresis, yaws
27-1	11-1-55	0:24	0:38	27:37	29:32	125369	34.6	T, R	Pilot familiarization - FTF
28-1A	11-2-55	0:25	0:43	28:22	30:15	125369	34.6	R	Demonstration flight
28-1B	11-2-55	0	1:08	28:22	31:23	125369	34.6	R	Engine checks on the water
29-1	11-5-55	0	1:27	28:22	32:50	160000	30.0	B	Flight aborted due to rough water and afterburner trouble
30-1	11-10-55	0:50	0:48	29:12	33:38	160000	30.0	B	Loaded mine door rotations
31-1	11-12-55	0:59	0:45	30:11	34:23	160000	30.0	B	Mine drops
32-1	11-17-55	0	1:17	30:11	35:40	149789	36.0	B	Afterburner trouble

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TABLE I-1 (CONTINUED)

TABLE 2 (CONTINUED)

Flight No.	Date	Flight Time Hr:Min	Taxi Time Hr:Min	Total Flight Time Hr:Min	Total Taxi Time Hr:Min	Take-Off Gross Weight (lb)	Take-Off C.G. % MAC	Pilot*	Remarks
33-1	11-21-55	0	1:40	30:11	37:20	149789	36.0	B	Afterburner trouble and fire warning light
34-1	11-22-55	2:09	0:42	32:20	38:02	149789	36.0	B	Tail tuft study, stalls, drag deceleration
35-1	11-30-55	0	1:40	32:20	39:42	149789	38.0	B	Afterburner trouble - hydroflap blowback
36-1	12-1-55	2:32	0:47	34:52	40:29	149789	37.9	B	Climbs, stick force per g, static longitudinal stability, phugoid, stall characteristics, sideslips
37-1	12-1-55	1:19	0:26	36:11	40:55	149789	39.8	B	Stick force per g, dynamic longitudinal stability, sideslips, static longitudinal stability
38-1	12-6-55	0	1:26	36:11	42:21	159789	37.7	N	Preliminary Navy evaluation - Taxi tests
39-1A	12-7-55	1:13		37:24		159789		N	Navy evaluation - maximum speed at 10,000 feet, rolls, static longitudinal stability
39-1B	12-7-55	0:21		37:45				N	Aircraft lost in Patomac River near Point Lookout, Maryland

* R - Rodney, G.
B - Bernhard, M.
T - Tibbs, O.E.
N - NATC Patuxent Pilots

TABLE I-2

Navy Preliminary Evaluation Detailed Flight Test Program

Flight I

1. Take-Off GW 159,000 lb 38.0% cg

Optimum take-off.

2. MRT Climb 38.0% cg

Climb to at least 35,000 feet or to 500 fpm ceiling. Climb speed as specified on schedule.

3. Maximum Speed NRT 35,000 feet 38.0% cg

Maximum speed with 97.5 % rpm

4. Maximum Speed MRT 35,000 feet 38.0% cg

Maximum speed with 100% rpm

5. Spoiler Roll (V_{MRT}) 35,000 feet 38.0% cg

Determine rate of roll from 60° bank with rudder fixed. Left and right. Wheel throw at discretion of pilot. 35,000 feet 38.0% cg.

6. Static Longitudinal Stability 35,000 feet 40.0% cg

Trim at V_{max} with MRT in level flight. Stabilize at 3 speeds (increments of 0.03 Mach number) below trim around 35,000 feet. Then stabilize at 3 speeds above trim. Do not exceed an indicated Mach number of 0.93.

7. Maximum Speed MRT 20,000 feet 40.0% cg

Descend from 6 (above) to stabilized maximum speed with 100% rpm.

8. Maximum Speed NRT 20,000 feet 40.0% cg

Stabilize at maximum speed with 97.5% rpm.

9. Cruise Speed (V_{cr}) 20,000 feet 40.0% cg

Stabilized speed at 93% rpm.

TABLE I-2 (continued)

10. Power-On Stall, Flaps Up   15,000 feet   40.0% cg

Stall using minimum entry rate. Maintain fixed trim, Approximately $V_{s_{po}}$ = 125 knots on swivel. Trim at V_o = 230 knots.

11. Power-On Stall

Repeat 10 maintaining zero control forces about three axes.

12. Land   40% cg

Flight II
(Flight 39-1A)

1. Take-Off   40% cg

Fixed-stick take-off, for upper limit at gross weight for end of Flight I. Set trim switch at discretion of pilot and maintain zero stick force.

2. Maximum Speed MRT   10,000 feet   40% cg

Maximum speed with 100% rpm.

3. Mine Door Operation   10,000 feet   40% cg

One cycle at 100% rpm.

4. Maximum Speed NRT   10,000 feet   40% cg

Maximum speed with 97.5% rpm.

5. Spoiler Roll   10,000 feet   40% cg

Rudder fixed roll from 60° bank, right and left. Wheel throw at discretion of pilot.

6. Static Longitudinal Stability (PA)   10,000 feet   40% cg

Trim at V_o = 160 knots (swivel) and power for level flight at this speed. Stabilize at following observed speeds: 140K, 120K, 110K, 170K, 180K.

TABLE I-2 (continued)

7. Power-On Stall, Flaps Down 15,000 feet 40% cg

Trim at 160K (swivel) with power for level flight. Maintain fixed trim and stall using minimum entry rate. $V_{s_{pa_o}}$ = 100K (swivel).

8. Power-On Stall 15,000 feet 36% cg

Repeat 7 maintaining zero control forces about three axes.

9. Land 36% cg

Flight III

1. Take-Off GW 159,000 lb 32% cg

Fixed-stick take-off for lower limit. Set trim switch at discretion of pilot and maintain zero during take-off run.

2. NRT Climb Maximum forward cg

Climb at NRT to 500 ft/min ceiling at speed as specified by schedule.

3. Thrust Required 35,000 feet Maximum forward cg.

Climb to 35,000 feet using MRT. Stabilize in level flight at following indicated Mach number: 0.76, 0.78, 0.80, 0.82, and V_{max}

4. Lateral Directional Static and Dynamic Stability 35,000 feet Aft cg

Trim at V_{max} for NRT. Perform steady sideslip to right using 200 pounds pedal force, maintaining constant heading. Release all controls and allow to oscillate for no more than five complete cycles. Repeat to left.

5. Maneuvering Stability 35,000 feet Forward cg

Wind-up turns holding constant altitude. Trim at V_{max} for MRT and stabilize at 1.5, 2.0 and 2.5g.

TABLE I-2 (continued)

6. Maneuvering Stability 35,000 feet Forward cg

Repeat 5 above maintaining constant indicated Mach number.

7. Descent at Idle Power Forward cg

Make maximum descent (minimum descent rate of 7500 ft/min) to 15,000 feet. Make air start during descent.

8. Power-Off Stall, Flaps Up 15,000 feet Forward cg

Trim at 170 knots (V_o swivel) with engines idling. Maintain fixed trim and stall using minimum entry rate. $V_{s_{g_o}}$ = 125K (swivel) (approximately).

9. Power-Off Stall, Flaps Up 15,000 feet Forward cg

Repeat 8 above maintaining zero control forces about three axes.

10. Landing Forward cg

Make high trim angle landing to check skipping tendencies.

Flight IV
(Flight 39-1B)

1. Take-Off 40% cg (Approximate TO GW = 121,000 lb)

At gross weight at end of Flight III, make fixed-stick take-off to check lower limit. Set trim at discretion of pilot and maintain zero stick force during take-off.

2. Static Longitudinal Stability (P) 10,000 feet 40% cg

Trim at V_{max} for NRT and then stabilize at three speeds below trim (increments of 0.03M) and three speeds above (increments of 0.03M).

3. Spoiler Rolls (PA) 10,000 feet 40% cg

Trim at V_o = 160 knots (swivel) with power for level flight. Make roll from 60° bank with rudder fixed; left and right. Wheel throw at discretion of pilot.

TABLE I-2 (continued)

4. Spoiler Rolls (PA) 10,000 feet 40% cg

Repeat 3 above with outboard spoilers off.

5. Spoiler Rolls (PA) 10,000 feet 40% cg

Repeat 3 above with inboard spoilers off.

6. Lateral Directional Static and Dynamic Stability (PA) 10,000 feet 40% cg

Trim at 160 knots (V_o swivel) with flaps down and power for level flight. Perform steady sideslip to right in increments of 1/3 travel to full pedal travel maintaining constant heading. From reduced sideslip angle, release controls and allow to oscillate for five full cycles.

7. Lateral Directional Static and Dynamic Stability 10,000 feet 40% cg

Repeat 6 above to left.

8. Emergency Longitudinal Control Check 5000 feet 40% cg

Shut off either primary hydraulic control system and check for trim change.

9. Thrust Required 5000 feet 40% cg

Stabilize in level flight at V_{max} for MRT and at following speeds: 450K, 400K, 350K, and 300K. (V_o swivel).

10. Power-Off Stall, Flaps Down 15,000 Feet 40% cg

From 9 above, pull up to 15,000 feet for V_1 stall. Trim at 140K, (V_o swivel) with power for level flight. With fixed trim, stall using minimum entry rate. (approximately $V_{s_{1_o}}$ = 100K swivel).

11. Power-Off Stall, Flaps Down 15,000 feet 40% cg

Repeat 10 above maintaining zero control forces about three axes.

12. Land 40% cg

APPENDIX

Transcript of XP6M-1 Wire Recording, Flight 39-1B

Maury: I want to say, anything you don't write down, you can read it back when you get on the ground.

Jim: Just for information on the wire recorder, let's say this is Flight 39-1.

Maury: Flight 39-1, it is!

Herb: The airspeed is a little bit high here--4 or 5 knots.

Maury: We're still not getting the power out of Number 2 engine that we should be.

Horell: Yea, she is low.

Herb: Maury, is this going to be one of those deals where we land and change pilots?

Maury: Yes.

Herb: O.K.

Horell: If you can, get a spot on this shot on the fuel remaining here at the end of the climb.

Herb: O.K.

Horell: Stall held.

Maury: How about some heat, Herb?

Herb: Yea, coming up.

Maury: This crap up here ain't much more than 10,000.

Horell: No, it isn't.

Jim: Herb, this will be fuel reading Number 1.

Herb: All right, just a minute, Jim, I'll make up a chart.

Horell: What I'll do Maury, we want V_{max} point at military power right after this, so I'll climb to a little above 10 and then we'll dive down and decelerate instead of accelerate.

Maury: For our own information and for the engine people, want to take some engine data when you get to 10,000?

Horell: O.K., fine.

Maury: All right, you can knock off your climb now.

Horell: Yes.

Maury: Yea, your photopanel at 11,000 is O.K.

Horell: Climb's off.

Maury: Herb, fuel remaining?

Horell: He'll be able to make a note of it for you.

Maury: O.K., fine. Take a fuel reading.

Herb: Right.

Horell: O.K. with a 100 per cent.

Maury: Cut the heat down a little bit, Herb.

Herb: Yea, darn this thing, I'm having an awful time with it.

Horell: Still riding 5000 isn't she--a little over--hydraulics.

Maury: Yea, it hasn't moved. Just like yesterday it was riding 1700.

Horell: 0.85 that's the limit isn't it?--10,000?

Maury: 10,000--0.875 is the limit.

Horell: O.K.

Jim: Do you want a high speed trim shot when you stabilize out up here, Maury?

Horell: Yea, I'm going to level off around about right now.

Maury: Let's don't point the airplane down to the ground now that you're going past your home.

Horell: I'd like to buzz them.

Maury: We've been dying to ourselves.

Horell: This is the same buzz, but it's higher frequency, Maury.

Maury: All right. Yea, now when you fly at high altitude you don't get this, definitely a function of "Q". Did you get that fuel reading, Herb?

Herb: Yep.

Maury: Get some engine readings while we're getting stabilized, Jim.

Horell: We're pretty close to it right now--at 9600 instead of 10,000--I don't think it will make much difference.

Jim: O.K., Maury.

Maury: You just holler when you want a trim shot, Ernie.

Horell: O.K. Would you record these two on your--right there?

Maury: O.K., we'll get them.

Horell: O.K.

Just in case the film doesn't come out, it's 467, 468 on speed, indicated swivel.

Jim: 468 indicated swivel.

Horell: You can go ahead and take your shot now, too.

Jim: This will be a trim shot, correct?

Horell: This is a trim shot--stabilize 10,000 foot engine data and speed.

Maury: He's not going to give you a trim shot--just take your shot.

Horell: Take your shot.

Jim: O.K., I got it.

Maury: All right now, take down this engine data.

Jim: O.K., shoot.

Maury: 100 per cent across the board--100 per cent rpm all four engines.

Jim: O.K.

Maury: 600.

Jim: O.K.

Maury: 560.

Jim: O.K.

Maury: 600.

Jim: O.K.

Maury: 570.

Jim: O.K.

Maury: All the fuel flows are 8000.

Jim: All fuel flows are 8000, right.

Maury: All right, I'm going to advance the throttles to the stop--I'll give the reading. Ready?

Jim: Ready.

Maury: Number 1--101 plus

Jim: O.K.

Maury: 620.

Jim: O.K.

Maury: 9000.

Jim: O.K.

Maury: Number 2 -

Jim: O.K.

Maury: Means I got to move--pull out to adjust--102 plus

Jim: All right.

Maury: 620.

Jim: Got it.

Maury: 9000 plus.

Jim: O.K.

Maury: Number 3 -

Jim: Go ahead.

Maury: 101 plus, 620 –

Jim: O.K.

Maury: 9000.

Jim: All right.

Maury: Number 2--Number 4--Number 4 looks like it's the only one that isn't going against the stop--100-1/2, 600, make it 101--it's creeping up.

Jim: O.K., 101 for Number 4.

Maury: Yep, 600.

Jim: O.K., 9000?

Maury: Right, yea, 9000 on the fuel flow 97-1/2 per cent.

Jim: Right.

Maury: _________________ all we'll just mope along here. This will be a very nice reading. I didn't know what this trip was going to be myself. All the tests we've done have only been two positions on the throttles--open and 80 per cent.

Horell: Take further note down here on the top, the Mach is indicated 0.85 on this side for this speed. About--almost 85.

Maury: Yep.

Horell: O.K., we'll say 97-1/2 per cent.

Maury: Put down 845.

Horell: O.K.--97-1/2 per cent, right, O.K.

Maury: Yea, 97-1/2 per cent--this will be normal rated power, normal rated thrust, V_{max}--Jim.

Jim: All right--normal rated thrust, V_{max}.

Maury: Roger, stand by to take the data.

Horell: Is there fuel remaining on that last run?

Maury: I'm going to take a fuel reading after this reading.

Horell: O.K.

Maury: This will be fuel reading Number 2, Herb, when we--after we get this run.

Herb: Right.

Maury: You ought to put down here--fuel reading Number 1 and then Number 2.

Horell: O.K.

Maury: We'll know what it is, see, we'll correlate your card with his card. You notice what a long time it takes to get stabilized--can't convince the engineers of that.

Horell: We're pretty close to it--now.

Maury: You want to take a shot here.

Horell: Just loused up on our speed on that little--Take your engine data now--I'll have your speed in a minute.

Jim: Hey, Herb, you want to take fuel reading Number 2 now, while we're trying to get stabilized on this break?

Herb: Right.

Horell: 442 on the speeds--0.815.

Maury: Take a shot.

Horell: Got it.

Maury: Oh, well, we won't need this thrust data for ourselves, you want this for yourself. Let me get it down here.

Horell: Yea, get it all down if you will.

Herb: Maury, you want to give me the panel--I'll level off these wings a little bit.

Maury: Got it--what happens is that when we're burning Number 1 and 4 afterburner only, you burn out more fuel of one wing than the other. I give him the panel manually, and he transfers it to level our fuel, that makes for his fuel readings better. Did you get your fuel readings?

Herb: Yea, I got them before that.

Maury: And you got your shot, Jim?

Jim: I got my shot, Maury.

Maury: Normal rated power?

Jim: I got maximum speed, military rated power, and I got maximum speed at normal rated power.

Horell: Are we getting our engine data temperatures and everything down?

Maury: Oh, yea.

Horell: O.K.

Maury: This one up here, I got for myself.

Horell: These are back on the photopanel, too, aren't they?

Maury: Yep.

Horell: O.K.

Maury: Everything you got here is on the photopanel.

Horell: This run is supposed to be rate of roll, military rated thrust 10,000.

Maury: Now, you got anything at slow speed?

Horell: Yea, static longitudinal test--you want to do it for next?

Maury: I'd like to do a little of it to give Herb a chance to go back and look at this thing.

Horell: O.K., power coming off.

Maury: I'll pull the friction off a little bit.

Horell: That was a rumbling and starts to rumble through and starts to rumble through again--that vibration or whatever it is.

Maury: That's what we've been calling a rumble. Herb, we're going to slow down here now--I want 10,000 so that's where we're going to stay. You better go back and take a look at that utility system gauge.

Herb: O.K. I'll put the system back in automatic, and you take it.

Maury: O.K., is it in automatic?

Herb: Yea.

Maury: O.K., I got it.

Horell: This is a PA configuration--longitudinal stability--so we should be able to check that utility system. This ________

Maury: Yea, we got to use it. He'll go and check the pressure while you're getting slowed up. And that's it and well, flying it better be good.

Horell: On this vibation, I think part of your--after this rumble goes through part of the shake is due to the nose boom, I think it starts this shaking and then it damps out, then it shakes and then it damps out.

Herb: What's the altitude, Maury?

Maury: 10,000.

Herb: We'll have to dump this cabin, it takes too long to use the air lock.

Maury: All right, dump it. Hold your ears.

Herb: All right, I'm going aft.

Maury: At high altitude, a guy will freeze in that air lock.

Horell: They told us at school this thing dumps something like 190,000 feet per minute.

Maury: You felt how fast it dumped air, well, it doesn't dump that fast.

Horell: Oh, is that right? Ah, let's see, is that our boat out there?

Maury: No, that's a liner--we're right over the Bay Bridge. Our boats see--you see the two ________ islands over there? The two islands? That's our seaplane area in there, see our boats will sit in there until we come home.

Horell: Oh, O.K.

Maury: What we'll probably do is to make an approach and left hand turn around, come on down the river, and then sashay, touch-down about Bowleys--that is just about where we took off, and go on out towards Miller's Island. I'll show you--go up here and start to make a left turn and I'll point out some of the sand bars.

Horell: O.K.

Maury: Give me your position report--Ah, there it is.

Jim: Maury, are you transmitting on the air?

Maury: You don't hear me, is that it?

Jim: No, I can't hear you.

Maury: I'm using the other transmitter. Hold on, I'll use this one.

Herb: I'm back here, Maury, we've got 3000 pounds.

Maury: O.K., Herb.

Horell: Want him to watch it while we put the flaps down back there?

Maury: Herb?

Herb: Yea?

Maury: Listen, we're going to ease the flaps down here and why don't you take a look at it?

Herb: O.K.

Maury: See how it acts. We're nice and slow now, Herb, we're getting down to P5M speed.

Herb: ____________________

Horell: See what's the flap speed on this.

Herb: Feels like you're doing something, all right.

Maury: What did you say?

Herb: Feels like you're doing something all right--I can't see nothing on the hydraulic system will the goddang tail going around.

Maury: We just hit some rough air.

Horell: I'm not doing a thing, I'm just as quiet as a mouse.

Maury: Yea, we just hit some rough air, Herb. We're right below the overcast--directly below--we're going to drop down a little when we put the flaps down.

Herb: O.K.

Maury: You see how long it takes to slow this airplane up? You come around for a landing, and I've flown this airplane, now, oh, I don't know, 40 hours I guess---

Herb: Maury, the whole trailing edge is--wait a minute, I'll get up forward.

Jim: Can you read that, Maury?

Horell: I heard that--said something about the trailing edge.

Maury: Yea, is he up in his seat yet?

Jim: No, I haven't seen him come through the door yet--he's probably at the aft beaching gear station looking through the windows.

Maury: Where are you, Herb?

Horell: How are we doing on the petrol?

Maury: He'll be up---he has to read it.

Maury: (or Horell) Now all we got to do is see it in the air--that's all I'm worried about.

Maury: We haven't come--we haven't used our wings.

Horell: There's plenty of buffet with those flaps down.

Jim: Here comes Herb now.

Maury: Oh, it'll be more when they're down full. Yea, this is flap buffet with the flaps.

Herb: I'm back forward, Maury.

Maury: What were you saying, Herb?

Herb: The whole outboard trailing edge of our right flap has been losing water out of it, and it is all frozen along the trailing edge, it's dirty as hell out there.

Maury: It is, huh?

Herb: Yea, I'll get in my seat.

Maury: About how much water's out there?

Herb: Just a long, just a hunk rime ice like stuck along the trailing edge about 1 foot and 1/2, for the last outboard edge of it.

Maury: It doesn't stick back 1 and 1/2 feet?

Herb: Oh, no. It's just running along, I'd say 1/2 inch thick so.

Maury: I don't think it ought to hurt you any.

Herb: No--it will probably snap off.

Horell: It will give you a little more buffet.

Maury: All right, put them down a little more.

Horell: Right.

Maury: All right?

Horell: It's shaking there, boy. Son of a gun, look at that thing shake.

Jim: Just took a stabilizer film shot, Maury.

Horell: Does this get any less as you get down toward approach speed?

Maury: Yea.

Horell: I can feel the increase in the lateral sensitiveness right away.

Maury: Yea.

Horell: I'm pretty close to being stabilized, just a second here. I think we can go ahead and shoot a trim shot, here.

Jim: O.K., trim shot coming up.

Horell: Zero forces, and we don't have a position, right? up here?

Maury: No. O.K. we've got the trim shot.

Horell: O.K., what's the next speed lower than this, Maury?

Maury: 140.

Horell: O.K., I'm slowing up to 140. Carrying about 94 per cent, 94 to 95 per cent if you want to put that down.

Jim: All right, I'll write it down.

Maury: You don't have to write it. We've got it up here. Get your trim shot.

Jim: That 94 or 95 per cent is rpm, correct?

Maury: Yea.

Horell: Put H.B. down and I'll tell you what it means later.

Jim: H.B., roger.

Maury: H.D.?

Horell: How Baker, I think (?) I'm going to call it heavy buffet.

Herb: Maury, you want to give me the panel? I'll level this up a little bit.

Maury: You got it ______________

Jim: Hal Baker or Mike Baker?

Maury: __________ you don't have to worry about taking down anything except what shots you take.

Jim: O.K., Maury.

Maury: Now your slats are starting to come out now for your information.

Horell: I'm holding no forces--I mean I have just slowed up to 140--you must be neutral stability. Go ahead and take another shot at 140-

Jim: Got it.

Horell: What's the next one, 120?

Maury: 120.

Horell: What's this thing stall out here, about 100?

Mauy: I think around 100 at this weight--maybe a little more. What's got left in the wing tanks, Herb?

Herb: I have about 35 per cent.

Maury: How much did we start out with?

Herb: We're around 70 per cent--pretty well about half way through that.

Maury: What's 35 show on your paper roughly?

Herb: Ah, just a minute, 35 about 10,000 pounds in each wing tank.

Horell: 10,000, O.K. give me a shot right now. I got about five pounds pull at 120. O.K. What do you want to do? Go back to about 115, the lowest or what?

Maury: O.K. pull it up to 115.

Jim: Maury, did we skip 140? I have 160 and 120.

Horell: We took 140--at least we called for a shot at 140.

Maury: Did you get a shot at 140?

Jim: O.K., I got it, O.K.

Horell: The slats are out now?

Maury: Yea, we've been marking them where they've been coming out on these--let's take it right about here for the weights you're at.

Horell: O.K. take a shot--every 2 to 3 pounds pull.

Jim: O.K. I got it; what do you read up there?

Horell: Control column, that's what I'm reading--power and air-speed. O.K. read it back. It's a roll call I'm reading--It's 150 at calibrated airspeed, indicated swivel. 115 and--O.K. let's make your next one more than that.

Herb: Take a fuel reading right here?

Maury: Drop to 170.

Horell: You're at a very high angle of attack for a fuel reading.

Maury: You ought to take a fuel reading when we level out, Herb.

Herb: Yea.

Horell: That's probably about--let's see--about right now--that time.

Jim: Herb, this is fuel reading Number 3.

Herb: Right.

Jim: We have about a 40 per cent cg right now.

Horell: O.K. 40 per cent.

Herb: O.K., Maury, you can have the panel back, I got everything leveled here.

Horell: O.K. we're still pretty well trimmed out--I'll go on down and get 170.

Maury: 170 and 180.

Horell: O.K.

Jim: Hey, Herb?

Horell: O.K., shoot it. Go out to 3 to 4 pounds push. This thing's buffeting so bad I can't read it.

Jim: You say 3 to 4 pounds push?

Horell: Push, that's it.

Maury: 180.

Horell: This stability in this configuration is so doggone weak it's pretty hard to get any data, especially with this buffet the way it is.

Maury: The flaps are going on back at this speed.

Horell: That could be it. We'll go ahead and take a shot here at 184.

Jim: O.K. 184 coming up, O.K.

Horell: Those are about the same--3 to 4 or 5 pounds somewhere around there. Let's run a little phugoid--Let's let her go right here on the high side.

Jim: You want this on record? A continuous record of phugoid? Right? Tell me just before you start and I'll start the camera rolling.

Maury: Start it.

Jim: O.K., it's moving.

Maury: Put down the same trim as the static long. Keep the camera going--start it at 183.

Horell: Just sit here all day for one oscillation.

Maury: 42,000 you will.

Horell: O.K. she's only touched up to about 165 there--she's pitching down a little bit already so our trim is off somehow--maybe the flaps are blowing back or something.

Maury: They are blowing back 20 per cent.

Horell: Let me pull her up and try her in a slow speed range at a phugoid. I'll pull her back to about 120 knots.

Maury: I dumped the flaps the rest of the way.

Jim: I still got the camera running, Maury.

Horell: O.K. turn it off.

Maury: O.K. shut if off. Cancel that phugoid?

Horell: Yea, I think so, it's not going to be much. What else have we got?

Maury: Well now--let's try the slow one you were going to do.

Horell: O.K. we'll cancel that last one.

Maury: Just abort that last one, the whole thing.

Jim: O.K. I'll bust it.

Maury: This will be phugoid from 130--130 with a V_{trim} of 160.

Horell: All right, O.K. stand by--O.K. I'm letting it go.

Maury: Start the camera.

Horell: It isn't going to 160 this time--its almost neutral--not quite--O.K. I think thats enought from that.

Maury: O.K. knock off your camera.

Jim: Camera's off. I got a trim of 160 knots on that, Maury--what other information did you give me, Maury?

Maury: That's all right, we got it here.

Jim: O.K.

Maury: Go ahead--you want to make some notes?

Horell: You hit it.

Maury: O.K.

Horell: You want to bring her back up to MIT? I think we can head back and pick up Vic--that about ends me except for a stall which I was going to leave off--we ran short of time.

Maury: You know what also may be affecting this? Herb, are you through with the indicator now--it's going down--going back to 2500.

Herb: Yea, you just can't take no word from that thing.

Horell: Can you go any higher, the only reason we re-pressurize this thing is that it re-pressurizes.

Maury: All right, Ernie.

Herb: O.K. just beats us up that much more.

Maury: Yea, don't bother with any re-pressurizing because we're going to make a V_{max} run. There it popped up--now it's over 6000--oh! it's going around the dial twice.

Herb: Yea, transmitter's falling apart back there.

Maury: Take a look at the utility system--wouldn't scare the hell a night a bombing mission and you knew--you had to unload the mine door.

Horell: How long have we been out?

Jim: Been out almost an hour.

Horell: O.K. let's head back toward the bay so I can get this rate of roll on the way back.

Maury: Yea, what time we take off?

Jim: I have 33, Maury.

Horell: Yea, I got it, Maury.

Maury: This will be a roll--a roll at V_{max}, 10,000.

Horell: I don't know whether I want to put full aileron on or not--have you ever done it?

Maury: No, you'll reach the stops.

Horell: I mean have you ever put in full control--10,000 at V_{max}?

Maury: No, not at 10,000--couple of them--work on it.

Horell: O.K. Tell me what other __________ over there, isn't it.

Jim: Tell me when you're going to start your roll.

Horell: O.K.

Maury: Yea, O.K., we'll tell you--we got to get the speed up first. Get a fuel reading, Herb.

Herb: O.K.

Maury: Is this fuel reading 3?

Jim: This is fuel reading 4 coming up, Maury.

Maury: O.K.

Horell: This is pretty good for high speed probably a little bit slow for slow speed, though, I don't know. We'll fly awhile. Oh! that old rudder gets stiff at high speed that high "Q". I had 200 pounds on the tail and I can't see any yaw. This thing doesn't come in very fast until you get over to 10, does it? Maybe about 15 control column movement, doesn't it?

Maury: Yea.

Horell: Can you time some of these rolls into degrees per second on your gadget over there? That'll be quite--oh! we have a rate of roll indicator don't we? Where is it?

Maury: We have a rate of roll indicator, ah---.

Horell: Yea, O.K., we'll take it on that, then that measures peak rate of roll, doesn't it? O.K. ready?

Maury: Ready. All right now--wait till he gets over in a bank.

Horell: First one will be relatively smooth and easy.

Maury: Yea, all right, now start your camera..

Jim: It's running.

Horell: All right, here we go.

Maury: Stop it.

Horell: Was I against the stop?

Maury: You possibly were.

Horell: Those are "Q" stops, huh?

Maury: Yea.

Horell: Ah, I can do those all day--let me do one to the right. I thought I was going to get 90-degree throw and I could feel myself cork-screwing through the air. O.K. stand by for one to the right.

Maury: All right start your camera.

Jim: It's running.

Maury: Stop your camera.

Horell: It's running about 17 to 18 degrees per second on here. This in degrees per second?

Maury: Yea.

Horell: And that is up against the stop.

Maury: That's in degrees per second but we'll read the data on the photo panel.

Horell: Let me make a couple more of those on the way back.

Maury: O.K. wait a minute, let me get some data.

Horell: O.K.

Maury: Get a fuel reading now while we're in level flight.

Jim: Get Number 5, Herb.

Herb: All right.

Horell: Hey! You sprung a leak, Maury, or something.

Herb: What's that, an air leak?

Horell: How about your overhead hatch?

Horell: Slow her down here slowly.

Maury: Hey, Herb, get my pin in here.

Herb: O.K.

Horell: For gosh sakes.

Maury: Come on, Herb.

Jim: He's coming up now, Maury.

Horell: I think we may as well go on in for a landing, Maury-- what do you think about that? Leaking through the hatch, I think, but I don't know.

Maury: I think it's my window. It's what, Herb? I think it's my window--put you hand over here.

Herb: Yea, I think it's your window, too.

Maury: What could have happend there--just the seal go out?

Herb: Well we were going at high speed and without being pressurized to hold her tight ______ that's why ______ blew in a little.

Maury: You want to put some pressure on and see what happens?

Herb: Yea, I thought maybe something up along the hatch here--the latch looks good. I'll ease it on, and you see if it quiets down.

Maury: Ease it on and see what happens.

Herb: Coming on.

Horell: Letting down, Maury--we're going into land--have Vic take over.

Herb: How's it sound, Maury?

Maury: Quite a difference.

Horell: I don't know what it was sounded like a sudden failure--just popped right out.

Maury: Boy! It just happend right away ______ take this seat out.

Herb: Maury, what't the altitude?

Maury: 7200--we're descending. Don't get much pressure.

Herb: Your hatch wouldn't take your seat. You'd have to pull it.

Maury: Yea, well it should be--all right we'll go on in and land and then we'll take a look at it.

Herb: Yea, O.K. I think if we just grease up that window it'll probably be O.K.

Maury: Ah, take a fuel reading, Herb.

Herb: Yea, O.K. I'll get in my seat.

Horell: Now let's see here we'll go into a left around the field.

Maury: This is fuel reading Number what?

Jim: 5--we have a 40 per cent cg right now.

Horell: O.K. set.

Maury: That's Jack Warfield--he's chief Air Force officer--O.K. check this. This is the danger area. Got to stay south of Poole's Island.

Horell: Where's Poole's Island, right here? O.K. I got it. What do you do--land right across in there now? Out this way?

Maury: Yea, land coming out here just the way he's going you can start way back there at the first island, see---

Horell: O.K.

Maury: And go all the way around on nice speed you can go right over the airdrome.

Horell: Have you gone out with the PBM, Maury?

Maury: All with the P5__________ Keep you rpm up around 80 per cent.

Horell: Yea, I'm slowing down now I'm putting her back up and you want to start my flaps down a little about 200.

Maury: All right now stand by, I'm going on the air.

II. WITNESS EXAMINATIONS

It is felt that witness coverage of this accident was exceptionally good when compared to such coverage in other major accidents. However, in spite of this, witness statements as such are generally unreliable. For that reason, every effort was made to contact all witnesses possible and improve by interrogation the reliability of each statement. With few exceptions all witnesses were interviewed as soon as they were found and in many cases, the witnesses were re-examined several times.

The initial interrogation of as many witnesses as possible was aimed to determine the exact location of the crash to facilitate the rescue of possible survivors. Also, it was of course necessary to gain that information for proper direction of the salvage operation. For these purposes, the statements of witnesses were most beneficial and, although there were no survivors, salvage was expedited.

In all, witness statements were obtained from 30 different locations. A chart and accompanying legend, Fig. II-1, summarizes this information. A map showing witness locations may be found in Chapter III, Fig. III-1.

For the most part, persons were asked to write in their own words what they had seen. In some cases, because of their unwillingness to write, their story was written down as they related it and then signed by them. In a few cases, it was necessary for the interviewer to take notes and later write a statement from those notes.

As soon as all the statements were available, a composite narrative or average statement was written. It was felt that this composite picture might, in the early stages, help direct the investigation. It did aid very materially in finding the areas in the river where wreckage could be found. Because the statements were assumed to be unknowledgeable, no one statement was given any more weight than another. However, where certain aspects were found to have majority agreement, these were given more credence. Also, as findings during the salvage substantiated a given statement, that statement was given more weight. This original composite narrative, which follows, has held up throughout the investigation with only minor revision.

"The aircraft was first observed in relatively level flight at an altitude of 7500 to 9000 feet on a southerly heading. Black vapor or smoke was issuing from the aircraft. An apparently controlled gradual descent was observed.

At an altitude of 3000 to 6000 feet the aircraft was seen on a southerly heading, in the vicinity of Webster Field. When the aircraft was east of St. Georges Island, a minor explosion or visual break-up was observed accompanied by a puff of white smoke or vapor. Minor debris fell from the aircraft. Fire followed immediately and the descent steepened. Two explosions in rapid sequence were seen and heard and major break-up occurred. Fire increased in intensity as the aircraft, in two or three major pieces and many smaller components, fell rapidly in steep descent. Secondary explosions were noted in some of the large pieces as they were descending. When the largest piece struck the water, audible explosion or impact concussion was heard. Fire continued on the water for 2 to 7 minutes around a large section of fuselage which floated for 10 to 12 minutes.

A parachute was observed, fully blossomed, above the falling aircraft at an estimated altitude of 500-600 feet. This chute sank rapidly after entering the water."

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LEGEND

Experience: O - Complete lack of aviation background or familiarity with aircraft.
MP - Military Pilot - recently or currently proficient in military aircraft.
Av - General aviation experience - some knowledge of aircraft greater than that of average individual.
F - Professional fisherman - a special category due to the particular ability of these people to note ranges, bearings, and observe accurately.

Position: Number corresponding to that on observers location chart.

Bearing and distance of observer from estimated position of first minor break-up.

Time of accident: time indicated + 1500 hour (i.e., 19 equals 1519)

Attention: What caused the observer to look at the aircraft.
C - Visual curiosity - general attention to aircraft without any special or particular reason
Ev - Explosion on visual - a visual breakup or explosion
Ea - Explosion audible - initially hearing the explosion
A - Sound of aircraft engines
F - Flash or flame - initially seeing a flash or streak of fire

Vapor: X indicates observer saw the black engine exhaust emission of black smoke trailing behind aircraft.

Minor explosion or debris: X indicates observer saw a minor explosion or breakup with accompanying minor debris.

White smoke: X indicates observer saw a puff of white "smoke".

Fire: X indicates fire was observed about aircraft while in flight.

Major explosion or breakup: X indicates observer saw a major explosion or visual breakup of the aircraft. [illegible]

III. SALVAGE OPERATIONS AND WRECKAGE RECONSTRUCTION

After the initial search by surface craft and aircraft for floating objects at the crash scene, considerable difficulty was experienced during salvage operations. Channel depth varied between 40 and 70 feet, and the bottom was composed of thick silt. Extreme diligence, however, was exercised by the salvage fleet over a period of about three months even though bad weather often hampered operations. All pieces recovered were carefully located, numbered, and identified, and the most significant parts were reconstructed at NAS Patuxent.

A. SALVAGE OPERATIONS

From 15:40 until darkness, on December 7, 1955, salvage work was done by local fishermen in their boats, Naval personnel in a crash boat from Webster Field, and Naval pilots in helicopters and airplanes.

Many floating pieces of the aircraft were recovered by boats on the scene and were deposited at the Webster Field dock. Two elevators and the flight helmet of the copilot were picked up by one of the boats and transferred to a helicopter.

The body of the flight engineer was taken aboard a fishing boat and delivered to Webster Field. From there, it was transported by a Navy helicopter to NAS Patuxent.

1. Formal Salvage Operations

On December 8, 1955, two Martin Company representatives arrived at the crash scene aboard the USS Preserver. Their purpose was to identify salvaged parts of the XP6M-1 and coordinate the salvage efforts of the Navy and the Martin Company.

All parts recovered were identified and assigned a number. The location of these parts were given in terms of range and bearing from Channel Buoy Number 6 in the Potomac River. This information was recorded in a log book aboard the USS Preserver and written on a tag which was attached to each part prior to being sent ashore. The locations of these recovered parts were plotted on United States Coastal and Geodetic Survey Chart Number 557 aboard the USS Preserver.

From eyewitness statements and charted locations of the first pieces recovered, it was possible to plot the probable course of the

SeaMaster as it crashed at the mouth of the Potomac River. This course enabled salvage ships to concentrate their efforts in the most likely areas of the wreckage.

2. First Phase

The USS Preserver was used as communication center for the operation and the efforts of the other ships dispatched from ComServLant were coordinated through it.

The USS Hoist, sister ship of the USS Preserver, and the USS Harkness, a sonar ship, joined the operation. The sonar ship was used to locate underwater objects and drop dan buoys near them. The Preserver or the Hoist would then anchor over these buoys and send divers down to investigate. The Solomon's Island diving boat assisted for about a week.

A boat from the Bureau of Ships at Washington, D.C., equipped with underwater television gear, worked for about three days. It was hampered by rough water and lack of some means of controlling the underwater camera. However, it did succeed in identifying parts of an engine and a portion of the aft hull. These pieces were dived for and recovered by the larger ships. If the underwater television camera had a larger field of vision (about 100 square feet or more) and some positive means of control when scanning the bottom for wreckage, it would be a valuable asset in future salvage work.

NAS Norfolk sent a YTL tug boat with a barge to transport salvaged parts from the crash area to the NAS Patuxent dock. Smaller parts were sent to the Webster Field dock aboard the crash boat. All salvaged material was hauled from the docks to the Operations hangar by public works trucks at NAS Patuxent.

The salvage work, using diving methods exclusively to recover the wreckage, continued seven days a week until just before Christmas. The operation was discontinued for a period of one week and the ships from Norfolk returned to base.

3. Second Phase

The USS Preserver returned to the crash scene on December 29, 1955, and continued the search. The USS Gillis came to do the sonar work and an LCM boat equipped with a dragging rake also arrived from Norfolk. The Preserver did some dragging at this time but the majority was done by the LCM boat because of its greater mobility. Dragging was concentrated around the buoys planted by the sonar ships. Parts recovered in this manner were plotted as coming from the buoy location, although they may have been recovered from an area encompassed by a 150-yard radius around the buoy.

Interrupted only by bad weather and periodic returns of the salvage ships to Norfolk, this method of recovery continued until February 23, 1956.

4. Final Phase

On February 23, 1956, the USS Preserver, equipped with a larger rake, returned from Norfolk. It was accompanied by two LCM boats with rakes. During the final phase, the three salvage vessels were lined up abreast and thoroughly dragged the main crash area. They were able to locate many small parts and several larger pieces. There is no positive location available for these parts. However, some credence can be placed in the location of some of the larger pieces.

The USS Harkness returned to the crash area on February 29, 1956, to make a final sonar search of the crash area. No positive indications were found.

On March 2, 1956, all salvage vessels ceased operations and left the crash scene bound for NAS Norfolk.

5. Search Areas

As shown on the salvage area and witness location chart, the sonar ships searched the entire Area B (Fig. III-1).

All wreckage of the XP6M-1 was recovered from Area A-1 by diving and dragging. Areas A-2, A-3, and A-4 were intensively searched by diving and dragging, but no parts of the SeaMaster could be found.

All sonar contacts outside of areas A-1, A-2, A-3, and A-4 have been identified by divers. None of these objects were from the XP6M-1.

6. Later Recovery

Inhabitants on the shores of the Potomac and St. Mary's Rivers brought in many pieces of wreckage in answer to radio and newspaper appeals. The Naval Air Station made periodic helicopter searches of the shore line but was unable to find the body of the missing crew member or any pieces of the SeaMaster. On March 21, 1956, the body of the missing crew member was found by some fishermen near Coles Point on the Virginia shore of the Potomac River.

7. Evaluation of Parts and Locations

At the Operations Hangar at NAS Patuxent, all parts were evaluated and the significant parts were assigned a number. These numbers were itemized on the attached list along with their corresponding azimuth and distance from Potomac River Channel Buoy Number 6. These points were plotted in their relative positions on a large map (one inch equals 110 yards). See Fig. III-2.

About 90 per cent of the XP6M-1 wreckage was recovered from December 8, 1955, through March 2, 1956. There were a total of 193 major points identified and plotted. Points one through 30 were positive locations recovered exclusively by sonar and diving. Points 31 through 188 were located by confined dragging and diving; their locations are accurate within a radius of 150 yards around these points. Points 190 and 191 are also located within a radius of 150 yards about points plotted on the chart. Point 192 is accurate within plus or minus 5 degrees and plus or minus 100 yards. Points 189 and 193, where many parts were recovered by mass dragging of the main crash area, have no significance as far as fall-out location is concerned.

B. WRECKAGE RECONSTRUCTION

All reconstruction was accomplished in the Operations Hangar at NAS Patuxent.

There were Martin people stationed at Patuxent for about three months to accomplish this work. Their efforts were augmented by people flown from the Martin plant for shorter periods of time. Many samples of burned structure and structural breaks were taken from the wreckage to the Martin Company engineering laboratory for detailed analysis.

The plan was that no unnecessary reconstruction would be done. Therefore, the work was concentrated on certain critical areas. These include parts of the hull, wing, tail, and engines.

1. Hull

The center hull section was considered the most important area and the lower nose section the most insignificant to the investigation. In every case, however, all instrument, control, hydraulic, electrical, and structural components were analyzed by their respective engineering specialists.

Forward Hull (Stations 0 to 407).- This portion of the hull was relatively intact above the flight deck and was placed on scaffolds in its normal attitude. The lower portion of the nose was badly damaged from impact. Since the latter was not considered to be significant, an attempt at reconstruction was not made.

Center Hull (Stations 407 to 749).- Although it was broken into many pieces, a reconstruction of this portion was accomplished. Attached photographs show the reconstruction of the mine bay area and the wing stub covers. The mine door broke into two major pieces. These two halves were placed in their respective positions. Hull fuel cells 1, 3, and 4 and much of their plumbing were recovered. These recovered parts were analyzed by the fuel systems engineers.

Aft Hull (Stations 749 to Stern).- This portion of the hull was recovered in several main portions. These sections were placed in position relative to the forward hull.

2. Wing

The left wing was recovered in one major inboard section and many small pieces of the outboard wing. The inboard portion was placed on a scaffold approximately in relation to the forward and aft hull. The pieces of outer wing, slats, flaps, and spoilers were placed on the hangar floor in their relative positions. The left hand wing tip float was found relatively intact and it was placed at the end of the wing.

The right wing, like the left wing, was recovered in one major inboard section and many small pieces of the outboard wing. The reconstruction was similar to the left wing except that outer wing parts were laid on a scaffold built adjacent to the inboard portion of the right wing. The right wing tip float was not recovered. There were about ten small parts of this float but not enough to warrant reconstruction.

3. Fin

The fin was reconstructed and analyzed by the structures and dynamics engineers. The controls and hydraulic engineers removed the stabilizer cylinder and other pertinent parts for closer scrutiny and testing.

4. Stabilizer and Elevator

The two elevators were recovered relatively intact and placed in position relative to the reconstructed stabilizer and bullet fairing. Structure and dynamics engineers analyzed these parts.

5. Engines

Engines 1, 2, and 3 were recovered almost completely but Engine 4 was only partly recovered. Allison and Martin powerplant engineers analyzed the engines. During their analysis they dismantled Engine 1.

6. Engine Nacelles

The right and left engine nacelles were found to be in about the same condition, comparatively intact. Inlet ducts were recovered.

The engine removal doors were broken into many small pieces and no reconstruction was attempted except to identify the engine.

IV. MEDICAL FINDINGS

Dr. Russell Fisher, Chief Medical Examiner of the State of Maryland performed the medical examination and autopsy of the Martin personnel. Commander Schmoyer, USN performed the same examination of the Navy pilot and was aided by Dr. Fisher. Brief summaries of these examinations are enclosed herein. The complete autopsy reports and accompanying photos are on file at the Martin Company and may be reviewed if necessary.

The body of the flight test engineer who had been flying in the aft port seat was found immediately after the accident floating on the surface with his parachute partially streamed. He had been subjected to a flash fire (high temperature for a short time duration) while still in the aircraft. These flash burns correspond to the flame pattern discussed in Chapter IX. Minor throat injuries were incurred during his subjection to high acceleration forces during break out or to a high-velocity air stream during ejection. This latter injury corresponds to the position of the helmet chin strap. At a time following, at least ten seconds later, he received severe fore and aft impact concussions across the back and head which produced his immediate death. Concussion was caused by impact with the water. His parachute failed to open because he had failed to attach the automatic opening device and there was no time to pull the ripcord.

The pilot and copilot were recovered on 18 December 1955 with the forward flight deck debris. They had received multiple extreme injuries which were caused by the impact of the forward flight deck with the water. Injuries appear to indicate that they, pilot and copilot, were still seated in their respective seats with feet on the rudder pedals and in normal flight position when the injuries occurred. It appeared that there had not been no time attempt to eject.

The flight engineer's body, which had been seen in a parachute, was recovered 20 March 1956. His death was caused by drowning. His body also showed evidence of flash burns corresponding to the flame pattern. He had one injury, a fracture of the tail bone which occurred at least 15 seconds prior to death. This injury undoubtedly resulted either from high acceleration forces during break-up or ejection forces. He was recovered in his parachute, straps still fastened, and he presumably had made no attempt to free himself of the parachute. His Mae West was under his flight jacket and had not been inflated. He was unconscious upon entering the water and it can be logically assumed that unconsciousness was due to severe pain of the tail-bone fracture or the high acceleration forces during his subjection to high velocity airstream. One of the straps of his parachute harness had been broken after burning, by the air blast.

The procedure for escape in this aircraft was by use of the face curtain and in the following crew sequence:

Starboard aft seat -- flight engineer

Port aft seat -- flight test engineer

Starboard forward -- copilot or assistant pilot

Port forward -- pilot.

It appears that this sequence was being followed. The flight engineer ejected and his parachute opened. The flight test engineer ejected and his chute only streamed. The copilot and pilot made no attempt to eject. There appeared to be a lack of time for successful ejection because of the quick onset of trouble and the high acceleration forces during breakup.

A. SUMMARY AND CONCLUSIONS IN THE CASE OF JAMES HENTSCHEL

Certain observations which can be assumed to be supported by such a high degree of positive evidence that they must be regarded as facts are available, and certain others which are considered likely probabilities, but which this analyst can be less certain of, are also to be considered. For the purpose of summary, these should be divided into two groups.

1. Facts

1. The identification of the deceased as James Hentschel is certain.

2. Ultimate cause of his death is crushing injury of the chest and head injury.

3. This person sustained extensive flash burns with involvement of the right arm and shoulder and right thigh and leg while only the left hand and left lower leg were involved. The face was similarly flash burned and, at the time of the flash, Hentschel was wearing a helmet but the oxygen mask was not strapped in place.

4. Hentschel sustained a violent impact to the upper interior portion of the neck at an interval of time estimated to be in excess of 10 seconds and probably in excess of 15 seconds before he sustained a second series of injuries which were immediately fatal.

5. Hentschel's body sustained an impact to the back of the head with a force directed relatively from left to right. The impacting object was extremely firm, i.e., metallic rather than water in nature and the helmet was in contact with it almost all the way across the back and distinctly on to the right side. The internal injuries in the head of the deceased may have been sustained as a result of this impact.

6. The body also sustained a strong impact against the back of the right shoulder, again by a firm object making a relatively narrow pattern of abrasion. This occurred after the body has been burned by a flash.

7. At the time of the flash, the body was wearing a parachute pack and vest life preserver.

8. Observations of the plane indicates that the hatch (cover) over Hentschel was off at the time of the flash burning and this, in connection with the condition of the seat and the location of the burning of Hentschel's body strongly suggests that he was in the seat at the time of the burns and that the direction of travel of the flame was from behind and below with respect to the seat.

2. Less Completely Proved Observations

1. As indicated above, the interval between the impact to the neck and ultimate death is evidenced by the hemorrhages in the larynx, is in excess of 10 and probably in excess of 15 seconds. This opinion was reached by this observer and confirmed on consultation with Dr. Stanley H. Durlacher, Chief Medical Examiner, Dade County (Miami, Florida) and Dr. Alan Moritz, Professor of Pathology at Western Reserve University in Cleveland, Ohio. Dr. Moritz is a leading American and an international expert in the pathology of injury.

2. Hentschel was in his seat and was ejected with the seat through the open hatch. At the time of ejection, his right leg was not in the stirrup.

3. The flash burn preceded his ejection from the plane but the interval cannot be determined.

4. The injuries to the neck were probably sustained as the result of the helmet being pulled up and back on the heat and the fact that the fire injury reached as high on the forehead as is observed suggest this may have been part of an explosive passage of the flame. If this be true, then the flash must have occurred 10 or more seconds before Hentschel ejected. It is not possible to rule out some independent impact to the front of the neck 10 to 15 seconds before the flash but this seems unlikely.

5. There was fracturing of glass presumably the photo panel, at a time when Hentschel was near enough that he sustained a cut in the palm of his hand. It seems extremely unlikely that this could have been sustained appreciably after the flash since the normal position for burned hands is with considerable flexion which should have protected the areas of the palm where the cut was. I suspect the fracturing of the photo panel and the flash might have been simultaneous again indicating a somewhat explosive event accompanying the flash.

6. The crushing injury of the chest with injury of the heart and avulsion of the aorta caused immediate cessation of the hemorrhagic processes in the larynx. It is impossible to state whether these were sustained at the time the helmet came in contact with a portion of the plane or at the time of impact on the water, but it seems probable, in view of the impact in back of the right shoulder and the back of the helmet, that all were sustained simultaneously. There is little or nothing to suggest that Hentschel sustained impacts to the front of the body than the neck.

B. SUMMARY AND CONCLUSIONS IN THE CASE OF MAURICE BERNHARD

Certain observations which can be assumed to be supported by such a high degree of positive evidence that they must be regarded as facts are available and certain others which are considered likely probabilities, but which this analyst can be less certain, are also to be considered. For the purpose of summary, these should be divided into two groups.

1. Facts

1. The certification of the deceased as Maurice Bernhard is a certainty.

2. The absence of significant alcohol or barbiturate and significant disease processes detectable by a pathologic examination are clear.

3. Death was instantaneous at the time of receipt of major injuries described in the autopsy protocol with either the head injury or the chest injury being sufficient to produce cessation of respiration and cardiac action within two or three minutes.

4. There is no evidence whatsoever to indicate that there was any significant time delay between the various injuries sustained by Mr. Bernhard.

5. The carbon monoxide saturation in the blood of the deceased was so small as to be negligible and certainly must be assumed to indicate that there was very little filling of the anterior cabin of the plane with products of combustion during the time of descent of the plane.

6. The sequence and nature of the injuries indicate that they were sustained as a result of an extremely rapid decelleration of the plane -- impact with the water rather than some episode while the plane was still airborne.

2. Less Completely Proved Observations

1. At the time of the impact of the plane on the water, Mr. Bernhard's feet were in the rudders. This conclusion is reached because of the nature of the fractures of the lower legs which make it appear that the heels were arrested as the body slid forward possibly including an actual impact of the seat against the upper legs as the feet were held by the rudders or vice versa, with the rudders being displaced backwards.

2. The direction of force incident to the impact was one pushing the body forward with respect to the seat while, at the same time, there was a strong component pushing the body against the seat. This resulted in extensive avulsion of the skin over the back of the body and, in my opinion, both components of force are necessary to produce this lesion.

3. The body moved forward against the restraining harness with extreme force causing the harness actually to be drawn up into the tissues of the perineum and fracturing some of the harness straps.

4. Subsequent to this first motion, which probably resulted in the fracture of the leg (as the feet were relatively fixed) and the displacement of the left femoral head into the pelvis, the body pivoted forward about the lower extremeties and the front of the chest and face suffered severe impacts with the most laceration involving the left side of the face. It is possible that a relatively flat surface was impacted, however, since some of this damage may have been related to fracturing the bones beneath the surface.

5. At least one of the structures which the face impacted left a definite patterned imprint. This can be seen in the close-up photograph of the face. It may be well that part or all of this particular pattern is related to the BX type of covering on the release mechanism for the parachute. If this be so, it must indicate that this was not an abnormal location at the time Mr. Bernhard's face came to impact it.

C. SUMMARY AND CONCLUSIONS IN THE CASE OF CMDR. VICTOR UTGOFF

Certain observations which can be assumed to be supported by such a high degree of positive evidence that they must be regarded as facts are available and certain others which are considered likely probabilities, but which this analyst can be less certain, are also to be considered. For the purpose of summary, these should be divided into two groups.

1. Facts

1. The identification of Cmdr. Victor Utgoff is certain.

2. The cause of death is multiple traumatic injuries; those capable of causing immediate death being the crushing of the chest and the crushing of the head.

3. The complete failure to demonstrate any residua of fuel indicates that there was no great concentration of fuel vapors in the cabin during the period of descent of the plate.

4. The injuries are of such nature that there is no evidence to indicate that they were not all sustained at the same time. There is no microscopic evidence of any reaction.

2. Less Completely Proved Observations

1. A sequence of events in the injuries sustained by Cmdr. Utgoff were, in general, similar to those of Mr. Bernhard. The compound comminuted fractures of both legs with the major tissue destruction on the inside and front of the right leg and the outside and front of the left leg would seem to indicate that the feet were in the rudders and that the body moved forward and somewhat to the left with the extreme force while the feet were arrested by the rudders.

2. The body further pivoted forward about the feet causing crushing of the chest in the front to back axis and the head impacted against its left side and front causing a broad depressed fracture of this area. Coupled with the findings in the legs, this probably indicates that he was looking relatively straight ahead and the body was displaced to the left and forward. This observation is in line with the structural injuries on the forward part of the plane.

3. There were two large lacerated injuries, one in the right buttock and the other in the left shoulder, both on the back of the body. The one in the buttock particularly suggests tearing by a sharp fragment of torn metal over which the body moved from the impact near the inside of the leg toward the left with contact being lost in the extreme back portion of the leg. The nature of this sharp impacting surface cannot be further defined.

4. It is unlikely that any respiratory attempt was made once the body was immersed in the water. This speaks only of suddenness of the death after the impact.

D. AUTOPSY REPORT ON HERBERT O. SCUDDER

Pathological Diagnoses:

1) Asphyxia due to drowning

2) Fracture of the coccyx - comminuted

3) Extensive post mortem decomposition.

Opinion:

The examination showed no injury sufficient to cause death other than the evidences of immersion. The only significant ante mortem injuries are those of the coccyx and muscles of the buttocks where there was considerable hemorrhage. It is considered highly probable that these injuries are the result of sudden impact against the individual during the course of the ejection from the plane. That they were survived many seconds is clear from the amount of hemorrhage into the tissues. The other injury of significance would appear to be the one in the right leg which from its location and similarity to that observed in the Hentschel case strongly suggests that both are stirrup injuries. The occurrence of burning over the left shoulder posteriorly and over the left chest in the region of the hand pull for the parachute and on the left pants leg and the medial portion of the right pants leg corroborate the impression that Scudder was in his seat on the right rear of the crew compartment when the flash fire occurred, the effects of which have been observed in Hentschel's case passing up the aisle and towards the top of the plane. Although post mortem decomposition had made evaluation of skin burns extremely difficult, there is little evidence to suggest that Scudder's face was burned significantly and the extent of burning of his clothing is considered less than that in Hentschel. This is interpreted to indicate that the center of the flash progressed to the left and upwards somewhat sparing the occupant of the right rear seat. Yet, the presence of burns on Scudder completely confirm the early hypothesis that both he and Hentschel were in their seats and did not eject themselves from the plane until after the flash fire. No effort was apparently made to inflate the Mae West nor was Scudder's knife removed from the case in his belt leading to the conclusion that he must have been unconscious at the time his body entered the water.

Therefore the assumption seems valid that his unconsciousness was on the basis of concussive forces incident to his ejection from the plane and not impact against any solid portion of the plane or the water later.

VI. STRUCTURE

The XP6M-1 aircraft is designed to withstand limit flight maneuver load factors of 3.8g positive and 1.8g negative at a gross weight of 140,000 pounds. The airplane was static tested to 110 per cent of the positive design limit load. The condition tested is critical for the horizontal tail, the aft hull, and portions of the wing. Because no ulimate static test airlane was provided by the contract, the flight airplane was restricted to two-thirds of these load factors, or 2.53g positive and 1.2g negative.

The gross weight of the airplane at the time of the accident was approximately 116,000 pounds, and the load factor during the stability runs, according to the flight plan, would be plus 1g with variations of not more than plus or minus 0.2g.

The examination of the wreckage indicates the sequence of structural break-up is probably the following:

1) Upward motion of the stabilizer leading edge;

2) Violent nose-down pitch of airplane;

3) Failure of the wings in negative bending after an original stability failure of the lower cover of the hull stub in compression;

4) Destruction of the primary tension-carrying material in the upper hull as the wings collapsed against the hull side;

5) Horizontal tail failure from excessive roll and or angle of attack; failure originating at the stabilizer hinge fittings.

The fractures have been examined in great detail in the Martin laboratory by Martin metallurgists. Some of the more significant fractures have been reviewed by metallurgists from the Aluminum Co. of America (Mr. Scott Hunter), from the Naval Research Laboratory (Dr. Eirwin and Mr. Joseph Kies) and the Bureau of Aeronautics (Mr. Schmidt). No evidence of fatigue exists in any of the examined details. All major structural pieces were subjected to hardness tests and no material deficiencies were noted.

The detailed examination of the wreckage was the primary means by which the breakup sequence was determined. A knowledge of the tail load variation on this airplane is of key importance to an understanding of the sequence. At the time of the last photopanel reading the indicated flight condition would result in a down tail load of 21,700 pounds. A two-degree nose up movement of the stabilizer at the flight speed indicated would create sufficient load factor (minus 3.9g) to fail the wings in negative bending with a relatively small up load on the tail (approximately 5000 pounds). The failing load factor is obtained by ratioing the design gross weight to flight gross weight, as follows:

Ultimate design load factor = - 1.8 x 1.5 = - 2.7g

$$\frac{\text{Design gross weight (flight)}}{\text{Weight at time of crash}} \quad \frac{140,000}{116,000} \times -2.7 = -3.25\text{g}$$

$$\frac{\text{Critical Design Condition*}}{\text{Flight Condition}} = 1.2$$

Failing Load Factor = 1.2 x - 3.25 = - 3.9g

* Transient Landing Condition

In addition to the general fracture examination, the honeycomb structure was examined in great detail by the Structures Design Staff engineer, by laboratory experts, and by Quality Control inspectors. The quality of bonds was found to be above the acceptable minimum in all cases.

The possibility of an early fire or explosion exists. One particular area, the No. 4 hull fuel cell region, apparently sustained an explosion between the fuel cell and tank door. This explosion detached the tank door from its support structure. An analysis was made to determine the resulting loss in aircraft stiffness. Results of this analysis can be found in the Dynamics Chapter of this report (Chapter VII). In addition to this study, an analysis was made of the aft hull structure with the assumption that fire had damaged the starboard hull side skin prior to aerial breakup.

A. EXAMINATION OF FORWARD HULL SECTION (Stations 0 to 407)

The major structural damage suffered by the forward section (Stations 0 to 407) of the airplane was caused by enormous impact loads at time of water entry. The estimated impact force was in the order of magnitude of 100g. The direction of this force was up, and aft, with very little lateral (side) component as evidenced by the direction of failures of the pilot's and copilot's seats. The pilot's seat failed in a forward, down, and outboard direction as did the copilot's, indicating the forward hull section contacted the water surface in a nose down, laterally symmetrical attitude.

From a window sill aft, the crown section of the forward hull (forward of Station 407) is in relatively good condition. All the windows in the pilot house were found in place although severely crazed. The entire lower section of the forward hull from and including the nose section below the window sill aft to Station 407 and between the chine longerons was completely disintegrated at impact.

The entire pilot house floor, seats, personnel (pilot and copilot) and flight equipment in the pilot compartment were torn from the supporting hull structure, as was a large section of the flight deck flooring and crew equipment; all were found at a short distance from the forward hull proper.

1. Fire Damage

There is no evidence of structural damage attributable to fire in the forward hull section. However, a flash fire occurred in the crew and pressure lock compartments. By laboratory tests this flash fire has been concluded to be in a temperature range as high as 1000°F and of less than 15 seconds duration. The source of this fire has tentatively been identified as JP-4 fuel. The areas subjected to the greatest heat and burning were the forward side of Bulkhead 407, the left side hull and crown skin and frames between Bulkheads 407 and 353, Bulkhead 407 door (both sides), Bulkhead 353 door (aft side), the aft and forward sides of Bulkhead 353 and the right side of the left crew seat. The other sections of these areas were subjected to smoke, soot, and some heat of a much lesser degree. The extreme right sides of the crew and pressure lock compartments were almost entirely free of smoke. The burning in this aft section of the forward hull was completely superficial in nature and contributed nothing to subsequent structural failures in this area.

One point of importance to note is the presence of punctures and tears in the web of Bulkhead 407 and in the hull crown skin of the left side of the pressure lock compartment through which smoke and/or flames passed to scorch and blacken the surfaces of the bulkhead web and crown skin around the holes on the side away from the fire. The left wing leading edge attaching clips on the crown skin were pulled off before fire in air lock compartment as evidenced by burning and smoke around the periphery of rivets holes. It is assumed that this is a clear indication of some degree of structural disintegration before the occurrence of the flash fire. There is no evidence of fire either in the pilot or electronic compartments.

2. Hatches

All four escape hatches have been recovered. The pilot's escape hatch was found in place on the forward hull section. The thruster of this hatch was fired but the locking hatches were not opened. A

5/16 NAS bolt had failed in double shear - at the torque tube to thruster bellcrank connection thus preventing undogging of the forward latches. The connection of the pull rod to the hatch lifting cam had also failed in shear. The copilot's escape hatch was found in good condition and had been ejected successfully. The left crew member's hatch was also recovered in good condition and had also been successfully ejected. Although the crown structure around the opening of the left crew member's hatch showed signs of burning from the flash fire previously mentioned, the hatch itself was free of smoke or burning. The hatch trim cover shows evidence of slight overheating on the aft end (temperatures of 350° to 400°F) which indicates the hatch was on at the time of the flash fire. The right crew member's hatch, also successfully ejected, showed evidence of flash burning, as did the adjoining crown structure indicating the hatch was in place at the time of fire. The trim cover was also burned.

A thorough examination of the ejected escape hatches eliminated all possibility that these hatches hit any aircraft structure during ejection.

The door at Bulkhead 353 was found with the main wreckage and was severely damaged. This door was extensively burned on the aft side with relatively no burning on the forward side indicating this door was open at the time of fire since both sides of this bulkhead suffered fire damage. The door at Bulkhead 407 was still hinged to the bulkhead and there were also indications that it was open at the time of the fire because of the presence of extensive burning on both sides of the door, whereas Bulkhead 407 was burned on the forward side only.

The ditching hatch and the left beaching gear hatch were secured when the forward hull was salvaged and the right beaching gear hatch was open. The main entrance hatch was also hinged to the structure when found and in generally good condition.

3. Seats

The pilot's and copilot's seats were found in the main lower forward hull wreckage and were severely distorted. Both seats were separated from their ejection rail structure. The copilot seat safety belt failed at the seat connection and the shoulder harness failed in the cloth. The pilot's seat had generally similar failures.

The right crew seat was recovered in excellent condition although subjected to effects of flash fire. Minor structural damage to this seat was caused by water impact.

The left crew seat was recovered in excellent structural condition except for minor damage resulting from water impact. This seat had also been subjected to the effects of the flash fire. The burning

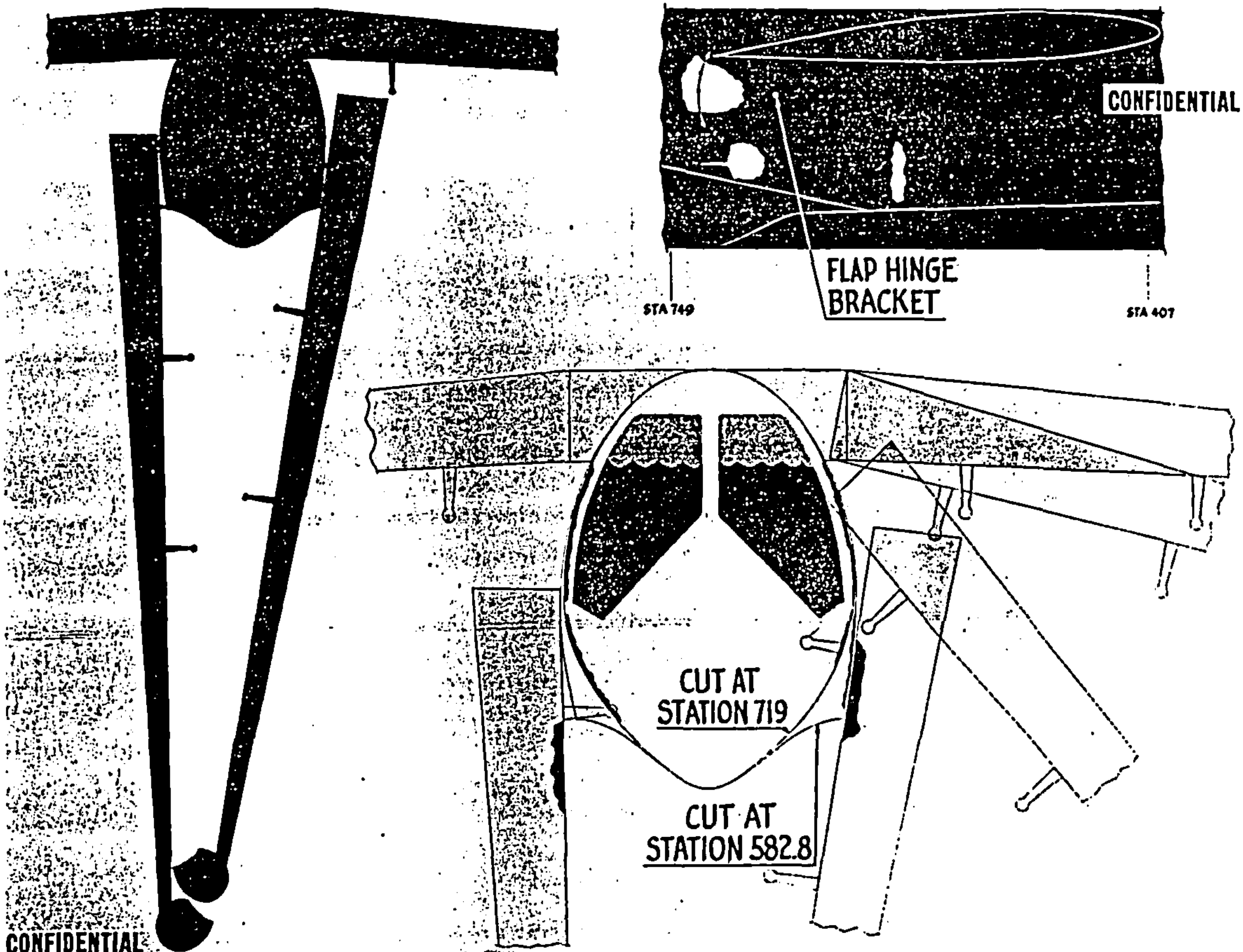

Fig. VI-5. Wing Failure

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The over-all decrease in stiffness from Station 647 to the tail is, of course, much less. The hull natural frequency in torsion is changed only 2.5 per cent; from 194.4 cpm to 189.6 cpm.

T-tail model tests, completed last December under a Martin Basic Studies and New Technology Program, covered one configuration similar to the XP6M-1 tail. When comparing a rigid hull to a highly flexible hull, a reduction in flutter speed of only 3 per cent with flexibility in torsion and 6 per cent with flexibility in lateral bending was obtained.

This negates the probability of an appreciable change in critical tail flutter speed with loss of the tank door - the actual change is considered negligible.

6. Tip Float Shake

Movies were taken of the mine door rotation during six flights of the XP6M-1 by a 35 mm camera in the left wing tip float and a 16 mm camera in the right tip float. Of all the movies taken, four of the 35 mm runs and one of the 16 mm runs show door operation. The others were either ruined or show no door operations. The one 16 mm roll of film is from Flight 26. One of the 35 mm rolls is also from Flight 26. The 16 mm camera in the tip float on Flight number 26 was a Cine Kodak Special L held down by one bolt at the bottom.

It had been reported by the flight crew that an airplane shake occurred during the mine door operation. Oscillograph records were taken during mine door rotation of accelerometers located at three points in the hull on primary structures Stations 80, 228 and 269. These records show that a vibration of 22.5 cps was present while the door was opening or closing. The magnitude of vibration seemed to depend on the speed at which the airplane happened to be flying. A maximum reading of 1.6g was obtained.

Of the five film runs of the mine door operation mentioned above, only the 16 mm film from Flight 26 (and not the 35 mm film from this flight) shows any evidence of this 22.5 cps shake. The picture in this film moves in a manner that could only be caused by camera motion. A frame by frame measurement of the picture motion indicates that the camera was moving in a motion corresponding to a tip float pitching motion at a frequency of about 23 cps and through an amplitude of about ± 2 degrees. The measurement were made on a door opening. The shake started when the door was approximately half-way open and had stopped by the time the door was about three-quarters open.

The wing vibratory mode obtained during the ground vibration survey, which is nearest the above mentioned 22.5 cps frequency, was a 19 cps mode of primarily wing outer panel torsion with tip float pitching.

3) T-tail flutter would put large torsional loads on the fin. No permanent torsional shear wrinkles were found in the fin leading edge, nor were permanent shear buckles found in the fin blanket panels.

4) T-tail flutter cannot, neither kinematically nor inertially, cause extension of the stabilizer actuating cylinder (which failed in its fully extended position).

2. Wing Flutter

Wing flutter again would be antisymmetric. The failure of the wing, as that of the tail, is remarkably symmetric.

3. Flap Flutter

Flap flutter could be caused by loss of the actuating cylinder but would be evidenced by damage to the top of the flap and the bottom of the adjacent beavertail on the nacelles. No such damage was found.

4. Elevator Flutter

Elevator flutter might be indicated by damage at both up and down stops but could not have happened before the actuator rods broke; it could have occurred after the breakup.

E. CONCLUSION

With loss of flap hydraulic actuators and loss of elevator actuator rods relatively mild flutter is indicated in speed ranges below the accident speed. With regard to the loss of the elevator actuator rods this result might be significant in the interpretation of the wreckage in that the elevators would flutter after the stabilizer as a whole has left the airplane.

The possibility of a rudder upper hinge failure was investigated (this possibility was of considerable interest in that failure of the rudder bracket would damage the hydraulic lines to the stabilizer actuator) -- and no flutter speed was found.

All remaining cases have been eliminated with the exception of T-tail flutter. High speed tests and further analytical investigations have been completed. The nature of this flutter has been explored: it is a violent antisymmetric flutter involving mainly fin torsion with stabilizer yawing and rolling motions.

It has been established that the critical speed of this flutter is determined by so many parameters which are not accurately known, including those of the hull and the wing, that analytical and experimental results are subject to various possible interpretations. A conservative interpretation yields a small margin of the order of six per cent above the accident speed (while a larger margin is by no means excluded). Thus, a firm conclusion that T-tail flutter did not cause the accident cannot be drawn from analytical and test investigations; on the other hand, this possibility would seem remote after a study of the previous flight records at higher speeds and by the examination of the failures of the T-tail.

F. RESULTING ACTION

For the second XP6M-1 and the YP6M's, a new fin is being designed to provide an increase of approximately 80 per cent in torsional stiffness(Fig. VII-2). The honeycomb panels will be replaced with relatively heavy aluminum sheet, the fin thickness will be increased at the upper end, and the bullet fairing will be redesigned. A substantial increase in critical T-tail flutter speed is expected from this change. Until the new fin is available, flight speeds for the second airplane will be restricted to Mach 0.7 at sea level, varing linearly to Mach 0.95 at 21,500 feet (Fig. VII-3). Analytical and model tests investigations will be continued.

IX. FIRE PATTERN AND ANALYSIS

The area of fire damage as indicated by the structure salvaged is shown in Fig. IX-1. Eyewitness reports and early recovery of the aft hull section placed special emphasis on fire or explosion as an initiating cause of the accident. It was decided to develop a heat pattern throughout the entire airplane in an effort to pinpoint the original source or sources of fire. The approach to this problem was divided into two basic classifications: metallurgical examination of chosen specimens; and analysis of organic finishes. The results of these separate studies are included in this report.

In addition to the studies made by the Martin Company laboratories regarding fire and heat effect, the following individuals or organizations were contacted in an effort to either confirm Martin findings, or to obtain data available only at these sources:

1) Mr. Sidney Berman, Chief Air Force Accident Investigator
2) NACA, Cleveland Branch
3) Aluminum Co. of America - Research Laboratories
4) Esso Standard Oil Company
5) Bureau of Standards
6) Aberdeen Proving Grounds, Terminal Ballistics Branch
7) Naval Research Laboratory

The information obtained from these sources is incorporated in the metallurgical section in general; however, a few pertinent facts are presented here:

1) The flame temperature for JP-4 fuel (burning in air with a velocity of 500 knots) is in excess of 2000°F.
2) The propagation of a flame front into a 100-knot free air stream is not probable.
3) The flame temperature for JP-4 fuel for various conditions is as follows:
   a) Wick burning -- 1000°F.
   b) Still air (under hood) -- 1300°F.
   c) Still air-fuel on water (under hood) -- 1500°F.

4) The flame temperature for hydraulic fluid (red oil) for Condition 3c -- 1250°F.

5) An internal flame source is required to maintain external burning at speeds in excess of 100 knots.

6) Atomized molten aluminum can be obtained only with high pressure and temperatures in excess of 1180°F.

7) Molten aluminum can not be obtained in less than 15 seconds considering the skin gages, flame temperatures, type of structure, and area of burning.

8) Explosion phenomena sometimes produce structural disintegration without evidence of fire or heat.

9) "Feathered" effect on edges of skin fractures is indicative of partial melting and high pressure.

Detailed examination of the burned portion of the salvaged wreckage has in practically every instance revealed a fracture line which has burning on one edge and has no burning on the mating edge. This is true of the float, the slats and wing leading edge, the flap, the spoilers, the wing trailing edge, the fin, and, in most cases, the nacelles. The burning which took place in the Number 2 nacelle inlet duct was considered to be after breakup because the wing upper cover, which forms the lower portion of the duct, was not burned.

The internal burning in the crew compartment and in the pressure lock is considered to have taken place in the air after breakup. The following facts lead to this decision:

1) The flight test engineers were burned by this fire while in in their seats;

2) The flight test engineers ejected from the airplane in the air;

3) Partial structural disintegration had occurred prior to this fire as noted in the Chapter VI (Structures).

The internal burning in the hull between bulkhead Station 604 and Station 749 could have partially occurred before breakup. However, on the starboard side between Stations 604 and 647 there is a fracture line indicating breakup before burning, and on the port side near Station 664 on the lower longeron and fairing there is a fracture line of fire demarcation.

X. AERODYNAMICS

A. SUMMARY

In consequence of the accident to the XP6M-1 airplane an extensive aerodynamic investigation was made. The flight test history of the airplane was re-examined in detail; the basic aerodynamic parameters of the design were reviewed and re-analyzed; and all possible mechanical failures which could jeopardize the controllability or alter the stability and response of the aircraft were examined.

A full-scale working mock-up of the controls system was utilized in conjunction with a Reeves Electronic Analogue Computer to simulate various control malfunctions and to determine the resulting effects upon the airplane. Trajectory studies employing the results of automatic digital computers were made in an effort to deduce the flight path and sequence of events in the break-up.

The flight test data were limited, precluding a complete analysis of the demonstrated flight characteristics. In the cases of the available flight test data which could be compared to the predicted characteristics based upon wind tunnel tests, very good agreement was generally found. In fact, flight tests of the tuck characteristics revealed no force tuck at test altitudes of 15,000 and 28,000 feet, although some force tuck had been predicted. Also, in general, the pilot's qualitative comments were that the flight characteristics of controllability, stability, and response were satisfactory. One general criticism was that the lateral control was oversensitive at low speeds with flaps down - a factor which is being remedied on the second XP6M-1 and has no bearing on the accident.

Conservative interpretation of the wind tunnel data used as the basis for the predicted stabilizer hinge moments still leads to the conclusion that, even with only one of the dual systems operative, the stabilizer hydraulic actuator should have had sufficient power to control the airplane at the probable flight conditions of break-up.

It was established both from analysis and from simulation on the controls system mock-up - REAC- pilot combination that many of the possible malfunctions considered probably would not have induced the accident. However, the accident sequence of a pitch-down with consequent downward failure of the wings could have resulted from loss of the feel system.

The trajectory studies served to substantiate the general pattern of flight and probable sequence of break-up. However, these studies, being

Floating pieces.- The surface wind was four knots at 90 degrees true while the river current was reported as three knots at 124 degrees true. The combined effect of the surface wind and current on floating pieces is difficult to evaluate; it depends upon the relative areas projecting above and below the water and the time afloat. Some examples will serve to give possible ranges of error:

1) Practically submerged object so wind effect is negligible:
   $t = 10$ min (witnesses reported pieces floating 10 to 12 min)
   $d = 3 \times 10 \times 101.3 \times \cos 20° = 2860$ ft (downstream from impact position)

2) A floating piece subject to equal effects of wind and current:
   $t = 10$ min
   $d = 10 \times 101.3\ (3 \times \cos 20° - 4 \cos 54°) = 477$ ft downstream from impact position

Sunken wreckage.- Because effects of river currents on sunken wreckage would be pure conjecture even if the exact times of salvage and a history of the magnitude and direction of river bottom currents were known, these effects were not estimated. Several feet of silt cover the bottom of the river in this area which would probably tend to anchor the wreckage.

Salvage locations.- The location of the salvaged pieces was determined with respect to Buoy Number 6 near the salvage area. The distance from Buoy Number 6 was obtained through triangulation using a known distance between two points while azimuth was read from a sextant. The accuracy of the locations is estimated as a circle of 50-yard radius.

Salvage methods.- Salvage methods had some effect on the location of wreckage. Most of the sunken pieces numbered through 30 (approximately) were located by Navy divers and hauled directly to the surface. Other pieces were found by dragging. Some of the dragging operations were made along the direction of the flight path. A drag search would start and be continued for as much as 1500 to 2000 yards before the drag would be hoisted for examination. Thus, an error in location up to as much as 2000 yards could be introduced in the case of small pieces. When a large object was dragged, the salvage crew sent a diver to inspect the pieces and the location was established at this point. Dragging was also done perpendicular to the flight path which, of course, would not introduce an error in the flight path trajectory pattern but would affect the pattern due to wind drift normal to the flight path.

2. Aircraft Heading

Eye witnesses variously described the flight path as "southerly" and, in some cases, volunteered estimates of the true heading. In general, the aircraft was making a port turn just prior to the accident which, if the witness descriptions of the heading as being southerly (or 160 degrees to 170 degrees true) are correct, would result in a southeast heading at the time of the accident. Examination of the salvage pattern showed that the Engines 1 and 2, the forward and aft hull, and a heavy piece of the center wing blanket fell along a common straight line. If none of these parts had yawing accelerations imparted to them at break-up, this line bearing 144 degrees true is a reasonable representation of the heading of the aircraft. Most of the parts along this line had high terminal velocities so that wind drift would have had small effect. Also, the majority of salvaged parts lie east of this flight path, having greater scatter along the path away from the engines. The wind components normal to the flight path account for this scatter; the objects farther up the flight path must have come off at higher altitudes and drifted farther from the flight path due to their passage through the moving air mass. This fact further substantiates the 144 degrees true heading at the time of the accident.

3. Basic Variables

The main variables to be considered in the trajectory analysis were the speed, altitude, and attitude of the aircraft at the time a part came off; the drag, weight, area, and center of gravity of the part; and the winds aloft. The net lift on the pieces was assumed to be zero. The salient aspects of the trajectory are:

1) Separation of the part from the aircraft or from another part;

2) The initially rapid deceleration of the horizontal speed component (which is a function of the initial velocity and angle of descent with respect to the horizontal and the drag of the object) and the more gradual deceleration which is chiefly a function of the increasing angle of descent;

3) The increase in value of the vertical speed component due to the acceleration of gravity. Here, the drag

$$\left(D = \frac{\rho}{2} C_D S V^2\right)$$

and the weight of the object determine the maximum (terminal) velocity. The terminal velocity is based on the condition of the weight equal to the drag and a 90-degree angle of descent. The effect of the winds in producing horizontal movement of an object falling from altitude can be expressed as

$$\Delta d_{wind} = \frac{1}{V_t} \int_{h_1}^{h_2} \cdot V_w \sqrt{\sigma} \, dh$$

wing span is attached to the airplane, the maximum allowable shear is developed, and a critical bending load is also applied to the wing root. Therefore, the bending and shear margins in the structural design are approximately identical. When more than 55 per cent of the wing span is attached to the hull, the bending rather than shear loads are critical, because the airplane limit load factor is only minus 1.8g for the design condition. It is apparent that the more wing span attached to the airplane beyond 55 per cent semi-span the less normal force may be developed prior to a structural failure. It may be concluded that a large portion of the outer wing (for instance, about 50 per cent of the wing span) would have to be broken off before airloads could be developed to throw the engines off the airplane.

The 800,000-pound maximum load corresponds to approximately minus 7.0g at the flight weight which is estimated at the time of the accident. Tentative estimates are that minus 9.3g are required to pull the engines off the aircraft.

Gyroscopic Loads.- There has been some question of the effect of gyroscopic loads failing the engine mounting attachments. Calculations were made of the gyroscopic effects for the idling engines at the presumed flight speeds. Results of these calculations indicate that the shear load on the attaching bolts due to gyroscopic moments are ten per cent or less of the tension load which corresponds to the same normal acceleration. The critical gyroscopic loads will definitely occur at high engine rpm and at times higher than those present at equivalent load factor at the presumed accident flight speed.

D. PERTINENT FLIGHT TEST HISTORIES

1. Airframe Shake

Throughout the flight testing of the XP6M-1 airplane, the pilots reported a "shake" which on most flights had been of a generally mild degree apparent over a certain range of speeds. Various modifications to the external configuration were made in an attempt to eliminate the shake and a program of flight tests to isolate the shake was followed. Although a continuing effort was exerted to analyze and eliminate the shake, at no time was it decided to temporarily shelve the SR-38E-2 flight test demonstration in order to devote full flight time to solve the shake problem, nor had the pilots expressed a conviction that the shake must be eliminated before the demonstration program could be continued.

Accelerometers were placed at various locations to measure local vibrations of equipment mounts and, after several flights, a pick-up was placed in the crew compartment. However, the prior claim on the available oscillograph channels resulted in no quantitative data being obtained of the shake. Therefore, the entire chronology is based upon the qualitative comments of the pilots and crew. The only flights discussed are the airborne flights during which the shake was investigated.

Flight tests.- On Flight 6-1, the first airborne flight, the pilot reported a shake starting at 200 knots IAS with the flaps up and afterburners off. It was of relatively low amplitude and low frequency. The shake varied little with q but did seem to diminish above 400 knots IAS. The pilot further classed the shake as "acceptable but highly undesirable". The afterflight inspection of the airplane revealed badly dented wing flaps at the inboard ends and it was postulated that the shake could have been induced by the damaged flaps.

The wing flaps were repaired and reinforced but the shake was still present on the second airborne flight, Flight 8-1. The lower spray strips were removed for this flight so it was established that neither the lower spray strips nor the dented flaps were the source of the shake. The shake was investigated in more detail on this flight and the pilot reported that the shake was present at speeds above 200 knots IAS, varying intermittently in amplitude and being worse from 200 to 300 knots, with considerable reduction in the shake at higher speeds. On a high-speed run with 100 per cent rpm at 10,000 feet and a swivel IAS of 428 knots, the shake was quite light. When the throttles were retarded to reduce speed, the intensity of the shake seemed to increase.

For Flight 9-1 the spray strips were reinstalled. A possible correlation between shake and engine rpm was to be checked. However, difficulty with the engines during acceleration tests resulted in aborting the program.

On Flight 10-1 the shake was unaltered at 200 knots when the wing flaps were lowered 10 per cent (4.5 degrees). At 20,000 feet the shake showed no appreciable variation as the engine rpm was changed progressively from 100 to 98 to 96 to 94 per cent and then to idle rpm at each of the following swivel indicated airspeeds; 350, 300 and 250 knots.

The bow spray strip was completely faired at the nose of the hull in the region of the base of the swivel boom on Flight 13-1. The characteristics of the shake were unaltered. During a deceleration test at 20,000 feet on this flight, covering a speed range from 364 to 176 knots (CIAS), the shake disappeared entirely when all four engines were retarded to idle rpm.

A triangular fairing was installed in the flap cove at the inboard end to reduce the size of opening through which air might be passing.

Then, on Flight 14-1, some checks of the variation of shake with engine rpm were made at 5000 feet. The pilot reported that, in general, the shake was decreased in both amplitude and frequency on this flight. The following summarizes the tests performed:

Test	Swivel IAS (knots)	RPM Engines 1 and 4 (per cent)	RPM Engines 2 and 3 (per cent)	Description of Shake
a	344	94	94	Intermittent and not as bad as on previous flights
b	300	90	94	Same as (a)
c	260	90	90	No shake
d	380	96	96	Less shake than in (a) both in amplitude and frequency
e	280	94	94	Shake returned

From the tabulation, it is evident that no correlation is clearly apparent between the shake and the engine rpm (either for all four engines or two engines in pairs). Instead, the previously established generality that the shake decreased with speed is a more evident conclusion.

The inboard section of the flaps were sealed on Flight 17-1 but the shake was still present at swivel IAS's below 350 knots. At 447 knots (swivel IAS) at 5000 feet the airplane was very smooth.

For Flight 18-1, no configuration changes were made but the characteristics of the shake as a function of airspeed and engine rpm were determined at 20,000 feet. No shake (or "appreciable roughness," as the pilot termed it) was noted at 320 knots IAS and 95 per cent rpm nor at 345 knots and 98 per cent rpm. Difficulty with the fuel transfer system made it necessary to discontinue the tests. The pilot reported that the mild shake was more noticeable on Flight 19-1 than on previous flights (Flight 11-1 having been the last previous flight for this pilot). For Flight 19-1, the number one engine had been replaced, the installation of the redesigned flap seals had been completed, the redesigned mine-door dams were installed, and the tolerances had been increased on the stabilizer bolts and fittings.

A static longitudinal stability test during Flight 20-1, in which the engine rpm's were held constant and the airspeed was varied by diving or climbing, prompted the pilot to stress again that it was his opinion that some correlation existed between the engine operation and the shake.

On Flight 27-1 the (new) pilot gave his detailed interpretation of the shake which was described as "good and solid, persisting as the speed increases, and should be eliminated." Some of the flap seal had been removed prior to this flight, a new number two engine was installed, and the leading edges of the fin and stabilizer had been stiffened.

Flight 30-1 was made at a take-off gross weight of 160,000 pounds with 30,000 pounds of mines in the mine bay and the revised flap seals completely installed. The pilot reported that the airplane was completely smooth at the test altitudes of 3000 to 4000 feet, there being no shake nor rumble at any speed tested (up to 522 knots CIAS). In addition, the buffet normally present with flaps down was not noticeable until the last 20 per cent of flap deflection (from 36 degrees to 45 degrees).

Tufts were placed around both sides of the upper end of the vertical tail, the lower inboard surface of the horizontal tail, and the area of the bullet fairing included between the horizontal and vertical tails for Flight 34-1. Runs at various airspeeds were made at 10,000 feet with observers in a B-57B chase airplane noting the tufts. The shake was present during stabilized speeds of 204, 331, 338, 387 and 429 knots CIAS yet the tufts showed a smooth pattern of airflow. On the same flight, several short climbs were made from 10,000 to 15,000 feet at 260 knots CIAS with various power settings from 91 to 100 per cent rpm. The shake remained unaltered at the various rpm's but the amplitude did diminish as the altitude increased.

The next two flights, 36-1 and 37-1, included various stability and control tests at altitudes up to approximately 40,000 feet. The pilot reported in general that the shake abated as the altitude increased.

The Navy evaluation pilot described the shake experienced during Flight 39-1A as being of a sporadic (or periodic) nature. It was visible in the swivel boom as the shake built up. The boom stopped shaking after the shake developed fully so that the impression was that the shake originated aft and progressed towards the nose. The shake was present at speeds from 250 to 400 knots, although it was not very evident at 400 knots. At speeds higher than 400 knots the shake was not evident and at 0.845 indicated Mach number (approximate swivel IAS = 468 knots) the airplane was quite smooth. The expressed opinion was that "the shake was not outlandish, but something should be done about it".

The flutter characteristics of free elevators on the XP6M-1, indicated from flutter analyses and wind tunnel tests, suggest the possibility that the shake is induced by backlash in the elevator linkage giving in effect a free elevator within the restricted deflections allowed by the linkage backlash. The free elevator flutter occurs at true airspeeds below 390 knots, being absent at higher speeds and the shake has the general characteristic of being present at calibrated indicated airspeeds from 200 to 400 knots, practically disappearing at higher speeds. It is recognized that actual flight tests of this theory must be made on the second XP6M-1 before final verification that the shake is due to a limited flutter of the elevator. Therefore, it is recommended that this possible correlation be investigated when the flight tests begin.

Conclusions.- The difficulties attendant to the systematic test program (of an agreed low priority) to isolate and eliminate the shake should be evident. Again, it should be emphasized that the nebulous nature of the shake (at times quite evident, at other times absent, and occasionally giving a short-lived promise of association with some airplane operational mode) was such that a systematic program was difficult. Neither was there a great emphasis on the part of the flight personnel to eliminate the shake before further demonstration tests were made. If the shake is present on the second XP6M-1 airplane, a systematic, quantitative program should be devised and followed.

2. Demonstrated Flight Envelope

During the flight testing of the XP6M-1, altitudes at 40,000 feet, calibrated indicated airspeeds to 522 knots, calibrated Mach numbers to 0.949 and load factors to 2.60g were obtained. Table X-3 gives a chronicle of flights and the maximum values of q, q_c, CIAS, M, TAS, EAS, load factor, and altitude attained.

The flight limit speeds were largely determined from flutter analysis; they were 15 per cent less than the predicted speeds at which flutter would ensue. These predicted flutter limit speeds were Mach 0.90 at sea level, varying linearly to Mach 0.95 at 21,500 feet and remaining at Number 0.95 at all higher altitudes. An additional limit of Mach 0.85 at sea level in consideration of the predicted tuck characteristics was set by the Bureau of Aeronautics. The flight limits were then finally interpreted as Mach 0.85 at sea level, increasing linearly to Mach 0.95 at 21,500 feet and remaining at Mach 0.95 above 21,500 feet. This flight limit line is shown on Fig. X-30 in the form of Mach number, true airspeed, and calibrated indicated airspeed. The highest speeds obtained in 1g flight are also shown on Fig. X-30. At 11,120 feet on Flight 26-1 (Table X-3), a speed was attained in excess of the maximum permissible speed. At the time of this flight, the airspeed calibration had not been completed and the pilot was limiting his speed on the basis of his Machmeter which indicated a value of Mach 0.89. Figure X-31 compares the maximum flight speeds, the design dive speed, and the speeds corresponding to q_c = 1020 psf.

10. Horizontal Tail Break-Up

The one unquestioned fact which forms the basis of the investigation of the structural failures on the XP6M-1 airplane is that the wings experienced a negative load factor type of failure. Approximately 3.9 negative g are required to fail the wings. This failure would result from the loss in the ability of the horizontal tail to supply the required down load of 21,700 pounds to trim the aircraft in pitch. An abrupt change in stabilizer deflection in excess of two degrees trailing edge down, or the loss of the horizontal tail because of a phenomenon such as flutter, would precipitate the negative load factor failure of the wing. However, the present discussion will be limited to the consideration of the effects of a change in tail load resulting from a change in stabilizer incidence. The flight condition at break-up is deduced as Mach 0.845 at an altitude of 6000 feet. These values are based upon the position of the q-feel screw jack in the longitudinal control system.

Symmetrical tail loads.- In order to establish a sequence of failure due to symmetrical motion in the pitch plane, the tail loads for symmetrical flight at the break-up speed and altitude will be considered. These loads are summarized in Table X-4 which presents the appropriate values of load factor, stabilizer incidence, horizontal tail load, stabilizer hinge moments and stick force. In the trim condition the stabilizer incidence is minus 4.5 degrees relative to the wing root chord and the tail load is 21,700 pounds down load. An instantaneous full-up deflection of the stabilizer to incidence of plus 3 degrees will result in an up tail load of 41,000 pounds. If the maximum possible down stabilizer deflection is developed by stalling the stabilizer actuator, there is a 51,000 pound tail down-load. If we consider the condition at the negative ultimate load factor of minus 3.9g the tail load becomes 4800 pounds with the stabilizer leading edge full up at plus 3 degrees incidence. The maximum tail up load occurs at the positive ultimate load factor of 6.9g with an incidence of plus 3 degrees. In this condition, an 86,000-pound up tail load is present. The design tail loads are 112,500 pounds down load and 75,000 pounds up load. These ultimate values must be distributed 60 per cent on one side and 40 per cent on the other side of the stabilizer, so the ultimate design up load in the symmetrical plane becomes 90,000 pounds. However, since the comparable value of down load is approximately 133,000 pounds, the tail should be capable of resisting an up load in excess of 90,000 pounds. It is again emphasized that these conditions are for symmetrical tail loads.

Unsymmetrical tail loads.- Since it is extremely unlikely that the complete XP6M-1 break-up involved motion only in the symmetry plane, it is important to consider the effects of side slipping upon the horizontal tail loads. Moderate angles of sideslip will not change the horizontal tail load in the plane of symmetry in the aircraft. However, there are large rolling moment torques developed about the fin tip by the horizontal tail in sideslipping flight. These torques must be restrained by the trunnion mounting at the top of the fin. The stabilizer is attached to the fin by a lug through which a pin is placed to fasten it to the trunnion fitting on the fin. These lugs had failed because of tension loads on the aircraft. The rolling moment about the fin tip caused by the horizontal tail produces the required tension loads to fail these lugs. Figure X-39 presents the variation of the tension loads in the lug as a function of sideslip angle for various values of horizontal tail load. Each lug will support a load of approximately 85,000 pounds prior to its failure. Inspection of Fig. X-39 will show that increasing up tail load reduces the sideslip angle at which critical load develops in the lug. In the event that the horizontal tail load is zero, a sideslip angle of 5.9 degrees is required to fail the lugs in tension. At a 100,000-pound tail load this angle of sideslip is reduced to 1.8 degrees.

Tail break-up.- When the wings of the P6M failed in negative bending, the angle of attack of the wing was approximately minus 3 degrees and the angle of attack of the hull was approximately minus 6 degrees. The airframe dynamics, of course, changed very markedly with the loss of the wing. The two main effects which are important as a consequence of the loss of the wing are first, an almost complete loss of roll damping; second, a 75 per cent reduction in rolling moment of inertia. These two changes in aircraft parameters result in the remaining hull-tail combination being very susceptible to the coupling of the longitudinal and lateral motions of the airframe. The inertias in pitch and yaw are relatively unaffected; the directional stability is approximately doubled with the loss of the wings: Because of the very low roll inertia and the high yawing and pitching inertia, the hull-tail combination will roll about the longitudinal body axis. A rapid roll motion of 90 degrees will convert the original angle of attack into an approximately equal angle of sideslip. Since the roll mode of the hull-tail combination doubles amplitude in 0.2 second, it is clear that a great deal of roll will be present when the wings leave the aircraft. It is considered that this roll coupling is responsible for the loss of the horizontal tail during the break-up of the P6M airplane. The horizontal tail was rolled off the fin tip because of the rolling moments on the horizontal tail resulting from the sideslip angle of the tail developed by the rolling motion after the loss of the wing.

There was also a failure of the vertical tail at a rib station at approximately the location of the lower attachment of the stabilizer actuating cylinder. It is expected that the fin would fail in this area at approximately 5.8 degrees of sideslip at the break-up flight condition. Since the design strengths of the stabilizer lug and the fin structure are very comparable, it is not unexpected that the failures occurred in both the fin and lug.

F. CONCLUSIONS

The aerodynamic investigation of the XP6M-1 accident has revealed that there were no evident aerodynamic deficiencies which might have precipitated the tragedy. The flight test data as well as the various pilots' qualitative comments had not disclosed any marginal conditions of stability or control during the prior flight tests. Based on the evidence of the salvaged longitudinal q-feel system, and the photo panel record (which conformed to the program for the flight) the conditions of speed, load factor, and altitude being flown had been demonstrated and exceeded on previous flights.

The following particular aerodynamic conclusions resulted from the investigation:

1) The longitudinal stability and control of the XP6M-1 is satisfactory and was, therefore, not a contributing factor in the accident.

2) Stabilizer hinge moments required to trim in the flight condition at break-up were estimated to be 10 to 20 per cent less than the output of one hydraulic actuator cylinder, based on a correctly rigged elevator. However, an elevator misrigged for greater trailing-edge-up deflections could result in excessive stabilizer hinge moments.

3) Directional and lateral stability and control characteristics were satisfactory and were not contributing factors in the accident.

4) Loss of the feel system could result in break-up of the airplane in the same manner as the actural sequence because of coupling between the bobweight and the natural freuency of the airframe.

G. RECOMMENDATIONS

As a result of the aerodynamic studies, and as direct corrollaries, the following recommendations are submitted:

1) Change the elevator-stabilizer linkage to decrease by at least one degree the elevator deflection during high-speed flight conditions. This reduced elevator travel will greatly decrease the required stabilizer hinge moments at high speed.

2) Increase the power of the stabilizer actuating cylinder by at least 25 per cent in order to provide larger margins in available stabilizer hinge moments for the condition of one hydraulic system inoperative.

3) Obtain early, accurate, flight-test measurements of stabilizer hinge moments with both hydraulic systems operative and with only one system operative on the second XP6M-1.

4) Systematic quantitative investigation of the airframe shake, if it exists, on the second XP6M.

The following series of tests were then run to determine the limits of satisfactory operating conditions:

Inlet pressure 1500 psig, cylinder line closed.(Fig. XIII-8). No restrictor in the accumulator and line 19 volts DC. When bypassed, (i.e., valve energized), so that the return line restriction allowed a return pressure of 1200 psig, there was interflow from pressure to return. When de-energized there was a hesitation, then the valve returned to normal when the return line pressure was reduced to 1000 psig or less and the valve operated normally.

The one way restrictor (E-120573 Fig. XIII-8) was added, and the operating conditions were identical to the previous run. There was no change in the pressure situation. Since there was no position indicator on the throttling return valve the variation in its position was unknown. Operating pressure was increased to 3000 psig and the valve operated normally. The valve in the cylinder line was cracked, allowing a flow of less than 1 gpm and the valve operated normally. Once, while restricting return line flow to attain a pressure of 1500 psig, the pressure went up to 2000 psig and interflow was initiated, i.e., pressure to return. When the valve did not respond to de-energizing, the retumn pressure was reduced and the valve returned to normal. This was repeated and the result was the same. Waiting was insufficient for the valve to correct itself. At return pressure of 1500 psig or less, the valve operated properly and did not malfunction.

By-pass valve (Serial Number 430007) from the actuating mock-up (left spoiler) was used to replace the recovered unit (Serial Number 43000*) in the laboratory test set up. This unit would operate at 18 volts-DC, but otherwise there was no appreciable difference in operating characteristics between it and the salvaged valve.

2. Test of By-Pass Valve in Mock-Up

The testing operation was then transferred from the Hydraulics Laboratory to the actuating mock-up. A complex series of tests were performed, the prime effort being directed toward by-pass valve malfunction, system operating conditions conducive to malfunction, and correlation of actuating mock-up data with flight data. Obviously, the scope of these tests is too extensive to be covered in this report; however, the following significant facts were determined:

1) Without the one-way restrictor installed between the by-pass valve and the accumulator, by-pass valve malfunction i.e., interflow pressure to return when energized, could be caused at will under almost any inlet pressure and flow conditions. Subsequent investigation revealed that when the valve is energized, it produces a return line surge which acts upon an

area on the pressure to cylinder poppet, being opposed only by atmosphere and a spring. If the return surge is of sufficient magnitude to open the pressure poppet causing the valve to "hang-up" in a hazardous condition, it cannot recover until return pressure is greatly reduced or shut-down i.e., pressure differential across the valve increased.

2) Installation of the one-way restrictor and the subsequent running of 50 consecutive cycles produced no malfunction of the by-pass valve. A cycle consisted of energizing the valve to dump the accumulator. The maximum return pressure was less than 500 psig. To complete the cycle the valve was de-energized i.e., pressure to cylinder return blocked. Response was rapid in both directions.

In conclusion, it is felt that the foregoing tests offer adequate proof that modification of the stabilizer circuits i.e., incorporation of the one-way restrictor, E-120573, downstream of the by-pass valve, incorporated prior to first flight on XP6M-1 ship, would circumvent by-pass valve malfunction under any predictable condition.

G. STABILIZER ANALYSIS

Fortunately the stabilizer actuator, control valve, mechanism and hoses were recovered still installed in the large compartment at the upper section of the fin. The unit was still operable and could be tested functionally except for the upper cylinder barrel which was broken off to the right side. The compartment was well preserved and bore evidence of considerable stabilizer actuation during the accident. From the examination of this area and the above-mentioned parts, it was established that the following events took place in the sequence given (See Fig. XIII-10 and XIII-9).

1. Sequence of Events

1) The stabilizer hinge failed, allowing the stabilizer to separate from the fin.

2) The stabilizer actuator elevator and slave linkage then absorbed the stabilizer left load and were pulled upward rapidly.

3) The stabilizer actuator moved 8-3/4 inches upward and 2-5/8 inches to the right where the head lock nut contacted the closing rib 7-5/8 inches aft of the original position (position A). Measurements refer to motion at upper attachment to front spar stabilizer at the centerline of the ship.

4) The actuator moved aft, rubbing along the side of the upper closing rib chord producing a gauge mark to a point 7-5/8 inches aft of the original position.

5) The actuator barrel and upper bearing broke, bending to the right across the corner of the closing rib as a result of the tension load of 14,000 to 27,000 pounds and a side load of 1200 to 3300 pounds.

6) The remaining section of the cylinder retracted from the plus 6 degree stabilizer position to the minus degree stabilizer position (position B) (original trim position -- minus 1.6 degree stabilizer) while the actuator swung forward until the valve control rod contacted the center spar web at the forward end of the clearance cut-out. This action required hydraulic pressure from the accumulator in the No. 2 stabilizer system located in the aft hull.

7) The unit remained in this position for a period of time during which at least three lateral accelerations occurred.

8) At this point, the upper section of the fin containing the actuator and control linkage separated from the lower fin to which the hydraulic hoses and control cables were attached.

9) The four stabilizer hoses were subjected to violent tension which pulled the actuator forward, shearing a flange on the forward closing rib cut-out and impacting the valve control rod against the center spar at the forward edge of the clearance cut-out. This action bent and pinched the control rod against the valve damper and cylinder head, and bent the lower piston rod 1 degree forward.

10) When the hose fittings tore out of the lower fin structure, the sudden release of tension allowed the unit to spring back, causing the upper piston and threaded end of the piston rod to impact against the lower right hand flange of the closing rib chord which bent the small upper piston rod 0.6 degree forward.

11) Separation of upper section of the fin pulled apart the control cables. The last to break exerted a violent down force on the linkage and broke the valve down stop.

2. Conclusions

The following conclusions resulted from the stabilizer actuator analysis:

1) Structural failure of the stabilizer cylinder barrel and upper bearing lug was caused by separation of the stabilizer from the fin after the stabilizer hinges broke.

2) The stabilizer actuator and valve was functionally operable at the time of the accident.

3) It was definitely established that hydraulic pressure was available in system No. 2 at the time of accident.

4) Seal blow out and ejection tests indicate that hydraulic pressure was probably available in system No. 1.

5) At the time of stabilizer separation (after wing-forward hull separation) the control system was held in a position corresponding to minus 0.15 degree stabilizer over a period of time.

H. CONTAMINATION OF HYDRAULIC SYSTEMS

Combination of the fluid in hydraulic systems by dirt, silt, metal chips, etc., can be very serious, particularly in surface control systems. These impurities can cause sticking or jamming of closely fitted control valve spools in the subsequent chatter (dynamic instability) and possible loss of control of the airplane.

After consultations with Mr. Jack Ludwig of Chance Vought, an expert with extensive previous experience regarding control system crash investigation and hydraulic system contamination, it was decided to determine insofar as possible the degree of contamination that existed in the system at the time of the crash and, secondly, to determine the system behavior resulting from contamination. A description of these investigations and test results follows.

The fluid used in the hydraulic systems was in accordance with Specification MIL-0-5606. Examination of Martin company records regarding procurement and stock, indicate that two sources of supply are used, Esso and Texaco, both of which are listed on the Government QPL as qualified vendors. The fluid is accepted from the vendors on the basis of certified government inspection. No additional contamination tests are run. A check with BuAer revealed that the Navy accepts the fluid, which they purchase on the same basis, but put it through a blotter press. The system was originally charged from a test truck that had been filled from one-gallon Esso cans and had been serviced many times before flight, when the oil level was low, with Esso cans.

XVII. CREW EJECTION

The hull upper nose section which houses the entire crew was one of the earlier salvage items. The flight deck crew had ejected with no apparent malfunctions of equipment. The section contained almost all parts of the ejection systems that normally remain in the ship after an ejection. The wreckage of the lower nose section was also found at an early date. It contained the bodies of the pilot and copilot and their seats, carriages, and catapults. Only the pilot's headrest and seat-mounted components were missing and they were subsequently found. The pilot's hatch was still in place on the nose section, a bolt having sheared in its removing mechanism.

Over the following three months, the remaining parts of the system, including removed hatches, ejection seats, and initiator lines, were gradually accumulated by the salvage crews until on March 2, 1956, all items of importance to the study had been recovered.

A. EXAMINATION OF WRECKAGE

All salvaged items were thoroughly examined at Patuxent, and photographs were made when advisable prior to any disassembly or removal of parts. The ejection control systems (i.e., lines, initiators, and thrusters) were removed to the revetment buildings at the Martin plant where they were "breadboarded" for ease of examination. Figure XVII-1 shows a typical display of one of the systems. When perhaps 75 per cent of the ejection system initiators and thrusters had been recovered, several specialists from Frankford Arsenal and Pittman-Dunn Laboratories were called in to check the findings. They concurred with the preliminary conclusion that the initiators and thrusters had operated perfectly in each case. The remaining cartridge units in the system were subsequently recovered, and checks of these by Martin technicians showed no malfunction.

The pilot and copilot systems showed some initiator and thruster firing. It was known, however, that these men had not been ejected. Their systems, therefore, were carefully studied and diagrammed. Figures XVII-2 and XVII-3 show the systems, indicate what components were used, and include a brief description of normal operations of the system.

1. Pilot and Copilot Systems

The tee handles in both systems had been fired. The hatch thrusters had been fired. The copilot's hatch was released; the pilot's hatch stayed in place because of failure of the 5/16-inch diameter bolt which attaches the thruster striker arm to the trunnion on which it is mounted. Other than the latter item, both systems performed identically.

When recovered, the seats were separated from their carriages and the pilot's headrest box had been torn from its carriage. There were also two instances of seat-belt mounting failures. In view of the fact that the horizontal acceleration at impact is estimated to have been from 75g to 125g and that the seats were designed for 40g, such failures are tolerable.

The recovered portion of the failed hatch mechanism bolt was tested by the materials laboratory. Hardness readings showed a heat treated spectrum which indicated that the bolt was exactly as specified, a "high" heat-treated NAS-464 bolt.

The pilot's hatch was carefully examined while it was installed and after it was removed. No sign of jamming or distortion was found. On December 28, the hatch was removed from the ship by utilizing a load measuring device to ascertain the torque required to statically operate the mechanism. The resultant load on the bolt faces was 2800 pounds, which checked exactly with two previous runs of the same test on the same hatch and airplane. A test hatch of the same configuration had been fired repeatedly (nine times) using the same size bolt during the preflight program. The bolt showed no sign of incipient failure or brinelling.

Figures XVII-2 and XVII-3 show that although the Number 1 initiators in the headrests were fired, the lines were actuated only to the disconnect. Below that point the lines are clean and the systems unfired except for the tee handle initiators and lines. It is obvious that the Number 1 initiators were fired with the disconnects "broken" in each case.

The Number 2 initiators were unfired. Because the pilot's hatch stayed in the ship, its lanyard kept the Number 2 initiator safetied. However, the copilot's hatch was fired off, and the idea of an operator pulling a face curtain through only one initiator is unthinkable to those who know the system well. To make certain that it was physically possible to continue face curtain pull through the second initiator, a dummy initiator was placed in the copilot's headrest and the curtain was pulled. Operation was completely normal with ample overtravel. The system was then examined under the theory that impact caused actuation.

Markings were found on the line nozzles at the disconnects which indicated a wrenching mode of removal. The tee-handle sections of the consoles were completely demolished; thus, the tee handles would have been fired on impact if they were not fired beforehand. The copilot's hatch was found at the salvage location of the nose section. The examining pathologist gave the opinion that the pilots went into the water with their feet on the rudder pedals, not in the seat stirrups. The fact seems inescapable that there was no use of the ejection or hatch removal controls by the pilots. If the pilots literally flew the nose section into the water, all of the evidence is consistent.

The nose section is estimated to have hit an angle of approximately 30 degrees with the horizontal and in an approximately upright (not rolled) altitude. The whole lower nose section disintegrated on impact. Water and debris pushed up through the pilot's floor, and the consoles were torn and shattered. The tee handles would have fired the hatch thrusters at this time. The hull crown, twisted and deflected, could easily have racked the pilot's hatch sufficiently to freeze the linkage and provide enough reaction to allow the thruster load to shear the bolt attaching the striker arm. The inertia of the pilots' bodies and their seats carried them forward and down through the floor. Such motion would have first wrenched the disconnect nozzles out and then possibly pulled (or pushed) the face curtains out enough to fire the first initiator in each.

2. Flight Crew Systems

The flight deck crew systems are similar to the pilot systems except that there is no provision for column snatching. Examination of these systems showed that all of their cartridge units had been fired, including the tee handles. Like the pilot systems, the consoles in which the tee handles were mounted were torn and twisted, and either tee handle would certainly have been fired when the nose section crashed if it had not been fired previously by a crew member. The flight engineer's head rest box revealed evidence which seemed to indicate that the Number 1 initiator leaked at its connection to the gas line. A fire could have begun at that point. In addition, all parts of the ejection systems in the flight deck were studied for the possibility of ignition occurring through their use. The findings were that such ignition was of a very low order of probability.

B. EJECTION NARRATIVE

In addition to an examination of system components for mechanical evidence, other investigations were pursued to gather a complete story on the ejections and the factors affecting them. One approach, for instance, was an examination of the fall patterns of the flight deck crew seats and hatches. This proved somewhat inconclusive, except that it reinforced other evidence that the ejections took place at 2000 to 3000 feet and that the flight test engineer probably used his tee handle prior to pulling his face curtain. Another set of facts which demanded inclusion in a story of the escape was the fire pattern throughout the airlock and flight deck, particularly as evidenced on the crew seats, hatches, and bodies. (Chapter IX).

The most coherent method of presenting the ejection story is a continuous narrative. Such a narrative will include only those aspects of the investigation having a bearing on the ejection of the crew. No attempt will be made to document or prove those parts of the narrative not directly a product of the ejection system study.

1. Break-Up and Airlock Fire

The airplane was flying between 7500 and 9000 feet at a speed of at least 490 knots IAS. The ship nosed over in a descent, reaching a speed of about 505 knots. At an altitude of from 3000 to 5000 feet an explosion or structural breakup in the wing box area freed the nose section of the hull from the remainder of the hull and the wings. At this time, or possibly shortly before, breakup or an earlier explosion in the hull crown (Stations 407 to 453) caused some projectiles to be fired forward and through Bulkhead 407. Both airlock doors at Station 407 and 353 were open.

Simultaneous with, or immediately following, the freeing of the nose section at Station 407, there was a flash fire or low pressure explosion in the flight deck area. It is possible that the projectiles ignited this fire. The fire was centered toward the left or flight test engineer side of the ship; this was indicated by the burn pattern of the interior trim and equipment, including the crew seats.

During the airlock flash fire, estimated to have lasted from two to five seconds, the flight deck occupants apparently sustained a negative-g condition. This was indicated by the burning on the buttocks region of the flight test engineer's body and the burning of the underside of his seat back cushion consistent with seat belt and shoulder harness slack.

2. Escape Hatches

An examination of the flight deck escape hatches showed no evidence of burning on the edges of the test engineer's hatch, although charring on his hatch coaming was more severe than on the flight engineer's. The inside faces of the two hatches, exclusive of the edges, were protected by trim covers. The flight engineer's hatch cover clearly showed high-temperature flash burns; the left or flight test engineer's trim cover showed evidence of much less heat, only 300°F to 400°F.

From the evidence, it was decided that the left hatch was ejected early in the fire sequence, perhaps during a lesser fire which preceded the explosion-like flash fire.

That this hatch was removed by the flight test engineer's tee handle, rather than as part of a complete face curtain operation, is substantially proved by the fact that this man's body and seat were badly burned, i.e., they were in the ship for some time after the hatch had left. Previous tests of the system have shown the time between hatch release and seat ejection to be only 0.160 second when the face curtain is used. This would not have been enough time for the fire to burn the flight test engineer's body as it was burned. It is very doubtful that there would be less than three seconds between a crew member's use of the tee handle and the face curtain. Otherwise, the man would more logically use his face curtain for the complete operation. The flight test engineer probably pulled his tee handle and released his hatch early enough to prevents its inner surfaces from being greatly burned or charred.

3. Trajectories

A further clue to the ejection sequence and method is found in a study of the fall pattern. The data were derived from studies by the aerodynamics department which utilized the salvage locations of recovered parts, winds aloft data, and a carefully reasoned estimate of the most probable rate and angle of descent for the basic airplane. These factors were integrated to produce a flight path for the airplane or nose section and a "loci of release points" curve for the falling objects.

The loci curves for the flight deck crew hatches and seats have been superimposed on a nose section flight curve to determine their intersections and the release points of the items. The speed of the airplane section was 540 knots TAS (which equals 912 feet per second). Because the catapult imparts a maximum velocity to the seat relative to the hull of only 80 ft/sec and the vertical component of the hull section speed at the release was Sin 55° = 750 ft/sec, the catapult effect was disregarded. With the velocity of the hull section known, distances along the flight path from one ejection point to another were easily translated into approximate time intervals. The time gap between the flight test engineer's hatch and seat release definitely shows tee handle usage. On the other hand, the flight engineer's time gap indicates face curtain usage; certainly there is too little time for the separate actions of tee handle and face curtain to have taken place. The two hatches appear to have come out almost simultaneously, with the flight engineer's being first by a slight margin. However, the tolerances involved here could easily change this picture. Because some dragging of the bottom has been done in a direction parallel to the flight path, the location of some of the items could be off by up to 1000 to 1500 yards.

4. Sequence

The best conclusion from this evidence is the following. Immediately after or possibly before breakup, strong fumes and/or limited fire were present in the cabin. Fire damage to the flight test engineer's hatch shows that it came off first. The flight test engineer pulled the tee handle, to release his hatch -- probably with the idea of venting the compartment of heat and/or fumes. The flash fire took place immediately, burning both crew members and causing the flight engineer, the more experinced of the two men, to pull his face curtain instantly. The flight test engineer then pulled his face curtain. If the flight test engineer's hatch had been found considerably further upstream, the foregoing sequence would be amply justified by the pattern.

C. EXAMINATION OF BODIES

The flight test engineer was seen to fall and hit the water without his chute blossoming. The flight engineer's chute was seen by observers at an estimated altitude of 500 feet. The observers stated that the chute may have blossomed earlier, but could have then been obscured from their views by smoke.

1. Flight Test Engineer

Examination of the flight test engineer's body revealed the following points in addition to those previously noted with respect to the burned areas:

1) The man sustained a heavy blow across the right back, shoulder, and head -- possibly due to a collision with an object other than the water at impact. All attempts to identify the object have been fruitless.

2) The arming cord for the barometric parachute release was still with the man's equipment (it should have been secured to, and on ejection left with, the seat).

3) The manual pull ring ("D" ring) was still stowed.

Having erred in fastening himself in the seat, the man did not use the manual ring of his chute. Possible reasons for this are:

1) Already burned badly, he was rendered unconscious or induced to shock by the catapult. Further immediate effects would be those of wind blast at high speed (540 knots).

2) The man collided with part of the airplane soon after leaving the nose section and was rendered unconscious.

2. Flight Engineer

The one boat at the scene was heading for the expected point of impact of the flight engineer when it was redirected by a Navy helicopter to the point where the flight test engineer's body had entered the water. The boat crew picked up the body as directed but subsequently could not find the flight engineer. The observers further stated that the body appeared lifeless as it came down.

When the body of the flight engineer was recovered, it was determined that he had drowned. He had worn his life vest under his flying suit and was unconscious at the time of drowning. Autopsy revealed that he had sustained a painful, but not fatal, fracture of the tail bone at the base of his spine. Burns on the body were consistent with that expected from the examination of his seat; they were less severe than those of the flight test engineer.

The flight engineer did not collide with structure or debris during his fall. The skeletal injury which he sustained would not have been caused by water impact. At the time of the flash fire, the flight test engineer's body was certainly pulled up and out of his seat by g forces to a degree consistent with seat belt slack. The same forces were exerted on the flight engineer and, because of the detail construction of the seat, it is reasoned that the flight engineer's injury occurred when the g forces reversed, slamming him down into the seat bucket. Such an injury, according to the medical examiner, often causes nausea. When this effect is combined with the other effects present, it is not surprising that unconsciousness ensued.

D. IGNITION OF AIRLOCK FIRE

When the tee handle is pulled an M-3 initiator is fired sending gas through a line to the M-1 thruster which undogs the hatch. The M-3 initiator is a sealed unit and could not ignite a fuel-air mixture at its location. The M-1 thruster is also a sealed unit; it also must be discarded as an ignition source. When the hatch leaves, it pulls the gas hose free at the quick disconnect (which is mounted on a clip in the crown region of Frame 32, the aft boundary of the hatch). Such disconnects, when examined after test firings of hatches or seats, have shown rather severe burning and might possibly be hot enough momentarily to ignite a combustible gas.

When the face curtain only is used and the hatch is still in place, the first possibility of ignition is the hatch disconnect. Milliseconds later, the seat ejection would start. Another possibility of ignition is a disconnect fitting as the seat leaves, followed (in milliseconds) by the M-3 catapult reaching the end of its travel. The M-3 catapult would definitely ignite any combustible gas in the area.

Another situation develops when the hatch is ejected with the tee handle (assuming that there was no ignition at that time) and seat ejection is then accomplished with the face curtain. Here, the possibility of a hot disconnect igniting the gas is ruled out by the fact that the hatch disconnect, probably the hotter of the two, has already been fired. The M-3 catapult would then be an ignition source.

1. Catapult

If the fire was actually ignited by the catapult of one crew member, the man and all except the lowest sections of his seat would be free of any easily discernible heat effects or burning. His seat would have been almost out of the airplane when ignition occurred. The catapults therefore can be ruled out of this analysis.

2. Hatch Disconnect - Face Curtain Ejection

If ignition by a hot disconnect is assumed to be possible, the first and hotter fitting would be the hatch disconnect in an ejection with the face curtain only. Milliseconds after the hatch is released, the seat would be ejected. There would not be enough time to allow burns to occur on the flight test engineer's body.

3. Hatch Disconnect - Tee-Handle Release

If a hot disconnect fitting could ignite the fire, the following situation might have occurred. The flight deck crew was surrounded by strong fumes, most probably JP-4 from a leaked tank and/or the single-point refuel line in the airlock. Doors at Bulkheads 407 and 353 were open. The crew mutually agreed, presumably wih the pilot's permission, to open one hatch. The flight test engineer used his tee handle to release his hatch.

Negative evidence.- If there were strong fumes but no fire and the hatch disconnect ignited them when the tee handle was pulled, the flight test engineer's hatch would have been completely free of fire effects. The hatch and its trim cover were recovered and the opinion of the laboratory is that the trim cover was subjected to 300° to 400°F for some seconds.

There is strong evidence that the fire started in the airlock and progressed forward. It would have gone aft in the event of disconnect ignition. Also, an examination of the flight test engineer's body shows that during the flash fire he had been pulled forward and up in the seat, again indicating a forward direction for the fire or blast.

No evidence was developed by the medical examiner to indicate the presence of strong hydrocarbon fumes. However, the medical examiner has stated that the breathing of these fumes might not be positively indicated in this case where subsequent breathing of clean air can be presumed and an immersion in sea water is known to have occurred.

Alternate ventilation methods.- The question whether there is an alternate means to clear the compartment of fumes immediately arises. The air conditioning system would ordinarily clear such fumes and, in this case, probably prevent their entry (the Bulkhead 407 door was open; the Bulkhead 353 door is assumed to be open, otherwise the fumes could not have entered the flight deck). There is an emergency vent control for the system. It is used only when the engine bleed air is contaminated and not for fumes from other sources. The unheated air introduced in this event has no higher rate of flow than the normal bleed-air system. However, there is evidence that the entire air conditioning system was inoperative at the time of the flash fire, probably due to interruption of power.

The ditching or beaching gear hatches could have been chosen for emergency ventilation; they swing into the airplane, whereas the ejection hatch leaves the ship and is in danger of hitting the tail. The best reason against a decision to open other than an ejection hatch is that a crew member must leave his seat.

4. Number 1 Initiator

When the flight test engineer's seat and equipment were examined, it was noted that the fire path on the headrest box seemed to terminate at the point where the line from the Number 1 initiator was joined to that unit. The conjecture was made that this line may have leaked hot gases which then ignited a fuel-air mixture surrounding it.

The headrest box and initiator line were removed as a unit from the seat assembly. Great care was exercised to avoid jarring or twisting the gas line. A pressure test was made at the Martin Hydraulics Laboratory on the line to the initiator. The joint was painted with liquid soap and air pressure was applied to the line. A pressure of 4550 psi, the maximum available, produced no leakage at either the joint or the initiator itself. Although pressures in the line at initiator firing can be approximately 7000 psi, any leak which at the higher pressure could cause ignition of a fuel-laden atmosphere would at least be apparent when checked with soap film at 4550 psi.

An examination of the booster initiator in the hatch release line showed it to have been fired. If the line leaked to any considerable extent at the first initiator, it is doubtful that enough pressure would have been transmitted to the end of the line to fire the next initiator.

The blistered paint which defines the fire path leading to the initiator is also apparent, though to a lesser extent, at all other holes or apertures in the headrest box. There is no indication of burning inside the box. A fume fire developing around the outside of the box and burning more hotly in those areas where unburned air (oxygen) is being fed to it would explain the pattern found on this structure.

Again, there is strong evidence that the flight test engineer removed his hatch by means of the tee handle. It follows that the firing of Number 1 initiator was the first stage in his face curtain pull. Previous tests show that the time interval between the start of face curtain pull and the start of the seat upward is but twelve-thousandths of a second. If the initiator ignited the flash fire, there would not have been enough time for the burns on the body and on the seat to have occurred.

It is concluded that the flight test engineer's Number 1 initiator was not a source of ignition. Ejection system ignition of the airlock fire in any way is considered to be of a low order of probability.

E. CONCLUSIONS AND RECOMMENDATIONS

The investigation determined the following basic facts regarding the crew escape systems and their use during the crash.

1) Both flight deck crew members ejected. Their hatch and seat systems operated in a normal manner.

2) Both ejections took place after the separation of the nose section and the subsequent flash fire in the airlock and flight deck.

3) The parachute of the flight test engineer did not open because he had not attached the automatic release cord to his seat belt and he did not use the manual release on the pack.

4) The flight engineer's chute opened successfully. He was unconscious and he drowned upon entering the water. He had worn his life vest under his flight jacket.

5) The pilot and copilot made no attempt to actuate any parts of their systems.

6) A bolt in the operating linkage of the pilot's hatch was found sheared; the failure proved to be tolerable under conditions existing at the time of failure.

7) A number of initiators were fired at the time of impact with the water by either water, structural debris, or inertia loads on the handles.

Evidence was developed to show that the following malfunctions or possible factors in the accident did not occur:

1) An ejection hatch or seat colliding with tail to cause failure or malfunction of the tail;

2) Pilot's hatch mechanism failure in flight;

3) Possible ignition of the airlock and flight deck fire by the ejection system.

The following recommendations are made concerning the escape system and crew equipment:

1) Provide ejection seats for all crew members;

2) Keep Bulkhead 353 and 407 hatches closed during flight by means of crew training and/or the installation of a hatch-open warning horn or blinker light;

3) Provide rear view mirrors or periscopes for crew as a means of inspecting the aft hull and tail in flight;

4) Provide automatically inflated life vests for crew members;

5) Provide cold weather survival suits for the crew.

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THE MARTIN COMPANY
Baltimore, Maryland

Date: 1 February 1957

To: Technical Information Officer
Bureau of Aeronautics, Room 1085
Main Navy Building
Washington 25, D. C.

Subject: ACCIDENT INVESTIGATION REPORT
USN XP6M-1 Martin SeaMaster, Ship No. 2

Subject material is submitted for clearance for (~~immediate release~~) (for release on a date to be prescribed). If the material cannot be cleared in its entirety, it is requested that all deletions be indicated, and the remainder of the text be cleared "As Amended."

CONFIDENTIAL

William B. Welling
William B. Welling
Information Services

CONFIDENTIAL

MARTIN
BALTIMORE 3, MARYLAND

ACCIDENT INVESTIGATION REPORT
USN XP6M-1 Martin SeaMaster, Ship No. 2

OUTLINE

Description of the Accident

Aircraft History

Flight History

Investigation - Part I - General

- Part II - Wreckage

- Part III - Crew & Witness Statements

- Part IV - Instrument Recordings

- Part V - Structures

- Part VI - Hydraulics & Controls

- Part VII - Aerodynamics

Flight Personnel

Findings

Cause

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Description of the Accident

The Navy's second prototype XP6M-1 Martin SeaMaster (Buno 138822), world's first multi-jet seaplane, was lost on its twenty-fourth test flight south of Wilmington, Del., on 9 November 1956 at 1536 EST. All four crew members ejected successfully and parachuted to the ground east of Odessa without injury.

The airplane took off from Chesapeake Bay near the Martin plant at Middle River, Md., at 1444 EST. A pass at 1,000 feet was made over several small company boats containing naval visitors who had witnessed the take-off. After doing acoustical tests at 5,000 feet, the airplane climbed to 12,000 feet where two successive openings and closings were performed with the hull rotary mine door. After a climb to 25,000 feet, the ship was put into a slight dive. At 21,000 feet, having taken data readings at an observed mach number of .90, a normal recovery to level flight was begun. A nose down pitch was felt by the pilot, however, and the latter exerted an estimated 20-25 pounds of controls column force (pull) for correction. The airplane then began to respond and column force was gradually released. But the climb continued and increased in rate as the pilot applied increasingly greater opposite control (forward column pressure). This action continued until the control column was at full arms reach and the pilot's push force was estimated to be 80 pounds. The airplane still did not respond. While subjected to somewhat greater than nine times the force of gravity, it continued to pitch up in a tight inside loop. The pilot of a Navy jet fighter chase plane, immediately behind the P6M, observed the pitch up to an approximate vertical position. Upon sighting some small unidentified parts falling off behind the SeaMaster, he radioed that the plane was breaking up and for the crew to eject. All four members ejected successfully during the loop, after which the aircraft fell into a downward spiral to an estimated altitude of 5,000 feet where an explosion took place, followed by complete break-up. The wreckage fell among fields and small

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Aircraft History

In April, 1951, the Chief of Naval Operations issued an operational requirement for a high performance all-jet seaplane that would live on the water, and be supported primarily by tenders. Martin's award of the contract, and the subsequent development of the P6M, was described to Congress on 1 June 1956 by the Deputy Chief of Naval Operations (Air) as follows:

"The original contract with the Glenn L. Martin Company called for two XP6M aircraft, the first of which made its initial flight in July 1955. This aircraft was 'flight-test instrumented' only--in other words, it did not have the electronics equipment which will be necessary to carry out the mining mission. As the No. 1 XP6M continued with the various phases of flight evaluation, flight test data showed equal or superior performance as regards the design criteria for such an aircraft.

"Additional production prototype aircraft were funded for in the fiscal year 1956 funds in order to have a sufficient quantity of aircraft for evaluation in 1957. A number of production P6Ms were placed on the fiscal year 1957 procurement list, but it will be a few years before we have them in operational quantities."

On 7 December 1955, after completing over 37 hours of flight time, the number one XP6M-1 prototype was lost over the mouth of the Potomac River west of Point Lookout during a test flight from Baltimore. Three Martin crew members and a naval officer lost their lives in this accident. From 8 December 1955 until 2 March 1956, full-fledged salvage operations were conducted by naval vessels in the Potomac River. Approximately 80 per cent of the aircraft in thousands of small parts and 193 major parts was recovered from depths ranging from 50-70 feet. The wreckage was set up in the operations hangar at the Naval Air Station, Patuxent River, Md., and analyzed thoroughly by Martin engineers and experts from the Navy, Air Force, National Advisory Committee for Aeronautics, and the Civil Aeronautics Board. The accident was attributed to a control systems malfunction in flight which caused a sudden severe nose down pitch and resultant failure of the wings in negative bending.

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Following is a description of the first XP6M-1 accident as given to Congress on 1 June 1956 by Rear Admiral James S. Russell, Chief of the Bureau of Aeronautics:

"Very briefly, the horizontal tail, which is completely hydraulic-controlled, went full up, suddenly, and the airplane broke up by doing the beginning of an outside loop. The engines came out about nine times the force of gravity, and went straight ahead. The wings bent completely down, and the underside touched the fuselage, and we think then they broke by clapping underneath the airplane. But it was due to the sudden swing upward of the horizontal tail. Something went wrong in the hydraulic contol, or something else in the control system."

The possible causes of the control system malfunction were listed at the time as: a minor explosion in the center wing stub which may have damaged control cables, hydraulic lines, or electrical circuits; a broken or snagged control cable; loss of pilot feel-force in the longitudinal control system; loss of one or two duplicate hydraulic systems, coupled with the overpowering of the remaining system; and elimination of hydraulic power from the stabilizer actuator. As there was insufficient evidence to label any one of the above as the single, indisputable, most probable cause of the accident, corrective action was taken to cover each instance prior to first flight of No. 2 XP6M-1. Among the revisions incorporated: the mechanical and hydraulic control systems were re-examined and additional margins of safety were provided beyond the design system; crew escape methods were reviewed and provision was made for ejection of all crew members.

The No. 2 XP6M-1 made its first flight from Chesapeake Bay on 18 May 1956. More than 42 hours of successful flight tests had been accomplished with this airplane at the time of its loss. The combined flights of both SeaMasters had qualitatively established flight characteristics of the airplane over a considerable range of center-of-gravity locations, altitudes, and speeds. The pilots have expressed unusual satisfaction with airplane control characteristics.

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Flight History

The second XP6M-1 SeaMaster, like the first, had manifested in-flight vibration over some speed ranges, and a continuous effort had been made to locate and eliminate these vibrations. On almost every flight of Ship 2, some change in configuration, or addition of tufting was made and its effect studied.

On the final flight, the horizontal tail configuration was changed by locking the elevators in a fixed neutral position, rather than leaving them geared to the stabilizer in their normal manner as on all previous flights. This experimental modification was another in the series of steps designed to eliminate in-flight vibration.

Although the flight was originally scheduled to record data at a maximum speed of mach .87 at 20,000 feet, the flight was authorized to the maximum permitted observed speed of mach .90 at this altitude. This in-flight decision to proceed to the higher rate of speed was based on the marked decrease in vibration reported by the pilot (and observed on telemetered data) at the lower mach .87 speed. Such a decision is considered to be normal procedure. In addition, the aircraft had been tested on earlier flights under conditions of mach number, dynamic pressure, and center of gravity which equalled or exceeded the conditions at the time of the accident.

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Investigation - Part I - General CONFIDENTIAL

The investigation was planned and directed by a committee of Martin engineers, each specifically chosen for a particular job. These included XP6M-1 group engineers, staff design engineers, and several section heads detached from their regular duties. This committee directed the work of approximately 100 technical people, assigned to the investigation for varying periods. In addition, others from Engineering, Manufacturing and other divisions of the company, while not directly assigned to the investigation, provided data, services, or advice to the committee.

To assure the objectivity of the investigation, the committee availed itself of the aid of representatives of the following: the Bureau of Aeronautics, the Naval Aviation Safety Center, Naval Air Development Center, Naval Research Laboratory, National Advisory Committee for Aeronautics, Civil Aeronautics Board, Aluminum Company of America, Frankford Arsenal, Allison Division of the General Motors Corporation, and the Martin Company subsidiary, Research Institute for Advanced Studies.

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Investigation - Part II - Wreckage

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Approximately 95 per cent of the wreckage has been recovered. Ninety per cent of the recovered items, including all major structural components, were picked up within a half-mile radius. The remainder of the items were recovered within an area of approximately 15 square miles, with a linear spread of seven miles from the aft hull section to a small piece of wing trailing edge.

Eight of the ten wing leading edge slats were recovered and found between five and six miles south-east of the main wreckage area. The left-hand outboard spoiler was recovered in two sections, between six and seven miles southeast of the main wreckage area. One small piece of an engine access door was also found in the latter area. The crew ejection seats and hatches were found approximately 3½ miles from the main wreckage site.

The fields, bordered on the west by U. S. Highway No. 15, on the south by Vance Neck Road, and extending approximately 1½ miles east and north to the main wreckage area, were strewn with small pieces of wreckage from all parts of the airplane. The winds were from the northwest and light pieces would have drifted to the southeast as they fell.

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Investigation - Part III - Crew & Witness Statements

The statements of the crew and chase plane pilots were taken by tape recorder on the evening of 9 November 1956 only a few hours after the accident. On the following day, written statements were prepared by each man. In each case, the recorded and written statements basically agree, and give the following picture of the accident:

Vibration tests had been carried out at 20,000 ft and constant speed points were recorded up to mach .87. The pilot reported that the airframe vibration was decidely less, and the control monitor requested a climb to 25,000 feet with a descent to reach the maximum speed of previous tests. This was done and a final reading was made at mach .90 at 21,200 feet altitude. During this descent the co-pilot was monitoring the engine instruments and hydraulic system pressures, and reported everything normal.

The pilot then reduced power to 90% RPM and started a mild pullup to slow down gradually. A nose-down pitching tendency occurred, and the pilot applied a pull force of 20 to 25 lbs. The ship responded to the control but continued the climbing maneuver at an increasing rate. The pilot applied increasing forward stick force, until the stick was at full arm's reach, and still the airplane did not respond. He estimated that he was applying 80 lbs of force (Later tests proved the actual force to be about 150 lbs). The "g" forces became so heavy that his chin was forced down on his chest. He then decided the airplane had failed aft, and elected to eject. After ejection, the pilot said he observed the airplane to be "all in one piece."

The co-pilot's report, obtained independently, is consistent with that of the pilot.

Investigation - Part IV - Instrument Recordings

Data collecting devices which were aboard the aircraft have provided all the basic information needed to provide the necessary answers as to the cause of the accident. This information is considered both reliable and consistent as a basis for the conclusions reached in the committee's report.

The two principal sources of data used in the crash analysis were the forward oscillograph, on which measurements were being recorded for use in the vibration elimination program, and the telemetering system which was used for ground monitoring and backup.

The telemetering installation consists of an ASCOP PWM system for monitoring positions, airspeed, altitude, and pitch and roll. The output of this system was fed into the 70 KC subcarrier oscillator of a conventional FM/FM telemetering system. In addition, seven other FM channels were used for measurement of acceleration data and for monitoring pilot comments. With the exception of the right wing accelerometer, which was not operative during this flight, data was recorded on all the remaining channels.

All data during this particular flight was recorded on magnetic tape in the base station and was being presented for visual display on direct-writing Sanborn recorders at the Martin Company Airport. The records were being monitored at the time of the accident by Flight Test and other Engineering personnel.

The records compiled from the telemetering data take into account the various normal corrections, sources of error, and radio noise. Worthy of particular attention is the fact that these telemetering records continued for 55 seconds after the airplane reached the maximum pitch acceleration. Thereafter, transmission was lost. This indicates that the major structural break-up occurred after the maneuver.

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The chase pilot, O. F. Brown, reported that he was following the aircraft at a distance of about 300 yards. He observed that the ship pulled up to a level flight faster than normal and climbed rapidly, continuing on over beyond the vertical. At this point he radioed that the plane was breaking up and for the crew to eject. Then the ship passed over his shoulder and he lost it in the sun. He next observed it in a descending spiral aft of his starboard wing. He saw undefined parts break off during the initial pitch-up, but at no time did he see major components break away. He stated: "The wings, fin, stabilizer, wing tip floats, fuselage and engines all remained intact until the airplane exploded and burned at an estimated altitude of 3000 or 4000 feet."

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Investigation - Part V - Structures

The telemetering information, the statements by crew members and chase pilots, and the location of wreckage all indicate that there was no failure of major structural components until the aircraft had completed its inside loop maneuver.

Special emphasis was placed on an examination of those components which could contribute to a control system failure. Among the areas considered: the left hand elevator locking device; the stabilizer structure supporting the left hand locking devices; the reinforcement doubler just inboard of the locking device on the stabilizer; the left hand elevator at mid-span; the left hand elevator at the closing rib; the main trunnions attaching the stabilizer to the fin; and all supporting structure relating to the mechanical control system.

One possibility was considered because of the improved vibration condition on the final flight. Since locking the elevators appears to be the reason for improvement, it was considered that the vibration energy was being absorbed by the locking devices and its supporting structure. If this had resulted in a failure, it would have been a fatigue type of relatively high cycles-low stress. The aerodynamic loads on the elevator for the locked condition are essentially zero. There was no evidence of fatigue in any of the failed structure.

An examination of the stabilizer bonded structure revealed that failure occurred from very high shear stresses along the edges. There was evidence of some peeling action near the center of the panels from the aft to forward direction, and in some areas, of material failure prior to the unbonding. There was no evidence of insufficient bonding strength.

Investigation - Part VI - Hydraulics & Controls

Both flight contol hydraulic systems are believed to have been pressurized and operating at the time of the aircraft pitch up for the following reasons: 1) The system pressures were monitored by the co-pilot from 15 to 30 seconds prior to the accident and he reports that the pressure was normal. 2) The condition of the stabilizer systems from their accumulator check valves up to the cylinder indicates that the lines and components were intact until late in the break-up sequence.

There was no evidence found to support the initial assumption that the uncontrolled pitching maneuver had been caused by a control system malfunction. A complete survey of the longitudinal control system revealed all failures to be of the static tension and bending type. The majority of the fractures clearly occurred on ground impact. The stabilizer cylinder control valve casting had an internal failure at the base of the inner valve port. Much emphasis was placed on the nature of this fracture early in the investigation. However, microscopic analysis and functional laboratory tests indicated this failure resulted from a static load at break up. These findings were confirmed by Aluminum Company of America casting specialists, as well as by government experts.

Investigation - Part VII - Aerodynamics

The XP6M-1 is the first large aircraft to be designed for high speeds at low altitudes. As a result, the XP6M-1 must be given the ability to withstand airloads two or three times as high as any existing aircraft of comparable size.

But these factors have opened a realm of unknowns for the aerodynamicist. For the XP6M-1 has been conducting exploratory developmental flight tests in a speed region where little is known about the aerodynamic forces involved for planes of this size, weight, and speed characteristics, and where sudden and sometimes unexpected force changes can occur with increasing speed. Further, the aircraft's flight envelope has made difficult any accurate prediction of the magnetude, direction, and particular flight conditions at which these force changes may occur.

The evidence in this investigation indicates that the possibility of error between aerodynamic calculations and actual flight test results is quite great in this realm of flight testing. Particularly is this true for an aircraft such as the XP6M-1 where the so-called "100 per cent boost" control system allows for no "feedback" of forces to the pilot. The design and perfection of such control systems is a necessary forward step in aviation progress, but it also means development of aircraft in which we are destroying one of our senses, namely the "feel" of aircraft movement normally experienced by the pilot. Loss of this feedback force means an inability on the part of the pilot to report to designers a true indication of what the aircraft has experienced in flight, and the only substitute is in the use of adequate and continuously monitored instrumentation to measure what the pilot would have sensed in a conventional control system.

Examination of telemetered data following the accident show that, in recovering from the dive to the maximum observed speed (mach .90), the stabilizer moved to a full leading edge down position, resulting in the airplane rapidly trimming up to a normal load factor of more than nine times the force of gravity. As a result a complete re-examination of all flight and wind tunnel stabilizer hinge moment data was initiated, and dynamic analyses were begun, using automatic computing equipment (REAC & IBM) in an effort to simulate the final climbing maneuver, and to investigate hinge moment variations under dynamic conditions.

The configuration of the XP6M-1 on its last flight was not standard in that the elevators had been locked in a fixed neutral position, eliminating a 2½-degree elevator deflection (trailing edge up) which exists at high sped trim conditions in the normal configuration where the elevators are geared to the stabilizer. The post-accident review of wind tunnel hinge moment data has uncovered an error which was made in converting the original Cooperative Wind Tunnel and Cornell Aeronautical Laboratory hinge-moment data to account for the difference between the tunnel model stabilizer hinge line, or trunnion, and the actual airplane stabilizer trunnion. Correction of this error has shown that there is a substantial change in the stabilizer hinge moment level at high mach numbers. With the elevators locked to the stabilizer, the hinge moments shift in the compression direction, or to the weaker side of the stabilizer cylinder. Revised calculations, on the basis of the corrected data, indicate that, with zero elevator deflection, the stabilizer hinge moments could have approached, or exceeded, the maximum capacity of the stabilizer actuator at the maximum speeds attained at the time of the accident.

Analyses on the automatic computing equipment have shown that, with the elevators locked, the stabilizer motion will still continue in the nose down direction after an initial small overpowering of the hydraulic system. Hence, the evaluation of wind tunnel data and, in addition, the corrected measured stabilizer loads(under locked elevator conditions) indicate the same thing. The hinge moment level was very close to the compression capacity of the stabilizer actuator at the time that the last speed reading (Mach .90) was taken. Only a slight disturbance, such as the pilot's pulling out of the dive, or a gust, was needed to overpower the stabilizer actuator.

Relative to the loss of the number one XP6M-1 over the Potomac River in December, 1955, the revised hinge moment data in the present accident investigation of the second airplane indicate that, at the conditions under which the first aircraft was lost, the stabilizer hinge moments were not an initiating cause of the earlier accident, unless coupled with other complicating factors.

The results of the present investigation have revealed no evidence of any basic deficiencies in the aerodynamic design which might reduce the potential capability of the P6M aircraft to perform its assigned mission.

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Flight Personnel

Crew members on the second XP6M-1 at the time of the accident were Robert S. Turner, pilot; William Cunningham, co-pilot; Thomas Kenny, flight test engineer; and William Compton, flight engineer. All employees of Martin, they each ejected safely and parachuted to the ground without injury.

Turner is a native of Scranton, Pa., where he was born on August 3, 1923. He has been serving as project pilot of the XP6M-1 since flight tests of the second aircraft were begun from Chesapeake Bay near Baltimore in May, 1956.

In an earlier contribution to military aviation and the aeronautical sciences, Turner was at the controls of the first piloted aircraft to be launched from a mobile platform in exactly the same manner as a tactical missile. Known as the "zero-length launch" technique, the first launching took place at Edwards Air Force Base, Cal., on January 5, 1954. The aircraft was an F-84G jet fighter which had been modified to accomodate installation of a large thrust booster rocket. Subsequent launchings have proven the technique to be one that offers a new tactical concept of dispersing multiple launching sites for present day, or future fighter aircraft.

Turner served as a B-17 pilot with the 15th Air Force in Italy during World War II and was later a B-29 pilot with the 20th Air Force in the South Pacific.

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Findings

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1. The aircraft was lost because of an uncontrollable nose up pitching maneuver which occurred during a shallow dive at a speed of Mach .90, and at an altitude of 21,200 feet.

2. The horizontal tail configuration had been changed for this flight only by locking the elevators in a fixed neutral position. This experimental modification eliminated approximately 2½ degrees of elevator deflection (trailing edge up) which exists at high speed trim conditions with the normal tail configuration, in which the elevators are geared to the stabilizer.

3. The aircraft had been tested on several previous flights under conditions of Mach number, dynamic pressure, and center of gravity, which equalled or exceeded the conditions at the time of the accident. These previous tests were with the design tail configuration (elevators geared to stabilizer), and no adverse control characteristics had been experienced.

4. A review of wind tunnel data has disclosed that an error was made in converting the stabilizer hinge moment data to account for the difference between the wind tunnel model stabilizer hinge line, or trunnion, and the actual airplane stabilizer trunnion. A correction of this error has shown that there is a substantial change in stabilizer hinge moment characteristics at high Mach numbers, and that with the elevators locked to the stabilizer, these hinge moments shift in the compression direction, or to the weaker side of the stabilizer cylinder. Revised calculations, on the basis of the corrected data, indicate that with no elevator deflection, the stabilizer hinge moments approach, or exceed, the maximum capacity of the hydraulic control system at speeds as high as those attained at the time of the second XP6M-1 accident.

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5. Analyses since the accident on automatic computing equipment have shown that, with the elevators locked, the stabilizer motion will still continue for a short time in the nose down direction after an initial small overpowering of the hydraulic system.

6. There was ample and conclusive evidence provided by in-flight recordings of data collecting devices, particularly the oscilligraph and telemetering systems.

7. Evidence that the airplane did not break up until well after the pitching maneuver is provided by: 1) statements from the XP6M-1 pilot and the pilot of the jet fighter chase plane; 2) the continued telemetering recordings for 55 seconds after the pitching maneuver; 3) the fact that the major portion of wreckage was recovered in a small area of only a half-mile in radius.

8. There is no evidence of pilot error, structural failure, or initial malfunction of either the airplane control system or the flight control hydraulic system.

9. There is no apparent direct connection between the accidents of the number one and number two XP6M-1 aircraft. The evidence reveals that they were separate and distinct as to cause.

10. The revision of the wind tunnel hinge moment data in the present investigation indicates that, at the conditions under which the first XP6M-1 was lost in December, 1955, the positive stabilizer hinge moments (tension in cylinder) were not an initiating or contributory cause of that earlier accident.

11. Within the flight limits tested to date, no serious functional, design, or flying deficiencies were found which might have contributed to the accident or which might impair the future service utility of the aircraft.

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Cause

The investigation committee has concluded that the cause of the second XP6M-1 accident was the fact that the airplane was flying with an experimental modification--locked elevators--which changed the load level on the stabilizer actuator. When the aircraft attained high speed and commenced recovery from the dive at 21,000 feet, the hinge moments acting on the stabilizer overpowered the stabilizer actuator, with the resulting uncontrollable climbing maneuver.

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12/16/1955

12/16/55

The first YF-105A rolled out of the factory in the autumn of 1955. It was shipped to Edwards AFB for initial trials over the Mojave Desert. The first flight of the YF-105A (54-0098) took place on October 22, 1955, with Republic test pilot Russell M. Roth at the controls. It easily exceeded the speed of sound on its first flight, although, as expected, the transonic drag was quite high. It was the largest and heaviest single-seat fighter ever built up to that time. The maximum speed attained was Mach 1.2, even though it was powered only by a J57 engine and lacked a fuselage that was area-ruled.

On December 16, the aircraft was extensively damaged when Russell Brown was forced to make an emergency landing at Edwards AFB after the right main landing gear had been torn away after having been inadvertently extended during high speed flight. The aircraft was returned to the factory because of the damage, but repair costs turned out to be too high to justify returning 54-0098 to flight status.

The second YF-105A flew for the first time on January 28, 1956. It was identical to the first YF-105A.

Only two YF-105As were built. Following their initial flight trials, they were used in support of the F-105B program.

Serials of the YF-105A:

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54-0098/0099                Republic YF-105A-1-RE Thunderchief
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Specification of the Republic YF-105A Thunderchief:

Engine: One Pratt & Whitney J57-P-25 turbojet, rated at 10,200 lb.s.t. dry and 15,000 lb.s.t. with afterburner. Performance: Maximum speed: 857 mph at 36,000 feet, 778 mph at sea level. Stalling speed was 185 mph. An altitude of 30,000 feet could be reached in 17.6 minutes. Combat ceiling was 49,950 feet. Normal range was 1010 miles and maximum range with full external fuel was 2720 miles. Fuel: Fuel capacity was 850 US gallons internal fuel. With full external fuel capacity, a total of 2500 US gallons of fuel could be carried. Dimensions: wingspan 34 feet 11 inches, length 61 feet 5 inches, height 17 feet 6 inches, wing area 385 square feet. Weights: 21010 pounds empty, 28,966 pounds combat, 40,561 pounds maximum takeoff. Armament: Armed with one 20-mm M61 rotary cannon. Up to 8000 pounds of ordinance could be carried.

Sources:

1. The Illustrated Encyclopedia of Aircraft Armament, Bill Gunston, Orion, 1988.

2. United States Military Aircraft Since 1909, Gordon Swanborough and Peter M.

ROUTING
1/3

JOINT MESSAGEFORM

COMMUNICATIONS CENTER NO.

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FROM: (Originator)
COMDR, AFFTC
EDWARDS AFB CALIF

DATE-TIME GROUP

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PRECEDENCE FOR: ACTION | INFORMATION
MAIL

TO: OTIG, USAF, NORTON AFB CALIF
COMDR, ARDC, BALTO MD
COMDR, WADC, WP AFB OHIO
COMDR, WADC (RDZ-1 SPA) WP AFB OHIO
COMDR, MOAMA, BROOKLEY AFB ALA

INFO: AFPR, REBUBLIC AVIATION CORP.,
FARMINGDALE, LONG ISLAND NY

☐ BOOK MESSAGE ☐ ORIGINAL MESSAGE

☐ MULTIPLE ADDRESS

CRYPTOPRECAUTION ☐ YES ☐ NO

REFERS TO MESSAGE:

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C O N F I D E N T I A L

FTOOF-1-1-M. FINAL REPORT OF AIRCRAFT INCIDENT

SPECIAL HANDLING REQUIRED IAW AFR 62-14, PARAS 49A AND 52

A. 16 DEC 55, 1519 HOURS PST

FE77-A

B. EDWARDS AFB, LAKEBED

C. YF-105A, SER NR 54-098

AMC amc 8/4

G274

D. BAILED TO REPUBLIC AVIATION CORPORATION. AIR FORCE CONTRACT NO. 33 (600) 22512

BAILMENT NO. AF 33 (600) 2026 AMENDMENT 36.

E. SUBSTANTIAL DAMAGE UNDERSIDE OF FUSELAGE. FUSELAGE SPLIT. RIGHT MAIN GEAR LOST.

LEFT WING AND STABILIZER DAMAGED.

J G274

F. PILOT, MR. RUSSELL M. ROTH, CIVILIAN, REPUBLIC AVIATION CORPORATION

CLASSIFICATION CANCELED OR CHANGE

G. N/A

TO SRP-1

H. NEG PRCHT, NEG INJURY

BY AUTHORITY AFR 205-1 ... S

BY M Weil DATE 8-16-61

I. TOTAL PILOT HOURS 3276; TOTAL JET HOURS 1250; TOTAL CONVENTIONAL HOURS 2026

Final

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EDWARDS AFB CALIF

DATE-TIME GROUP

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MULTIPLE ADDRESS | CRYPTOPRECAUTION YES NO

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TO:

INFO:

PAGE TWO

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J. TOTAL PILOT HOURS LAST 30 DAYS 15; TOTAL PILOT HOURS LAST 30 DAYS THIS MODEL 15; TOTAL PILOT HOURS LAST 90 DAYS THIS MODEL 19

K. N/A

L. ENGINES RUNNING, IN FLIGHT AND LANDING

M. THE RIGHT MAIN LANDING GEAR EXTENDED IN FLIGHT DURING AN ATTEMPTED SIX G PULL UP AT 530 KNOTS AT 10,000 FEET. THE FRONT UPLOCK FITTING OF THE RIGHT MAIN LANDING GEAR BECAME DISENGAGED AT 5.5 - 6.0 G AS A RESULT OF THE HOOK ROLLERS BEING FORCED PAST THE LOCKING CAM. THIS OCCURRED AS THE RESULT OF DEFORMATION OF THE HOOK PIVOT BOLT AND THE ROLLER PIN. THE RIGHT MAIN LANDING GEAR WAS LOST IN FLIGHT. SUBSEQUENT DAMAGE OCCURRED TO THE FUSELAGE ON GEAR UP LANDING.

N. PRIMARY CAUSE OF INCIDENT WAS THE LACK OF ADEQUATE STRENGTH AND RIGIDITY IN THE UP-LOCK MECHANISM.

O. NONE

CLASSIFICATION CANCELED ~~CHANGED~~

TO

BY AUTHORITY OF AFR 205-1 para 39A

BY M Vail DATE 8-16-61

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☐ MULTIPLE ADDRESS CRYPTOPRECAUTION ☐ YES ☐ NO

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PAGE THREE

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P. N/A

Q. N/A

M X-1 A

R. PHASE I X-1, LOCAL VFR

S. 1527 OBSR. EST 25,000 FEET BROKEN, VISIBILITY 60 MILES, TEMPERATURE 61, DEW POINT 38, WIND WEST 18 GUST 22, ALT SETTING 2995.

T. NONE

CLASSIFICATION CANCELED ~~OR CHANGED~~

TO ______

U. NOT REPAIRABLE

BY AUTHORITY OF AFR 205-1 para 39

V. N/A

BY M Vail DATE 8-16-61

W. N/A

X. THE MAIN LANDING GEAR UPLOCKS ARE BEING REVISED TO INCORPORATE GREATER STRENGTH AND RIGIDITY. REVISED LOCKS WILL BE INSTALLED IN AIRCRAFT 54-099 BEFORE THE FLIGHT TEST PROGRAM IS RESUMED. THE FUSELAGE SPLICE FITTINGS AT STATION 284 ARE BEING REINFORCED AND THIS WILL BE INCORPORATED IN AIRCRAFT 54-099 AT THE EARLIEST POSSIBLE DATE.

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	[redacted]

PRECEDENCE FOR: ACTION | INFORMATION

☐ BOOK MESSAGE ☐ ORIGINAL MESSAGE

☐ MULTIPLE ADDRESS | CRYPTOPRECAUTION ☐ YES ☐ NO

REFERS TO MESSAGE:

IDENTIFICATION	CLASSIFICATION

TO:

INFO:

PAGE FOUR

C O N F I D E N T I A L

Y. THE MAIN LANDING GEAR FORWARD AND AFT UPLOCKS BE REDESIGNED TO INCORPORATE GREATER STRENGTH AND RIGIDITY. Z. THE FUSELAGE SPLICE FITTINGS AT STATION 284 BE REDESIGNED OR STRENGTHENED TO THE STRENGTH OF THE ATTACHING BOLTS.

CLASSIFICATION CANCELED [redacted]
TO ________
AFR 205-1 para 39A
BY M Vail 8-16-61

SECURITY CLASSIFICATION	PAGE 4 OF 4 PAGES
[redacted]	

DRAFTER'S NAME (and number, when required)	RELEASING OFFICER'S SIGNATURE
Richard C. Kennan Jr. RICHARD C. KENNAN, CAPTAIN, USAF	Bentley H. Harris BENTLEY H. HARRIS, JR., LT. COLONEL, USAF

SYMBOL	TELEPHONE	OFFICIAL TITLE
FTOOF/sb/5 JAN 56	27141	DEPUTY CHIEF OF STAFF, OPERATIONS

DD FORM 1 OCT 49 173 REPLACES NME FORM 173, 1 MAY 49, WHICH MAY BE USED [redacted]

PILOT'S OR CO-PILOT'S QUALIFICATION AND EXPERIENCE RECORD

APPROVAL IS REQUESTED FOR: ☒ PILOT ☐ CO-PILOT (Check One)	DATE July 21, 1955
NAME ROTH, RUSSELL M	CITIZENSHIP U.S.A.
ADDRESS (NUMBER AND STREET) Edwards AFB — (CITY) Muroc — (ZONE) — (STATE) Calif	
CAA LICENSE NO. 1226621 — DATE Oct 17, 1951	RATINGS Airplane Single and Multi Engine Land, Instrument
PLACE OF LAST PHYSICAL EXAMINATION Los Angeles, Calif.	DATE Oct 4, 1954
CONTRACTOR REPRESENTED XXXXXXX Republic Aviation Corporation	LOCATION Farmingdale, New York
TYPE, MODEL AND SERIES OF AIRCRAFT TO BE FLOWN XF-105	
PLACE OF FLIGHT OR SERIES OF FLIGHTS Edwards A.F. Base, Muroc, (Edwards) California	DATE
Flights are to be Conducted above 35,000 feet ☐ Yes ☐ No (Check One) 10 Oct 1955 If yes, give Date of Last Pressure Oxygen Breathing Indoctrination— Williams AFB, Arizona	DATE 10 Oct 55

PURPOSE OF AND REASON FOR FLIGHT

CLASSIFICATION CANCELED ~~OR CHANGED~~

Initial flights of XF-105

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M Vail 9-11-61

TOTAL FLYING TIME (HOURS)

Pilot	Co-Pilot	Instrument	Night
3,006 Hrs.	269 hr.	60 Hr.	130 Hr.

TYPES OF MILITARY AND CIVILIAN AIRCRAFT FLOWN AS

PILOT Type	Hours	Date Last Flown	CO-PILOT Type	Hours	Date Last Flown
F-80	300:00	Sept 1951	C-47	130:00	Jul 1951
T-33	61:00	Sept 1951	B-25	76:00	Sept 1950
F-94	34:00	Aug 1951	C-45	7:00	1950
F-86	154:00	Sept 1951	B-26	6:00	1949
F-92	1:00	Apr 1950	YC-125B	1:00	
F-89	19:00	June 1951	B-24	11:00	
XF-43	89:00	June 1951	B-17	27:00	
B-45	1:00	Apr 1949	B-29	9:00	
T-28	44:00	May 1950	B-45	1:00	
T-6	285:00	Apr 1949	F-82	10:00	1951
L-5	7:00		B-26	20:00	Aug 1950
F-51	56:00	Dec 1950	PT-22	60:00	1943
L-13	20:00	Aug 1950	ST-13	71:00	1943
P-39	175:00	1945	UC-78	10:00	1943

BRANCH OF SERVICE OR CIVILIAN ORGANIZATIONS WHERE EXPERIENCE WAS OBTAINED

USAF

TYPED NAME AND TITLE OF REQUESTING OFFICIAL	TYPED NAME, GRADE AND TITLE OF APPROVING OFFICIAL
O.P. Haas, Director Flight Operations Republic Aviation Corporation	Carrell T. Murrell Lt Col. USAF, AF Plant Representati
SIGNATURE OF REQUESTING OFFICIAL	SIGNATURE OF APPROVING OFFICIAL

AMC Form 32, 1 Feb 54 — PREVIOUS EDITIONS OF THIS FORM MAY BE USED. — AF WP O 3? JAN 55

PILOT'S OR CO-PILOT'S QUALIFICATION AND EXPERIENCE RECORD

APPROVAL IS REQUESTED FOR: ☐ PILOT ☐ CO-PILOT (Check One)

DATE: Jul 21, 1955

NAME

CITIZENSHIP

ADDRESS (NUMBER AND STREET) | (CITY) | (ZONE) | (STATE)

CAA LICENSE NO. | DATE | RATINGS

PLACE OF LAST PHYSICAL EXAMINATION | DATE

CONTRACTOR REPRESENTED | LOCATION

TYPE, MODEL AND SERIES OF AIRCRAFT TO BE FLOWN

PLACE OF FLIGHT OR SERIES OF FLIGHTS | DATE

Flights are to be Conducted above 35,000 feet ☐ Yes ☐ No (Check One)
If yes, give Date of Last Pressure Oxygen Breathing Indoctrination— | DATE

PURPOSE OF AND REASON FOR FLIGHT

TOTAL FLYING TIME (HOURS)

Pilot	Co-Pilot	Instrument	Night

TYPES OF MILITARY AND CIVILIAN AIRCRAFT FLOWN AS

PILOT			CO-PILOT		
Type	Hours	Date Last Flown	Type	Hours	Date Last Flown
F-47	10:00	1945			
F-40	10:00	1945			
C-47	186:00	May 1955			
UC-78	10:00	1943			
B-25	101:00	Jul 1951			
C-45	28:00	Dec 1949			
F-48	337:00	1945			
XF-91	11:00	Mar 1954			
XF-84F	166:00	Nov 1954			
RF-84F	79:00	Jul 1955			
F-84F	156:00	~~XXX~~ Jul 1955			
F-84J	12:00	Sept 1954			
F-84	6:00	Mar 1955			

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TO ____________
BY AUTHORITY OF [illegible]
BY M Vail DATE [illegible]

BRANCH OF SERVICE OR CIVILIAN ORGANIZATIONS WHERE EXPERIENCE WAS OBTAINED

USAF

TYPED NAME AND TITLE OF REQUESTING OFFICIAL
U.P. Hass, Director Flight Operations
Republic Aviation Corporation

TYPED NAME, GRADE AND TITLE OF APPROVING OFFICIAL

SIGNATURE OF REQUESTING OFFICIAL

SIGNATURE OF APPROVING OFFICIAL

INVESTIGATING OFFICER'S STATEMENT

HISTORY OF FLIGHT

On 16 December 1955, at approximately 1435 hours PST, YF-105A, S/N 54-0098, piloted by Mr. Russell M. Roth of Republic Aviation Corporation, took off from the lakebed of Rogers Dry Lake on a Phase I Stability and Control flight, with VFR clearance. An F-100A chase aircraft, flown by Captain Robert M. White, picked the YF-105A up after takeoff and the two aircraft were then climbed in military power to slightly above 30,000 feet where the afterburners were lighted and a shallow dive was made to a Mach number of 1.18 and accelerated turns accomplished up to 4 g's. A descent to 20,000 feet was made and maneuvering flight tests were performed over a Mach number range of 0.7 to 0.94. Several 360° aileron roll tests were also accomplished at 20,000 feet before the aft booster pump warning light came on with 300 pounds of fuel remaining in that tank. Mr. Roth then pulled the aft and forward tank circuit breakers to prevent adverse aft C.G. conditions from developing. Descent was then made to 10,000 feet where accelerated turn tests were conducted at a Mach number of 0.9, approximately 500 knots. Turns of 2, 3, 4 and 5 g's were made and a separate turn was set up for a 6 g test. The aircraft position, at the initiation of the turn, was over the South edge of the dry lake on a Southerly heading. As the g load was applied, the pilot experienced no unusual control problems until approximately 5.5 g's were reached. At this point Mr. Roth experienced what to him sounded like an explosion and the aircraft pitched up to positive 10 g loading and then to a negative 2.3 g loading and back to positive 6 g's. From this point the longitudinal oscillation was reduced rapidly and longitudinal control regained. Lateral control during the pitch-up was erratic but the pilot maintained control with corrective aileron and spoiler controls. The chase pilot, who was flying approximately 200 yards aft of the YF-105A, observed the pitch-up maneuver and simultaneously observed three objects fall from the YF-105A. The chase pilot informed Mr. Roth of his observations and immediately moved into position for a close inspection which resulted in the discovery that the entire YF-105A right main gear was missing.

The YF-105A was slowed to 170 knots, where full leading edge flaps were extended and 80% trailing edge flaps extended. One circle of the landing area was made by Mr. Roth and the chase aircraft, then a landing pattern for the North lakebed runway 23 was set up with the remaining gear retracted on the YF-105A. A very shallow descent was made to the runway at 170 knots and the aircraft was slowed to 160 knots with the touch-down coming very shortly thereafter. The ventral fin on the underside of the aircraft dragged the runway surface for approximately 270 feet before the nose dropped rapidly and the main fuselage struck the runway in a level attitude. The canopy came off at the point of main fuselage impact and the aircraft skidded straight ahead and lateral control was maintained during the major port

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BY [illegible] DATE 8-16-67

left wing went down the last few feet of skid and the left wing and horizontal stabilizer made contact with the runway. Total skid distance was 2,000 feet. The YF-105A pilot shut the engine down upon first contact with the runway and all switches were turned off prior to departing the aircraft after it came to rest. No indication of fire during landing was observed by the chase aircraft, nor by Mr. Roth after he departed the aircraft. The fire equipment arrived at the point where the YF-105A came to rest and there was no action required of the firemen. The fuel aboard at the time of landing was approximately 300 pounds in the main tank, 1,100 pounds in the forward tank and 800 pounds in the aft tank. The latter two tanks' circuit breakers were still out, thus the fuel available to the engine was only that in the main tank.

INVESTIGATION AND ANALYSIS

1. On 16 December 1955, at approximately 1435 hours PST, Mr. Russell M. Roth of Republic Aviation Corporation departed Edwards AFB in YF-105A, S/N 54-0098, and was accompanied by a safety chase F-100A aircraft, S/N 53-1662, piloted by Captain Robert M. White. Phase I Stability and Control tests were conducted at altitudes of 28,000, 20,000 and 10,000 feet during the first thirty-five minutes of flight. At 10,000 feet the YF-105A pilot was attempting a 6 g pull-up at 520 knots airspeed, when the right main landing gear extended and was torn from the aircraft. A landing was made on the Rogers Dry Lake runway with the remaining gear in the retracted position. Total flight time was forty-five minutes.

2. Post flight investigation and analysis was conducted by both Republic Aviation Corporation personnel and Air Force personnel. The results of the investigation conducted by Republic Aviation Corporation may be found in detail in this report under TAB D. A summation of the investigation results is as follows:

a. Examination of the right main landing gear front uplock revealed that the roller on the hook was off the emergency release cam (See Tab F, Photograph No. 116 RAC). The emergency system latch was engaged, so that the cam was in position. A dimensional check of the uplock revealed that the cylinder was fully extended. The overcenter linkage was 11/64" overcenter, or slightly less than the 0.18" minimum called for.

b. Disassembly of the right front uplock assembly revealed severe bending and shear deformation of the hook pivot bolt, and also distortion of the pin holding the roller into the upper end of the hook. The roller was displaced so that it was riding the radius at the base of the cut-out in the hook, and was binding so that it could not be rotated by hand.

c. The surface of the roller was brinelled along a line contact with the cam, with a corresponding mark on the cam. The cam part of the cam was also scuffed.

By authority of AFR 205-1 para 31a
By M. Vail Date 8-16-61

[redacted].

d. The right rear uplock assembly was severely deformed, and the hook was in open position although it was still engaged on the cam, and the hydraulic cylinder was in locked position (See Tab F, Photograph No. 118 RAC). The locking linkage was 38/64" overcenter as compared to the 0.22" maximum specified. The attachment bolt hole at the upper end of the actuating cylinder was severely elongated, the head of the cylinder was cracked, and the entire assembly housing was deformed. The forward edge of the hook was severely scuffed.

e. The right inner door was in open position, and the hinges were tight and undamaged. The door was buckled, with the forward edge bent down relative to the rear roller. The rear roller was deeply scored. The front roller was undamaged. Both outer door support bolts were bent and the heads were scuffed in a direction corresponding to the outer door having forced the inner door to open.

f. Both locks on the left main gear were inspected, prior to releasing the gear, and it was observed that on both locks the roller hook was at the edge of the cam, having almost pulled past. Examination of the locks after extension of the gear revealed brinelling of the cams and rollers on both locks. Both hooks were sloppy on the pivot bolts, either from bushing elongation or bolt deformation or both.

g. The right gear strut failed through the head of the strut, bending aft and outboard, and apparently shearing the bolt attaching the strut to the side brace. The gear struck and damaged the lower surface of the wing outboard of the gear attachment point.

h. The side brace was intact, except for a failure of the fitting to the main retracting cylinder. The end fitting at the strut attachment was twisted, with the bottom aft, and the spherical bearing was rotated in the same direction in the end fitting. The direction of rotation was consistent with aft bending of the gear strut. The down lock latch on the side brace was not engaged.

i. The right main gear retracting cylinder was in extended position. All other hydraulic units in the landing gear system were in normal position for the gear up and locked.

j. Pressure was applied to the right gear down-lock cylinder and retracting cylinder utilizing a ground stand with a hand pump hooked into the system at the wing root. Return fluid was filtered into a can. The system functioned normally at 400-500 psi., and no foreign matter was observed in the return fluid.

k. The above test was repeated with the drag brace being held at the limit of its outward motion. It was found that the force applied easily with one hand and was sufficient to keep the down-lock cylinder from stroking, and hence to block pressure to the retracting cylinder.

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DATE 8-16-61

l. The fuselage failed in negative bending at the splice at Sta. 285 (See Tab F, Photograph No. 9098 and Photograph No. 9099). Both upper longeron splice fittings failed, with resulting failure of all structure above the cockpit floor. The lower longerons were buckled in compression aft of the splice. It appears that this failure occurred during the wheels up landing, as the load factor in flight varied from approximately +10 to -3 to +6 immediately after the landing gear extended, and had the failure occurred at the +10g it appears probable that the nose would have broken off completely at the subsequent 6 g.

m. Heat discoloration and soot streaks were observed on both sides of the rudder near the lower end. Upon removal of the aft section, extensive localized sooting and evidence of excessive heat were found on the aft fuselage frame at the splice and in the forward fuselage from the splice to the fire wall. The flexible metal hose in the afterburner drain line, located at the bottom of the fuselage, was wet and was dripping slightly, and the fuselage skin was wet below the line.

n. Inspection of the engine, shroud and forward fuselage after engine removal revealed evidence of local heat on fuselage skin, frames, wiring, etc. on the right side and bottom aft of the fire seal. The outside of the shroud was sooted and discolored from heat in the same areas. The inside of the shroud and the engine, lines, etc. were heavily sooted but no indications of excessive heat were observed. There was no soot or evidence of heat forward of the fire seal on either the engine or fuselage.

o. The flexible hose section of the afterburner drain line was removed and pressure tested, and found to be leaking badly at the aft end fitting attachment.

p. Review of the operating record of the aircraft revealed that the afterburner had been operated on the thrust stand on 15 December and it was later learned that no fuel was seen discharging from the afterburner drain when the afterburner was shut down. The subject incident occurred on the first flight after this thrust stand run.

q. Soot was found throughout the length of the cooling air ducts from the compressor inlet to both the inside and outside of the shroud.

r. The extent of fire damage indicates a localized fire of short duration, such as might have occurred from leaking of the afterburner drain line, which only discharges the fuel in the system downstream of the shut-off valve when the afterburner is shut-off. Ignition could have occurred by contact with the hot shroud or by fuel vapor being drawn inside the shroud and igniting on the tail pipe. The heavy sooting inside the shroud tends to support the latter possibility.

s. The general forward flow of the soot pattern and the soot in the cooling air ducts indicate that a fire of this nature may have occurred during the thrust stand run, when reverse flow cooling exists. The soot and heat streaks on the rudder indicate that a similar fire may have occurred in the subject flight. Soot deposits around lightening holes inside the ventral fin indicate that the fire may have been drawn up through the fin, thus impinging on the rudder.

t. Immediately following the extension of the right main landing gear, the pilot observed a complete loss of pressure in the P_2 primary system. The reservoir of this system was empty. The P_2 reservoir was re-serviced, and a ground stand used to pressurize the system. No pressure could be developed, and hydraulic fluid was observed leaking from the bomb bay. As the aircraft was still on the flat bed, the bomb bay doors could not be opened. Therefore the source of the leakage could not be determined, and is still under investigation.

u. Analysis of the witness' statement and oscillograph records indicate the pilot technique used at the time of the gear loss and subsequent violent longitudinal and lateral oscillations was both timely and proper and further aircraft damage was prevented by this action.

v. The load factor encountered by the pilot during landing was estimated by him to be more than twice that encountered during ejection which he had experienced recently in an altitude indoctrination course at Williams AFB.

w. The wheels up landing was accomplished at normal landing speeds, which produce a high fuselage angle with the landing surface and a rapid nose down pitch when the aft portion of fuselage makes contact.

FINDINGS

1. The primary cause of the incident was the lack of adequate strength and rigidity in the up-lock mechanism, thus causing the front up-lock fitting of the right main landing gear to become disengaged as a result of the hook rollers being forced past the locking cam (See Tab F, Photograph No. 116 RAC). This occurred as the result of deformation of the hook pivot bolt and the roller pin. Following the release of the front hook, the inner door buckled and the combined effect of air loads and g loads on the landing gear deformed the rear hook linkage sufficiently to disengage the hook and release the landing gear (See Tab F, Photograph No. 118 RAC).

2. A contributing cause for the extensive damage incurred was the inadequate strength in the fuselage structure at the splice located at Station 284. This failure was caused by load factor encountered during the inflight pitch-up and/or wheels up landing.

RECOMMENDATIONS

1. The main landing gear forward and aft up-locks be redesigned to incorporate greater strength and rigidity.

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2. The fuselage splice fittings at Station 284 be redesigned or strengthened to the strength of the attaching bolts.

Milburn G. Apt

MILBURN G. APT
Captain USAF
16678A
Investigating Officer

CLASSIFICATION CANCELED
TO
BY AUTHORITY OF AFR 205-1 para 39A
BY M Vail DATE 8-16-61

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FLIGHT TEST REPORT

Ship Number YF-105A S/N 54-098 Card No. 29F

Pilot R. M. Roth Date 16 Dec. 1955 Flight Time 45 Min.

Gr. Wt. 30,850# Ext. Stores None C. G. 24.7%

After flight discrepancies:

Right main gear lost in flight during accelerated maneuver and aircraft crash landed on lake bed.

Purpose:

Control system evaluation and maneuvering stability.

Comments:

Take-off was made on the lake bed with a quartering 25-30 knot down-wind. The aircraft became airborne at approximately 175 knots in heavy turbulent air and some control difficulty was experienced.

Climb was made at .8 Mach number, military power to 28,000 ft. Afterburner was fired and a Mach number of 1.18 obtained in a shallow dive. At this speed 2, 3 and 4 g turns were completed at 28,000 ft. At 4 g's light buffet is present. At 20,000 ft. at .94, .85, .8 and .7 Mach numbers maneuvering stability was accomplished in wind-up turns.

360° rolls were accomplished at 1/3 and 1/2 lateral control displacements at .9 Mach number with ailerons both in and out of operation.

At this time the warning light on the aft booster pump came on although 800 lbs. of fuel remained in the tank. To prevent an adverse aft C. G. condition the forward and the aft tank circuit breakers were pulled. Forward tank at this time showed 1100 lbs. of fuel remaining.

Descent was then made to 10,000 ft. and 2, 3, 4 and 5 g turns made at .9 Mach number, approximately 520 knots. Some speed was lost during this maneuver and a second one was made to obtain 6 g's at .9 Mach number. As the g load was applied the pilot experienced no unusual control problems and at 5.5 g's, which was the last number observed by the pilot, the right main gear was torn from the airplane. Prior to this run gear indication showed up and locked. At this time photopanel records show a positive 10 g loading and a negative 2.3 g loading, although the undersigned has no recollection of aircraft pitch. Longitudinal control was readily regained but some difficulty was experienced with the lateral control.

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BY AUTHORITY OF AF-R205-1 ... DATE 1-16-61

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Aircraft was slowed to 170 knots full leading edge and 80% trailing edge flaps extended. Approach was made on the lake bed at 170 knots very shallow descent. Approximately 4 or 5 feet above the lake bed the aircraft was slowed to 160 knots with touchdown occuring shortly thereafter. Tail skid drug approximately 100 yards on the lake bed before the nose dropped into the ground. When the nose dropped the canopy came off the aircraft. It is believed that less damage would have occurred to the aircraft had a higher touchdown speed been made but this pilot was concerned with the aircraft bouncing back into the air. The aircraft slid straight and lateral control was maintained during the major portion of the ground slide. Total sliding distance was just over 2,000 ft. All switches were turned off prior to departing the aircraft.

The longitudinal control on this flight and the previous 3 flights is much improved. The main objections are too high stick forces for maneuvering turns. It is also difficult to fly the aircraft smoothly at 1 g condition above .89 indicated Mach number. Aircraft response to control movement is very slow in this speed range.

The break-out had been lowered on the lateral control system prior to this flight but it is still felt that through the first few degrees of lateral control motion in either direction force gradient build-up is practically non-existent. Feed back from the system is definitely present in the stick as can be seen from the oscillograph record. Following losing the gear this pilot very nearly diverged with lateral control.

At the time the gear left the aircraft the primary 2 flight control system was lost. However, even though the cylinders on the right gear were torn from the aircraft utility pressure was always available during the ensuing landing. No difficulty was experienced during this landing with only the primary 1 flight control system in operation.

R M Roth
R. M. Roth

RMR:pf

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TO
BY AUTHORITY OF AFR 205-1 para 39A
M Veif DATE 9-16-61

STATEMENT

On Friday, December 16, 1955, at 1430 hours PST, I took off from Edwards AFB in aircraft F-100, S/N 662, to escort the Republic YF-105A, S/N 54-098. As per prior briefing the flight was to primarily consist of longitudinal accelerated maneuvers. After takeoff a military climb was made to approximately 35,000 feet where speed was increased and accelerated points obtained at supersonic speed. A descent to 20,000 feet followed where further points were taken in subsonic flight. Several aileron rolls were performed at this altitude while returning to an area over Rogers Dry Lake. A descent was made to 10,000 feet where accelerated maneuvers, up to a load factor of 5.0 "g's" at 0.9 Mach number, were accomplished. A level run was then made at 0.9 Mach number while heading south directly over the lake. Just after passing the Southern boundary of the lake, the YF-105 was banked for a left turn in an attempt to obtain 6.0 "g's". At this time I was about 200 yards behind the YF-105. During the maneuver I observed a rapid, but mild, lateral oscillation followed immediately by a sharp pitch up, then an immediate return to level flight. At the instant the pitch occurred I saw three pieces breaking away from the airplane simultaneously. I advised the pilot of structural failure and upon inspection of the aircraft underside saw that the entire right landing gear had broken away. A small syphoning was evident in the right wheel well and the pilot of the YF-105 indicated this to be hydraulic fluid. Further inspection revealed no other apparent damage.

The YF-105 was then slowed to approximately 200 knots and leading and trailing edge flaps were lowered. During this period an emergency landing was planned on lakebed runway 23. A final approach was made with the remaining gear retracted. I remained in a position about 100 feet to the right of the YF-105 until just prior to touch down. I called height above the ground three times, at 5 feet, 5 feet and 2 feet. Initial ground contact occurred on the ventral fin and the aircraft virtually flew along dragging the fin for about 100 yards. The aircraft then settled fully on its underside, at which time the canopy left the airplane, and continued to slide straight ahead. The left wing settled to the ground at just about the time the aircraft came to a stop. I circled the area once; the pilot had immediately left the airplane and waved as I passed overhead.

Robert M. White
ROBERT M. WHITE
Captain USAF
24589A
Chase Pilot

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TO ________
BY AUTHORITY OF AFR 205-1 para 39A
BY [illegible] DATE 8-16-61

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December 21, 1955

STATEMENT

1. On the basis of a study of the pilot's statement and a detail examination of the aircraft, the following findings and conclusions are submitted in regard to the incident to YF-105A Aircraft S/N 54-098 at Edwards AFB on 16 December 1955.

Investigation and Findings

2. The right main landing gear extended in flight during an attempted 5g pull up at 530 knots at 10,000 ft. The exact load factor at the time of extension cannot be determined; however, the last reading observed by the pilot before the aircraft pitched up violently was 5.5g.

3. The right gear strut failed through the head of the strut, bending aft and outboard, and apparently shearing the bolt attaching the strut to the side brace. The gear struck and damaged the lower surface of the wing outboard of the gear attachment point.

4. The side brace was intact, except for a failure of the fitting to the main retracting cylinder. The end fitting at the strut attachment was twisted, with the bottom aft, and the spherical bearing was rotated in the same direction in the end fitting. The direction of rotation was consistent with aft bending of the gear strut. The down lock latch on the side brace was not engaged.

5. The right main gear retracting cylinder was in extended position. All other hydraulic units in the landing gear system were in normal position for the gear up and locked.

6. There was no failure of the utility hydraulic system. Normal pressure of 3000 psi was available after the landing gear failure, and the leading edge flaps were extended normally before landing. The utility reservoir was full after the aircraft landed.

7. Pressure was applied to the right gear down-lock cylinder and retracting cylinder utilizing a ground stand with a hand pump hooked into the system at the wing root. Return fluid was filtered into a can. The system functioned normally at 400-500 psi., and no foregin matter was observed in the return fluid.

8. The above test was repeated with the drag brace being held at the limit of its outward motion. It was found that the force applied easily with one hand was sufficient to keep the down-lock cylinder from stroking, and hence to block pressure to the retracting cylinder.

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9. Examination of the right main landing gear front uplock revealed that the roller on the hook was off the emergency release cam. The emergency system latch was engaged, so that the cam was in position. A dimensional check of the uplock indicated that the cylinder was fully extended. The overcenter linkage was 11/64" overcenter, or slightly less than the 0.18" minimum called for.

10. Disassembly of the right front uplock assembly revealed severe bending and shear deformation of the hook pivot bolt, and also distortion of the pin holding the roller into the upper end of the hook. The roller was displaced so that it was riding the radius at the base of the cut-out in the hook, and was binding so that it could not be rotated by hand.

11. The surface of the roller was brinelled along a line contact with the cam, with a corresponding mark on the cam. The lower part of the cam was also scuffed.

12. The right rear uplock assembly was severely deformed, and the hook was in open position although it was still engaged on the cam, and the hydraulic cylinder was in locked position. The locking linkage was 38/64" overcenter as compared to the 0.22" maximum specified. The attachment bolt hole at the upper end of the actuating cylinder was severely elongated, the head of the cylinder was cracked, and the entire assembly housing was deformed. The forward edge of the hook was severely scuffed.

13. The right inner door was in open position, and the hinges were tight and undamaged. The door was buckled, with the forward edge bent down relative to the rear roller. The rear roller was deeply scored. The front roller was undamaged. Both outer door support bolts were bent and the heads were scuffed in a direction corresponding to the outer door having forced the inner door to open.

14. Both locks on the left main gear were inspected, prior to releasing the gear, and it was observed that on both locks the roller hook was at the edge of the cam, having almost pulled past. Examination of the locks after extension of the gear revealed brinelling of the cams and rollers on both locks. Both hooks were sloppy on the pivot bolts, either from bushing elongation or bolt deformation or both.

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15. All four uplock assemblies were forwarded to the Republic factory for laboratory examination.

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16. Immediately following the extension of the right main landing gear, the pilot observed a complete loss of pressure in the P_2 primary system. The reservoir of this system was empty.

17. The P_2 reservoir was reserviced, and a ground stand used to pressurize the system. No pressure could be developed, and hydraulic fluid was observed leaking from the bomb bay. As the aircraft was still on the flat bed, the bomb bay doors could not be opened. Therefore the source of the leakage could not be determined, and is still under investigation.

18. The fuselage failed in negative bending at the splice at Sta. 285. Both upper longeron splice fittings failed, with resulting failure of all structure above the cockpit floor. The lower longerons were buckled in compression aft of the splice. It appears that this failure occurred during the wheels up landing, as the load factor in flight varied from approximately +10 to -3 to +6 immediately after the landing gear extended, and had the failure occurred at the +10g it appears probable that the nose would have broken off completely at the subsequent 6g.

19. The right landing gear was not recovered.

20. Heat discoloration and soot streaks were observed on both sides of the rudder near the lower end. Upon removal of the aft section, extensive localized sooting and evidence of excessive heat were found on the aft fuselage frame at the splice and in the forward fuselage from the splice to the fire wall. The flexible metal hose in the afterburner drain line, located at the bottom of the fuselage, was wet and was dripping slightly, and the fuselage skin was wet below the line.

21. Inspection of the engine, shroud and forward fuselage after engine removal revealed evidence of local heat on fuselage skin, frames, wiring, etc. on the right side and bottom aft of the fire seal. The outside of the shroud was sooted and discolored from heat in the same areas. The inside of the shroud and the engine, lines, etc. were heavily sooted but no indications of excessive heat were observed. There was no soot or evidence of heat forward of the fire seal on either the engine or fuselage.

22. The flexible hose section of the afterburner drain line was removed and pressure tested, and found to be leaking badly at the aft end fitting attachment.

23. Review of the operating record of the aircraft revealed that the afterburner had been operated on the thrust stand on 15 December and it was later learned that no fuel was seen discharging from the afterburner drain when the afterburner was shut down. The subject incident occurred on the first flight after this thrust stand run.

24. Soot was found throughout the length of the cooling air ducts from the compressor inlet to both the inside and outside of the shroud.

25. The extent of fire damage indicates a localized fire of short duration, such as might have occurred from leaking of the afterburner drain line, which only discharges the fuel in the system downstream of the shut-off valve when the afterburner is shut-off. Ignition could have occurred by contact with the hot shroud or by fuel vapor being drawn inside the shroud and igniting on the tail pipe. The heavy sooting inside the shroud supports the latter possibility.

CLASSIFICATION CHANGED TO UNCLASSIFIED
TO ______
BY AUTHORITY OF AFR 205-1 [illegible]
B. Vail [illegible] 8-26-61

26. The general forward flow of the soot pattern and the soot in the cooling air ducts indicate that a fire of this nature may have occurred during the thrust stand run, when reverse flow cooling exists. The soot and heat streaks on the rudder indicate that a similar fire may have occurred in the subject flight. Soot deposits around lightening holes inside the ventral fin indicate that the fire may have been drawn up through the fin, thus impinging on the rudder.

27. Investigation of the overheat condition is continuing and the afterburner fuel system will be pressure tested for possible leaks.

Conclusions:

28. The front uplock fitting of the right main landing gear became disengaged at 5.5 - 6.0g as a result of the hook rollers being forced past the locking cam. This occurred as the result of deformation of the hook pivot bolt and the roller pin.

29. Following release of the front hook, the inner door buckled, and the combined effect of air loads and g loads on the landing gear deformed the rear hook linkage sufficiently to disengage the hook and release the landing gear.

30. The cause of the failure was lack of adequate strength and rigidity in the up-lock mechanism.

31. Both uplocks on the left main gear had been overloaded and the hook rollers had been pulled almost off the cams.

32. The fuselage structure failed at the splice at Sta. 284 from loads experienced during the wheels up landing, although it is possible that initial structural damage occurred during the uncontrolled maneuvers of the airplane following extension of the right main landing gear.

33. The heat damage in the rear engine compartment apparently resulted from a leak in the afterburner drain line, permitting fuel to drain into aft fuselage when the afterburner was shut-off. This condition existed prior to the subject flight, and was not related to the subject incident.

TO ____________

BY AUTHORITY OF AFR 205-1 para 31A

BY McCail DATE 8-16-61

Corrective Action:

34. The main landing gear uplocks are being revised to incorporate greater strength and rigidity. Revised locks will be installed in aircraft 54-099 before the flight test program is resumed.

35. The fuselage splice fittings at Sta. 284 are being reinforced and this will be incorporated on Aircraft 54-099 at the earliest possible date.

William I. Stieglitz
William I. Stieglitz
Design Safety Engineer
Republic Aviation Corp.

CLASSIFICATION CANCELED
TO
AUTHORITY OF AFR 205-1 Para 39A
M Vail DATE 8-16-61

DAMAGE REPORT YF-105A #54-098

1. Ventral Fin demolished - only splice web stayed on aircraft.

2. Crack in Fwd. Fuselage Sta. 285 extending from cockpit rail to FF17 and FF18 (both sides of fuselage cracked). Cockpit longeron splice fittings and all stringer clips failed, Sta. 285. Lower longerons buckled, aft of Sta. 285.

3. R/strut, fairings, wheel, and brake assemblies lost in flight and not found as of this time.

4. R/fwd. inner door uplock hook pulled past its stop.

5. R/aft. inner door hook pulled down past center, and outboard and inboard walls of housing sprung.

6. FF17 and 18 H.H.'s bent and warped out of shape in lower area and aft cam locks ripped and some missing from doors.

7. Canopy glass shattered and structure warped from impact.

8. L/gear retracted but sagging approximately 1/4" and inner door hooks found to be slipping past emergency cam (fwd and aft).

9. L/wing tip fairing dented on lower side but found intact structurally.

10. L&R navigation lights broken.

11. FF28 dented and distorted out of shape.

12. R/inner door warped in aft roller area. Fwd. is warped to contour of fuselage.

13. Turbine (engine) extension pipe bulged out and wrinkled at forward flange area. Extends around lower two thirds of pipe.

14. Rivets of canopy hinge mounting to canopy sheared (six rivets in all attaching point).

CLASSIFICATION CANCELLED OR CHANGED

15. L&R/Bomb Bay doors buckled mostly at fwd ends.

AFR 205-1 para 31A

16. Rod end bent on R/gear actuating cylinder.

M Vail DATE 8-16-61

17. Dent and several holes underside of R/wing caused by upper R/gear door-damage is same shape as door.

18. Aft. section hard to separate-evidence of formers or bolts being out of jig.

19. Evidence of fire in area aft of firewall and fwd. of splice - Afterburner flex line at firewall found to be porous.

20. R/wing skin rippled above outboard w/w between forward and aft spars.

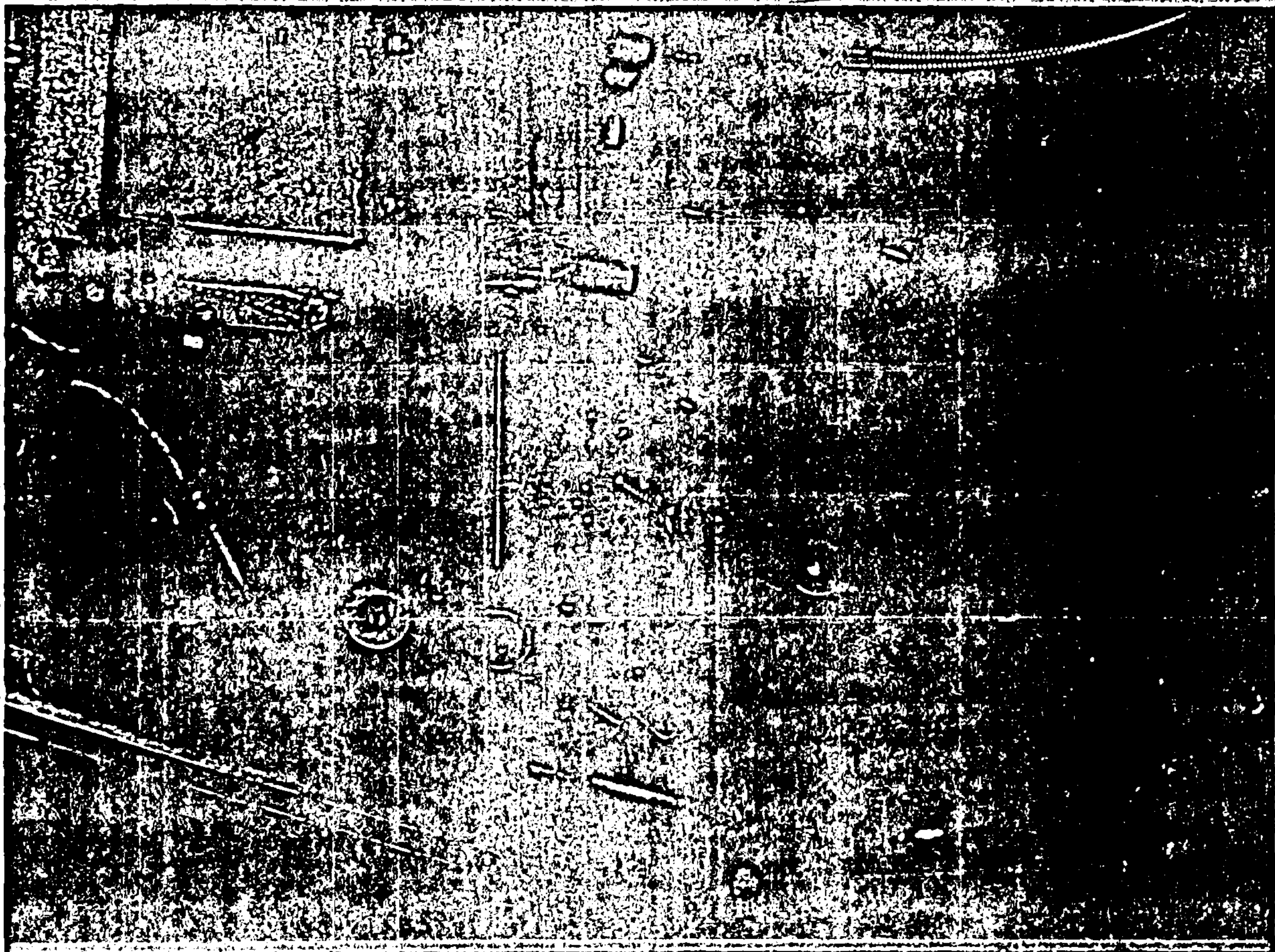
21. Pilots seat binding on rails when attempting removal - crane required to start seat out on removal.

22. 1000°F fire detector of speed ejector dented and bent.

~~CONFIDENTIAL~~

INDEX TO PHOTOGRAPHS

9096	Right side of fuselage
9097	Right front three-quarter view
9098	Closeup of fuselage splice, left side
9099	Closeup of fuselage splice, right side
9100	Left side of fuselage, three-quarter view
9101	Closeup of damaged right main gear
9102	Left front three-quarter view
9103	Closeup of damaged right main gear
9104	Up-lock fittings
116 (RAC)	Forward Innerdoor Uplock Hook
118 (RAC)	Innerdoor Aft Uplock Hook



118 RAC-AFFTC-16 DEC. 55-YF-105A S/N 54-098-[illegible]9F-GEAR UP LANDING
INNER DOOR AFT UPLOCK HOOK

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Statement of Chase Pilot

TAB D . . . . Statement of William I. Stieglitz, Design Safety Engineer, Republic Aviation Corporation

TAB E . . . . Damage Report

TAB F . . . . Photographs

TYPE, MODEL, SERIES

YF-105A

ACCIDENT NUMBER

55-12-16-1

ACCIDENT/INCIDENT DEFICIENCY SHEET

-1-

PROCESSING AND CODING BRANCH

(Check Each Item) (Initial and Date Each Suspense and/or Item Requested)

	CHECKLIST FOR ADMINISTRATIVE COMPLETENESS OF REPORT	Req Activity Date & Initial	Date of P&C Corr	Date Docu Rec	Remarks
✓	Forms 14, A, B, C, D, E, F Joint Msg Form Sections				
NA	U. R. (Specify components)				
////	AMC Action on U.R.				
////	Compliance with Paragraph 32				
////	Copy of TDR (Specify component)				
////	AMC Action on TDR (Specify component)				
////	AMC Letter on Report	12 1 56		3/21	[illegible]
NA	Rebuttals 1, 2, 3				
✓	Letter of Transmittal				
NA	DD Form 175				
NA	Weight and Balance (Form F)				
NA	Board Proceedings (If applicable)				
✓	Witnesses' Statements (Specify)				
NA	Form 5's (Specify Person)				
NA	Form 1				
NA	Miscellaneous Forms				
NA	Classification (Security)				
	ROUTING OF REPORT (Para 41, AFR 62-14)				
✓	Comdr - Operator's attached Unit for flying				
✓	Comdr - Operator's Home Base (Assigned Base)				
NA	Comdr - Org. Poss. Acft (Only if different from Opr)				
✓	If UR, TDR, MAT failure, Prime AMA for Acft-design def involved				
	INCORRECT				
	CORRECT				
NA	MATS (AACS or AWS Pers of Fac Inv)				
✓	WADC (All Reports)				
NA	Natl Guard Bureau if ANG Acft				
NA	Comdr, 6511th Parachute Dev Center (Fm 14D)				
NA	Surgeon Gen. Fm 14A & B if Fatal or Maj Inj				
	ANALYST'S CHECKLIST				
	Command Correspondence				
	AMC Action — Report (If not req abv)				
	AMC Action — U. R.				
	AMC Action — TDR				
	MATS Action — AACS				
	MATS Action — AWS				
	MATS Action — ARS				
	Rebuttals — Based on Bd Findings				
	Rebuttals — Based on Command Eval				
	Classification Under AFR 62-14				

REMARKS (Use Reverse if necessary)

YF-105
54-40098

INCOMING CLASSIFIED MESSAGEFORM

CLASSIFICATION

PRECEDENCE	INTERNAL REFERENCE NO.	DTG (Z TIME)	MONTH
OPER IMMED	F700F-12-6-E		DEC. 55

FROM: COMDR AFFTC, EDWARDS AFB, CALIF.

REQUIRED PARAPHRASE: YES / NO

TO: CHIEF OF STAFF, USAF, WASH D.C.
OFFICE OF TIG, NORTON AFB, CALIF.
COMDR ARDC, BALTIMORE, MD.
COMDR WADC, WRIGHT PATTERSON AFB, OHIO
COMDR WADC WSPO, WRIGHT PATTERSON AFB, OHIO

INFORMATION: COMDR AMC, WRIGHT PATTERSON AFB, OHIO
COMDR AFAC, EGLIN AFB, FLA.
COMDR AF CAMBRIDGE RSCH CEN, CAMBRIDGE, MASS.
COMDR AFMTC, PATRICK AFB, FLA.
COMDR AFSWC, KIRTLAND AFB, N. MEX.
COMDR HOLLOMAN ADC, HOLLOMAN AFB, N. MEX.
COMDR ROME ADC, GRIFFISS AFB, ROME, N.Y.
COMDR 6590 HQ SUPP GP, BOX 1395, BALTIMORE, MD.
COMDR ARNOLD ENGR DEV CEN, TULLAHOMA, TENN.
AFPR, REPUBLIC AVN CORP, FARMINGDALE, L.I., N.Y.
COMDR MOAMA, BROOKLEY AFB, ALA.

#840
YF-105 BH
Rep. Hic. ...

SPEC HANDLING REQUIRED IAW AFR 62-14, PARA 49A AND 52.

PRELIM REPORT OF ACFT INCD.

A. 16 DEC 55, 1519 HRS PST.
B. EDWARDS AFB, LAKE BED.
C. YF-105, SER NR 54-40098.
D. AMC, ON BAILMENT TO REP AVN CORP, EDWARDS AFB, CALIF.
E. SUBSTANTIAL DAMAGE, UNDERSIDE OF FUS. FUS SPLIT, RIGHT MAIN GEAR LOST. LEFT WING AND STABILIZER DAMAGED.
F. PLT, RUSTY ROTH CFO CIV, REP AVN CORP.
G. NOT APPLICABLE.
H. NEG PRCHT, NEG INJURY.
I. UNKN.
J. UNKN.
K. NOT APPLICABLE.
L. ENG RUNNING, LANDING.
M. PLT ON PHASE 1 STABILITY FLT PULLED 5 AND 1/2 GRAVITY, RIGHT MAIN GEAR SNAPPED OUT AND WAS LOST IN FLT. ACFT WAS LANDED WITH REMAINING GEAR RETRACTED ON EDWARDS AFB LAKE BED, RUNWAY 23.
N. UNKN.
O. NONE.
P. NOT APPLICABLE.
Q. FINAL REPT.
R. PHASE 1 X-1, LOCAL VFR.
S. 1527 CBSR, EST 25,000 FT BROKEN, VIS 60 MILES, TEMP 61, DEW PNT 38, WIND WEST 18 GUST 22, ALT SET 2995.
T. NONE. U. UNKN. V. NOT APPLICABLE.
W. NOT APPLICABLE. X. FINAL REPT. Y. FINAL REPT.

CLASSIFICATION CANCELED OR CHANGED
TO ________
BY AUTHORITY OF AFR 205-1 para 39D
BY M Vaf DATE 8-16-61

AC- PARAPHRASE NOT REQUIRED EXCEPT PRIOR TO CATEGORY B ENCRYPTION-PHYSICALLY REMOVE ALL INTERNAL REFERENCES BY DATE-TIME GROUP PRIOR TO DECLASSIFICATION-NO UNCLASSIFIED REFERENCE IF THE DATE-TIME GROUP IS QUOTED.

CLASSIFICATION	CRYPTO CENTER NO.	CRYPTOGRAPHER'S INITIALS	PAGE 1 OF 1 PAGES
~~CONFIDENTIAL~~			

AF FORM 101

Official Contacts [illegible] to [illegible] Republic [illegible] - Loss of F-105, [illegible] 54-098, [illegible] [illegible] (Oct)

3. Examination of the information and [illegible] on the [illegible] right main gear [illegible] attached to the aircraft revealed that the forward latch [illegible] had failed [illegible]. Failure of the [illegible] parts and retaining bolts of this latch [illegible]. Examination of the [illegible] retaining [illegible] of a [illegible] by the [illegible] revealed that the head of the [illegible] bolt contacted the landing gear fairing striker plate at the edge of the plate and [illegible]. Due to deflection of the structure [illegible] landing, the head of the bolt can easily slip off the striking plate, thus permitting the gear and fairing to [illegible] several inches. Ram air at 5[illegible] knots entering this [illegible] from air scoop opening will exert an internal pressure of approximately 873 pounds per square foot. This pressure acting [illegible] on the gear fairing coupled with the weight of the gear times the "G" load factor is more than necessary to deform the latch, thus freeing the gear.

4. Mr. [illegible] called this inadequate design to the attention of Mr. Kartveli, Vice President and Chief Engineer, and Mr. Bill [illegible], Design Safety Engineer. Mr. Kartveli stated that the design would be corrected before another F-105 would fly.

58-[illegible]-02

20 December 1955

Investigation of Facts, Republic [illegible] Aircraft Accident at Edwards AFB, California, on 16 [illegible] 1955

Mr. Sydney D. Berman, Engineering [illegible], AAB Division

Director, Flight Safety Research

X [illegible] - Aircraft Accident Investigation

1. Mr. Sydney D. Berman and Major [illegible] R. [illegible] were detailed to aid in the investigation of the subject accident. The subject aircraft, on bailment to Republic Aviation Corporation and flown by a civilian, had an accident necessitating a belly landing on Rogers Dry Lake. The pilot was uninjured. The aircraft's fuselage and wings sustained major damage.

2. The purpose of the flight was to evaluate the maneuverability and longitudinal control of the aircraft. In accomplishing a 5.5 "G" left turn at 510 knots at an altitude of 15,000 to 18,000 feet, the right landing gear unlatched and was torn from the aircraft. This gear was not recovered although the search by helicopter is still in progress. The pilot recovered control of the aircraft in approximately 15 seconds and effected a [illegible] landing on the dry lake at approximately 140 knots. The mechanism for retraction of the gear is by hydraulic means, utilizing a 3000 pound pressure system. The gear is held in the up position by mechanical means, fastened to the inner gear door. The restraining of the gear in the up position is accomplished by a restraining bolt on the inner gear door bearing against the striker plate of the landing gear fairing. This locking mechanism should be capable of retaining the gear in the up position against an applied load of 13 "G's". Interrogation of Republic personnel revealed that the locking mechanism had been tested only for 3 "G's", but that additional testing had been programmed.

3. The Engineering Branch will monitor gear retraction design, also Republic will notify the Directorate of Flight Safety Research when right gear is found.

Mr. Sydney D. Berman

AFCFS-[illegible] AFCFS-DA AFCFS-D
AFCFS-DAL AFCFS-DA

SR [illegible] for 14'

NARRATIVE REPORT

(Elaborate on pertinent prior data in appropriate spaces; include statement of unusual conditions, obstacles, deficiencies, meritorious actions, etc.; identify condition of personnel removed at the time rescue was effected; enter appropriate comments and recommendations involving organization, equipment, personnel, methods, training, etc., as developed by the incident and as may relate to improved efficiency.)

50. FIRE ACCIDENT STATUS

N/A

51. ALARM RESPONSE

Crash trucks were on standby, runway alert and runway standby upon notification from Control Tower that the aircraft was to crash land. All crash trucks responded and assumed normal positions on the runway.

52. ACCIDENT

Pilot radioed Control Tower that the right main gear had broken off in flight and that he would crash land with remaining gear up. Immediately upon impact the pilot blew the canopy. Aircraft then traveled for approx 2000 ft on the lake bed before stopping. Damage was to the underside and forward section of the aircraft.

53. FIRE CONTROL

Batteries were disconnected.

54. DEFICIENCIES

N/A

55. RESCUE EFFORT

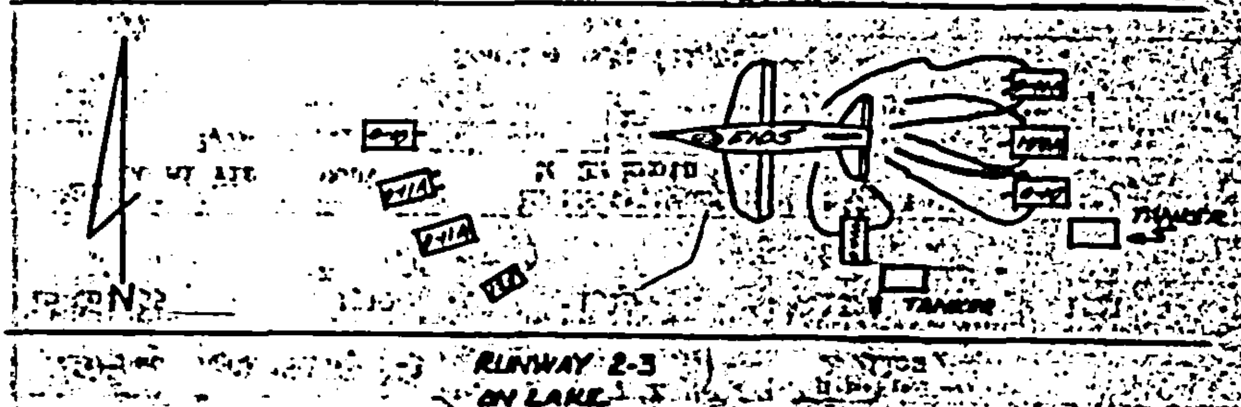
INDICATE LOCATION IN PLANE, DESCRIBE METHODS, EQUIPMENT AND CLOTHING USED. IDENTIFY CAUSE OF DEATHS AND INJURIES, ETC.

Rescue could have been made if necessary. All firefighters wore protective clothing.

56. COMMENT RECOMMENDATION

57. DIAGRAM

(Show location of aircraft at rest, placement of apparatus, turrets and hand lines operating, location of personnel in aircraft, points of entry and rescue, etc.)



APPROVAL AND REVIEW

[illegible] COLLINS Fire Chief DATE [illegible] Dec 55	FRANK [illegible] COLLINS, Col Comdr, [illegible] ABG DATE	59. REVIEWED BY COMMANDER USAF DATE 30 Dec	60. REVIEWED AND ENTERED BY (IN USAF) DATE

U.S. GOVERNMENT PRINTING OFFICE

55-12-16-422

AIRCRAFT CRASH FIRE AND RESCUE REPORT

REPORTS CONTROL SYMBOL AF-[illegible]

1. [illegible] | 2. [illegible] 29 Dec 55

Hq 6510 [illegible] (ARDC) | [illegible], Air Research & Dev Command

3. REPORTING INSTALLATION: Edwards AFB, Edwards, California | 4. [illegible]: P.O. Box 1395, Baltimore 3 Md. (RDSIDF)

I. IDENTITY OF ACCIDENT

5. LOCATION	6. ON / OFF BASE	7. DISTANCE FROM APPARATUS
[illegible] NACA Runway [illegible]	ON	2 Miles

8. DATE OF ACCIDENT	9. TIME OF ACCIDENT	10. TIME ALARM RECEIVED	11. TIME APPARATUS ARRIVED	12. TIME UNDER CONTROL
15 Dec 55	1505	1510	1522	1521

13. DELAY IN RESPONSE ☐ YES ☒ NO (If yes, give reason)

II. WEATHER

14. CEILING	15. WIND DIRECTION	16. WIND VELOCITY	17. TEMPERATURE (°F)	18. HUMIDITY (%)
25000, 60 Mi Vis	West	15 Knots, Gusting to 22 knots	61	60

III. NATURE OF ACCIDENT

19. FIRE INVOLVED N/A — A. BEFORE ACCIDENT; B. ON IMPACT; C. AFTER IMPACT; D. DAMP UP; E. NO FIRE

20. TYPE EMERGENCY — A. TAKE-OFF; B. LANDING ☒; C. IN FLIGHT ☒; D. ON LINE; E. IN PARK; F. TAXIING

21. DESCRIBE PRE-ACCIDENT STATUS OF AIRCRAFT: Routine Test Flight

22. LOCATION OF FIRE: N/A — A. INITIAL; B. ON ARRIVAL; C. ULTIMATE

IV. ALARM STATUS

23. NOTIFICATION BY (Identify order by number in appropriate box): A. RADIO-AIRCRAFT; B. RADIO-TOWER; C. TELE-TALK 1; D. CRASH-PHONE; E. OTHER

24. STATUS OF CRASH CREWS AT TIME OF ALARM: A. IN STATION ☒; B. LINE ALERT ☒; C. RUNWAY STANDBY ☒; REMARKS

25. DESCRIBE DELAYS OR DEFICIENCIES: N/A

V. AIRCRAFT

26. TYPE	27. MODEL	28. SERIAL NUMBER	29. NO. OF ENGINES	30. UTILIZATION
F-105	A	54O-98	(1) ☒ JET ☐ CONVENTIONAL	Test

31. FUEL ON BOARD	32. FUEL INVOLVED	33. OTHER HAZARDOUS CARGO
1700 lbs	None	Seat Ejection Cartridge

VI. TERRAIN

34. TYPE (Check as many multiple boxes as appropriate): A. RUNWAY ☒; B. TAXIWAY; C. APRON; D. HARDSTAND; E. REVETMENT; F. AIRFIELD ☒; G. OPEN FIELD; H. WOODS; I. OVERGROWN; J. HOUSING; K. SWAMP; L. WATER; M. OPEN WATER; N. MOUNTAIN; O. OTHER — P. DESCRIBE IF PERTINENT: N/A

35. CONDITION: A. CONCRETE; B. MACADAM; C. DIRT ☒; D. SAND; E. GRASS; F. HARD ☒; G. SOFT; H. WET; I. DRY ☒; J. LEVEL ☒; K. SLOPE; L. DITCH; M. OTHER — N. DESCRIBE IF PERTINENT: N/A

VII.

36. CAUSE OF ACCIDENT: Right gear broke off during flight

37. CAUSE OF FIRE: N/A

LOSS DATA

38. PHYSICAL EXTENT OF DAMAGE: A. [illegible] 100%; B. FIRE N/A; C. RESCUE EFFORT N/A

39. MONETARY LOSS: A. LOSS TO CONTENTS N/A; B. LOSS TO ADJACENT PROPERTY None; Not Available at this Hq

VIII. RESCUE

40. TOTAL NUMBER INVOLVED: One — A. CREW: One; B. PASSENGERS: N/A

41. TOTAL NUMBER OTHER THAN OCCUPANTS INVOLVED: N/A

A. TYPE OF RESCUE	B. NUMBER OF PERSONS	C. PHYSICAL INJURIES Major	Minor	None	D. BURN INJURIES Major	Minor	None	B. NUMBER OF PERSONS	C. PHYSICAL INJURIES Major	Minor	None	D. BURN INJURIES Major	Minor	None
(1) ESCAPED UNAIDED	1			1										
(2) RESCUED ALIVE														
(3) REMOVED DEAD														
(4) RECOVERED DEAD														

IX. OPERATIONS

42. TYPE AND REGISTRATION NUMBER OF ALL EQUIPMENT RESPONDING (List in order of arrival): O-10 AF-1592, O-11A AF-2717, O1 #505545, O-11A #2718, #2480, #2715; Tankers T-2034, T-2035, O-10 #1171, O1 # 502200

43. NUMBER OF PERSONNEL RESPONDING: A. CIVILIAN 14; B. MILITARY 19

44. SUPERVISORY CAPACITY IN CHARGE OF OPERATIONS: Fire Chief

45. EQUIPMENT [illegible]: O-10 #1592, [illegible] AF-3717, 730 #1933, 730 AF-3221

46. PERSONNEL REMAINING IN SERVICE: 20

47. METHOD OF FIRE CONTROL (General): N/A

48. METHOD OF RESCUE (General): N/A

49. EXTINGUISHING MATERIALS USED

A. WATER (gals)	B. CO2 GAS (lbs)	C. FOAM LIQ (gals)	D. FOAM POWD (lbs)	E. DRY POWD (lbs)	F. C. B. (gals)	G. OTHER
0	0	0	0	0	0	0

AF FORM 282 — REPLACES WD AGO FORM 9-6, WHICH IS OBSOLETE IN THE AF.

ACCIDENT BOARD ACTION FINDINGS

RECOMMENDATIONS

REMARKS REVIEW & ANALYSIS DIVISION

I concur with the findings and action taken to prevent recurrence. 5 APR 56 WM

REMARKS MEDICAL SAFETY DIVISION No Comment. ms

REMARKS I & S E DIVISION

ART REFERENCE SHEET DIV.

Operator's Name & Rank: [illegible]

Type, Model and Series	
Serial No.	54-098
Type	YF-105A

Missing Acft.	Command	Accident Number
—	AMC	55-12-16-402

Place of Accident: Edwards AFB [illegible]

Home Station: ~~[illegible]~~ ~~[illegible]~~ N.Y.

Activity or Mission Prior to Accident: [illegible] AF Base

Phase of Operation

10		Engines Running, Not Taxiing
20		Taxiing
21		To Takeoff
22		From Landing
23		Within Other Areas
30		Takeoff
31		Run
32		Climb
33		Discontinued
40		In Flight
41		Normal
42		Acrobatics
43		Formation Tactics
44		Other Maneuver
50	✓	Landing
51		Approach
52		Flareout
53		Roll
60		Go Around
80		Other
90		Undetermined

Type of Accident

	PRI	Sec	Sec	
01				Ground or Water Loop
02				Wing Tip Landing
03	✓			Wheels Up Landing
04				Hard Landing
05				Collapse or Retracting of Gear
06				Undershoot
07				Overshoot
08				Nose up or Nose Over
09				Collision with Other Aircraft
10				Collision with Ground or Water
11				Other Collision
12				Spin or Stall
13				Fire &/or explosion on ground
14				Fire/Explosion in Air
15				Air Frame Failure in Flight
16				Abandoned Aircraft
17				Prop or Jet Blast
18				Equipment Loss in Flight
98				NEC
99				Undetermined

Activity or Mission Prior to Accident

A		Rat Race
B		Acrobatic Maneuver
C		Ground Gunnery Pass
D		Aerial Gunnery Pass
E		Low Level Flight
F		Normal Flight
G		Under Control With Major Malfunction
H		Dive
I		Climb
J		Testing
K		Hovering
L		Join Up
M		Cross Over/Cross Under
N	✓	Adquly Done By Phase
P		Refueling
X		as NEC
Z		Undetermined

Conditions Affecting Accident

	PRI	Sec	Sec	
A				Immediate Forced Landing
B				Precautionary Landing
C				Fuel Exhaustion
D				Engine Stoppage or Flame Out
E				Lost on Navigation Accident
F				Non Compliance with T.O.
G				Simulated Emergency
H				Ditching
I				Water Landing — Other than Ditch
J				Explosive Decompression
K				Intentional damage to avoid greater damage
L				GCA or ILS Approach
M				Exceeded Mach or Near Mach (including probable)
O				Gear Failed to Extend
P				Prop Reversed
Q				Uncontrollable Porpoising, Buffeting, or Oscillating in Flight
R				Struck Arresting Barrier
Y				Other

Flight Reference

1	✓	Contact
2		Instrument (Actual)
3		Instrument (Simulated)
4		On Top
5		Transition
9		Undetermined

1	✓	Day
2		Night
3		Dawn
4		Dusk

1		In Formation
2	✓	Not in Formation

Aircraft Damaged		Persons Injured	
Destroyed	/	Fatal	
Substantial		Major	
Minor		Minor	
No		No	/

R. & A.	JR. & A.
Date 23 Jan 56	Date [illegible]
Coded by EB	EV by [illegible]

CAUSE FACTORS

UNSAFE ACTS: Pers Duty	MAJOR	Specific	Visit Item	UNSAFE CONDITIONS: MAJOR	Specific	Minor	Cross Ref	SEC	Cause Age	Basic Cause
				03	08	01		11	6	30
								Z		

[illegible handwritten remarks]

NOTE: If change is made subsequent to original evaluation — write in change indicate date of change and initial.

SMAMA- May 55 5M (OFF)

CONFIDENTIAL

[illegible], Aircraft Incident Report, IP-1054, S/N 54-0098

b. Part "T" of the DD Form 173 indicates the fuselage splice fitting at Station [illegible] is being reinforced and will be incorporated in aircraft 54-099 at the earliest possible date. What action is necessary to get this work accomplished? What directive will be forthcoming outlining this rework?

c. Paragraph 28 of the statement, by Mr. I. Stieglitz, indicates the front up-lock fitting of the right gear became disengaged as a result of the hook roller being forced past the locking cam. This occurred as a result of deformation of the hook pivot bolt and roller pin. If this is factual information, what corrective action is being taken?

5. Further request your comment concerning the report and the above paragraphs two(2), three(3) and four(4) be initiated and forwarded to arrive this Headquarters not later than 15 March 1956, in order that we may comply with paragraph 41e, AFR 62-14. Any other comments you may have, concerning this incident, will be appreciated.

6. No copy of the report is being forwarded since our letter of transmittal indicates copies of the report were forwarded the Commander, WADC and WADC (RDZ-1 SPA). We will appreciate you using one of the copies forwarded to WADC. If you desire us to have the report reproduced, please advise us by teletype and we will forward copies as expeditiously as possible.

FOR THE COMMANDER:

EHP

for ELLIS H. JONES, JR.
Major, USAF
Chief, Maint Engr Services Division

COORDINATION	
Tech	[illegible]
Sec Eng	
Br Sup	
[illegible]	
WWALC	
Supply	
Proc	

CLASSIFICATION CANCELED OR CHANGED
TO ____
BY AUTHORITY OF AFR 205-1 para 39A
BY M Vail DATE 8-16-61

56 MDE 1192

CONFIDENTIAL

CONFIDENTIAL

[illegible] (Incident) Subject: Aircraft Incident Report, YF-105A [illegible]

[illegible] 1st Ind [illegible]

FR: AIR RESEARCH AND DEVELOPMENT COMMAND, DETACHMENT #1, Wright-Patterson Air Force Base, Ohio ([illegible])

TO: Commander, Mobile Air Materiel Area, Attn: MOTAS, Brookley Air Force Base, Alabama

1. Generally, the findings and recommendations of the AFFTC Incident Report are concurred in. An analysis is being made and you will be advised of the action taken.

2. For your information the gear uplock fix currently installed in the number two "A" aircraft was tested to 120% ultimate load with no sign of failure.

BY ORDER OF THE COMMANDER:

W. R. RANKIN
Ass't Chief, F84/105 Weapon Systems Project Office
Fighter Aircraft Division
Directorate of Systems Management

CLASSIFICATION CANCELLED [illegible]
TO [illegible]
BY AUTHORITY OF AFR 205-1 [illegible]
BY [illegible] DATE 8-16-61

DOWNGRADED AT 3 YEAR INTERVALS;
DECLASSIFIED AFTER 12 YEARS.
DOD DIR 5200.10

56MOE 1192

CONFIDENTIAL

~~S-6 RDZ-1028~~

~~CONFIDENTIAL~~

[illegible]

31 JAN 1956

SUBJECT: Aircraft Incident Report, YF-105A, S/N 54-0098

TO: Commander
Air Research and Development Command
Attn: RDZ-1
Wright Patterson Air Force Base, Ohio

1. Reference the YF-105A, S/N 54-0098 incident which occurred 16 Dec 1955, at Edwards Air Force Base.

2. Part "H" of the DD Form 173 indicated the front up-lock fitting of the right main landing gear became disengaged at 5.5 - 6.0 G's as a result of the hook rollers being forced past the locking cam. This occurred as the result of deformation of the hook pivot bolt and the roller pin. Subsequently the right main gear was lost during flight. Part "N" of the DD Form 173 indicates the primary cause of the incident was the lack of adequate strength and rigidity in the up-lock mechanism. Paragraph "7B" of the Investigation and Analysis indicates that disassembly of the right up-lock assembly revealed severe bending and shear deformation of the hook pivot bolt, and also distortion of the pin holding the roller into the upper end of the lock. The roller was displaced so that it was riding the radius at the base of the cut-out in the hook, and was binding so that it could not be rotated by hand.

3. Request we be advised of Engineering Analysis that may be in progress or contemplated to prevent the landing gear from falling from the aircraft and failure of the splice fitting at Station 284 as outlined in the report.

4. The following facts are cited for your comments and/or action deemed necessary:

a. Part "K" of the DD Form 173 indicates the main landing gear up-locks are being revised to incorporate greater strength and rigidity. Revised locks will be installed on aircraft 54-099 before the Flight Test Program is resumed.

CLASSIFICATION CANCELED
TO
BY AUTHORITY OF AFR 205-1 para 39A
BY mvl DATE 8-16-61

~~CONFIDENTIAL~~

SCMOE 1192

Incl #2

~~CONFIDENTIAL~~

FTC ltr., Subject: Transmittal of Aircraft Incident Report, YF-105A, S/N 54-0098

MOG (10 Jan 56) 1st Ind MAR 2 8 1956

HQ MOBILE AIR MATERIEL AREA, Brookley Air Force Base, Alabama

TO: Office of The Inspector General, Attn: Safety Research and Analysis Division, Directorate of Flight Safety Research, Norton Air Force Base, California

1. ARDC generally concurs with the information in the report in that the primary cause of the incident was failure of landing gear up-lock mechanism to retain the gear in the up and locked position when approximately 5.5 - 6.0 g's were exerted on the aircraft. This failure was due to the lack of adequate strength and rigidity in the up-lock mechanism.

2. Reference paragraph 34, of the statement by William I. Stieglitz, which states "the main landing gear up-locks are being revised to incorporate greater strength and rigidity. Revised locks will be installed in aircraft S/N 54-099 before the flight test program is resumed". These revised up-locks, which were tested to 120% ultimate load with no sign of failure, were installed on the number two (2) airplane (S/N 54-099) prior to the first flight. Since the flight test program was resumed 27 January 1956, the landing gear up-lock mechanism has not shown any sign of failure.

3. In view of the above information and the fact that the YF-105A is a test airplane, no further action by this Headquarters is considered necessary.

LAURENCE B. KELLEY
Brigadier General, USAF
For and In the Absence of: FRED. R. DENT, JR.
Major General, USAF
Commander

1 Incl
w/d Incl #1
Added 1 Incl
2. Copy of MONTAE Ltr, dtd 31 Jan 56, w/1st Ind.

cc: AMC (MCAOF)
ARDC (RDZ-1)
AMC (MCMR)

CLASSIFICATION CANCELED OR CHANGE
TO
BY AUTHORITY OF AFR 205-1 para 39
BY M Vail DATE 8-16-61

~~CONFIDENTIAL~~

FSR
4LDR

56MOE 1192

file

107322

~~CONFIDENTIAL~~

OFFICE OF THE COMMANDER
AIR FORCE FLIGHT TEST CENTER
Air Research and Development Command
EDWARDS AIR FORCE BASE
CALIFORNIA

FTG

SUBJECT: Transmittal of Aircraft Incident Report, YF-105A, S/N 54-0098

TO: Commander
Mobile Air Material Area
Brookley Air Force Base
Alabama

1. In accordance with paragraph 41a (5), AF Regulation 62-14, dated 3 June 1954, transmitted herewith are Reports of Aircraft Incident concerning YF-105A, S/N 54-0098, that occurred on 16 December 1955.

2. The undersigned has personally reviewed this Report and concurs in the findings and recommendations of the Aircraft Incident Investigating Officer.

3. No further action is contemplated by this Center.

J. S. Holtoner

1 Incl
Rpt Acft Incd (2 cys)

J. S. HOLTONER
Brigadier General, USAF
Commander

DISTRIBUTION:

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AFPR, Republic Aviation	1	Cy
AFFTC File	1	Cy

CLASSIFICATION CANCELED ~~SECURITY~~
TO
BY AUTHORITY OF AFR 205-1 par 31b
BY M Vail DATE 8-16-61

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SPECIAL HANDLING REQUIRED IAW PARAS 49A AND 52, AFR 62-14

56MOE 1192

~~CONFIDENTIAL~~

55-0-1550

DIRECTORATE OF FLIGHT SAFETY RESEARCH
Office of The Inspector General
United States Air Force
Norton Air Force Base, California

Page ______

Control No: 4-C-23

Suspense Date ______

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TO	TO		INIT	DATE	REMARKS
		DIRECTOR FSR			
		DEPUTY DIRECTOR			
		EXECUTIVE			
		Navy Liaison			
		AACS Liaison			
		AWS Liaison			
		INVES & SAFETY ENGR DIVISION			
		Division Administrative Staff			
		Fighter Branch			
		Bomber Branch			
		Cargo Branch			
		Engineering Branch			
		Opns & Facil Branch			
		Guided Missiles Branch			
	/	SAFETY RESEARCH & ANAL DIVISION	[illegible]	20 Apr	
		Division Administrative Staff			
		Processing & Coding			
		Research & Special Study			
		Investigative Anal Branch			
		AERO MEDICAL SAFETY DIVISION			
		Division Administrative Staff			
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		SAFETY EDUCATION DIVISION			
		Division Administrative Staff			
		Flying Safety Magazine			
		Production Branch			
		Acft Acdt Maint Review			
		Information Education Branch			

FOR: Action's) as checked:

______ Information ______ Action

______ File

NOTE: This circulation slip will remain with and become a part of the record while in this Directorate. Informal reply may be made under "Remarks" also on reverse side, turning bottom edge up.

PLEASE INITIAL APPROPRIATE BLOCK

FORM 14 SUPPLEMENTAL DATA

ROUTINE SLIP

ACCIDENT NR. 55-12-16-402

		DATE	INITIAL	DATE
✓	INVESTIGATIVE ANALYSIS BRANCH	4/2	WM	5 Apr 56
	AERO MEDICAL SAFETY			
	ENGINEERING BRANCH			
	CARGO & TRAINER BRANCH			
	FIGHTER BRANCH	28 Mar 56	[illegible]	[illegible]
	FACILITIES BRANCH			
	SAFETY EDUCATION			

SUBJECT:

COMMAND CORRESPONDENCE	
AMC LETTER	✓
TEARDOWN DEFICIENCY REPORT	
UNSATISFACTORY REPORT	
REBUTTAL (S)	
MATS COMMENTS	
FORM 14B	
FORM 14C	
SPECIAL INVESTIGATION IND	
ANSWER TO CORRESPONDENCE	
SUPPL ACDT INFO:	

REMARKS: Closed out

~~CONFIDENTIAL~~

OFFICE OF THE COMMANDER
AIR FORCE FLIGHT TEST CENTER
Air Research and Development Command
EDWARDS AIR FORCE BASE
CALIFORNIA

FTG

SUBJECT: Transmittal of Aircraft Incident Report, YF-105A, S/N 54-0098

TO: Office of The Inspector General, USAF
Norton Air Force Base
California

1. In accordance with paragraph 41a (1), AF Regulation 62-14, dated 3 June 1954, transmitted herewith is Report of Aircraft Incident concerning YF-105A, S/N 54-0098, that occurred on 16 December 1955.

2. The undersigned has personally reviewed this Report and concurs in the findings and recommendations of the Aircraft Incident Investigating Officer.

3. No further action is contemplated by this Center.

1 Incl
Rpt Acft Incd

J. S. Holtoner

J. S. HOLTONER
Brigadier General, USAF
Commander

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Comdr, MOAMA	2	Cys
AFPR, Republic Aviation	1	Cy
AFFTC File	1	Cy

CLASSIFICATION CANCELLED OR CHANGED
TO ______
BY AUTH. AFR 205-1 par 39A
BY McVail DATE 8-16-61

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SPECIAL HANDLING REQUIRED IAW
PARAS 49A AND 52, AFR 62-14

2 Feb

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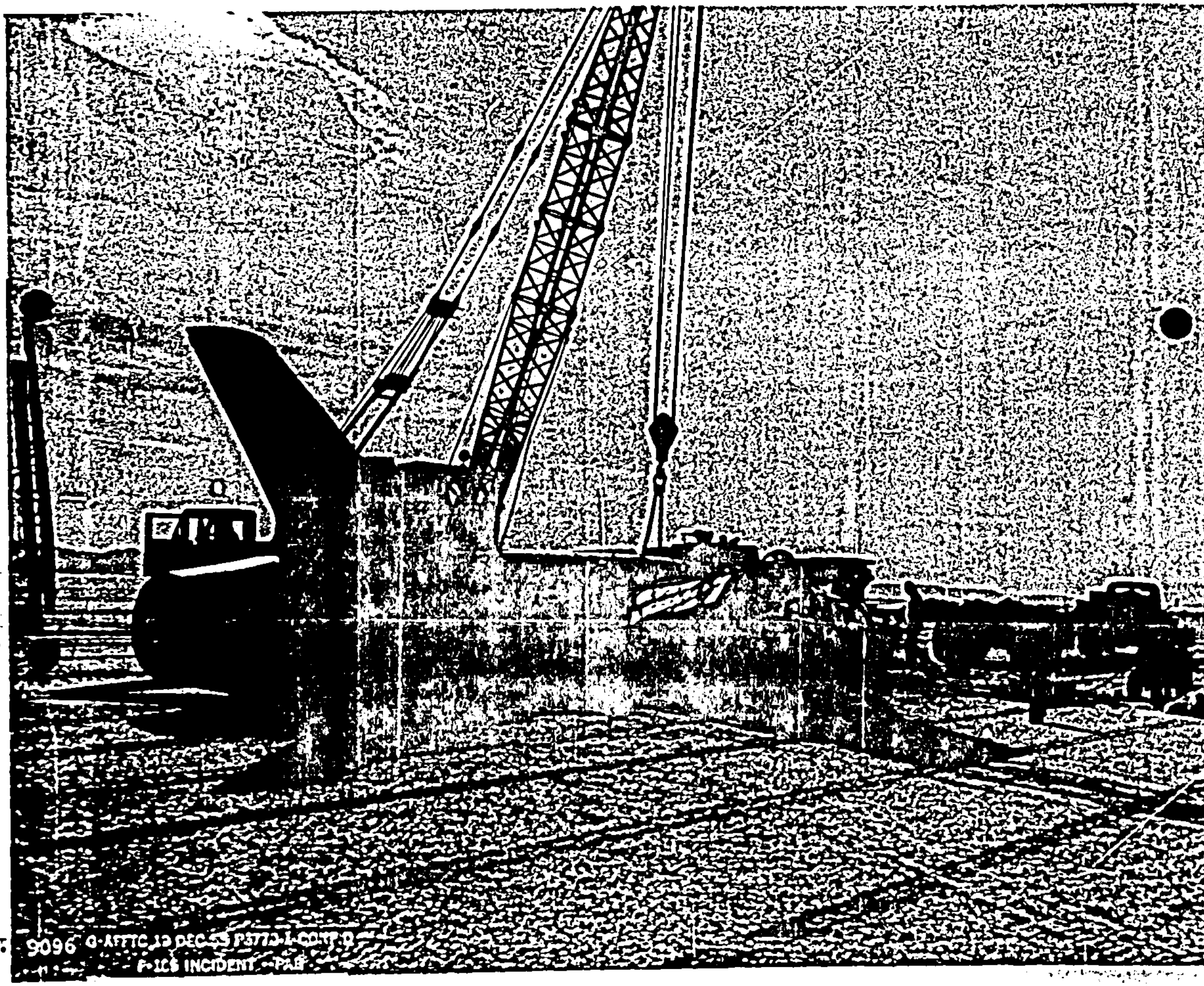
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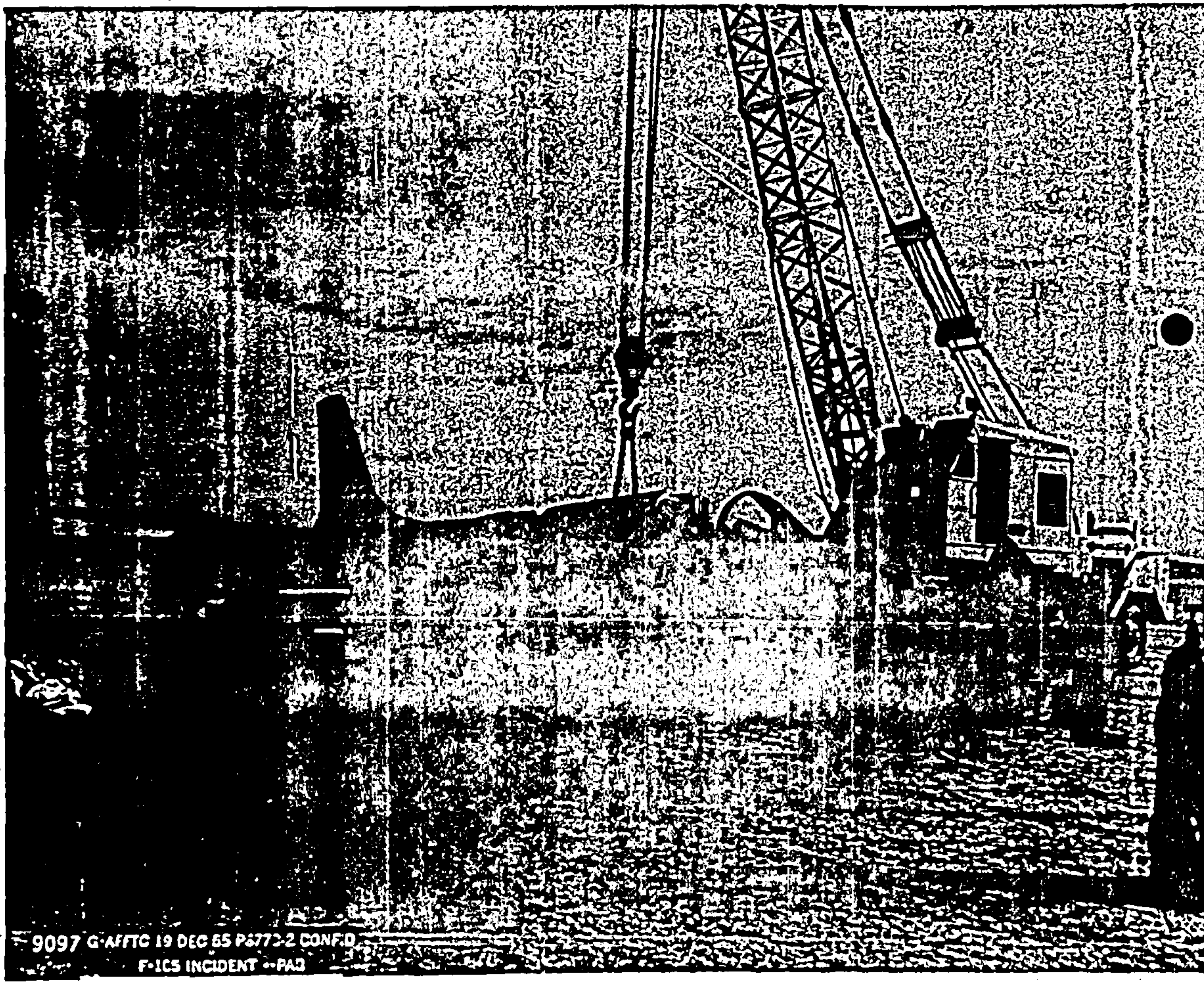
INCIDENT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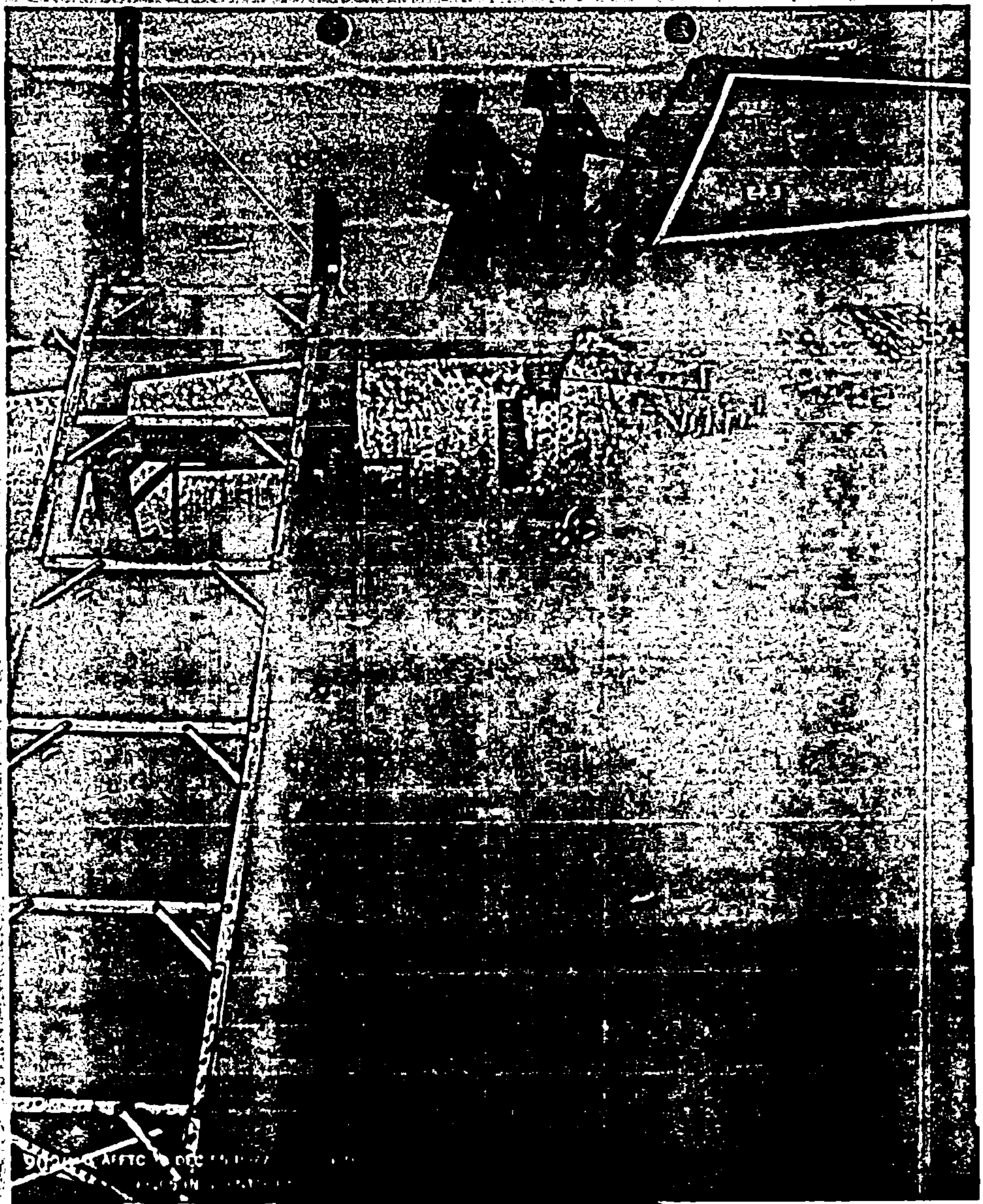
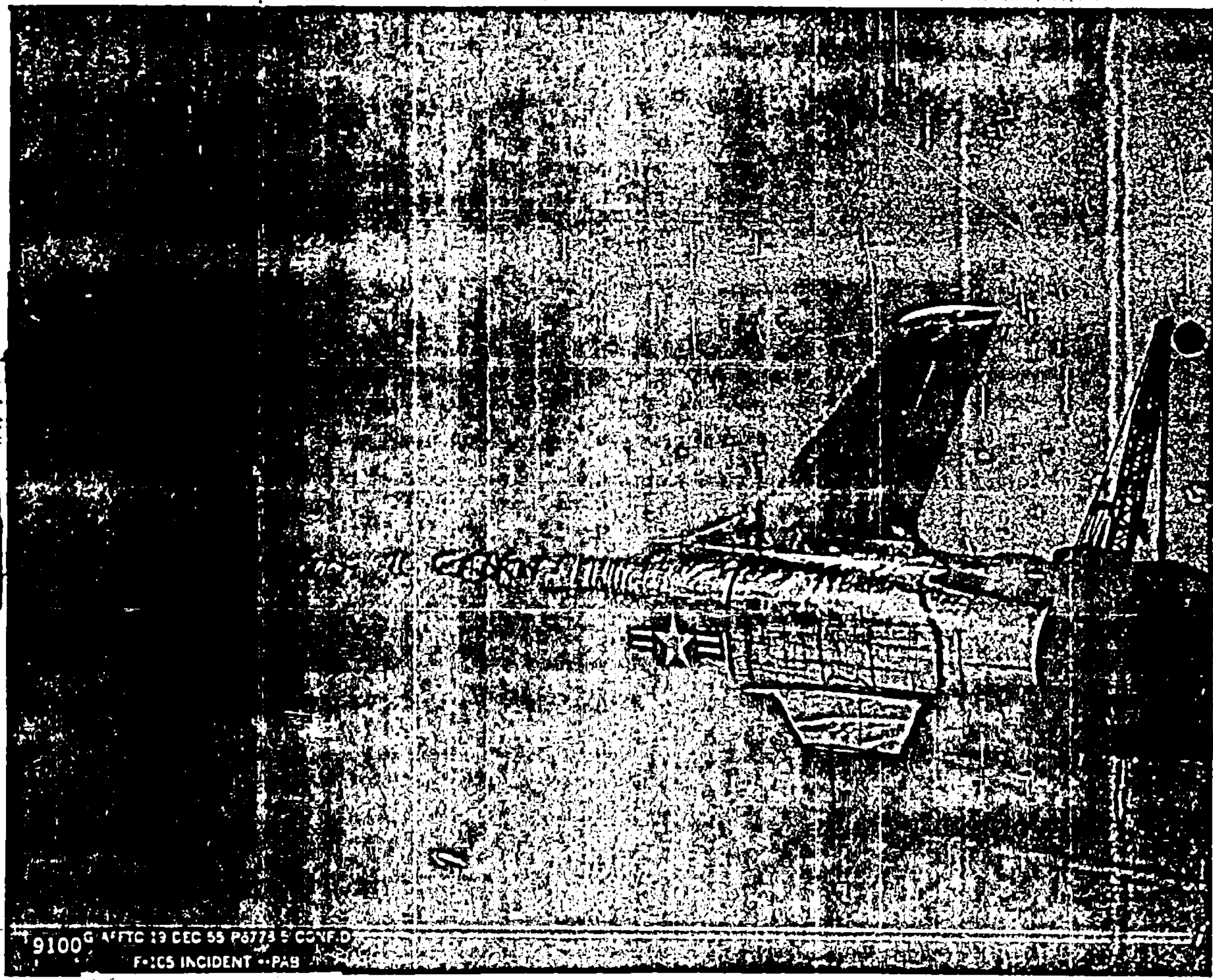

AFFTC
DEC


9099 G AFFTC DEC 55
INCIDENT



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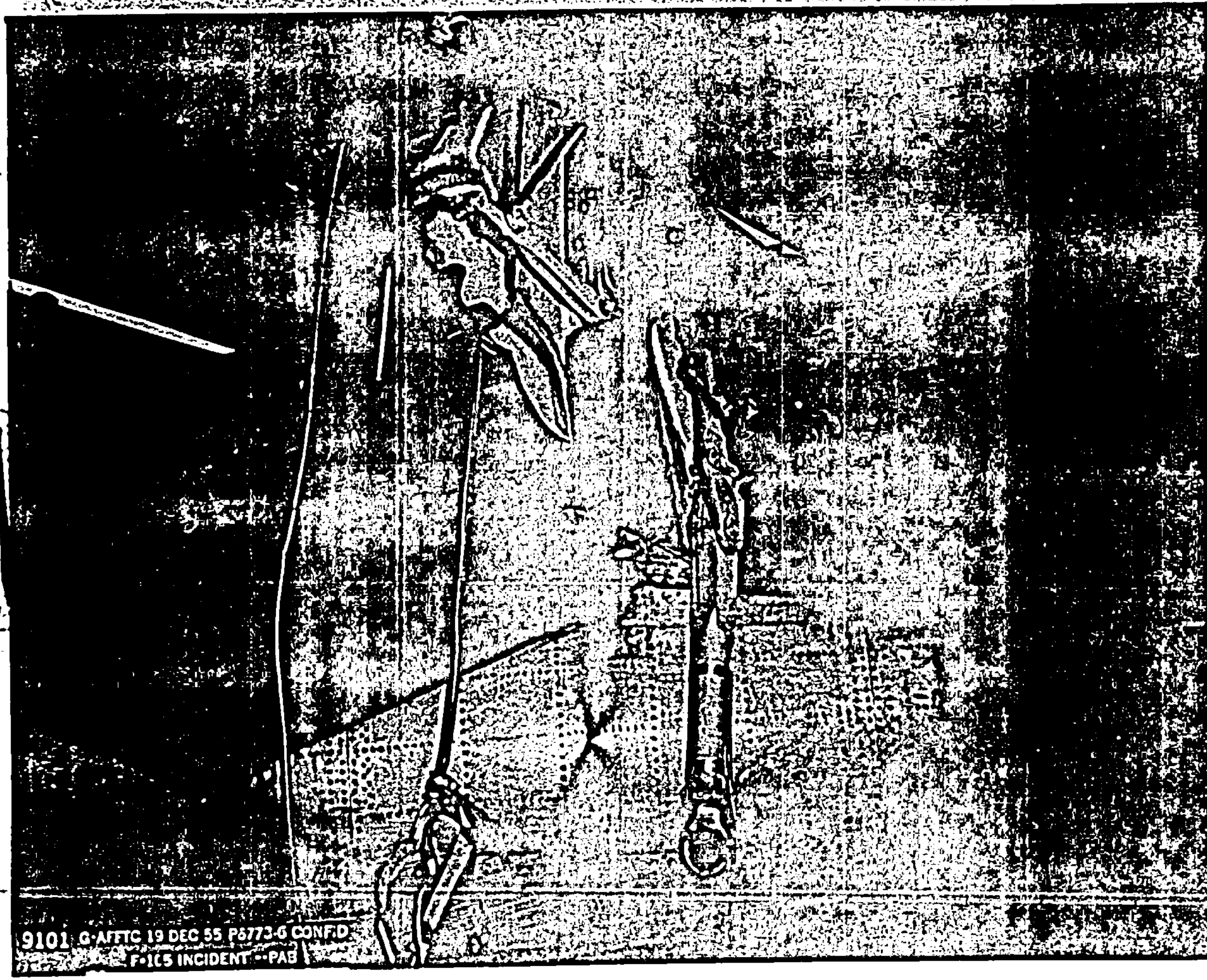
F-:CS INCIDENT --PAB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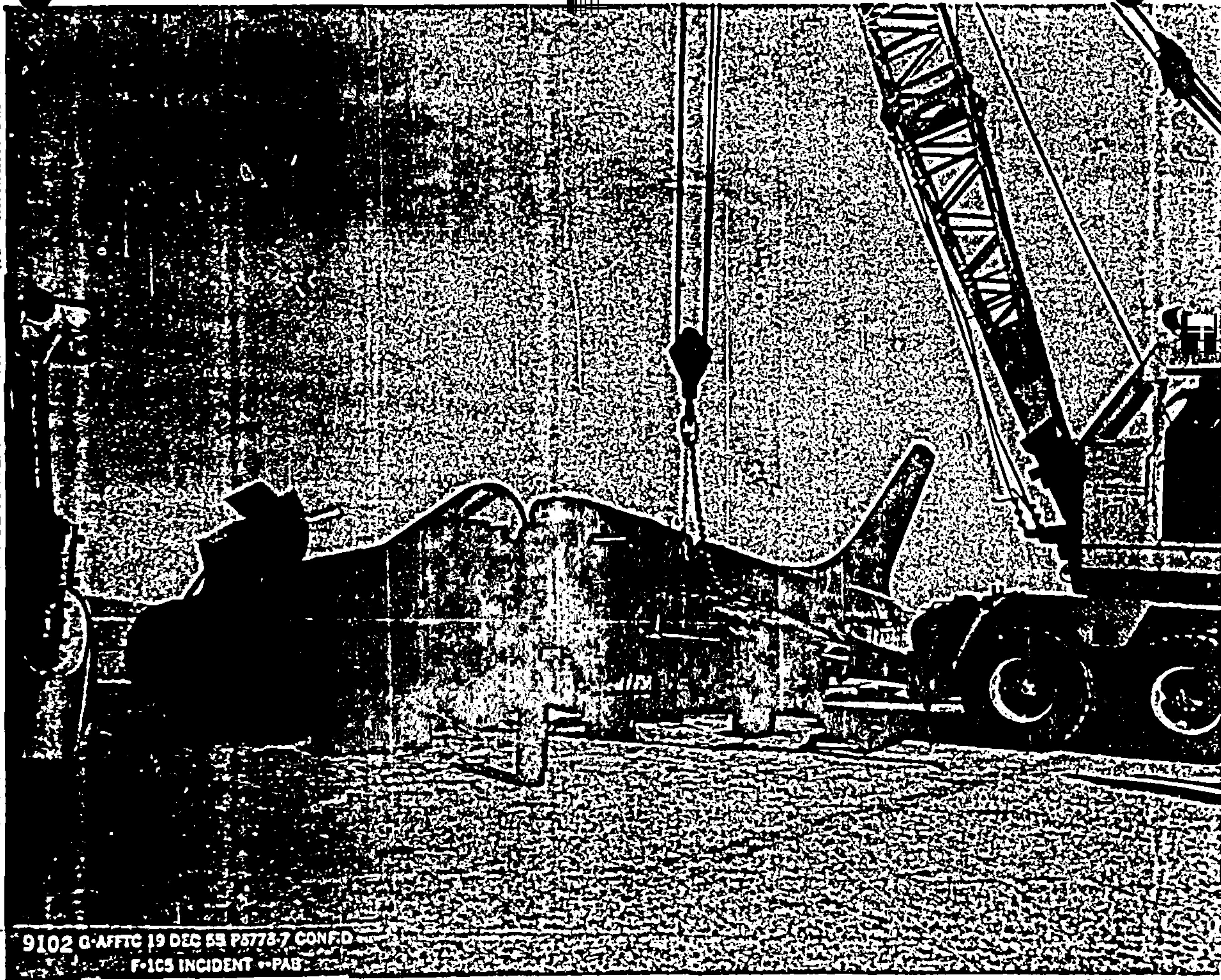
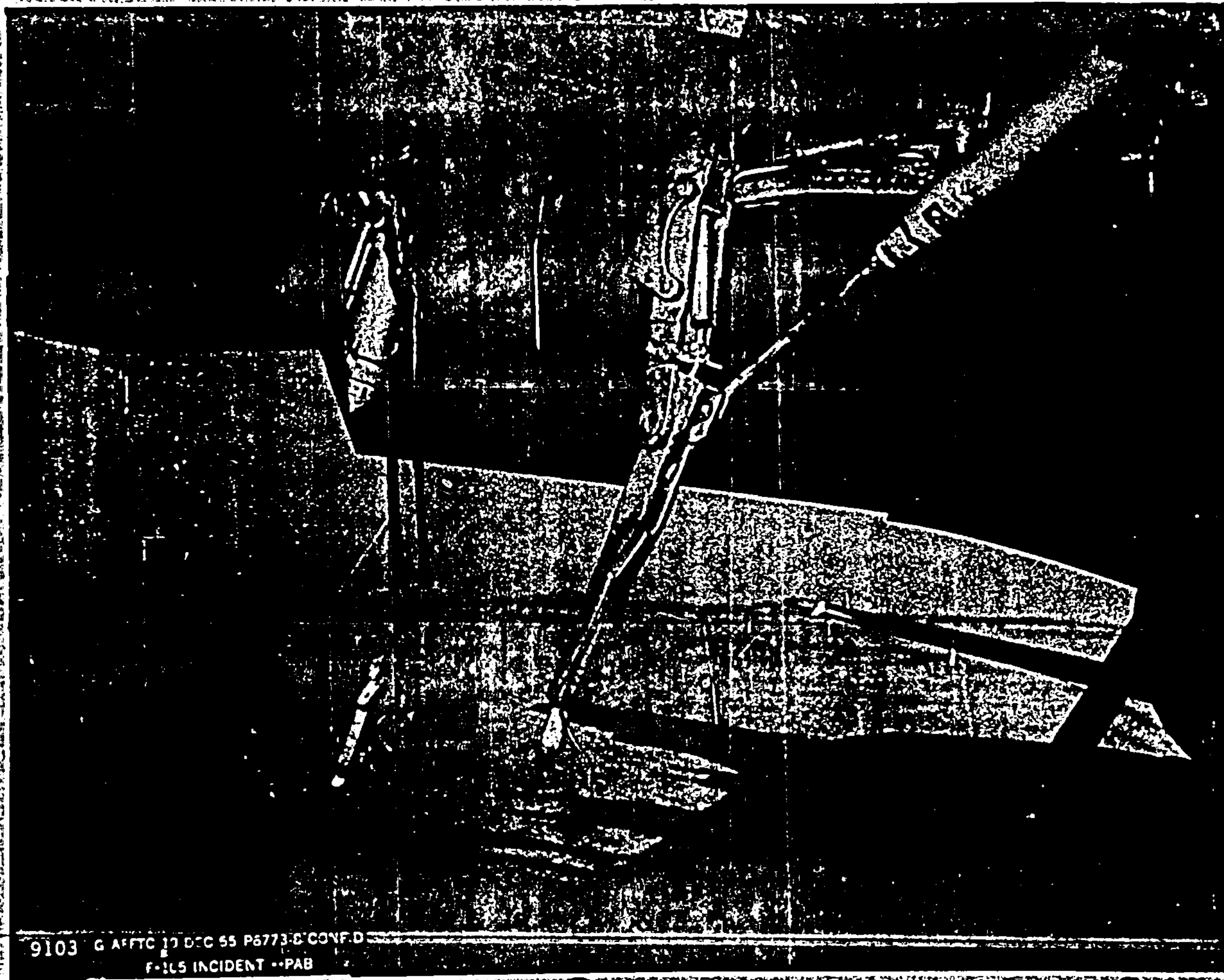
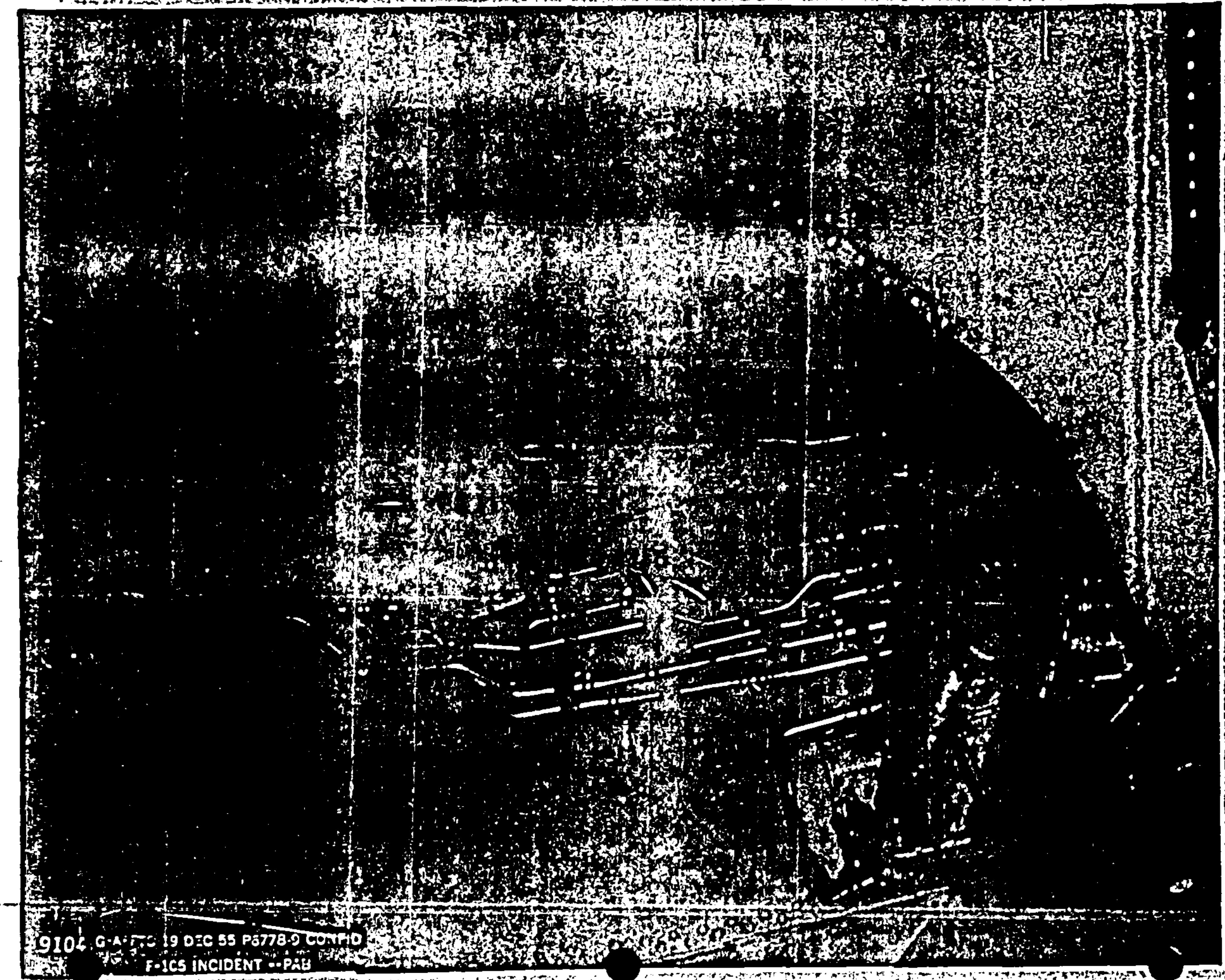
F-105 INCIDENT --PAB


9102 G-AFFTC 19 DEC 58 P5778-7 CONF'D
F-1C5 INCIDENT --PAB


9103 G AFFTC 17 DEC 55 P6773-C CONF.D
F-105 INCIDENT --PAB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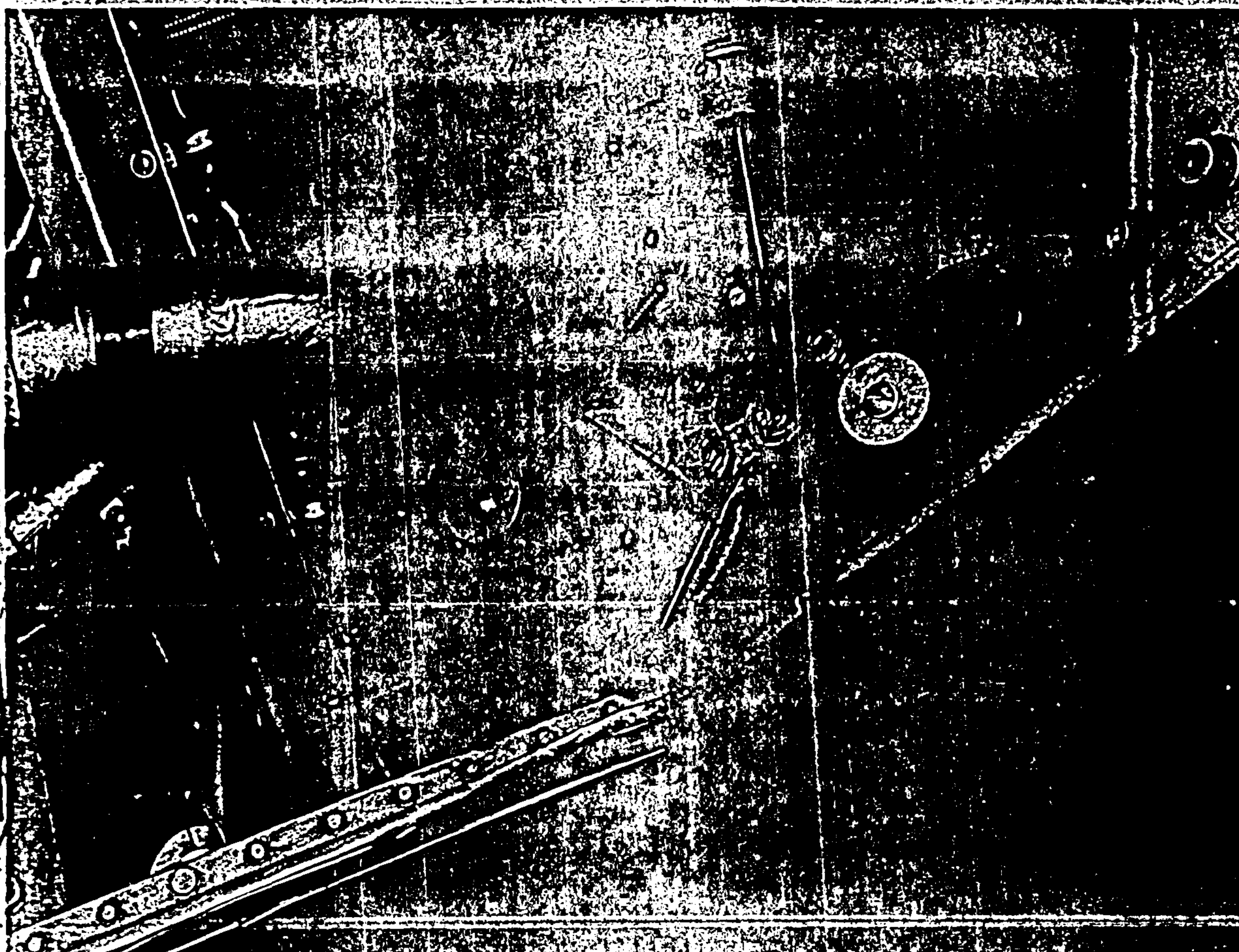
F-1CS INCIDENT --PAB



116-RAC-AFFTC-16 DEC. 55-YF-105A S/N 54-098-2?5-GEAR UP LANDING
FORWARD INNER DOOR UPLOCK HOOK

09/10/56

09/01/59

09/10/56
09/01/59

could eject right through the canopy without having to jettison it first.

On January 1, 1957, the YF-107A contract was amended to provide for only three flying examples, plus one static test airframe.

The first F-107A (serial number 55-5118) took off on its maiden flight on September 10, 1956 at Edwards AFB, with NAA test pilot Bob Baker at the controls. It went supersonic on its first flight, although there was some minor damage upon landing when the drag chute malfunctioned and the aircraft overran the end of the concrete runway and ended up in a ditch. The aircraft was quickly repaired and flew again three days later.

55-5118 achieved its first Mach 2.0 flight on November 3, 1956.

55-5119 flew for the first time on November 28. It was equipped with the armament of four 20-mm cannon and was assigned the job of carrying out performance and integrated control system testing, and was to check out the separation characteristics of the centerline store.

55-5120 flew for the first time on December 10. It was the first YF-107 to have the fully-automatic variable area inlet duct. Unfortunately, the variable-geometry duct did not live up to its expectations. In spite of repeated attempts at steady climbs at subsonic or supersonic speeds and even zoom climbs from maximum speed at 35,000 feet, 55-5120 was never able to get above 51,000 feet. This was blamed on problems with the variable-geometry intake duct and with the J75 engine, both of which were relatively new at the time. In addition, there was an annoying "buzz" in the variable air intake at high speeds, which was traced to instability of the airflow at the inlet.

55-5118 was asssigned the taks of exploring the zoom climb characteristics. Test pilot Al White was able to start off at 39,000 feet at Mach 2.1, and was able to reach a maximum height of 69,000 feet.

55-5119 was assigned the job of evaluating the weapons delivery system. It was the only one of the three F-107 prototypes to be fitted with the four 20-mm M39 cannon. Wind tunnel tests had suggested that there might be problems with the release of weapons from the streamlined centerline container at supersonic speeds. After some initial problems, on February 25, 1957, test pilot Al White finally successfully delivered the weapon store while flying at Mach 1.87 over the Naval test range at China Lake.

The F-107A found itself in direct competition with the Republic F-105 Thunderchief for production orders. In March 1957, the USAF decided to go with the F-105, and the F-107 was relegated to aerodynamic testing duties. The first and third F-107As were turned over to NACA for high speed flight testing work.

The first F-107A (55-5118) reached NACA at Dryden on November 6, 1957. It was given the NACA number of 207. However, it was so mechanically unreliable that it was grounded by NACA after only four flights and was scavenged for spare parts to keep the other one flying.

The third F-107A (55-5120) reached NACA at Dryden on February 10, 1958. The flight testing of the variable geometry intake of the aircraft was cut short because of its mechanical problems. Eventually, NACA gave up on the F-107A's variable-geometry inlet altogether and it was bolted fixed in position, limiting top speed to Mach 1.2. This aircraft also experienced buffeting problems at high angles of attack. 55-5120 completed some forty test flights for NACA/NASA during 1958-59. On the basis of F-107 flight testing, North American refined the design of the side-stick planned for the X-15. 55-5120 was damaged on September 1, 1959 when test pilot Scott Crossfield was forced to abort a takeoff because of control problems. Both tires blew and the left brake burst into flames. Crossfield was uninjured, but the resulting damage to the F-107A was deemed to be too severe for economical repair, and NASA decided to scrap the aircraft. It was cut up and its fuselage shipped to Sheppard AFB in Texas where it was used for as a fire fighting training aid.

The other two F-107As still survive. After being retired by NASA, F-107A number 55-5118 was turned over to the Pima Air Museum in Tucson, Arizona, where it is now on display. F107A number 55-5119 is in the Air Force Museum at Wright-Patterson AFB in Ohio.

Serials of North American YF-107A:

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55-5118/5126     North American YF-107A
                           5121/5126 cancelled.
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Specification of the YF-107A:

Engine: One Pratt & Whitney YJ75-P-9, 17,200 lb.s.t. dry and 24,500 lb.s.t. with afterburning. Performance: Maximum speed: 890 mph at sea level, 1295 mph at 36,000 feet. Initial climb rate: 39,900 feet per minute. Service ceiling 53,200 feet. Normal range 788 miles, maximum range 2428 miles. Dimensions: wingspan 36 feet 7 inches, length 61 feet 10 inches, height 19 feet 8 inches, wing area 376 square feet. Weights: 22,696 pounds empty, 39,755 pounds gross, 41,537 pounds maximum takeoff. Total internal fuel capacity was 1260 US gallons, carried in fuselage tanks and in two wing cells. Additional fuel could could be carried in a recessed centerline external tank, as well as in drop tanks carried undereneath underwing hardpoints. Armament consisted of four 20-mm cannon M39 cannon with 200 rounds per gun (fitted only to 55-5119). A centerline position was provided for a recessed store. Six underwing pylons could be

October 1956

XV-3

Bell

Tilt Rotor

Resto

Origin of the Species | Bell XV-3 Tilt-Rotor

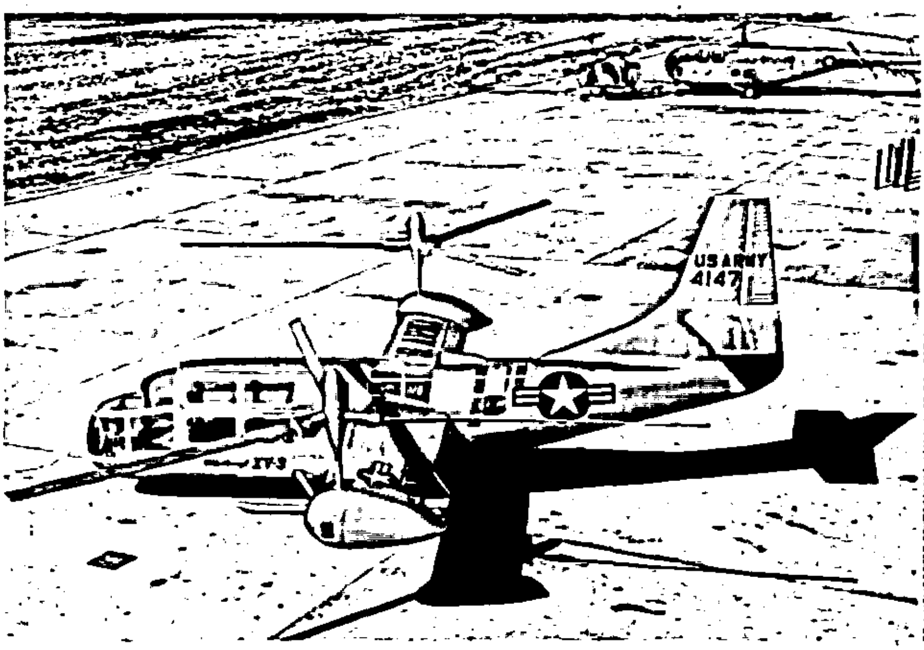
Nearly a half-century ago, a hybrid aircraft with a stubby nose, truncated wings, and propeller rotors became the aeronautical headliner at the Bell Helicopter Company. Work on a combination helicopter and fixed-wing aircraft had begun in the late 1940s, when the industry accepted that the helicopter's usefulness was limited by its comparatively low speed. The XV-3 was unveiled at Bell's Hurst, Texas facility on February 10, 1955, and six months later, on August 11, it was flown in hover mode for the first time by Bell's chief test pilot, Floyd Carlson. On December 18, 1958, in the hands of test pilot Bill Quinlan, it became the first tilt-rotor aircraft to transition from vertical to horizontal flight and back again. Over the next eight years the tilt-rotor underwent extensive flight testing, the last segments in May 1966 at the 40- by 80-foot full-scale wind tunnel at NASA's Ames Research Center in California. The XV-3 logged 270 flights and tutored 11 Army, Air Force, NASA, and Bell pilots. (The first XV-3 was lost in October 1956 when a rotor instability problem led to an uncontrollable descent and hard landing. A second prototype, significantly modified, stepped in to replace it.)

Initially, Bell designated the convertible aircraft the model 200. As a joint Army and Air Force project, its given name—its military designation—was XH-33 (experimental helicopter), which eventually became XV-3 (experimental vertical) to better denote its capabilities. Like a helicopter, its lift came from rotor blades, but unlike most helicopters, it had two sets of rotors, one at each wingtip. The masts supporting the rotors were rotated by electric motors from vertical to horizontal to transition the craft from helicopter mode to fixed-wing-airplane mode.

Retired Bell engineer Ken Wernicke was a key player in the company's post-XV-3 tilt-rotor development. "In 1964, I went to work for Bob Lichten, and we looked at all sorts of ways to combine the helicopter and the fixed-wing aircraft," he recalls. "We looked at slowed rotors, stopped rotors, and folding rotors. To my mind, they were all garbage. We also looked at the variable-diameter rotor, which turned out to be too complex." Basing his assessment on his experience with the XV-3 in its final years of flight testing, Wernicke says, "The tilt-rotor was the only feasible way to go." Bell Helicopter Textron experimented with the twin-engine proof-of-concept XV-15 tilt-rotor in the 1970s, and in the 1980s teamed with Boeing to produce the V-22 Osprey. Today, the direct descendant of the XV-3 is in test and evaluation at U.S. Navy and Marine Corps bases in Maryland, North Carolina, and California.

After the wind tunnel tests, XV-3 no. 2 was turned over to the U.S. Air Force Museum at Wright-Patterson Air Force Base in Ohio, then was placed in outdoor storage at Davis-Monthan Air Force Base in Arizona. Several years later it was moved to the Army Aviation Museum at Fort Rucker, Alabama, cosmetically restored, and sent back outside for display, where it slowly deteriorated.

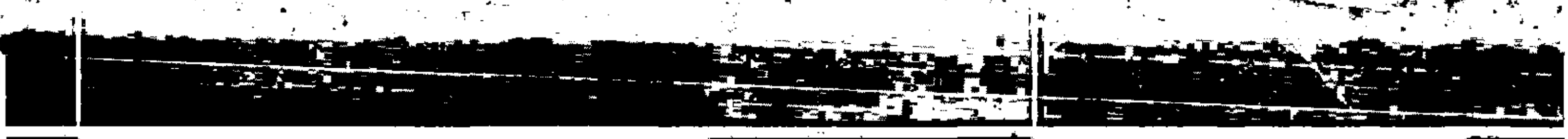
Last fall, a photo of the XV-3 in the Hurst office of Bell Helicopter's new



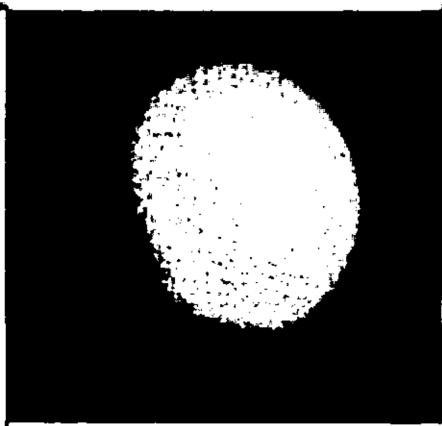
BELL HELICOPTER TEXTRON VIA JAY MILLER COLLECTION

JAY MILLER

The first of two Bell XV-3s rolled out of the Hurst, Texas plant in 1955 (left). An electric motor moved the rotors from vertical to horizontal in 20 seconds (above).



Computer screens in Darmstadt, Germany will get the first views from Huygens of Titan's surface.



Titan looks orange for the same reason skies over Los Angeles do: hydrocarbons in the atmosphere.

Space exploration has always been an odd blend of millennial vision and civil-service bureaucracy, and Cassini-Huygens has seen extremes of both during its quarter-century gestation. The visionaries who got it started were inspired, in their various countries, by Voyager, which opened the outer solar system in the early 1980s and convinced space aficionados that unmanned missions could be as much of a rush as Apollo. "I remember investigators fighting for a seat at the terminals at JPL so they could look at Voyager images on closed circuit," recalls the University of Arizona's Jonathan Lunine. Titan, obviously reachable yet still unseen, struck this throng of scientific imaginations as a natural focus followup.

The idea of Europe going to Saturn, David Southwood recalls, was at the time "seen as laughable" to anyone outside the visionary circle and many within. ESA had been formed only seven years before—in 1973, when John Glenn was already a U.S. senator and Yuri Gagarin was long dead—and its mission, beyond building a rocket with a French name, was unclear. Then Daniel Gautier found a resourceful ally in Wing Ip, an astronomer who lobbied for a Titan probe while at Germany's Max Planck Institute in the early 1980s and now works at Taiwan's National Central University. When in 1982 ESA put out an all-points-bulletin for mission proposals, Ip set to work on a Titan plan. "ESA was very flexible just then," Ip notes. "It was a chance that didn't happen often and might not happen again."

Not that Ip—who was born in Macau, earned his doctorate at the University of California at San Diego, and then followed his thesis adviser to Max Planck—immediately found common language with Gautier, a Parisian who in the Voyager period was working at NASA's Goddard center. "Daniel, being French, thought he owned Titan and no one should interfere with his plans," Ip remembers. "But eventually he agreed to talk to me."

Upstart ESA was raising the level of its game elsewhere too. In 1985, it showed up NASA by sending the Giotto probe to Halley's Comet, cooperating with the Soviets and Japanese, who also sent spacecraft. The United States alone sat out the mission to Halley.

Besides the independent streak in U.S. space policy, NASA's bureaucratic customs differ from those of ESA, most markedly in budgetary practices. The 15 nations that kick in funds to Europe's space agency make up their collective mind slowly. The Huygens team worked for five years before its first presentation to the ESA board, and final project approval came only in 1988. But once a project is okayed, funding is locked in until the mission is finished, and that rigidity proved a lifesaver for Cassini-Huygens during decades of shifts in the U.S. Congress' moods. ESA's firm resolution stayed Congress' hand in 1993-'94, when budget hawks had Cassini in their sights, Toby Owen recalls. "When we were hanging by a thread, the director general of ESA wrote to Newt Gingrich telling him Europe wouldn't support the International Space Station if the U.S. didn't back Cassini," Owen relates. "Without ESA, we wouldn't be here."

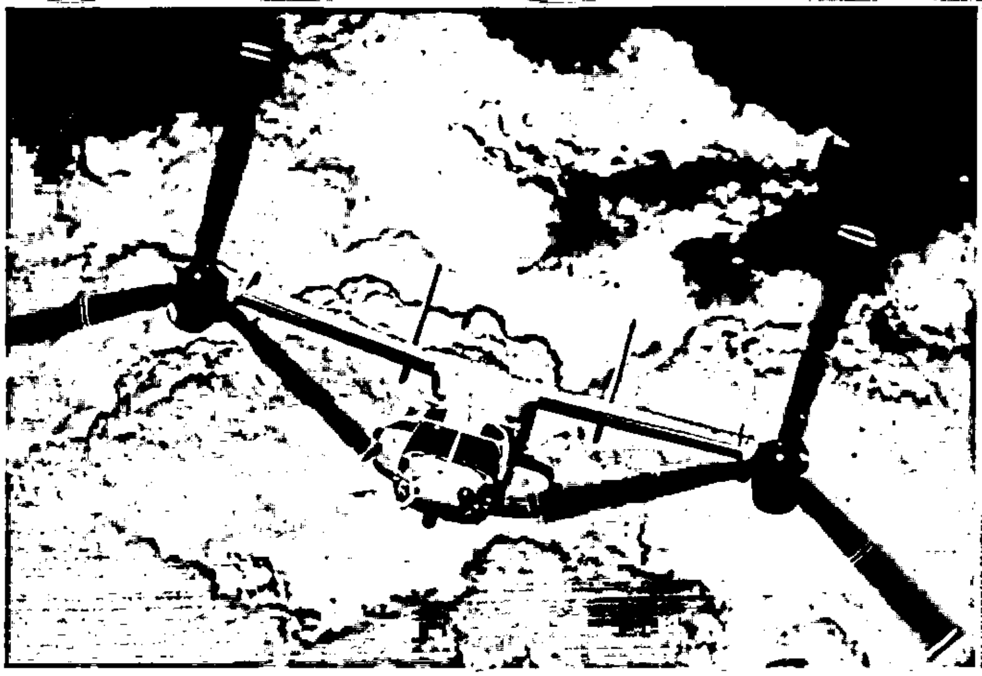
"Here," for the little disk of hope and dreams called Huygens, is two billion miles away and approaching Saturn, its computers to be awakened for one final diagnostic before Christmas, when it cuts its Cassini umbilical cord and hurtles into black space. For space veterans like Toby Owen and Daniel Gautier, "here" tends to be a restless orbit around the globe, anywhere there are ideas to be shared and plans to be laid for the next grand scheme—a lander for Jovian moons Europa and Ganymede, a Titan orbiter accompanied by balloons that could float and photograph just above the surface. Requests for interviews for this story found Huygens scientists perpetually somewhere else—the Arizonans in Grenoble or London, the Parisians at Goddard and JPL.

For Lebreton and the cadre of scientists who have coddled Cassini-Huygens through the years, "here" means approaching one of the watersheds of their lives, and some disquiet can be expected. François Raulin, a University of Paris professor who is Huygens' senior chemist, speaks for the group when he is asked what happens if the mission flops. "I don't want to think about that," he answers flatly. What they can do from here on to avoid spectacular (if noble) failure or assure spectacular success is exactly nothing.

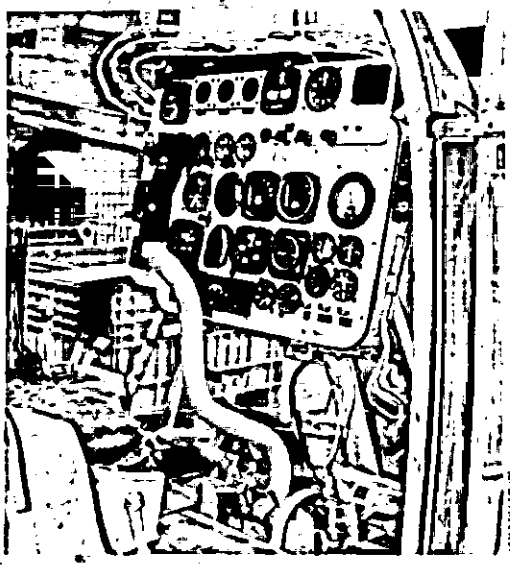
Charting the trajectory of a path-breaking space mission like Cassini-Huygens reveals a vivid paradox: Those who push the edges of mankind's envelope must live by old-fashioned—certainly pre-Baby Boomer—principles of patience and dedication, soldiering on for decades in the face of technical and political obstacles, and living always with the significant chance that it won't work—that all you will have for the best years of your life is a good, honorable try. Offsetting this insecurity, space scientists live with an old-fashioned faith: that they are part of a great venture whose ultimate success is inevitable, whether now or a generation hence.

ration

chief executive officer, Mike Redenbaugh, triggered a discussion. Retired Bell executive Dick Spivey noted the XV-3's importance to the company's unique tilt-rotor history, and lamented that "the aircraft is deteriorating and it's only a matter of time before restoration efforts could prove futile." Bell employees were aware of the aircraft's condition, he told Redenbaugh, "but earlier attempts to save it received virtually no company support at a corporate level."

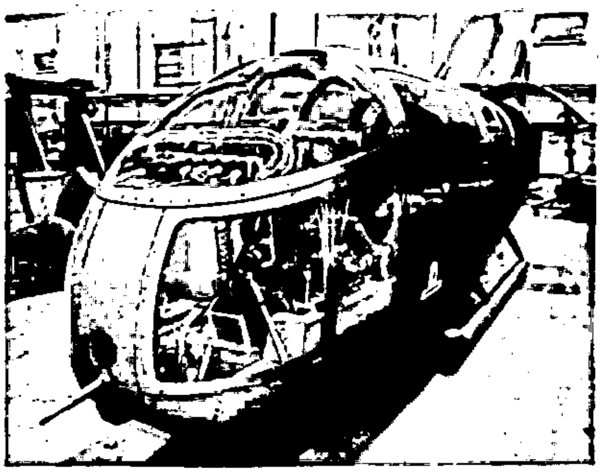


BELL HELICOPTER TEXTRON



JAY MILLER (2)

Controls included a helicopter collective that phased out as the XV-3 converted to airplane mode.



An early V-22 Osprey (above) bears little resemblance to its XV-3 predecessor (left), but the lineage is direct.

In weeks, Spivey and Major General Charles Metcalf, director of the Air Force Museum, met in Fort Rucker, where it was agreed the XV-3 would be turned over to Bell for restoration. The aircraft's wings, horizontal tail surfaces, and upper vertical tail panel were unbolted and packed alongside the fuselage in a flatbed truck. At Bell's Plant 6 in Arlington, Texas, the various sub-assemblies were delicately off-loaded by forklift and moved into a hangar that was originally built to accommodate prototypes of the V-22. Bell plans a four-year refurbishment by a team of employees and retirees, then will deliver the *grande dame* of tilt-rotors to the Air Force Museum.

Originally concerned about corrosion, particularly of hard-to-replace parts, Bell has found little, and the company can buy or fabricate virtually everything necessary to reconstitute the aircraft back to near-original appearance. Areas of greatest concern, like the instrument panel, were essentially intact. Only two instruments were missing, but a check of old photos suggested they had never been installed.

The XV-3's mid-fuselage-mounted, 450-horsepower Pratt & Whitney R-985 radial engine had been sufficiently preserved—the spark plugs had been replaced with desiccant-filled inserts to prevent moisture from accumulating in the cylinders. But the multi-piece canopy was declared unrestorable. The restoration team plans to hand-craft replacements for the broken or cracked panels.

The restoration efforts will be shepherded by Charles Davis, one of the original XV-3 engineers. "Looking at it today, I realize just how basic it really was," he says. "But the XV-3 was able to do what it was designed for: Prove tilt-rotors could work. The V-22 and [civilian] model 609 are the result."

—*Jay Miller*

12/26/1956

F-106A

12/26/56

ground controllers to "fly" the aircraft during the final approach to the target. A Tactical Situation Display (TSD) between the pilot's feet showed a moving map of the route across the ground during the intercept.

The first F-106A (56-0451) was finally available by the end of 1956. The first flight was made by Convair test pilot Richard L. Johnson at Edwards AFB on December 26, 1956. He was the same pilot who had made the maiden flight of the F-102. The flight was not entirely glitch-free--it had to be aborted early due to air turbine motor frequency fluctuations, and the speed brakes opened but would not close. Consequently, the aircraft did not go supersonic on its first flight. The second aircraft (56-0452) followed on February 26, 1957. They were both powered by the YJ75-P-1 engine. The first two aircraft were not equipped with the MA-1 system, carrying nose ballast to compensate for the missing weight.

The test and development work on the F-106 was divided into six phases. Phase I was conducted by the contractor, and Phase II was conducted by the Air Force. Phase II tests wee carried out between May and June of 1957. The first 12 aircraft off the production line were devoted to tests at Edwards AFB in California. They differed from the prototypes in having J75-P-9 engines. Early testing reached a speed of Mach 1.9 and an altitude of 57,000 feet, but this was still well below expectations. In addition, the F-106A's acceleration was significantly below Convair's estimates, and it took almost 4 1/2 minutes to accelerate from Mach 1 to Mach 1.7 and another 2 1/2 minutes to accelerate to Mach 1.8. With such poor acceleration, it was felt that Mach numbers above 1.7 would not be tactically usable.

The poor speed and acceleration was cured by altering the aircraft's air intake cowling and charging ejectors. The capture area of the intake ducts was enlarged and the duct lips were thinned down. There were also problems with the reliability of the J75-P-9 engine. Eventually, the more powerful J75-P-17 engine was substituted, which was rated at 17,200 lb.s.t. dry and 24,500 lb.s.t. with afterburner. There were further problems with the MA-1 fire control system and with the cockpit layout. Originally, the control column had occupied the traditional center location, but was later moved to the side at USAF insistence in order to ensure an unrestricted view of the Horizontal Situation Indicator. This arrangement turned out not to be viable, and the control column was later moved back to the center and provided with a two-handed grip for both radar and aircraft control. The right-hand grip was used for control of the aircraft and the left-hand grip was used for operation of the radar. A button in the middle of the yoke gave the pilot control of the radar antenna, and another button on the left grip enabled the pilot to put the pipper on the target by following directions on the radar scope. The pilot selected the missiles to be fired by using a switch on the left console, with the trigger that was used to launch the missiles being on the right hand grip.

01/31/1957

DC-7/F-89

Mid Air over

So Cal

1/31/57

AviationSafetyNetwork
Accident Description

Accident description

Date:	**31.01.1957**
Type:	Douglas DC-7B — DC-6A?
Operator:	Douglas Aircraft Company
Registration:	N8210H
C/n:	45192/764
Year built:	1957
Crew:	4 fatalities / 4 on board
Passengers:	0 fatalities / 0 on board
Total:	4 fatalities / 4 on board
Location:	Sunland; 6,5 km NW (USA)
Phase:	Cruise
Nature:	Test
Flight:	Santa Monica, CA - Santa Monica, CA (Flightnumber)

Remarks:
Douglas DC-7B N8210H took off from Santa Monica at 10.15h for a local functional test flight. At 10.50h a Northrop F-89J Scorpion took off from Palmdale, also on a functional test flight following overhaul. Purpose of the flight was to check the radar fire control systems of both all-weather interceptors. Both aircraft were performing their tests at an altitude of 25000ft, over a published local flying zone (bounded by San Diego, Santa Barbara, Bakersfield and El Centro). An almost head-on mid-air collision occurred and part of the DC-7's left wing was sheared off. The F-89 crashed in flames in the mountains; one of the two crew ejected safely. The DC-7 crashed onto a schoolyard. At the time of the collision the DC-7 was flying at FL250 and at about 330kts true airspeed to check carburettor operation at maximum cruise power. The F-89 was turning left from a 135deg heading to 45deg heading using a 30deg bank for a simulated intercept. PROBABLE CAUSE: "The high rate of near head-on closure at high altitude, which together with physiological limitations, resulted in a minimum avoidance opportunity during which the pilots didn't see each other's aircraft."

Source:
ICAO Aircraft Accident No.9 (Circular 56-AN/51), p. 38-44

[disclaimer]

AviationSafetyNetwork

Accident Description

Accident description

Date:	**10.03.1958**
Type:	Douglas DC-7B
Operator:	Douglas Aircraft Company
Registration:	N846D
C/n:	45452/967
Year built:	1958
Crew:	fatalities / on board
Passengers:	fatalities / on board
Total:	fatalities / on board
Location:	? ()
Phase:	
Nature:	
Flight:	- (Flightnumber)

Remarks:

Source:

[disclaimer]

	ACCIDENT DETAILS
Date:	January 31, 1957
Time:	11:18
Location:	Near Sunland, California
Airline / Op:	Douglas Aircraft
Flight #:	?
Route:	Santa Monica - Santa Monica
AC Type:	Douglas DC-7B / U.S. Air Force F-89J
Registration:	N8210H/52-1870A
cn / ln:	45192 / 4447
Aboard:	6 (passengers:0 crew:6)
Fatalities:	5 (passengers:0 crew:5)
Ground:	3
Summary:	Midair collision between a DC-7 and F-89J Air Force fighter. The DC-7 crashed into a playground of a school killing 3 junior high school children 3 miles northwest of Sunland. The F-89 crashed into the mountains. Four crew members on the DC-7 were killed. One crew member aboard the F-89 was killed and the other ejected to safety. The high rate of near head-on closure at high altitude, which together with physiological limitations, resulted in a minimum avoidance opportunity during which the pilots didn't see each other's aircraft. It was the first test flight of the DC-7B.

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	ACCIDENT DETAILS
Date:	February 23, 1934 First flight 2-8-33
Time:	c 02:00
Location:	Near Salt Lake City, Utah
Airline / Op:	Boeing Aircraft Company
Flight #:	?
Route:	Salt Lake City - Cheyenne
AC Type:	Boeing 247
Registration:	NC13357
cn / ln:	1739
Aboard:	8 (passengers:? crew:?)
Fatalities:	8 (passengers:? crew:?)
Ground:	0
Summary:	Crashed into a mountain shortly after takeoff during a snowstorm while en route.

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CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: November 22, 1957 Released: November 26, 1957

DOUGLAS AIRCRAFT, INC., DOUGLAS DC-7B, N 8210H, AND U. S. A. F., NORTHROP F-89J, 52-1870A, NEAR SUNLAND, CALIFORNIA, JANUARY 31, 1957

The Accident

At approximately 1118,1/ January 31, 1957, a Douglas owned and operated DC-7B, N 8210H, and a U.S.A.F. owned and Northrop operated F-89J, 52-1870A, collided at 25,000 feet2/ over the San Gabriel Mountains about three miles northwest of Sunland, California. The DC-7 crashed on the playground of the Pacoima Junior High School, Pacoima, California, killing three students and injuring 70 others. The four crew members, sole occupants of the aircraft, were killed. The F-89 crashed in the Verdugo Mountains southeast of the collision position, killing the pilot. The radar operator of the F-89, though severely burned, parachuted to safety. Both aircraft were destroyed.

History of the Flights

The DC-7B. On January 31, at 1015, N 8210H took off from runway 3 of the Santa Monica, California, Airport. The aircraft was a new DC-7B being flown for the first time for the purpose of functionally checking the aircraft and its components in flight following production. The flight crew were Douglas Aircraft employees consisting of Pilot William G. Carr; Copilot Archie R. Twitchell; Flight Engineer Waldo B. Adams; and Radio Operator Roy Nakazawa.

The aircraft had been subject to many regular inspections during its manufacture and numerous inspections which were required after production preceding the first flight. Accordingly, it was presumed the DC-7B was in airworthy condition.

Preparations for the flight by its crew were routine. Departure was on a local VFR flight plan filed with the operations office of the company. The plan showed six hours of fuel aboard and that the flight duration was estimated as 2 hours 15 minutes. It also showed the gross takeoff weight of N 8210H was 88,000 pounds, well under the maximum allowable. The load was properly distributed with respect to center of gravity limitations.

1/ All times herein are Pacific standard and based on the 24-hour clock.
2/ Altitudes herein are mean sea level (m. s. l.).

According to routine procedure the flight switched to the Douglas company radio frequency after takeoff and made periodic progress reports. At 1030 the crew reported over the Catalina intersection, 9,000 feet, routine, and thereafter, at 1106, over Ontario, 25,000 feet, routine.

The F-89J. At 1050 that morning, the Northrop operated F-89J, 52-1870A, took off from runway 25 of the Palmdale, California, Airport, accompanied by another F-89J, 53-2516A. The flight of 52-1870A was one of a series of functional flight checks following the completion of IRAN (inspection and repair as necessary), an overhaul project performed under contract by Northrop Aircraft for the United States Air Force. The specific flight was in accordance with provisions of the contract and its purpose was to check the radar fire control systems of both of the all-weather interceptors. The two-member flight crew of 52-1870A consisted of Pilot Roland E. Owen and Radar Operator Curtiss A. Adams, both employees of Northrop.

Preparations for the operation were routine and departure was in accordance with a local VFR flight plan filed with the flight department of the company. The plan indicated the estimated duration of the operation as one hour with sufficient fuel aboard for approximately 1 hour and 45 minutes, considering afterburner time, altitude, and power settings for the mission.

The F-89's took off individually, using afterburners, with a separation interval of 20 seconds. In a wide starboard orbit the pilots utilized radar in a "snake climb" to 25,000 feet. At that altitude, a predetermined scissoring flight pattern was utilized which positioned the F-89's, without ground radar control, for simulated all-weather interceptor attacks on each other, during which the operation of airborne radar equipment could be checked. Radio transmissions, on company frequency, were recorded by ground facilities. These were routine commands between the pilots as they executed the radar check pattern and intercepts.

At 1118 activity in the Douglas radio room was interrupted by an emergency transmission from N 8210H. The voices were recognized by radio personnel familiar with the crew members. Pilot Carr first transmitted, "Uncontrollable." Copilot Twitchell then said, "We're a midair collision - midair collision, 10 How (aircraft identification using phonetic How for H) we are going in - uncontrollable - uncontrollable - we are . . . we've had it boy - poor jet too - told you we should take chutes - say goodbye to everybody." Radio Operator Nakazawa's voice was recognized and he concluded the tragic message with, "We are spinning in the valley." This final transmission from the flight is presented because it contained important information relative to the accident investigation. It not only establishes the midair collision but also indicates the DC-7 was rendered uncontrollable. It further indicates that Mr. Twitchell at least recognized the aircraft with which they collided as a jet. Further, the DC-7 spun during its descent to the ground.

Weather conditions in the area at the time of the accident were reported by the Weather Bureau as clear, visibility 50 miles. Winds aloft at 25,000 were approximately 30 knots from 320 degrees.

Investigation

A committee, headed by Board investigators, was designated to obtain all pertinent information available from eyewitnesses to the collision. Among others, the most important objectives of the group were to obtain the place and altitude of the collision, the headings and movements of the aircraft prior to collision, the portions of the aircraft involved in the inflight impact, and the manner in which the aircraft descended to the ground. Pursuant to these objectives it was learned that more than 140 persons had seen some phase of the accident, most, however, only that portion which followed the impact. About 115 of the known witnesses were personally interviewed and 106 formal statements were obtained from the total. From the interviews and statements several representative witnesses were selected to testify concerning their observations at the Board's public hearing. The selections were made considering the aeronautical experience and background of the persons, the positions from which their observations were made, and how much of the accident they saw. Only a few saw the important phase prior to impact. All stated that clear weather conditions prevailed.

Of the witnesses who saw the aircraft before inflight impact a few were oriented or, by the nature of their work, were fully cognizant of directions. The preponderance of these witnesses stated that the DC-7 was on a heading of nearly due west and the F-89 was on a heading of nearly due east a few seconds before impact. They stated that the DC-7 seemed to be flying in a straight and level attitude. The F-89 was also described by most as flying straight and level; however, a few thought it was turning left. None described any movements indicating either aircraft made evasive maneuvers to avoid the collision. They, however, stated that because of the altitudes, variously estimated above 20,000 feet, it would have been difficult, if not impossible, to see any such movements. Neither aircraft was making a contrail which would have marked its flight path.

Nearly all witnesses stated a smoke cloud appeared in evidence of the inflight impact and this was followed by a sound, resembling a clap of thunder. These were the factors directing the attention of most witnesses to the accident.

Eyewitnesses said that the DC-7 continued on a westerly heading for a short interval, then rolled to its left. As this occurred a plan view was afforded and several people noted that a portion of the left wing was sheared off. They also saw a shower of metal pieces near the smoke cloud reflecting the sun. The roll continued and the DC-7 entered an increasingly steep descent. Several witnesses thought that the plane turned about its longitudinal axis during the descent and said that metal pieces continued to break off in the area of the wing fracture. Numerous persons stated there was no fire but that white-gray smoke trailed from the wing fracture. Witnesses close to the crash site noted a general breakup of the aircraft before it struck the ground.

Witnesses stated that the F-89 emerged from the smoke cloud on an easterly heading. It burst into flames which enveloped the aircraft from its midsection rearward. While most witnesses said the aircraft did not spin a few thought that it did. Most stated that the visible portion of the F-89 seemed intact, in that the wings and tip tank-rocket pods were in place. The fall of the F-89 was described as a consistently steep trajectory. Although the preponderance of witnesses who saw the F-89 before collision said it was headed easterly, many who saw it fall stated the trajectory was southeast. It was estimated that Mr. C. A. Adams, the radar operator, ejected from the aircraft about halfway down the descending arc of the jet.

The pilot of the F-89 that accompanied 52-1870A stated that the radar check flight had been entirely routine until the accident occurred. He stated that he and Mr. Owen had completed several simulated intercepts and that just before the accident each aircraft was being positioned for another. He stated that Mr. Owen's aircraft was to attack and his was to be the target. At this time, according to the pattern, the interceptors were 15-20 miles apart with Owen's aircraft on a heading of 135 degrees and his own on a heading of 45 degrees. He explained that according to the procedure Mr. Owen would next issue a radio command at which time both pilots would execute standard bank 90-degree turns. In the case of Mr. Owen a left turn to a heading of 45 degrees, and in his own case a right turn to a heading of 135 degrees. In this manner, at the completion of the turns, the aircraft would be positioned so that Mr. owen could proceed 90 degrees to the flight path of the target aircraft, commonly called the "attack vector." As the flights converged the radar operator of Mr. Owen's aircraft would locate the target plane on his radar scope and direct his pilot toward the target in a manner which would enable the pilot to simulate a firing pass. The procedure required both aircraft to maintain 380 knots true airspeed. He stated that the purpose of this type interceptor was to seek out an enemy aircraft by use of radar and destroy it in a weather situation which precluded positioning by visual reference. The witness explained that no feature of the radar ever flew the aircraft or took control from the pilot, it being designed to provide information to the pilot to enable him to maneuver into firing position. He explained the "lockon" phase was not a reference to control of the aircraft but meant that the radar was being directed to one specific target to the exclusion of all others.3/ He added that during this phase, target information was presented directly to the pilot on a small radar scope in his cockpit.

The pilot testified that Mr. Owen had given the signal for each pilot to begin his 90-degree turn. This, he recalled, was, "Start making your ninety, now, Jim." He said that he immediately began his turn and would assume, according to regular practice, that Mr. Owen did too. The pilot added that it was standard practice for the attacking pilot to transmit, "Steady on," indicating when the turn was complete. He said that this transmission was not received and subsequent calls to Owen were not answered. The witness said that he could not see the other F-89 at any time during this period and did not know the collision had occurred until notified by ground radio, which had intercepted the message from N 8210H. This occurred approximately one minute after the witness had finished his 90-degree turn. Then, aware of a collision, he could only suspect that 52-1870A was involved.

The radar operator who survived the collision stated that when it occurred he was checking a navigational feature of the radar equipment. The nature of the check required the radar search feature to be off. He said that he was not looking out but was looking at the equipment with his head lowered into a shield, "muff," which excluded most of the outside light. He testified that he did not

3/ An electronic device coupled to the pilot radar scope of F-89, 52-1870A, for the purpose of recording lockons, showed that 52-1870A had completed three. It showed no incompleted passes.

recall hearing the command to make the turns and to his best recollection the F-89 was on a heading of 135 degrees, its true airspeed was 380 knots, and its altitude was 25,000 feet when the impact occurred. The radar operator said the turn could have been started without his knowledge while he was concentrating on receiving the interrogator beacon signal in checking the navigational device. Also, because he was looking into the hood, without outside reference, a turn might not have been noticed. He estimated that he was occupied with the check about 45 seconds. He described the impact as being extremely severe but did not know whether it was a collision or an explosion. He said his cockpit was quickly enveloped in flames and his sole thought was to eject. This he accomplished quickly and with no recollection of the specific details. The witness stated there was no fault with the aircraft operation prior to the accident.

A part of the accident investigation was devoted to determining as accurately as possible the geographic location over which the collision occurred. While eyewitness' statements were being obtained, it was learned that a movie crew, on location, had accidently photographed the explosion cloud while shooting a western movie scene. To facilitate retakes, and for other purposes, a feature of the camera used permitted putting exposed film in the camera and aligning it precisely with features on the film. Thus it was possible to insert a frame of film bearing the explosion cloud in the camera, place the camera in its original position, and align the topographic details on the film with the same details on the lens image. After determining the elevation of the terrain (750 feet), the height of the camera, and other details, sightings were made using a surveyor's transit. Assuming the collision occurred at approximately 25,000 feet, it was calculated the accident occurred 5,000 feet northeast of the Hansen Dam Spillway located between Pacoima and Sunland, California. Because the distance between the camera and the accident was over 30 miles the film, even when blown up to its maximum, did not show either aircraft or any detail of the collision.

During this phase of the investigation it was also learned that a surveyor, at work, had seen the collision. The witness stated that the next day he repositioned his transit and made bearings on the position of the explosion cloud position as he recalled it. Again assuming the collision was at 25,000 feet, results showed the accident took place over a position about 12,500 feet northeast of the Hansen Dam Spillway.

From the results of both of these investigatory actions, together with considerable eyewitness testimony, it was determined that the accident occurred over an area northeast of the Hansen Dam Spillway, which is sparsely populated.

Following the midair collision, the DC-7 continued on a westerly heading for approximately four miles where it crashed on the grounds of the Pacoima Junior High School and an adjoining church.

Wreckage distribution and the manner in which various components struck the ground made it clearly evident that the DC-7 sustained structural failure of its basic airframe during descent. A considerable number of major pieces from the tail surfaces and aft fuselage were recovered along a two-mile path ending just east of the principal wreckage area. For the most part pieces of the aft fuselage were closer to the principal area, showing this portion of the aircraft failed after the tail section. Portions of fuselage forward of the wing and just aft of the wing were located on the church property, indicating disintegration in this area prior to the initial ground impact.

The major portion of the DC-7 fell on the school property and on impact it broke up into numerous pieces, many of which were additionally damaged or destroyed by intense ground fires. Distinct craters were made by each of the four powerplants and the main wing center fuselage unit. The wide separation between the craters compared to the normal distance between the components as installed on the aircraft showed these units had also separated from their supporting structure before ground impact. Characteristics of the craters, and the way debris was thrown out of them, showed clearly the units which made them were moving westerly.

Following the inflight impact the F-89 fell southeastward for nearly 2-1/2 miles where it crashed on a narrow ridge in the rugged terrain of the Verdugo Mountains. Evidence showed the aircraft struck the ground relatively flat with a high sink velocity but little forward motion. The impact and an accompanying explosion caused extensive disintegration of the aircraft. An intense ground fire also completely or partially consumed many of the wreckage pieces.

During the structural investigation every effort was expended to determine, independent of eyewitness information, if there had been an inflight collision between the aircraft and, if so, the manner in which it occurred. After the many scattered wreckage pieces were found, identified, and their locations documented, they were transported to one location. There, the problems were approached by mockup, reconstruction, layout, and isolation of pieces bearing collision evidence. This work disclosed and isolated areas of damage which, by their nature, conclusively prove that a midair collision did occur. Results of this work also provided the material for determining the physical relationship of the aircraft to each other at the instant of impact.

One of the most significant areas involved in the inflight contact was the left wing of the DC-7, between stations 530 and 613. This area had been severely fragmented by impact forces with the largest single piece found about 18 by 12 inches in size. This piece and many others from the wing area were severely torn, crushed, and curled. They also bore scratches and smudges associated with the collision contact. Some of these pieces were recovered from ground positions below the previously described collision area considering the drift effect from winds aloft.

Outboard of station 613 to the wing tip, a span of about 8-1/2 feet, the wing panel was recovered in one piece. This component was recovered in the Sunland area and was in a relatively undamaged condition. At the fractured inboard end of this piece the stringers and spar sections were crushed and deformed rearward. On the bottom surface skin in the fracture area, scratches running aft and inboard were noted. Others were evident adjacent to the fracture with a few light smudges and scratches on the upper leading edge skin. Corresponding scratches were noted near the inboard end of a portion of aileron normally positioned on the wing in this area.

The average angle of the fracture, measured at the inboard end of this severed wing panel, was three degrees from a perpendicular to the centerline of the center wing spar. The aft end of the separation plane was farther inboard than its leading edge.

At station 530 the leading edge wing skin was deformed rearward. There, additional scratches and black-gray smudges were noted. Between station 530 and the wing root there was no evidence of collision except minor deformation and a few grayish smudges at station 397 on the upper leading edge wing surface. Spectographic and microchemical tests identified these gray smears as paint, identical with samples taken from the F-89 horizontal stabilizer.

With respect to the F-89, it was learned it had fallen to the ground intact except for components which separated because of the inflight collision damage. This damage was obviously so extensive that continued control was impossible. Further, characteristics of fire damage showed the aircraft was afire during its descent to the ground.

Of equal importance to the structural objectives was the F-89 fuselage nose section rearward to about station 125. This area had sustained severe inflight strike damage causing much of it to separate in flight as two large pieces and many fragments. One large section consisted of the upper panel structure above the nose section side doors from station 12.688 rearward to station 105. Below this panel structure an area the length of the panel and about 15 inches wide was gouged out. This area measured four degrees to the longitudinal axis of the aircraft with the aft end higher than the forward end. A portion of the front nose circular ring was still in place at station 12 on the large nose piece. The ring was fractured 22-1/2 inches from the top centerline on the right side and 10 inches from the top centerline on the left side. Measurements were made over the peripheral distance.

The second large piece from the nose section was from the area below the nose section side door between stations 12.688 and 105, or roughly the structure below the bottom edge of the gouged-out area. Similar to the upper nose section piece, this component bore inflight impact evidence, had been torn off in flight, and was recovered away from the main wreckage area of the F-89. The bottom portion of the fractured circular nose section ring at station 12 was attached to this large lower panel section. A line joining the edges of the fractures of this ring on the lower section made an angle of about 29 degrees with a waterline plane, the right side being lower than the left.

From the damage described and mockup reconstruction it was clearly evident that an object, about 15 inches deep, had passed through the F-89 nose compartment from front to rear at an approximate angle of 29 degrees. The object passed through the fibreglass radome, the nose frame at station 12, and through all intermediate frames and bulkheads, rearward to and including station 105.

The F-89 radome was recovered in two large pieces. The separation line on these two pieces corresponded approximately to the fractures in the circular nose section ring. The larger radome piece bore scratches in its black exterior paint and it was evident that they were made by a rivot line on the object which penetrated the entire nose section.

During the structural investigation considerable other inflight impact and collision sequence evidence was found. Most, however, was cumulative in the principal areas already described or it was so inconsistent with the clearly established pattern that the damage was considered secondary.

It was also possible during the layouts, the reconstruction, and isolation work to examine the individual pieces of wreckage which were not involved in the inflight impact but which separated from the DC-7 before the ground impact. The characteristics of the various fractures clearly showed that the general breakup of the DC-7 before ground impact was the result of airloads beyond the design or required strength of the airframe. Such loads were undoubtedly imposed during unusual attitudes of the airplane in its fall. This general disintegration, according to wreckage distribution, occurred shortly before ground impact and started with the empennage of the aircraft.

An equally exhaustive effort was expended in examining the engines of both aircraft and, in the case of the DC-7, its engines and propellers. The objective was to determine whether or not any inflight failure or operating difficulties of these components contributed in any way to the cause of the midair collision.

As indicated, the four DC-7 powerplants separated from the aircraft before ground impact as a result of excessive airloads. The units were severely damaged by this impact and were principally recovered from the widely separated craters in the schoolyard. In each case the propeller assemblies, nose, supercharger, and rear accessory cases were broken from their respective power sections. All cylinders were broken loose from their power section. Numerous components from these assemblies were scattered forward of the craters for distances as great as 250 feet. There was no evidence on the engines of inflight contacts.

Following a preliminary examination at the wreckage site, the powerplants were removed to suitable facilities for disassembly and detailed examination. This showed the various gear trains, bearings, and shafting of the engines had been normally lubricated prior to impact and that there was no evidence of failure or operational distress. Boroscopic examination of the cylinders revealed no indication of combustion irregularities. The articulating assemblies of the engine showed no evidence of operating distress and the oil pumps and screens were free of foreign material. While all of the engine accessories were recovered, ground impact damage precluded them from being functionally checked.

The DC-7 propellers remained tight on their shafts; however, each assembly, as indicated, was broken from its engine. The propeller blades exhibited various degrees of camber and face-side bending. Careful examination of the propeller blades, especially of the Nos. 1 and 2 engines, showed clearly they were not involved in the inflight collision.

Examination of the propeller pitch-changing mechanisms disclosed the stop rings properly indexed for a blade range of 94-1/2 degrees positive, full feathering, and minus 14 degrees, reverse. Impact markings on the spider shims and shim plates revealed a propeller blade angle at ground impact averaging 58.5 degrees. Because of the inflight disintegration of the aircraft and separation of the powerplants, as well as possible throttle manipulation during the descent, little significance can be attached to this evidence with respect to power or airspeed at the instant of collision.

The turbo-jet engines of the F-89 were recovered in the main wreckage of the aircraft. Both were heavily damaged by ground impact and fire after impact.

Some portions of the engines were hurled 4,000-5,000 feet from the crash site. The inlet and accessory sections of both engines were broken off and consumed by fire. The first three stages of the left engine compressor and the first stage of the right engine compressor were broken away. Variable bending and lack of damage to some blades in the same stages were indications that the damage was the result of impact with the ground. The combustion cans, although deformed, showed no indication of overheat. Crossover tubes were normal. Both turbine assemblies were intact but displaced rearward. The aft sides of the turbine wheels were freshly scored, indicating rotation when the wheels were forced rearward.

From the investigation of the powerplants of the DC-7 and the engines of the F-89 there was no evidence found to indicate that a malfunction or failure of any of these units was a factor in the accident.

Because of some misunderstanding during the accident investigation, the Board believes it is in the public interest to explain the status of the DC-7, the nature of its first flight, and the requirements and restrictions associated with the operation. These subjects were fully explored during the public inquiry through witnesses representing the Douglas Company and the Civil Aeronautics Administration (CAA).

From inception of an air-carrier-type aircraft to commercial production of the model many months, or years, of design, evaluation, and tests are required. During this period after the model is produced it is an experimental aircraft and may be flown only under an experimental certificate issued in accordance with Civil Air Regulations by the CAA. This strictly limits operation of the aircraft in the interest of safety. During this period the model must exhibit, through every manner and type of test, its strength, safety, performance, and quality, and meet or exceed the standards required by appropriate Civil Air Regulations. On completion of this work, if the airworthiness is proved the model is awarded a type certificate and may be duplicated in exact kind and quality for commercial sale. N 8210H was such a duplicate, one of over 300 already manufactured and in use in commercial aviation.

The manufacture of such aircraft under type certification is closely supervised by CAA personnel. This is a form of quality control and accomplished by inspection and tests performed regularly and frequently throughout manufacture. When production is complete numerous additional checks are accomplished by the manufacturer, and in the case of N 8210H nearly 15 hours ground time were accumulated on the powerplants during this work.

Before a formal airworthiness certificate is issued for the individual aircraft, Civil Air Regulations require that a functional inflight check be accomplished. This is principally a flight to gather information from which, if necessary, final and minor adjustments on the aircraft and its components can be made. Accordingly, N 8210H was being flown for this purpose when the subject accident occurred.

The functional check flight is made under a special flight authorization certificate issued by the CAA and it also is restrictive. Among other limitations, the aircraft must be flown in visual flight rule weather conditions, without passengers and, except for landing and takeoff, the operation must be over sparsely populated areas.

The F-89 was produced in a similar manner; however, the standards and specifications of a military plane are governed by the military establishment and not by Civil Air Regulations.

The IRAN project, in the case of the F-89, was principally a complete overhaul of the aircraft. This in no manner changed the basic proven airworthiness of the aircraft; however, such projects may modernize some of its components, especially those relating to its weapons systems.

Northrop records showed that after the overhaul work was completed with respect to 52-1870A, the aircraft had been flown six times for various checks of the work performed. The subject flight was to be a final check by the Northrop Company before turning the aircraft back to the U.S.A.F. It was for the purpose of checking the radar portion of the weapons systems of the aircraft and thus was a functional check flight.

In accordance with Air Force regulations pertaining to the Air Force flying activity at Palmdale, which were mutually agreed upon and part of the Northrop operating procedures, the F-89 flights were not to be made over congested areas except during landings and takeoffs. Also, the flights were to be conducted within an area generally bounded by San Diego, northwest to Santa Barbara, northeast to Bakersfield, and southeast to El Centro. As a standard Air Force requirement this area was designated and published as a local flying area; however, such did not set it apart for the exclusive use of the company. As a matter of fact, the same area is used in the flying operations of the numerous aircraft manufacturers located in the Los Angeles vicinity. Witnesses stated the joint use of this airspace was common knowledge. They also said it was heavily used by the aircraft of the manufacturers, the military, and commercial traffic serving the large metropolitan area. Further, the space was limited by restricted areas bordering the aforementioned local flying airspace on the east and west sides. The accident occurred within this local flying area.

It will be recalled that both flights were operated under local VFR flight plans. Accordingly, the avoidance of other aircraft was a direct responsibility of the pilots of both aircraft. Civil Air Regulations, Part 60, Section 60.12 (c), clearly place this responsibility on all pilots, regardless of the type aircraft. Rules for avoidance and right-of-way are also spelled out in these regulations, Section 60.14 (a) through (c) and Section 60.15.

Because of this pilot responsibility it was considered important to determine what, if any, effect the operational nature of the flights had on the ability of the pilots to carry it out. Specifically, it was important to learn whether or not the operational nature of the flights required an unusual amount of pilot cockpit preoccupation. Witnesses, well qualified through actual experience in performance of the flights, were questioned with respect to this subject.

A Douglas representative described the production flight check from its beginning to end, stating that each was very similar and followed a definite pattern. He stated the purpose was a thorough operational check of the aircraft, its powerplants, and its equipment involving flight at various power settings, aircraft configurations, all at various altitudes. The witness testified that flight check sheets are carried aboard the flights and the items are accomplished in the sequence of their arrangement on the sheets. He also said that as the flight progressed and the items were accomplished the results were recorded. This duty, he said, was exclusively a responsibility of the flight engineer. He also said the manipulation and setting of controls, except flight controls, was principally done by the flight engineer. He concluded that there was no greater pilot cockpit preoccupation in this type of operation than in any other.

During the investigation these flight check sheets were recovered from the wreckage of N 8210H. It was noted that many of the items had been completed and in sequence. The end of the completed items indicated that when the collision occurred the aircraft was being flown at 25,000 feet and at about 330 knots true airspeed, for the purpose of checking carburetor operation at maximum cruise power. A study of the writing showed clearly it was in the handwriting of Mr. W. B. Adams, the flight engineer.

Witnesses experienced in the F-89 radar check flight operation stated it required precision flying and that accuracy of headings and altitudes was required within narrow tolerances. Because of this the simulated intercepts were usually flown using autopilot. Witnesses familiar with Mr. Owen's technique believed he would have been using it continuously during the radar pattern and simulated intercepts which would include the turn preceding the attack vector. The radar operator could not tell from his cockpit. The witnesses testified that using the autopilot provided the precision necessary and greatly reduced the pilot's concentration within the cockpit. Testimony indicated that during the turn preceding the attack vector the pilot had only to monitor the turn. During this time there was nothing connected with the radar equipment to occupy his attention. Greatest cockpit concentration on the pilot's part would be later during the lockon phase of the intercept which follows completion of the turn to the attack vector and after the search phase has been accomplished. Witnesses concluded that during the positioning turn Mr. Owen would be free to look out for other aircraft. As previously stated, the responsibility to look out for other aircraft was in no manner reduced by the designation of a local flying area.

Analysis

The several areas of primary collision damage and markings furnished the foundation for a successful analytical study of how the inflight collision sequence occurred and the relative attitudes of the aircraft at impact.

Initial contact occurred when the leading edge of the left wing of the DC-7 between stations 530 and 613 made contact with the fibreglass radome of the F-89. As the two aircraft passed, the left wing of the DC-7 and nose section of the F-89 progressively penetrated one another until the left wing outboard of station 530 was sheared off and the nose section rearward to station 125 was destroyed. Impact markings made during this sequence showed clearly that the aircraft were rolled 36 degrees to the left with respect to each other.

As the split second sequence continued the left horizontal stabilizer of the F-89 brushed across the upper surface of the DC-7 left wing at station 397 leaving paint smudges in that area. The relative angle in the roll plane between the aircraft and location of the stabilizer brush marks showed the F-89 would clear the No. 1 propeller arc of the DC-7, thus accounting for the absence of propeller cuts and blade damage. The aircraft then passed one another and from all the available evidence there were no other primary contacts between them. Damage received by the F-89 clearly showed it would have been rendered uncontrollable. In the case of the DC-7 it is doubtful that effective control would have existed, the latter substantiated by the final transmission from its crew, "Uncontrollable."

The relative angle between the aircraft in the pitch plane must be deduced from the impact markings and the existing angles of attack of the aircraft when the marks were made. Impact damage was all predominately rearward and slightly inboard on the DC-7 with little or no upward or downward indications. On the F-89 the damage was rearward with a four-degree upward angle. With respect to airspeeds, a principal consideration in determining angles of attack, ample evidence indicates that the true airspeed of the F-89 was 380 knots and, though less conclusive, it is quite probable that the true airspeed of the DC-7 was 330 knots. Considering this evidence, it is very reasonable to conclude that both aircraft, relatively, were level in the pitch plane.

The impact angle in the yaw plane is perhaps the most important factor of the collision orientation because it is most indicative of the converging flight paths before impact. This angle is based on considerations of airspeeds and the fracture angle of the cut on the left wing of the DC-7, which was measured as three degrees inboard from front to rear. Accepting the airspeeds mentioned and the angle of the cut, the resultant angle of convergence was about five degrees from head-on.

As previously indicated, the correlation of physical damage, collision marks, and impact angles relate one aircraft to the other but not with respect to the ground. It is therefore necessary to deduce the orientation with respect to the ground through other means. While direction of flight at impact may often be indicated by the direction of wreckage scatter, in the subject accident this was not definitive. Thus, orientation of the aircraft with respect to the ground and the direction of flight of the aircraft at impact are necessarily based on the observations of eyewitnesses and some circumstantial evidence.

The preponderance of eyewitnesses, some aeronautically qualified and cognizant of direction, believed that the DC-7 was heading about due west and the F-89 was heading approximately due east when they collided. While it is possible that some error may exist in these collision headings because of the difficulty of such estimates from ground positions, it is noteworthy that only substantial errors would have an appreciable effect on the results based on them. Recalling it was Pilot Owen's intention to turn left from 135 degrees to 45 degrees using a 30-degree bank, and accepting the collision headings as substantially correct, it is entirely reasonable to conclude that the F-89 was banked to its left about 30 degrees with respect to the ground when the impact occurred. This conclusion would thus place the DC-7 flying straight and level, or nearly so, when the two aircraft collided.

In summary, based on all the available evidence, it is the judgment of the Board that this collision occurred nearly head-on while the DC-7 was flying straight and level, or nearly so, on an approximate westerly heading. It is believed that it occurred while Pilot Owen was executing a level left turn from 135 degrees toward an anticipated heading of 45 degrees and that his aircraft was banked approximately 30 degrees. It is also clearly evident that the accident took place in clear weather conditions at 25,000 feet over a noncongested area between one and two miles northeast of the Hansen Dam Spillway.

The small difference between the standard bank of 30 degrees and the 36-degree impact angle in the roll axis cannot be positively explained. It is possible, however, that this six-degree difference is indicative of the start of an evasive maneuver. From the transmission by Mr. Twitchell, "Poor jet too," it is known that he saw the F-89. Because the collision sequence occurred in about 1/100 of a second he could not have recognized the aircraft as a jet at that time and must have done so before impact. It is possible, therefore, he saw the jet in time to react and start a left bank which had progressed six degrees but which was insufficient to avoid the collision.

In order to evaluate the all-important question of whether or not the crews could have seen and avoided the collision, an analytical study of the opportunities was made. The aforementioned collision factors were applied, with others, such as closure speed, visual range, and angular position of the conflicting aircraft on the other's windshield. It must be realized that some of these latter factors are the products of numerous tangible and intangible considerations.

The maximum distance that an aircraft can be seen depends upon its angular presentation, its color contrast with the existing background as affected by the degree of illumination, and the atmospheric conditions of visibility including altitude effect. These factors are highly variable and different in each actual situation, and small amounts less than optimum in the conditions result in an appreciable reduction of the maximum distance that an aircraft can be seen. Also, it is known that the head-on or near head-on flight paths are the most unfavorable situations for sighting other aircraft because of the relatively small frontal profile presented during such closure.

Realizing the intangible nature of the maximum sighting distance, the Board carefully considered each factor, together with published material on the subject, and selected 3.5 miles as its best estimate in the subject situation.

Accepting this distance and applying it to the flight path portion of the analytical study, the F-89 would enter visual range about five degrees to the right of zero reference on the DC-7 windshield. Movement during closure would be slowly from right to left until just before impact. At visual range the DC-7 would be positioned 22 degrees to the left of zero reference on the F-89 windshield. Considering the banked attitude of the F-89, this initial position would be on the canopy glass off the armorglass windshield. Movement of the DC-7 during closure would be slowly diagonally downward from left to right until just before impact.

Considering the probable flight path of each aircraft to collision, the visual range, and the true airspeeds of the aircraft, computations show the closure speed between them was about 700 knots. The calculated time from visual range to collision was about 15 seconds.

While a conflicting aircraft is within visual range it must first be detected by the pilot, then an avoidance decision must be made and, finally, the aircraft must respond to and carry out the avoidance maneuver. Each of these factors requires an element of time, the total of which must be sufficient for a successful collision avoidance.

Detection of another aircraft is probably the greatest time-consuming factor, being restricted by physiological limitations of the human eye. The eye will best detect an object when it is within the focal field of vision, some 2-3 degrees wide. With sufficient motion the object may be detected within the peripheral field, a few degrees outside the focal area. To compensate for these restrictions the pilot must employ scanning to search the broad areas of potential collision to detect other aircraft. Thus a reasonable opportunity to avoid collision must include a reasonable time for detection.

Following detection, the pilot must then evaluate the situation and determine if collision courses exist and, if so, decide on the proper evasive maneuver. The time required for such decision may vary considerably, according to the situation. For example, it may be hard to determine whether or not a conflicting aircraft is approaching or moving away. It may also be difficult to decide which way a turning aircraft is progressing and where its projected flight path will take it from its sighted position. This is especially difficult when the conflicting aircraft and the aircraft from which it is viewed are being flown at high speed.

Aircraft response, especially for the large transport type, is less than immediate. Although with boosted controls the attitude of the aircraft may be altered rapidly, several seconds are required before the direction of flight is sufficiently changed to avoid collision.

Considering these collision avoidance elements and all the available evidence, it appears that only the minimum time opportunity existed for the pilots to have carried out the basic elements of collision avoidance. It is clear that only if the pilots sighted the other's conflicting aircraft early in the period when it was visible and took immediate evasive action could the collision have been avoided. Thus, it is the considered opinion of the Board that, while visual separation could have been effected in the time available, because of the near head-on closure and the high rate of closure at high altitude the pilots were confronted with unusually great problems of visual separation.

The accident, which appears to have occurred under almost the most adverse conditions insofar as the time opportunity for the pilots to see and avoid is concerned, raises the question whether the long established "see and be seen" philosophy applicable to VFR flight is adequate in uncontrolled operations. It is clear that, under certain conditions of speed and angle of convergence, very little time opportunity exists for pilots to observe the other aircraft and take avoidance action. As aircraft speeds and traffic density increase, this problem will be aggravated. While this problem is serious, and growing more so, it is not sufficient cause to discard the see and be seen rule. Alternatives to this fundamental rule in VFR operations either do not exist as yet or are so extreme that they would penalize the expeditious flow of traffic to the point where aircraft operations in general would be stifled. For instance, the practical consequences of immediate implementation of full positive control for such operations regardless of weather would be the grounding of a large percentage of current aircraft operations. Therefore, until technological advances are made which will insure separation of aircraft without reliance on the vigilance of the pilot, the Board will continue to rely on the see and be seen policy with whatever refinements circumstances and the state of the art permit. In this connection, the Board calls attention to certain regulatory amendments already adopted and others in preparation which serve to refine the see and be seen rule in the light of high-speed, high-performance aircraft operations. In this group are the pilot vigilance and restrictions on flight testing rules; the VFR minimums within control zones for flights with traffic clearance, and speed control and communication rules in high density air traffic zones; the high altitude quadrantal rules; and the rules establishing the continental control area.

In view of the foregoing, the Board must call to the attention of all persons engaged in the operation of high speed aircraft that the closure rates of such aircraft in normal operations impose obligations for vigilance on the part of operating crews which are of extreme urgency. We are faced with no immediate alternative but to seek the redoubling of effort on the part of management and operating crews to prevent any avoidable diversion or preoccupation which would tend to compromise the ability of pilots to see and avoid other aircraft. It has not been possible in this instance to determine specifically what had prevented the crews of either aircraft from taking timely action; however, we conclude that the avoidance of collision by visual means was not beyond the physical capabilities of the pilots involved provided full attention was given to collision avoidance. Accordingly, reliance must continue to be placed upon pilots of aircraft engaged in similar operations to provide for separation under visual flight rules. To this end, however, the Board will continue to review inflight procedures, cockpit design including instrument and equipment layout, aircraft crew complements, and the training and indoctrination of flight crews to insure that the possibility of recurrence of such a collision is minimized.

Findings

On the basis of all available evidence the Board finds that:

1. The aircraft and the crews were properly certificated according to the status of the aircraft and nature of the operations.

2. Preparations for the flights were complete and routine.

3. The flights were operated in clear weather conditions and in accordance with the provisions of local VFR flight plans.

4. Under VFR weather conditions and VFR flight plans collision avoidance rested in visual separation, a pilot responsibility.

5. The DC-7 and F-89 collided in flight on approximately west and east headings, respectively. They were at 25,000 feet over a noncongested area between one and two miles northeast of the Hansen Dam Spillway.

6. At impact the F-89 was rolled about 30 degrees left, both aircraft were about level in the pitch plane, and the convergence angle was about five degrees from head-on.

7. Both aircraft fell out of control and the DC-7 crashed in a populated area.

8. From visual range, estimated at 3.5 miles, the closure speed between the two aircraft was 700 knots and over the probable flight paths the time to collision from visual range was about 15 seconds.

9. The nature and purpose of the flights did not prevent all pilots from maintaining a lookout for other aircraft.

10. There was no evidence found to indicate that any malfunction or failure of the aircraft or their components was a factor in the accident.

Probable Cause

The Board determines that the probable cause of this midair collision was the high rate of near head-on closure at high altitude which, together with physiological limitations, resulted in a minimum avoidance opportunity during which the pilots did not see the other's aircraft.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE

/s/ CHAN GURNEY

/s/ HARMAR D. DENNY

/s/ G. JOSEPH MINETTI

/s/ LOUIS J. HECTOR

S U P P L E M E N T A L D A T A

Investigation and Hearing

The Civil Aeronautics Board was notified of this accident through its Santa Monica office a few minutes after it occurred. Investigators were promptly dispatched to the scene and an investigation was initiated and conducted in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board and held in the Hollywood Roosevelt Hotel, Hollywood, California, on March 20-21, 1957.

Companies

The Douglas Aircraft Company, Inc., a Delaware corporation, has its principal offices in Santa Monica, California. The company is principally engaged in the manufacture of aircraft.

Northrop Aircraft, Inc., a California corporation, has its principal offices in Beverly Hills, California. The company is principally engaged in the manufacture of aircraft.

Flight Personnel

1. Douglas. Pilot William G. Carr, age 36, was employed by the company on January 14, 1952. He held a valid airman certificate with an airline transport rating and rating for the subject aircraft. He also held numerous other type ratings as well as ratings on airframes and powerplants. Pilot Carr had 11,757 total flying hours, of which 598 were in the DC-7 type. His last medical examination was accomplished November 27, 1956, without waivers.

. Copilot Archie R. Twitchell, age 50, was employed by Douglas since February 2, 1955. He held a valid airman certificate with airline transport and DC-7 ratings. The pilot had accumulated 7,115 flying hours, of which 287 were in the DC-7. His last medical examination was accomplished, without waivers, on February 9, 1956.

Flight Engineer Waldo B. Adams, age 43, was employed by Douglas, January 4, 1937. He held a valid airman certificate with flight engineer, airframe, engine, and commercial pilot ratings. Company records showed he had accumulated 2,711 flying hours as a flight engineer, of which 278 were in the DC-7 type aircraft. He had taken his last physical examination on February 22, 1956, and it was accomplished without waivers.

Flight Radio Operator Roy Nakazawa, age 29, was employed by the company May 26, 1952, and held the position of a flight line technician (electronics). Mr. Nakazawa held a second-class radiophone license issued by the Federal Communications Commission on December 11, 1953.

2. Northrop. Pilot Roland E. Owen, age 36, was employed by the company on October 15, 1951. He was the Chief of Production Test at the time of the accident. He held a valid airman certificate with commercial and instrument

ratings. He also held a formal certificate of authority from the United States Air Force to fly the F-89. Pilot Owen had accumulated 2,754 flying hours, of which 1,320 were in jet aircraft and 1,249 were in the F-89 type jet. His last physical examination was accomplished in May 1956, without waivers. His last high-altitude indoctrination was accomplished May 31, 1955, (valid for three years).

Radar Operator Curtiss A. Adams, age 27, was employed October 10, 1951, as an electronic checkout man. His last physical and high-altitude indoctrinations were received in May 1956 and September 1956, respectively.

The Aircraft

The DC-7B, N 8210H, had a total of 1:03 flying time since its manufacture. It was equipped with Wright engines, model 972TC18DA-4, and Hamilton Standard propellers, model 34E60-363, blade model 6921A-8. The engines and propellers had accumulated about 14 hours of ground running time since new.

The F-89 bore manufacturer's serial number 4447 and U. S. A. F. designation 52-1870A. The aircraft had been flown 261 hours since manufacture and 6 hours since IRAN. The F-89 engines were Allison, model J-35A-35. The left and right engines had accumulated 258 hours and 200 hours, respectively, since new.

XF-104 11 July 1957

REPORT OF AF AIRCRAFT ACCIDENT

Use this form in accordance with AF Reg. 62-14 and AF Manual 62-6, "Aircraft Accident Prevention-Investigation-Reporting." Fill in all spaces applicable. If additional space is needed, use additional sheet(s) and identify by proper section letter and subsection number.

Section A—GENERAL INFORMATION

1. PLACE OF ACCIDENT: State, County, nearest town, distance and direction from nearest town. If accident occurred on airport, identify.
California, Kern, 12 N miles, S SW, Bakersfield

2. DATE OF ACCIDENT: 11 July 1957
3. HOUR AND TIME ZONE (Local): 0850 PST
4. DAY X DAWN NIGHT DUSK
5. AIRFIELD OF LAST TAKEOFF: AF Plant No. 42 Palmdale, California

6. CLEARANCE: (Check all applicable) IFR___ VFR X Local X DD Form 175___ Other X Cleared Direct___ Cleared Via Airways___
Cleared from ______ Cleared to ______

7. BASE SUBMITTING REPORT: AMC, SMAMA McClellan AFB, Calif
8. DURATION OF FLIGHT: 10 minutes
9. MISSION OF FLIGHT (Use DD Form 781-1): X-1
10. ALTITUDE of aircraft above terrain at collision, fire, airframe failure, bailout, spin, stall, spiral, occurred: Approx 6000 ft (Bailout)

11. AIRFIELD DATA. FILL IN (a) OR (b) AS APPLICABLE. (For seaplanes landing on seadrome, fill in length of landing lanes and other data as applicable. Discuss in Section M.)

(a) If accident occurred on airport:
Length of runway in use ______ ft.
Heading of runway in use ______ degrees
Field elevation ______ ft. MSL
Type of runway surface: (Check)
Concrete___ Asphalt___
Other___ (Specify) ___
Wet___ Dry___

(b) If accident occurred off airport: elevation at scene of acct. 500 ft. MSL
Was aircraft taking off, approaching or maneuvering to land? Yes___ No X
If yes, state airport involved ______
If no, state nearest airport suitable for landing the aircraft Mojave, Calif.
For either airport mentioned in 11b above:
State airport type (i. e., AF, A, N, CG, PC, P) MCAAS
Distance, airport to accident 46 miles. Heading of runway in use N/A degrees.
Magnetic bearing, airport to accident 265 degrees. Airport elevation 2787 ft. MSL

12. LIST NUMBERS OF ALL OTHER AIRCRAFT INVOLVED: (File separate Form 14 for each aircraft)

13. VIOLATIONS: Yes___ No X If yes, discuss in Section M.

Classification (Cancelled or Changed)
To ______
By Authority of ______
Date ______

Section B—AIRCRAFT

1. AIRCRAFT NUMBER: 53-7786
2. TYPE, MODEL, SERIES AND BLOCK NUMBER: XF-104
3. ASSIGNMENT AND STATUS CODE at time of accident (As specified in AFR 65-110): AMC BT. Bailed to Lockheed Aircraft Corporation

4. ORGANIZATION POSSESSING AND REPORTING AIRCRAFT ON AF-110 REPORTS AT TIME OF ACCIDENT

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
AMC	SMAMA	Aircraft bailed to Lockheed Aircraft Corporation				

5. IF AIRCRAFT WAS BEING FERRIED OR DELIVERED INDICATE: (Gaining and losing organizations, date of transfer, ultimate destination)

Section C—PILOT(S) INVOLVED (Flight Crew)

1. OPERATOR (Person at controls at time of accident)

a. LAST NAME (Jr., II, etc.) FIRST NAME MIDDLE NAME	GRADE	COMPONENT	SERVICE NUMBER	NATIONALITY	YR. OF BIRTH
PARK WILLIAM CHARLES	Civ.			USA	[redacted]

b. POSITION IN AIRCRAFT AT TIME OF ACCIDENT: Front Seat X Rear or Right Seat___
c. ASSIGNED DUTY ON FLIGHT ORDER: AC___ IP___ P X CP___ Other (Specify)

d. ASSIGNED ORGANIZATION

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
AMC	SMAMA	AF Plant Representative, Lockheed Aircraft Corp., Burbank, Calif				

e. ATTACHED ORGANIZATION FOR FLYING

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
AMC	SAC	—	—	—	—	

f. ORIGINAL AERONAUTICAL RATING AND DATE RECEIVED: USAF July 1949
g. PRESENT AERONAUTICAL RATING AND DATE RECEIVED: CAA Commercial 11-14-55 #1172962
h. INSTRUMENT CARD: Type CAA; Date of expiration Good until revoked
i. AFSC: Primary N/A; Duty ___

2. OTHER PILOT

a. LAST NAME (Jr., II, etc.) FIRST NAME MIDDLE NAME	GRADE	COMPONENT	SERVICE NUMBER	NATIONALITY	YR. OF BIRTH

b. POSITION IN AIRCRAFT AT TIME OF ACCIDENT: Front or Left Seat___ Rear or Right Seat___ Other___
c. ASSIGNED DUTY ON FLIGHT ORDER: AC___ IP___ P___ CP___ Other (Specify)

d. ASSIGNED ORGANIZATION

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base

e. ATTACHED ORGANIZATION FOR FLYING

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base

f. ORIGINAL AERONAUTICAL RATING AND DATE RECEIVED
g. PRESENT AERONAUTICAL RATING AND DATE RECEIVED
h. INSTRUMENT CARD: Type___ Date of expiration___
i. AFSC: Primary___ Duty___

NOTE: IF MORE THAN TWO PILOTS ARE INVOLVED (FLIGHT CREW) REPORT SAME INFORMATION REQUIRED IN SECTION C2 ON ADDITIONAL SHEET FOR EACH

57-7-11-1

Section D—FLYING EXPERIENCE OF PILOT(S) INVOLVED

1. WAS OPERATOR ON INSTRUMENTS AT TIME OF ACCIDENT OR IMMEDIATELY BEFORE: Yes No X Unknown If "Yes," check one Weather Hood

(Complete items 2 through 14 for each crewmember pilot)

ASSIGNED DUTY ON FLIGHT ORDER	PILOT (Last Name)	CO-PILOT (Last Name)	INSTR. PILOT (Last Name)	AIRCRAFT CMDR. (Last Name)	STUDENT PILOT (Last Name)
NOTE: List all time to the nearest hour	PARK				
2. Total flying hours (including AF time, student time, and other accredited time)	3311				
3. Total rated 1st pilot and instructor pilot hours, all aircraft	3261				
4. Total weather instrument hours	150				
5. Total 1st pilot and instructor pilot hours this model (F-86, B-50, C-119, etc.)	30				
6. Total other (Command, a/c cmdr, co-pilot, radar control pilot) hours this model	0				
7. Total 1st pilot and instructor pilot hours this model and series (F-84F, F-86D, etc.)	3				
8. Total other (Command, a/c cmdr, co-pilot, radar control plt) hrs this model and series	0				
9. Total pilot hours last 90 days	35				
10. Total 1st pilot and instructor pilot hours last 90 days	35				
11. Total pilot hours (night) last 90 days	0				
12. Total pilot hours, weather and hood, last 90 days	5				
13. Date and duration of last previous flight this model	7/8/57 1				
14. Date and duration of last previous flight this model and series	6/27/57 1				

Classification Cancelled or Changed To By Authority of AFR 205-1 By [illegible] Date 6-18-64

15. INSTRUCTIONS: Attach a copy of AF Form 5 for pilot(s) involved for the previous calendar month, and for month in which the accident occurred, to include the flight on which the accident took place.

Section E—PERSONNEL INVOLVED

(Including operator and all other persons, whether in plane or not)

Duty at time of accident (1)	Name (Last name first, Grade, Serial Number and Component or Service) (2)	Type Aero Rating (3)	ORGANIZATIONAL ASSIGNMENT Command, Subcommand, Group Number and Type Base (4) AML AE40	Injury Class. (or missing) (5)	Parachute Used Yes (6)	Parachute Used No (7)	Ejection Seat Used Yes (8)	Ejection Seat Used No (9)
P 01	PARK, WILLIAM CHARLES	CAA Commercial	Engineering Test Pilot Lockheed Aircraft Corp. Burbank, California	M	X		X	

NOTE: If additional space is required to list all personnel involved, attach additional sheet.

Section F—WEATHER

(At time and place of accident)

Ceiling	Visibility	Wind Direction and Velocity	Temperature	Dew Point	Alt. Setting	Other Weather Conditions
12,000. Scattered	30 miles	WN W 7	88	55	30.00	ACC SOUTH

If weather, including wind conditions, was a factor in the accident, attach statement of weather officer.

Section G—ENGINEERING DATA

1. Damage: (Check one) Destroyed X Substantial Minor None 2. Was aircraft damaged beyond economical repair? Yes X No

3. Estimated number of direct manhours for repair, if applicable. Cost of damage to aircraft $4,000,000

4. Fire before accident Fire after accident X Fire did not occur 5. Did explosion occur? Yes X No upon impact

6. How many T.O.s not complied with at time of accident? 1 (List T.O. numbers and titles on separate sheet)

7. Has your Base previously submitted a UR on any factor involved in this accident? Yes No X

8. Is a UR being submitted as a result of this accident? Yes No X (If "Yes" attach copy) UR number

9. Is TDR requested? Yes No X Attach copy of request

SECTION K, FORM 14

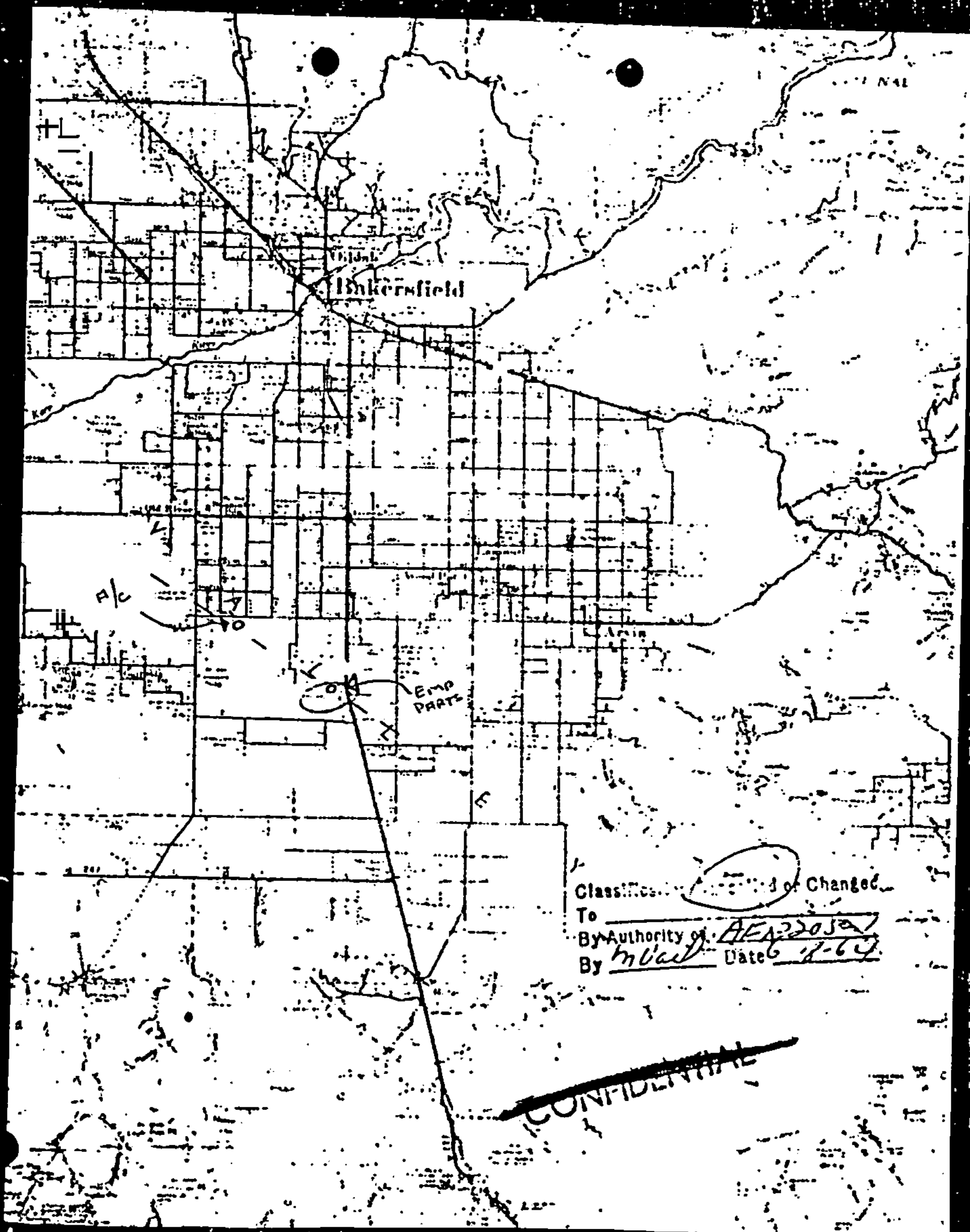
"HISTORY OF FLIGHT"

On 11 July 1957, at 08:40 PST, XF-104, AF Serial No. 53-7786, departed Air Force Plant 42, Palmdale, California, to act as a chase aircraft for an F-104A, Serial No. 55-2957, which was on an expennage dynamics engineering test flight. This aircraft was bailed to Lockheed Aircraft Corporation to be used as a chase aircraft and for pilot checkout and proficiency. The aircraft was on a local test flight and was properly cleared on a Lockheed Aircraft Corporation Clearance Form No. 1264-10, with 670 gallons of fuel aboard, enough for approximately one hour of flight. The pilot had been briefed on the mission by the flight engineer involved in the expennage dynamics program and had discussed the test with Mr. Robert Mayte the pilot of F-104A, No. 55-2957.

The first point to be obtained was full military power on the F-104A, No. 55-2957, and was flown at 12,500 feet at subsonic speeds. After this was completed F-104A, No. 55-2957, under test, accelerated to Mach 1.05 and began his second test. At this time, pilot Park in the XF-104 was subsonic and dropping back. He reported control trouble and shortly thereafter that he would have to leave the airplane. Mr. Park experienced difficulty in ejection, but eventually made a successful ejection with no injuries. He landed one-half mile south east of the impact point of the aircraft and was picked up almost immediately by a civilian in a truck who had seen him land. He rode to the scene of the crash where a California State Highway Patrol car took him to the hospital in Bakersfield, Calif.

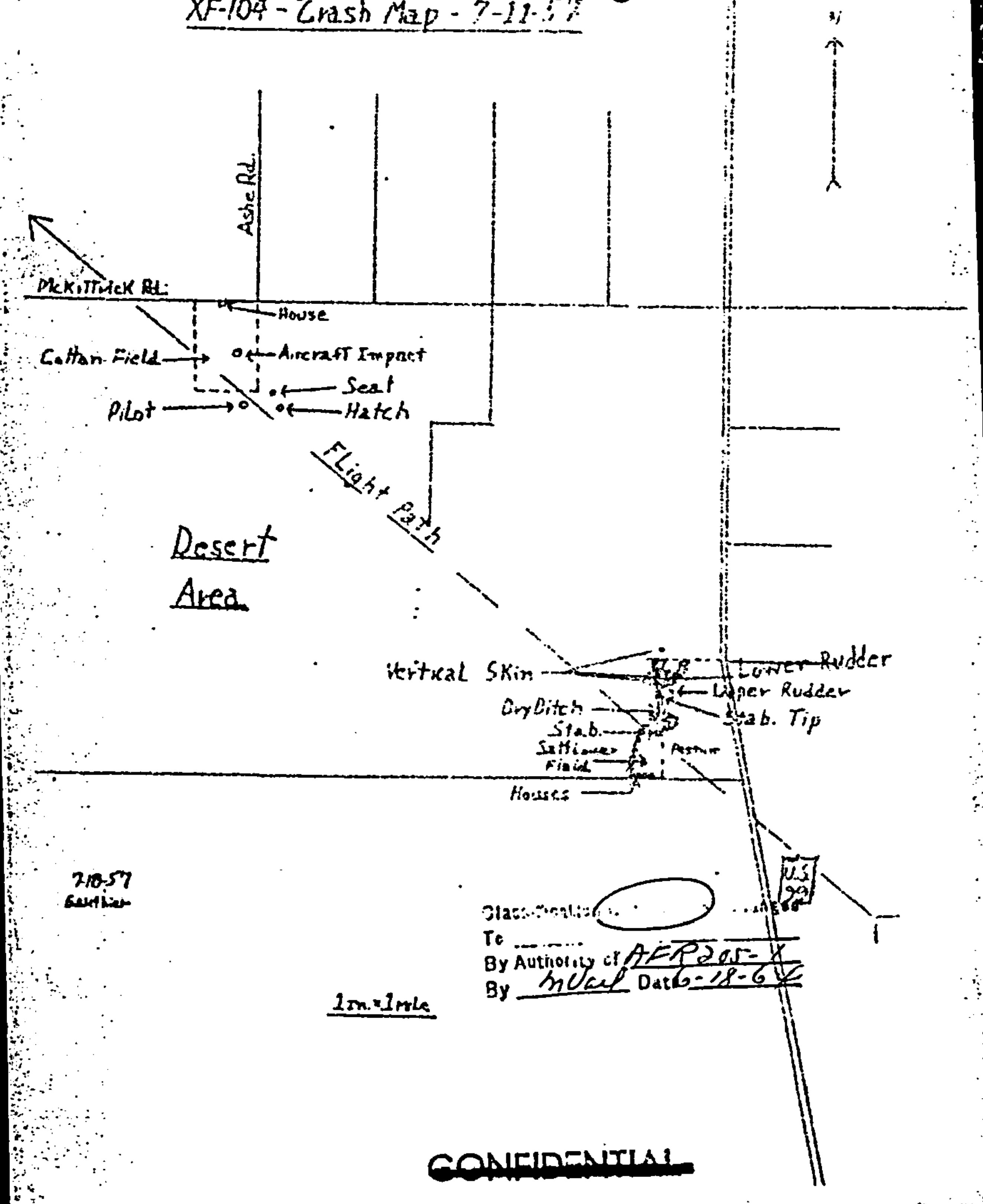
~~CONFIDENTIAL~~

Classification Cancelled or Changed
To
By Authority of AFR 205-1
By M... Date 6-18-64


Bakersfield
A/C
EMP PARTS
Arvin
CONFIDENTIAL
Classification ... or Changed
To
By Authority of AFA 220507
By m Vail Date 6-18-64

~~CONFIDENTIAL~~

XF-104 - Crash Map - 7-11-57



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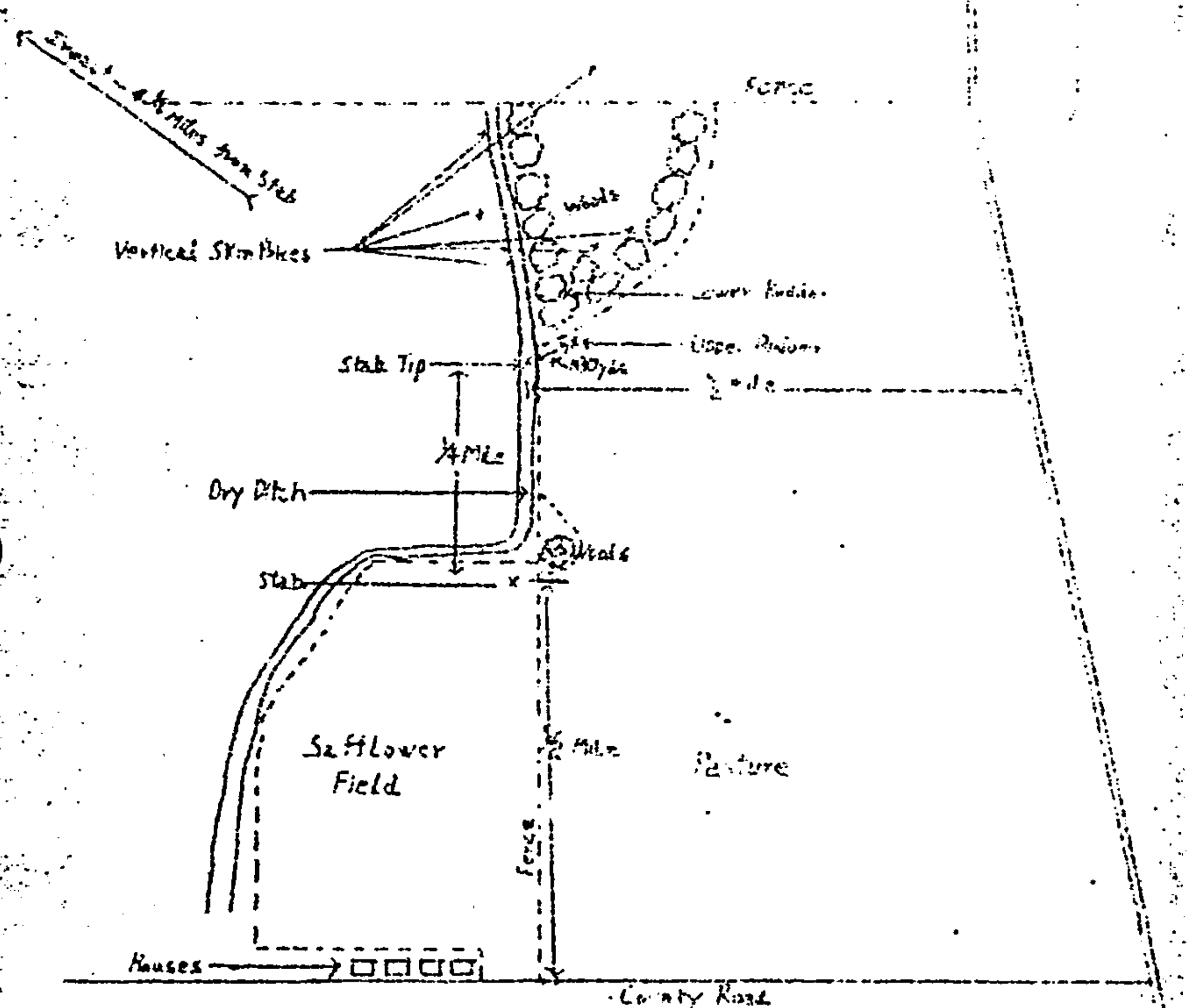
YF-104 Crash Map - 7-18-57



7-18-57
Gauthier

6 in. = 1 mile

Classified ... To ___
By Authority of AFR 205-1
By M dail Date 6-18-64

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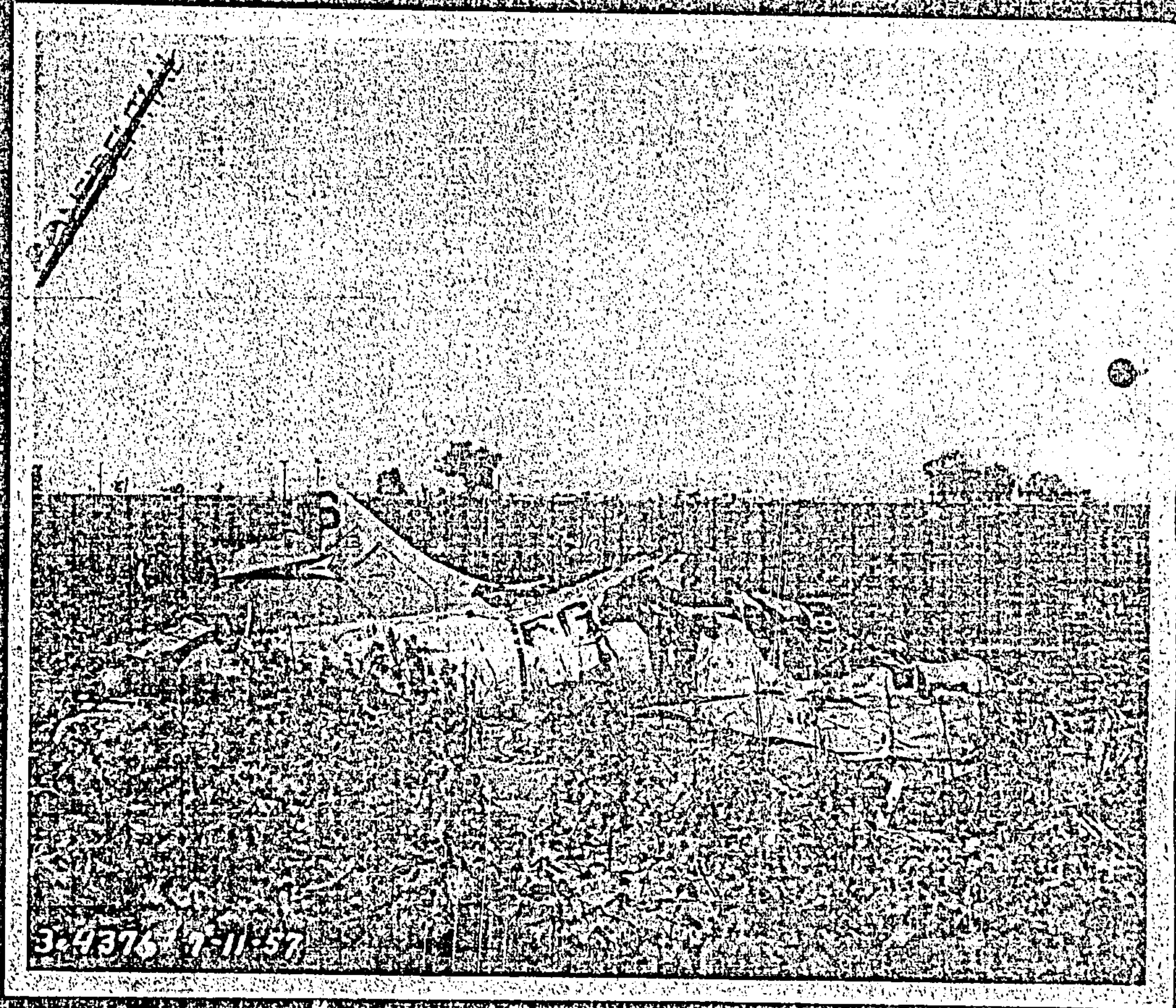
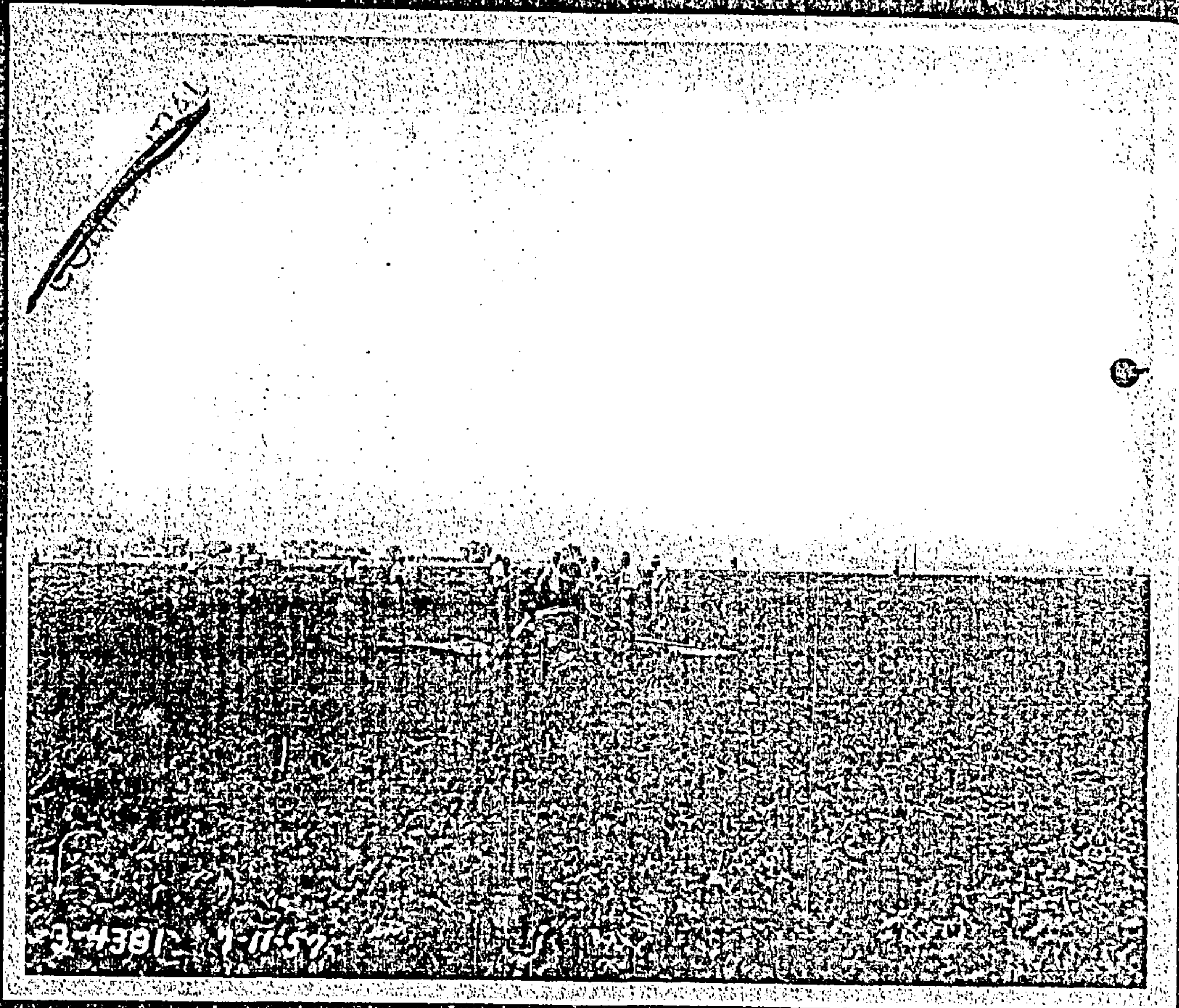

3-4376 7-11-57


3-4381C 7-11-57

11/06/1957

Bristol 175 Britannia
301

11/6/57

AviationSafetyNetwork

Accident Description

The Aviation Safety Network

300 BEST

Home
- sign guestbook
- view guestbook
- editorial
- what's new?

Accident reports
Accident specials
CVR / FDR
Database
Mailing list
News
Other sites
Pictures
Publications
Safety issues
Statistics

Forum
E-mail
About ASN...

Accident description

Date:	**06.11.1957**
Type:	Bristol 175 Britannia 301
Operator:	Ministry of Supply
Registration:	G-ANCA
C/n:	12917
Year built:	1956
Crew:	4 fatalities / 4 on board
Passengers:	11 fatalities / 11 on board
Total:	15 fatalities / 15 on board
Location:	Downend (UK)
Phase:	Final Approach
Nature:	Training
Flight:	Filton - Filton (Flightnumber)

Remarks:
The Bristol 175 had just completed a testflight of 1h and 40 minutes. Tests included a strain-gauge measurements on the non-standard propeller of the no.2 engine, and high speed upset manoeuvre recovery tests in connection with the US certification. Returning to Filton, the aircraft entered a circuit and partial gear extensions occurred for unknown reasons. Attempts may have been made to complete undercarriage free fall tests as these had failed the previous day; such test were not on the programme however. At 1500ft a left turn to base leg was initiated. The right wing suddenly dropped and the aircraft went into a very steeply banked right hand turn. The Britannia briefly recovered but banked steeply again and struck the ground in a wood near a residential area.
PROBABLE CAUSE: "The accident was the result of the aircraft developing a very steep descending turn to the right which the pilot was unable to control. The reason for this could not be determined, but the possibility that it occurred as the result of malfunctioning of the autopilot cannot be dismissed."

Source:
ICAO Accident Digest Circular 62-AN/57 (19-22)

[disclaimer]

05/09/58

Fairchild F27

Ship #1

5/9/58

The Aviation Safety Network

AviationSafetyNetwork

Accident Description

300 BEST

Accident description

Date:	**09.05.1958**
Type:	Fairchild F-27
Operator:	Fairchild
Registration:	N1027
C/n:	01
Year built:	1958
Crew:	0 fatalities / on board
Passengers:	0 fatalities / on board
Total:	0 fatalities / on board
Location:	? (USA)
Phase:	Ground
Nature:	-
Flight:	- (Flightnumber)
Remarks:	

Source:

[disclaimer]

06/11/1958

CF-105

attack aircraft, optimized to fly at low altitudes, were on the drawing boards, the missile seemed to be the future both as vector for nuclear weapons and as air defence system. In 1957 the British aviation industry was dealt a sharp blow when Duncan Sandys's cancelled all aircraft projects, except the English Electric Lightning, which was considered in a too advanced development stage to be cancelled. If anyone had announced then that the Tu-95 'Bear' would still be in service in 1995, he would probably have been put in a straightjacket immediately.

Meanwhile, the IM-99B Bomarc B surface-to-air missile had been ordered to reinforce the air defence. Bomarc B was more an unmanned interceptor aircraft than a missile in common sense: It was 13.3 meter long, weighed 7260kg, and had a range of 710km. Although Bomarc could ostensibly not replace the Arrow,it did contribute to the feeling that the Arrow was really unneccessary.

06/11/58

The prototypes

For the CF-105, a similar production plan was adopted as the Cook-Craigie plan adopted by the USAF for the F-102. The prototypes were built on production jigs. The first CF-105 Mk.1 was rolled out on 4 October 1957, four years after the definition of the RCAF requirement. This was certainly a notable achievement. The Minister of Defence, George R. Pearkes, announced with some pride a new age in Canadian aviation. The Chief of Air Staff used the opportunity to hint at a possible purchase of the Arrow by the USAF, and to point out that American subcontractors had contributed significantly to the Arrow. Probably this could have saved the Arrow from its final fate, but it was never much more than a faint possibility.

In preparation for the first flight, the design parameters of the CF-105 were fed to a computer — still very limited, in 1958! — to predict the behaviour of the aircraft in the air. The usefulness of this was probably small, because the computer predicted that the Arrow was unstable and would crash 13 seconds after take-off.

This did not deter the chief test pilot for the CF-105, Jan Zurakowski. He was born in Poland and flew combat missions in 1939, before he escaped to Britain. There he joined the RAF, and later became a test pilot for Gloster. He joined Avro Canada in 1952. The second test pilot was Spud Potocki, and for the RCAF Lt. Jack Woodman would test the CF-105.

During taxi tests all four mainwheel tires exploded, and the brakes had to be modified. On 25 March 1958 Zurakowski took the CF-105, number 25201 (coded RL-201) into air for the first time. Apart from a landing gear warning light, the flight was without problem. Zurakowski declared that the Arrow was easier to fly than the F-102 or the Gloster Javelin, two other delta-winged fighters. This would later be confirmed by other test pilots, who praised the handling of the CF-105 highly. Zurakoski complained about the high workload in the cockpit, despite the sophisticated AFCS (Automatic Flight Control System), but on the other hand the reliability of the electronic systems was better than expected.

On its third flight, the CF-105 reached Mach 1.1, at an altitude near 13000m. Mach 1.52 was reached on the seventh flight. But on its 11th flight, on 11 June, the left landing gear leg failed during landing, because it had not aligned itself properly with the axis of the aircraft. The landing gear broke off completely, and 201 skidded of the runway on its belly. Damage was not extensive, and on 5 October the aircraft flew again. Meanwhile, on 1 August, the 202 had joined the flight test program. But in November the landing gear of 202 failed when the brakes blocked.

08/30/1958

H.P HPR-7 Herald 100

08/30/58

AviationSafetyNetwork

Accident Description

Home
- sign guestbook
- view guestbook
- editorial
- what's new?

Accident reports
Accident specials
CVR / FDR
Database
Mailing list
News
Other sites
Pictures
Publications
Safety issues
Statistics

Forum
E-mail
About ASN...

Accident description

Date: 30.08.1958
Type: Handley Page HPR-7 Herald 100
Operator: Handley Page Ltd
Registration: G-AODE
C/n: 147
Year built:
Crew: 0 fatalities / 2 on board
Passengers: 0 fatalities / 7 on board
Total: 0 fatalities / 9 on board
Location: Milford (UK)
Phase:
Nature:
Flight: - Farnborough (Flightnumber)

Remarks:
The Herald had taken off from Woodey to take part in the Farnborough air display. Half an hour into the flight an intense and uncontrollable fire broke out in the no.2 engine nacelle. A rapid descend was carried out and a crash landing was made in a field. PROBABLE CAUSE: "The accident was caused by an intense fire which became uncontrollable and necessitated an immediate crash landing. The fire resulted from a major mechanical failure of the starboard engine and the disruption of the fuel system."

Source:

[disclaimer]

03/04/1954

East German
(Junkers) Model 152

03/24/59

The Rise and Fall of the East German Aircraft Industry

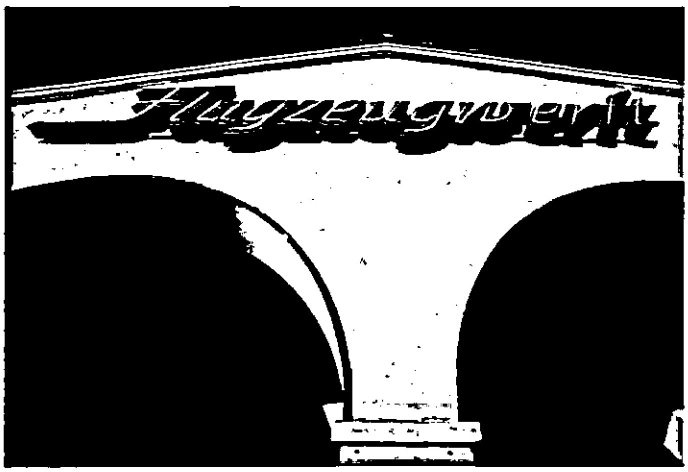
Under the inconstant patronage of the Soviet Union, the warplane builders of the Third Reich reached for their former glory.

by Fred Stahl

Color photographs by Mark Simon

When Germany surrendered in 1945, Joachim Foellbach was a young engineer with the Siebel aircraft factory. Although Siebel's main contribution to the war effort had been the licensed manufacture of Junkers Ju 88 bombers, at war's end Foellbach was working on advanced experimental projects that would prove very interesting to the Soviet forces that came to occupy Halle. As a result, Foellbach would experience personally the capricious policies with which the Soviet Union managed its zone of occupation.

Like the other Allied victors, the Soviets co-opted German designers and engineers for the development of their own aerospace industry. But the Soviets alternately starved and rewarded the Germans, first imprisoning them in the Russian hinterlands, then returning them to their own country to build what was intended to be a new, world-class commercial airliner.



"It was the biggest madness imaginable," Foellbach told me not long ago. "[The East German communist leadership] wanted this small country, so wretched and shabby after the war, to be just like before, with a magnificent aircraft industry." I spoke to Foellbach in Munich in 1993, almost half a century after the events he described took place. He derided the postwar political folly, but he was speaking with the benefit of hindsight. In the 1950s, when he and thousands of other workers came to a factory outside Dresden, they were caught up in the dream. Working with a single-minded intensity reminiscent of war production, the East Germans built a four-engine jet airliner, the Model 152, and flew it in 1959, less than five years after they had begun work. Their goal had been to produce an airliner that could compete with the new jet aircraft just beginning to fly in the West. Had the Soviets been steadier patrons—or had the Germans won control of their designs a few years earlier—they might have pulled it off. Few in the West know how close they came. For three decades, the epic rise and fall of the East German aircraft industry lay under a cloak of silence.

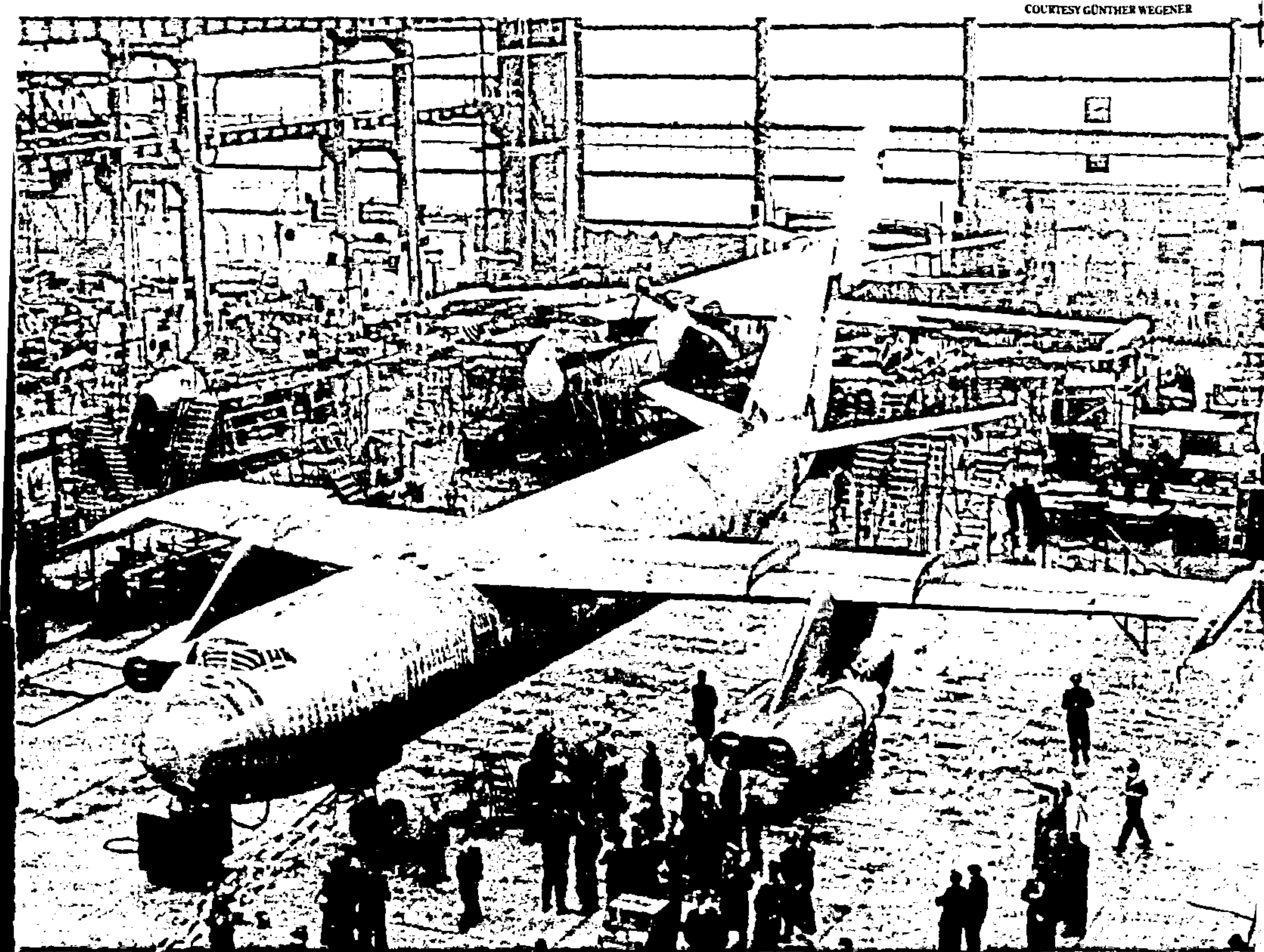
While the United States was organizing the Marshall Plan to nurse western Germany back to health, the Soviets, who had lost 18 million lives to German aggression, exacted staggering war reparations from the east. Moscow took a quarter of the eastern zone's annual economic output and picked the country clean of everything of value, even the rails from the railroads. Perhaps the most valuable commodity the Soviets took was German technical know-how. They had access to some of the most impressive aviation minds of the period, for Heinkel, Arado, Siebel, and Junkers all had factories in the east.

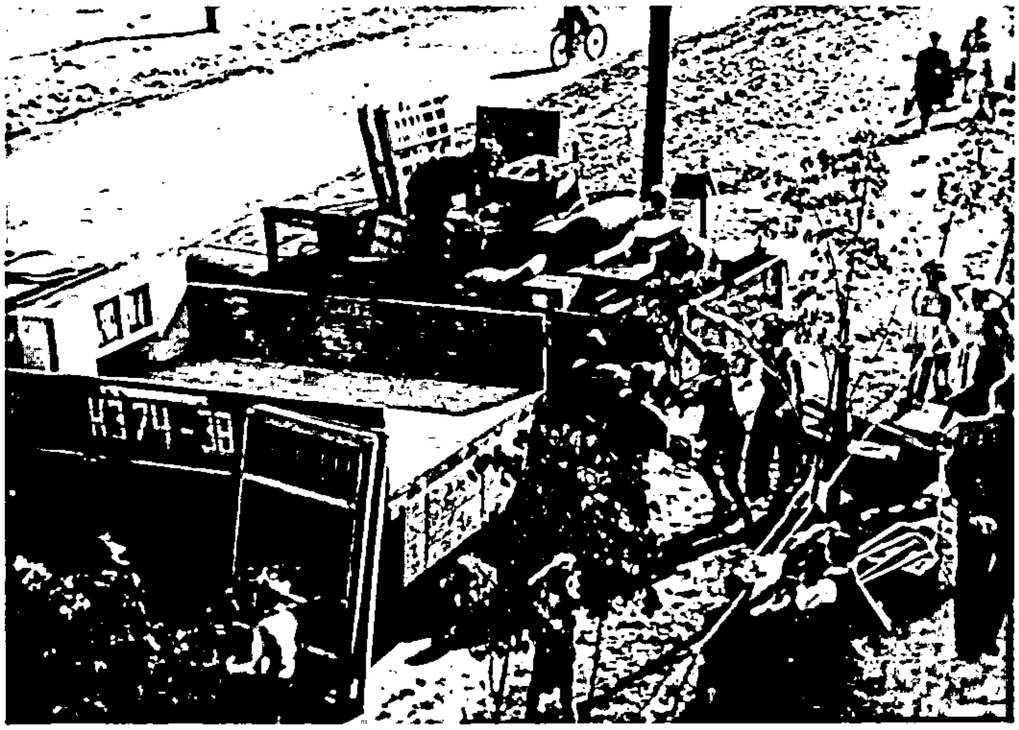
In Dessau the Soviet occupation force established a company headed by a Red Army lieutenant colonel to rebuild the Junkers aircraft factory and muster German engineers and mechanics for military research and development. A similar operation was put in place at Stassfurt for jet engines.

The German specialists in Dessau were ordered to write down everything they knew about the design, construction, and testing of aircraft and jet engines. They prepared 2,000 reports and shipped them to the Soviet Union. The Junkers engineers picked up where they had left off in developing medium-range jet bombers, and other aviation specialists were put to work at Siebel dismantling and packing up experimental aircraft, like the Model 346, a small rocket-pow-

The gate that once guarded a Nazi airfield (opposite) became the monumental entrance to a new aircraft industry. The East German state intended to prove the superiority of socialism with a single airliner—the Model 152 (below).

COURTESY GÜNTHER WEGENER





ered aircraft that had been designed to fly at Mach 2.

Foellbach remembered that in the beginning the workers were not paid; instead, the Soviet minister for aviation sent shipments of food. But in the first of many abrupt reversals, the engineers began receiving good wages in April 1946. It looked as though their lives would return to something close to normal; at least they would have predictable incomes. Foellbach recalled signing a contract that said he might have to work in another city, but the Soviets assured everyone in Halle and Dessau they would remain in Germany.

Then, at 3 a.m. on October 22, 1946, Soviet soldiers with machine guns appeared simultaneously at the homes of selected aircraft specialists while trucks with more troops waited in the streets. "We were abducted by the Russians," said Foellbach. "We had four hours to gather up our belongings."

For two weeks they traveled across Eastern Europe on a train with no other passengers except Red Army guards—530 engineers, scientists, mechanics, and metal workers, bound for Podberez'ye, a small village 75 miles north of Moscow at the confluence of the Volga and Dubna rivers. Some men were allowed to take their families. Others were not. Some could take nothing; others could take furniture and anything else they might want. The lucky ones took food. Foellbach took only his personal possessions. His wife, children, and mother-in-law followed six months later with their furniture.

At Podberez'ye, in abandoned buildings the Soviets had filled with machinery scavenged from German aircraft manufacturers, the transplanted engineers continued to work on aircraft they had been developing when the war ended. Inside the factories, at least, it must have seemed like home.

Siebel's supersonic rocket plane was put through a test flight program, but the Junkers designs were the most influential. Toward the end of the war the Junkers engineers had been experimenting with wings swept both forward and aft to improve aerodynamic performance near Mach 1. They built the Ju 287, a multi-engine jet that flew in 1944, and a more sophisticated research aircraft, the EF (*Erprobungsflugzeug*, experimental aircraft) 131. With six jet engines in two clusters slung under its forward-swept wings, the EF 131 was to be a 50,000-pound bomber with a flight radius of 1,425 miles.

In Podberez'ye the Germans lived under the poorest conditions. Some families were lodged in unheated barracks adjacent to a German prisoner of war camp; others were put up in an unused school. When the Germans arrived in the village in November 1946, the ice on a nearby lake was already three feet thick. That winter, temperatures went down to –40 degrees Fahrenheit at night. To warm their families, the men surreptitiously made small stoves in the aircraft factory and smuggled them home piece by piece—a dangerous business. One man got caught stealing 12 feet of wire to electrify his daughter's doll house and was sent to a camp in Kazakhstan. He was released after a year, but it took him another 12 months to make his way back to his family at Podberez'ye.

From 1946 through 1948, Soviet authorities sporadically

Almost 80 when he talked about his exile in Russia, Joachim Foellbach remembered the shabbiness of Podberez'ye. The Germans transplanted there were eventually allowed to retrieve furniture and other possessions from home (top).

gave cartons of food to the German families, but there were always shortages. Again, resourcefulness eased deprivation. Men made iron bars at the factory to break fishing holes in the ice. Eventually the Germans were paid salaries, with which they could purchase food at neighboring towns.

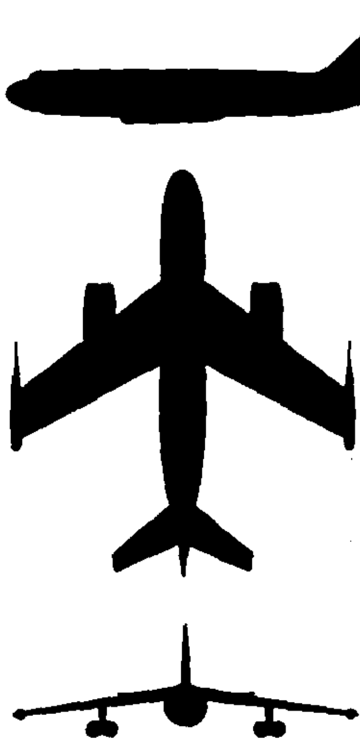
There was no fence to keep them in, but most Germans did not even think about escape. To the north were impassable swamps. To the west was a great artificial lake created by the Volga dam. To the south was the Volga itself with guards patrolling its banks.

Although the Germans were always confined by these boundaries, Podberez'ye became more comfortable for them as the years went by. Photos from the time show boat excursions on the Volga, outings in the forest, and numerous theatrical productions. The Germans could go to larger towns to shop and to Moscow for theater and concerts, although never without a Soviet escort.

Joachim Foellbach was almost 80 when I spoke to him, and when he talked about Podberez'ye, he seemed to focus his eyes on that distant time. "The hard part was the uncertainty," he said. "What was to be our future? Were we going home? When?"

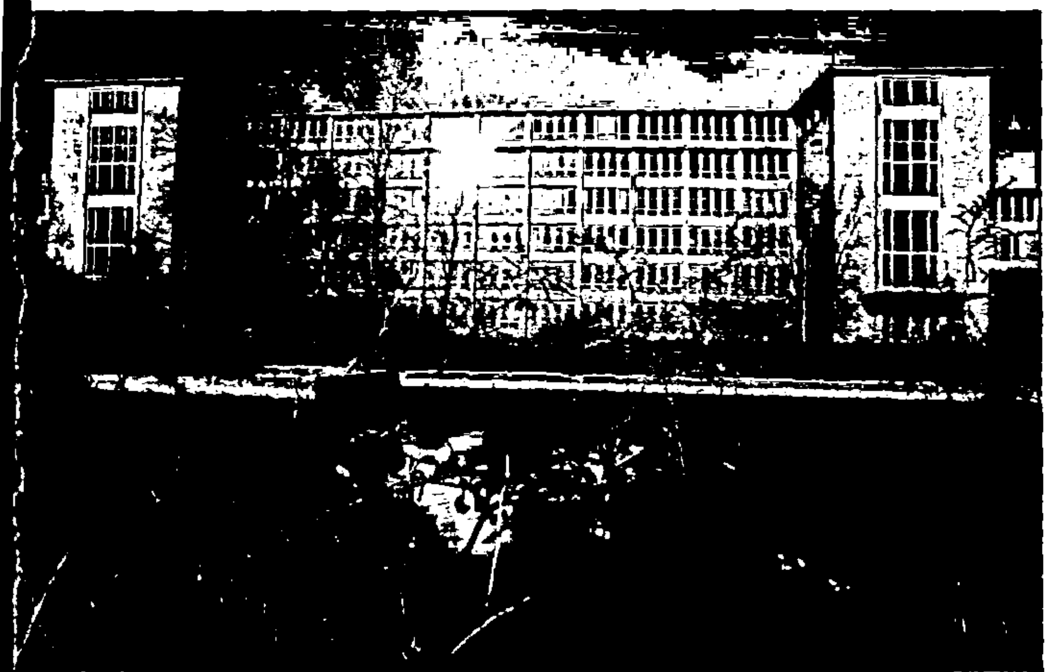
If any of the German expatriates could have influenced the answers to those questions, it was Brunolf Baade. A landing gear designer, though apparently not a very good one, Baade had a gift for leadership. He received rigorous technical training from the Berlin Institute of Technology, which also instilled in him Berlin pragmatism. He was an excellent speaker and actor, his associates from Junkers recall. "He could charm people," says one engineer.

After the war, the Soviets appointed Baade to rebuild the Junkers factory at Dessau and eventually to act as chief of the German aircraft and engine development effort in the Soviet Union. His relationship with Moscow officials must have been cozy; unlike the other interned Germans, Baade was allowed to travel freely. He and his family were permitted to take unescorted vacations at Crimean resorts on the Black Sea while his countrymen shivered north of Moscow.



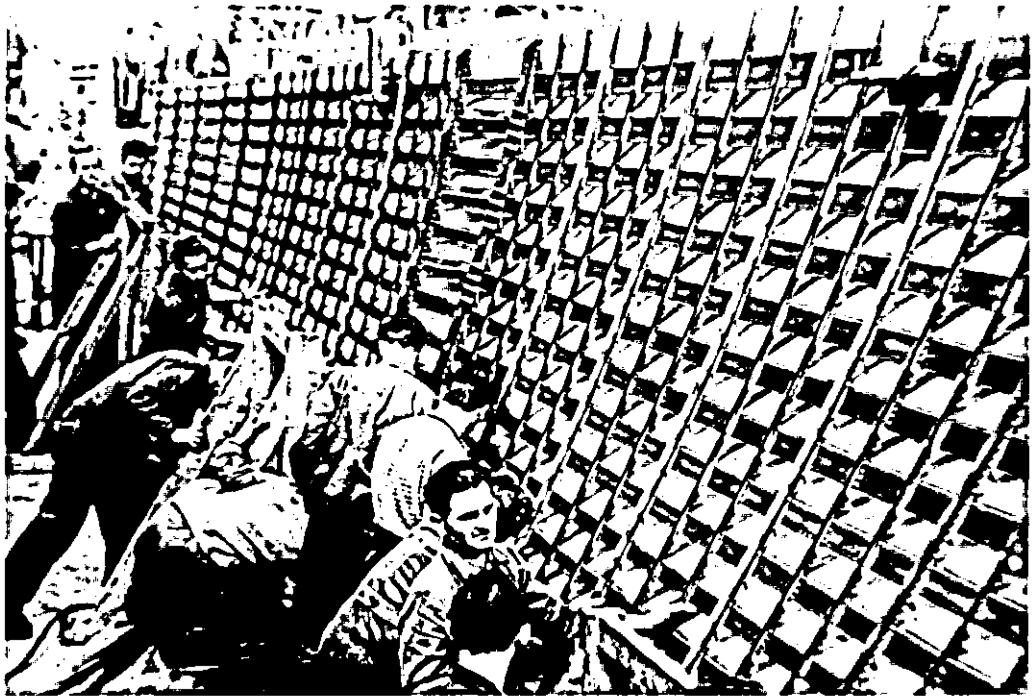
Germany's First Commercial Jet

Like other bomber-derived jet airliners of its day, the Model 152 had swept wings, but they were mounted higher on its fuselage than those on Boeing's 707 or Tupolev's -104. The 152 was designed to carry 58 passengers over routes as long as 1,800 miles at a cruise speed of almost 500 mph. With a wingspan of 88 feet and a length of 103 feet, it was slightly smaller than the Tu-134, which eventually filled the role of medium-range jet for East Germany after the 152 was canceled.



The seven-story office building that the East German government built for Brunolf Baade still stands outside Dresden. Baade and his airliner were so important to the country's economy they made the cover of a Life-like *magazine in 1958.*

With Baade in charge, the Germans continued to develop the swept-wing jet bombers they had been building at the Dessau factory. By 1951 they were testing an aircraft that had a range close to a thousand miles and could carry 13,000 pounds of bombs. With a Soviet designation but a Junkers model number, the two-jet-engine Samolyot ("Aircraft") 150 was a successful design, but it was abandoned in 1952 as the requirements of the Soviet air force shifted to longer-range bombers. Still, the Samolyot 150 had given the German team experience with large (90,000-pound) multi-engine jet aircraft, and Baade saw it as their technology ticket home. As early as 1951, he began to peddle the idea, in both Moscow and Berlin, of building in what was by then East Germany a brand-new commercial aircraft industry around the expertise of his engineers sequestered at Podberez'ye. But although small numbers of Germans and their families had been released by 1951, the Soviets continued to regard German invention as Soviet property.



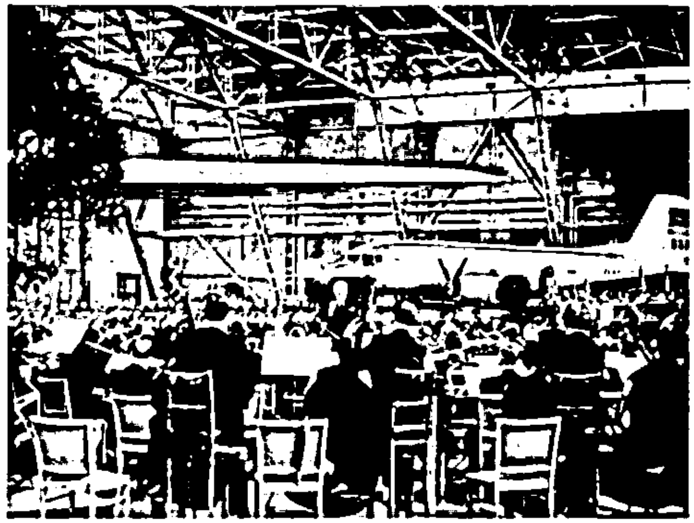
COURTESY GUNTHER WEGENER (3)

The 152s were essentially hand-built. Whether assembling wings (above) or drilling holes for fasteners (opposite), workers felt a personal commitment to the job, says Erhard Voss (below, holding a piece of a 152 he helped build).

While the Soviets stalled, Baade lost his moment. Another multi-engine jet bomber entered service in 1951. Boeing's B-47—which began with straight wings until German wind-tunnel data recovered in the war persuaded engineers to sweep them—gave the Seattle manufacturer the experience that would eventually produce one of the most successful commercial airliners in history, the Boeing 707. And just one year after the B-47 entered service, the Soviets began flying a twin-engine bomber, the Tupolev Tu-16, which quickly evolved until in 1956 it became the first jet airliner to begin sustained, commercial service: the Tu-104. Many years later, some of the Germans wondered if the Soviets' own plans for the Tu-16 had caused Moscow to hold Baade back. But in the early 1950s the dream still seemed possible.

In 1953, after persistent food shortages and worsening economic conditions, workers throughout East Germany revolted over an increase in Soviet-imposed production quotas. Although Soviet forces crushed the insurrection, the revolt finally marked a change in the political relationship between the two countries. When Stalin died that same year, the Soviets stopped treating East Germany as an occupied enemy.

With politicians in Moscow and Berlin now looking for fresh ways to improve the East German economy, Brunolf Baade's sales pitch was beginning to have an effect. At the time he was fond of saying that a kilogram of aircraft-grade aluminum sold for five West German marks on the world market; manufactured into an aircraft, it sold for 200. In December 1953 Baade received permission from Moscow to turn his team's full energies to developing from the Samolyot 150 bomber a large jet airliner, the Model 152. By the time the last Germans left Russia in June 1954, they had the plans and calculations for the 152 and its engines in their al tags marked 7240. He then went to a storeroom where a monitor distributed hand tools in exchange for tags and hung the tags on a board in place of the tool. On Friday the monitor reconciled tools and tags. Any tags still hanging on the board revealed a problem: maybe a tool in an aircraft. The penalty for substituting another tool for one's own was instant dismissal.



COURTESY GÜNTHER WEGENER

The Soviets supported the new industry with technical assistance and, more importantly, orders for and kits to assemble five copies of the Ilyushin Il-14, a short-range, twin-engine airliner, which the Germans continued to produce until 1959. Baade organized his industry into two teams: One team of manufacturing and flight test people honed their airplane production skills with the twin-engine Ilyushin. Chief designer Fritz Freytag took charge of the other team, which polished the designs and put together prototypes of the real prize, the four-jet Model 152.

Baade's Soviet connections continued to serve him well. In the years after 1954, the Soviets sent trainloads of machines and equipment to outfit the East Germans' factories. When various shortages held up production, Baade would simply pick up the telephone and call a ministry acquaintance in Moscow. The needed material would be dispatched immediately.

Baade was no less effective with his engineers. Günther Wegener, a flight test engineer for the Model 152, says that Baade could see quickly to the heart of a problem and then get his people working on it. "He was to us a beloved god," says Wegener's wife Ingebord, Baade's chief of staff for many years. Baade cut an impressive figure: He was a tall, powerful man with a big head framed by silver hair. His work habits brought him to his office relatively late, about eight or nine o'clock, but he would typically work late into the evening. "It was the Junkers style," recalls Inge Wegener. The Junkers engineers liked the peace and quiet of the evening to think and to work undisturbed.

Despite Baade's inspirational leadership, the dedication of his workforce, and the full support of the communist state, the Model 152 suffered from the two problems that habitually plague aircraft development programs: missed schedules and high costs. Although Baade held weekly staff meetings—Red Meetings, he called them—to assess problems and progress, he became impatient with progress on the 152. He had barely managed the rollout of a prototype to impress Communist Party bosses in April 1958. He knew that he could not buy much more time in Berlin with his charm and socialist vision. "Kiddies," he chided his chiefs, "we have got to fly. Otherwise—no more money from Berlin."

But the teams were working hard already. As they struggled to complete a prototype, the plant was running 24 hours a day, seven days a week. Erhard Voss remembers that for

Günther Wegener revisits a scene from his past. When he investigated the crash of the 152, he interviewed witnesses who had seen the airplane while they were working on the church's steeple. (Right) Pilot Willi Lehmann, center, and copilot Kurt Bemme, right, were among the four men killed. The entire city mourned. The Dresden Symphony Orchestra played at the service in a factory hall (above). Later, the factory erected a monument to the lost airmen (opposite).

COURTESY FRANK LEMKE

suitcases. The only thing they lacked was the infrastructure to build it.

At a Luftwaffe airfield in Klotzsche on the outskirts of Dresden, Baade set up headquarters for an entire industry. Having been given the highest priority for resources from the East German economy, the repatriated engineers built a seven-story engineering office, test rigs and wind tunnels, and massive construction halls—the largest in Europe at the time—for airframes, jet engines, and electrical and hydraulic equipment.

Baade immediately became a member of the East German Central Committee, even though he had to wait the obligatory three-year period for his Communist Party membership. In this position he was able to influence state planning and make clear that the 500 specialists who had come back from Russia would be too few for the colossal industry he and the German communists envisioned. Orders came from East Berlin for trade schools and institutes to recruit and train production workers, engineers, and technicians.

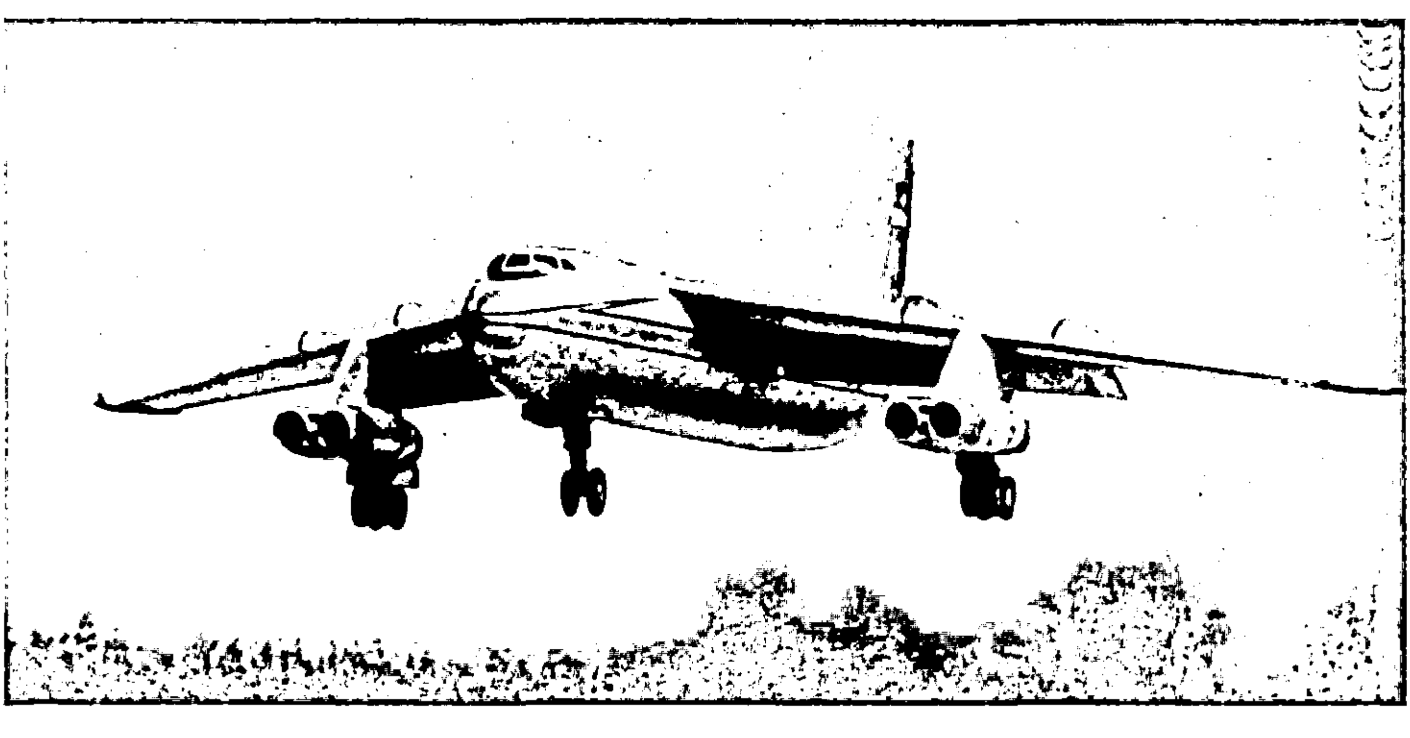
An airliner industry needs an airline to buy its aircraft. Even before Baade and his engineers got off the train from Moscow, the East German airline Deutsche Lufthansa (later Interflug) was being organized. An airliner industry also needs a national aviation authority to certify airworthiness. East Berlin created one.

The second prototype of the Model 152 flew twice—in August and September 1960. By then the engines designed for it, four Pirna 014 turbines, were ready, but Boeing and Tupolev had already captured the jet airliner market.

The Central Committee opened new facilities and commandeered old ones in Dresden and beyond to support the fledgling industry: a bureau at Pirna, an ancient city just upriver from Dresden, to design aircraft engines and a factory not far south of Berlin to assemble them; factories southwest of Dresden to manufacture precision hydraulics, electrical equipment, and piston engines; plants near Leipzig to make wing flaps, horizontal and vertical stabilizers, and other parts. To design the thousands of smaller components needed, specialists were harnessed into the new industry from all over East Germany: Brandenburg, Halle, Dessau, Rostock, Oranienburg. Eventually 25,000 East Germans would be committed to the project.

Erhard Voss's father was one of the hundreds of workers who moved his family to Dresden to get in on the potential prosperity. At 15, Voss entered an apprentice metal worker program at the factory, and his memories of his work there create a picture of committed, disciplined laborers working to build something they could be proud of. One foreman still has a special place in Voss' memory. The mechanics called him "Rivets" Krause. "He would wipe a ball of cotton over a line of rivets," says Voss. "Any tufts caught on rivets or burrs earned his special attention." (The apprentices probably enjoyed the double meaning of Krause's nickname: The German word for "rivets"—*niete*— is also slang for "loser.")

Voss also remembers exquisitely authoritarian measures to keep tools and small aircraft parts from disappearing into the craft under construction and becoming a hazard later. Each worker was assigned a number; Voss still remembers his: 7240. Every Monday morning he received a dozen met-



a couple of years, management had lunch delivered to workers at tables in the factory cafeteria to avoid losing precious minutes queuing up for food. Women in traditional black and white waitress uniforms served food selected by the workers from rolling carts. To Voss, these measures instilled the right philosophy in the workers—to value time and strive for quality.

Günther Wegener recalls working every night until nine or ten. They were all emotionally committed to building the 152. According to Wegener and some of the other engineers, the East German people wanted to prove themselves to the world. If they could create an industrial miracle out of the ruins pillaged by the Soviets, they would no longer be perceived as the poor relations of the Westerners.

The strength of the engineers' belief in their abilities was apparent when they returned from Russia. They had the choice to go west or remain in East Germany to help build a new aircraft industry. Twenty left. Hundreds stayed to follow Baade's vision.

Of course by that time, Berlin was also offering premium wages to attract the best workers. All aircraft workers and engineers in Dresden and elsewhere earned a good bit more than their counterparts in other East German industrial sectors. The technicians and builders who had spent time in Russia were paid an additional allowance on top of that.

The people of Dresden also got caught up in the dream. They turned out to cheer the rollout of the prototype on April 30, 1958. And at its first flight almost seven months later, on December 4, even the women who swept the floors in the factories stood by the runway and wept.

They didn't know, of course, and neither did Communist Party secretary Walter Ulbricht, that it flew with Soviet RD-9B engines, used in the MiG-19. Development of an engine for the Model 152 was far behind schedule.

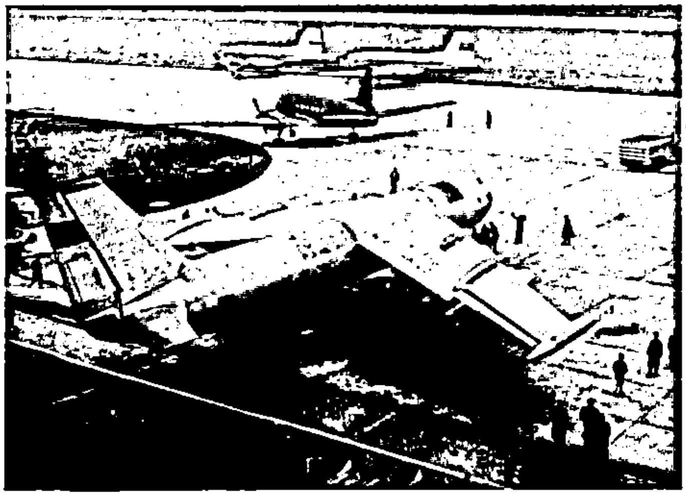
Willi Lehmann, a flight test engineer and fighter pilot who had been at Podberez'ye with his wife and son, landed the aircraft at Klotzsche without incident 25 minutes after takeoff. Lehmann had earned the nickname "Stogram" in Podberez'ye, Russian for "one hundred grams," the capacity of a standard Russian drinking glass. The German engineers hung the nickname on Lehmann when he proved that he could swill vodka with the toughest Soviet drinkers. Lehmann would fly the prototype on its second and last flight the following March.

Early March was always important for the East German communists. It was the time of the big trade fair at Leipzig, a tradition originating in the Middle Ages. After the second world war, the spectacle was used to show off the glories of socialism. The 1959 event was of special significance because Nikita Khrushchev and many other Communist Party and eastern government dignitaries were going to attend.

The political leadership in East Berlin ordered the one flying prototype of the 152 to make a slow, low-level pass over the Leipzig fair. Baade agreed, but he must have known better. Low-level flight is a dangerous regime for a new aircraft design. There is no room to recover from difficulties. Baade must also have known that he lacked the political capital to contest the order and still keep the money flowing from East Berlin.

At 3:00 p.m. on Wednesday, March 4, 1959, Khrushchev and 100,000 spectators waited at Leipzig. The 152 never showed up. The symbol of the East German economic miracle had crashed an hour and nine minutes earlier while rehearsing a low-level pass near Klotzsche.

Günther Wegener's memory of the crash has never faded. "I can remember precisely that morning after breakfast standing with Georg Eismann," he says. "He said to me: 'Boy, Günther, I have the funniest feeling today. I don't know what will happen if I fly today—this funny feeling.'



COURTESY GÜNTHER WEGENER

From a window of the abandoned control tower at Klotzsche, a derelict runway near the aircraft factory is barely visible through weeds. In the early sixties, this same runway was used to test the Model 152 (left, foreground) and Il-14s.

"I said, 'One always has fear with a test flight. But look, if you're really afraid or have a funny feeling, stay on the ground and let Bemme, the copilot, switch on the airborne instrumentation to record the flight parameters we need.'

"But he said, 'Naw. If I fly then we'll make more progress. If I am on board, I can record more things than automatic equipment can.' "

Eismann made his decision in order to help speed the pace of the program. He and the other four men in the airplane died in the crash. To this day, no one is sure what caused it. There was no telemetry data and no crash-proof black box. An official board of inquiry concluded flaccidly that the accident was caused by an "unfortunate combination of unfavorable circumstances."

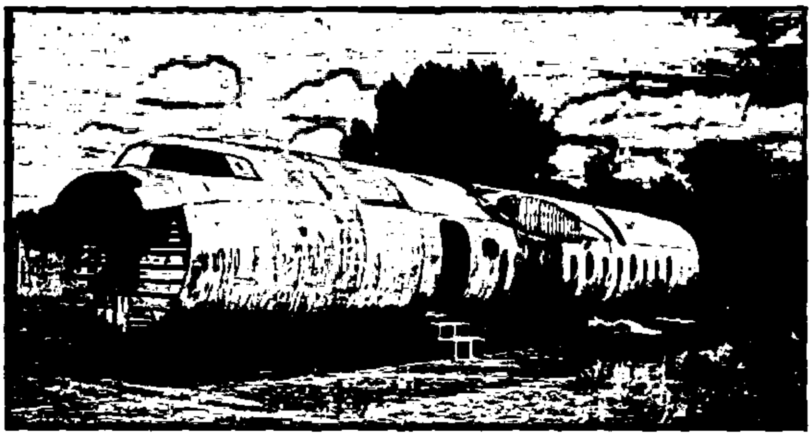
The evidence points to a fuel supply problem. Later tests revealed fuel system problems inherent in the design of the 152. The Dresden engineers found inadequate ventilation of the fuel bladders in the wings. In ground tests replicating the nose-down attitude of an aircraft on a glidepath into Klotzsche, the fuel bladders of another prototype 152 were torn apart by pressure differences.

The fuel system had not been tested on a tilt table, as is customary before the first flight of a new model. Later, when engineers ran tilt table tests with clear acrylic fuel lines, they saw air bubbles in the fuel when the shallow glide profile was simulated.

The orders that came from East Berlin after the inquiry were no surprise: information about the crash was to be kept secret. The wreckage was to be buried; the report was classified. But when factory officials organized the funeral in Building 285, one of the large of the assembly halls, thousands of Dresdeners turned out. The Dresden Symphony Orchestra canceled its tour to China to play at the event.

Fritz Freytag, the chief designer of the 152, led the memorial service. His contemporaries say today that Freytag felt personally responsible for the tragedy. At graveside, however, he repeated the official line about a combination of unfortunate circumstances.

The crash was a watershed event for the East German industry. Some of the engineers left Klotzsche, Foellbach among them. "I knew it wasn't going to come to anything," he said many years later. Wegener recalls that he and his colleagues were at first stunned by the crash, but they quickly recovered. They knew that other jet airliners had had their share of crashes at first. They knew of the British Comet disasters. A crash was natural. They turned again to the tasks at hand. The Dresden team concentrated on getting a fixed prototype into the air. They designed and installed remedies for the defects in the fuel system, and the next prototype flew without incident on August 26, 1960, more than a year after the crash.



When the 152s were broken up for scrap, the East German air force took two fuselages to use for storage. One survives, having spent years in this field at a former fighter base near Poland.

FRED STAHL

No one saw much of Baade right after the crash. Curiously, he did not show up for the funeral. It was a couple of weeks before he resumed his Red Meetings.

Baade must have known that while crashes of test aircraft are not surprising, this crash could be fatal to his program. Delays putting the 152 into production must have been damaging. By June 1960, Baade had to announce that the delivery of the first 152 would be postponed to 1962.

He knew that East Berlin had dumped more than two billion marks into the industry, a massive subsidy for a small country trying to rebuild its economy. Now it was becoming painfully obvious that there would be no return on the investment. Western jets on the market, such as the Comet, the French Caravelle, and the Boeing 707, were more advanced. Beyond selling a dozen 152s to the state-owned airline, the Germans could not compete. Baade admitted in 1960 that they "would always be limping along behind."

As in the past, East Berlin turned to the Soviets for help, but this time in vain. In October and November, when a delegation to Moscow seeking general support of the flagging East German economy brought up the question of buying 152s from Dresden, the party bosses in Moscow declined. The Soviet Union already had all the capacity it needed for building airliners. "Then how about building a Soviet jet under license at Klotzsche?" the East Germans asked. The Soviets took it under advisement but never bothered to respond.

In East Berlin on February 28, 1961, the Politburo decided to dissolve the East German aircraft industry. At a Plenum of the East German Central Committee on April 5, 1961, party leaders announced that aircraft construction in East Germany would be terminated immediately. All aircraft, complete or under construction, were to be destroyed. The tens of thousands of aircraft workers and specialists were to be dispersed to other industries.

The factory doors were locked. Inside, men with axes broke up the airframes of the 26 Model 152s under construction. Wegener says the hard aircraft aluminum alloys shattered under the blades. Steel parts were cut up with torches.

Their dream broken, some of the aircraft engineers made their way to East Berlin and to the West through the last gap in the Iron Curtain. Fritz Freytag, Baade's chief designer, was among them. Four months later, Erich Honnecker walled off East Berlin. The files on the 152 were locked and sent to Moscow.

The central committee's action left an industrial vestige, the Dresden Aircraft Depot, which continued to operate for three decades, mainly to repair, overhaul and reassemble Soviet-built MiGs and helicopters. In 1991, the year after Germany reunified, Deutsche Aerospace purchased the depot, and today machinists are again working on big airliners in the great aircraft assembly halls at Dresden. Their new assignments include outfitting Airbus fuselages, building aft fuselage sections for Fokker 70s and 100s, and overhauling Boeing 737s.

In the midst of this work, the Dresdeners also completed a task that reflects the newer political turnabouts in their part of the world. As signatories to the 1990 conventional-arms reduction treaty between NATO and the countries of the Warsaw Pact, both West and East Germany were required to destroy fighter aircraft. When the time came to dispose of the airplanes, however, the Warsaw Pact had dissolved, the two Germanys had united, and one government owned both sets of fighters. Rather than try to refit the older aircraft from the East to fly in the West, the Germans decided to destroy them anyway. And in 1993—in what seemed like an eerie *re-staging* of the destruction of the Model 152s—the Dresden workers broke apart 140 MiG-21s that the machinists had serviced as East German citizens.

05/14/1959

DC-8

Hard Landing

FLIGHT CARD

Model DC-8 Airplane No. N8018D

Flt. No. 56 Date 14 MAY 59

T. O. Wt. 205,000 T. O. C.G. 17 % MAC

Flt. Crew

Pilot TYMCZYSZYN FAA Co-Pilot HEIMERDINGER

Sys. Eng. MAGRUDER F. T. E. EDWARDS
BELYEA
SCHLEUTER

FAA: FRANCEK
BRYDE

Approvals:
Ch. Pil. [illegible]
Pilot [illegible]
T.P.E. [illegible]
Gr. Eng. [illegible]
F.T.E. [illegible]
Gr. Eng. [illegible]
F.T.E. [illegible]

Test	Config.	Altitude	Weight	C.G.
A. Take-off Performance	T.O.	4 EAFB	205,000	17.3 %
B. Instrumentation Phase Check	Cruise	6,000	OPT	OPT
~~C. Longitudinal Control~~	~~T.O.~~	~~6,000~~	~~275,000~~	~~32.0%~~
~~D. Static Longitudinal Stability~~	~~GR Down~~	~~6,000~~	~~275,000~~	~~32.0%~~
~~E. Static Longitudinal Stability~~	~~Cruise~~	~~6,000~~	~~275,000~~	~~32.0%~~
~~F. Static Longitudinal Stability (Climb)~~	~~Cruise~~	~~6,000~~ 2000	~~275,000~~	~~32.0%~~
~~G. Static Longitudinal Stability~~	~~Cruise~~	~~35,000~~	~~260,000~~	~~32.0%~~
~~H. Long. Trim Required (level Flt)~~	~~Cruise~~	~~OPT~~	~~>260,000~~	~~32.0%~~
~~I. Long. Trim Required (level flt)~~	~~GR Down~~	~~OPT~~	~~260,000~~	~~32.0%~~
~~J-1 Airspeed Calibration (tower pass)~~	~~Cruise~~	~~2,500~~	~~OPT~~	~~OPT~~
~~J-2 Airspeed Calibration (tower pass)~~	~~P.A.~~	~~2,500~~	~~OPT~~	~~OPT~~
~~J-3,4 Airspeed Calibration (trailing bomb)~~	~~Various~~	~~11,000~~	~~OPT~~	~~OPT~~
~~K. Static Longitudinal Stability (PTC OFF)~~	~~Cruise~~	~~11,000~~	~~OPT~~	~~OPT~~ AFT
~~L. Static Longitudinal Stability (PTC ON)~~	~~Cruise~~	~~11,000~~	~~OPT~~	~~OPT~~ AFT
~~M-1 Askania Climb Survey~~	~~Cruise~~	~~36,000 to 40,000~~	~~OPT~~	~~OPT~~
~~M-2 Airspeed Calibration (level & dive)~~	~~Cruise~~	~~36,000~~	~~OPT~~	~~OPT~~
~~N-1 Static Longitudinal Stability (PTC OFF)~~	~~Cruise~~	~~35,000~~	~~OPT~~	~~FWD~~ AFT
~~N-2 Static Longitudinal Stability (PTC ON)~~	~~Cruise~~	~~35,000~~	~~OPT~~	~~FWD~~ AFT
~~O. Fuel Tank & Fuel Heater Temp Survey~~	~~Cruise~~	~~35,000 to 2,000~~	~~OPT~~	~~OPT~~
P. JT4 Engine Surge Evaluation	Cruise	3,000 to 6,000	OPT	OPT
~~Q-1 Static Longitudinal Stability (PTC OFF)~~	~~Cruise~~	~~24,000~~	~~OPT~~	~~AFT~~
~~Q-2 Static Longitudinal Stability (PTC ON)~~	~~Cruise~~	~~24,000~~	~~OPT~~	~~AFT~~
~~R-1,2 Longitudinal Trim Change~~	~~Various~~	~~OPT~~	~~190,500~~	~~32.0%~~
~~S-1 Longitudinal Control~~	~~50° Flap~~	~~2,000~~	~~190,500~~	~~32.0%~~
~~S-2 Longitudinal Control~~	~~40° Flap~~	~~6,000~~	~~190,500~~	~~32.0%~~
~~T-1 Static Longitudinal Stability~~	~~Approach~~	~~OPT~~	~~190,500~~	~~32.0%~~
~~T-2 Static Longitudinal Stability~~	~~Landing~~	~~OPT~~	~~190,500~~	~~32.0%~~
~~U-1 Longitudinal Control (Idle Pwr)~~	~~Landing~~	~~6,000~~	~~190,500~~	~~32.0%~~
~~U-2 Longitudinal Control (NET)~~	~~Landing~~	~~6,000~~	~~190,500~~	~~32.0%~~
V-1,2 Longitudinal Trim Change	Various	OPT	190,500	16.5%
W Longitudinal Trim in Glide	Landing	OPT	190,500	16.5%
X Static Longitudinal Stability	Landing	OPT	190,500	16.5%
Y Longitudinal Trim in Glide	GR Down	OPT	190,500	16.5%
~~Z-1 Longitudinal Control~~	~~Landing~~	~~2,000~~	~~189,000~~	~~16.5%~~
Z-2 Longitudinal Control	Landing	6,000	169,000	16.5%
ZZ Landing	Landing	Field	180,000	OPT
ALTERNATE FLAP BLOW BACK TEST	NOTED	OPT	NOTED	OPT

DC-8 N8018D FLIGHT NO. 56 TEST 22

DATE 14 MAY 59

40° PERFORMANCE

LANDING

Config Noted	Weight Less than ~~180,000~~ 170,000	Altitude Field
Flaps 40°	C.G. Opt 16.3 %	O.A.T.
Gear Dwn	Fuel Sched. Normal	Wind Vel. 15 KT
Spoilers Armed	Flap Inter. Inop	Wind Dir. 240
Braking Med	Yaw Damper Inop	Runway 22
Hytrol Oper	Aileron Pwr. ON	1.3 $V_{s_{min}}$ = 130 KTS
Reverse Thrust ~~Inop~~	Rudder Pwr. ON	

Control System Config: ih = 8.2 PRIOR 50' APN-22

Instrumentation: Photo Rec. FR/SEC #1 1 #2 1

OSC. IN/SEC #1 #2 #3 1.6 #4 4.0

Procedure: ~~Conduct a 1 g stall landing with noted flap setting. Yes No~~

Trim CN ________ Trim IAS ________ kts; Trim Stab. Pos. ________

Trim Flaps 40 RT 41 LT deg TEST INST PILOTS CN 8700 133 KTS

1200 FPM IAS (50 ft) 130-133 kts. REMARKS:

IAS (touchdown) 128 kts. HARD LANDING MADE

CN 8747

NOTE: 1. After landing - with all trims set at zero and with aileron and rudder power "ON" apply gust lock CN ——

2. Conduct full throws on all surfaces with power "ON" CN ——

MODEL DC-3, No. N301SD

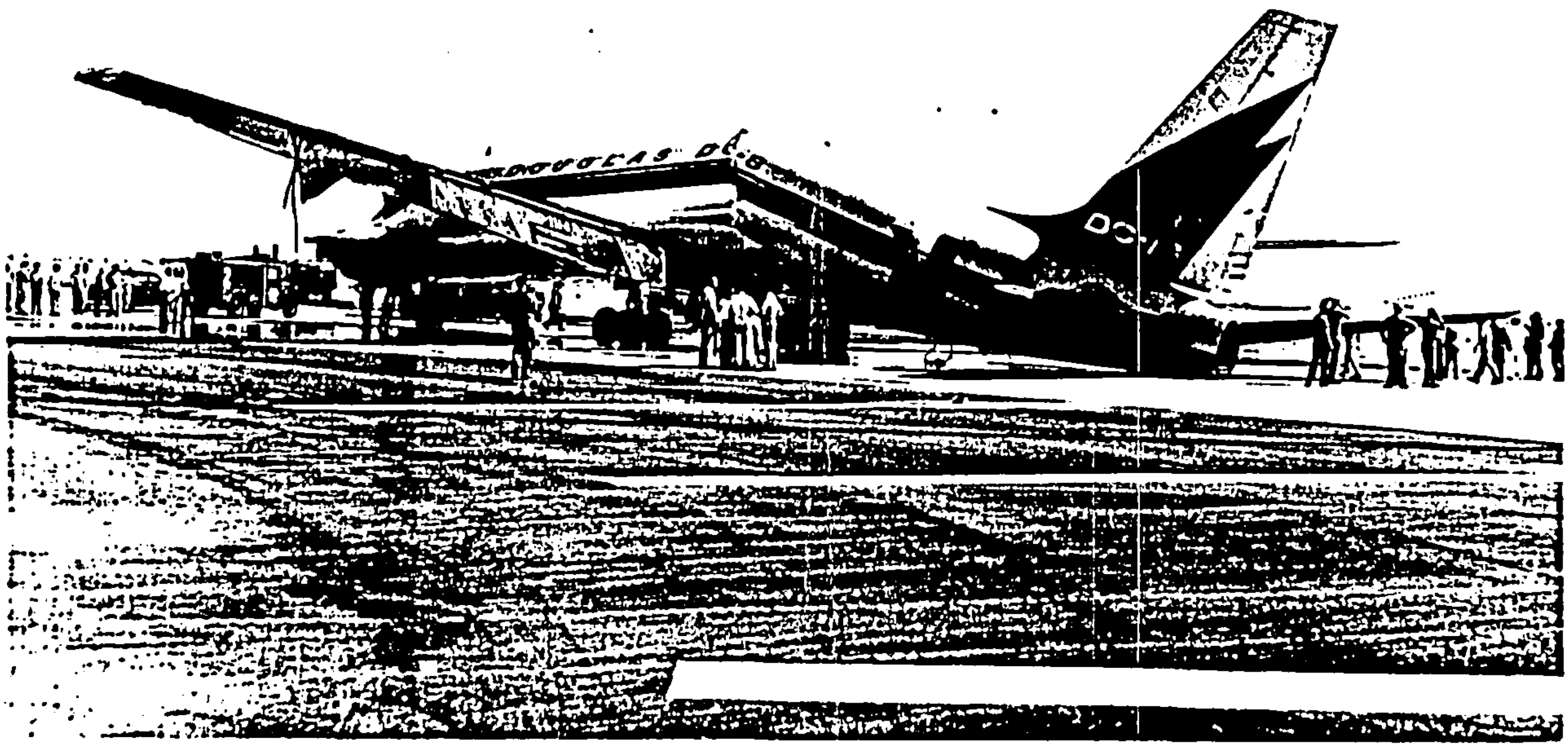
Flight No. 56

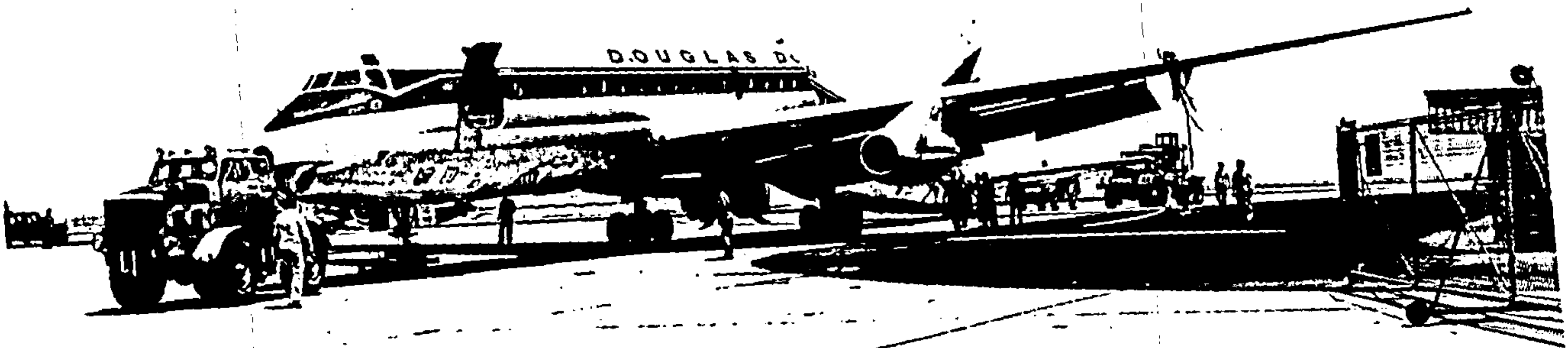
COMMENTS BY: R. H. EDWARDS:

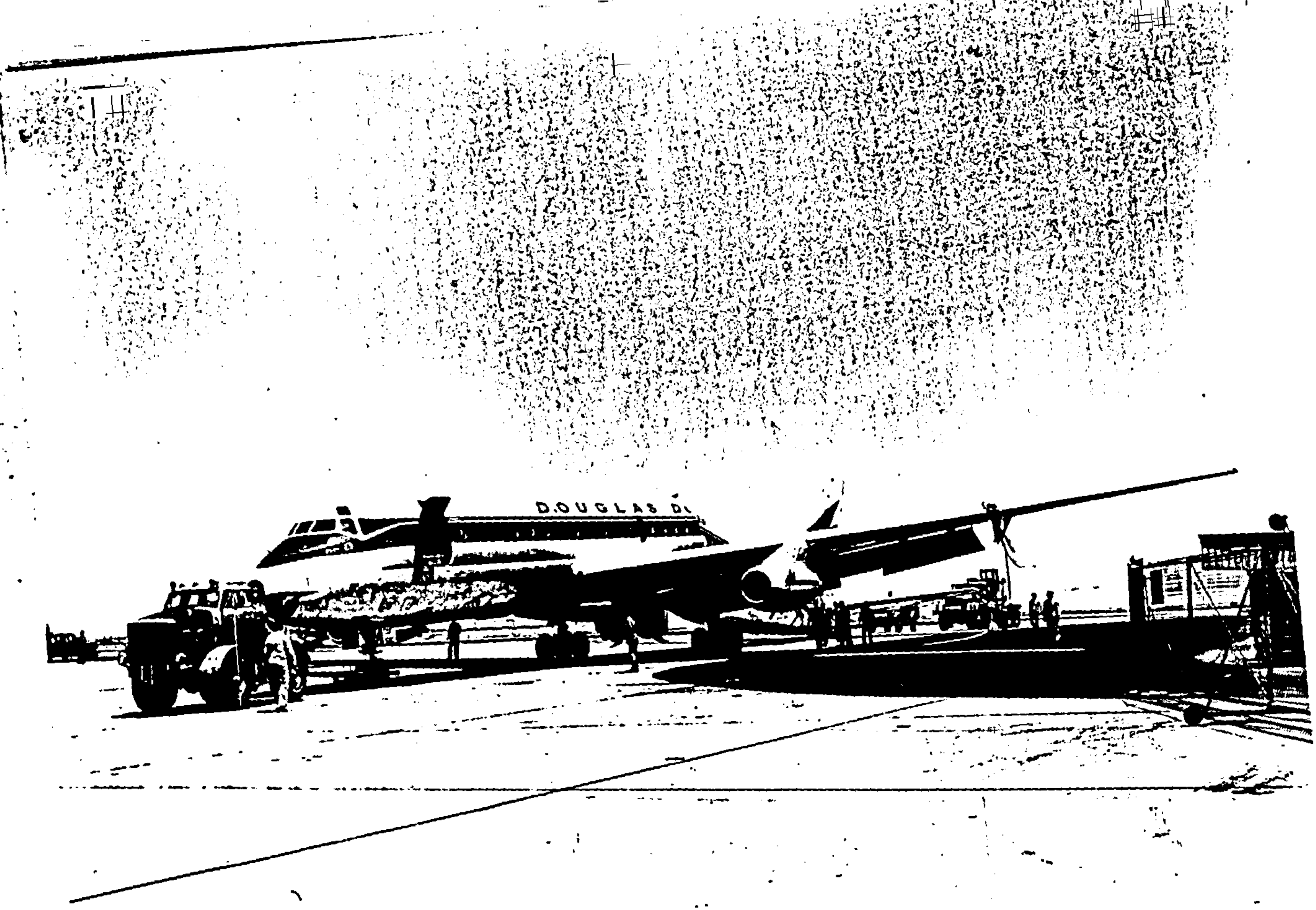
I was sitting in the flight test engineer's seat where I turned the test instrumentation on above the over run. After checking the cameras and oscillographs to see that they were working, I looked out the window to observe what appeared to be a normal approach, similar to the two previous FAA landing flights I have seen. I looked back at the pilot and noticed him holding full aft elevator, and at the same time heard a comment in the cockpit. I don't know what it was, but it alarmed me. I turned the instrumentation to high speed, and following ground contact turned on the wheel cameras. Upon contact, there was a severe jolt which caused head sets and loose equipment to fling forward. After coming to a stop I went back and threw out the rope ladder through the front cabin door and climbed out of the airplane.

RHE:blb

Richard H Edwards




DOUGLAS


DOUGLAS

10/19/1959

107-227

Boeing

D/R Demo

10/19/59

AviationSafetyNetwork

The Aviation Safety Network ••••••••••••••••••• Accident Description

Accident description

Date:	19.10.1959
Type:	Boeing 707-227
Operator:	Boeing
Registration:	N7071
C/n:	17691/45
Year built	1959
Crew:	4 fatalities / 8 on board
Passengers:	0 fatalities / 0 on board
Total:	4 fatalities / 8 on board
Location:	Arlington, WA (USA)
Phase:	Cruise
Nature:	Training
Flight	- (Flightnumber)

Remarks:
The Boeing 707 N7071 was operating on a customer guarantee and acceptance training flight prior to delivery of the plane to Braniff. The plane was being flown by a Braniff captain and a Boeing testpilot as instructor. Other Braniff and Boeing personnel were on board as crew members and observers. A series of Dutch Rolls were performed; one of the rolls was executed beyond the maximum bank restrictions. Control was lost, but the aircraft recovered. During the recovery however, the no. 1, 2 and 4 engines were torn off. An intense fire burned away portions of the jet control near the no.2 engine attachment area. An emergency descent was carried out and the plane crashlanded along river. PROBABLE CAUSE: "The structural failure induced during an improper recovery attempt from a Dutch Roll which exceeded the angle-of-bank limits prescribed by the company."

Source: (also check out sources used for every accident)
ICAO Accident Digest, Circular 62-AN/57 (190-194)

[legenda] [disclaimer]

?" It was recorded in Washington. The $100,000 final pay-
nt check was handed to Beall. Phones clicked. Beall looked
und at worried faces.

'What the hell have we done here?" asked the Astoria banker.
It's all right," said Gledhill. Then he turned sternly to Beall.
all, you happen to be the most valuable guy in the world at
moment." He grabbed Beall by the back of his coat collar.
t's go get that damn piece of paper."

eall's feet sank ankle deep in the mud bank. What if the cer-
ate wasn't there? What if the rowboat overturned in the
ppy water? What if... They got out to the ship. The cer-
ate was there. The screwdriver shook in Beall's hand as he
it off the wall. He gave it to Gledhill and sat down. Limp,
y.

You need a vacation," said Gledhill. "Better come along on
maiden flight to Hong Kong."

n American was planning to start operation first on the
fic, then the Atlantic. On February 22, the Clipper Ship—
nber Two—soared out over San Francisco's Golden Gate
ge. Aboard, Wellwood Beall thought of the time he had
ed out this way before, five and a half years ago. He wished
nie could be with him now. Hawaii, Midway, Wake, west-
l in the sky. Beall thought of the people at the Cathay, his
ls of wisdom: "Just a stunt...." Those people would know
r now. They'd know that he knew better.

ver the blue expanse between Honolulu and Wake Island
passed above the sailing clipper *Trade Wind*. Captain W. A.
e circled a salute. —

ith stops en route, the trip lasted three weeks. On March 14
stepped onto the Pan American dock at San Francisco. The
boys on the dock were shouting something. News of their
? He could hear a little better now: "Nazi troops in Czecho-
kia."

Washington, an apprehensive Congress was considering
evelt's proposal for a half billion dollar defense program,

ion of it for airplane procurement. Claire Egtvedt, with
ay, the company's vice president and eastern represen-
as holding close to Washington and Dayton. They
e Air Corps people brutally frank about Boeing's
"You are good at design, but poor on production. You
delivered a single B-17B." Egtvedt felt no one realized
e they had with turbo-superchargers and other modi-
There had been no opportunity to work on a produc-
But the record didn't look good.

earned that the B-17 would be in the defense program,
but maybe its production would go to one of the
plants. The schedule now called for delivery of the
"Bs" in May. Fred Laudan said it was going to be
make that. "We've got to," said Egtvedt. Laudan hired
n, though he knew that new hands couldn't get them

anager Fred Collins and his new assistant, Ben Pearson,
ing hard to get more orders for the Stratoliner trans-
e Allen had finished his part of the initial testing of
liner. The pressure cabin hadn't been tried in the air
h it had been pumped full of air in the plant and given
n rubdown with soapsuds to see if the air would bubble
e seams. It didn't.

e weekend of Beall's return from the Clipper flight
re two representatives of the Dutch airline, KLM, in
to fly in the Stratoliner. The visitors weren't so interested
ercharging as in the control problems of a four-engine
What happens," asked Albert vonBaumhauer, the engi-
the two, "if you have two engines out on one side and
er clear over for a maximum angle of yaw"—that would
e airplane crabbing sideways—"and then you put it in a

inshall looked at Ralph Cram. "You have no reason to
with a big ship like this," said Cram. Still, vonBaum-
wanted to know. He had made a study of this. It was
hat they would try out various angles of yaw at low

INVESTIGATIONS OF AIRCRAFT ACCIDENTS 1934 - 1965

DOCKET #	-347
FILE #	2
DATE ADOPTED	06/13/1960
DATE RELEASED	06/20/1960
ACCIDENT DATE	10/19/1959
CARRIER	BOEING AIRPLANE COMPANY
LOCATION	NEAR ARLINGTON, WASHINGTON

Link to PDF Version

SA-347 File No. 2-1754

CIVIL AERONAUTICS BOARD

AIRCRAFT ACCIDENT REPORT

ADOPTED. June 13, 1960 RELEASED June 20, 1960

BOEING AIRPLANE COMPANY, BOEING 707-227, N 7071, NEAR ARLINGTON, WASHINGTON, OCTOBER 19, 1959

SYNOPSIS

On October 19, 1959, at 1620 P s t., a Boeing 707-227, N 7071, crashed and burned in the Stillaguamish River about 10 miles northeast of Arlington, Washington. Four of the eight occupants aboard received serious injuries.,

A Boeing Airplane Company test pilot was acting as an instructor-pilot on a demonstration and acceptance flight prior to the aircraft being delivered to the customer. The company was also utilizing this flight time for flight instruction purposes in qualifying airline personnel in the aircraft.

The instructor-pilot demonstrated several maneuvers, including Dutch Rolls, to a pilot-trainee, an airline captain who was making his first training flight training flight prior to checkout on the Boeing 707

The instructor-pilot initiated a Dutch Roll in which the roll-park angle of the aircraft reached 40 to 60 degrees. This bank angle is in excess of limitation set by the company for demonstration of his maneuver. The pilot-trainee, who was to make the recovery, rolled full right aileron control while the right rank was still increasing. The instructor-pilot immediately rolled in full opposite aileron. The airplane stopped its right roll at a point well past a vertical bank and then rolled to the left even more violently. Several gyrations followed and after control of the aircraft was regained, it was determined that three of the four engines had separated from the aircraft and it was on fire. The fire rapidly reduced controllability of the aircraft and an emergency landing was attempted, however, the aircraft struck trees and crashed short of the intended landing area because power on the engine remaining had to be shut down to keep the aircraft wings level.

Subsequent to this accident the Boeing Airplane Company flight training syllabus was revised to reemphasize the maximum roll-bank angles permissible for the Dutch Roll maneuver. In addition, demonstration of the Dutch Poll has been put off until a later time in the curriculum so the pilot-trainees will have more flight experience before practicing the maneuver.

Investigation

N 7071 was a new model of the Boeing 707 series aircraft on which FAA type certification flight tests had just been completed. Final certification was awaiting verification of these test results and the aircraft meanwhile was being operated on an experimental certificate of airworthiness. The flight of October 19, 1959, was one of a series of flights to demonstrate to the purchaser that the aircraft met the performance qualities guaranteed by the manufacturer, and to train the Brainy pilots.

The crew for this flight, which consisted of R. H. Baum, BAC (Boeing Airplane Company), instructor-pilot, Captains J A Berke and M F. Staley, BNF (Braniff Airways), copilots, and G. C. Hagan, BAC, flight engineer, all received fatal injuries when the aircraft struck the ground. The following personnel who were listed as passengers on the flight plan received minor to serious injuries at ground impact A. G. Krause, BNF flight engineer, F. W. Symmank, BNF technical instructor, W J. Allsopp, BAC pilot; and W H Huebner, FAA Air Carrier Operation, inspector

Mr. Baum, as pilot in command, conducted a preflight briefing of the crew. Takeoff data and takeoff procedures were discussed along with the maneuvers which were to be performed An IFR (instrument flight rules) flight plan was filed for an estimated departure at 1330 P. s t 1 The aircraft was serviced with sufficient fuel for five hours. Its gross weight was 208,000 pounds and the center of gravity located at 26.5 percent MAC (mean aerodynamic chord).

Shortly before departure the IFR flight plan was canceled and the flight proceeded according to VFR (visual flight rules) for an estimated 4-hour and 15-minute flight. Captain Berke, who was making his first flight in the aircraft, occupied the left seat and Mr. Baum the right Mr Krause was performing the duties of flight engineer

After takeoff the flight proceeded normally through a series of maneuvers which were first demonstrated by Mr. Baum and then executed by Captain Berke Several Dutch Rolls 2 in a clean configuration were initiated and the proper recovery was demonstrated by Baum. Captain Berke then made several recoveries from Dutch Rolls in this configuration.

Following this, the aircraft was slowed to 155 knots and 40 degrees of flaps were lowered Captain Berke then made recoveries from a series of Dutch Rolls in this configuration which were initiated by Mr Baum. During these rolls, angles of bank greater ban 25 degrees were permitted to develop. 3 Mr. Allsopp stated that he leaned over to Mr. Baum and reminded him of the bank-angle restriction. He said Baum indicated that he was aware of the restriction

As all of Berke's recoveries up to this time had been made from the left (nose-left position), Baum suggested that a recovery be made from the right (nose-right) Baum then initiated another Dutch Roll in which the angle of bank was quite large. Survivors estimated the aircraft rolled 40 to 60 degrees. Before attempting recovery, Berke allowed the aircraft to complete several oscillations in each of which the roll-bank angle reached 40 to 60 degrees.

The survivors stated that Berke initiated recovery while the right bank was still increasing. They said he applied full right aileron control while the right wing was still moving downward. The airplane immediately yawed heavily to the right and rolled rapidly to the right, well beyond a 90-degree bank

Immediately after Berke had applied right aileron and early in the yaw-roll movement of the aircraft, Baum Look the controls and applied full left aileron. At this time the aircraft was rolling to the right. The roll stopped after the wings had passed the vertical and then rolled back to the left even more rapidly and violently than to the right. The survivors stated during these two rotations sounds were heard which could have been the engines separating from the aircraft. They also stated that during these rolls the thrust levers were seen to snap and the cables go slack

The movements of the airplane which followed were described as "spins" or "snap rolls." Although the exact number of rotations could not be determined, the survivors were in agreement that the aircraft rotated to the left and that the rate of roll finally slowed almost to a stop with the aircraft in an inverted nosedown attitude. The left roll was continued and the recovery was made to an upright position with the aircraft in a medium dive.

A normal pullout was made from the dive, during which it was noted that the engine instruments indicated complete absence of thrust on engines Nos. 1, 2, and 4. In addition, the thrust levers and start levers for engines Nos. 1, 2, and 4 ware completely slack. Flight Engineer Krause also reported a complete loss of electrical power.

During most of the flight and throughout the uncontrolled gyrations of the aircraft, all eight occupants were on the flight deck. Immediately after control was gained, Mr Huebner went aft to determine what, if any, damage had been sustained He stated that No. 1 and No. 4 engines were gone and there were small fires in the areas where the engines had been. He said No. 2 engine was also on fire and it appeared that the forward mount had failed and the engine was hanging down at an angle with the tailpipe pointed into the flap.

Huebner went back to the flight deck and informed the pilots of his observations. Shortly after this Mr Allsopp stated that he saw a very large fire burning the area of the No. 2 engine and that that engine, as well as Nos. 1 and 4, vas gone. The aircraft by this time had descended through the overcast and he suggested that an immediate ditching be made in Lake Cavenaugh, which was very close. Baum, who had taken over the controls at the first upset, was apparently looking for a more suitable landing area or attempting to reach an airfield nearby and continued his circle east of the lake 4

During this time Mr Hagan took over the flight engineer's station. the four survivors-Krause, Symmank, Allsopp, and Hueoner-then took ditching positions in the rear of the aircraft. The fire emanating from the area ofNo 2 engine continued to burn fiercely. It was seen to burn a hole in the flaps and to consume most of the left inboard aileron. It also burned through the top wing surface and the survivors stated that they could see the structure in the interior of the wing.

Weather was not a factor in this accident although a thin broken to overcast cloud coverage existed over the entire area with ceilings reported as about 4,000 feet. A number of ground witnesses saw the aircraft after it had emerged from this overcast in its descent. The probable flight path of N 7071, depicted in Attachment "B" to this report, is based on evaluation of the sightings of these witnesses.

Several witnesses located west of the final crash site described hearing the aircraft on an easterly heading in or above the clouds. They reported hearing an unusual sound similar to that of an aircraft breaking the sound barrier Shortly after hearing this sound they saw three objects fall out of the overcast. These objects were located and proved to be engines Nos. 1, 2, and 4. The sound of a jet engine continued and the aircraft was seen to emerge from the base of the clouds on a northeasterly heading. It was on fire and descending. Other witnesses, located several miles farther east, saw the burning aircraft, still descending, make a sweeping left turn, passing near the east end of Lake Cavenaugh and straightening out on a southeasterly heading of about 110 degrees. They said that during this turn they heard an explosion-like noise and the jet engine sound then ceased The only sound which could be heard after this was a loud whistling noise. Several of these witnesses who were familiar with the Boeing 707 stated that there was only one engine on the aircraft and that a severe fire was burning in the area where the No. 2 engine had been. One witness said that the fire had burned away a large portion of the trailing edge of the wing in the area of the No. 2 engine.

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1/ All times herein are Pacific standard based on the 24-hour clock

2/ See Attachment "A "

3/ The BAC 707 training manual restricts the Dutch Roll maneuver to a desired maximum roll-bank angle of 15 degrees and an absolute maximum of 25 degrees.

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The aircraft continued on its southeasterly heading down Deer Creek and then made a gradual right turn to a heading of 230 degrees. By this time it had descended almost to treetop level. The aircraft continued on the heading of 230 degrees for about one mile, during which it descended until it contacted treetops and crashed in the Stillaguamish River bed approximately one-half mile short of a large open field which had undoubtedly been selected by Baum for the crash landing.

The first contact with treetops 110 feet high was on the north side of the river and nearly 1,400 feet from the point at which the fuselage struck the ground Four hundred feet from this first contact the aircraft struck another row of trees along the north bank of the river, at a height of about 90 feet. The swath cut through these trees, which varied in diameter from 7 to 13 inches, was approximately the width of the wing span and showed that the aircraft was in a wings-level attitude A section of the left wing tip, 16 feet long, was severed by contact with these trees. As the aircraft continued across the river the left wing, which was dropping rapidly, cut a path inclined at an angle of 45 to 50 degrees through more trees on the south bank. Toward the end of this cut through the trees, the left wing contacted the ground gouging several long ditches in the sandy soil As the aircraft continued its forward travel, the left wing broke up progressively until finally the fuselage struck the ground.

The forward portion of the fuselage (station 960 forward) was almost completely destroyed by the impact and intense ground fire which followed The aft fuselage, where the survivors were located, broke off just to the rear of the trailing edge of the wing and skidded out into the middle of the river Although it was badly damaged by inflight fire and ground impact, it was intact and was not subjected to the ground fire which consumed most of the other wreckage.

The section of the left wing tip, severed by contact with the trees on the north side of the river, came to rest across the river approximately 50 feet before the first of the gouges which were dug in the ground by the remaining wing structure The wing, from the point at which the tip was severed inboard to the landing gear beaver tail strap, was broken up and sections were scattered along the ground path Most of these pieces received damage from ground fire and large areas were consumed completely Inboard of the beaver tail the box section was nearly intact but partially consumed by ground fire, as was the center box section and inboard 30 feet of the right wing. The remainder of this wing was broken into two major pieces which were partially consumed in ground fire.

There was extensive inflight fire damage to the left wing in the area of the No. 2 engine, to the entire left side of the aft fuselage, and to the left side of the empennage.

The wing upper skin from the area of the aft end of the over wing pylon strap was identified This skin was badly wrinkled by heat over each fuel vent channel and the skin over one was ruptured for a length of three feet The edges of the rupture were curled outward, were very fibrous, and were heavily sooted, indicating that an explosion had occurred. In addition, rivets in the area which attached the skin to the vent were failed in tension.

From the rear spar aft, the wing trailing edge and flight controls were severely burned. The left inboard aileron and the entire trailing edge structure nearby were consumed except for small fragments The inboard half of the No. 2 and the outboard half of the No 3 spoilers were partly consumed The outboard two feet of the No. 2 flap cove lip door was heavily sooted and a few small holes were burned in the skin. The internal structure in this area was consumed. The lower trailing edge just forward of the door was burned through and blackened.

The outer closing rib on the No. 2 flap was heat wrinkled. The flap lower surface was lightly sooted and the upper surface was heavily sooted The inboard corner of the No. 1 flap was badly burned and three feet of its upper surface was consumed. It was determined that the flaps were extended approximately 28 degrees at impact. The left inboard spoiler valve fell from the aircraft about one mile from the crash site It had large deposits of "runback" (solidified) aluminum on its lower side The aileron trim mechanism and the aileron bellcranks also had these runback deposits on them. All control components in the area and even the rear wing spar web vertical stiffeners were badly burned by inflight fire.

The left side of the aft fuselage was heavily sooted and all of the windows were heat checked In addition, paint on the rear loading door and on the fuselage aft to the stabilizer was blistered Just forward of the vertical fin, light sooting angled across the fuselage top centerline and back along the upper right side of the tail cone and lower third of the right side of the vertical fin

The lower half of the left side of the vertical fin was lightly sooted and paint was blistered and scorched The lower balance panel covers were heat wrinkled The lower half of the rudder was severely heat wrinkled The left side of the tab was also heat wrinkled and heavily sooted. The right side of the rudder tab was lightly sooted from smoke which was drawn through the tab hinge, indicating right rudder trim during the fire

The left horizontal stabilizer and elevator were sooted and heat wrinkled on the upper and lower surfaces. In addition, the severe fire from the left wing burned through the upper skin between the internal stiffeners

Three of the four powerplants, with a major part of their pylons attached, separated from the aircraft in flight. They were found one to one and one-half miles northwest of the main wreckage. The Nos. 1 and 4 engines, with their nacelles, broke from the airplane in the outboard directions The No. 2 engine, with its nacelle, broke partially outboard but appeared to have rotated downward and rearward during its separation from the aircraft. The No 3 engine remained attached to the aircraft until impact. It was found at the main wreckage site. Investigation revealed that there were little or no indications of inflight fire damage to engines Nos. 1, 3, and 4. However, the cowling which fell with the No. 2 engine showed evidence of heavy smoke and sooting prior to impact

The damage found on all four engines was the result of impact or minor ground fire. No evidence of operational distress or malfunction prior to impact with the ground was found. In addition, indications were found on all four engines that they were rotating very slowly, if at all, at impact.

During the public hearing a Boeing witness testified that pilots who have had an engineering background or test-pilot experience in the Armed Forces are selected as test pilots for Boeing These pilots are then given extensive ground school training and flight experience under the supervision of instructor-pilots He said before a pilot could be released as an instructor he had to have a check ride and approval by the Chief of Flight Test or his designee He further stated that Baum had met all of these requirements and was considered fully qualified to conduct this particular flight

The witness then described the company checkout and training program for airline personnel He said the airline pilots would have had the 707 training syllabus for a considerable length of time prior to the beginning of flight training and would also have completed the ground school courses. A briefing would be conducted prior to flight which was a general review of the entire training syllabus. Immediately before each flight an additional briefing would be held to cover item by item the maneuvers to be accomplished

The witness stated that the Dutch Roll characteristic is present in all large aircraft but is more pronounced in those with swept-back wings like the 707 It is most likely to be encountered during approach to landing when the aircraft is at slow speed with a high coefficient of lift and in rough or turbulent air. He said the characteristic constituted a minor annoyance to pilots and slight discomfort to passengers and it was therefore desirable to give instructions in recovery technique. All Boeing flight personnel had been informed that the desired maximum roll-bank angle in this maneuver was 15 degrees and that the absolute maximum was 25 degrees These restrictions were not imposed because of a structural limitation on the aircraft, but because the maneuver and its recovery could be satisfactorily demonstrated with these conservative limitations Subsequent to the accident Boeing re-emphasized the roll-bank angle limitations and deleted demonstration of the maneuver with flaps down because recovery can be demonstrated equally as well in the clean configuration In addition, the Dutch Roll training has been moved back in the training program so that the trainee will be more familiar with the characteristics of the airplane when the maneuver is demonstrated.

A flight recorder was installed in the aircraft but was not in operation during this flight Civil Air Regulations require the flight recorder to be in use during scheduled passenger operations only

Analysis

There is little question that the violent gyrations of N 7071 which followed the improper Dutch Roll recovery attempt resulted in the separation of the three engines and the inflight fire. A safety factor is designed into the nacelle supporting structure so that, in the event of abnormal loading, it will fail before destructive loads are transmitted to the aircraft wing. Separation of engines from the aircraft is therefore expected when the aircraft is subjected to high abnormal loadings such as occurred in this case.

It is equally clear that the Dutch Rolls being performed reached angles of bank far in excess of the limitations established by the company Responsibility for the safety of this aircraft rested solely on the instructor-pilot. The Board can find no valid reason for Mr. Baum initiating the final Dutch Roll so violently No training advantage could be gained by conducting these maneuvers at the extreme angles of bank reached Baum certainly should have been aware of this and he was admittedly aware of the company's restrictions In addition, it was surely less than prudent to permit a pilot with no previous experience in the airplane to attempt a recovery from this extreme maneuver.

The severity of the gyrations to which the aircraft was subjected developed loads greater than the design strength of the nacelle pylon structure After the three engines were lost and while the flaps were still extended 40 degrees, the airplane was committed to land The flaps may have been raised to the 28-degree position intentionally so that full outboard aileron effectiveness would be available during the landing. It is possible that in this configuration, with power available from the No. 3 engine, the airplane could have flown at least long enough to reach a suitable airport for a crash landing However, the intense fire which is believed to have come from a ruptured fuel line, was threatening the left wing and made an immediate landing mandatory

Lateral control with flaps down at least 28 degrees is provided by the following: Outboard ailerons, 40 percent, outboard spoilers, 30 percent, inboard ailerons, 15 percent, and inboard spoilers, 15 percent The outboard ailerons are moved by means of a cable bus arrangement actuated by movement of the inboard ailerons. As the fire gradually destroyed the inboard left aileron and the flight control components in that area, the outboard ailerons were lost Loss of electrical power cut out the auxiliary hydraulic system which operates the inboard spoilers and the rudder boost When the left inboard aileron was consumed the only lateral control remaining to keep the heavily damaged left wing up came from the right inboard aileron (7-1/2 percent) and possibly the right outboard spoilers (30 percent). Lift on the left wing was seriously impaired because of the loss of approximately 35 square feet of upper surface which was burned through, the additional fire damage to the flaps which reduced their effectiveness, the extra drag from the No 2 pylon stub, and the spoiler effect on the upper wing surface caused by the ruptured skin over the fuel vent channels.

This drag, coupled with any appreciable thrust from the No 3 engine, would force the left wing down. In view of the limited aileron control available, considerable right rudder would be required to induce a yaw to the right to assist in holding the wing up. However, with the rudder boost inoperative, there would not be sufficient rudder control available to induce enough yaw to counteract these forces. It is therefore apparent that the No 3 engine was shut down prior to impact so as to be able to keep the wings level with the minimum amount of control available. This is also supported by the fact that the engine had almost stopped rotating at impact

When the aircraft hit the trees on the north bank of the river and a 16-foot section of the left wing was severed, the control available was insufficient to maintain the wings level As it crossed the river, the aircraft rolled rapidly to the left to a bank angle of approximately 55 degrees and crashed on the south bank.

Conclusions

The Board concludes that this accident was the result of the structural failure of the Nos. 1, 2, and 4 nacelle pylons, and the fire in the area where the No. 2 nacelle broke off It also concludes the nacelles failed as a result of overloads imposed on them during several violent uncontrolled gyrations which were encountered when the pilot-trainee applied improper control movement in an attempt to recover from a Dutch Roll

The Board further concludes that the instructor-pilot initiated the Dutch Roll to an angle of bank far in excess of the limitations imposed by the company. In addition, the instructor-pilot was fully aware of these limitations and was, in fact, reminded of them during this flight Even so he permitted the pilot-trainee, who was on his first training flight, to attempt recoveries from these extreme maneuvers

It concludes that after control of the aircraft had been regained, Mr. Baum had selected an excellent clear area for the imminent crash landing but failed to make it by one-half mile because the No. 3 engine had to be shut down prematurely to keep the wings level.

Subsequent to the accident the company revised its training syllabus to reduce the possibility of recurrence of a similar accident The limitations on angle of bank for the Dutch Roll maneuver have been re-emphasized to all company pilot personnel. In addition, Dutch Roll familiarization has been delayed so that the pilot-trainee will have more experience in the aircraft prior to attempting this maneuver.

The company has also incorporated a full-time boosted rudder system in the aircraft In addition, it has increased the vertical stabilizer area and has added a ventral fin These changes are anticipated to substantially increase the low speed control characteristics of the aircraft.

Probable Cause

The Board determines that the probable cause of this accident was the structural failures induced during an improper recovery attempt from a Dutch Roll which exceeded the angle-of-bank limits prescribed by the company

BY THE CIVIL AERONAUTICS BOARD

/s/ WHITNEY GILLILLAND
Chairman

/s/ CHAN GURNEY
Vice Chairman

/s/ G. JOSEPH MINETTI
Member

/s/ ALAN S. BOYD
Member

SUPPLEMENTAL DATA

Investigation and Hearing

The Civil Aeronautics Board was notified of this accident at 1800, October 19, 1959. An investigation was immediately initiated in accordance with the provisions of Title VII of the Federal Aviation Act of 1958. A public hearing was ordered by the Board and held at the Olympic Hotel, Seattle, Washington, on November 19, 1959.

Flight Personnel

Mr. Russel H. Baum, age 32, was employed by Boeing Airplane Company, June 7, 1957, as a Test Pilot "B." He was promoted May 2, 1958, to Experimental Test Pilot "B." He held an FAA airline transport pilot certificate with a rating in the B-707. His total flying time was 5,015 hours, of which 369 were in the 707. His latest FAA class I physical was taken June 2, 1959. Mr. Baum had received a total of 86 hours of ground school instruction on the 707, plus a cockpit and systems familiarization class on the KC-135. According to testimony of a Boeing Airplane Company employee, Mr. Baum was fully qualified to act as instructor-pilot on the 707.

Captain John A. Berke, age 49, was employed by Braniff Airways April 15, 1936, was promoted to captain in April 1938, and to check pilot January 1, 1958. He had a valid FAA airline transport pilot certificate with ratings in the DC-3, DC-4, DC-6, DC-7, and L-188 aircraft. Captain Berke had a total of 23,563 flying hours. His latest first-class physical examination was taken April 3, 1959. Captain Berke had completed the Boeing Airplane Company pilot training ground school course which consisted of 160 hours of instruction. This was his first training flight in preparation for checkout in the aircraft.

Captain M. Frank Staley, Jr., age 43, was employed by Braniff Airways August 18, 1939. He was promoted to captain November 1, 1942, and to check pilot August 28, 1959. He held a valid airline transport pilot certificate with ratings in the DC-3, DC-6, DC-7, and L-188. Captain Staley had accumulated 20,450 flying hours. His last first-class physical was taken June 23, 1959. Captain Staley had completed the Boeing Airplane Company pilot ground school training course of 160 hours of instruction. This was his first training flight in preparation for checkout in the Boeing 707.

Flight Engineer George C. Hagan, age 28, was employed by Boeing May 11, 1959, as a Flight Test Analyst "A." He held a valid FAA flight engineer certificate. His last second-class physical examination was taken May 27, 1959. He had accumulated a total of 1,260 flight hours, of which, as of August 29, 1959, about 90 had been in the Boeing 707. Mr. Hagan had completed a training course, consisting of 152 hours for flight crew ground instructors, June 12, 1959.

The Aircraft

N 7071, a Boeing 707-227, serial number 17691, was manufactured June 11, 1959. It was owned and was being operated by the Boeing Airplane Company, Renton, Washington. The aircraft was a new model on which about 173 flying hours had been accumulated for the purpose of qualifying it for certification by the FAA. The airplane was equipped with four Pratt and Whitney turbojet, model JT4A-3 engines.

ATTACHMENT "A"

Explanation of the Dutch Roll

The term Dutch Roll applies to a wallowing motion characteristic of swept-wing aircraft. During this motion the aircraft rolls right and left around the longitudinal axis while yawing right and left around the vertical axis. Angle of bank and degree of yaw are dependent upon the amount of force applied in initiating the Dutch Roll.

Normally the motion is caused by turbulent air or lateral overcontrol. The low lateral directional damping of swept-wing design allows the motion to continue at slow i. a. s.

Compensating for the Dutch Roll may be made by simply keeping the wings level. When the airplane is rolling one direction or another, the aileron should be used to stop the roll and keep the wings level.

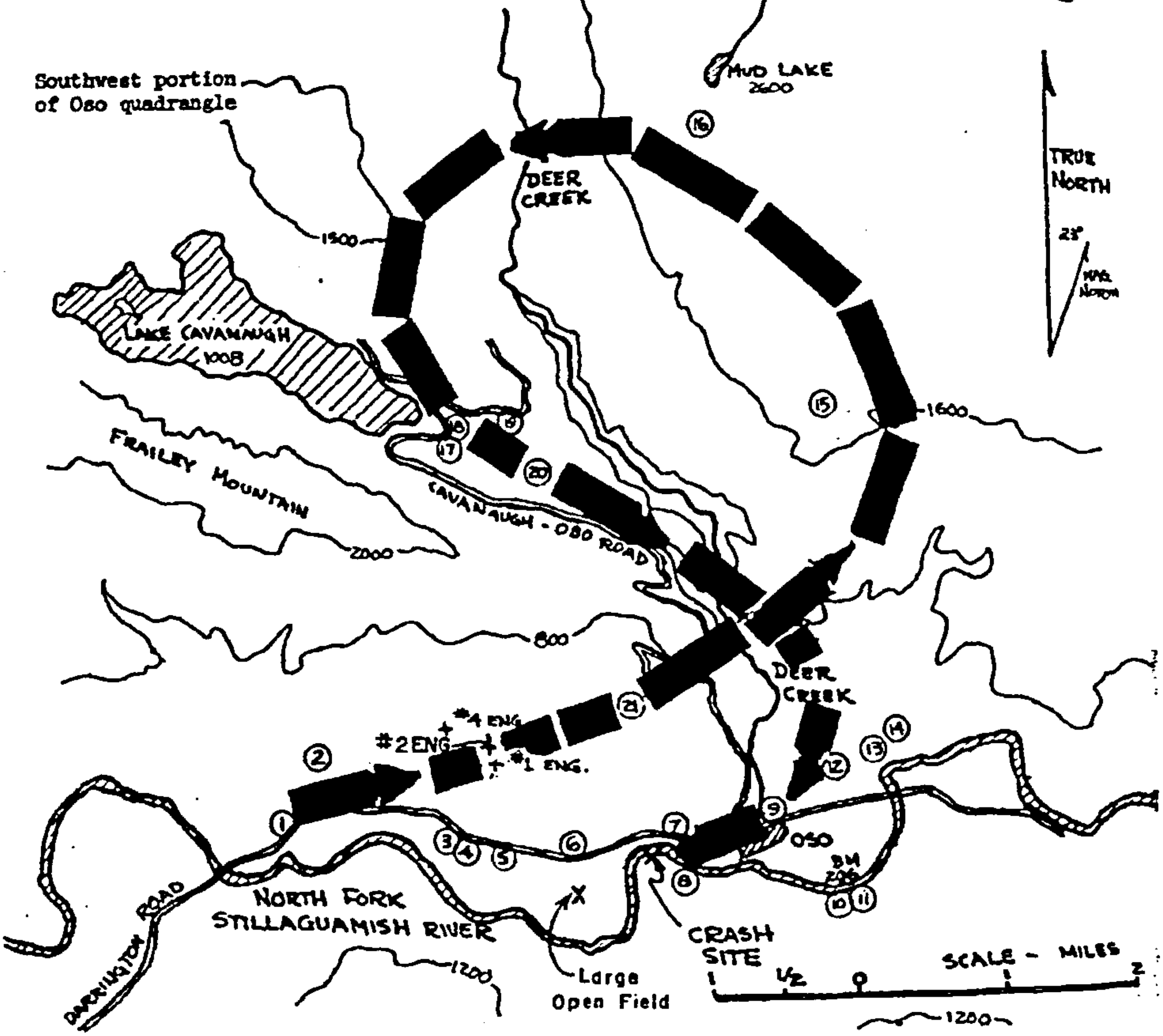
Another method is to apply cross-control. For example, if the aircraft is Dutch Rolling, left rudder and right aileron should be applied when the nose has started to swing from left to right with control forces slowly relieved as the aircraft's yaw angle diminishes.

Rudder application must be applied in the right direction or the Dutch Roll will be further aggravated. If there is uncertainty as to the rudder required, application of aileron only is recommended for recovery.

The damping in the lateral-directional mode is lowest when the angle of attack is high, so that at low indicated airspeeds with flaps up or down, the Dutch Roll will seem to be more pronounced. At high indicated airspeeds the natural yaw-damping forces minimize or tend to zero out any Dutch Roll tendencies.

The purpose of Dutch Roll familiarization is to introduce to the pilots who are generally not acquainted with swept-wing airplanes this inherent characteristic peculiar to the design.

ATTACHMENT "B"



CIRCLED NUMBERS INDICATE LOCATION OF EYE WITNESSES.

Accident involving Aircraft N 7071 occurred one mile west of Oso, Washington, on October 19, 1959

Prepared by
Civil Aeronautics Board
Bureau of Safety

USCOMM-DC-25360

10/21/1959

YF4H-1

Phantom

10/21/59

complex pattern of large perforations was applied to the spoilers which were mounted on the upper wing trailing edges ahead of the flaps and just inboard of the wing folding points. The aircraft had no ailerons in the conventional sense, with control being provided by spoilers and downward flaperons only. The outer wing panels were canted up by twelve degrees and had no control surfaces except for the hinged (drooping) leading edge. The stabilators had a 23 1/4 degree anhedral, and provided all of the pitch control.

The YF4H-1 prototype made its maiden flight on May 27, 1958, taking off from Lambert-St. Louis Municipal Airport with McDonnell test pilot Robert C. Little at the controls. On the first flight, the nose gear door would not close, there were difficulties with the hydraulic system, and there were problems with the engines. Consequently, the flight had to be cut short, but the aircraft landed safely. The right engine was replaced and the air inlet ramps were repositioned at 4 degrees. On the second flight on May 29, the nose landing gear door still would not close. However, on the third and fourth flights on May 31 and June 2, things went better and the aircraft flew at speeds of Mach 1.30 to 1.68.

142259 was sent out to Edwards AFB for initial flight trials. The YF4H-1 and the competing F8U-3 were put through the Navy Phase I flight evaluations at Edwards AFB, and in December of 1958 the F4H-1 was declared the winner of the contest. On December 17, 1958, McDonnell was awarded a follow-on contract for 24 more F4H-1s (BuNos 148252/148275). This brought the total production order to 45 machines.

The second YF4H-1 (BuNo 142260) flew in October of 1958. It was provided with an operable AN/APQ-50 radar and a fully-equipped rear cockpit. Variable-inlet ramps were fitted which were set at 5 degrees for the fixed portion and at ten degrees for the variable panel downstream. The aircraft was provided with unperforated spoilers, and a ram-air turbine was fitted which could be extended upward by a pneumatic ram from a compartment situated above the left intake duct. This turbine drove an emergency hydraulic pump that powered the controls in the case of an inflight emergency. An ASA-32 autopilot was provided. YF4H-1 144260 was later retrofitted with Martin-Baker Mk H5 ejector seats. In 1960, wiring was installed for the firing of the Sparrow missiles.

On July 3, 1959, the F4H-1 was officially named *Phantom II* in a ceremony held at the McDonnell plant in St Louis. At one time, the project manager, Don Malvern, had wanted to name it *Satan*, and James S. McDonnell himself had wanted to name the aircraft *Mithras*, after the Persian god of light. In practice, the Roman numeral II was often omitted from the name, since the original Phantom, the FH-1, had long been out of service and there was no possibility of confusion.

Following trials at Edwards AFB, the first YF4H-1 (BuNo 142259) was returned to the manufacturer in St Louis in October of 1958. It continued to be used for various flight

(OVER)

test programs. On its 296th flight, on October 21, 1959, the aircraft suffered a failure of the aft access door of the right engine, which led to a further catastrophic failures and to the crash of the aircraft, killing test pilot Gerald "Zeke" Huelsbeck.

The Navy was anxious to publicize its newest fighter, and the second YF4H-1 (142260) was used on December 6, 1959 by Commander Lawrence E. Flint, Jr. to set a new world's altitude record of 98,560 feet. This record, set as a part of Project *Top Flight*, bettered the existing record of 94,658 feet, set by Major V. S. Ilyushin of the Soviet Union in a Su-T-43-1. To set this record, Commander Flint took his YF4H-1 up to 47,000 feet and a speed of Mach 2.5. He then pulled the aircraft up into an angle of attack of 45 degrees, and then climbed to 90,000 feet. He then shut down his engines and coasted up to 98,560 feet and went over the top and then began to fall back to earth. At 70,000 feet, he restarted his engines and made a normal landing.

On December 22, 1961, Marine Corps Lt.Col. Robert B. Robinson used 142260 to set a new world absolute speed record of 1606.347 mph. On his second run at an altitude of 45,000 feet over the measured 15/25 km course, Lt.Col. Robinson's Phantom was clocked at over 1700 mph. This speed run was known as *Operation Skyburner*. For the record attempt, 142260 was fitted with a special water/alcohol spray in the engine inlet ducts to cool the air ahead of the compressors and thus increase engine thrust.

Flying the previously-modified YF4H-1 BuNo 142260, Commander George W. Ellis set a new sustained altitude record of 66,443.8 feet.

Sources:

1. The World's Fighting Planes, William Green, Doubleday, 1964.
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3. The American Fighter, Enzo Angelucci and Peter Bowers, Orion, 1987.
4. United States Military Aircraft Since 1909, Gordon Swanborough and Peter M. Bowers, Smithsonian, 1989.
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6. The American Fighter, Enzo Angelucci and Peter Bowers, Orion, 1987.
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10/27/1959

11/07/1959

06/04/1860

04/22/1960

B-58

04/22/60
06/04/60
11/07/59
10/27/59

Convair B-58 Hustler - *Chapter 8*

Operational History

Last revised: 18 October 1998

Convair B-58 Hustler
Convair B-58 Hustler - Chapter 7: TB-58A Trainer
Convair B-58 Hustler - Chapter 9: Specifications and Performance Data

By July of 1956, construction of the first B-58 was well underway. The name *Hustler* was officially applied to the aircraft at this time, although it had been used in-house at Convair for years before that.

The delays in the B-58 program were such that the development of the General Electric J79 engine caught up with the Convair airframe program and the initial flight testing with the J57 was found to be unnecessary. By August, the four YJ79-GE-1 engines had arrived at Convair. The YJ79-GE-1 was an early test version of the J79 and was nominally rated at 9300 lb.s.t. dry and 14,350 lb.s.t. with maximum afterburner. It was basically an experimental engine and was not capable of sustained operations with any regularity. Mean time between engine overhauls was very limited and numerous teething problems were encountered. It was, however, the first Mach 2-capable production turbojet in its class.

The first B-58, at that time officially designated YB/RB-58 and serialed 55-0660, was completed in late August, and was rolled out of the factory on September 4, 1956. It had little in the way of operational equipment fitted, the available space being taken up primarily by test equipment. The first engine run-up was on October 1, and the first taxi tests began on Oct 29.

55-0660 made its maiden flight on November 11, 1956, taking off from the Convair Fort Worth facilities at Carswell AFB, Texas. The crew of three consisted of B.A. Erickson, pilot, John. D. McEachern systems specialist, and Charles P. Harrison as flight test engineer. The underfuselage pod was not fitted. The maximum speed reached on the first flight was Mach 0.9. Supersonic flight was first achieved on December 30, at which time Mach 1.17 was attained. Category I tests began in November, and lasted for about 3000 hours of flight time. On February 16, 1957, 55-0661 flew for the first time with a pod, a test MB-1 free-fall pod. On June 29, 1957, 55-0660, while carrying a "dry" MB-1 pod, reached Mach 2.03 at 43,350 feet. On June 5, 1957, the first pod drop took place, when 55-0662 released an MB-1 pod while flying at Mach 0.9 at 40,000 feet over the Holloman AFB test range. Successful drops took place at progressively higher and higher speeds, culminating on December 20 in a drop at Mach 2.0 from above 60,000 feet.

By the end of 1957, the YB-58 had attained a maximum speed of Mach 2.11 at altitudes over 50,000 feet. It had made two successful pod drops from 42,000 feet at speeds of over Mach 2. It had maintained a speed of more than Mach 1.15 for 91 minutes.

Some serious problems were found. The J79-GE-1 engines installed on the first YB-58s pending certification of the J79-GE-5s had a number of flaws. Malfunctions in the fuel system caused the fuel to slosh around in the fuel tanks when the aircraft accelerated or slowed down, causing stability problems. Problems with the afterburners caused intermittent yawing at supersonic speeds. There were acoustical

Several accidents had revealed that the Convair-developed ejection seats were not sufficient to protect the crew throughout the B-58's performance envelope. Consequently, an encapsulated seat built by Stanley Aviation Corporation of Denver, Colorado was adopted.

Due to the delays in the B-58 program, the various aircraft that had been delivered had great variation in equipment, systems updates, maintenance requirements and capabilities. As a result, the USAF instituted the *Senior Flash-Up* program to update and normalize the aircraft in the inventory. The first aircraft to go through the program was delivered to SAC on November 7, 1960. Among the changes introduced were anti-icing systems, electronic countermeasures gear, an improved HACON and TACAN installations, and a structurally improved vertical fin and fuselage empennage systems.

As the flight test program neared completion, the Air Force was faced with the problem of what to do with the flight test aircraft. Many of them had low times on their airframes and were hence still viable from a useful life standpoint. It was decided that these aircraft would be updated and configured for operational service under a program named *Junior Flash-Up*, which started in February of 1960. Later, other low airframe time pre-production aircraft were added to the program. Eventually, eleven of the 17 test aircraft produced under the second B-58 contract were upgraded.

On October 15, 1959, 58-1015 flew from Seattle, Washington to Carswell AFB in 70 minutes at an average speed of nearly 1320 mph. This was the first sustained Mach 2 flight.

The accident rate in 1959 and 1960 had been alarmingly high, which led SAC to delay acceptance of executive responsibility for the aircraft. The first accident had taken place on December 16, 1958, near Cannon AFB, New Mexico when 58-0018 was lost. The accident was attributed to a loss of control during normal flight when autotrim and ratio changer were rendered inoperative due to an electrical system failure. On May 14, 1959, 58-1012 was destroyed by fire during a refueling operation at Carswell AFB. 58-1017 was destroyed on September 16 of that year when a tire blew during takeoff from Carswell AFB. On October 27, 55-0669 was destroyed near Hattiesburg, Mississippi when it lost control during normal flight. On November 7, 55-0664 was destroyed during a high-speed test flight near Lawton, Oklahoma when it disintegrated in mid-air. Convair test pilot Raymond Fitzgerald and Convair flight engineer Donald A. Siedhof were both killed. The flight was attempting to collect vertical fin side loads data under the conditions of the loss of an engine at high speed. A friend of mine witnessed this accident from the ground. Although the cause of the accident was never adequately explained, it appears that a design flaw in the aircraft's flight control system and defects in the integrity of the vertical fin structure were to blame. There is also the possibility that when the number 4 engine was purposely shut down for the test, number 3 lost thrust as well. On April 22, 1960 a failure of the Mach/airspeed/air data system caused the loss of 58-1023 near Hill AFB, Utah. On June 4, 1960, 55-0667 was lost due to pilot error while flying at supersonic speed near Lubbock, Texas.

The unusually high accident rate made SAC apprehensive about the reliability of the aircraft in service, and led to postponement of Category III testing. In addition, the Fitzgerald accident raised questions about certain aspects of the control system. As a result, B-58s were restricted to subsonic flight only for nearly a year afterwards until the control system and tail structure could be fixed.

By mid-1960, the combination of a shortage of funds, competition from other weapons systems, and a variety of technological difficulties had combined to cause a delay in the B-58's initial deployment. Although the aircraft had been scheduled to become operational in June, it appeared that the first wing would not be activated until January of 1961. SAC was still planning on three B-58 wings, since they

On May 26, 1961, 59-2451, crewed by Maj. William Payne, Capt. William Polhemus and Capt. Raymond Wagener, while en route to the 1961 Paris Air Show, set a New York-to-Paris speed record, covering the 3626.46 mile route in 3 hours, 19 minutes, 58 seconds (an average speed of 1089.36 mph). The flight also set a Washington, D.C.-to-Paris (3833.4 miles) speed record of 3 hours, 39 minutes, 48 seconds (average speed of 1048.68 mph). The crew was later awarded the prestigious Mackay and Harmon Trophies for this flight. Sadly, the return flight crew, consisting of Maj. Elmer Murphy, Major Eugene Moses and Lt. David Dickerson (the same crew who had won the Bleriot Trophy two weeks earlier) were killed when 59-2451 crashed on June 3 following departure from Le Bourget Field.

Further records were set on March 5, 1962, when 59-2458 crewed by Capt. Robert Sowers, Capt. Robert Macdonald and Capt. John Walton set a transcontinental speed record by flying non-stop from Los Angeles to New York and back again. The first leg (Los Angeles to New York) was completed in 2 hours, 0 minutes, 56.8 seconds at an average speed of 1214.71 mph. The return leg was completed in 2 hours, 15 minutes, 48.6 seconds, at an average speed of 1081.77 mph. This return flight was particularly notable, because it was the first transcontinental flight in history that moved across the country at a speed faster than the rotational speed of the earth.

The 43rd BW, which had been prevented from being declared combat-ready by the B-58's teething problems, was finally declared as such in August of 1962. The wing was placed on alert in September of 1962.

On September 18, 1962, 59-2456, with a crew consisting of Major Fitzhugh Fulton, Captain W.R. Payne and civilian flight test engineer C.R. Haines was used to set two more records. During a zoom climb over Edwards AFB, the aircraft reached an altitude of 85,360.84 feet while carrying a payload of 5000 kg, winning the crew the 1962 Harmon trophy. This broke two previous Soviet-held records.

On October 16, 1962, 61-2059 crewed by Major Sidney Kubesch, Major John Barrett and Captain Gerard Williamson, flew supersonically from Tokyo to London, spending five hours at supersonic speed. The flight set five world absolute records.

Just at the point of entry of the B-58 into active service, it was revealed that the number of B-58 wings wad going to be one less than that which SAC had anticipated, and 30 aircraft ordered for FY 1962 were cancelled. A wing of B-47 Stratojets would be retained to offset the reduction. Unit cost of the B-58 had jumped to 14 million dollars, which made the aircraft almost three times as expensive as a production B-52G. The delays in the B-58 program had now put the Hustler in direct competition with the B-70 program for funding, and the B-70 was at that time pictured as the next step in the USAF's bomber program.

In spite of its initial teething troubles and the long delays in initial entry into service, by the mid-1960s the B-58 had become a fairly effective weapons system. By the end of 1962, USAF crews had made over 10,500 flights and logged 5,300 hours (1,150 of them supersonic, including 375 at Mach 2). Initially, B-58 training was conducted by the 43rd Combat Crew Training School. From 1960 through 1964, this unit fulfilled the requirements of both its parent 43rd BW and the 305th BW. In August of 1964, the 305th activated its own CCTS.

In a little-known attempt to increase the flexibility of the B-58 as a weapons system, experiments were carried out in April of 1964 under a program known as Operation *Bullseye* to see if the B-58 could carry and deliver conventional bombs. In coordination with Republic F-105Ds and McDonnell F-4C/Ds, sorties were flown using B-58s as lead ships and pathfinders and as independent strike aircraft. It was demonstrated that the B-58 could carry iron bombs on the wing root bomb racks that had earlier been added to accommodate four Mk. 43 nuclear weapons. Iron bombs of varying weights up to 3000 pounds were dropped, usually from low altitudes and at speeds of 600 knots. Almost all of the drops were visual, with the AN/ASQ-42 system rarely being used. However, the fear that the B-58's integral wing tanks would make it vulnerable to ground fire during low-altitude delivery lead to the abandonment of the program.

The active service life of the B-58 was destined to be rather short. Phase-out of the B-58 fleet was ordered by Secretary of Defense Robert McNamara in December of 1965, since it was felt that the high-altitude performance of the B-58 could no longer guarantee success against increasingly sophisticated Soviet air defenses. At that time, Secretary McNamara also announced that the FB-111A would be built. McNamara proposed that the new FB-111A, along with improvements in the Minuteman and Polaris missiles and modernization of the subsonic B-52 would enhance strategic deterrence and make the B-58 superfluous to the needs of the USAF. Although SAC had never been happy with the relatively limited range of the B-58 and felt that the Air Force through congressional pressure had forced the B-58 on them, the aircraft had gone through a long gestation period during which lots of bugs had been wrung out of the system, and it was now thought to be a valuable and effective weapons system. Consequently, SAC pressed the Defense Department for the retention of the B-58, at least until 1974. However, the decision of 1965 was to stand.

Another factor was the B-58's relatively high cost as compared to the B-52 and B-47. The unit cost of the B-58 was 33.5 million dollars as compared to 9 million for the B-52 and 3 million for the B-47. The cost of maintaining and operating two B-58 wings equaled the cost of maintaining six B-52 wings. In addition, the B-58 was quite costly to maintain.

The B-58's high accident rate was probably its most serious failing. Out of the 116 aircraft built, some 26 were destroyed in accidents before the type was removed from service, and several additional aircraft were damaged seriously enough to prevent them from being returned to flight status. Most of the accidents took place during the B-58's flight test and operational evaluation period, with a lower attrition rate actually being attained late in its operational career. Many of the accidents were due to plain carelessness and were not the aircraft's fault, but others were a result of mechanical or systems failures that were basically a consequence of the B-58's rapid leap forward in technology. Nevertheless, there was more than a slight residual dislike for the aircraft among the SAC and USAF hierarchy.

On October 27, 1969, Secretary of Defense Melvin Laird announced a round of base closings. Included on the list were Little Rock AFB and Bunker Hill AFB (now named Grissom AFB, in honor of the astronaut Virgil Grissom who had been killed along with fellow astronauts Edward White and Roger Chaffee in the Apollo 1 capsule fire on January 27, 1967). Although these two bases would remain intact as military bases, they would lose their B-58 wings. The aircraft would be removed from the inventory and scrapped.

The first B-58 to go to the boneyards was 59-2446, which flew to Davis-Monthan AFB on November 5, 1969. Once underway, the B-58 retirement program moved relatively rapidly. The retirement was completed on January 16, 1970, when the 305th Bomb Wing's last two B-58s (55-0662 and 61-0278) were flown to Davis-Monthan AFB in Arizona for storage. Once their B-58s were in storage, the 43rd BW was temporarily inactivated, but was immediately reactivated with the assets of the 3960th Strategic Wing at Anderson AFB on Guam. The 305th BW was converted to an in-flight refuelling wing using KC-135As.

5YB

First flight 11/30/57; flew first mission profiles for operational use from 6/27/58 to 3/17/59; carried pod number B-122; destroyed on 11/7/59 -- 25 n. miles SE of Lawton, OK; accident cause never absoultely established, but official report noted "design deficiency in that the directional restoring moments on the aircraft were not adequate for the test conditions"; Convair Pilot Raymond Fitzgerald (fatal), Convair Flight Engineer Donald Siedhof (fatal), no third crewmember aboard.

55-665 6 YB/RB-58 *Snoopy*

First flight 9/28/57; first test aircraft delivered to the USAF on 2/15/58; on 2/15/59 modified to test AN/ASG-18 radar system and associated GAR-9/AIM-47 missile for the F-108 Rapier and later the YF-12A programs; currently static derelict on the Edwards AFB photo test range.

55-666 7 YB/RB-58 n/a

First flight 3/20/58; used as the GE J79-GE-5 engine test aircraft using a special centerline pod -- on 11/8/58 flew 32 minutes at sustained Mach 2 with the YJ79-GE-5s; made longest B-58 early test program flight of 11 hours 15 minutes on 8/16/62; carried pod B-134; currently on static display at Chanute AFB, IL wearing serial number 61-2059. [Note -- Chanute has since closed.]

55-667 8 YB/RB-58 n/a

First flight 12/14/57; used in ten month long fire control system tests at Eglin AFB, FL in 1959 but no live ammo fired; carried pods B-1-1 and B-2-1; destroyed 6/4/60 -- 26 n. miles ESE of Lubbock TX; accident cause was loss of control in normal flight due to atmospheric conditions and subsequent abandonment of aircraft in supersonic flight regime; Convair pilot Jack Baldridge (fatal), Convair flight engineer Hugh Coleman (fatal), Convair flight engineer Charles Jones (fatal).

55-668 9 YB/RB-58 *Wild Child II/Peeping Tom*

First flight 5/13/58; used for various special projects -- Hughes AN/APQ-69 SLAR, Goodyear AN/APS-73; orignally scheduled to be first airframe fitted with GE J79-GE-9 engines for B-58B; converted to TB-58A and became last Hustler assigned to 43rd BW; arrived at MASDC 1/16/70 but was saved from scrapping and transported by C-5A to Southwest Aerospace Museum, Forth Worth TX where currently displayed.

New information from Donald White on 2/8/95 -- 55-668 is on display at the Lone Star Flight Museum, Galvaston, Tx. (402) 740-7722. Another internet user who emailed and pointed this move out was Michael Colangelo. My thanks to both of them.

55-669 10 YB/RB-58A n/a

First flight 5/3/58; used for passive ECM system tests; used for engine performance tests; used for autopilot eval. tests; scheduled for conversion to TB-58A; destroyed 10/27/59 -- 7 n. miles west of Hattiesburg, MS; accident cause was loss of control during normal flight; Convair pilot Everett Wheeler (survived); Convair flight engineer Michael Keller (survived); Convair flight engineer Harry Blosser (fatal).

55-670 11 YB/RB-58A n/a

First flight 6/26/58; placed in climatic test chamber at Eglin AFB, FL on 7/8/58 and removed 9/58;

12/30/60; assigned to 43rd BW; as of 10/65 had highest number of B-58 flight hours (1,078); arrived at MASDC 12/15/69 and scrapped on 6/27/77.

58-1022 29 YB/RB-58A n/a

During 3/60 became fatigue test aircraft and used for cyclic loading tests through 1/61; aircraft completed two months before conversion for tests; destroyed during fatigue test program some five years after program was begun.

58-1023 30 YB/RB-58A n/a

First flight 7/24/59; first production standard aircraft; destroyed 4/22/60 -- 29 n. miles NW of Ogden, UT; accident cause was loss of control during normal flight due to Mach/airspeed/air data system failure; Convair pilot Ray Tenhoff (fatal); Convair flight test engineer Walter Simon (fatal); Convair flight test engineer Kenneth Timpson (survived).

59-2428 31 B-58A n/a

First B-58 to incorporate an operational tail gun; on 11/30/59 became first tactical inventory aircraft accepted by 6592 TS; eventually assigned to 43rd BW; carried pod B196; arrived at MASDC 1/8/70 and scrapped 7/6/77.

59-2429 32 B-58A *The Pulaski Hustler*

First B-58 assigned to 1960 SAC bombing competition at Bergstrom AFB; assigned to 43rd BW; arrived at MASDC 12/18/69 and scrapped 8/2/77.

59-2430 33 B-58A n/a

Accepted by AF on 1/28/60 and delivered 2/10/60; second B-58 assigned to 1960 SAC bombing competition at Bergstrom AFB; eventually assigned to 305th BW; arrived at MASDC 1/13/70 and scrapped 8/10/77.

59-2431 34 B-58A n/a

Made 78 minute Mach 2 flight while assigned to 6592 TS; later assigned to 43rd BW; arrived at MASDC 12/8/69 and scrapped 6/29/77.

59-2432 35 B-58A *Regal Beagle*

Assigned to 43rd BW; arrived at MASDC on 12/19/69 and scrapped 8/1/77.

59-2433 36 B-58A *Now or Never*

Assigned to 43rd BW; carried pod B177; arrived at MASDC on 1/7/70 and scrapped 7/20/77.

59-2434 37 B-58A *Cannonball*

Assigned to 43rd BW; arrived at MASDC 12/17/69 and scrapped on 6/24/77.

59-2435 38 B-58A *Shackbuster*

REPORT OF AF AIRCRAFT ACCIDENT

Use this form in accordance with AF Reg. 62-14 and AF Manual 62-5, "Aircraft Accident Prevention-Investigation-Reporting." Fill in all spaces applicable. If additional space is needed, use additional sheet(s) and identify by proper section letter and subsection number.

Section A—GENERAL INFORMATION

1. PLACE OF ACCIDENT: State, County, nearest town, distance and direction from nearest town. If accident occurred on airport, identify.
Mississippi, [illegible] County, [illegible] of [illegible], [illegible] Airport.

2. DATE OF ACCIDENT	3. HOUR AND TIME ZONE (Local)	4. DAY DAWN NIGHT DUSK	5. AIRFIELD OF LAST TAKEOFF
27 Oct. 195[illegible]	17[illegible] CST	NIGHT X	Carswell AFB

6. CLEARANCE: (Check all applicable) IFR___ VFR X Local___ DD Form 175 X Other___ Cleared Direct X Cleared Via Airways___
Cleared from Carswell to [illegible] Area [illegible] Cleared to Carswell from [illegible] Area

7. BASE SUBMITTING REPORT	8. DURATION OF FLIGHT	9. MISSION OF FLIGHT (Use DD Form 78-1)	10. ALTITUDE of aircraft above terrain if collision, fire, airframe failure, bailout, spin, stall, spiral, occurred
Air Force Industrial Board [illegible]	Approximately 52 minutes	Flight Test (X-1)	Between 25,000 & 30,000 Ft.

11. AIRFIELD DATA. FILL IN (a) OR (b) AS APPLICABLE. (For seaplanes landing on seadrome, fill in length of landing lanes and other data as applicable. Discuss in Section M.)

(a) If accident occurred on airport:
Length of runway in use N/A ft.
Heading of runway in use N/A degrees
Field elevation N/A ft. MSL
Type of runway surface: (Check)
Concrete N/A Asphalt N/A
Other N/A (Specify) N/A
Wet N/A Dry N/A

(b) If accident occurred off airport: elevation at scene of acdt. 150 ft. MSL
Was aircraft taking off, approaching or maneuvering to land? Yes___ No X
If yes, state airport involved N/A
If no, state nearest airport suitable for landing this aircraft Brookley AFB, Ala.
For either airport mentioned in 11b above: 3748-R
State airport type (i.e., AF, A, N, CG, PC, P) AF
Distance, airport to accident 80 miles. Heading of runway in use UNK degrees.
Magnetic bearing, airport to accident 300 degrees. Airport elevation 26 ft. MSL

12. LIST NUMBERS OF ALL OTHER AIRCRAFT INVOLVED: (File separate Form 14 for each aircraft) None

TS S

13. VIOLATIONS: Yes___ No___ If yes, discuss in Section M.

Section B—AIRCRAFT

1. AIRCRAFT NUMBER	2. TYPE, MODEL, SERIES AND BLOCK NUMBER	3. ASSIGNMENT AND STATUS CODE at time of accident: (As specified in AFR 65-110)
55-669A	YB/RB-58A	ARDC, GFE to Convair, Fort Worth Code EB

4. ORGANIZATION POSSESSING AND REPORTING AIRCRAFT ON AF-110 REPORTS AT TIME OF ACCIDENT

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
AMC ARDC	SAAMA 5A	SARFF	—	—	—	AD 72 Convair, Fort Worth

5. IF AIRCRAFT WAS BEING FERRIED OR DELIVERED INDICATE: (Gaining and losing organizations, date of transfer, ultimate destination)
N/A

Section C—PILOT(S) INVOLVED (Flight Crew)

1. OPERATOR (Person at controls at time of accident)

a. LAST NAME (Jr., II, etc.) FIRST NAME MIDDLE NAME	GRADE	COMPONENT	SERVICE NUMBER	NATIONALITY	YR. OF BIRTH
Wheeler, Everett L.	Civ	N/A	N/A	USA	[redacted]

b. POSITION IN AIRCRAFT AT TIME OF ACCIDENT: Front or Left Seat X Rear or Right Seat___
c. ASSIGNED DUTY ON FLIGHT ORDER: AC___ IP___ P X CP___ Other (Specify)

d. ASSIGNED ORGANIZATION

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
Flight Dept., Convair, Ft. Worth (A Division of General Dynamics Corp.						

e. ATTACHED ORGANIZATION FOR FLYING

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
Flight Dept., Convair, Ft. Worth (A Division of General Dynamics Corp.)						AD 72

f. ORIGINAL AERONAUTICAL RATING AND DATE RECEIVED	g. PRESENT AERONAUTICAL RATING AND DATE RECEIVED	h. INSTRUMENT CARD	i. AFSC
Pilot (Navy) March 1944	CAA Commercial Pilot October 2, 1953	Type CAA (dated Aug. 1947) Date of expiration Indefinite	Primary N/A Duty N/A

2. OTHER PILOT

a. LAST NAME (Jr., II, etc.) FIRST NAME MIDDLE NAME	GRADE	COMPONENT	SERVICE NUMBER	NATIONALITY	YR. OF BIRTH
N/A	N/A	N/A	N/A	N/A	N/A

b. POSITION IN AIRCRAFT AT TIME OF ACCIDENT N/A: Front or Left Seat___ Rear or Right Seat___ Other___
c. ASSIGNED DUTY ON FLIGHT ORDER N/A: AC___ IP___ P___ CP___ Other (Specify)

d. ASSIGNED ORGANIZATION

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
N/A	N/A	N/A	N/A	N/A	N/A	N/A

e. ATTACHED ORGANIZATION FOR FLYING

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
N/A	N/A	N/A	N/A	N/A	N/A	N/A

f. ORIGINAL AERONAUTICAL RATING AND DATE RECEIVED	g. PRESENT AERONAUTICAL RATING AND DATE RECEIVED	h. INSTRUMENT CARD	i. AFSC
N/A	N/A	Type N/A Date of expiration___	Primary N/A Duty N/A

NOTE: IF MORE THAN TWO PILOTS ARE INVOLVED (FLIGHT CREW) REPORT SAME INFORMATION REQUIRED IN SECTION C2 ON ADDITIONAL SHEET FOR EACH.

59-10-27-1

Section D—FLYING EXPERIENCE OF PILOT(S) INVOLVED

1. WAS OPERATOR ON INSTRUMENTS AT TIME OF ACCIDENT OR IMMEDIATELY BEFORE: Yes No Unknown — If "Yes" check one: Weather Hood

(Complete items 2 through 14 for each crewmember pilot)

ASSIGNED DUTY ON FLIGHT ORDER	PILOT (Last Name)	CO-PILOT (Last Name)	INSTR. PILOT (Last Name)	AIRCRAFT CMDR. (Last Name)	STUDENT PILOT (Last Name)
NOTE: List all time to the nearest hour	[illegible]	N/A	N/A	N/A	N/A
2. Total flying hours (including AF time, student time, and other accredited time)	[illegible]				
3. Total rated 1st pilot and instructor pilot hours, all aircraft	[illegible]				
4. Total weather instrument hours	[illegible]				
5. Total 1st pilot and instructor pilot hours this model (F-86, B-50, C-119, etc.)	[illegible]				
6. Total other (Command, a/c cmdr, co-pilot, radar control pilot) hours this model	N/A				
7. Total 1st pilot and instructor pilot hours this model and series (F-84F, F-86D, etc.)	13:[illegible]				
8. Total other (Command, a/c cmdr, co-pilot, radar control plt) hrs this model and series	N/A				
9. Total pilot hours last 90 days	69:45				
10. Total 1st pilot and instructor pilot hours last 90 days	69:45				
11. Total pilot hours (night) last 90 days	6:25				
12. Total pilot hours, weather and hood, last 90 days	3:50				
13. Date and duration of last previous flight this model	10-23-5[illegible] (4:15)				
14. Date and duration of last previous flight this model and series	10-23-5[illegible] (4:15)	N/A	N/A	N/A	N/A

15. INSTRUCTIONS: Attach a copy of AF Form 5 for pilot(s) involved for the previous calendar month, and for month in which the accident occurred, to include the flight on which the accident took place.

Section E—PERSONNEL INVOLVED

(Including operator and all other persons, whether in plane or not)

Duty at time of accident (1)	Name (Last name first, Grade, Serial Number and Component or Service) (2)	Type Aero Rating (3)	ORGANIZATIONAL ASSIGNMENT Command, Subcommand, Group Number and Type, Base (4) CIV AL	Injury Class. (or missing) (5)	Parachute Used Yes (6)	Parachute Used No (7)	Ejection Seat Used Yes (8)	Ejection Seat Used No (9)
Pilot 01	Wheeler, Everett L 1 J	Pilot	Flight Dept., Convair, Ft. Worth (A Division of General Dynamics Corp.)	Major 3	X D		X A	
Obs. Flight Engr. 13	Keller, Michael F. 2 J	Obs. Engr.	Flight Dept., Convair, Ft. Worth (A Division of General Dynamics Corp.)	Major 3	X M		X A	
Obs. Flight Test Engr. 13	Blosser, Harry N. 3 J	Obs.	Engineering Dept., Convair, Ft. Worth (A Division of General Dynamics Corp.)	Fatal 4	R	X	X A	

NOTE: If additional space is required to list all personnel involved, attach additional sheet.

Section F—WEATHER

(At time and place of accident)

From weather reported by Laurel, McCrub, Keesler and Airline Pilot.

Ceiling	Visibility	Wind Direction and Velocity	Temperature	Dew Point	Alt. Setting	Other Weather Conditions
High Brkn to Ovcst	15	Calm	52°F	46°F	30.12	Est. 10,000 to 15,000 Sctd clouds

If weather, including wind conditions, was a factor in the accident, attach statement of weather officer.

Section G—ENGINEERING DATA

1. Damage: (Check one) Destroyed X Substantial__ Minor__ None__ 2. Was aircraft damaged beyond economical repair? Yes X No__

3. Estimated number of direct manhours for repair, if applicable N/A Cost of damage to aircraft N/A

4. Fire before accident No Fire after accident Yes Fire did not occur__ 5. Did explosion occur? Yes X No__

6. How many T.O.s not complied with at time of accident? 68 (List T.O. numbers and titles on separate sheet) See Maint. Rept.

7. Has your Base previously submitted a UR on any factor involved in this accident? Yes__ No X

8. Is a UR being submitted as a result of this accident? Yes X No__ (If "Yes" attach copy) UR number TP59-1406

9. Is TDR requested? Yes__ No X Attach copy of request TP59-1435

HISTORY OF FLIGHT

1. YB/RB-58A, Serial Number 55-669A, was prepared for flight on 27 October 1959, in accordance with applicable Convair procedure. The aircraft and crew station preflight was accomplished by the civilian flight test crew assisted by Convair maintenance personnel. Following an abort from take off position for a malfunction of the number one engine control alternator the malfunction was rectified and a normal take off was made from Carswell AFB at 1843 CST, 27 October on a VFR Fort Worth to Eglin to Fort Worth clearance.

2. A high overcast necessitated initial level off at 24,000 feet and subsequently a descent to 22,000 feet. Approaching Alexandria Omni the cloud condition permitted climb to 30,500 feet and cruise at Mach .92. Shortly after passing south of McComb Omni the pilot disengaged auto pilot, changed heading for Evergreen Omni and elected to climb to 34,500 feet to get above forecast weather in the Eglin area. At a point near Hattiesburg, Mississippi, the pilot experienced a roll-off of the aircraft to the right. The pilot applied what he considered to be corrective action with no apparent effect and after what he considered a two turn spin condition he gave the order to eject from the aircraft. All three crew members ejected and the aircraft impacted with the ground approximately 7 nautical miles west south west of Hattiesburg, Mississippi, at 1935 CST 27 October 1959. The aircraft was totally destroyed by ground impact. Total time of this flight was fifty-two minutes.

[redacted]

AIRCRAFT CLEARANCE

(DELIVER DUPLICATE TO BASE OPERATIONS AT DESTINATION)

DATE: 10-27-59

A. OPERATIONS OFFICE: CONVAIR FLIGHT OPERATIONS FORT WORTH, TEXAS

AIRCRAFT SERIAL NO.: 55-669

B. OCCUPANTS (State whether crew or passenger. List additional passengers on separate sheet and attach.)

DUTY	NAME AND INITIALS	GRADE	SERVICE NO.	ORGANIZATION	HOME STATION
PILOT IN COMMAND	WHEELER, E.I.	CIV	—	CONVAIR	FWH
FE	KELLER, M.F.	CIV	—	"	"
FTE	ULOSSER, H.N.	CIV	—	"	"

C. FLIGHT PLAN

RADIO CALL: CONVAIR 669

AIRCRAFT TYPE: B-58A.

POINT OF DEPARTURE: Fort Worth

BASE NAME OF DESTINATION: CARSWELL AFB

ROUTE TO BE FLOWN

IFR	VFR	ALTITUDE	ROUTE	TO
	V	VFR	DIR	BRT
	V	VFR	DIR	AEX
	V	VFR	DIR	MCB
	V	VFR	DIR	EVR
*	V	VFR	DIR	VPS 3HR DELAY
	V	VFR	DIR	MCB
	V	VFR	DIR	AEX
	V	VFR	DIR	BRT
	V	VFR	DIR	FWH
				ZQ

MILEAGE: 1270 NAUT. — ETD: 0030Z

EST TRUE AIRSPEED: 500+ KTS — ETE: 5+15

ALTERNATE: NR. — ETE TO ALTERNATE: NR

TRANS. FREQ.: 72 UHF

PILOT'S LAST NAME: WHEELER

FUEL ON BOARD: 6 HRS. 00 MIN.

INSTRUMENT RATING

NAVY	AIR FORCE	ARMY
SPECIAL PILOT	PILOT RATING	PILOT RATING
STANDARD PILOT	INST RATING FAA	INST RATING

DATE INSTRUMENT CARD EXPIRES: IND

DD FORM 365F FILED AT: CONVAIR

DATE FILED: 10-27-59

HIGHEST RANK ON BOARD: CIV

REMARKS: WILL FLY BETWEEN EVERGREEN *OMNI AND VPS UNDER SATIN CONTROL, FOR 3 HOURS.

300 100/87 R.W.

E. L. Wheeler
(SIGNATURE OF PILOT)

D. WEATHER

EXISTING — DESTINATION: — TIME OF OBS:

ALTERNATE: — TIME OF OBS:

FORECAST — DESTINATION (ETA): FWH. 0 40M 12M, E 10K

ALTERNATE (ETE): 30.14

ROUTE FORECAST

MIN CIG: 3M AT VPS — MAX CLD TOPS: 31M FT MSL — THUNDERSTORMS: SCATTERED — TURBC: L — HAIL: —

MIN VIS FLT LVL: 10 — DUST OR HAZE: — — SMOKE: — — RAIN: — — FOG: —

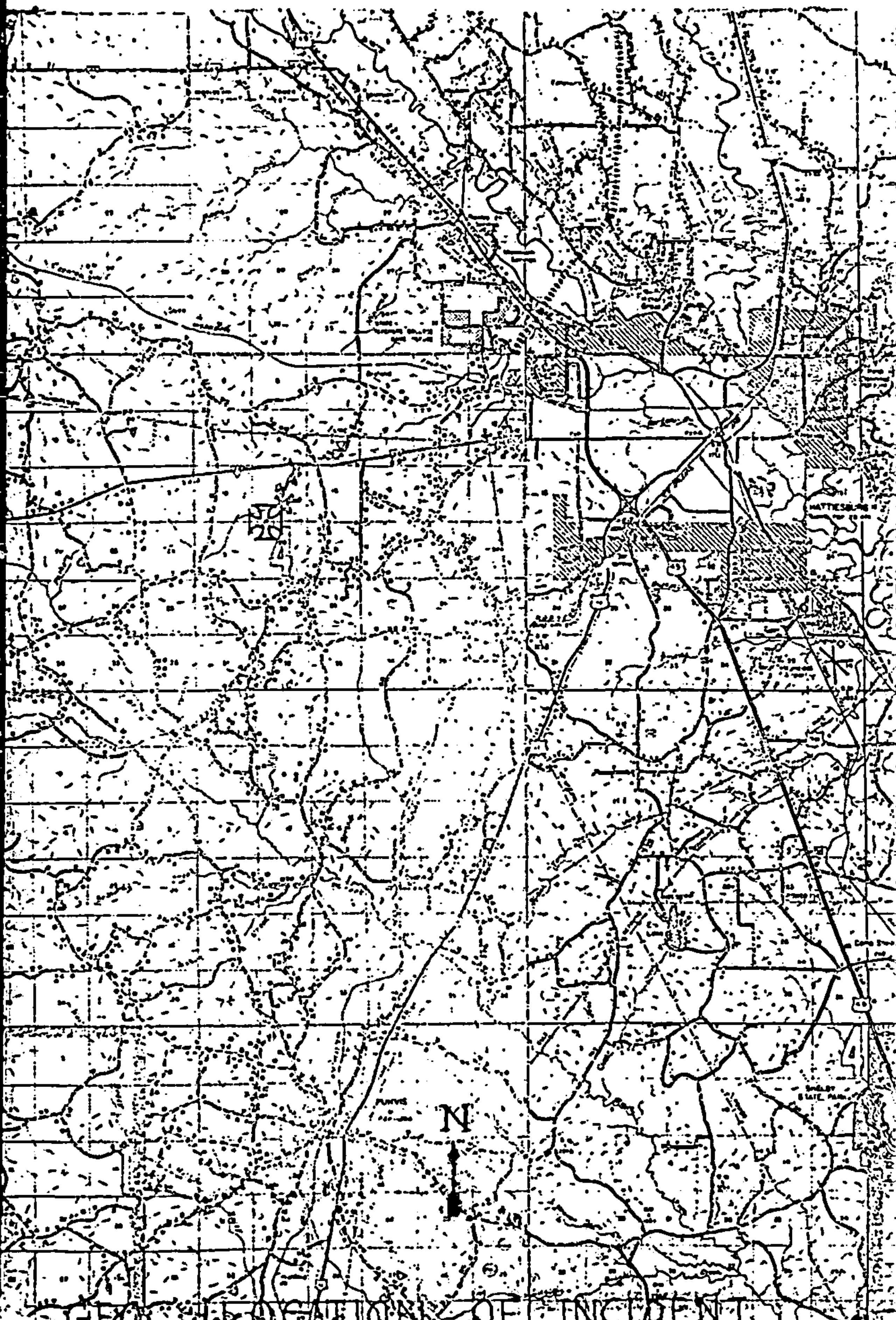
MIN FRZ LVL: 13000 FT MSL — ICING: — — FRZ PCPN: — SNOW: — — BRIEFING VOID AFTER: 0040

WINDS: 250°/60 — SIGNATURE: R.F.

E. FLIGHT CLEARANCE AUTHORIZATION

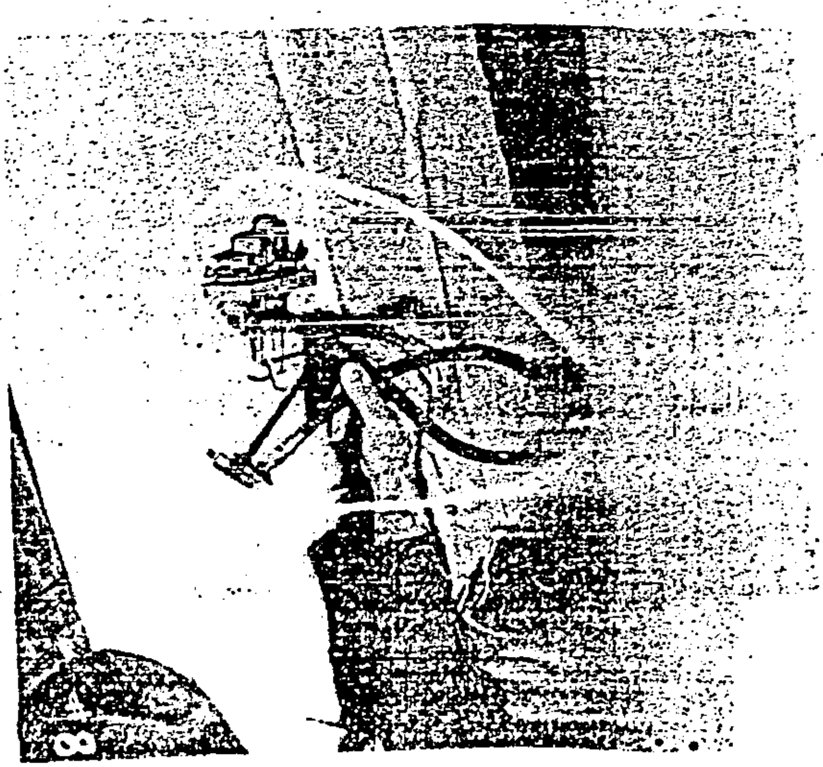
SUBMITTED TO	TIME	BY	SIGNATURE OF CLEARING AUTHORITY
INSTRUCTIONS AND APPROVAL TRANS. TO TOWER OR PILOT BY		ACTUAL T.O. TIME	E. L. Wheeler
STATION ARRIVED AT	TIME	NAME	GRADE OR POSITION

DD FORM 1 MAY 54 175 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. REPLACES WD FORM ... WHICH IS OBSOLETE IN THE USAF.



GEO. LOCATION OF INCIDENT



11/07/1959
& 04/03/1960
B-58

REPORT OF AF AIRCRAFT ACCID[redacted]

(Fill out form in accordance with AF Reg. [illegible] and AF [illegible] [redacted] [illegible]. If additional space is needed, use additional sheet(s), and identify by proper section letter and subsection number)

Section A—GENERAL INFORMATION

1. PLACE OF ACCIDENT: State, County, nearest town, distance and direction from nearest town. If accident occurred on airport, identify.
Oklahoma, Commanche, Lawton (12 MI SE of Lawton, Oklahoma)

2. DATE OF ACCIDENT: 7 Nov. 1959
3. HOUR AND TIME ZONE (Local): 1702C
4. DAY, DAWN, NIGHT, DUSK: x
5. AIRFIELD OF LAST TAKEOFF: Carswell AFB

6. CLEARANCE (Check all applicable): IFR ___ VFR ___ Local X DD Form 175 ___ Other ___ Cleared Direct X Cleared Via Airways ___
Cleared from: Carswell AFB Cleared to: Carswell AFB

7. BASE SUBMITTING REPORT: USAF INDUSTRY BOARD
8. DURATION OF FLIGHT: 0:52
9. MISSION OF FLIGHT (Use DD Form 781-1): 2 X 1
10. ALTITUDE of aircraft above terrain if collision, fire, airframe failure, bailout, spin, stall, spiral, occurred: 35,553 feet

11. AIRFIELD DATA: FILL IN (a) OR (b) AS APPLICABLE (For compliance landing on airdrome, fill in length of landing lanes and other data as applicable. Discuss in Section M.)

(a) If accident occurred on airport:
Length of runway in use ___ ft.
Heading of runway in use ___ degrees
Field elevation ___ ft. MSL
Type of runway surface (Check): Concrete ___ Asphalt ___ Other (Specify) ___ Wet ___ Dry ___

(b) If accident occurred off airport: elevation of scene of accident 1157 ft. MSL
Was aircraft taking off, approaching or maneuvering to land? Yes ___ No X
If yes, state airport involved ___
If no, state nearest airport suitable for landing this aircraft Altus AFB
For either airport mentioned in (b) above: AN 49
State airport type (i.e., AF, A, N, CG, PC, etc.) AF
Distance, airport to accident 55 miles. Heading of runway in use 170 degrees.
Magnetic bearing, airport to accident 090 degrees. Airport elevation 1378 ft. MSL

12. LIST NUMBERS OF ALL OTHER AIRCRAFT INVOLVED (File separate Form 14 for each aircraft): N/A

13. VIOLATIONS [redacted] If yes, discuss in Section M.

Section B—AIRCRAFT

1. AIRCRAFT NUMBER: 55-664A
2. TYPE, MODEL, SERIES AND BLOCK NUMBER: YB/RB-58A
3. ASSIGNMENT AND STATUS CODE at time of accident: ARDC (GFE to Convair-Ft Worth) Code EB (As specified in AFR 65-110)

4. ORGANIZATION POSSESSING AND REPORTING AIRCRAFT ON AF-110 REPORTS AT TIME OF ACCIDENT

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
ARDC AMC	SAAMA	AFPRO	#4, Convair, Fort Worth, Texas			AD 82

5. IF AIRCRAFT WAS BEING FERRIED OR DELIVERED INDICATE: (Gaining and losing organizations, date of transfer, ultimate destination)
N/A

Section C—PILOT(S) INVOLVED (Flight Crew)

1. OPERATOR (Person at controls at time of accident)

a. LAST NAME (Jr., II, etc.) FIRST NAME MIDDLE NAME	GRADE	COMPONENT	SERVICE NUMBER	NATIONALITY	YR. OF BIRTH
Fitzgerald, Raymond (NMI)	CIV	N/A	N/A	CAU	1925

b. POSITION IN AIRCRAFT AT TIME OF ACCIDENT: Front or Left Seat X Rear or Right Seat ___
c. ASSIGNED DUTY ON FLIGHT ORDER: AC ___ IP ___ P X CP ___ Other (Specify) ___

d. ASSIGNED ORGANIZATION

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
N/A	N/A	N/A	N/A	N/A	N/A	N/A

e. ATTACHED ORGANIZATION FOR FLYING

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
N/A	N/A	N/A	N/A	N/A	N/A	N/A

f. ORIGINAL AERONAUTICAL RATING AND DATE RECEIVED: Pilot A.F. 1943
g. PRESENT AERONAUTICAL RATING AND DATE RECEIVED: F.A.A. Commercial 22 Oct. 1945
h. INSTRUMENT CARD: Type F.A.A. Date of expiration Indefinite
i. AFSC: Primary N/A Duty N/A

2. OTHER PILOT

a. LAST NAME (Jr., II, etc.) FIRST NAME MIDDLE NAME	GRADE	COMPONENT	SERVICE NUMBER	NATIONALITY	YR. OF BIRTH
N/A	N/A	N/A	N/A	N/A	N/A

b. POSITION IN AIRCRAFT AT TIME OF ACCIDENT: Front or Left Seat N/A Rear or Right Seat N/A Other N/A
c. ASSIGNED DUTY ON FLIGHT ORDER: AC ___ IP ___ P ___ CP ___ Other (Specify) N/A

d. ASSIGNED ORGANIZATION

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
N/A	N/A	N/A	N/A	N/A	N/A	N/A

e. ATTACHED ORGANIZATION FOR FLYING

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
N/A						

f. ORIGINAL AERONAUTICAL RATING AND DATE RECEIVED: N/A
g. PRESENT AERONAUTICAL RATING AND DATE RECEIVED: N/A
h. INSTRUMENT CARD: Type N/A Date of expiration N/A
i. AFSC: Primary N/A Duty N/A

NOTE: IF MORE THAN TWO PILOTS ARE INVOLVED (FLIGHT CREW) REPORT SAME INFORMATION REQUIRED IN SECTION C2 ON ADDITIONAL SHEET FOR EACH.

59-11-7-1

5912-7-1401

Section D—FLYING EXPERIENCE OF PI[redacted]S) INVOLVED

1. WAS OPERATOR ON INSTRUMENTS AT TIME OF ACCIDENT OR IMMEDIATELY BEFORE? Yes___ No___ Unknown X If Yes, check one: Weather___ Hood___

	(Complete items 2 through 14 for each crewmember pilot)				
ASSIGNED DUTY ON FLIGHT ORDER NOTE: List all time to the nearest hour	PILOT (Last Name)	CO-PILOT (Last Name)	INSTR. PILOT (Last Name)	AIRCRAFT CMDR. (Last Name)	STUDENT PILOT (Last Name)
2. Total flying hours (including AF time, student time, and other accredited time)	6120				
3. Total rated, 1st pilot and instructor pilot hours, all aircraft	5370				
4. Total weather instrument hours	219				
5. Total 1st pilot and instructor pilot hours this model (F-86, B-50, C-119, etc.)	323				
6. Total other (Command, a/c cmdr, co-pilot, radar control pilot) hours this model	N/A				
7. Total 1st pilot and instructor pilot hours this model and series (F-84F, F-86D etc.)	323				
8. Total other (Command, a/c cmdr, co-pilot, radar control plt) hrs this model and series	N/A				
9. Total pilot hours last 90 days	71				
10. Total 1st pilot and instructor pilot hours last 90 days	71				
11. Total pilot hours (night) last 90 days	4				
12. Total pilot hours, weather and hood, last 90 days	1				
13. Date and duration of last previous flight this model	4 Nov 3-05				
14. Date and duration of last previous flight this model and series	4 Nov 3-05				

15. INSTRUCTIONS: Attach a copy of AF Form 5 for pilot(s) involved for the previous calendar month, and for month in which the accident occurred, to include the flight on which the accident took place.

Section E—PERSONNEL INVOLVED

(Including operator and all other persons, whether in plane or not)

Duty at time of accident (1)	Name (Last name first, Grade, Serial Number and Component or Service) (2)	Type Aero Rating (3)	ORGANIZATIONAL ASSIGNMENT Command, Subcommand, Group Number and Type, Base CIV (4) AD82	Injury Class (or missing) (5)	Parachute Used Yes (6)	Parachute Used No (7)	Ejection Seat Used Yes (8)	Ejection Seat Used No (9)
Pilot 01	Fitzgerald, Raymond J Civilian	Commercial	Convair	F 4		x		x
Flight Test Engr. 13	Siedhof, Donald A. J Civilian	Observer	Convair	F 4		x		x

NOTE: If additional space is required to list all personnel involved, attach additional sheet.

Section F—WEATHER

(At time and place of accident)

Ceiling	Visibility	Wind Direction and Velocity	Temperature	Dew Point	Alt. Setting	Other Weather Conditions
Clear	15+	SSE 13K	57°F	28°F	28:96	N/A

If weather, including wind conditions, was a factor in the accident, attach statement of weather officer.

Section G—ENGINEERING DATA

1. Damage: (Check one) Destroyed X Substantial___ Minor___ None___ 2. Was aircraft damaged beyond economical repair? Yes X No___

3. Estimated number of direct manhours for repair, if applicable N/A Cost of damage to aircraft $15,000,000.00

4. Fire before accident___ Fire after breakup X Fire did not occur___ 5. Did explosion occur? Yes X No___ After breakup

6. How many T.O.s not complied with at time of accident? 39 (List T.O. numbers and titles on separate sheet)

7. Has your Base previously submitted a UR on any factor involved in this accident? Yes___ No___

8. Is a UR being submitted as a result of this accident? Yes___ No___ (If "Yes" attach copy) UR number___

9. Is TDR requested? Yes___ No___ Attach copy of request

Section H—DAMAGE

[redacted]E BRIEFLY EXTENT OF DAMAGE TO AIRCRAFT AND A[redacted]OPERTY DAMAGE INCURRED

	Section I—PHASE OF OPERATION (Check only ONE)	Section J—ACCIDENT TYPE			Section K—CONDITIONS AFFECTING ACCIDENT	
	ENGINES RUNNING—NOT TAXIING	P	S	Check one accident type as "Primary." Check all others applicable as "Secondary."		(Check all applicable)
	Pre-flight			Ground or water loop		Immediate forced landing
	Post flight			Wing-tip landing		Precautionary landing
	Other			Wheels-up landing		Fuel exhaustion or starvation
	TAXIING			Hard landing		Engine stoppage or flameout
	To takeoff			Collapse or retraction of gear		Lost or inaccurate navigation
	From landing			Undershoot		Pertinent T.O.s not complied with
	Within other area			Overshoot		Simulated emergency
	TAKEOFF			Nose-up or nose-over		Ditching (intentional and controlled)
	Run			Collision with other aircraft		Accidents in water (other than ditching)
	Climb			Collision with ground or water		Explosive decompression
	Discontinued (aborted takeoff)			Collisions—Other		Intentional damage to avoid greater hazard
	IN FLIGHT			Spin		GCA, ILAS or range approach used
	Normal flight			Stall		Exceeded mach or near mach
	Acrobatics			Fire and/or explosion on ground		Compressibility
	Formation tactics			Fire and/or explosion in the air		Gear failed to extend
x	Other maneuvers Flight Test		x	Airframe failure in flight		Prop reversal
	LANDING			Abandoned aircraft		Uncontrollable porpoising in flight
	Approach			Prop or jet-blast		Struck arresting barrier
	Flare-out			Equipment loss in flight		Touch and go
	Roll			Other (indicate)	x	Other (indicate) Yaw Excursion
	GO-AROUND	x		Undetermined		At Supersonic Speed
	OTHER (Indicate)					

Section L—CAUSE FACTOR ANALYSIS

(See AFM 62-5 for definitions)

P / C		
	Check one primary cause factor (P), and those contributory cause factors (C) that may be applicable. NOTE: Contributory cause factors may appear in same major category as primary cause, i.e.—both primary and contributing cause factors may be Operator error.	
[redacted]	OPERATOR ERROR	Incorrect operation of the aircraft or its systems; improper technique; inadequate flight preparation; improper procedures; faulty judgment, etc. by person(s) at controls of aircraft at time of accident.
	CREWMEMBER ERROR	Error committed by any member of the flight crew except operator(s).
	SUPERVISORY ERROR	Inadequate exercise of command; inadequate supervision of aircrews, operations, maintenance, and other functions supporting flying operations; inadequate supervision of training, etc. (Incl. IP's & AC's)
	MAINTENANCE ERROR	Improper repair, service, inspection or installation of aircraft components, parts or systems; inadequate or improper compliance with established maintenance procedures.
	OTHER PERSONNEL ERRORS	Errors committed by other than aircrew, supervisory or maintenance personnel. Includes GCA, Weather, Tower, Communications, Installations and any other supporting personnel, etc.
	MATERIEL FAILURE	Failure or malfunction of the airframe, engine or any other system, component or accessory of the aircraft, etc.
	AIR BASE OR AIRWAYS	Any malfunction, inadequacy or absence of air base and/or airways equipment or facilities, including deficiencies and hazards of runways, taxiways, aprons, overruns, clear zones, etc.
	WEATHER CONDITIONS	Reduced visibility, icing, turbulence, thunderstorms, surface wind, winds aloft, low ceiling, etc.
	MISCELLANEOUS CONDITIONS	Bird strikes, struck tow target, chock, ricochets, hypoxia, vertigo, fatigue, etc.
	UNDETERMINED	Most probable cause is design deficiency.

Present detailed description of acts, events, or conditions considered to be primary or contributory cause factors (separate paragraph for each) in FINDINGS portion of Narrative Description of Accident required by Section M.

HISTORY OF FLIGHT

1. YB/RB-58, Aircraft Serial Number 55-664A, was prepared for flight on 7 November 1959, in accordance with applicalbe Convair procedures. The aircraft and crew station preflight was accomplished by the civilian flight test crew assisted by Convair maintenance personnel. During preflight, an inoperative number 7 booster pump warning pressure switch was replaced and accumulated fuel was removed from a leaking number 2 engine fuel flow divider. The aircraft was then released for flight. A normal engine start was made and take-off from Carswell AFB was accomplished at 1610 CST, 7 November 1959 on a VFR Fort Worth to Fort Worth clearance.

2. Ten minutes after take-off, the pilot made good a scheduled rendezvous with a KC-135 tanker; however, attempts to refuel were unsuccessful due to malfunction of the receiver refueling system and the planned air refueling portion of the mission was cancelled.

3. At 1630 CST after a short discussion with Convair Test Control regarding scheduled test mission accomplishments, the pilot advised that he would attempt the test involving sudden engine stoppage of number four engine at Mach 2.0 at 37,000 feet. At 1634 CST the pilot reported his position as 15 miles southeast of Enid, Oklahoma at 29,000 feet altitude, Northbound, and conditions routine. North of Enid, Oklahoma, a 180° turn was made to line up for the north to south run in the flight corridor utilized for this test. The pilot next reported his position as crossing a river south of Enid, Oklahoma. Radio transmission was then received indicating that intermittent angle of sideslip indicator oscillation was being experienced. Test Control advised that telemetry indicated sideslip trace was steady on zero and the pilot responded that the airborne indicator was then steady. At 1701 CST a short calibration run was made, fuel readings were taken, and the pilot advised he was on speed schedule. At 1702 CST, the pilot advised that he was starting the maneuver. A few seconds following this advisory, the aircraft broke up in flight.

[redacted]

5. The primary structure of the aircraft struck the ground approximately 12 nautical miles southeast of Lawton, Oklahoma. The aircraft was totally destroyed by inflight breakup and ground impact. Total time of this flight was fifty-two minutes.

REPORT OF AF AIRCRAFT ACCIDENT

Use this form in accordance with AF Reg. 62-14 and AF Manual 62-5, "Aircraft Accident Prevention, Investigation, Reporting." Fill in all spaces applicable. If additional space is needed, use additional sheet(s) and identify by proper section letter and subsection number.

Section A—GENERAL INFORMATION

1. BASE INVESTIGATING ACCIDENT	2. ASSIGNED BASE OF AIRCRAFT	3. APPROXIMATE DISTANCE OF ACCIDENT FROM INVESTIGATING BASE (Miles)	
Air Force-Industry Investigating Board	AFPR Convair Fort Worth, Texas	13.5 miles SE of Ft. Sill, Okla	
4. PLACE OF ACCIDENT	5. AIRCRAFT TYPE, MODEL, SERIES SERIAL NUMBER	6. TIME OF ACCIDENT (local)	7. DATE OF ACCIDENT
13.5 miles SE of Ft. Sill, Oklahoma	YB/RB 58A 55-664A	17:05	7 Nov 59

8. BRIEF DESCRIPTION OF FACTORS AND EVENTS LEADING TO ACCIDENT

As pilot was testing effect of engine stoppage during flight, aircraft disintegrated.

Section B—EQUIPMENT AND AIRCRAFT STRUCTURES
(USE ADDITIONAL SHEETS AS NECESSARY)

1. FIXED SEATS: Nr. 0 Nr. occupied ___ Nr. failed ___
2. EJECTION SEATS: Nr. Avail. (armed) 3 Used: Yes ___ No X
Nr. used in downward ejection ___ Nr. used in upward ejection ___
Failed: Yes ___ No X Nr. failed ___
3. CABIN PRESSURIZATION: Available to all pers.? Yes X No ___
Used by all pers.? Yes X No ___ Failed? Yes ___ No X
4. OXYGEN SYSTEM: Available to all pers.? Yes X No ___
Type (e. g. high pressure, low pressure, etc.) Liquid oxygen, low pressure
Used by all pers.? Yes X No ___ Date serviced ___
Failed? Yes ___ No ___ Time used this flight 50 min.
Amount used this flight ___
5. OXYGEN MASK: Available to all pers.? Yes X No ___
Type (e. g. A-13A, Pressure demand, etc.) A-13A
Used by all personnel? Yes X No ___
Did mask(s) fit? Yes X No ___ Nr. poorly fitted ___
Failed? Yes ___ No X Nr. failed ___ Nr. used ___

6. PROTECTIVE HELMET: Available to all pers.? Yes X No ___
Type (e. g. P-1, P-1A, P-3, etc.) Lombard
Used by all pers.? Yes X No ___ Nr. used 2
Failed? Yes ___ No X Nr. failed ___
7. ANTI G SUIT: Available to all pers.? Yes ___ No X
Type (e. g. G-3, G-4, etc.) ___
Used by all pers.? Yes ___ No ___ Nr. used ___
Failed? Yes ___ No ___ Nr. failed ___
8. PARACHUTES: Available to all pers.? Yes X No ___
Type (e. g. back pack, seat pack, etc.) Back Pack
Used by all pers.? Yes X No ___ Nr. used ___
Failed? Yes ___ No X Nr. failed ___
9. AUTOMATIC LAP BELT RELEASE: Available for all pers. Yes X No ___
Used by all pers.? Yes X No ___ Nr. failed ___
Failed? Yes ___ No X Nr. failed ___

10. OTHER PERSONAL EQUIPMENT (SPECIFY)

Type (e. g. pressure suit)	Nr. Used	Nr. Failed
1. Leg Restraints	0	0
2. Arm Restraints	0	0

11. SPECIAL FACTORS WHICH CONTRIBUTED TO OR PREVENTED INJURY: (List any items of personal or aircraft equipment details of structure, incidents such as being trapped in plane, or any other factors which aided or impeded escape from aircraft.)

Aircraft disintegrated in flight

12. SPECIFICALLY DESCRIBE DAMAGE TO

Cockpit	Aircraft
Seats, shoulder harness, safety belt	disintegrated
Crew stations (other than cockpit)	in
Emergency exits, hatches, canopies	flight
Passenger cabin	

MAINTENANCE OFFICER'S [illegible]

Use this form in accordance with [illegible] 62-14 and AF Manual 62-6, "Aircraft A[illegible] [illegible] Investigation Reporting" when AF Aircraft Accident/Incident Involves Inadequacy, Malfunction, or Failure of AF Materiel.

Section A—GENERAL INFORMATION

1. Date of accident	2. Type and model of aircraft involved	3. Aircraft No.	4. Place of accident	5. Base investigating accident
7 November 1959	YB/RB-58A	55-664A	12 miles SE of Lawton, Oklahoma	D/FMSR, USAF

Section B—AIRCRAFT HISTORY, AIRFRAME COMPONENTS AND AIRCRAFT ACCESSORIES DATA

Complete the following when material failure, inadequacy or malfunction are known or suspected cause factors.

1. Date of Air Force acceptance of aircraft	2. Total airframe hours	3. Date last overhaul
14 November 1957	58:55	New
4. Overhauling activity	**5. Aircraft hours since overhaul**	**6. Date and type of last periodic inspection**
None	New	2 September 1959 2nd Periodic Inspection
7. Aircraft hours at last periodic inspection	**8. Name, part number and position on aircraft of part contributing to accident**	
49:45		

9. Is part available for analysis? NO___ YES___ (If yes) Where located

10. Date of Air Force acceptance of part	11. Date part last installed	12. Date part last overhauled
13. Last overhaul activity	**14. Total flight hours of part**	**15. Total flight hours of part at last inspection**

Section C—FIRES AND EXPLOSIONS

1. Did fire occur? YES X NO___ Before impact X After impact___ If yes, discuss in Section F.	2. Did explosion occur? YES___ NO___ Before impact After impact___ If yes, discuss in Section F. SEE NOTE	3. Was aircraft fire detection system activated? YES___ NO X (If yes, give type and manufacturer)

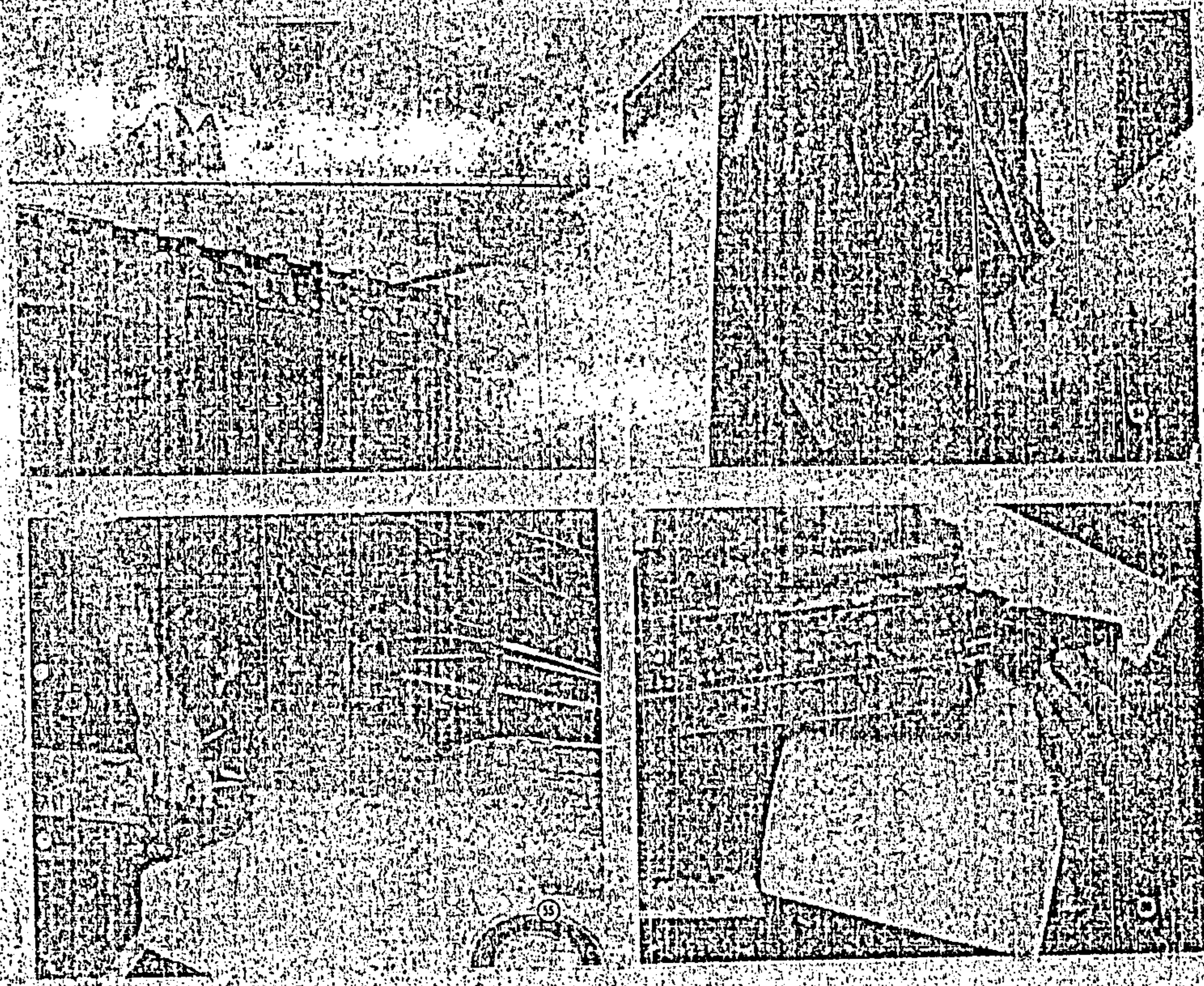
4. Was aircraft fixed fire extinguishing system used? (If yes, give type and manufacturer) NO X YES___ Effective___ Ineffective___ Quantity___

Section D—POWER PLANT HISTORY

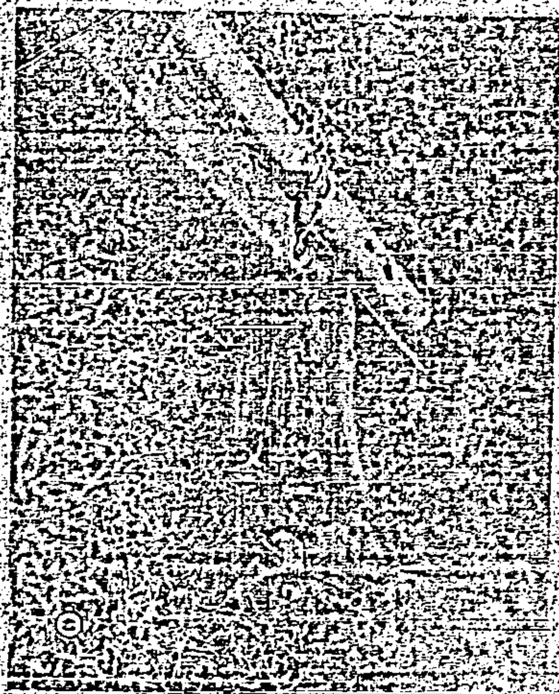
Complete the following when applicable for engines, afterburners, propellers, turbo-superchargers, helicopter rotors and/or any other power plant components involved. Use a separate column for each component. Complete a separate column for each engine when specific engine(s) involved, or accident cause factor involving engine(s) is undetermined.

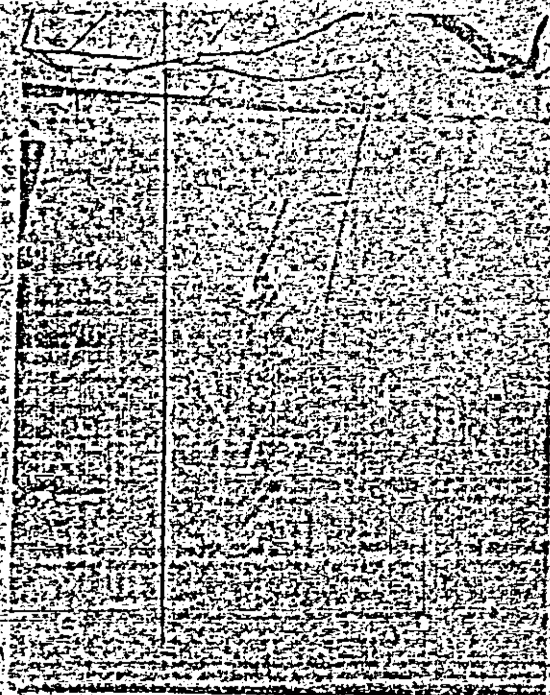
1. Name of component	Jet Engine	Jet Engine	Jet Engine	Jet Engine	
2. Location (if applicable) No. 1, 2, etc.	No. 1	No. 2	No. 3	No. 4	
3. Model or Part Number	YJ79GE-1	YJ79GE-1	YJ79GE-1	YJ79GE-1	
4. Serial Number (if applicable)	031-124	031-122	031-140	031-142	
5. Manufacturer (or licensee)	General Electric Co	General Electric	General Electric	General Electric	
6. Total hours	51:50	59:55	58:55	77:00	
7. Number of major overhauls	1	None	None	None	
8. Hours since last major overhaul	38:20	None	None	None	
9. Date of last overhaul	June 1959	None	None	None	
10. Overhaul activity	GEn. Electric Evendale, Ohio	None	None	None	
11. Date last installed	4 June 1959	4 March 1959	22 June 1959	20 July 1959	
12. Hours since last installed	12:20	21:45	12:20	12:20	
13. Date of last periodic inspection	Jan 1959	Jan 1959	June 1959	Sept 1958	
14. Type of last periodic inspection	Minor O/H 50:00 hr	Minor O/H 50:00 hr	50:00 hr	50:00 hr	
15. Fuel (Type or octane rating)	JP-4	JP-4	JP-4	JP-4	

AF FORM 1 FEB 58 14c Previous editions of this form may be used.




FWD



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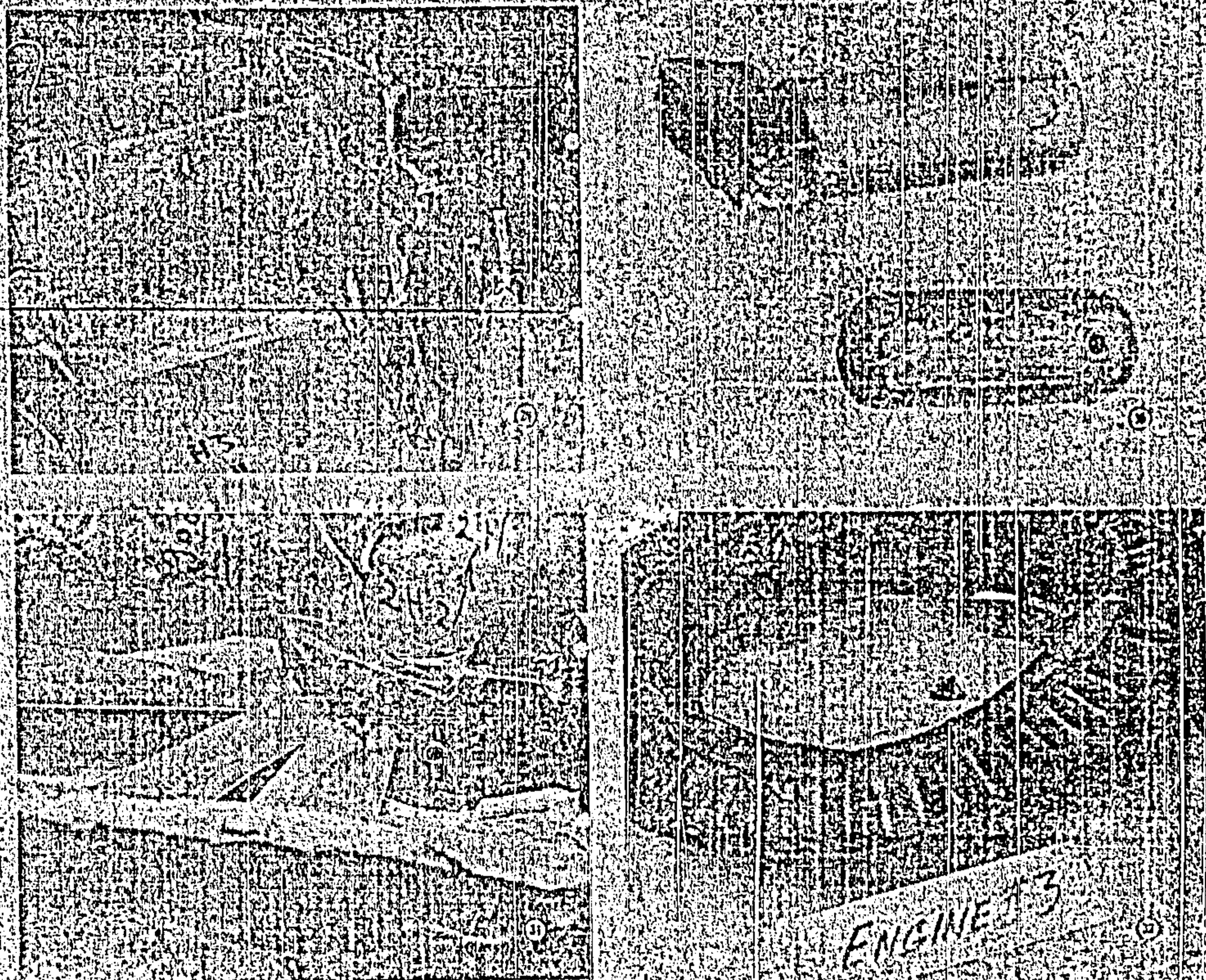
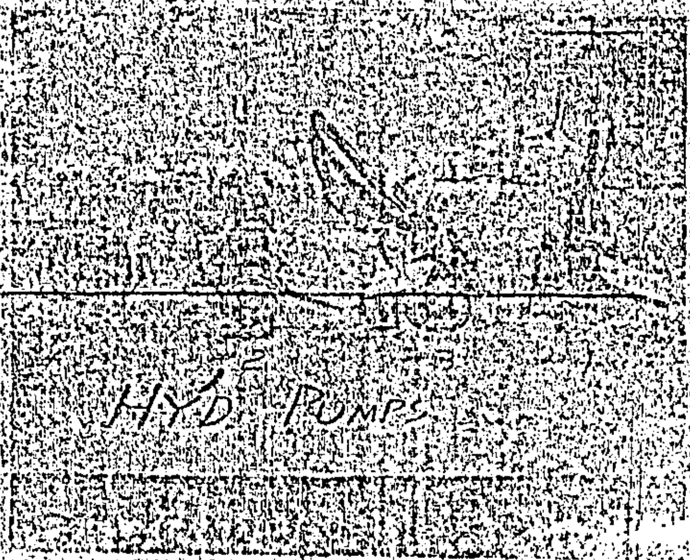
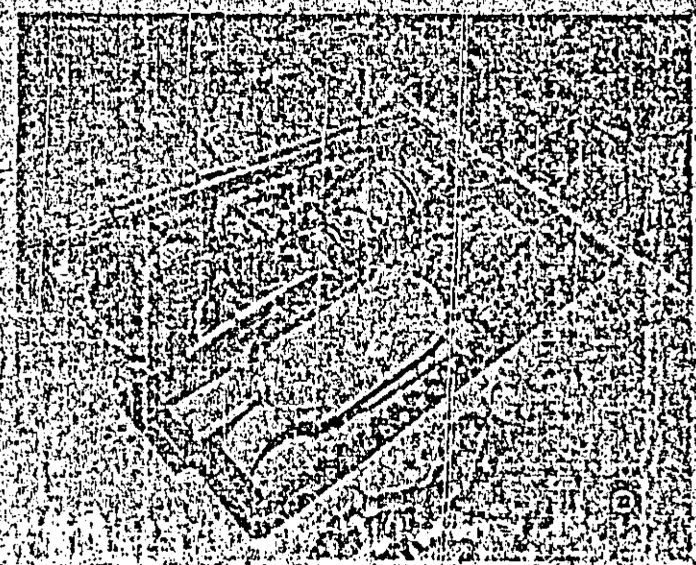
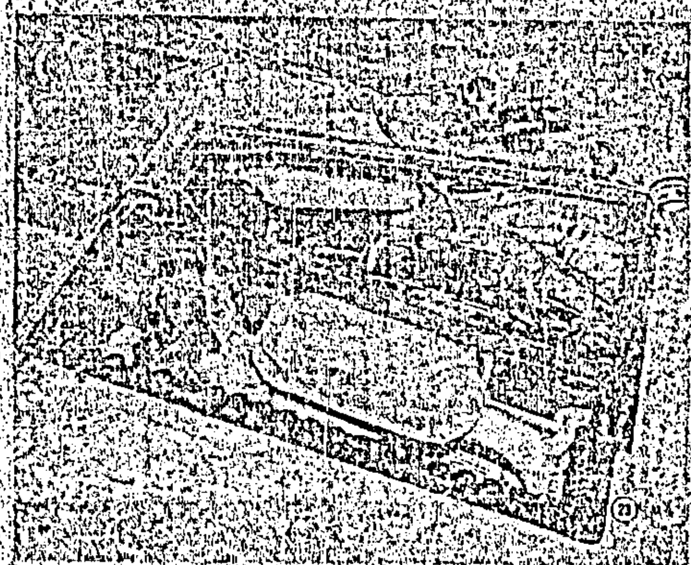
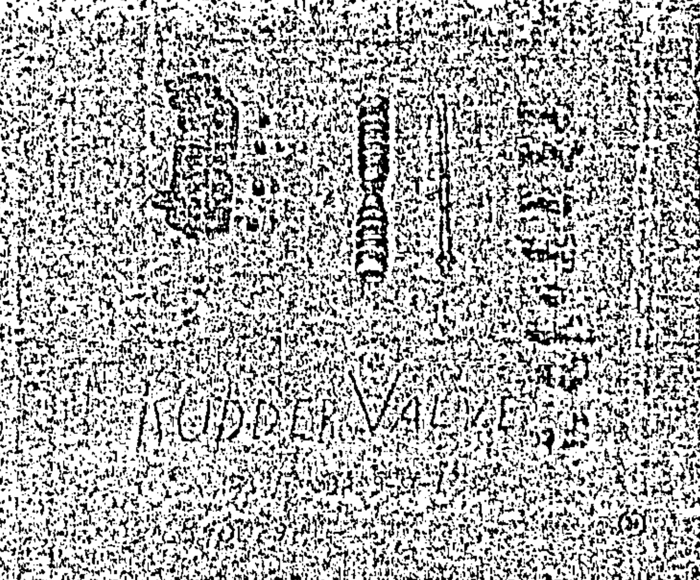
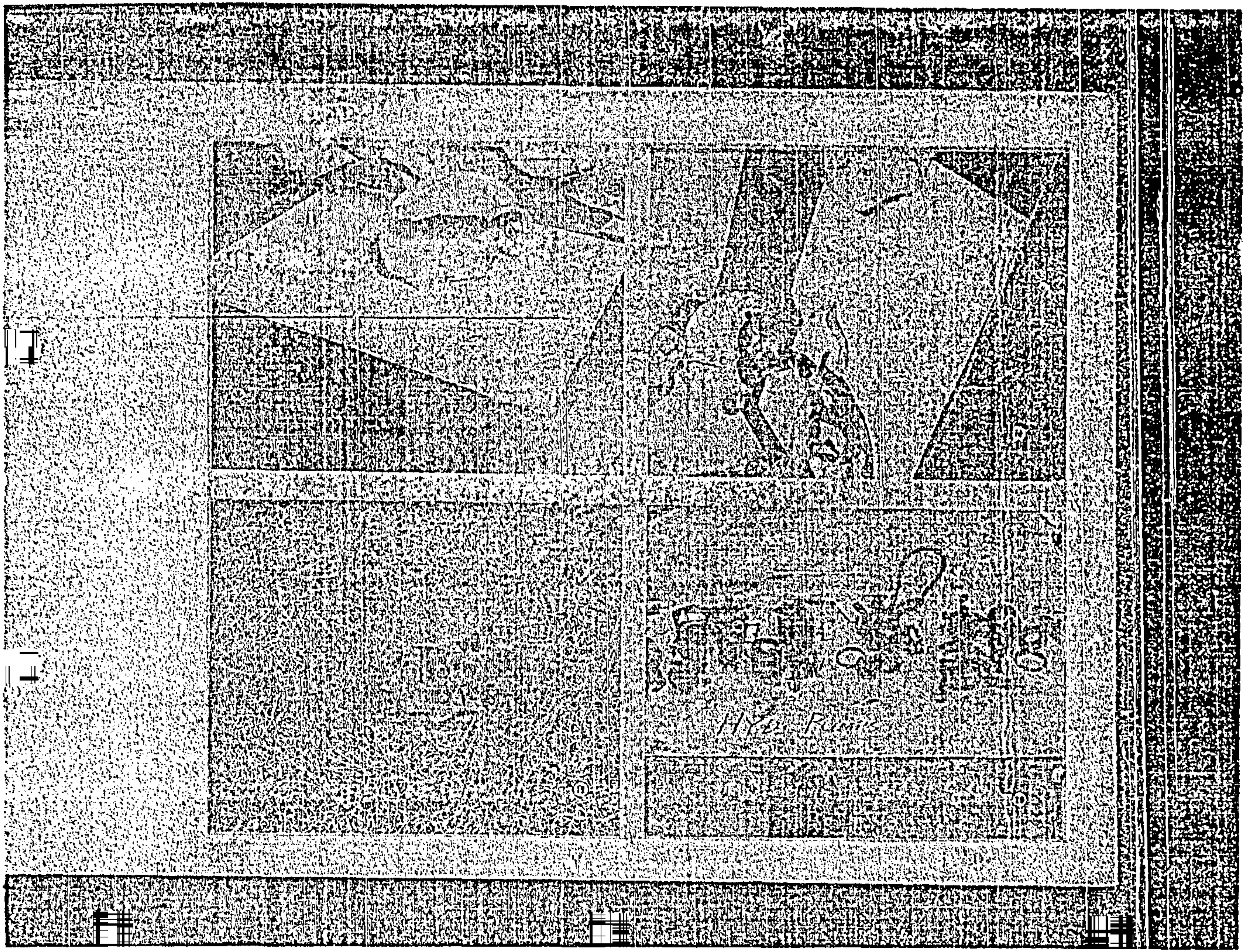

ENGINE #3

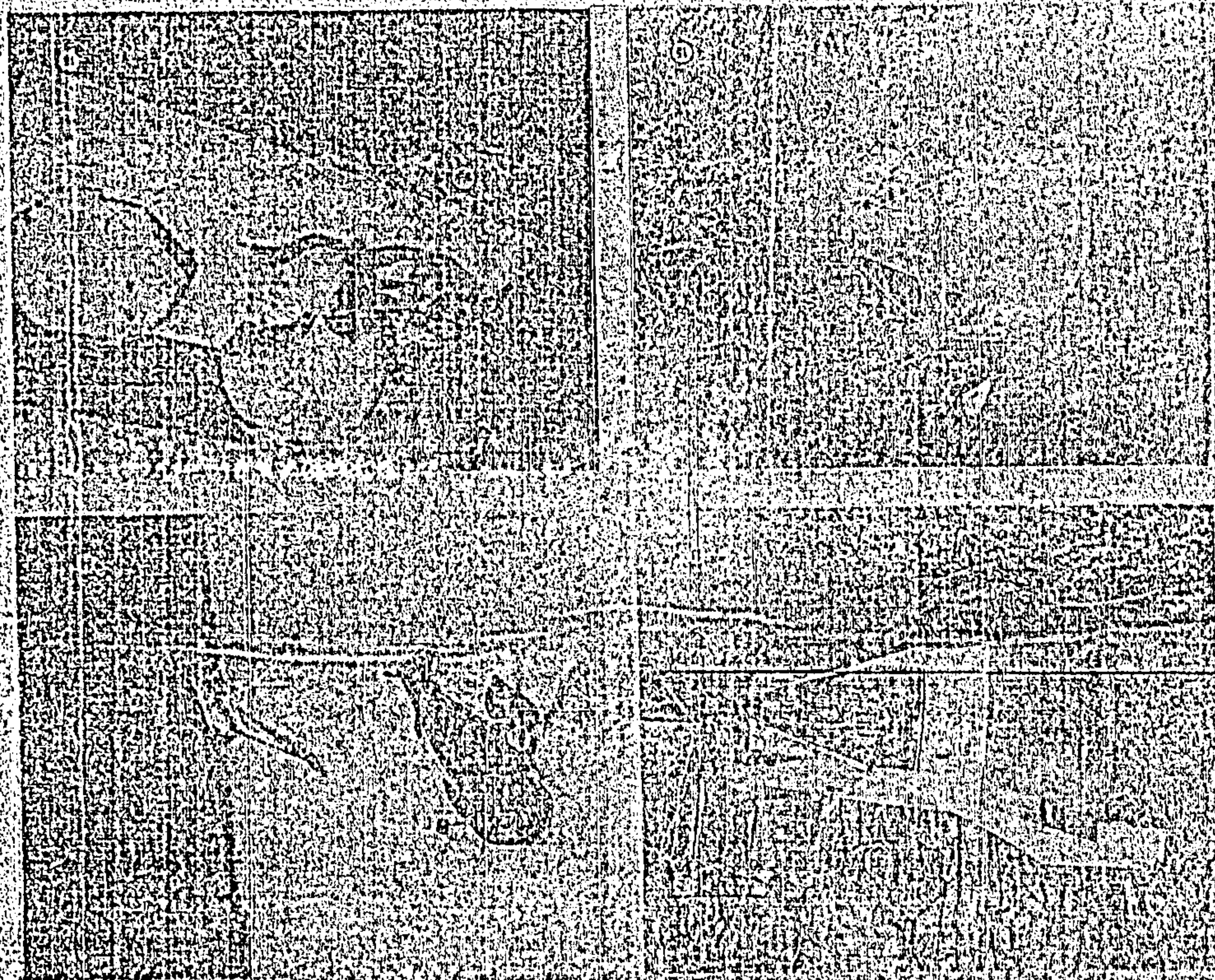

HYD PUMPS

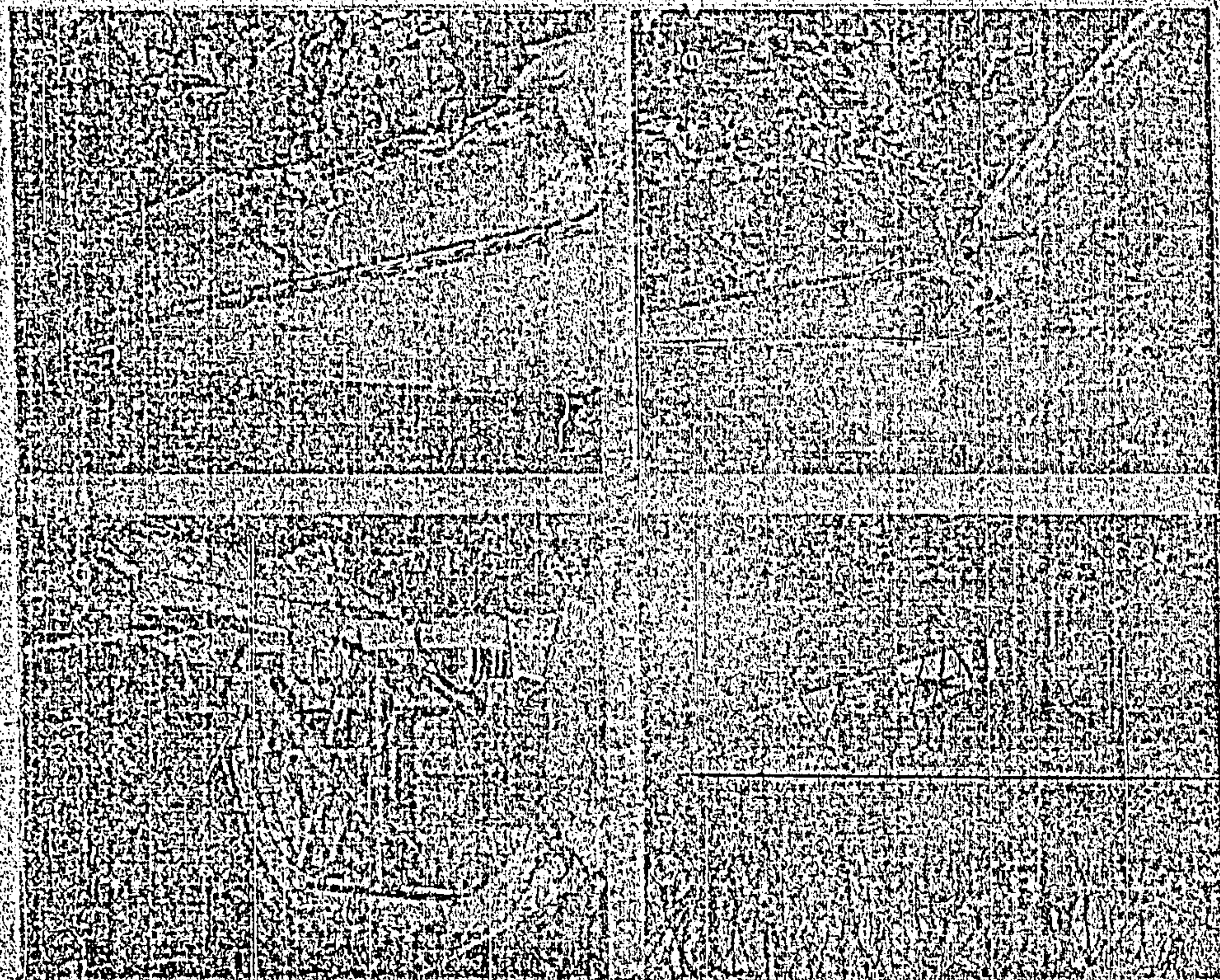


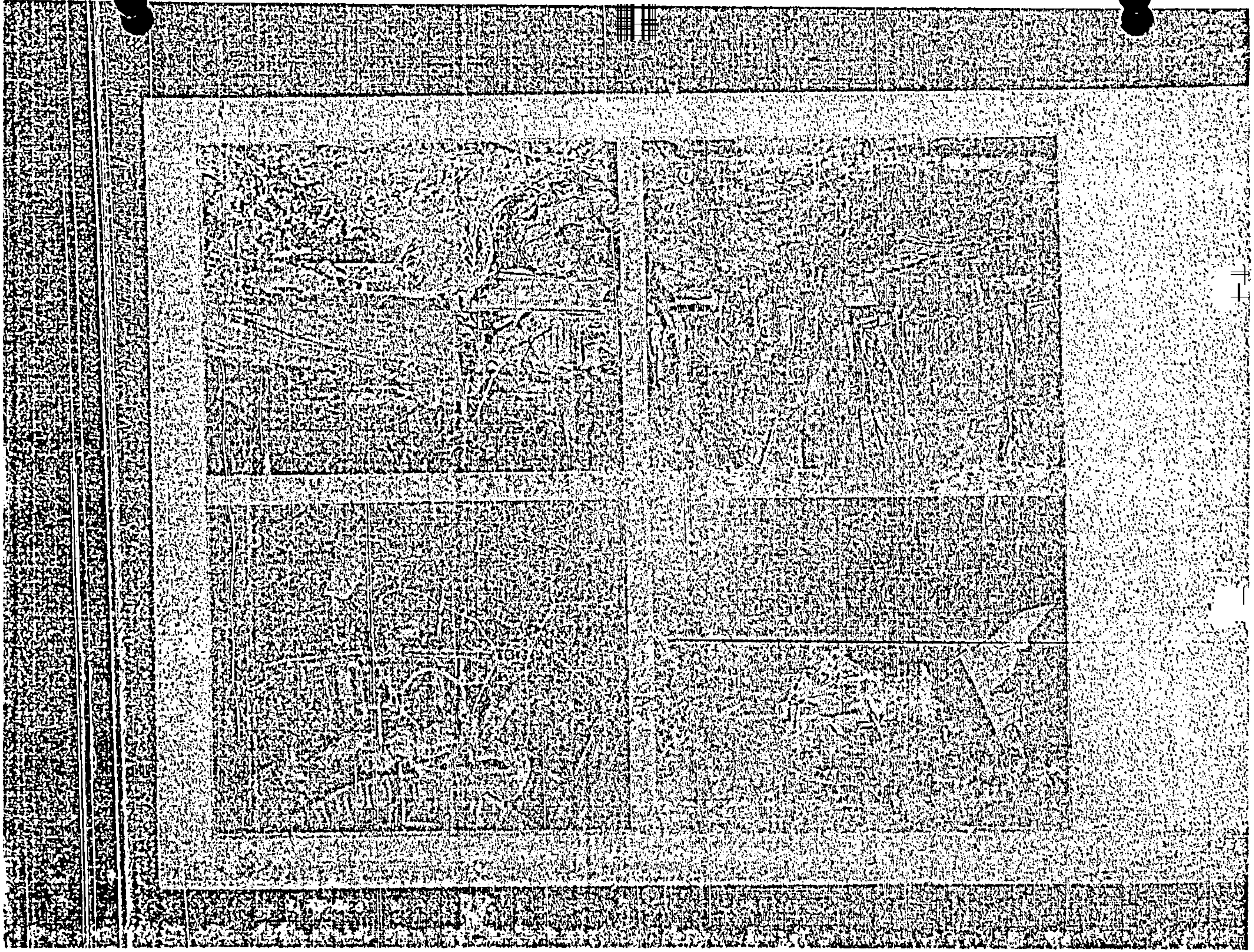


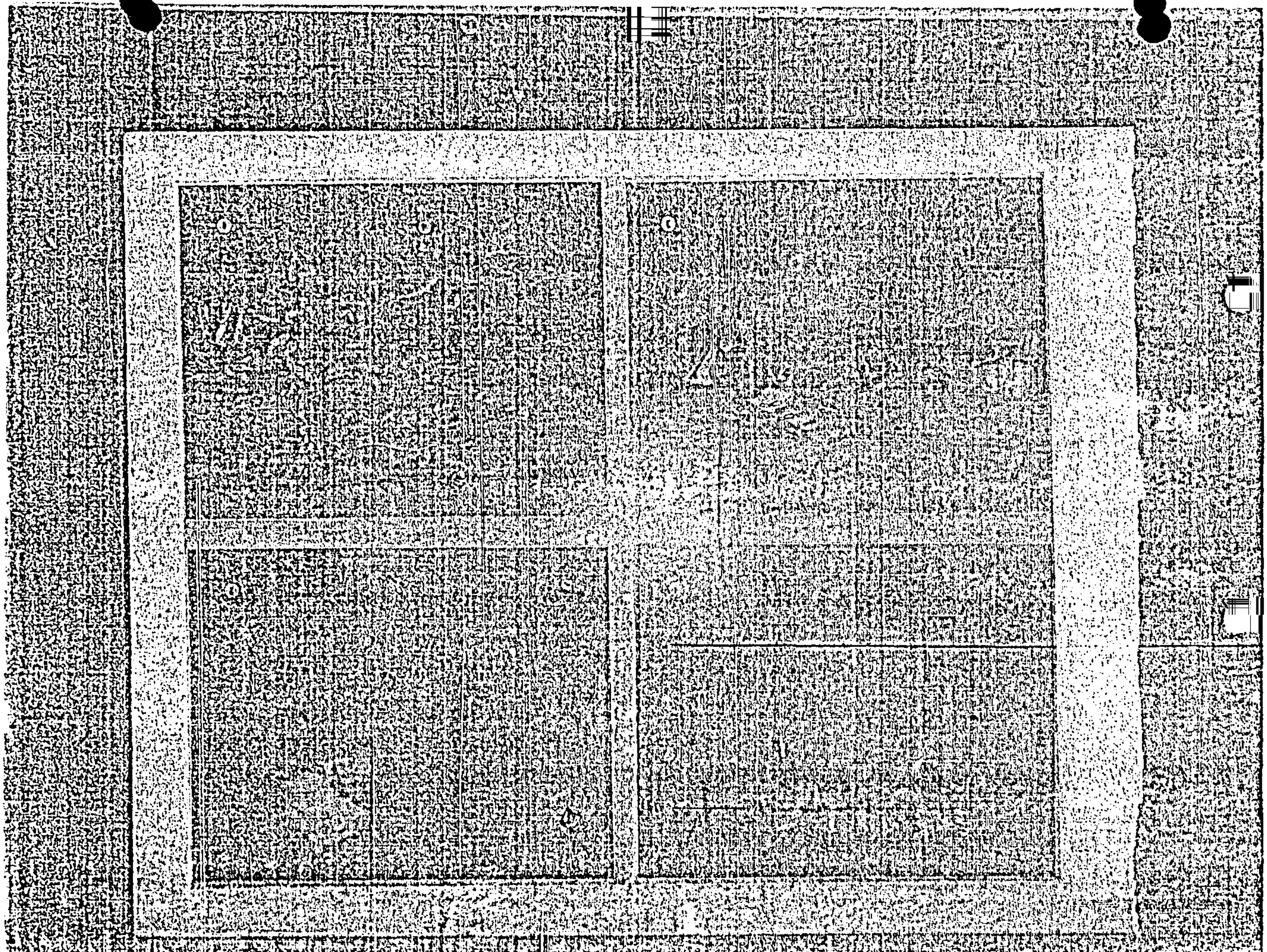

RUDDER VALVES











- CENTER SECTION

IE

A., LH.
ESERVOIR
EAD
RESERVOIR

L., 2nd STA.

1

HANISM T.T. NO. 2)

3
ER
NO. 3
L.
LAGE
RDER

, 15 FEET

STA 226

ENGINE

S HELMET

N, OKLA.

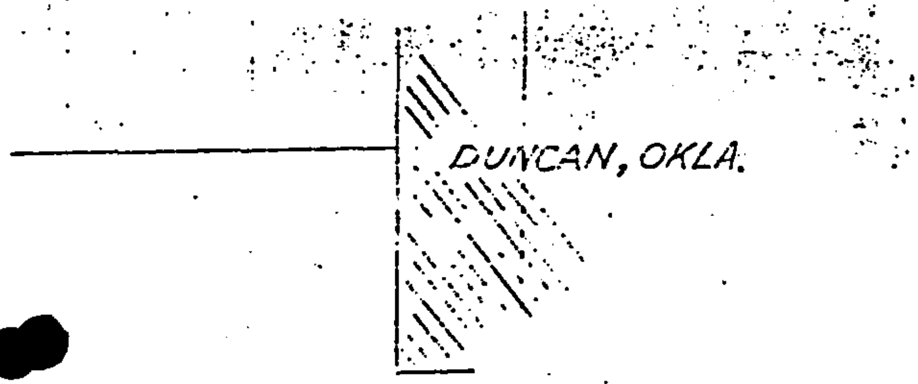
55.	4C	HARNESS
56.	4C	SPIKE, NO. 3
57.	4C	CANOPY, NO. 3
58.	4C	CANOPY, PILOT'S
59.	5C	RUDDER, LOWER
60.	5C	POD, AFT
61.	5C	WING SURFACE, UPPER
62.	5C	PARTS LIST "A"
63.	5C	NACELLE INLET NO. 1
64.	5C	ELEVON, LEFT OUTBD.
65.	5C	EXTERNAL RELEASE CANOPY NO. 3
66.	5C	PYLON, L.E. SECTION, NO. 3
67.	5C	LANDING GEAR CONTROL PANEL
68.	5C	WING, RIGHT, PART OF SURFACE
69.	5C	RESOLUTION SURFACE, RIGHT
70.	5C	POD BULKHEAD
71.	5C	WING TIP, RIGHT
72.	5C	LATCH, RIGHT, 2nd CANOPY
73.	5C	RUDDER SECTION
74.	5C	PART OF PANEL 385 & NO. 3 NACELLE, UPPER WING SURFACE W/INSIGNIA, LOWER WING SURFACE W/BOOST PUMP
75.	5C	SECTION, OUTBD, RIGHT OUTBD ELEVON
76.	5C	WING TRI., LOWER LEFT INBD
77.	5C	TAPE TRANSPORT NO. 2
78.	5C	IH1295 BOX (1 EACH)
79.	5C	RUDDER, CENTER
80.	5C	WING TRAILING EDGE, RIGHT, AFT NO. 4
81.	5C	THIRD INST. FUSE, R
82.	5C	BOTTLE, SMOKE
83.	5C	ELEVON, LEFT INTER., PORTION OF
84.	5C	RUDDER, TOP
85.	6C	PLUGS AND BRKT J102-1, 2, 3
86.	6C	PUMP, POD
87.	6C	COVER, TAPE TRANSPORT NO. 2
88.	6C	COVER, DATA PACKAGE
89.	6C	FUSE PANEL, RIGHT
90.	6C	HOUSING, NO. 3 SPIKE ACT.
91.	6C	RESOLUTION SURFACE, LEFT
92.	6C	WING, L.E., LEFT
93.	6C	INLET, NO. 1 ENGINE
94.	6C	FUSE PANEL, 3rd STA, LEFT
95.	6C	NO. 2 NACELLE HYDRAULIC INLET
96.	7C	SECOND STA, RIGHT SIDE AND RIGHT INTER ELEVON
97.	7C	WING ASSY, 4W3200A93
98.	8C	ITEMS LIST "B"
99.	8D	DRAG CHUTE
100.	9E	TAPE
101.	8C	DOME OF ENGINEER'S HELMET & LOBE OF PILOT'S HELMET
102.	8C	MISCELLANEOUS
103.	8C	ITEMS BROUGHT IN BY SALTZ
104.	10C	LINER, POD WARHEAD
105.	11C	LINER, POD WARHEAD
106.	12C	SKIN, INTER. WEDGE, LEFT ELEVON
107.	12D	TAPE NO. 1
108.	7A	DUCT, INLET NO. 3

WRECKAGE SCATTER DIAGRAM
STRUCTURES GROUP REPORT

YB/RB-58A SERIAL NO. 55-664A
INCIDENT 7 NOVEMBER 1959 NEAR LAWTON, OKLA.

PREPARED W.W. Wolcott	APPROVED
SCALE 2" = 1 MILE	DATE 11-20-59

1. 2A MAIN SITE: FUSELAGE — CENTER SECTION
2. 2A ENGINE NO. 2
3. 2A MLG, LEFT
4. 2A MLG, RIGHT
5. 2A ENGINE NO. 3
6. 2A ENGINE NO. 1
7. 2B PITOT TUBE
8. 2B NOSE BOOM
9. 2B BATTERY
10. 2B FUSELAGE — TAIL CONE
11. 3B FORWARD POD HOOK
12. 3B OXYGEN BOTTLE
13. 3B POWER SUPPLY, 3rd STA., LH
14. 3B UTILITY HYDRAULIC RESERVOIR
15. 3B PILOT AND 3.0 BULKHEAD
16. 3B PRIMARY HYDRAULIC RESERVOIR
17. 3B WIRE RECORDER
18. 3B MISCELLANEOUS INSTR., 2nd STA.
19. 3B WING, LEFT
20. 3B PUMPS, FUEL, AFT
21. 3B TAPE TRANSPORT NO. 1
22. 3B FED. POWER SUPPLY
23. 3B FUSELAGE — NOSE
24. 3B ACTUATOR, NLG.
25. 3B INST. TR.
26. 3B TAPE RECORDER (MECHANISM T.T. NO. 2)
27. 3B SPIKE AMPLIFIER
28. 3B TAPE TRANSPORT NO. 3
29. 3B PUMPS, FUEL TRANSFER
30. 3B RECORDER AMPLIFIER NO. 3
31. 3B MONITOR AND CONTROL
32. 3B RIGHT WING AND FUSELAGE
33. 3B MAGAZINE, WIRE RECORDER
34. 3B RECORDER, TAPE
35. 3C PILOT'S INSTRUMENT PANEL
36. 3C FIRE EXTINGUISHER
37. 3C POD, CENTER SECTION, 15 FEET
38. 3C DRAG STRUT
39. 3C TAIL GROUP
40. 3A RING, NO. 4 NACELLE, STA 226
41. 3A ENGINE NO. 4
42. 3A AFTERBURNER, NO. 4 ENGINE
43. 4B FORWARD OSC. RACK
44. 4B VIBRATOR AMPLIFIER
45. 4B SPIKE, NO. 4
46. 4B OSCILLATOR SCATTER
47. 4B CENTER PART, PILOT'S HELMET
48. 4C POD NOSE
49. 4C SUPER. OSC.
50. 4C FUSE PANEL
51. 4C SPIKE, NO. 1
52. 4C NO. 3 INTER INLET
53. 4C HARNESS
54. 4C ELEVON, LEFT INBD.
55. 4C HARNESS
56. 4C SPIKE, NO. 3
57. 4C CANOPY, NO. 3
58. 4C CANOPY, PILOT'S
59. 5C RUDDER, LOWER
60. 5C POD, AFT
61. 5C WING SURFACE, UPPER
62. 5C PARTS LIST "A"
63. 5C NACELLE INLET NO.
64. 5C ELEVON, LEFT OUTBD.
65. 5C EXTERNAL RELEASE CANOPY N
66. 5C PYLON, L.E. SECTION NO. 3
67. 5C LANDING GEAR CONTROL PANE
68. 5C WING, RIGHT, PART OF SURFACE
69. 5C RESOLUTION SURFACE, RIGHT
70. 5C POD BULKHEAD
71. 5C WING TIP, RIGHT
72. 5C LATCH, RIGHT, 2nd CANOPY
73. 5C RUDDER SECTION
74. 5C PART OF PANEL 385 & NO. 3 NA
W/INSIGNIA: LOWER WING SURFA
75. 5C SECTION, OUTBD, RIGHT OUTBD
76. 5C WING TRL, LOWER LEFT INBD
77. 5C TAPE TRANSPORT NO. 2
78. 5C IH1295 BOX (1 EACH)
79. 5C RUDDER, CENTER
80. 5C WING TRAILING EDGE, RIGHT, A
81. 5C THIRD INST. FUSE, R
82. 5C BOTTLE, SMOKE
83. 5C ELEVON, LEFT INTER. PORTIO
84. 5C RUDDER, TOP
85. 6C PLUGS AND BRKT. 102-1, 2, 3
86. 6C PUMP, POD
87. 6C COVER, TAPE TRANSPORT NO.
88. 6C COVER, DATA PACKAGE
89. 6C FUSE PANEL, RIGHT
90. 6C HOUSING, NO. 3 SPIKE ACT.
91. 6C RESOLUTION SURFACE, LEFT
92. 6C WING, L.E., LEFT
93. 6C INLET, NO. 1 ENGINE
94. 6C FUSE PANEL, 3rd STA, LEFT
95. 6C NO. 2 NACELLE HYDRAULIC INL
96. 7C SECOND STA, RIGHT SIDE AND R
97. 7C WING ASSY, 4W3200A93
98. 8C ITEMS LIST "B"
99. 8D DRAG CHUTE
100. 9E TAPE
101. 8C DOME, OF ENGINEER'S HELMET
102. 8C MISCELLANEOUS
103. 8C ITEMS BROUGHT IN BY SALTZ
104. 10C LINER, POD WARHEAD
105. 11C LINER, POD WARHEAD
106. 12C SKIN, INTER, WEDGE, LEFT ELE
107. 12D TAPE NO. 1
108. 7A DUCT, INLET NO. 3



WRECKAGE SCATTER D

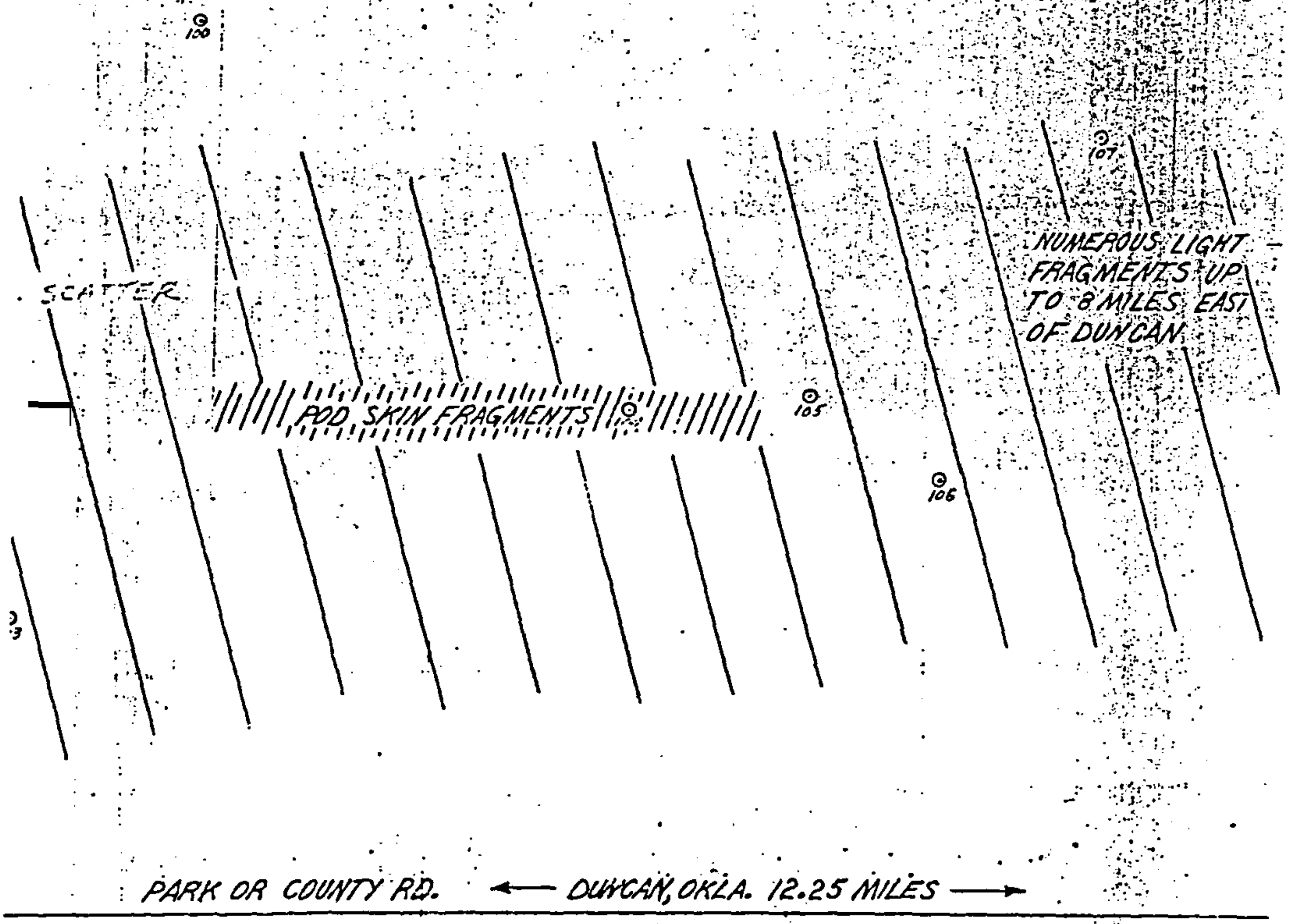
STRUCTURES GROUP RE

YB/RB-58A SERIAL NO

INCIDENT 7 NOVEMBER 1959 NEA

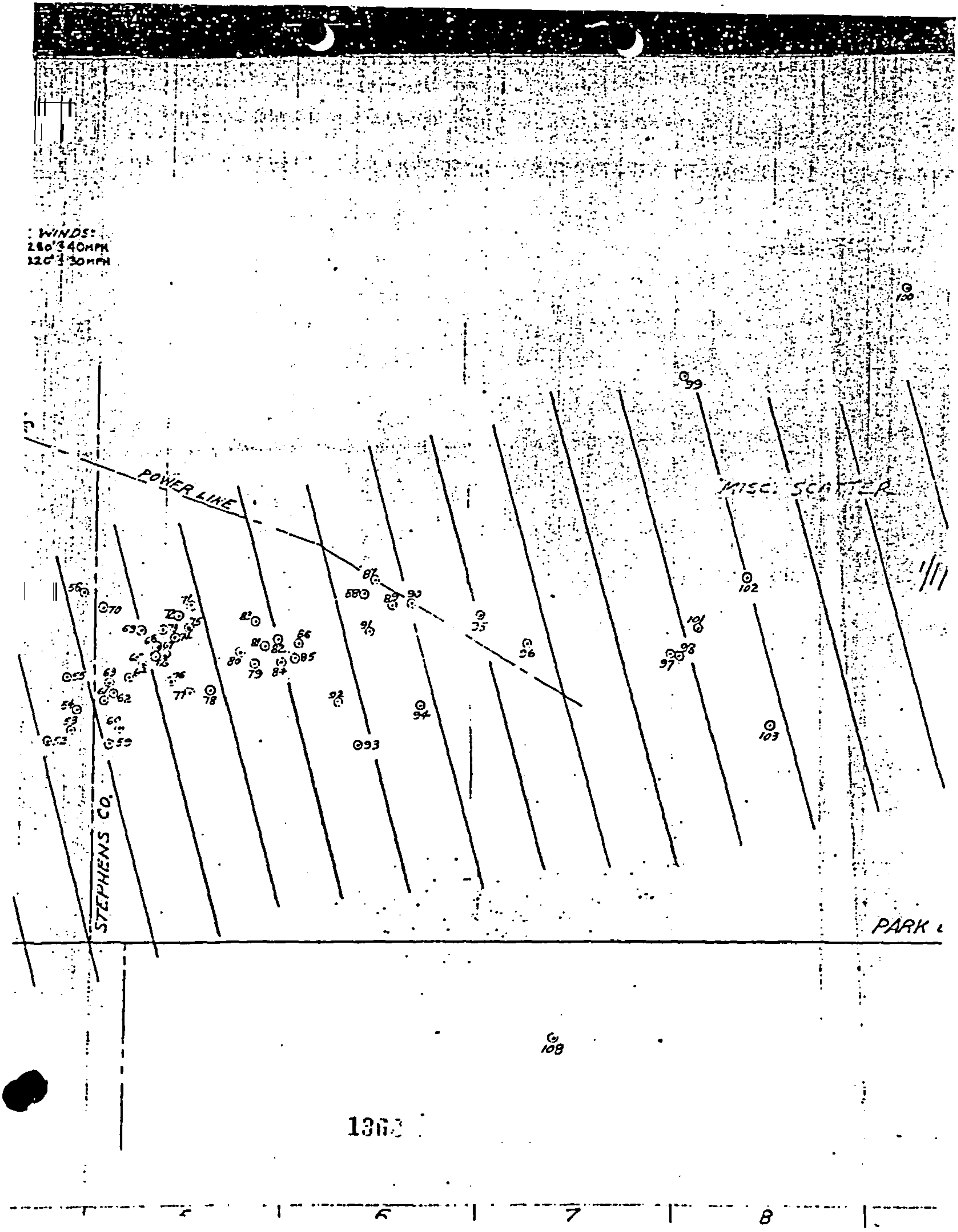
PREPARED A.W. Westcott	APPROVED
SCALE 2" = 1 MILE	DATE 11-2

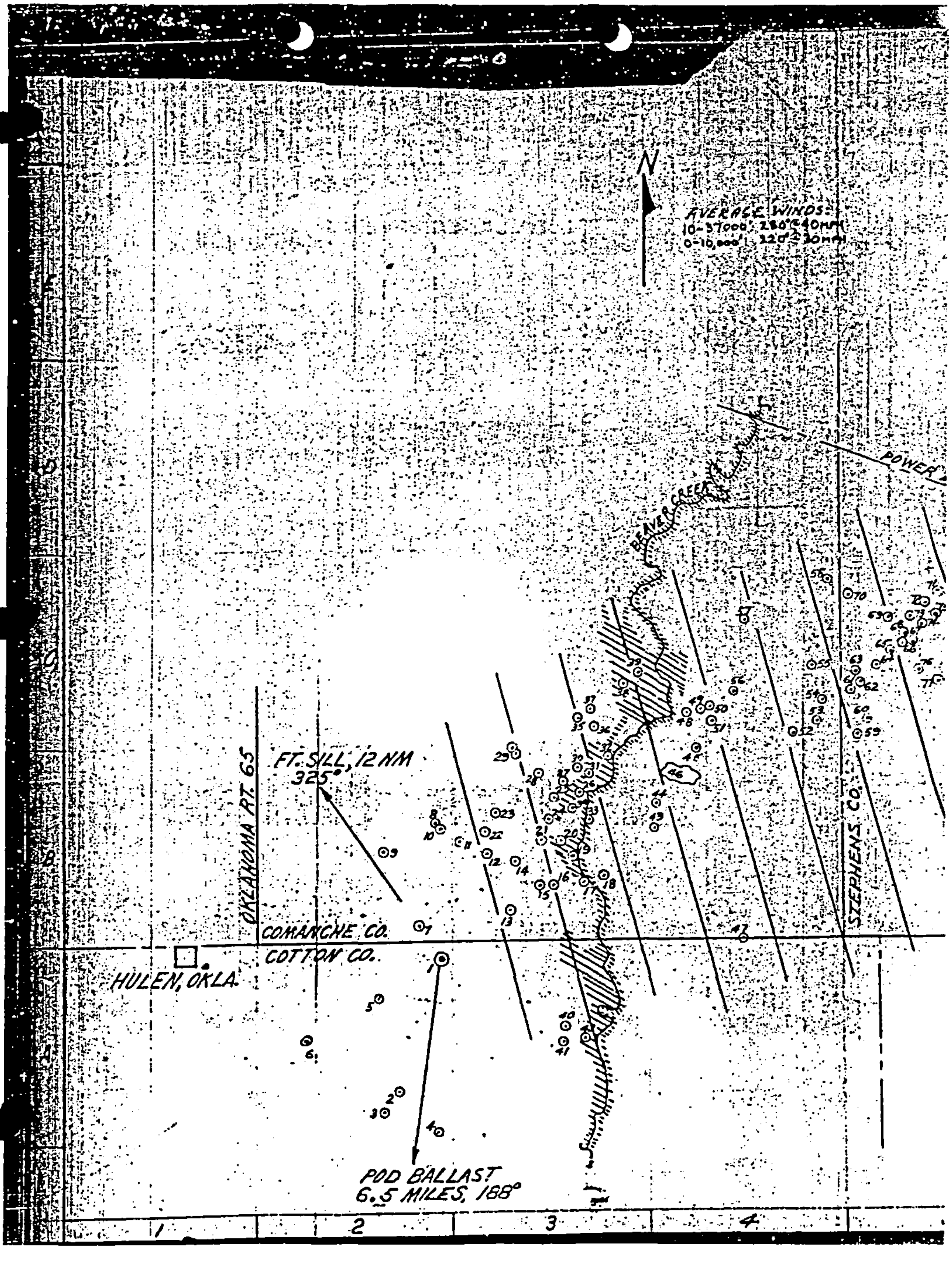
~~SPECIAL HANDLING REQUIRED~~
~~IAW PROVISIONS PARS 49 AND 52 AFR 62-14~~



1362

SPECIAL HANDLING REQUIRED
IAW PROVISIONS PARS 49 AND 52 AFR 62-14


WINDS:
POWER LINE
MISC. SCATTER
STEPHENS CO.
PARK
52 53 54 55 56 59 60 61 62 63 68 69 70 71 72 73 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 108
6 7 8


N
AVERAGE WINDS:
10-37000' 280° @ 40 MPH
0-10,000' 220° @ 30 MPH
POWER
BEAVER CREEK
OKLAHOMA RT. 65
FT. SILL, 12 NM
325°
COMANCHE CO.
COTTON CO.
HULEN, OKLA.
STEPHENS CO.
POD BALLAST
6.5 MILES, 188°
1
2
3
4

53 Left Hand Door Showing Forward Direction of Tear
54 From Nose Wheel Door Hook, Right Side
55 Left Side Skin Moving Forward in Nose Wheel Area
56 Relative Rotation at Lower Right Longeron Forward Bulkhead No. 3
57 Lower Right Longeron Forward of Bulkhead No. 3
58 General Static Test Set Up for No. 3 Inlet Cowl
59 Static Test Failure of Inboard Cowl - Nacelle Fitting at 133% DUL (Equivalent Sideslip angle of 35°)
60 Structural Reconstruction of Aircraft 55-664

PHOTO INDEX

1 Earliest Photo of Fall-out
2 Later and Different Angle of Fall-out
3 Nose Gear and Forward Section Fuselage
4 Bottom Portion Fuselage and Parts of Wing
5 3rd Station Ejection System Parts
6 1st Station Canopy
7 Right Wing and Part of Fuselage
8 Left Wing, Bottom Side Up
9 Vertical Fin and Fuselage
10 Fuselage at No. 14 Break-up Point
11 Upper End of Fin - Showing Rudder Gear
12 Fin Spar
13 Bottom View of Tail Section
14 Tail - Aft Fuselage Assembly
15 1st Station Canopy
16 Flight Engineers Helmet
17 Flight Engineers Helmet
18 Pilots Helmet
19 Air Conditioning Control Panel
20 Hydraulic Pumps
21 Hydraulic Pumps
22 L. H. Refrigeration Unit
23 R. H. Refrigeration Unit
24 Rudder Control Valve
25 Rudder Actuators
26 No. 3 Engine Compressor
27 Turbine Wheels
28 No. 3 Engine Front Frame Reconstructed
29 No. 3 Engine Front Frame
30 Object Found in Combustion Section of No. 3 Engine Compared with Inlet Guide Vane Journal
31 No. 3 Engine Front Frame
32 No. 3 Engine Front Stage Turbine Nozzle
33 No. 3 Engine Combustion Liner and Turbine Wheels
34 Fuel System Parts Showing Collapsed Liner
35 Constant Speed Drive Shaft Inner Body Forward End
36 Constant Speed Drive Shaft Inner Body Aft End
37 Constant Speed Drive Shaft Inner Body Forward End
38 No. 4 Spike Fitted into Gash in No. 3 Spike
39 No. 4 Spike Fitted into Gash in No. 3 Spike
40 No. 4 Spike Fitted into Gash in No. 3 Spike
41 Diagonal Tension Wrinkler Right
42 Rear Connection Pod to Fuselage
43 3rd Station Canopy
44 Static Test Failure of Inboard Cowl - Nacelle Fitting at 133% DUL (Equivalent Sideslip Angle of 35°)
45 Lower Rudder Ram Actuator Rod Failure
46 Fatigue Area Nose Gear Right Journal
47 Mating of Hook with Rear Right Roller
48 Brinnell Mark Aft Hook Right Side Nose Door
49 Failed Trunnion Boss with Trunnion Pin
50 No. 3 Inlet Cowl - Nacelle Attaching Fitting
51 Lower Right Fuselage Longeron Forward at Bulkhead No. 3
52 Burned Area of Part of Left Door

LOCAL FLIGHT CLEARANCE

STATION		DATE
CONVAIR FLIGHT OPERATIONS FORT WORTH, TEXAS		11/7/59
TYPE A/C	A/C NO.	MISSION
B-58A	55-664	Experimental

DUTY SYMBOL	NAME AND INITIALS	RANK OR GRADE	SERIAL NO.	HOME STATION
P	Fitzgerald R.	CW	—	FWH
FE	Seehof D.	✓	—	✓

(List additional passengers on reverse side)

ETD	ETE (Hours mins)	HOURS OF FUEL	AUXILIARY BASE OF 1ST INTENDED LANDING
1620 / 1515	2+40	3+40	FWH

FORM 175 FILED AT	DATE FILED (Day, month, year)
1510 FWH	11/7/59

WEATHER IS FORECAST TO REMAIN VFR FOR THE DURATION OF THIS FLIGHT. I CERTIFY THAT I AM FAMILIAR WITH LOCAL AND AIR FORCE REGULATIONS AFFECTING THIS FLIGHT AND THAT THIS FLIGHT WILL BE CONDUCTED IN ACCORDANCE WITH SUCH REGULATIONS.

CLEARANCE AUTHORITY	PILOT'S SIGNATURE
C. E. Esterline	R. Fitzgerald
ACTUAL DEPARTURE	ACTUAL ARRIVAL

REMARKS:
FWH - ICT - HBR - JCT - SPS - ICT - HBR - JCT - COT - MFA - FWH.
Operating 21,000 to 37,000

C O N V A I R
Fort Worth Division

B-58 AIRCRAFT FLIGHT RELEASE

ORIGINAL [ ] RE-RELEASE [XXX] MODIFIED [ ] TURN AROUND [ ]

This aircraft # B-58 #5, A.F. # 55-661, has been inspected to applicable requirements and is safe in all respects for flight # 42, A.F. # —.

NOTE: Field Operations will accomplish the following operations upon request of pilot.

1. Remove pitot covers.
2. Remove ground wires and canopy covers.
3. Remove engine air inlet covers.
4. Remove tail pipe covers.
5. Remove all landing gear locks.
6. Remove pod ground lock pins.

FUEL IN TANKS IN LBS.		C.G. SYSTEM INPUT DATA		OIL IN TANKS IN QTS.	
FWD WING TANK	23,500			NO. 1 ENGINE TANK	16
RESERVOIR TANK	0	UL	NA	NO. 2 ENGINE TANK	16
AFT WING TANK	34,900	UC	NA	NO. 3 ENGINE TANK	16
AUX. OR BALANCE TANK	5,500	UR	NA	NO. 4 ENGINE TANK	16
FWD POD TANK	8,200	LL	NA	TOTAL	64
AFT POD TANK	7,900	LC	NA		
TOTAL	80,000	LR	NA		

TIRES INFLATED: 1315 TIME 11-7-59 DATE

BASIC WT: 65,200 GROSS WT: 147,000 C.G. 28.2%

THIS RELEASE EXPIRES AT: TIME: 0155 DATE: 11-9-59 (84) HRS EXPIRES: 11-11-59 0155
DATE / TIME

REMARKS: The following areas are temporarily closed and sealed: (1) PCLA Area; (2) Fuselage void doors, upper L/R. Instrumentation fuses installed in accordance with instrumentation pre-flight. (40) amp ignition emergency power fuse installed backwards. See carry-over FCRs. Routine action T.O. 1B-58-533 N/C/W.

RELEASING CVAC INSPECTOR: [signature] TIME: 1355 DATE: 11-7-59

NOTE: APPROVAL OF THIS FLIGHT RELEASE INDICATES ONLY THAT THE CONTRACTOR'S INSPECTION RECORDS SUPPORTING THIS RELEASE HAVE BEEN REVIEWED AND SUCH RECORDS INDICATE THAT ALL NECESSARY WORK HAS BEEN ACCOMPLISHED OR SATISFACTORILY DISPOSITIONED.

A.F.Q.C. INSPECTOR: [signature] TIME: 1405 DATE: 11/7/59

ACCEPTING FLIGHT CREW MEMBER: [signature] TIME: 1410 DATE: 11/7/59

RECEIVED BY FLIGHT DISPATCH AT: TIME: 1406 DATE: 11-7-59 DISPATCHER: [signature]

FLIGHT RELEASE RETURNED TO INSPECTION TO ACCOMPLISH FCR OR IDRO
DISPATCHER:
TIME: DATE:

THE FOLLOWING FCR OR IDRO IS COMPLETE AND RELEASE RETURNED TO FLIGHT OFFICE	DATE	TIME
CVAC INSP.		
A.F. INSP:		

a7 7et 6079

FLIGHT CREW'S QUALIFICATION AND EXPERIENCE RECORD

DATE: 30 Jan 1959

APPROVAL IS REQUESTED FOR: [ ] FLIGHT ENGINEER [ ] RADIO OPERATOR [X] OTHERS (Specify) Observer

CONTRACTOR REPRESENTED: CONVAIR-Fort Worth Division
LOCATION: Fort Worth, Texas

TYPE, MODEL, AND SERIES OF AIRCRAFT TO BE CREWED: B-58
PLACE OF FLIGHTS OR SERIES OF FLIGHTS: Continental USA

PURPOSE OF AND REASON FOR FLIGHT:
Request approval for D.A. Siedhof to fly as an observer on above listed aircraft in support of contracts:
AF33(038)-21250, AF33(600)-32841, AF33(600)-36200

NAME: D. A. Siedhof
CITIZENSHIP: USA

ADDRESS (Number and Street): 3821 Winfield
CITY: Fort Worth
ZONE:
STATE: Texas

MECHANICS CERTIFICATE NR:
CLASS:
EXPIRATION DATE:

RADIO TELEPHONE LICENSE NR:
CLASS:
DATE OF ORIGINAL LICENSE:

RADIO TELEGRAPH LICENSE NR:
CLASS:
DATE OF ORIGINAL LICENSE:

PLACE OF LAST PHYSICAL EXAMINATION: Fort Worth, Texas - Dr. Z. N. Gaut
DATE: 21 Jan 1959

FLIGHTS ARE TO BE CONDUCTED ABOVE 35,000 FT [X] YES [ ] NO (Check One)
IF YES, GIVE DATE OF LAST PRESSURE OXYGEN BREATHING INDOCTRINATION: CAFB, Texas
DATE: 30 Jan 1957

TOTAL FLYING TIME (HOURS)

ENGINEER	RADIO OPERATOR	OTHER (Specify)	OTHER (Specify)
			Observer 30:15

TYPES OF MILITARY AND CIVILIAN AIRCRAFT FLOWN

ENGINEER TYPE	HOURS	DATE LAST FLOWN	Observer CREW MEMBER TYPE	HOURS	DATE LAST FLOWN
			B-36	12:00	Feb 1957
			F-94C	2:20	Oct 1957
			B-58	15:55	Jan 1959

BRANCH OF SERVICE OR CIVILIAN ORGANIZATION WHERE EXPERIENCE WAS OBTAINED: CONVAIR - Fort Worth Division

MECHANICAL EDUCATION

NAME OF SCHOOL:
NR HOURS ATTENDED:
HOURS OR MONTHS OF TRAINING: PLANE / ENGINE / INST
CITY AND STATE:
YEAR GRADUATED:

RADIO EDUCATION

NAME OF SCHOOL:
NR HOURS ATTENDED:
CITY AND STATE:
YEAR GRADUATED:

TYPED NAME AND TITLE OF REQUESTING OFFICIAL: B. A. Erickson, Manager of Flight
TYPED NAME, GRADE AND TITLE OF APPROVING OFFICIAL: Leonard R. Hall, Col., AF Plant Rep.

REQUESTING OFFICIAL (Signature and Date): B. A. Erickson
APPROVING OFFICIAL (Signature and Date): 4 Feb 1959

AMC FORM 17 MAY 55 32A — PREVIOUS EDITIONS OF THIS FORM MAY BE USED — AF-WP-O-22 MAR 56 27M

6-7-7-1

AIR FORCE APPROVAL OF CONTRACTOR'S PILOT

DATE: 9 Jun 1959

Budget Bureau No. 21-R118.1
Expires 30 Apr 1959

1. NAME OF PILOT (Last, First and MI)	2. ADDRESS OF PILOT (No., St., City, Zone and State)	3. DATE OF BIRTH
Fitzgerald, Raymond (NM)	4429, Tamworth Road Fort Worth, Texas	1 Jul 1925

4. PILOT'S PHYSICAL EXAMINATION

A. CLASS OF EXAMINATION	B. NAME OF EXAMINER	C. DATE AND PLACE OF EXAMINATION
First	Dr. Z. N. Gaut, M.D.	9 Jun 1959 Convair

5. CAA PILOT CERTIFICATE (Number, Date, Privileges and Ratings)	6. NAME AND ADDRESS OF CONTRACTOR REPRESENTED
525736 Oct 22 1945 Single & Multi-Engine Land and Instrument	CONVAIR Fort Worth, Texas

7. TYPE, MODEL AND SERIES OF AIRCRAFT TO BE FLOWN	8. CAPACITY (Check One)
B-58	☐ PILOT ☐ CO-PILOT ☒ INSTRUCTOR PILOT

9. PURPOSE OF PILOT APPROVAL AND CONTRACT TO WHICH APPROVAL APPLIES

☒ ENGINEERING/EXPERIMENTAL PILOT ☐ SERVICE PILOT
☒ PRODUCTION ACCEPTANCE PILOT ☐ OTHER (Specify in Detail)

CONTRACT NUMBER AND EXPIRATION DATE

AF33(038)-21250, AF33(600)-32841, AF33(600)-37532, AF33(600)-32517, AF33(600)-36200.

10. ALTITUDE AT WHICH FLIGHTS ARE TO BE CONDUCTED (Check One or More)	11. INDOCTRINATION (Reference Item 10) (If B is checked, give date and place of last physiological/altitude indoctrination. If C is checked, give date and place of last pressure suit and physiological/altitude indoctrination.)
☐ A. BELOW 10,000 FEET ☐ B. ABOVE 10,000 FEET ☒ C. ABOVE 45,000 FEET	16 Jul 1957 W-P AFB, Ohio

12. FLYING HOURS AND PILOT EXPERIENCE (List jet aircraft first, conventional and then all others. Indicate Instructor Pilot time by an asterisk*)

A. TOTAL FLYING HOURS LAST SIX MONTHS (Additional hours may be listed on a separate sheet)

TYPE, MODEL AND SERIES AIRCRAFT	PILOT	CO-PILOT	1ST PILOT NIGHT	1ST PILOT WEATHER	HOOD
B-58	104:15	-	1:15		
F-101	6:25		-		
TF-102	4:20				
F-104	10:05				
TOTAL FOR 6 MONTHS	125:05		1:15	-	

B. TOTAL FLYING HOURS FOR 4½ YEARS PREVIOUS TO THE TIME LISTED IN ITEM (A) (Additional hours may be listed on a separate sheet)

TYPE, MODEL AND SERIES AIRCRAFT	PILOT	CO-PILOT	1ST PILOT NIGHT	1ST PILOT WEATHER	HOOD
B-58	130:05				
F-101	103:10		3:30		
F-104	18:15			*0:30	
F/TF-102	153:30	1:25	2:20	3:0	1:0
F-94	35:25				
RF84F.	47:50				
F-89	7:30				
B-47	71:05	8:50	6:15		11:25
T-33	20:15	4:05			
B-29		1:50			
L-23	0:30				
C-45	99:20		29:40	8:0	
B-36	511:40		27:30	17:20	1:0
B-50.	60:55				
C-54	130:10		8:05	9:15	
Aero Comd.	23:40		10:50	0:30	
Stinson	4:15				
PQ-14	4:10				
TOTAL FOR 4½ YEARS	1410:05	16:10	88:10	32:35	13:25

C. TOTAL FLYING HOURS PRIOR TO TIME LISTED IN ITEMS A AND B (If any flying time is deemed to be of significant value, list on a separate sheet by hours, type, model, series and date last flown.) (F-80, B-36, etc.)

FIGHTER	BOMBER	CARGO
760:00	2498:30	1685:30
LIAISON	HELICOPTER	OTHER
10:30		

D. BRANCH OF SERVICE OR CIVILIAN ORGANIZATION WHERE MAJORITY OF PILOT EXPERIENCE WAS OBTAINED

USAF, American Overseas Airlines, Convair

E. NAME OF INSTRUCTOR PILOT WHO GAVE LAST PROFICIENCY CHECK, DATE OF CHECK AND/OR SCHOOL ATTENDED AND DATE ATTENDED.

B. A. Erickson 28 Sep 1957

13A. TYPED NAME AND TITLE OF CONTRACTOR'S REQUESTING OFL	13B. REQUESTING OFFICIAL (Signature and Date)
B. A. Erickson Manager of Flight	10 Jun 59
14A. TYPED NAME AND TITLE OF CONTRACTOR'S APPROVING OFL	14B. APPROVING OFFICIAL (Signature and Date)
B. A. Erickson Manager of Flight	10 Jun 59
15A. TYPED NAME AND TITLE OF AIR FORCE APPROVING OFL	15B. AIR FORCE APPROVING OFFICIAL (Signature and Date)
Leonard R. Hall, Col., USAF AF Plant Representative	L. R. Hall 12 June 59

AMC FORM MAY 57 32 AF-WP-O-3 JUN 57 75M PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

4/13/60

50th Anniversary of the Air Force Flight Test Center

THIS WEEK IN HISTORY...

Edwards Air Force Base

60s

APRIL 13, 1960

To commemorate the 50th Anniversary of the Air Force Flight Test Center, which was established June 25, 1951, the AFFTC History Office will recall some of the milestones in flight that took place here during the last half century. These articles will appear on a weekly basis throughout the year 2001.

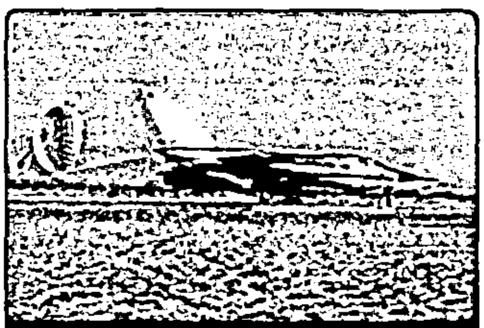
The Day the Rubber Met the Ramp

By Dr. Raymond L. Puffer
Air Force Flight Center historian


When conducting heavyweight takeoff tests on the B-58, pilot Maj. Fitzhugh L. "Fitz" Fulton had to jettison the plane's large fuel-and-weapon pod in flight in order to bring him and his crew down safely

One day just 41 years ago — on April 13,1960 — an Air Force Flight Test Center test pilot experienced the other side of evaluating high performance aircraft for the nation's warfighters. On that spring morning, Maj. Fitzhugh L. "Fitz" Fulton was conducting three-engine heavyweight takeoff tests on the B-58 *Hustler.*

The supersonic bomber's revolutionary design and its four J79 engines gave it dazzling performance in the air but, as always, this came at the price of some tradeoffs in design. In order for the *Hustler*'s landing gear to fit into the thin delta wing, it had been necessary to design a complex wheel arrangement. The four wheels of each main gear were divided into two sets with an axle for each set. Thus eight tires, four wheels, and four high capacity disc brakes were mounted on each main landing gear. The tires were small, and had a very high rotational rate at takeoff speeds that provided only a small margin of overload capacity.


Maj. "Fitz" Fulton landed the crippled B-58 on a heavily foamed runway.

On the flight in question, Fulton reached his go/no go decision speed of 153 knots and, following the flight plan, shut down the number 4 engine. One of the main tires promptly exploded, leading to a chain reaction where six of the other tires on the same side failed in rapid sequence. Several of the wheels disintegrated and debris ruptured one of the bomber's two hydraulic systems, making it impossible to raise the landing gear. Fulton had no choice but to continue his takeoff and then see if some procedure could be devised to get him and his crew safely back on the ground.

The only other B-58 pilot on the base that day was Maj. Charlie Bock... who was just getting ready to take off in a B-52 carrier aircraft for the launch of Maj. Bob White's first flight in the X-15. Instead of taking off in the B-52, Bock quickly jumped into an F-100 and went up to assess the situation.

Fulton and his crew elected to remain with the aircraft and to bring it back home. In order to make a safe landing, he would have to jettison the B-58's large fuel-and-weapon pod in flight, which had never before been tried with the landing gear down. After burning off fuel for three hours, he made a successful drop — which also turned out to be the last time that feat was accomplished. He then jettisoned the two rear canopies and proceeded to land on a heavily foamed runway. Coming to a stop, he and his crewmembers exited the aircraft in very short order.

An AFFTC firefighter sprays foam on the burning tires of the B-58 after "Fitz" Fulton safely landed the plane

Though a small fire ensued, there were no injuries to the crew and Fulton later shrugged the incident off as "Just another day at Edwards." In the meantime another pilot had replaced Bock in the B-52 and White's X-15 launch went off without a hitch. The following year, White went on to take the X-15 not only to its design limits but also slightly beyond; he became the first human to fly an airplane beyond Mach 4.0, Mach 5.0 and Mach 6.0. Fulton retired from the Air Force in 1966 as chief of Bomber/Transport Test Ops Division and moved north along Forbes Avenue to NASA. He eventually became chief test pilot at the Dryden Flight Research Facility, became project pilot on the YF-12A and YF-12C programs, and flew NASA's 747 Shuttle Recovery Aircraft.

As for the B-58: The incident on April 13, plus two similar events involving operational planes, made it obvious that some means was necessary to provide for safe handling in the event of future tire failures. Accordingly, a non-frangible wheel was developed for the Hustler; a solid metal disc or flange in the center of each dual tire rim that would support the aircraft after a tire blew and allow the wheel to continue to rotate. Fulton tested the new arrangement later that year; his last sortie of the test series was the only solo B-58 flight ever made. The new "third tire" arrangement worked successfully and was retrofitted to all operational B-58s where it subsequently saved several aircraft. As "Fitz" put it later: "Everything worked out fine."

Previous week Following week