

NTSB Analyzes Crash in Virgin Islands

(Following is the first part of a report by the National Transportation Safety Board on the Sept. 2, 1978, crash of an Antilles Air Boats Grumman G21A while on a flight from St. Croix to St. Thomas, Virgin Islands. The crash killed the captain and three passengers. The report will be continued in a subsequent issue.)

Synopsis

About 1021 AST on Sept. 2, 1978, an Antilles Air Boats, Inc., Grumman G21A, operating as Flight 941, crashed while on a passenger flight from St. Croix to St. Thomas, Virgin Islands. The plane crashed after the left engine failed and level flight could not be maintained with one engine.

The captain attempted to fly the aircraft in ground effect, about 20 to 50 ft. above the surface of the water.

The aircraft struck the water when single-engine flight could not be maintained even in ground effect, cartwheeled around the left wing, and broke apart. The captain and three of the 10 passengers were killed, and the aircraft was destroyed.

The National Transportation Safety Board determines that the probable cause of the accident was the inability of the aircraft to sustain single-engine flight and the captain's decision to attempt to fly the aircraft in ground effect rather than attempt an open sea emergency landing. Single-engine flight was not possible at any altitude because of the drag induced by the loss of the engine cowl, the decreased efficiency of the improperly maintained right propeller and the overgrossed condition which resulted from a deficient FAA supplemental type certificate.

Personnel Information

Capt. Charles F. Blair, 69, was the president of Antilles Air Boats, Inc., and had been flying as a line captain since the company was formed in 1963. He held Airline Transport Pilot Certificate No. 28900, with airplane multiengine land and sea, and airplane single-engine land ratings.

He had type ratings for the Lockheed Constellation, Consolidated Vultee PB7, Boeing 337/707/720 and Sikorsky VS-44. His first-class medical certificate was issued May 9, 1978, with the limitation that he wear correcting lenses for near vision while flying.

Capt. Blair had a total of 42,005 flight hours, 5,233 hr. of which were in the Grumman G21A. He had flown about 2.5 hr. in the previous 24-hr. period and 18.8 hr., 81.8 hr., and 158.8 hr., respectively, in the last 30, 60 and 90 days. His last pilot proficiency check was accomplished June 25, 1978, and his last route check on June 11, 1978. He completed an annual equipment check on June 25, 1978, and a written examination on June 26, 1978.

Contributing to the accident were the company's inadequate maintenance program, the management influence which resulted in a disregard of Federal Aviation Regulations and FAA-approved company maintenance policies, inadequate FAA surveillance of the airline and deficient enforcement procedures.

Contributing to the fatalities in this survivable accident was the captain's failure to brief passengers properly on emergency procedures.

Factual Information

History of the Flight. On Sept. 2, 1978, an Antilles Air Boats, Inc., Grumman G21A, N7777V, was operated as Flight 941, a regularly scheduled passenger flight from St. Croix to St. Thomas, Virgin Islands. The aircraft had departed St. Croix earlier that day and had flown four other flights before Flight 941. The captain of Flight 941 had flown the aircraft on all previous flights and had accumulated about 2.5 hr. of flying time.

Ten passengers, including three children, boarded Flight 941 at St. Croix. The captain prepared the weight and balance for the flight. No flight plan was filed, nor was one required; flight following was conducted through company facilities. With the 25 lb. of baggage and about 480 lb. of fuel on board, the gross weight of the aircraft was 8,269 lb. at takeoff, which was below the 8,750-lb. maximum allowable gross weight.

The passengers were on board the aircraft when the captain entered and walked through the passenger compartment to the cockpit. The 13-year-old passenger seated in the right cockpit seat stated that the captain sat down in the left cockpit seat, took off his sunglasses and placed them in his shirt pocket. He did not wear eyeglasses during the flight.

Only one passenger stated that he heard the captain brief passengers concerning emergency flotation gear and emergency exits. All other passengers, including the passenger in the right cockpit seat, either stated that passengers were not briefed or stated that they did not recall a briefing.

All passengers did recall that they were told to fasten their seatbelts.

Flight 941 took off from St. Croix at 1003 AST (all times herein are Atlantic standard time and are noted on a 24-hr. clock). The weather was VFR with 25-mi. visibility; the wind was from 120 deg. at 12 kt. After takeoff, the aircraft flew at a cruising altitude of 1,700 ft. msl (all altitudes herein are expressed in mean sea level unless otherwise noted). At 1017, when the aircraft was about 5 mi. south of the St. Thomas seaplane ramp, the left engine failed.

Passengers stated that they heard a loud "pop" or "clacking noise" which emanated from the left engine. The cowling was missing from the engine, and a dark object hung beneath the engine. Passengers who observed the captain stated that he immediately feathered the left propeller and shut down the left engine.

They saw him advance the throttle of the right engine to maximum power setting. Although they did not feel the aircraft yaw to the left, at least one passenger stated that the

aircraft was then flown with the left wing lower than the right wing.

At 1017, the captain transmitted, "Saint Thomas Tower, Antilles 77 Victor, I'm about 5 south. I just got engine failure." The tower controller responded, and at 1017:09, the captain transmitted, "I'm landing at West Gregerie. If you'll get a boat out to me, they'll disembark the passengers." At 1019:09, the captain transmitted, "Saint Thomas, 77 Victor, I'm landing probably pretty far out on West Gregerie. If you could be sure to expedite that boat." This was the last transmission from Flight 941.

The captain of N48550, another Antilles Air Boats G21A, heard the exchange of transmissions between Flight 941 and the St. Thomas tower controller, and at 1020:34, transmitted, "Tower, this is Antilles 550. I've got him in sight. I'll stay with him." This captain stated that when he first saw Flight 941, it was about 2 mi. south of Water Island, or about 5 mi. from his position. He turned toward Flight 941, but as he approached, he saw Flight 941 hit the water. At 1020:46, the captain of N48550 transmitted, "Okay tower, let's get a rescue aircraft out immediately. He went in the water."

According to the captain of N48550, Flight 941 landed to the northwest, about 0.6 mi. south of Water Island in the open sea. When the aircraft touched down it left a heavy spray of water behind it. After a "rollout" of three or four plane lengths, "a large explosive spray of water occurred, the aircraft appeared to cartwheel on its left wing, and momentarily disappeared from my view."

When he reached the accident site, the aircraft was floating upside down. Initially, he saw no survivors but soon saw them appear around the wreckage. He circled the accident site and attempted to guide pleasure and fishing boats to the area.

He stated, "The water was quite choppy with many whitecaps handicapping visual observation."

After the left engine was shut down, the passengers stated that the aircraft began a gradual descent to the water. There was no

Aircraft Information

Grumman G21A, manufacturer's serial number B-111, N7777V, was owned by Antilles Air Boats, Inc. The airframe hours and the data on the left engine are listed in the section on Aircraft Information in the report.

The two propellers were Hartzell three-blade model HCB3 R302E. There was no propeller historical data or operating times available.

The right engine was a Pratt & Whitney Wasp, Jr., R985-AN-14B, serial number 1678. The engine was installed on the aircraft on July 11, 1978. According to company-supplied records, there were 602.3 hr. on the engine at the time of the accident.

buffeting or any abrupt motions. Some passengers believed that it was a normal approach to the water.

Passengers did not see the flaps extended during the descent. At no time after the loss of the engine did the captain brief the passengers on a possible water landing.

The passenger in the right cockpit seat recalled that the airspeed indicated about 100 mph. during the descent. He also observed a 300-400-fpm. rate of descent on the vertical speed indicator.

The captain had his left hand on the control wheel, and his right hand on the right throttle until impact. As the aircraft approached the water, the airspeed was still about 100 mph. The passenger in the right cockpit seat saw whitecaps on the water and high sea swells. He believed that the right engine was being operated at a high power setting as the aircraft hit the water. Another passenger recalled 5- to 6-ft. swells, which were moving from the southeast.

Other passengers also believed that the aircraft was approaching the water at a fast speed. Some passengers recalled that the aircraft was level at impact; some recalled that the right wing was down. The impact was hard and the aircraft bounced.

Most passengers stated that after the first bounce, the captain placed both hands on the control wheel and turned it to the left. When the aircraft struck the water, the left wing dug into the water and the aircraft cartwheeled, pivoting on the left wing.

The aircraft broke apart after the cartwheel and sank within a few minutes. The aircraft came to rest on the bottom of the ocean in 85 ft. of water. The accident occurred during daylight hours at latitude 18 deg. 18 min. N and longitude of 64 deg. 58 min. W.

Injuries to Persons. Fatal: crew, one; passengers, three. Serious: crew, 0; passengers, seven.

Damage to Aircraft. The aircraft was destroyed.

Personnel Information. The captain was properly certificated and trained for the flight in accordance with Federal Aviation Administration (FAA) requirements.

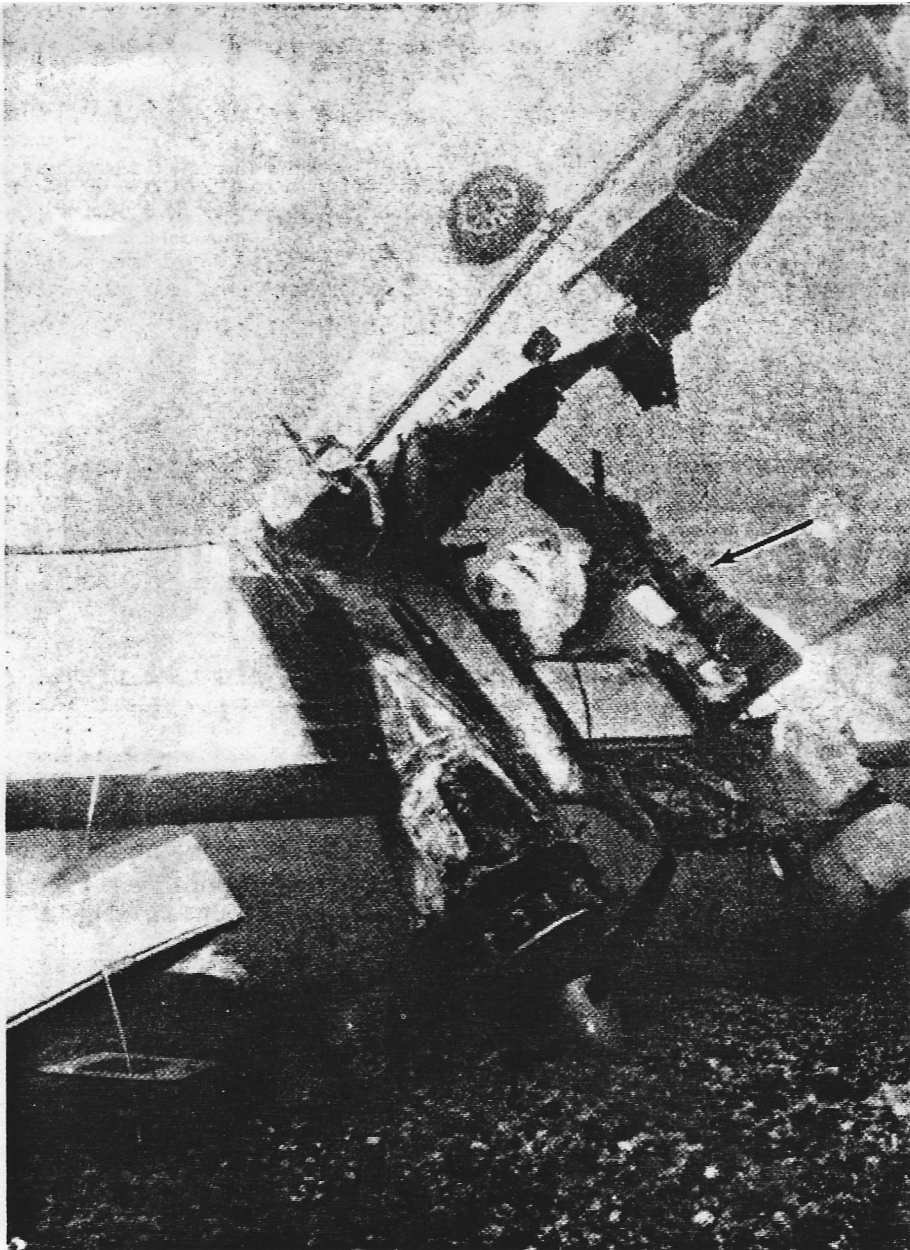
The safety board reviewed his last five first-class medical examinations. In June and December, 1976, his near vision was tested as 20/60 in both eyes. After each examination, his medical certificate had the limitation that he must possess corrective lenses for near vision while flying.

In November, 1977, and at his last first-class physical examination on May 9, 1978, his uncorrected near vision was 20/20; however, both medical certificates contain the limitation of: "Holder shall wear corrective lenses for near vision while exercising the privileges of his airman's certificate."

During the same five physical examinations, the captain's uncorrected distant vision went from 20/20 for the right eye and 20/30 for the left eye to 20/40 for both eyes. None of the five medical certificates issued during this period contained the limitation that the captain must wear corrective lenses for distant vision.

14 CFR 67.13 and 14 CFR 67.15 state that to be eligible for a first- or second-class medical certificate, the applicant must have:

"Distant visual acuity of 20/20 or better in each eye separately, without correction; or of at least 20/100 in each eye separately corrected to 20/20 or better with corrective lenses, in which case the applicant may be qualified only on the condition that he wears those corrective lenses while exercising the privileges of his airman certificate."



Wreckage of the Grumman G21A aircraft is shown 85 ft. below the surface of the ocean. Arrow indicates the right cabin wall structure still attached to the wing.

14 CFR 67.25 states that after a medical certificate is issued, it is valid unless the Federal Air Surgeon reverses the issuance. The Federal Air Surgeon must reverse the issuance of the certificate within 60 days of the date of issue.

Aircraft Information. The aircraft was certificated according to Federal Aviation Administration regulations. The safety board requested all records and logbooks related to N7777V from the company in order to determine the airworthiness of the aircraft. The following records were not available: the aircraft logbook, which was not recovered from the wreckage, and the logbook sheets (Form M2-6) for Aug. 28, 29, 30 and 31, which were supposed to be filed with the maintenance coordinator.

Although propeller logbooks were supplied, they did not match the serial numbers of the propellers recovered from the aircraft. The company could give no reason for this discrepancy. After company officials had stated that the aircraft did not fly between Aug. 27 and Sept. 2, 1978, the vice president-assistant general manager stated, "I have not seen nor to my best information and belief does Antilles Air Boats, Inc., have the aircraft flight log sheets of N7777V in our possession for the period Aug. 28 to Sept. 2, 1978."

N7777V was due for a number 6C airframe maintenance inspection when the total airframe hours reached 16,897.4 hr. Although the last available logsheet, dated Aug. 27, 1978, indicated a total of 16,890.6 hr., the company's Daily Aircraft Status Report effective 0700 hr. on Aug. 29, 1978, showed 16,897.2 hr. on the airframe. During the investigation, weight and balance sheets were discovered for N7777V for Aug. 28, 29, 30 and 31. Although the sheets did not reflect flight time, they did prove that the aircraft flew those days. After being confronted with this information, the vice president-assistant general manager admitted that the aircraft had been flown on those days, and he compiled the scheduled flight time for Aug. 28 through Aug. 31 from the weight and balance sheets.

The times were: Aug. 28—6.1 hr.; Aug. 29—5.9 hr.; Aug. 30—5.1 hr.; Aug. 31—3.1 hr. The total of 20.2 hr. were not reflected on the Aug. 29 or the Sept. 1 status sheets. This time, plus the 2.5 hr. flown on the day of the accident, placed the aircraft about 22.5 hr. beyond a required scheduled inspection at the time of the accident.

After the aircraft had flown 6.1 hr. on Aug. 28, it exceeded the legal inspection limit. The aircraft Daily Maintenance Log (M2-9) for

Aug. 29, 30, 31, Sept. 1 and 2 should have reflected this fact; a mechanic could not sign the aircraft logbook to certify the airworthiness of the aircraft. Furthermore, no pilot could accept the aircraft with the time expired or without a maintenance release.

Since the aircraft was flown on those days, either the logbook times and maintenance release were falsified, or Antilles' captains accepted the aircraft knowing the aircraft exceeded the inspection limit. The aircraft was flown by the following pilots on the days indicated: Aug. 28—president; Aug. 29—vice president-assistant general manager; Aug. 30—president and a line captain; Aug. 31—president, and Sept. 2—president.

The maintenance coordinator stated that on Aug. 27, he informed the St. Croix maintenance foreman to expect N7777V in for a 6C inspection. However, he noted, on Aug. 28, 29, 30, 31 and Sept. 2, that the aircraft was not in for inspection but was flying. Furthermore, he did not receive any log sheets for those days, so no time was being added to the total airframe time. As a result, he stated that the logbooks probably continued to reflect the total on Aug. 27, or 0.2 hr. left until inspection.

He mentioned the situation to the president, who was his direct supervisor. He believed that any further action was not his responsibility. The maintenance coordinator stated that there were other times in 1977 and 1978 when aircraft were flown beyond scheduled inspection times. Generally, the aircraft were needed and no maintenance capability existed to perform the inspection.

The maintenance coordinator further stated that when an aircraft was flown beyond an inspection limit, "It was more of a practice of [the president] not to record [any flight time] than to record it." He stated that he was aware of times when falsified aircraft logbooks were presented to FAA inspectors. According to the maintenance coordinator, the president and other employees were aware that falsified logbooks were presented to FAA officials as valid records.

Personnel in the flight operations department and the night maintenance supervisor from St. Thomas were aware that N7777V was being flown beyond the scheduled maintenance inspection limit.

The vice president-assistant general manager stated that he was not aware that N7777V was overdue for an inspection when he flew it on Aug. 29.

The logbook showed there was sufficient flight time remaining for the trip, and the log was signed by a certificated mechanic. The line captain who flew N7777V on Aug. 30 stated that, when he looked at the logsheet, there was sufficient time remaining for him to fly his trip and that the logsheet had been signed by a maintenance person who certified the airworthiness of the aircraft.

The left engine was installed on N7777V on Mar. 25, 1978, and since then the aircraft had undergone 10 engine and airframe inspections. The records related to the left engine were incomplete.

Officials from the repair station that received the engine before it was installed could not substantiate that the proper records were available to prove that the engine was airworthy. Furthermore, there was no work order on file for the installation of the engine. No repair and alteration Form 337 or serviceable parts tag accompanied the engine.

The maximum gross takeoff weight authorized for N7777V was 8,750 lb. At takeoff, the

aircraft weighed about 8,268 lb. This included 480 lb. of aviation fuel.

The aircraft was within the prescribed center of gravity limits. About 64 lb. of fuel was used before the accident.

Meteorological Information. The surface observation taken by FAA personnel at the Harry S Truman Airport at St. Thomas near the time of the accident was as follows:

0945, record: clouds—2,500 ft. scattered; visibility—25 mi.; weather—rain; temperature—81F; dewpoint—69F; wind—120 deg.; 15 kt.; altimeter—30.04 in.; remarks—rain began 0939.

The temperature at sea level was 88F, and computed to be 79F at 1,700 ft. (adiabatic lapse rate of 5.4F per 1,000 ft.).

The surface winds at St. Thomas and St. Croix for the morning of the accident were consistently 120 deg. at 12 to 15 kt. The winds aloft, as recorded at San Juan, Puerto Rico, were 847 ft.—110 deg. at 11 kt., and 1,714 ft.—108 deg. at 14 kt.

The Coast Guard Assistance Report reported the wind at the accident site between 10.1 and 20 kt. and the sea state as 5 to 6 ft.

Communications. No communications problems existed.

Flight Recorders. There were no recorders installed, nor were any required.

Wreckage and Impact Information. The aircraft landed in the open sea and broke up almost immediately. The fuselage, empennage and wings, with both engines attached, sank in 85 ft. of water. All pieces came to rest on the bottom of the ocean close together. Divers recovered all major sections of the aircraft with little additional structural damage.

The entire wing section, including both engines, remained attached to the fuselage. However, the wings separated from the attachment points at the leading edge and peeled rearward, remaining attached only where the trailing edge of the wing was joined to the fuselage. The right cabin wall structure remained attached to the wing. The wall separated from the fuselage along a vertical line from the wheel well to the right cockpit side window, and horizontally about 1 ft. below the cabin windows. The left cabin wall was torn diagonally from the top of the left side cockpit window, through the cabin windows, to the floorline at the base of the main entrance door.

The hull remained intact. There were no tears or separations in the hull below the floorline, but there were some buckles evident. All landing gear parts and assemblies were undamaged.

The cockpit entry door frame was broken on both sides, and the bulkhead between the cockpit and the cabin was bent forward toward the cockpit. The frame of the main entrance door on the left side of the aircraft was separated at Station 24, and there was a large break in the fuselage just aft of the main entrance door at Station 26. There was a large buckle in the left side of the fuselage at Stations 28, 29 and 30 from the top of the fuselage to the floor line. The right side of the fuselage at Stations 26 and 27 had a deep compression buckle from the top to the hull line.

The empennage separated from the fuselage at Station 33 with upward bending at the separation. The horizontal stabilizer spar was attached to the vertical stabilizer spar. The right side of the horizontal stabilizer was bent downward at the strut attach point, and the center of the strut was buckled downward. The right elevator spar was separated at the center

hinge. The rudder top hinge was bent upward at an 86-deg. angle between Stations 271 to 254. The underside skin was buckled.

The left wing outboard end of the aileron at Station 256 was bent upward 95 deg. The leading edge at Station 178 had a 10-in. hole with white paint in the area of the hole. There were additional scratches, dents and white paint smears in the leading edge outboard of the engine from Stations 111 to 226. The left float forward strut separated from the attach point and punctured up through the lower and upper skin.

The strut attaching bolts were pulled off with the bolts still in the fitting holes.

The right wing from the tip to Station 279 was bent upward 90 deg. Compression damage was evident. From Station 279 to 196 the leading edge was undamaged. However, the aileron in that area was bent and broken inward. The float was crushed and pushed inward, with the front upper fitting eye section pulled out by tension. The rear upper fitting eye sections were pulled out to the aft and to the left.

All control surfaces were accounted for, and all damage to the control linkages, cables and pulleys resulted from breakup.

The right engine ring cowl and accessory cowl were dented and wrinkled on the outboard side. The left engine ring cowl was missing.

The right propeller was in flat pitch and the left propeller was feathered. The No. 5 cylinder and piston were separated from the left engine and the master rod (No. 5) was broken. All cylinder hold-down studs of the No. 5 cylinder were broken.

Medical and Pathological Information. There was no evidence of pre-impact incapacitation of the captain. The cause of death of the captain and three passengers was drowning. Each exhibited multiple contusions, abrasions and lacerations. These passengers were seated in the two left rear center-facing seats, and the rearmost, forward-facing seat.

The 13-year-old boy seated in the right cockpit seat suffered a minor cut on his left arm, a bruise on the left side of his chin and a bruise on his left forehead. Survivors from the cabin suffered lacerations, bruises and abrasions. One survivor suffered a compression fracture of the L-1 vertebra. Three children received minor cuts and bruises, but were classified as seriously injured because they remained hospitalized for more than 48 hr.

Fire. There was no fire.

Survival Aspects. Survivors were rescued by private boats which were in the vicinity of the accident. They were directed to the accident site by the captain of N48550. He stated that the nearest boat was 2 to 3 mi. away when the plane crashed. The U. S. Coast Guard was not notified until 1045 because tower controllers and Antilles personnel were not able to contact the Coast Guard by telephone. The U. S. Coast Guard arrived at the accident site at 1125.

The accident was survivable. When the aircraft cartwheeled, the cabin ceiling and right wall separated, which greatly enhanced egress from the cabin and cockpit. The passenger seats were mounted on floor channel structures which, in turn, were fastened to the floor of the cabin. During the accident sequence, the floor channel structures separated from the floor, and most seats and floor channel structures were found outside the cabin. No cabin seatbelts failed, and three were found buckled. Both cockpit seats remained in place in the cockpit. When part of the pilot's seat failed where the

inboard seatbelt was attached, the pilot's restraint system failed completely. There was no shoulder harness installed, nor was one required.

Survivors extracted themselves from the wreckage and clung to any floatable object they could find until they were rescued. No lifevests were used, although they were located below each seat. Some of the seat cushions did float and were used by some survivors for flotation assistance. The foam in the cushions was not flotation foam, and the survivors stated that the vinyl cushion cover became very slippery in the water. Since there were no straps or handholds on the cushions, they could not be used easily to provide flotation aid. There were no life rafts on board, nor were they required. Two survivors who could not swim were kept afloat by other survivors.

Tests and Research

Grumman G21A Certification. The Grumman G21A was certificated initially based on the Airworthiness Requirements for Aircraft Aeronautics Bulletin 7A. Bulletin 7A, dated Oct. 1, 1934, required that multiengine aircraft must be capable of maintaining level flight with one engine shut down and the propeller feathered. Level flight had to be maintained at an altitude of at least 1,000 ft. for amphibious aircraft. The bulletin stated further that multiengine aircraft must be capable of climbing from sea level to 1,000 ft. with one engine shut down. Bulletin 7A did not specify that a minimum rate of single-engine climb had to be maintained, or that the climb to 1,000 ft. be accomplished in a certain time limit.

Since the Grumman G21A was certificated under Bulletin 7A, it had "grandfather rights."

As new airworthiness and performance requirements were established by regulation, the G21A could continue to operate in Part 91 and Part 135 operations under certain conditions according to the certification requirements of Bulletin 7A.

The G21A had been operated with a maximum gross takeoff weight of 8,000 lb. for most of the 45 years since initial certification. In March, 1978, Catalina Airlines, a California-based G21A commuter operator, requested that the FAA Western Region Engineering and Manufacturing Branch approve a supplemental type certificate (STC) which would increase the maximum gross takeoff weight from 8,000 lb. to 8,700 lb., or almost 9%. No structural or powerplant changes were required according to the request.

Catalina Airlines submitted the necessary paperwork. The Western Region project manager accepted a verbal report of the developmental flight tests by Catalina Airlines that the aircraft would meet the performance and engine cooling requirements of Bulletin 7A.

The project manager for the STC was: (1) The chief of the Aircraft Modification Branch; (2) the flight engineer on the test flight; and (3) the FAA official authorized to approve the STC. The review process for the Western Region requires that a type inspection report, the final summary of the work done to create the STC, be reviewed after the work is completed.

The reviewing authority was the chief, Flight Test Branch. However, the STC can be issued before the type inspection report is reviewed. In the STC requested by Catalina Airlines, the flight test was made on Apr. 4, 1978, the STC

was issued on Apr. 5, 1978, but the type inspection report was not reviewed and approved until Nov. 13, 1978.

The project manager prepared a standard type inspection authorization which outlined the flight test program. The FAA Order 8110.4 Type Certificate outlined the tasks which must be accomplished before a test flight. These requirements were, in part, as follows: (1) "Instruments, gauges, recording devices, etc., which are used in official flight tests must have been recently calibrated by a qualified agency and affidavits furnished"; and (2) "The manufacturing inspector should witness the weighing of the aircraft and verify scale accuracy."

However, neither of these tasks were accomplished. As part of the test conditions, the project engineer and the test pilot elected to simulate a zero thrust condition on the left engine instead of shutting down the engine and feathering the propeller. This procedure is acceptable only if zero thrust is determined properly.

The test flight aircraft was a Catalina Airlines G21A which had been overhauled recently. Two Pratt & Whitney R985AN1 engines were to be used. The STC required that takeoff power of 450 horsepower be applied for 1 min. and then maximum continuous power of 400 horsepower be applied.

On Apr. 4, 1978, a 25-min. test flight was made. The single-engine climb performance portion lasted 7 min. Although the project engineer stated that the flight "started out as primarily a cooling test," the aircraft was flown in a single-engine configuration from the surface to 1,000 ft. At that point, the project manager and the test pilot determined that since the cooling test was satisfactory and the aircraft did climb to 1,000 ft., the requirements of Bulletin 7A were satisfied. Furthermore, since the takeoff weight was about 8,808 lb., a verbal request was made by Catalina Airlines and approved by the project manager to set the maximum gross weight at 8,750 lb. The STC, SA 3630 WE, was approved and issued Apr. 5, 1978.

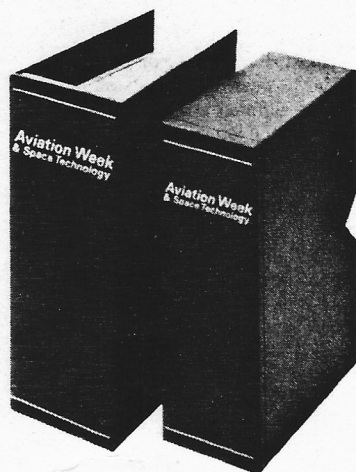
At that point, the project manager was not aware that the engines on the test aircraft were not R985AN1 engines, but were R985AN14B engines. The difference is in the carburetor and will result in 465 horsepower at takeoff power and 410 horsepower with maximum continuous power when the AN1 engine power settings were used.

In addition, the zero thrust determination during the test was incorrect; it actually provided some thrust on the left engine. Finally, the aircraft weight was incorrect; the actual weight at that time was more than 8,800 lb.

STC SA 3630 WE was purchased by Antilles Air Boats in May, 1978, and applied to N7777V. Although the STC authorized the aircraft to operate up to 8,750 lb., Antilles Air Boats' procedures limited the aircraft to 8,500 lb.

When N7777V crashed on Sept. 2, 1978, the FAA Southern Region contacted the STC project manager to request performance data on the G21A. There were no data, however, since under Bulletin 7A no specific rates of climb were required, and no data were recorded during the STC flight test.

On Sept. 8, 1978, the Southern Region placed a 7,800-lb. weight restriction on the operation of Antilles Air Boats G21A aircraft while extensive maintenance program revisions were made. When the revisions were complete, Antilles Air Boats requested that the weight restriction be removed. The Southern Region



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scheduled a series of G21A test flights to determine if the typical Antilles G21A could perform at 8,000 lb. and higher weights.

A series of test flights were conducted by the FAA Southern Region on Nov. 2, 3, 4 and 5, 1978, at weights between 7,609 lb. and 8,179 lb. The right propeller had been filed to minimum limits and considered to be a typical minimum service propeller. Four single-engine test flights were flown with the left engine at zero thrust before the aircraft experienced an inadvertent autofeather of the operating right engine. A forced landing was made, and the aircraft sank into the water shortly thereafter. Most of the flight test data were lost in the accident.

However, from data FAA personnel could recall, a graph was constructed which indicated that at sea level, on a standard day, positive single-engine climb could be achieved at a maximum gross weight of about 7,775 lb. Level single-engine flight could be maintained at a maximum weight of about 7,750 lb. FAA personnel involved in the flight tests stated that because the flight testing had not been completed and since they did not have full benefit of all the data, the information was inconclusive. Furthermore, the minimum service condition of the propeller detracted from the validity of any of the data.

After the Southern Region test flight, which resulted in the loss of the G21A, the data recalled were passed to the Western Region Flight Test Branch, along with the details of the accident. As a result of the information passed by the Southern Region shortly after the Nov. 5 accident, the Chief, Western Region Flight Test Branch, stated that they began to have second thoughts on the validity of STC SA 3630 WE regarding the "remarkably lower climb performance" which was observed by the Southern Region.

However, on Nov. 13, 1978, the Chief, Western Region Flight Test Branch, the reviewing authority for STC SA 3630 WE, approved the type inspection report on the STC.

The Western Region began to plan for new flight tests to revalidate the STC performance data. Meanwhile, the Southern Region, on Dec. 7, 1978, conducted two evaluation flights in Antilles G21A aircraft to explore the single-engine performance at 8,000 lb. and 8,200 lb. The evaluation flights were conducted by the San Juan GADO (General Aviation District Office), but were not conducted according to FAA-accepted test flight procedures, according to the Western Region Chief, Flight Test Branch.

During the evaluation flights, the aircraft was found to be able to meet Bulletin 7A requirements at 8,200 lb. Based on these data, the chief, San Juan FSDO (Flight Standards District Office), wrote a letter to the chief, Southern Region Flight Standards Div., stating, "Armed with these data, we recommend that Antilles Air Boats be permitted to resume operations at 8,000 pounds gross takeoff weight." The request was not approved by the Southern Region.

On Feb. 13, 1979, the Western Region attempted to duplicate the performance data which were the basis for the original issue of STC SA 3630 WE. In contrast to the April, 1978, test, the Western Region required verification of the aircraft weight and calibration of the instruments.

The left engine feathered during the single-engine climb tests. At 8,750 lb. and at an altitude of 1,500 ft., a 3-min. single-engine, single-heading climb was attempted. At the end of 3 min., a rate of sink of 72 fpm. was

established. At that point, the flight test was terminated. According to the project manager, "... it was pretty obvious that 72 ft. minimum [rate of sink] wasn't going to meet [Bulletin 7A]." As a result, the Western Region canceled the STC on Feb. 26, 1979.

The chief, Western Region Flight Test Branch, stated that the reason there was such a marked difference in performance between the April, 1978, and the February, 1979, flight tests was: (1) One used zero thrust while the other employed actual feathering of the left engine; (2) in the second test, instruments were calibrated; (3) in the second test, power was set properly according to the type of engines, and (4) in the second test, aircraft weight was proper.

He also stated that in the first Western Region flight test, cooling, not performance, had been the principal objective, and that overall, the first flight test was not as rigorously conducted as it should have been.

After the Feb. 13, 1979, test, the chief, Western Region Flight Test Branch, required the computation of the maximum gross weight at which the Grumman G21A could meet the climb requirements of Bulletin 7A using 400 brake horsepower.

The computations were based on data, which were described as "mediocre quality"; these data were measured on Feb. 13, 1979. The maximum computed weight at which the G21A would meet Bulletin 7A requirements was 8,150 lb. on a standard day.

Performance. The two cowled nacelles of the Grumman 21A represent about 20% of the total drag on the aircraft. This figure includes the increase in drag due to wing/nacelle interference. NASA has conducted cowled and uncowled engine drag studies, which concluded that a cowling reduces engine drag conservatively by 40 to 50%. The loss of a cowling will approximately double the drag of that engine and increase the total drag about 10%.

There are no reliable data available to indicate the actual maximum gross weight that the Grumman G21A will carry, and the FAA flight tests relating to the G21A have been contradictory. As a result, the performance capability of N7777V was determined from an extrapolation of the data which was recalled from the Nov. 2, 3 and 4, 1978, FAA-conducted test flights. Although these tests were conducted with a minimum service right propeller, the recalled data should approximate the actual flight and performance capabilities of N7777V. An extrapolation from the test flight data indicates that, at a gross weight of 8,200 lb., a rate of descent of about -100 fpm. at sea level would have resulted.

The 10% increase in drag would result in a rate of descent of about -250 fpm. The loss of efficiency of the right propeller would increase the rate of descent to the 300- to 400-fpm. range observed by the passenger.

Metallurgical Tests. The damaged cylinder pad, the fractured studs and the fractured master rod from the left engine were examined at the safety board's Metallurgical Laboratory. Examination of the master rod fracture, with the aid of a stereomicroscope, disclosed no evidence of fatigue or other progressive failure. The fracture was typical of tensile bending from overload.

Examination of the cylinder pad face disclosed several areas of moderate to severe fretting, which apparently were caused by a cyclic motion between the mating surfaces of the cylinder pad and the cylinder.

A detailed examination of the stud fractures,

with the aid of a stereomicroscope, disclosed that the No. 2, 3, 4 and 5 studs had been failed by low-stress, high-cycle fatigue. The fracture features indicated the fatigue cracks had been progressing for a long period of time. The No. 2 stud fracture had been induced entirely by fatigue.

The No. 3, 4 and 5 stud fractures appeared to be about 80 to 90% fatigue with the remaining portion of the fractures typical of a tensile overload failure. The other stud fractures were caused by overload.

Engine Examination. After recovery from the ocean floor, the engines were examined at the Antilles Air Boats maintenance facility. On the left engine, all accessories were intact, mounted properly and undamaged. The propeller was undamaged and feathered. The No. 5 cylinder assembly, piston, piston pin, both valve push rods and a large piece of the master rod had separated from the engine.

Only the cylinder assembly was recovered near the aircraft.

The cylinder head, rocker arm boxes and covers, and the cylinder barrel were not damaged.

Visual inspection of the cylinder head revealed no cracks. Although the cylinder walls were rusted, they were not scored or scuffed. The spark plugs were not fouled or damaged.

On the crankcase, the No. 5 cylinder mounting pad was battered and distorted. There were numerous gouges on the inside diameter of the pad. A deep, heavily gouged and dented area was located between No. 5 and No. 6 cylinders. This area's roughly square, parallel sides matched the shape of a connecting rod. The crankcase web between No. 4 and No. 5 mounting pads was gouged and battered on the inner surface.

The web on the rear half of the crankcase was bent outward and contained the through bolt, which was bent. The nut was missing and a portion of the bolt hole on the crankcase front half was broken out. All cylinder mounting studs were broken off.

Studs 7, 8, 9 and 10 were broken off below the mounting pad surface. The remaining studs were broken off 0.25 in. to 0.50 in. above the pad surface.

On the pad surface adjacent the No. 6 pad, between mounting studs 3, 4 and 5, the surface appeared rubbed and fretted. Opposite this area and adjacent to the No. 4 pad, the surface was heavily rubbed between studs 8 and 9. There was a sharp-edged lip raised up about 0.010 in. to 0.015 in. around the perimeter of the surface in this same area.

A portion of the No. 4 pad on the rear crankcase half was cracked and bent rearward. All the No. 4 cylinder mounting studs in the crankcase rear half were broken off.

The right engine and propeller exhibited no apparent external damage. All controls operated properly.

Ignition leads were connected properly, and fuel and oil lines were not damaged. Three cylinders were examined internally and were in good condition.

No damage to the pistons, cylinder skirts, crankshaft, master rod, or articulated rods was evident.

Right Propeller Examination. The leading edges and tips of all blades on both propellers had been dressed and reworked to remove erosion damage. The blades of the left propeller were reduced slightly in size from that of a new blade. On the blades of the right propeller, both the planform and airfoil shape had been altered considerably. (To be continued.)