1 Fuel exhaustion

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File No. 1-0022

CIVIL AERONAUTICS BOARD

AIRCRAFT ACCIDENT REPORT

PTED: December 23, 1958 **RELEASED:** December 30, 1958

ALASKA COASTAL AIRLINES, LOCKHEED VEGA, N 47M,
NEAR TENAKEE, ALASKA, JANUARY 15, 1958

The Accident

January 15, 1958, about 1600,1/ a Lockheed Vega 5C, Seaplane, N 47M, owned and operated by Alaska Coastal Airlines, was totally destroyed when it crashed near Tenakee, Alaska. The pilot was killed and the two passengers were seriously injured.

History of the Flight

Alaska Coastal Airlines, a scheduled air carrier, is authorized to conduct operations throughout southeastern Alaska. On January 15, 1958, Captain Fred B. Sheldon departed from Juneau to fly Trip 40. Scheduled stops were planned at Angoon, Hood Bay, Baranof, Rodgers Point, Tenakee, and the flight was to terminate at the point of origin, Juneau.

Weather reports for the area indicated conditions to be generally good, enabling the flight to be conducted according to visual flight rules. Ceilings were forecast to be 2,000 to 3,000 feet and winds near the surface were anticipated to be moderate and generally southwesterly. At least one mountain pass over the route was reported closed because of clouds.

The gross takeoff weight of the aircraft at Juneau was calculated to be 5,237 pounds, approximately 4 pounds less than the maximum allowable. The load was correctly distributed within the center of gravity limitations.

Flight 40 departed Juneau at 1301 and was routine to Angoon. After refueling, the flight continued uneventfully to Hood Bay, Baranof, Rodgers Point; arriving at Rodgers Point about 1520. About 1530, after the takeoff from Rodgers Point, a radio operator there advised the station agent at Tenakee (the next intended en route stop) that Flight 40 was off the water and would need 20 gallons of fuel when it arrived.

At approximately 1557 the agent at Tenakee heard a distress call from Flight 40 over the radio. The pilot called "Mayday" and stated he was trying to make it to the flats in Kadashan Bay. The agent then called Flight 40 by radio asking its position. Sheldon's final message was " . . . the flats across from Tenakee." Immediately thereafter the aircraft crashed.

1/ All times are Pacific standard based on the 24-hour clock.

Investigation

N 47M came to rest inverted a few feet below the high tide level in Kadashan Bay on the island of Chichagof. In its final descent it struck several trees which severed the left wing tip and a portion of the left aileron. As a result of the destruction of the wing the aircraft crashed and was totally destroyed; however, no fire occurred.

All major components of the aircraft were found at the scene. No evidence was found to indicate any malfunction or inflight failure of the aircraft or its components prior to striking the trees.

The engine and propeller assembly were recovered and taken to the company's base for examination. The wreckage of the engine and aircraft had been under water approximately 36 hours, consequently sand and gravel were found throughout the engine. However, upon disassembly and inspection it was determined that the engine had been well lubricated and should have been capable of normal operation prior to impact.

The carburetor was thoroughly examined. The fuel inlet fitting was broken and the throttle body was cracked and distorted. The fuel inlet screen and the carburetor bowl contained sand and water from immersion. The float mechanism was found to be binding due to impact damage; however, the float level was within allowable limits permitting adequate fuel flow to the engine. It was determined that all this damage was the result of impact forces.

Further inspection revealed that the economizer valve had been improperly set at overhaul. It appeared that this valve was set so as to open at approximately 12 degrees of throttle travel instead of 30 degrees as is proper. This error in setting would not seriously affect the satisfactory operation of the carburetor but would result in a rich mixture to the engine.

The propeller blades were found to be in low pitch and both were bent rearward by impact. It was determined that the propeller was capable of operating normally prior to impact but from the blade positions it was evident that little or no power was being developed by the engine at impact.

The aircraft had been completely overhauled in July 1957. At that time all deteriorated wood in the fuselage was replaced, the fuselage was recovered, all fittings were inspected and any which were defective were replaced. The control system was overhauled, control surfaces were repaired, the wing was refinished, and the floats were repaired. In addition, the electrical system was rewired, overhauled components were installed, all aircraft instruments and accessories were replaced with overhauled units, and the radio was overhauled. An overhauled engine and propeller assembly were also installed. Then the aircraft was weighed and a new center of gravity was computed.

Since this extensive reconditioning the aircraft had flown approximately 285 hours. A review of maintenance records revealed that all required inspections had been performed and all significant pilot flight log "write ups" had been properly corrected.

N 47M was equipped with a fuel tank in each wing. Each tank had a capacity of 48 gallons, a total of 96 gallons. During the latter part of

December 1957 a fuel leak developed in N 47M. After examination and test it was determined that the leak was in the right fuel cell. A liquid rubber sealing compound (not available locally) was ordered to make the necessary repair. While waiting for delivery of the sealant it was decided to return the aircraft to use. Accordingly, the tank was drained, the filler cap was sealed over, and a placard was placed next to the fuel selector valve. This placard read, "USE LEFT TANK ONLY." In addition, a note was placed in the aircraft release and acceptance form, "PILOT NOTE - RH FUEL TANK DRAINED ACCOUNT OF LEAKS. USE LEFT TANK ONLY - DO NOT SELECT BOTH." With the right tank out of operation the maximum fuel capacity of the aircraft was 48 gallons.

The Lockheed Vega was manufactured according to the provisions of type certificate No. 384. This type certificate specifies that the Lockheed Vega shall have a fuel capacity of 96 gallons. It was originally certificated under the provisions of Aeronautical Bulletin 7A, Airworthiness Requirements of Air Commerce Regulations. Par. 75 (c) (1) of this bulletin contains a requirement that the aircraft have a minimum fuel capacity of 0.15 gallons per rated engine horsepower. For the Lockheed Vega equipped with an R985J Wasp, Jr. engine, which has a rated horsepower of 450, the minimum allowable fuel capacity, according to this formula, would be 67.5 gallons.

It is therefore evident that with one fuel tank out of service N 47M did not conform with its type certificate nor did it meet the fuel capacity requirements of Bulletin 7A and it was therefore being operated contrary to Civil Air Regulations.2/

The procedure to be used by Alaska Coastal Airlines pilots in determining fuel requirements for VFR flights is listed in the company operations manual. First, the total flying time at normal cruise is computed, taking into consideration anticipated wind and weather conditions. Next, seven minutes are added to the total flying time for each proposed takeoff to allow for additional fuel consumption at higher power settings. Forty-five minutes are then added for the reserve fuel requirement. Finally, this total time in hours is multiplied by the hourly fuel consumption. The product will be the total fuel required for the flight. In computing the fuel required, a figure of 25 gallons per hour is to be used for the Lockheed Vega.

Testimony of operations personnel indicated that this method of computation had been changed several times; however, the manual had not been revised.3/ Personnel stated that because the normal flights on Alaska Coastal Airlines routes were of short duration, a fuel consumption figure of 2.5 lbs./min. was substituted for the hourly fuel consumption to facilitate load computation. As gasoline weighs 6 lbs./gal. this 2.5 lb./min.-figure equals 25 gals./hr. Later, as a result of an analysis of fuel consumption, it was determined that a fuel consumption of 3 lbs./min. (30 gals./hr.) was more realistic of the actual fuel consumption. Accordingly, the formula was again changed and the figure 3 lbs./min. was to be used. Testimony indicated that

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2/ CAR Part 41.20 (a)

3/ CAR Part 41.120

the most recent change was intended to eliminate use of the formula; that the 3 lbs./min. was an overall fuel consumption amount which took into account takeoff and climb. It did not alter the 45-minute reserve requirement. As stated before, the company operations manual did not reflect this change, but the revised method for fuel computation had been disseminated to the pilots by memorandum which each signed.

From the conflicting testimony by flight personnel it was apparent that considerable confusion concerning fuel requirement computation existed. Some pilots used 3 lbs./min. to determine the amount of fuel necessary for point-to-point flight and then used 25 gals./hr. to compute the reserve requirement; others used a straight 3 lbs./min. for both the flight time and the reserve.

A further area of confusion was evident in the application of the formula for determining fuel requirements. The memorandum directing that 3 lbs./min. be used to determine gas consumption did not specify that the formula set out in the operations manual was no longer to be used. It was impossible to determine from company records what the correct procedure was to be.

A survey conducted by the company in the spring of 1957 showed that the Wasp, Jr. engines in the fleet actually consumed approximately 3 lbs./min. (30 gals./hr.) for the Lockheed Vega (which is equipped with a P&W R985 Wasp, Jr. engine). However, the records for December 1957 and January 1958 indicate a fuel consumption for this airplane of 34.1 and 34.5 gallons per hour, respectively.

A possible explanation for this increase may be that because of the colder weather in December and January longer warm-up periods are required and also that carburetor heat is used more extensively. The improperly set economizer did not contribute to this increase in fuel consumption because the setting had not varied since installation in July 1957.

Testimony concerning a flight in January from Juneau to Sitka and return indicated that the fuel consumption of N 47M was about 35 gallons per hour. The pilot had taken off with 48 gallons of gasoline in the left tank (the right tank was sealed over). The flight to Sitka took 1 hour, 6 minutes. At Sitka, 39 gallons of gasoline were added to the tank to fill it to its 48-gallon capacity. Thus, it is evident that the flight landed with but nine gallons of reserve fuel. The return trip to Juneau took 1 hour, 10 minutes, and the aircraft was refueled with 40 gallons. The pilot testified that although he noted the unusually high fuel consumption it did not cause him any concern and therefore he did not report the matter to the maintenance department.

The company does not normally keep a running record of fuel consumption of each of its aircraft and the pilots had not complained about any excessive fuel consumption; however, in view of the records collected after the accident it appears conclusive that the fuel consumption for this aircraft had increased significantly in recent months.

Using these most recent fuel consumption analysis figures (34.5 gallons per hour), a reconstruction of Sheldon's flight was made. Based on an

estimated ground speed of 110 m. p. h. over the probable route of flight followed, it could be shown that the flight did not comply with the CAR governing reserve fuel requirement.4/

As stated before, the right fuel tank of N 47M was not in use, but the left tank was "topped off" prior to departure from Juneau, bringing the total usable fuel to 48 gallons. In addition, 30 gallons of aviation fuel contained in six cans were placed in the cabin.5/ This additional fuel was to be used to refuel the aircraft at Angoon. Any fuel not required at Angoon was to be left there to help replenish gasoline stocks for future refueling stops.

On the flight to Angoon the pilot made several position reports by which it was possible to determine his groundspeed and an estimate of 42 minutes for his actual time en route. The amount of fuel consumed for this flight, based on a rate of 34.5 gallons per hour, would be 24.1 gallons.

At Angoon, the pilot, with the assistance of one of the passengers, refueled the seaplane with 20 of the 30 gallons of fuel carried in the aircraft.6/ This brought the total usable fuel aboard to 43.9 gallons, or enough for 1 hour, 17 minutes of flight time. The total flying time to the next intended refueling point, via the route normally used for this flight, was one hour, leaving a reserve available of 17 minutes; 28 minutes less than the reserve specified by CAR.7/

Another flight plan was reconstructed using the company recommended fuel consumption figure of three pounds per minute. Even with this lower fuel consumption it could be shown that there was not sufficient reserve fuel to comply with the regulation. Under the most favorable conditions the flight would have had only 35 minutes of reserve fuel when it reached Tenakee.

All of the information for these flight routes was taken from the load manifest filled out by Sheldon prior to takeoff from Juneau. He had indicated his only proposed refueling stops were to be at Angoon and at Tenakee. Also, although available weather reports indicated Tenakee Pass (the normal route between Rodgers Point and Tenakee) was closed and an alternate route would have to be used, no apparent consideration of this was given in computing fuel requirements for the flight. Yet the pilot's clearance was accepted and signed by dispatch. It was pointed out that ACA has been authorized by the Administrator to deviate from certain portions of Part 41 of the CAR and is not required to have a dispatcher on duty or to file a flight plan for VFR flights.8/

4/ CAR Part 41.98 (a) and ACA Operations Specifications Deviation

5/ CAR Part 49

6/ The remaining 10 gallons in two containers was stored as planned

7/ CAR Part 41.98 (a)

8/ CAR Part 41.1 (a); 41.84; 41.101; and ACA Operations Specification dated 4/22/56

CAR Part 41.84 requires the company to utilize certificated aircraft dispatchers. Alaska Coastal has been authorized by the Administrator to deviate from this regulation and operate small aircraft in day VFR scheduled flights without a dispatcher, provided such flights are monitored by a flight-following system acceptable to the Administrator.

Testimony of company witnesses describing the flight-following system indicated that it consists mainly of monitoring company radio contacts. These contacts are logged and posted so the radio operator or dispatcher can note the position and time the flight last reported. No specific instructions were issued by the company for procedures to be followed in rendering flight assistance to flights in progress. In addition, these witnesses said that because radio communications in the area were unreliable it was not uncommon for Juneau to miss position reports entirely. They said no significance would be attached to this if the weather was reported good. It was noted, however, that ACA was not availing itself of these authorized deviations; that a dispatcher was on duty at Juneau and Sheldon did complete a clearance which was accepted by operations.

Company witnesses also stressed that, under company policy, the pilot was solely responsible for determining fuel requirements and that it was his responsibility to refuel when necessary. These witnesses stated that the pilots were instructed to "stick" the gas tanks at each stop to determine the exact amount of fuel remaining. They were told not to rely on the sight gauge because it was inaccurate. They also said that suitable fuel was available at various points throughout the entire area over which the flight operated, and that ACA pilots were authorized to refuel at any of these places when necessary.

The surviving passengers were able to recall seeing several landmarks with which they were familiar during the flight from Rodgers Point to Tenakee. Based on this information it is believed the flight proceeded down Peril Straits turning left to fly over Sitkoh Lake and turning left again at the head of Sitkoh Bay, from this point flying up the valley to the crash site at the head of Kadashan Bay.

Using this probable route of flight and the best available information on actual flight time between en route stops and the fuel consumption rate of 34.5 gallons per hour, Flight 40 was reconstructed. It was calculated that the fuel supply of N 47M would have been exhausted at 1559. The distress call from Flight 40 was heard at 1558 at Tenakee and Juneau.

The passengers stated that the flight had been smooth and everything appeared to be normal until just a moment before the crash. They stated at this time the engine cut in and out several times and then quit completely. One of the passengers who had many years of experience with engines stated it appeared to him that the aircraft ran out of fuel.

As stated previously, under company procedures the aircraft pilot is responsible for maintaining sufficient fuel for the flight plus adequate reserve fuel. A passenger, who assisted the pilot in servicing the aircraft at Angoon, said the pilot had remarked he thought this (the 20 gallons added

to the left tank) would be enough to get to Tenakee. After the flight left Angoon, no unscheduled stops were made. All of the passengers said the pilot did not again service the aircraft and did not physically check the amount of fuel in the tank by stick.

Company witnesses testified that Sheldon had been thoroughly briefed before this flight. He knew that the right fuel tank was out of service and had been particularly cautioned about refueling and was well aware he would have to refuel at least twice during the trip.

Information developed at the public hearing indicated that the company operations manual was inadequate and obsolete and was therefore not used. A company witness said the manual had not been revised because for a number of years the company had been under the impression that regulatory changes would be made affecting the operation of small planes in Alaska which would mean they would be required to change their manual completely. To save additional time and money the company has continued to postpone revising the manual. Changes in procedures are brought to the attention of personnel by memoranda.

Both the company and the CAA were in agreement that the manual was not current and therefore not used. A CAA witness stated he was aware that the manual was not current. He said that although CAA did not specifically require that they be inspected, he had done so. When he found it was not current he spoke to the operator who said it was in the process of being revised. No further action was taken.

This witness testified that CAA suggests that inspection schedules be arranged to monitor all phases of the carrier's operation for the purpose of promoting aviation safety and to ensure compliance with Civil Air Regulations. It is also suggested that at least 10 percent of the periodic pilot proficiency and en route checks be monitored for the same reason. He testified that he had monitored less than 10 percent of these checks.

Alaska Coastal conducts its scheduled operations over its regular routes under Part 41 of the Civil Air Regulations and over its irregular routes under the small aircraft rules of Part 42. Numerous deviations from the requirements of Part 41 have been authorized in the operations specifications of the Administrator. The purpose of these deviations was to permit the operation of aircraft of 12,500 pounds or less maximum certificated takeoff weight under more realistic operating requirements than was possible under the Part 41 rules.

Analysis

It is evident that Captain Sheldon allowed the aircraft to exhaust its fuel. The statements by the passengers describing the events immediately prior to the crash, along with the reconstructed flight plan, are conclusive on this point. In addition, nothing irregular or unusual was noted in the performance of the aircraft and no evidence of such was found in the wreckage.

The conduct of the entire flight also suggests this occurrence. The pilot had listed on the load manifest for the flight his proposed route of flight and his intended points of refueling. His statement of the refueling

at Angoon also indicates that he did not intend to refuel again until reaching Tenakee, even though he knew or should have known that it was impossible to make the flight and arrive at Tenakee with the required fuel reserve. Also, the pilot did not "stick" the tank to determine the exact amount of fuel remaining at the en route stops but apparently relied solely on his own calculations or the reading on the visual sight gauge, which was known to be inaccurate.

Further, no consideration was given to the possibility of weather conditions requiring the flight to follow a longer alternate route. Yet these weather reports were available to Sheldon prior to takeoff from Juneau. In addition, he could have seen Tenakee Pass from his last stop, Rodgers Point. He therefore knew before his takeoff from there that the pass was closed and he would have to follow the much longer route.

The Board concludes that the pilot had no excuse or valid reason for continuing his flight without maintaining an adequate fuel reserve. This is especially true in view of the fact that suitable fuel was available at various settlements over the entire area. With just the slightest effort he should have known his fuel supply was insufficient to reach Tenakee by the alternate route.

Although, under company policies, the pilot of the flight is responsible for determining the proper fuel loading, the company should have exercised closer supervision over this flight. This is true notwithstanding the fact that the company, by authorized deviation, is not required to file clearances or maintain qualified dispatchers for day VFR flights.

During the investigation of this accident a number of items in company operating procedures were noted which the Board believes indicate a lack of supervision and coordination within the company, as well as between the company and CAA.

With one fuel cell out of use, N 47M did not comply with the requirements under which it was certificated. The dispatch of this aircraft was not only improper but also "set the stage" for the events which followed.

The investigation of fuel records revealed that the fuel consumption of this aircraft was significantly higher than normal. Even though the company is not required by regulation to keep a running check on fuel consumption of each of its aircraft, the Board believes it is good operating practice to do so. No logical reason appears to exist for a pilot failing to report unusually high fuel consumption.

The methods used by personnel of ACA to compute fuel requirements vary greatly and indicate considerable confusion. The company should take action to establish a standard and realistic procedure for these computations. It is also obvious that closer monitoring and supervision of the pilots in this phase of operations is warranted.

The flight-following system described by company witnesses appears to the Board to be entirely too casual for scheduled operations. Deviations from specific requirements of CAR, Part 41, are authorized when the Adminis-

trator finds that the general standards of safety require or permit them. It is intended that the issuance of a deviation by the Administrator shall include specifications to provide for an equivalent level of safety for that operation. In this instance the deviation should have contained specific information regarding the purpose and scope of the flight-following system and its relationship to the overall supervisory management and control of flight operations. A company which operates under such adverse conditions of terrain and weather should take special precautions and issue specific instructions to keep strict account of its aircraft at all times.

The company operations manual,9/ which is supposed to serve as a guide for personnel to follow, was totally inadequate and obsolete. In this respect the objective and purpose of the regulation was negated. The Board cannot accept as valid the company excuses for not revising and keeping the manual up to date. This requirement is not arbitrarily imposed upon Alaska Coastal Airlines. It has been determined by the Board and operators to be a necessary adjunct for safe, efficient operating practices for all carriers. The Board further believes that the company operations manual forms a necessary yardstick upon which to determine whether the operation conforms to the safety standards intended in the Civil Air Regulations and the air carrier's operating certificate.

The CAA safety inspection program was ineffective and should have noted the operating deficiencies developed in this investigation. The Board believes that a more rigid inspection program by the CAA would have revealed these deficiencies, whereupon immediate effective correction could have been taken to ensure full compliance with applicable standards of safety.

Subsequent to the accident, enforcement action was taken by the CAA for the violations noted.

Constructive corrective action has been taken by Alaska Coastal to remedy the deficiencies found during the investigation. The operations manual has been revised and is now current. The dispatch procedures have been revised making it possible to maintain a closer operational control over all flights. Flight planning procedures are monitored more closely to ensure that flights are being conducted in accordance with all applicable regulations and instructions.

The management and employees of Alaska Coastal have shown a receptive attitude for improvement in the level of safety of their operation. They have approached the implementation of safety improvement practices with an attitude of willingness and a seriousness of purpose which should result in long term effectiveness in this program of corrective action.

Findings

On the basis of all available evidence the Board finds that:

1. The company and the pilot were properly and currently certificated.

9/ CAR Part 41.120

2. With one fuel tank out of use, the aircraft did not comply with the requirements of Bulletin 7A under which it was certificated for passenger-carrying service.

3. No evidence of mechanical or structural failure was found.

4. The pilot did not plan his flight to provide for an adequate fuel reserve at all times.

5. The company did not provide adequate supervision or control over flight planning or clearance of flights.

6. A longer alternate route had to be followed by the flight because of unfavorable weather.

7. The aircraft exhausted its fuel supply and crashed.

8. The air carrier's operations manual was incomplete and was not maintained current as required by regulations.

9. The CAA safety inspection program was ineffective in terms of ensuring that the carrier was conducting operations at a level of safety appropriate for the carrier's operating certificate and associated operating specifications.

Probable Cause

The Board determines that the probable cause of this accident was the poor flight planning by the pilot and his poor judgment in allowing the aircraft to run out of fuel. A contributing factor was the lack of adequate organization and management of the air carrier's operations to ensure that all flights were planned and conducted with safety.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE

/s/ CHAN GURNEY

/s/ HARMAR D. DENNY

/s/ G. JOSEPH MINETTI

/s/ LOUIS J. HECTOR

SUPPLEMENTAL DATA

Investigation and Hearing

The Civil Aeronautics Board was notified of this accident and an investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was held in Juneau, Alaska, February 12 and 13, 1958.

Operator

Alaska Coastal Airlines is a partnership of two corporations, Air Transport, Inc., and Marine Airways, Inc. Its general office is located in Juneau, Alaska. It operates under a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration. These certificates authorize the company to transport by air persons, property, and mail between various points in Alaska, including the route involved.

Pilot

Captain Fred B. Sheldon, age 37, was employed by Alaska Coastal Airlines, January 2, 1957. He had accumulated a total of 1,263 flying hours, of which 209 hours were in the Lockheed Vega and Bellanca aircraft. Captain Sheldon held a valid airman certificate with a commercial pilot rating for airplane single-engine land and sea and an instrument rating. He had passed his CAA physical and was issued a class 2 medical certificate on November 30, 1957, without waivers. Captain Sheldon had received his competency check and cleared for flights in the Lockheed Vega on July 28, 1957.

The Aircraft

Lockheed Vega, model 5C, N 47M, was certificated under CAA aircraft type certificate No. 384. The standard gross weight for seaplane operation was increased from 4,880 pounds to 5,240 pounds under the provisions of Special Civil Air Regulation SR-337, as amended, for operations conducted solely in Alaska. This airplane had a total time of 13,496 hours. It had accumulated 86 flying hours since the last 100-hour inspection and 285 hours since overhaul. The aircraft was equipped with a Pratt & Whitney R 985-AN-6B engine, and a Hamilton Standard constant speed propeller, model 2D-30.