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File No. 1-0041

C I V I L A E R O N A U T I C S B O A R D
AIRCRAFT ACCIDENT REPORT

Adopted: April 16, 1963 Released: April 18, 1963

KODIAK AIRWAYS, INC., GRUMMAN G-21A, N 1503V,
OLD HARBOR, KODIAK ISLAND, ALASKA,
DECEMBER 24, 1961

SYNOPSIS

On December 24, 1961, N 1503V, a Kodiak Airways, Inc , Grumman G-21A, a twin engine six-place amphibian crashed shortly after initial lift-off while making a water takeoff from Old Harbor, Kodiak Island, Alaska. One passenger seated in the cockpit was thrown into the water and drowned. The pilot, who was also thrown from the aircraft, and the remaining three cabin passengers, who exited through the main cabin door, were rescued within a few minutes The aircraft was totally destroyed at impact and sank in 75 feet of water. Ceiling and visibility were unrestricted and the sea was relatively calm

At approximately 1050 a.s.t., the aircraft started its takeoff in a southwesterly direction. The initial takeoff appeared to be normal, but immediately after lift-off the aircraft was observed to descend, strike the water, and climb steeply. The aircraft then pitched down abruptly and crashed, with the nose and tail breaking off at impact.

The Board determines that the probable cause of this accident was an improperly executed takeoff which resulted in an inadvertent descent into the water. This produced a high-speed low-angle porpoise from which the pilot was unable to recover

Investigation

Kodiak Airways, Inc., Grumman G-21A, N 1503V, departed Kodiak, Alaska, at approximately 1000 1/, December 24, 1961, on a regularly scheduled passenger, mail and cargo flight with planned en route stops at Old Harbor, Kaguyak, Lazy Bay, Moser Bay, Olga Bay, and return to Kodiak. According to the pilot's testimony and company records, a complete preflight check, including draining of the bilge, was performed. The aircraft was found to be airworthy, within weight and balance limits, and was properly dispatched from Kodiak. The pilot, Jack N. Kingston, was properly certificated.

Passengers were not carried on the flight to Old Harbor. The flight, conducted under day Visual Flight Rules, was routine in all respects, and a normal water landing was made at Old Harbor at about 1040. The aircraft was then taxied to shore, beached, and 33 pounds of mail were off-loaded. Four passengers and about 40 pounds of cargo were then loaded aboard. Shortly after this the parking brake slipped, and the aircraft pivoted 5-6 feet to the left where the tailwheel of the airplane became entangled in the tubular steel passenger loading ladder, which had been placed to one side. This ladder is 3 feet long, 13 inches wide, and weighs 4-1/2 pounds. The pilot then assisted the passengers out of the airplane and, with the help of bystanders, removed the ladder from beneath the aircraft. Since a previous incident had punctured the hull, Pilot Kingston crawled underneath the aircraft to inspect for any damage which might have been caused by the ladder. A visual inspection by the pilot revealed that the paint was not scratched and there was no apparent structural damage externally; however, no internal

1/ All times herein are Alaska Standard based on the 24-hour clock.

inspection of the hull was conducted He then performed a routine walkaround inspection of the aircraft and found no discrepancies, further noting that there was an absence of external ice and that the hull drain plugs were secure The passengers again boarded the aircraft. A boy and two women occupied the passenger cabin, and another boy was seated in the cockpit to the right of the pilot

The pilot said that when the flight departed Old Harbor, "... the weather was clear and sunny, the water calm I would estimate the wind calm to three or four knots It was not glassy but a few ripples on the water surface "

At approximately 1048 the aircraft was taxied into takeoff position in the bay. According to the pilot, during the taxi run all items of the pre-takeoff checklist were completed, including gear retraction, flaps up, trim tabs neutral, and flight controls free At about 1050 he started the takeoff in a southwesterly direction.

Three groundwitnesses observed the takeoff and subsequent crash One of these had been employed previously by Kodiak Airways for three years, and one had observed numerous takeoffs from Old Harbor. These witnesses describe the series of events as follows The initial part of the takeoff appeared to be normal, but after gaining an altitude of about 50 to 150 feet, the airplane descended and struck the water Almost immediately the airplane was seen to rise in a climbing attitude of about 45 degrees until it attained an altitude of 300 to 400 feet. The aircraft then nosed over abruptly and dove into the water. The witnesses also said that the engines sounded normal throughout the takeoff and subsequent maneuvers No parts were seen to fall from the aircraft and the landing gear appeared to be retracted

One of the two women passengers and the surviving boy could not give an account of what occurred prior to final impact. The other woman, who had flown several times before, testified that after the takeoff run the airplane "...got just a little way up in the air and then came down and hit the water....." At this time the airplane bounced and went up into the air at a steep angle. She looked out the window and saw the ocean. The next thing she remembered was hitting the water, at which time the seats of all three cabin passengers broke loose and all occupants were thrown into the forward part of the cabin, still in their seats. She testified that, with water surging in, she and the other cabin passengers unfastened their safety belts and left the airplane through the main cabin door.

According to the pilot, the following sequence of events took place: "I taxied out into the bay and made my check and started my takeoff. I felt my takeoff was good because I did not get any water on the windshield. I kept the airplane low on the takeoff to gain airspeed. We do this in Alaska because of possible turbulence if you pull the airplane up too fast."

He further states that, "As I was about to make a power reduction I noticed the nose and bow started up so I pushed forward on the wheel to keep the bow in a level flight attitude until we gained positive climb speed, and the wheel went forward and hit the instrument panel, and there was no resistance whatsoever in its forward movement. During this time the bow was still coming up and it got to a position I would say definitely much steeper climbing attitude than we would like to have, and then the bow started dropping ....when I noticed it dropping I started going back a little bit and the wheel hit the

backstops, there was no resistance. Then I realized there was some kind of failure so I was afraid to go any higher, so I reduced the power to try to stop my climb and I was afraid to reduce it too fast for fear that I would nose back into the water again, so I maintained a gradual nose-low descent and I was hoping that I could apply full flaps, 60 degrees, and hit the throttles just before impact because I thought possibly I could hit the water at reduced speed...." He further stated, "I have an impression of a downward impact and then everything was green. Then I realized I was under the water and in the seat sinking. I released the seat belt and swam up to the surface. I saw the bow section of the airplane in front of me about 10 feet away. I swam for it and thought it was the airplane....As I put my foot on it I looked around and I could see the airplane a good 100 feet behind me. Then this girl put her head out the door and said, 'None of us can swim can you help us?' I then swam over to the rest of the airplane. The woman said 'I can't hang on.' I grabbed her by the wrist and my right arm around the tailwheel. The little boy got hold of my parka hood and the girl hung on to the woman and me. Finally a boat started coming. The plane sank about 20 seconds before the boat got to us. The rest of the time I was trying to hold the people off and help them stay up -----I had a time, because I could not help the people when they were trying to pull me down. When I was under water I saw a life preserver the boat had thrown and I swam up to it and hung on. Then the boat picked me up." He did not believe that the aircraft reached an altitude higher than 50 feet, nor that there was any contact with the water after takeoff except at final impact. He also said that he did not use the elevator trim tabs to control the aircraft.

The boy who was seated in the right seat of the cockpit was thrown from the aircraft and drowned. His body still in the seat, was recovered approximately 15 feet from the point of impact.

The distance from the start of the takeoff run to the point where the aircraft crashed was approximately one mile.

The nose section of the aircraft, which had completely separated at impact, was recovered shortly after the accident. The tail section also broke off at impact but remained attached to the fuselage by several control cables. Because it was being battered by tidal action, these cables were cut and this part of the airplane was salvaged on January 17, 1962. The main fuselage, with wings and engines still intact, was recovered from 75 feet of water on January 24, 1962. The aircraft incurred considerable damage during salvage operations.

Examination of the engine and propellers revealed that they were complete with all control linkage connected and capable of normal operation up to the time of impact. Both throttles and both propeller pitch controls were found in full power positions. The engine fuel shutoff valves were open and the crossfeed valve was "on", normal for takeoff in this type aircraft. The main fuel selector valve, located in the cockpit, was found in the "off" position. The wing flap selector valve was found in the flaps-full-down position. Although the landing gear was damaged by impact forces and was hanging loose at recovery, all components appeared to be properly connected and safetied.

Examination of the wreckage at the time of recovery included alignment of the separated sections and the center fuselage section. The tears, splits,

and fractures matched almost perfectly, indicating all hull damage occurred at impact and as a result of salvage operations. Several fractures in the aileron control system were found. The right aileron cable was broken at the control column, both pulleys were torn from their brackets, and the bottom arm of the aileron bellcrank at station No. 11 was broken. These failures had occurred when the nose separated from the rest of the aircraft at this station.

In the elevator control system the control columns, which are interconnected by a torque tube, were found intact and properly connected. The bellcrank assembly, which transmits control from the pilot's column to the elevator cables and is also located at station No. 11, was broken in several places. From this point, the elevator cables run aft under the floor of the cabin through fairleads and pulleys to the elevator bellcrank at station No. 35 in the tail section. The fairlead for both the elevator and rudder cables at station No. 14 was pulled rearward from the bulkhead. It was found intact with the cables running through the proper holes. At station No. 29 the elevator and rudder cables run over pulleys which are attached to the forward bottom face of this bulkhead. There is one axis bolt for the two rudder pulleys and one axis bolt for the two tailwheel retraction pulleys and the two elevator pulleys. These six pulleys and the two axis bolts had been torn out of their attach brackets in a forward and upward direction. At station No. 35 the down arm of the elevator bellcrank was bent at about a 90-degree angle, with its axis bolt bent slightly. All actuating mechanisms mounted in the tail section were found properly attached, safetied, and capable of normal operation. The elevator trim tab system was found intact except for the tab operating/indicatin control attached to the pilot's seat, which was not recovered

The rudder control system was found in generally the same condition as the elevator controls. The ends of the push-pull tubes were properly attached to the rudder pedals and the bellcrank at station No. 11, but were broken off when the nose separated from the aircraft. The bellcrank assembly was fractured in several places. From the bellcrank aft to the rudder horn in the tail, the rudder cables, connectors, and pulleys were properly routed and attached except at station No. 29, where the rudder pulleys were torn from their attach brackets The rudder trim tab system was found intact except for that part forward of station No. 16 where the cable had severed; this part was not recovered.

The elevator bellcrank at station No. 11 and a section of the fuselage at station No. 29 containing the tailwheel retraction, elevator, and rudder pulley brackets were sent to the Civil Aeronautics Board headquarters in Washington, D. C., for detailed examination and analysis. It was determined by this examination that the bellcrank failed from an instantaneous overload applied in a forward direction, that there was no metal fatigue, and the mechanical properties of these materials were within prescribed limits. Examination of the six pulley cluster showed that all portions had failed in the same manner and at the same time from a forward and upward overload applied by the cables to the pulleys resulting in a direction of failure 45 degrees to the longitudinal axis. It was also noted that the sides of the brackets were bent toward the middle of the cluster, there were no signs of fatigue and all material met design specifications

The entire tailwheel assembly including its retraction mechanism, was examined. All components of this system were found properly connected and believed capable of normal operation prior to impact

A review of the aircraft logs and maintenance records of N 1503V revealed no significant irregularities prior to the departure of the aircraft from Old Harbor on December 24, 1961

Analysis and Conclusions

Weight and balance checks conducted during the investigation, utilizing information supplied by Kodiak Airways' personnel, indicated that the aircraft was within gross weight limits and loaded well within the center of gravity range prior to departing the beach at Old Harbor

Nothing was found to indicate in-flight fire Evidence revealed that the powerplants were operating normally at the time of impact.

The main fuel selector valve was found in the "off" position, however, it is believed to have been moved during the salvage operation

In analyzing the statements of the pilot, passengers, and groundwitnesses, a composite picture of the takeoff indicates that initial lift-off was normal Shortly thereafter, while accelerating under full power to climb airspeed, the aircraft struck the water in a shallow descent, climbed back into the air in a nose-high attitude and stalled After pitching forward, the aircraft struck the water in a nose-low attitude The nose of the aircraft separated at impact The tail section was severed from the main fuselage, but remained attached by control cables

The possibility that airframe and/or control surface icing may have been a complicating factor in this accident was considered There is no source of official weather observations at Old Harbor; however, the air temperature at Kodiak Naval Air Station, 48 miles away, at 1100 a s.t., was 19 degrees F. The salt water temperature, at 0745 a s t., was 28 2 degrees F No excessive deviation from these readings would be likely at Old Harbor

Using these data as a basis, the aircraft's environment at the time of the accident would have been conducive to the formation of airframe ice as the result of spray generated during the takeoff run. However, an accumulation capable of producing the maneuver described would have prevented a normal lift-off and the subsequent interval of normal flight previously mentioned A small accumulation of ice on the tail surfaces would add to any control difficulties encountered but, because of the sequence of events and their time relationship, icing is not considered a factor in this accident.

There are several prominent possibilities of prime consideration in attempting to determine the cause of the maneuver executed by the aircraft. They are failure of the elevator control system, water in the hull creating an excessive aft CG [2/] movement, and a high-speed, low-angle porpoise. These will be discussed individually.

The loss of longitudinal control could have resulted from elevator control system failure, as diagnosed by the pilot. However, examination revealed that the two pairs of elevator and rudder control cables run through common fairleads and adjacent pulleys from station No. 11, where the nose section separated, to station No. 32 near where the tail section broke off At station No. 29, where four pulleys permit these cables to make a 90-degree turn upward, two tailwheel retraction cable pulleys are also adjacently installed. Here, one axis bolt serves the two rudder pulleys, and another axis bolt the four pulleys through

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2/ Center of Gravity

which the elevator and tailwheel retraction cables run. There was no metal fatigue found in these assemblies and it was determined that these two axis bolts, with the six pulleys, were torn simultaneously from their brackets as a result of an instantaneous overload of the cables acting on the pulleys. It is believed that this failure was due to impact forces which occurred when the tail section broke off at station No. 31. Moreover, all fractures in the flight control and tailwheel retraction systems were determined to have been caused either by impact forces or salvage operations. Having also determined that the powerplants were operating properly, it is reasonable to conclude that the airplane was mechanically capable of normal operation up to the time of impact.

A second possibility which could account for the loss of control is an excessive CG shift caused by water in the hull of the aircraft.

Proper loading of an aircraft will place the CG within specified limits. As the CG moves beyond the aft limit, the control forces tend to become zero with respect to the control surface deflection. When the CG continues rearward to and beyond the point of neutral stability, the aircraft becomes increasingly longitudinally uncontrollable. The absence of resistance to control movement experienced by the pilot could be the result of the above condition.

However, there are several factors which serve to eliminate this possibility. A routine preflight draining of the hull was conducted prior to departure from Kodiak. The inspection of the hull by the pilot prior to departure from

the beach at Old Harbor did not reveal any damage. A normal lift-off and short interval of normal flight preceded the accident, and close examination of the wreckage thereafter verified the water-tight integrity of the hull prior to impact

The most probable explanation of the maneuver described is that following takeoff the pilot intended to level off at low altitude in order to gain airspeed prior to the climb. The pilot testified that in Alaska this is done to avoid possible turbulence. However, instead of maintaining altitude the aircraft entered a shallow descent. The pilot failed to recognize the gradual loss of altitude and the resulting first contact with the water as described by the witnesses and the passenger. The above circumstances would result in the aircraft striking the water in a slightly nose-low attitude, which would produce a phenomenon known as high-speed low-limit porpoising. This condition of flight peculiar to flying boats has been the subject of several studies by various interested agencies. A consensus of their findings is that when a flying boat contacts the water at a shallow angle of incidence, with an airspeed in excess of that normally required for landing, the nose will initially be sucked deeper into the water. Then as the entire bow area of the hull is submerged the hydrodynamic forces will reverse and repel the aircraft with a violent thrust out of the water. This nose-up movement will increase the angle of attack and result in increased lift from the wing. The violence of the porpoise will be in direct proportion to the trim angle and airspeed of the aircraft at contact, and it will occur regardless of any action on the part of the pilot. Recovery must be effected during the ascent, or a stall will occur and the cycle will repeat itself with

increasing violence until either structural failure occurs, or the aircraft dives. Diving is the result of the nose completely submerging, and the aircraft flipping on its back and/or sinking.

The following is quoted from report number 1025 of the Aviation Design Research Section, Bureau of Aeronautics, Navy Department, which is a survey of landing and takeoff accidents of flying boats during a 22-month period:

"High Speed Low Angle Porpoising

Provided the aircraft does not dive, if it is landed at too high a speed, and too low an attitude, the first half cycle of a violent low angle porpoise is very liable to occur. If the pilot is alert ... he may be able to recover at the top of the cycle. If he is not, or the airplane won't respond to the controls it may hit again to start another cycle or it may dive in."

The appropriate recovery procedure from this maneuver requires full power throughout the recovery effort, and involves flying the aircraft out of the ascent phase of the cycle.

Report Number 1025 further states, "There were three incidents involving diving in smooth water, one of which followed the first cycle of high-speed low-angle porpoising. The fourth case of diving occurred in moderately rough water. In all these accidents the aircraft were completely demolished. In one instance the diving started at about 85 knots, which is some 25 knots above the stalling speed " This section referred specifically to the JRF-4 and 5, which is the U. S. Navy designation for the Grumman G-21A The report also included a drawing to differentiate between diving and high-speed low-limit porpoising. The sketch is included in this report as Attachment A.

The sequence of events described by the witnesses and passengers, and which, with the exception of the first high speed touchdown in the water, is consistent with the pilot's testimony, corresponds precisely to the sequence of events

associated with high-speed low-angle porpoising. While this accident occurred on takeoff, the pilot's failure to recognize the subsequent loss of altitude, resulted in the aircraft striking the water under conditions nearly identical to those of an improperly executed high-speed low-trim landing. In this instance structural failure occurred at impact after the first cycle.

The pilot did not realize that the aircraft descended into the water and had entered a porpoise, but erroneously assessed the resulting actions of the aircraft as having been generated by elevator control system failure Accordingly, the corrective actions taken by the pilot, such as the reduction in power and the use of full flaps, were completely incompatible with the actual condition, thus eliminating the little opportunity he had to effect a safe recovery.

Probable Cause

The Board determines that the probable cause of this accident was an improperly executed takeoff which resulted in an inadvertent descent into the water. This produced a high-speed low-angle porpoise from which the pilot was unable to recover.

BY THE CIVIL AERONAUTICS BOARD:

/s/ ALAN S. BOYD
Chairman

/s/ ROBERT T. MURPHY
Vice Chairman

/s/ CHAN GURNEY
Member

/s/ G. JOSEPH MINETTI
Member

/s/ WHITNEY GILLILLAND
Member

SUPPLEMENTAL DATA

Investigation and Taking of Depositions

The Civil Aeronautics Board was notified of this accident at 11 30 a.s.t., on December 24, 1961. An investigator was immediately dispatched to the scene and an investigation was initiated and conducted in accordance with the provisions of Title VII of the Federal Aviation Act of 1958. The taking of depositions was ordered by the Board and conducted at Kodiak, Alaska, on February 14, 1962

Air Carrier

Kodiak Airways, Inc., an Alaskan corporation with headquarters in Kodiak, Alaska, holds a certificate of public convenience and necessity issued by the Civil Aeronautics Board to engage in air transportation of persons, property and mail within Alaska. It also possesses a valid air carrier operating certificate issued by the Federal Aviation Agency.

Pilot

Gene Ralph Kingston, age 37, was employed by Kodiak Airways, Inc., on February 5, 1961 He held a valid commercial pilot certificate with airplane multiengine land and sea, airplane single-engine land and sea, and flight instructor ratings His current first-class Federal Aviation Agency physical certificate was issued June 27, 1961, without limitations. As of the date of the accident, Mr. Kingston had accumulated approximately 6,809 flying hours, of which approximately 1,160 were in amphibious aircraft. He was given approximately 26 hours of training in the G-21A aircraft before being checked out in this aircraft by Kodiak Airways, Inc., and had flown between 100-200 hours in the

G-21A prior to the accident. His last FAA proficiency check was satisfactorily accomplished in a Grumman G-44 on August 12, 1961. His last FAA route check was accomplished on December 12, 1961.

The Aircraft

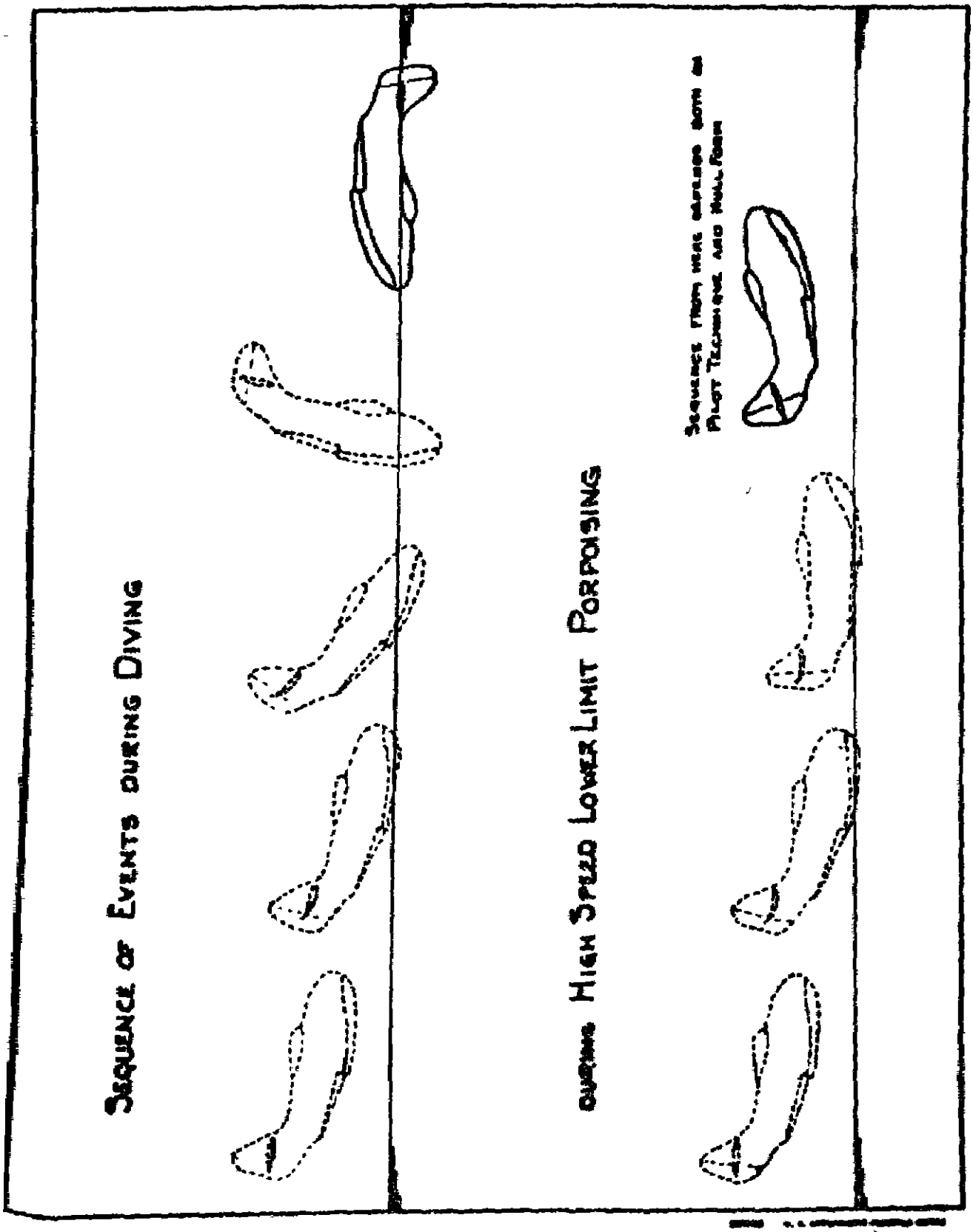
The aircraft, a Grumman Goose, model G-21A, U. S. Registry N 1503V, serial number 1020, date of manufacture unknown, airworthiness certificate issued August 19, 1956. The aircraft had a total flying time of 8,694.5 hours. The last periodic inspection was accomplished on April 7, 1961, and the aircraft had been flown 513.8 hours up to the time of the accident. The last major inspection (100 hours) was accomplished on December 11, 1961, and the aircraft was then flown 21.3 hours prior to the accident. The airplane was equipped with two Pratt and Whitney model R-985-AN1 engines with Hamilton-Standard propellers, hub model 2D30 and blade model 6167A-12. Time since overhaul for both engines and propellers was 513.8 hours each.

PREPARED BY _____ BUREAU OF AERONAUTICS DATE

CHECKED BY _____ NAVY DEPARTMENT PAGE - 9 - .

WASHINGTON, D. C.

AVIATION DESIGN RESEARCH SECTION REPORT NO _____



Attachment A