NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Ashburn, Virginia 20147

April 16, 2011

IMPACT STUDY AND ALTITUDE ALERTER OPERATION

ANC10MA068

by John Clark

ACCIDENT

Location:	Aleknagik, Alaska
Date:	August 9, 2010
Time:	1442 Alaska Daylight Time (ADT)
Aircraft:	de Havilland Canada DHC-3T, N455A

DETAILS OF STUDY

An approximate pitch attitude and an approximate climb angle at impact were derived from impact damage and ground scars that were documented in the Airworthiness Group Chairman's Factual Report. In addition, altitude alerter information and the general topography at the accident site were used to establish an approximate time between the activation of the altitude alerter and impact.

Pitch Attitude and Climb Angle at Impact

The Airworthiness Group Chairman's on-scene investigation and photographs provided evidence to establish the airplane attitude at impact. The report had defined a 30 degree bank angle at impact. Further examination of the photographs provided evidence of the flight path angle (climb angle) at the time of the impact. The Airworthiness Group Chairman's Factual Report determined that a 13-degree crush line found on the left float would have matched the 30-degree upslope of the terrain at the point of float impact. Matching the crush line with the slope of the terrain yields a 17-degree pitch attitude at impact. The airworthiness report provides further corroboration of those findings.

The following study provides details that define the climb angle as well above 5 degrees, likely in the 8-11 degree range. It is recognized that the results of the study are not precise, but provide a solid indication that the airplane was not cruising at impact, but was climbing

and maneuvering. The difference between the pitch attitude at impact and the climb angle provides a measure of angle of attack.

Photograph 1 depicts the overall crash scene.

Photograph 2 depicts the relative roll angle of the float impacts and of the wing impacts. The Airworthiness Group chairman determined that the impact angle of the floats was about 30 degrees, left wing down (LWD). The ground scar left by the left wing depicted a 21 degree angle. That equates directly to a 24 degree roll angle LWD (the dihedral is 3 degrees). It is possible that the difference between the impact angles of the floats and wing is a result of changing angles during crash sequence. However the elapsed time of the impact sequence is relatively short, about 0.17 seconds (discussed later). The left wing was folding back and that could also account for an apparent roll angle that is slightly less than the actual bank angle.

Photo 1 - Overall crash scene

Photo 2- Roll Angle at Impact. The float and left wing ground scars are highlighted.

Photo 3 - The float impact marks are highlighted.

Photograph 4 depicts the airplane rotated up 17 degrees so that the 13 degree crush on the left float matches the 30-degree upslope of the terrain. Photographs 5 and 6 depict the relative height at a point defined by the leading edge of the wing and centerline of the fuselage (LE/CL). That point on the fuselage is used to define the motion of the airplane during the impact sequence. The two positions are transferred to Photograph 7 and labeled point B and point C. The center of a line between points B and C are a reasonable representation of the reference point LE/CL. Another line represents the centerline along the ground. That line is centered between the ground scars created by the floats and features that are common to Photographs 1 and 2. A vertical height of the LE/CL point on the crashed fuselage is defined as point A. That vertical height is transposed to the ground scar area to the right.

A line that is midpoint between points B and C and transects point A defines the motion of the reference point LE/CL. The upslope of that line is consistent with a flight path (γ) of 11 degrees climb. The derived angle should not be considered an absolute, but does show that the climb angle was significant and not near zero (as if the airplane had cruised into the hillside).

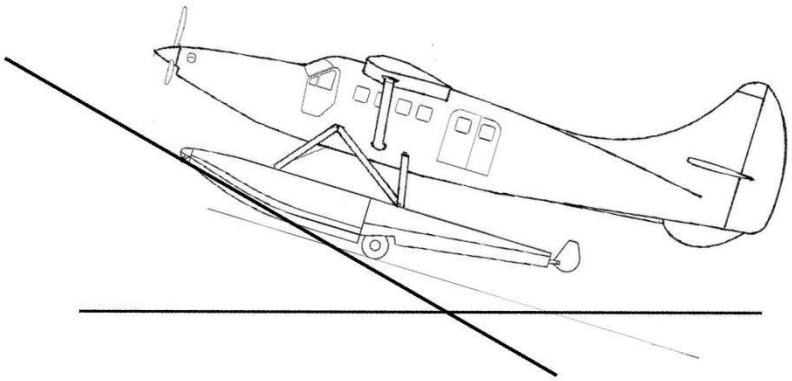

Figure 1 - Airplane rotated 17 degrees nose up so that the 13 degree crush matches the 30 degree terrain

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Photo 4 - A two-dimensional photograph of a DCH-3 on floats is rotated 17 degrees up to derive the height of the point at the leading edge of the wing at the centerline (LE/CL) – left float.

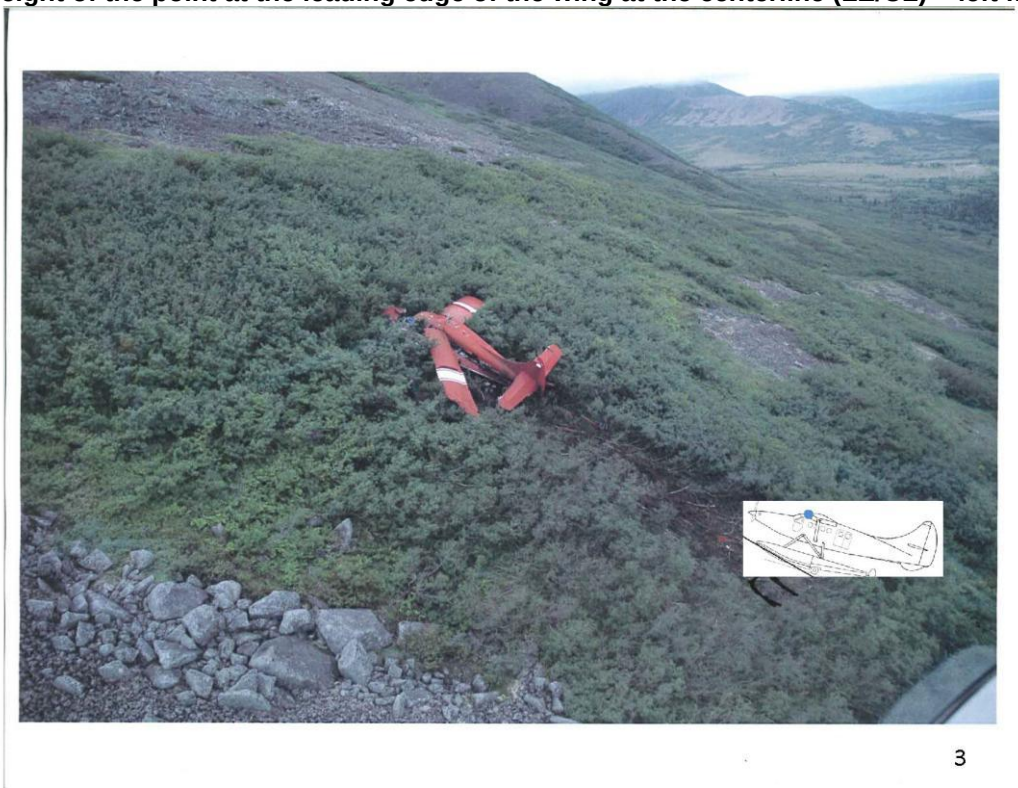

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Photo 5 - A two-dimensional photograph of a DHC-3 on floats is rotated 17 degrees up to derive the height of the point at the leading edge of the wing at the centerline (LE/CL) – right float.

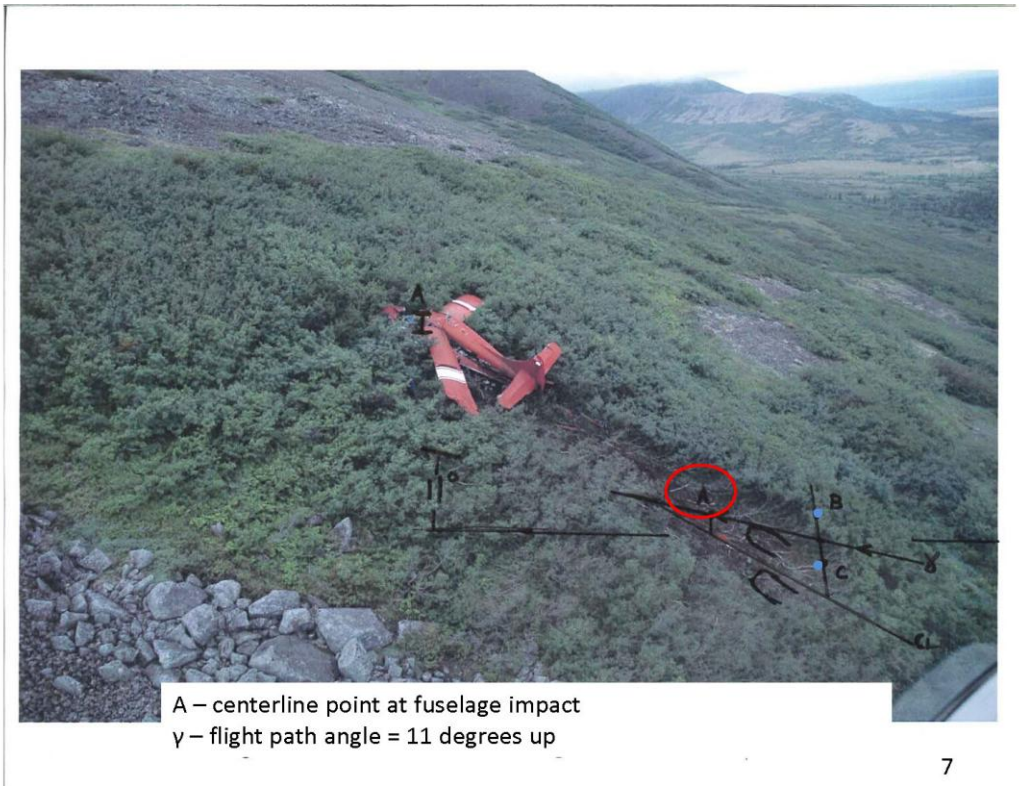

Photo 6 – Reconstructed flightpath angle of 11 degrees.

Reference length = (55.5 mm/81 mm)*41.9 ft = 28.7 ft

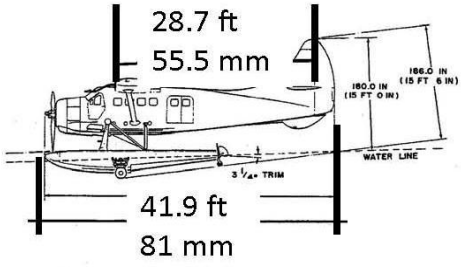

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Figure 2 - The drawing was used to determine a distance from the wing leading edge to the rudder hinge line. The distance was used to scale Photograph 8. (The scale factor changes when the figure is added to the report.)

The distance traveled by the fuselage between the points of contact of the floats and left wing root was about 27 feet. Although the impact speed is unknown, a representative ground speed of 95 knots would yield an elapsed time from float impact to wing tip impact of about 0.17 seconds.

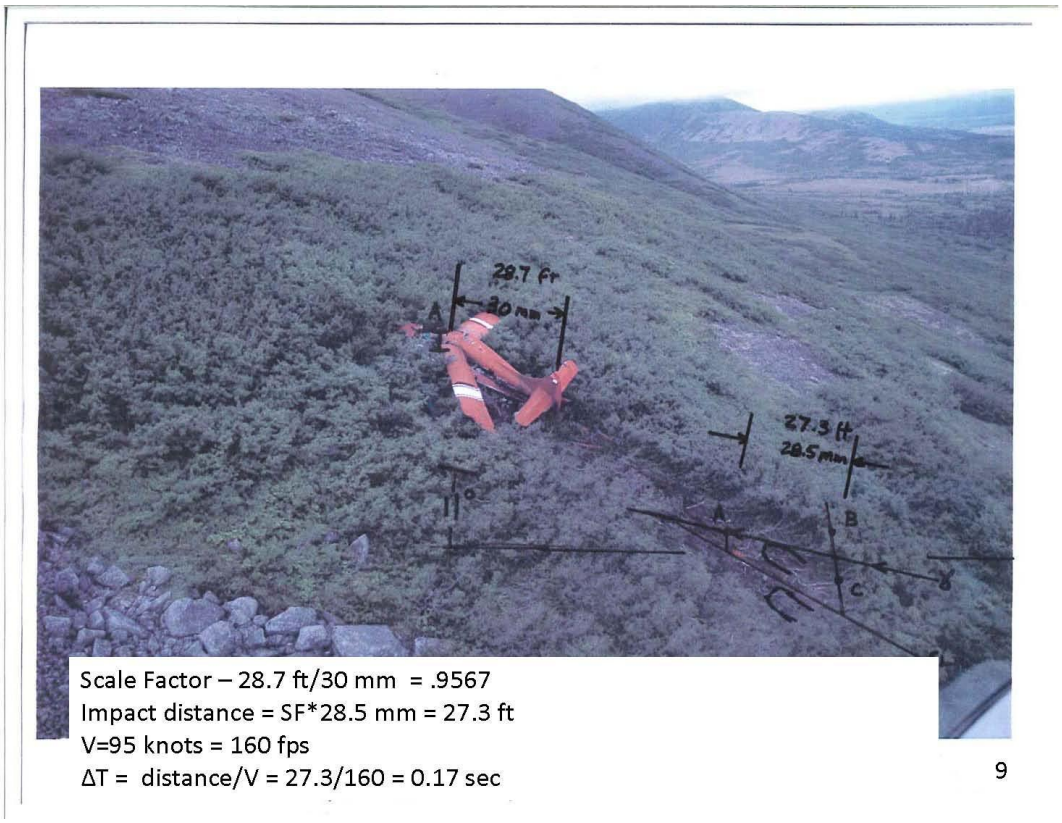

Photo 7 - Time and Distance Calculations. The distance travelled from float impact to wing impact was about 27 feet. At 95 knots, the time to travel that distance is about 0.17 seconds.

Example: Time from Altitude Alert to Impact

Measurements show that the airplane had pitched up to 17 degrees or more and the flight path had increased to 11 degrees at impact. The following is presented as an example of typical calculations since the actual speeds, pitch rate, bank rate, and normal accelerations (Gs) are not known:

> Assumption for the calculations: a steady bank angle of 25 degrees is assumed (recognizing that the starting bank angle was less than the 30 degree bank angle when the airplane hit the ground); an average normal acceleration of 1.75 Gs; and an airspeed of 100 knots. The time for the flight path angle to increase from 0 to 11 degrees

is about 1.7 seconds. The heading would change about 14 degrees to the left during the 1.7 second period and the airplane would climb about 30 feet. The altitude alerter was set at 275 feet for a total of about 305 feet elevation change from the point of altitude alert to impact. Several samples from Google Earth (one is presented in Figure 2) show that al elevation change of 305 feet could occur in about 700 feet. That distance would be traveled in about 4 seconds at a 100 knot ground speed.

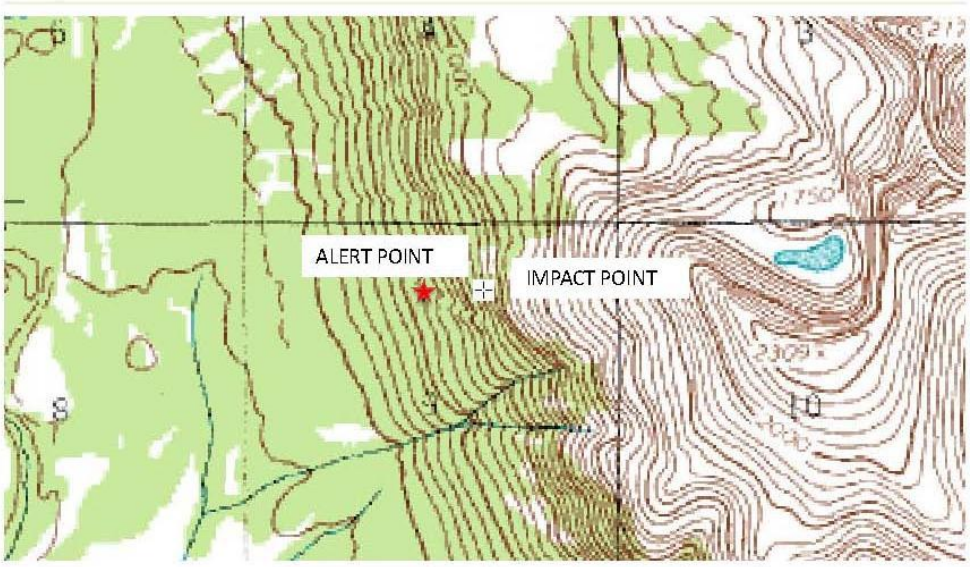

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Figure 3 - Estimated position of altitude alert.

Summary

The attitude at impact was about 30 degrees left wing down, and 17 degrees airplane nose up. The flight path angle was about 11 degrees up and the elapsed time from float contact to left wing tip contact was less than 0.2 seconds. One calculation using nominal values suggest that the time from altitude alert to impact is about 4 seconds. However, other reasonable estimates and measurements can result in times from alert to impact that range from 4 to 6 seconds.

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