



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

August 11, 2014

AIRWORTHINESS

Group Chairman's Factual Report

DCA13MA121

A. ACCIDENT: DCA13MA121

Operator: Rediske Air, Inc.
Location: Soldotna, Alaska
Date: July 7, 2013
Time: 1120 Alaska Daylight Time
Aircraft: de Havilland DHC-3 Otter
Registration Number: N93PC

B. AIRWORTHINESS GROUP

Chairman: Clinton R. Crookshanks
National Transportation Safety Board
Denver, Colorado

Member: Brice Banning
National Transportation Safety Board
Anchorage, Alaska

Member: Anthony Bockelman
Federal Aviation Administration
Anchorage, Alaska

Member: Dave Rees
Viking Air Limited
Sidney, British Columbia, Canada

C. SUMMARY

On July 7, 2013, about 1120 Alaska daylight time, a single-engine, turbine powered de Havilland DHC-3 “Otter” airplane, N93PC, was destroyed after a collision with terrain shortly after takeoff from the Soldotna Airport, Soldotna, Alaska. The airplane was registered to Rediske Family Limited Partnership, Nikiski, Alaska, and was operated by Rediske Air, Inc. under the provisions of 14 CFR Part 135, as an on-demand charter flight. The commercial pilot and nine passengers were fatally injured. Visual meteorological conditions prevailed and no flight plan was filed for the flight destined to Bear Mountain Lodge, approximately 90 miles southwest of Soldotna.

D. DETAILS OF THE INVESTIGATION

1.0 Aircraft

Manufacturer’s Serial Number (MSN): 280
Total Time: 22,831.8 hours (as of 6/13/13)

The de Havilland DHC-3 Otter is a single engine, propeller driven, single pilot, high wing short take-off and landing (STOL) airplane originally designed in the early 1950's (Figure 1¹). The original airplane was powered by a single radial engine but can be converted to turbine engine power by Supplemental Type Certificate (STC). The accident airplane was configured to carry 10 passengers and cargo and had a maximum gross weight of 8000 pounds. The airplane is 46 feet, 11 inches long, 12 feet, 6.6 inches high at the tail and has a wing span of 58 feet. The airplane is equipped with a cruciform tail and conventional landing gear. The accident airplane was powered by a Honeywell TPE-331 turboprop engine in accordance with Texas Turbine Conversions, Inc. STC SA SA009866SC. The type certificate for the airplane is currently owned and maintained by Viking Air Limited, Sidney, British Columbia, Canada.

2.0 Accident Aircraft Examination

The airplane came to rest about 2,320 feet from the threshold of runway 25 and about 154 feet right of the runway centerline. Runway 25 has an asphalt surface and is 5000 feet long and 132 feet wide. There was an extensive post-crash fire that consumed most of the cabin area of the airplane (Figure 2). The entire airplane was accounted for at the wreckage site. The airplane station diagram for the reciprocating engine powered airplane is presented in Figure 3 and can be referenced for all areas aft of the firewall.

The right wing was separated from the airplane at the wing root and recovered adjacent to the right side of the airplane lying on its lower surface and rotated aft about 90 degrees from its installed position as identified by the yellow arrow in Figure 2. The right inboard fore and aft flaps, outboard fore flap, and the inboard half of the aileron remained attached to the wing. The outboard third of the right wing had severe crushing damage in a downward and aftward direction. There was a ground scar that began about 13 feet south of the wing tip and led to the right wingtip that contained small, red fiberglass and aluminum pieces from the wing tip. The right aileron was fractured at the center hinge point. The outboard half of the right aileron was recovered in 2 pieces adjacent to the right wing. The right wing strut remained attached to the wing with both the upper and lower bolts intact. The strut was rotated aft and deformed around the inboard flap center hinge. The fuselage attach lug fitting was pulled from the fuselage. The lower 30 inches of the strut had minor sooting and fire damage. The aileron cable was intact from the right wing outboard quadrant through the center wing area to the left wing outboard quadrant. The aileron balance cable was fractured about 34 inches inboard of the right wing root. The fractured cable had a splayed appearance consistent with tension overload. The wing leading edge was crushed aftward from the wing root at wing station (WS) 34.15 to about WS 135.0. The inboard aft corner of the right wing was beneath the aft right fuselage and sustained light to moderate fire damage. The flap control system was intact from the wing root to the aft end of the inboard push-rod tube and to the outboard flaps but was jammed in place. The inboard flap push-rod was fractured about 2 inches forward of its mounting point at the center hinge. The inboard flaps were free to move and the outboard flaps were jammed in the up position due to the outboard wing deformation. The spanwise flap connecting rod was fractured about 13 inches inboard of the wing root. The outboard right aileron quadrant was fractured from its mount. The stall fence was intact on the upper wing surface. The upper surface of the wing had sooting and minor fire damage from the wing root to about WS 72.5. The forward spar attach lug on the

¹ All Figures are presented in Appendix A to this report.

fuselage side was fractured, but the bolt remained installed. The rear spar attach fitting was torn from the wing and found in the wreckage with the bolt intact and with significant fire damage.

The left wing was found inverted on the right side of the fuselage and was rotated forward about 120 degrees from its installed position as identified by the blue arrow in Figure 2. The inboard portion of the left wing forward of the rear spar was consumed by fire from about WS 122.5 inboard. The rear spar was intact with heavy fire damage, and the rear spar attach fittings and bolt were intact. A portion of the center wing rear spar remained attached to the left wing inboard of the attach point. The forward spar attach point was consumed by fire. The remaining lower wing skin inboard of WS 172.5 sustained light to heavy fire damage. The upper left wing strut fitting was intact and about 35 inches of the strut remained attached. The remainder of the strut and the fuselage attach point were consumed by fire. The left flaps and aileron remained intact and attached to the left wing. The outboard portion of the wing was intact with little damage. The inboard portions of the inboard fore and aft flaps sustained light to heavy fire damage. The flap control system was intact but the inboard quadrant mount was consumed by fire. The flaps and aileron were free to move. The pitot tube was fractured at its mount to the stinger in a downward direction but remained attached. There was grass embedded in the upper portion of the stinger. The stall fence on the upper wing surface was intact. The remaining upper surface of the left wing had minor sooting inboard of about WS 210.0.

The right fuselage, lower fuselage, and floor were consumed by fire forward of about fuselage station (FS) 204.0. The left fuselage was consumed by fire forward of about FS 308.0 and the upper fuselage was consumed by fire forward of about FS 294.0. There was heavy fire damage to the existing structure forward of about FS 308.0. The remains of a cargo net were found installed in the aft baggage compartment area. The cockpit was almost entirely consumed by fire. The control column was intact and the right yoke was attached but sustained heavy fire damage. The left yoke was consumed by fire. All of the aluminum control quadrant structure below the cockpit was consumed by fire but the control cables were intact. There were remains of a few unknown instruments and one of the Garmin GPS receivers found but the rest were consumed. The fiberglass nose fairings were heavily fire damaged or consumed by fire. The engine mount and engine were attached to the firewall.

The rudder trim and pitch trim cables were intact from the tail to the remains of the trim mechanisms at the forward portion of the airplane. The elevator and rudder cables were intact from the tail to the cockpit area. One of the pitch trim cables had the barrel missing from the turnbuckle but the safety wire was intact (Figure 4) and the other was intact. The aileron cables were intact from the cockpit area to the wing rear spar center section.

The empennage was intact and deformed to the left near FS 405.9. The horizontal stabilizer was further rotated to the left. The left side of the horizontal stabilizer, elevator, and flap/elevator interconnect tab were intact. The flap/elevator interconnect tab cables were intact from the lever in the empennage to the quadrant on the center section of the rear spar. The aft fuselage and empennage was laying on its right side and resting on the right horizontal stabilizer.

The wreckage was moved to a hangar and the empennage was shored up in a level position so the group could work. The horizontal stabilizer remained attached to the forward fin bulkhead at

the pivot points (FS 405.9). The horizontal stabilizer was rotated left leading edge forward with respect to the centerline of the fin. It was measured and calculated to be 34.5 degrees. The empennage was rotated to the left with respect to the fuselage at FS 405.9. It was measured to be 15 degrees. The left elevator was intact with no damage. The left side of the horizontal stabilizer was intact with only minor buckling damage at the inboard forward corner where it impacted the vertical fin. The fiberglass leading edge exhibited some cracked paint. The flap/elevator interconnect tab was intact and undamaged. The tab interconnect cables were attached to the lower end of the actuating lever and the actuating lever was intact. The tab forward connecting rod was attached to the top of the actuating lever. The tab forward connecting rod was fractured at the aft end of the forward rod end adjacent to deformation in the bulkhead. The aft end of the tab forward connecting rod was attached to the forward end of the tab intermediate connecting rod. The tab intermediate connecting rod was intact and attached to the bellcrank at the forward end of the left elevator. The tab aft connecting rod was intact and attached to the bellcrank at the forward end and to the tab at the aft end. All connections were secured with cotter pins. There was negligible play in the tab connecting rod ends. The flap/elevator interconnect tab had less than 1/32 inch movement at the trailing edge. The left tab was equipped with the redesigned mass balance arm in accordance with de Havilland Canada Modification Bulletin No. 3/912.

The right side of the horizontal stabilizer was intact but was deformed downward starting about horizontal stabilizer station (HSS) 68. The outboard end of the stabilizer was crushed downward and aft. The paint on the leading edge was scraped off from about HSS 42 to the tip. The right elevator was intact and deformed downward starting about HSS 90. The aft inboard corner of the elevator was crushed and deformed where it impacted the vertical fin and rudder. The servo tab was intact and penetrated the rudder at about rudder station 54.5 so that about 11.5 inches was protruding out of the left side of the rudder. The servo tab was deformed where it penetrated the rudder. The servo tab control rod was intact and attached at both ends. There was no noticeable play in the rod ends. The play at the trailing edge of the servo tab could not be evaluated since it was stuck in the rudder. The elevator torque tube was intact between the elevators and the control horn was deformed to the left. The elevator connecting rod was fractured about 5 inches forward of the aft rod end connection to the torque tube control horn. The rod was fractured adjacent to the damage in the surrounding fin structure and had compression buckling on the left side. The stabilizer trim jackscrew was intact and connected at the lower end. The fitting normally installed on the lower surface of the stabilizer to attach the trim jackscrew was pulled from the elevator. The threads were pulled from the nuts on the stabilizer side of the connection.

The rudder was intact and installed on the vertical fin. The only damage was where the right elevator servo tab punctured the rudder. The rudder was free to move so the position was not able to be determined. The rudder trim tab was installed with no damage. The rudder stops did not exhibit any evidence of repeated contact. The rudder trim was deflected slightly trailing edge right on-scene but had been moved further trailing edge right during recovery. The rudder trim tab exhibited about 1/16 inch of play at the trailing edge as installed.

All of the fractures examined exhibited features consistent with overstress separation

The elevator position at impact was recreated on a similar, intact airplane by moving the elevator to the position where the servo tab on the right elevator penetrated the rudder. The elevator measured 17° up at this position.

The rudder, upper vertical fin, and horizontal stabilizer with the elevators attached were removed to access the control system components. The horizontal stabilizer trim actuator was removed from the airplane and the extension distance was measured to be 0.650 inch between the housing and the land on the end fitting. The trim actuator setting was recreated on a similar, intact airplane by utilizing a 0.650 inch spacer. With the actuator set to this extension, the trim indication in the cockpit was about ½ unit aft of the zero position and 1 ½ units forward of the recommended takeoff position (Figure 5). The horizontal stabilizer on the airplane has a range of travel from 4.5° stabilizer nose up with 0 inches of extension on the actuator to 3.5° stabilizer nose down with 2.01 inches of extension on the actuator.

The diameter of the pivot bushings on the horizontal stabilizer were measured as follows:

RH OB – 0.371 inch, RH IB – 0.367 inch

LH OB – 0.372 inch, LH IB – 0.370 inch

The horizontal stabilizer pivot point lugs on the fuselage each measured 0.373 inch in diameter. The two bushings installed at the lower end of the trim actuator were measured at 0.309 inch each.

Several of the weld joints on the engine mount were cracked or fractured. The mount was cut along a vertical plane about 28 inches aft of the engine mount ring to facilitate engine removal. All six of the engine mount pieces were retained and shipped to the NTSB Materials Laboratory for further examination of the weld quality².

A digital camera and an iPhone were recovered in the wreckage and sent to the NTSB Vehicle Recorder Division for download and review. Several photos of the loading of the airplane and a video of the takeoff were recovered³. The recovered video was used to calculate the airplane motion⁴.

3.0 Maintenance Records

The accident airplane was manufactured in 1958 by the de Havilland Aircraft Company of Canada. The Rediske Family Limited Partnership purchased the airplane in October 2010. Prior to the purchase, the airplane was owned by a Canadian company and registered as C-FMPX. In July 2010, the airplane went to Recon Air Corporation in Geraldton, Ontario, Canada, for a major overhaul and conversion to a turbine powered airplane at an airplane total time of 22,536.5 hours⁵. The following Federal Aviation Administration (FAA) or Transport Canada (TC) STC's

² See the NTSB Material Lab Factual Report 14-018 in the public docket for details of the examination.

³ See the NTSB Non-Volatile Memory Devices, Specialist's Factual Report in the public docket for the details of the review.

⁴ See the NTSB Video Study in the public docket.

⁵ See Attachment 1 to this report for the Airframe Logbook pages that detail the work performed.

were incorporated as part of the work done by Recon⁶. TC major repair forms and the STC approval pages for these STC's were contained in the permanent maintenance records and were dated July 12, 2010.

SA03-82 (TC) or SA01855NY (FAA) – Kal-Air Model 1460 Extended Range Fuel System

SA94-114 (TC) – Baron STOL Kit

SA4005NM (FAA) – Pulse Light Control System

SA02-15 (TC) or SA009866SC (FAA) – Texas Turbine Conversion

Recon also performed all required inspections and complied with all applicable airworthiness directives (AD) during the overhaul. On July 9, 2010, the airplane (C-FMPX) was removed from the Canadian Civil Aircraft Register and placed on the US registry as N93PC. At this time the airplane received a FAA Standard Airworthiness Certificate in the Normal category.

Following the Recon conversion, in August 2010, three additional STC's were incorporated by Peninsula Aero Technology in Kenai, Alaska, to install updated avionics in the airplane at an airplane total time of 22,566.2 hours. The FAA major repair forms for these installations were contained in the records but there were no STC approval pages found in the records. There were airframe logbook entries for these installations.

SA01933LA (FAA) – Installed Garmin 430W in Avionics Stack

SA02153LA (FAA) – Installed Garmin G600 system

SA01933LA (FAA) – Installed Garmin 430W in Pilot's Panel

The records indicated that two additional STC's had been installed on the airplane prior to the conversion by Recon. The STC approval pages for these were contained in the permanent maintenance records. The shoulder harness STC had a TC repair form in the records dated August 26, 1995. There was no major repair form for the cargo net in the records examined.

O-LSA01-452/D (TC) – Cargo Net Installation

SA95-17 – Installation of Shoulder Harnesses

The airplane was maintained under an Approved Airplane Inspection Program (AAIP) dated 2/11/2011 that was approved by the FAA on 3-9-2011⁷. The AAIP was used for maintaining the accident airplane in lieu of conventional 100 hour and annual inspections. The AAIP divided the maintenance of the airplane into 4 consecutive phase inspections to be performed every 50 hours of flight time. Accomplishment of the phase inspections provided for the complete inspection of the airplane within each 12 month period. There was a special note in the AAIP that required accomplishment of all 4 phase inspections within each 12 months even if the airplane hour requirements were not met. The AAIP had provisions for a 10 hour grace period on all of the phase inspections. All special inspection items, calendar time inspections, AD's, and Service Bulletins (SB) outside the scope of the phase inspections were to be tracked and complied with under the AAIP. Rediske Air, Inc. documented all of the requirements of the AAIP in the Aircraft Inspection Record (AIR) maintained at the company headquarters.

⁶ See Attachment 2 to this report for the STC approval pages.

⁷ See Attachment 3 to this report for the AAIP.

On June 17, 2011, an inspection of the airplane in accordance with an annual, 800 hour, phases 1-4, and all calendar and special inspection items was completed at an airframe total time of 22,611.8 hours and the airplane was placed on the AAIP. At this time the engine and propeller had accumulated 75.3 hours and 26 cycles since the conversion. The records indicated that all applicable AD's were complied with at this time.

The inspections shown in Table 1 were performed between June 2011, when the airplane was placed on the Rediske AAIP, and the accident. The most recent inspection of the airplane incorporated phases 2, 3, and 4 on June 13, 2011 at an airplane total time of 22,831.8 hours⁸, and engine and propeller times of 295.3 hours since overhaul and installation on the airplane. There were 10 discrepancies recorded in the records during the most recent inspections and all were rectified. None of the discrepancies were notable in terms of major repairs to the airplane.

Phase Inspection	Date	Airplane Total Time	Time since last inspection	Total Cycles
1-4	6/17/11	22611.8	NA	26
1	10/7/11	22652.1	40.3	66
2	6/8/12	22678.9	26.8	80
3 & 4	6/28/12	22724.0	45.1	117
1	9/10/12	22765.9	41.9	144
2, 3, 4	6/13/13	22831.8	65.9	Not documented

Table 1 – Airplane Inspection Information

The Federal Aviation Regulations (FAR) 91.413 transponder tests required every 24 months were last performed on September 24, 2012. The FAR 91.411 static system tests required every 24 months were last performed on September 24, 2012. The FAR 91.207 ELT inspections required every 12 months were last performed on May 30, 2013. All of these recurring inspections were documented and tracked in the AIR and the transponder and static system tests were also documented in the airframe logbook.

The airframe logbook documented two items that were not documented in the AIR. On November 9, 2012, the horizontal stabilizer actuator bearings were replaced at an aircraft total time of 22,791.1 hours. On March 11, 2013, two new batteries were installed at an aircraft total time of 22,812.1 hours.

The following recurring AD's were listed and signed off in the records.

AD 83-04-05 Control Column Lower Weld, 6/13/2013

AD 83-02-01 Wing Strut Tie-Bar, 6/13/2013

AD 2005-14-12 Propeller Mounting Bolts, 6/13/2013

AD 2011-18-11 Elevator Control Tab Play, 6/13/2013

AD 86-16-12 Elevator Controls, N/A (due when wind gust of 60 kts are encountered)

The following one-time AD's were listed and signed off in the records.

AD 2011-12-02 Airspeed Limitations, 6/16/2011

⁸ See Attachment 4 to this report for the pertinent pages from the AIR.

The Instructions for Continued Airworthiness records were examined by the group and consisted of instructions for the Ameri-King ELT, Garmin 400W, Garmin G600, Teledyne Battery, Precise Flight Pulselight System, and Amerex C352 Fire Extinguisher. All instructions were incorporated into the AAIP.

4.0 Weight & Balance

The weight and balance information for the airplane was contained in the AIR⁹. As part of the Recon overhaul, the airplane was physically weighed on July 7, 2010, with the cargo net, ELT, turbine engine conversion, STOL kit, extended range fuel system and pulselight system listed as installed equipment. The new Empty Weight, as weighed, was 4259.00 pounds with a center of gravity (CG) at 132.66 inches. The notes stated that the airplane had residual fuel, full oil, and full hydraulic fluid for this weighing. In August 2010, the weight and balance was recalculated after the installation of the updated avionics. The recalculation removed the attitude indicator, turn and bank indicator, directional gyro and vertical speed indicator and installed the PMA7000H audio panel, two GNS430W GPS/nav/comm units, an electric attitude indicator, a GDU620 display unit, a GRS77 attitude and heading reference system, a GMU44 magnetometer, a GDC74A air data computer, and a GTX327 transponder. The new empty weight, as calculated, was 4283.09 pounds with a CG at 132.66 inches. Table 2 below shows a calculation of the weight and balance based on the data from the August 2010 paperwork. The total moment of removed equipment, highlighted in yellow, was calculated to be 138 lb-in greater than that in the paperwork. The data for the total installed, highlighted in orange, was also calculated to be different than that in the paperwork. The total installed weight was calculated to be 1.5 pounds greater, the total moment was calculated to be 103.50 lb-in greater, and the arm (CG) was calculated to be 2.11 inches less. The resultant total weight was calculated to be 4284.59 pounds with a CG at 132.60 inches. Subsequent to this calculation, the airplane weight and balance was recalculated on September 22, 2010, by Rediske Air to add two flashlights with a total weight of 3.4 pounds at an arm location of 111.0 inches. With this equipment added the airplane empty weight was calculated in Table 2 to be 4287.99 pounds with a CG at 132.59 inches.

Determination of the airplane weight and balance should be accomplished using the procedures contained in the original DHC-3 Otter Airplane Flight Manual (AFM) published by de Havilland Canada along with the information in the various flight manual supplements for the STCs installed on the airplane. The entire flight manual and all supplements were carried in the airplane during the accident flight. Portions of some of the manuals were recovered in the wreckage with fire and water damage. See Appendix B for photos of the title pages of those manuals that were recovered. Copies of the flight manual and all supplements were obtained from the various manufacturers for use by the investigation¹⁰. The basic operational loads diagram for the airplane contained the data for the passenger, cargo, oil, and fuel locations with instructions for calculating the actual weight and balance of the airplane as outlined in Section 4.7 of the original AFM. The Texas Turbines modification did not change the weight definitions or technique from the original but provided an updated balance diagram and operational loads diagram for use by the operator in Section 6 of their AFM Supplement. The updated diagrams

⁹ See Attachment 5 to this report for the pertinent weight and balance information.

¹⁰ See Attachment 6 to this report for the Airplane Flight Manual (Sections I-V) and pertinent Supplements.

showed the modified nose section of the airplane, had new data for the oil location, and modified the fuel tank sections with weights and moments consistent with the use of aviation turbine fuel with a density of 6.7 lb/gal. The fuel tank capacities were also changed to US gallons from the original imperial gallons capacities. The pilot, passenger, and cargo arms were not changed from the original. The Kal-Air extended range fuel system installed on the accident airplane increased the capacity of the rear fuel tank from 51 to 87 gallons by adding two additional fuel cells under the floor aft of the existing rear tank between FS 204 and 237. The three fuel cells making up the new rear tank were plumbed together and vented to act as one tank. The flight manual supplement for the extended range fuel system modified the operational loads diagram with the increased capacity and changed the arm for the rear fuel tank to 199.0 inches. Section V of the Kal-Air flight manual supplement states that the unusable fuel in the newly installed tanks is 4 pounds at an arm of 210.6 inches. The compliance documents for the extended range fuel system showed that the new rear tank arm was calculated based on all three cells being full and the aircraft in a level attitude. There was no information in the documents detailing the fuel distribution between the three cells with the tank partially full or the airplane in a tail-down attitude. The information on the two installed cells placed the arm for the forward cell at 211.0 inches and for the aft cell at 228.0 inches. The other STCs installed on the airplane made no change to the weight and balance procedures or performance of the airplane according to their flight manual supplements.

N93PC (S/N 280)		de Havilland DHC-3	
Data below from weighing of airplane July 7, 2010			
	Weight (lb)	Arm (in)	Moment (lb in)
LH	1930.0	108.30	209019.00
RH	2014.0	108.30	218116.20
Tail	315.0	437.70	137875.50
Total	4259.0	132.66	565010.70
Data below from W&B calculation August 19, 2010			
<u>Removed Equipment</u>			
Attitude Indicator	2.00	69.00	138.00
T&B	1.20	72.00	86.40
D.G.	2.40	69.00	165.60
VSI	0.85	72.00	61.20
Total Removed	6.45		451.20
<u>Installed Equipment</u>			
PMA7000H	1.50	69.00	103.50
GNS430	6.20	67.00	415.40
GNS430	6.20	67.00	415.40
4300 Electric Attitude Ind.	2.50	69.00	172.50
GDU620	6.38	72.00	459.36
GRS77	3.46	301.00	1041.46
GMU44	0.50	160.00	80.00
GDC74A	2.30	301.00	692.30
GTX327	3.00	69.00	207.00
Total Installed	32.04	111.95	3586.92
Total	4284.59	132.60	568146.42
Data below from W&B calculation September 22, 2010			
<u>Installed Equipment</u>			
2 Flashlights	3.40	111.00	377.40
Total	4287.99	132.59	568523.82

Table 2 – Empty Weight and Balance Calculations

The certificated maximum gross weight for the original airplane was 8000 pounds with a CG range from 135.8 to 149.8 inches. Beginning with S/N 225, de Havilland incorporated a modification to the airplane that added stall bars to the wing leading edges. This modification extended the aft CG limit to 152.2 inches. The accident airplane had this modification incorporated during manufacture. The Baron STOL kit STC replaced the leading edges on the wings and removed the stall bars. According to the STC holder, the reconfigured leading edges would not affect the CG range of the airplane and the performance of the modified airplane would meet or exceed that of the original airplane. The flight manual supplement for the STOL kit indicated that the weight and balance procedures and performance were unchanged. The FAA confirmed that the approved flight manual supplement for the STOL kit indicated that the CG range for the airplane was 135.8 to 152.2 inches. The original AFM provides information on the structural load limits for the various areas of the airplane in Figure 4-4. The aft cargo area between FS 264 and FS 294 has a load limit of approximately 650 pounds that can be distributed at 75 lb/ft². The cargo net STC (O-LSA01-452/D) states that the aft cargo area has a load limit of 750 pounds aft of FS 253. Information from the STC holder, JCM Aerodesign Limited, substantiated the increased load limit in the cargo area due to the increased size of the compartment.

4.1 Pilot & Passengers

The accident airplane was configured to carry a pilot and 10 passengers with one passenger able to sit in the right front (co-pilot's) seat as shown in Figure 6. The airplane was carrying a pilot and 9 passengers on the accident flight. Photographic evidence was obtained from an iPhone and a digital camera that were recovered in the wreckage. The photos were taken from the exterior as the passengers were loading the airplane and from the interior after all were loaded and the doors were closed. Prior to autopsy, the Alaska State Medical Examiner weighed each victim with all clothes removed but noted that all victims sustained thermal damage and degradation. Additionally, an email was obtained from the destination lodge that contained the passenger weights reported by one of the adult male passengers in preparation for the trip. Based on the photos and the recovery location of each victim, the seating location of each passenger was determined and matched to the weights. The weight in parentheses is the email reported value. The clothing listed for each person represents only what was visible in the photographs and may not include everything worn. The pilot was seated in the left front seat, weighed 200 pounds (220 pounds¹¹), and was wearing long pants and a light jacket. An adolescent male passenger was seated in the right front seat, weighed 160 pounds (145±3 pounds), and was wearing shorts, a shirt, a hooded sweatshirt, and athletic shoes. The two adult females were seated in row 1. One weighed 148 pounds (145±3 pounds) and was wearing jeans, a light jacket, and athletic shoes. The other weighed 133 pounds (145±3 pounds) and was wearing jeans, a shirt, a light jacket, and athletic shoes. One pre-adolescent female was seated in row 2, weighed 102 pounds (100 pounds), and was wearing athletic pants, a shirt, a light jacket, and athletic shoes. One adolescent female was also seated in row 2, weighed 128 pounds (145±3 pounds), and was wearing jeans, a shirt, a light jacket, and athletic shoes. One pre-adolescent male and one adolescent female were seated in row 3. The male weighed 103 pounds (110 pounds) and was wearing athletic pants, two shirts, a light jacket, and athletic shoes. The female weighed 121 pounds (145 ±3 pounds) and was wearing athletic pants, shorts, a shirt, a sweatshirt, and athletic shoes. One adult male was seated in

¹¹ Weight of pilot obtained from Rediske Air, Inc.

row 4, weighed 181 pounds (190 pounds), and was wearing pants, a light jacket, and athletic shoes. One adult male was seated in row 5, weighed 218 pounds (220 pounds), and was wearing pants, two shirts, a light jacket, and hiking shoes. The load manifest provided by Rediske Air listed a total passenger weight of 1350 pounds consistent with the email reported weights (1345 pounds total).

4.2 Cargo and Baggage

In addition to the passengers and their baggage, the airplane was carrying a load of food and supplies to the lodge. The photographic evidence shows the pilot fastening the cargo net prior to the passengers boarding, there was no cargo carried in the passenger area of the airplane, and the cargo net was installed at the forward end of the baggage area prior to the flight. During recovery, all of the identifiable baggage and personal effects were separated from the identifiable cargo so they could be weighed. The recovered baggage all sustained fire damage and weighed 187 pounds in total. Almost all of the cargo recovered had some amount of fire damage and an unknown quantity was consumed by the post-crash fire. Only those items that could be conclusively identified as food or supplies were retained and weighed. The cargo weighed 613 pounds in total. The individual items were not weighed.

A total of 9 unique pieces of baggage were recovered and documented during the on-scene portion of the investigation and turned over to the Soldotna Police Department after weighing. Contents of some of the bags were discernable due to fire damage or based on photographic evidence provided by the police department. The identifiable baggage consisted of the following.

1. One red and black Lowe Alpine backpack that contained a notepad, miscellaneous papers, 2 sets of keys, cased sunglasses, headphones and other unidentified items. The lower half of the backpack sustained fire damage that consumed most of that portion.
2. One black camera bag that contained a DSLR camera, at least two lenses, and various camera accessories. One end of the bag sustained heavy fire damage that consumed a portion of it and melted portions of the contents.
3. One unidentifiable black canvas bag that contained clothing. This bag sustained heavy fire damage such that only one corner of the bag remained along with some of the clothing. An unknown amount was consumed by fire.
4. One black Under Armour backpack with unidentified contents. This bag was essentially intact with light fire damage that melted the bottom portion.
5. One small black roller bag that contained unidentified contents. This bag sustained heavy fire damage to the top, back and sides that consumed and melted portions.
6. One black Tumi bag that contained unidentified contents. This bag sustained heavy fire damage to the top and sides that consumed and melted portions.
7. One medium green roller bag that contained clothing and other unidentified contents. This bag sustained heavy fire damage to the top, front and sides that consumed and melted portions.
8. One large red roller bag that contained clothing, a curling iron, a box of ammunition, a black Pelican 1170 case, and other unidentified contents. This bag sustained heavy

- fire damage to the top, front, and one side that consumed those portions. The Pelican case contained a handgun and was immediately turned over to the police department along with the box of ammunition prior to the bags being weighed.
9. One metal box that contained survival equipment. This box was intact with only the paint burned off. Representatives for Rediske Air said this box was installed in the airplane when they purchased it and was normally carried in the baggage area. There was no mention of this box as installed equipment on any of the weight and balance documentation for the airplane and there was no entry in the maintenance records installing it. This box was not included in the weight of the recovered baggage.

The black Pelican 1170 case contained a Ruger Super Redhawk Alaskan revolver chambered for 454 Casull or 45 Colt and 4 rounds of ammunition. The box of Hornady ammunition recovered in the red roller bag next to the Pelican case had 4 rounds missing from the box. The caliber of ammunition was not documented. The Pelican case did not have a lock installed on it. According to the documented specifications, the Ruger revolver weighs 44 ounces, the Pelican 1170 case weighs 2.1 pounds and the box of Hornady ammunition ranges from 1.11 pounds to 1.48 pounds depending on the caliber.

Examination of the photographic evidence was able to pinpoint the location of several items of baggage carried on by the passengers. The passenger in the right front seat did not carry a bag on the airplane. The passenger in the row 1 left seat had a black purse or satchel and the passenger in the row 1 right seat had a black backpack during the loading of the airplane. The passenger in the right seat placed her bag on the floor at her feet and the bag location for the left seat passenger was not visible in the photographs once the airplane was loaded. The row 2 passengers did not carry bags on the airplane. The row 3 left seat passenger had a blue and black backpack and the row 3 right seat passenger had a black Under Armour backpack that were each placed on their laps. The row 4 passenger had a black backpack during the loading of the airplane but its location was not visible in the photographs once the airplane was loaded. The row 5 passenger had a red and black backpack and a camera bag that were placed on the floor at his feet. The large red roller bag was placed in the passenger area forward of the cargo net at the location of the row 5 left seat. Photographs showed this bag in an upright position prior to takeoff. The large red roller bag is identified by the green arrow in Figure 7. The medium green roller bag that was recovered in the wreckage was not visible in any of the pre-accident photos and is identified by the yellow arrow in Figure 7. The steel box containing survival equipment that was recovered in the wreckage was not visible in the pre-accident photos and is identified by the blue arrow in Figure 7. The small black roller bag (Figure 8) and the small black Tumi carry-on bag (Figure 9) also recovered in the wreckage were not evident in any of the pre-accident photos. The email between the lodge and one of the male passengers indicated that the passengers would consolidate their items into 2 bags, each weighing 40 pounds. The load manifest obtained from the operator after the accident listed a total passenger baggage weight of 80 pounds. There was no evidence in the photographs of any restraining devices on the baggage located in the passenger cabin forward of the cargo net.

The lodge operator requested that a load of groceries and lodge supplies be flown out with the passenger group. He estimated the weight of the cargo at 300 pounds and delivered the cargo to the airport. The lodge operator was present during the loading of the airplane and stated that the cargo was not weighed prior to it being loaded. He stated that he assisted with the loading and handed all of the cargo to the pilot who loaded it in the airplane. Immediately after the accident, a receipt for the purchase of some of the food was provided by the lodge. Collection of the food debris in the wreckage revealed evidence of most of the items on the receipt. Identifiable food items in the wreckage consisted of unknown canned goods, red onions, yellow onions, green onions, potatoes, carrots, oranges, bread, eggs (broken and unbroken), cantaloupes, cheese, and broken open bags of frozen fruits and vegetables. The burned remains of some packages of bedding and some metal wall art were recovered in the wreckage. The recovered canned or bottled liquids were all breached and no liquid remained. There was a significant amount of meat products recovered in the wreckage that were not listed on the receipt provided to include hamburger, whole chickens, ribs, steaks, roasts, and packaged chicken. Repeated attempts to obtain a complete set of receipts from the lodge were unsuccessful. The group visited the store where the groceries were purchased and weighed each individual item on the receipt, with the purchased quantity. The total weight of items from the receipt was calculated to be 386.1 pounds. The load manifest listed a total freight weight of 300 pounds.

4.3 Fuel

The accident airplane was configured to carry 62 gallons of fuel in the forward tank, 102 gallons of fuel in the center tank, and 87 gallons of fuel in the extended range aft tank. Rediske Air did not keep fueling records for each flight and could not provide information on how much fuel was on board the airplane prior to the accident. A witness that was present during the fueling operations at Nikiski prior to departure to Soldotna said that he saw the pilot top off (fill) the forward tank, and then the pilot began to fill the center tank. The witness walked away from the airplane at that point and did not witness the remainder of the fueling operation. The witness later returned to the fuel supply tank to fuel his helicopter, and thought that he noticed 56 gallons on the fuel meter. The witness stated that he and the accident pilot would have been the only people to use the fuel from the fuel tank.

The Texas Turbines AFM Supplement instructs the operator to burn fuel from the forward tank during takeoff and from the aft tank forward after takeoff in order to leave as much fuel in the forward tank as possible for landing. The minimum amount of fuel for takeoff is 20 gallons in each of the three tanks to prevent introduction of air into the fuel system. According to Texas Turbines the engine would typically burn about 72 gal/hr at a takeoff power setting and 50-55 gal/hr at a cruise power setting depending on altitude. The higher burn rate would be for low altitudes and the lower burn rate for higher altitudes, i.e. 10,000 feet msl. The Soldotna airport is about 17 nautical miles south-southeast of the Nikiski airport where the Rediske base is. Bear Mountain Lodge where the airplane was destined for is about 71 nautical miles southwest of the Soldotna airport.

4.4 Operations Specifications for Weight and Balance

The Operations Specifications, section A096, for the operator allowed the operator to use only actual weights for determining weight and balance. The current section was approved in

March 2009. The pertinent pages are included in Attachment 5. The operator was allowed two alternatives for determining the actual weights; either using measured weights for all passengers and bags or using solicited (asked) passenger weights plus 10 pounds and measured weights for all bags. The procedure for cargo weight was not explicitly stated in the operations specifications. The specifications listed loading schedules for 5 specific airplanes but the DHC-3 airplane was not included even though it was included in the Aircraft Authorizations section of the operations specifications. The Britten-Norman Islander airplane required asked weights plus 10 pounds and the 4 Cessna 206 or 207 airplanes required actual weights. After the accident, the FAA attempted to insert a revised section A096 that included the accident airplane with a retroactive date¹².

Determination of the airplane weight and balance based on the known factual information is presented in the Weight and Balance Study in the public docket for this accident.

5.0 Tests and Research

In order to facilitate the Video Study, the group reconvened in Soldotna in November 2013 to perform a site survey of the airport and surrounding landmarks with the assistance of the Federal Bureau of Investigation (FBI). The FAA and Viking Air elected to not be present for this activity. Select items evident in the recovered video were located and surveyed with Total Station survey equipment provided and operated by the FBI that were then conclusively tied to two benchmarks located at the east and west ends of the runway. The surveyed items included runway 25, end lights, side lights, portions of the airport perimeter fence, portions of two power lines south of the runway, and distinct ground features and trees.

Additionally, the group examined a similar DHC-3 airplane (N491K) in order to collect various measurements. The recovered video was shot through the left, number 4, passenger window. The window measurements on the example airplane were all made to the inner edge of the rubber gasket. The left, number 4, passenger window measured 12.5 inches square and was located 10 inches below the lower wing surface and 58-7/8 inches aft of the wing leading edge. The wing chord measured 80.5 inches at the wing root and at the outboard flap hinge. The flap measured 137.5 inches long (spanwise) and the aileron measured 161-3/8 inches long (spanwise). The aileron chord measured 15.25 inches. The wing measured 25 feet, 1/2 inch long along the trailing edge from the side of the fuselage to the outboard end of the aileron and 25 feet, 1.5 inches long along the aft spar from the side of the fuselage to the inboard edge of the wing tip fairing. The center of the wing strut attach point on the lower surface of the wing was located 9 feet outboard of the side of the fuselage and 28.75 inches aft of the wing leading edge. The center of the wing strut attach point on the fuselage was located 52-3/8 inches below the lower surface of the wing and 34.5 inches aft of the wing leading edge.

¹² NTSB Operational Factors Group Chairman's Factual Report, Section 6.1 states "The operator was required to have each aircraft that it operated listed in the company weight and balance program (Ops Spec A096). A review of the company's Ops Specs after the accident revealed that the accident airplane was not listed in the weight and balance program. When asked why the airplane had not been added, the POI stated that it was an oversight. Rediske personnel were asked to add the accident airplane to the weight and balance program documents after the accident occurred."

The flaps on the Otter are hydraulically actuated by a hand pump in the cockpit. The pilot must pump the flaps to the desired position shown on the flap indicator located on the windshield center post. The flaps on the example airplane were set at each position on the indicator in the cockpit and the distance between the hinge arms was measured at the upper edge of the linkage on the center flap hinge. The example airplane had an STC installed that limited the flaps to 30 unlike the accident airplane. At flaps UP (CRUISE) there was no separation between the hinge arms, at flaps 10 (CLIMB) the hinge arms were separated 5/8 inch, at flaps 20 (TAKEOFF) the hinge arms were separated 1 inch, and at flaps 30 (LAND) the hinge arms were separated 1.25 inches. The center flap hinge linkage measured 9.5 inches long between the center of the attach points on the example airplane. Photos were taken of the left wing center flap hinge on the example airplane from the left, number 4, passenger window similar to the view in the recovered video. The photos were scaled so that the center flap hinge linkage was 9.5 inches long and the separation of the flap hinge was annotated and measured. Figure 10 shows the example airplane, N491K, center flap hinge with the flaps set at 20 and Figure 11 shows the example airplane center flap hinge with the flaps set at 30. A similar process was used for the accident airplane using one frame from the video during the takeoff roll as shown in Figure 12. The video showed that the flap position did not change for the duration of the video. Examination of the photos of the accident airplane during the loading of passengers showed the flaps in the up position. Viking Air utilized an airplane at their facility (C-FDNK) to recreate the accident airplane flap setting by extending the flaps on the example airplane until the flaps appeared to match the accident airplane flap setting in the video frame. At this position the flaps on the example airplane were in the full down position against the stop (Figure 13).

6.0 FAA Regulations

The accident flight was being operated under the provisions of 14 CFR, Part 135, as an on-demand charter flight and was subject to the applicable rules from that part and the requirements set forth in the operating specifications. The operator was not allowed to operate the accident airplane without complying with “the takeoff weight limitations in the Approved Flight Manual or equivalent” per 14 CFR 135.399. The requirements of 14 CFR 135.87 state that all cargo and baggage (including carry-on baggage) must be carried in an approved means, must be secured, and must not impose loads on the seats or floor greater than the limits in the design. Additionally, any stowage of baggage under the passenger seats requires that some means to restrain such baggage from sliding forward during a crash be present. There are no requirements in Part 135 or in the company’s operations specifications for the operator to physically document the weight and balance for any flights in their airplanes. However, 14 CFR 135.63 requires that operators using multiengine airplanes are “responsible for the preparation and accuracy of a load manifest in duplicate containing information concerning the loading of the aircraft.” This load manifest must be prepared before each flight and include the number of passengers, total weight of the loaded aircraft, the maximum allowable takeoff weight, and the CG location of the loaded aircraft among other items. One copy of the load manifest should be carried in the airplane and the operator is required to keep the records for at least 30 days.

The requirements for operation under 14 CFR, Part 121 are much different. All certificate holders under Part 121 are required to produce a load manifest that contains all of the weight and balance information including evidence that the airplane is within the approved CG limits for

each flight per 14 CFR 121.693. Copies of the load manifest must be carried on board the airplane and retained by the certificate holder for domestic and flag operations for at least three months per 14 CFR 121.695. For supplemental operations, 14 CFR 121.697 requires that copies of the load manifest be left at the departure location in addition to being carried on board the flight.

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