NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

AIRWORTHINESS GROUP CHAIRMANS' FACTUAL REPORT

November 9, 2017

A. ACCIDENT: DCA17FA109

Operator:	Air Cargo Carriers flight 1260
Location:	Charleston, West Virginia
Date:	May 5, 2017
Time:	0651 EDT
Aircraft:	Short Brothers Ltd. SD3-30 Variant 200
Registration:	N334AC
Serial Number:	SH-3029

B. AIRWORTHINESS GROUP

Co-Chairman:	Clinton R. Crookshanks National Transportation Safety Board Denver, Colorado
Co-Chairman:	Adam Huray National Transportation Safety Board Washington, District of Columbia
Member:	Robert Vickery Air Accidents Investigation Branch Hampshire, United Kingdom
Member:	Charlie Monola Federal Aviation Administration Charleston, West Virginia
Member:	Joe Southern Air Cargo Carriers Charleston, West Virginia

Member: Duane Stroik
Air Cargo Carriers
Milwaukee, WI

Member: Les Doud
Hartzell
Piqua, OH

C. SUMMARY

On May 5, 2017 at 6:51 a.m. eastern daylight time (EDT), Air Cargo Carriers flight 1260, a Shorts SD3-30, N334AC, crashed during landing on runway 5 at the Charleston Yeager International Airport, Charleston, WV. The airplane was destroyed and the two pilots suffered fatal injuries. The flight was a scheduled cargo flight from Louisville, Kentucky, operated under the provisions of 14 CFR 135. The aircraft was executing a VOR-A approach, weather was reported as overcast clouds at 500 feet and 10 miles visibility with light winds at the time of the accident.

D. AIRCRAFT DESCRIPTION:

1.0 General Information

The Short Brothers SD3-30 Variant 200 is an all aluminum high wing, twin turbo prop airplane that was introduced in 1976 (Figures 1-3). The airplane is equipped with retractable landing gear in a tricycle arrangement and twin vertical stabilizers and rudders mounted at the outboard ends of the horizontal stabilizer. It has a length of 58 ft-0.54 in, a height of 16 ft-3 in, and a wingspan of 74 ft-8.20 in. The airplane was originally designed as a passenger aircraft capable of transporting up to 30 people but could be converted for use in cargo operations. The airplane has a maximum takeoff weight of 22,900 pounds and a maximum landing weight of 22,600 pounds. The airplane is powered by two Pratt & Whitney Canada PT6A engines driving 5-blade Hartzell tractor propellers.

The accident airplane, registration number N334AC, serial number SH-3029, was built in 1979 and was issued its most recent Standard Airworthiness Certificate on December 17, 1998. The airplane was converted to a cargo airplane in December 1998 through the installation of several Supplemental Type Certificates (STC) prior to receiving its airworthiness certificate. Prior to the accident flight, the airplane had accrued 28,023.2 hours and 36,738 cycles. The airplane was not equipped with a cockpit voice recorder (CVR) or flight data recorder (FDR). [1]

[1] The accident airplane was originally delivered with a CVR installed; however, the CVR was not required after the cargo conversion and it was subsequently removed. The manufacturer also had an option for the installation of an FDR if requested by the customer.

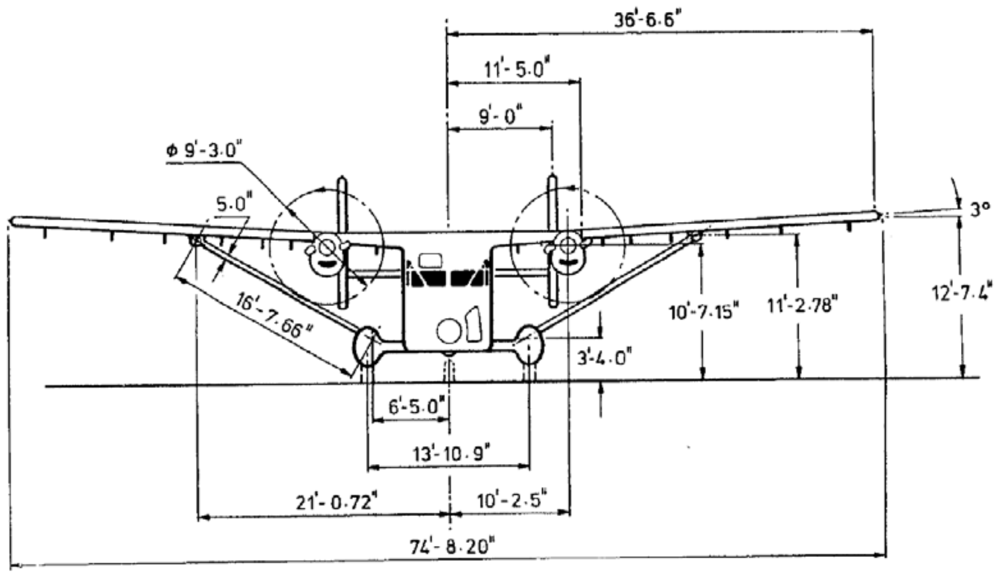

Figure 1: SD3-30 Front View

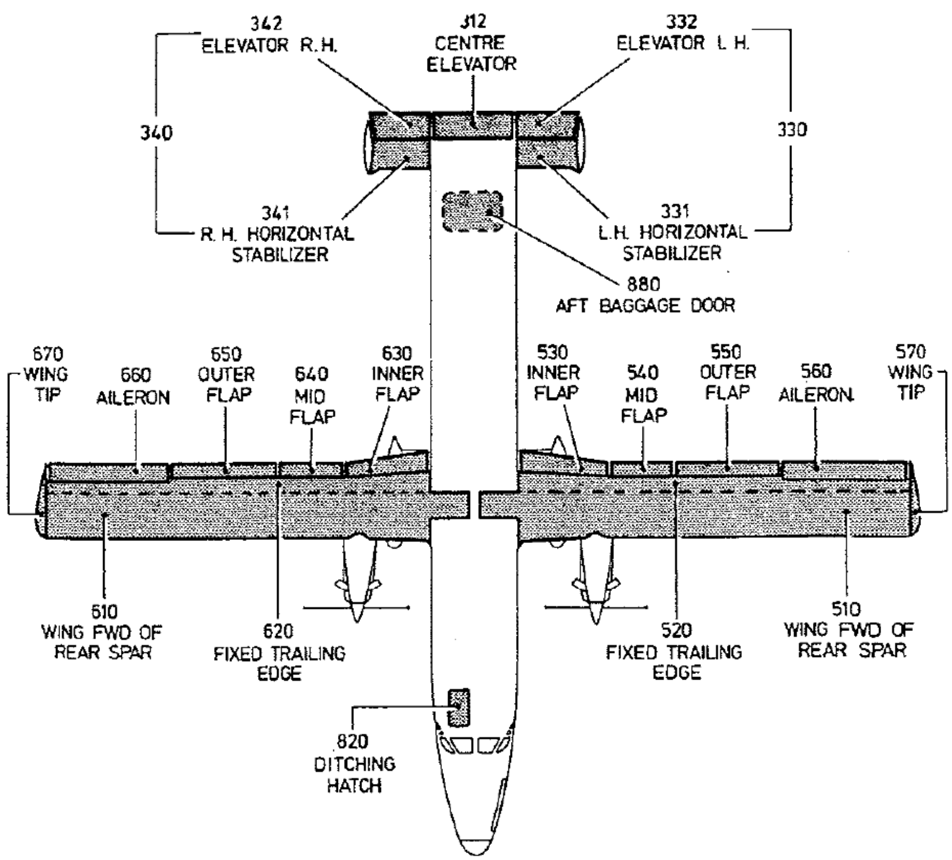

Figure 2: SD3-30 Top View and Flight Control Surface Locations

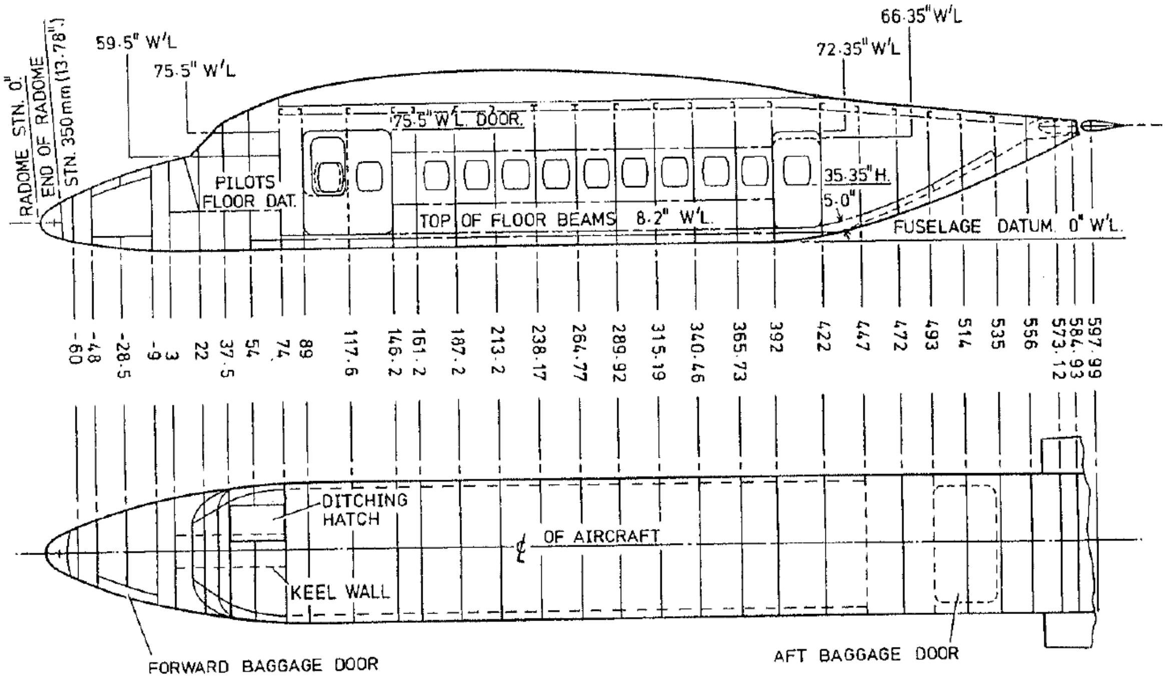

Figure 3: SD3-30 Fuselage Station Diagram

2.0 Airplane Systems Description

The mass and aerodynamically balanced primary control surfaces (elevators, ailerons, and rudder) are manually operated from conventional control columns, handwheels, and rudder pedals by reversible circuits of push/pull rods. Gear/trim tabs on the primary surfaces are adjusted by handwheels on the flight compartment center console which operate cable circuits to screwjacks at the tab linkages.

There are three flaps (inner, mid, and outer) installed on the trailing edge of each wing. The flaps are hydraulically operated and controlled by cable circuits from a selector lever on the center console. The flaps selector lever has gated positions for 0°, 4°, 8°, 15°, and 35°. The control system consists of a duplicated cable input circuit from the selector lever to a springpot that signals all six actuators. Beyond the springpot the signal to the inner flap actuators is conveyed by a rod and lever system and to the mid and outer flap actuators by interconnected control cables. As an additional safety feature, a link connects the adjacent ends of the mid and outer flap surfaces to prevent flaps asymmetry.

The main system hydraulic power supply provides for the operation of the flaps, landing gear, brakes, and nosewheel steering. The left and right engine driven pumps provide 3000 psi. The system has four accumulators: the main system accumulator which acts as a smoothing device for the pumps and allows for sudden changes in flow demands, a landing gear emergency accumulator, an emergency brake accumulator, and a flap system accumulator.

Primary electrical power for the aircraft is supplied by two engine driven starter/generators, one on each engine. The generators each supply 28 VDC to an associated General Busbar. The two General Busbars normally operate independently, but provision is made to couple them for engine starting, when external supply is connected, and in the event of a generator failure. AC power is normally provided by two inverters, one connected to each General Busbar. Both inverters will provide 115 volts (400Hz), single phase, power. A third (standby) inverter is installed which will automatically provide an alternative AC supply in the event of failure of either normal inverter. A 24 volt battery is connected to each General Busbar, providing reserve DC power. The system is designed to preclude the total loss of electrical power as a result of a single fault in any part of the system with provision for busbar coupling, load shedding, and alternative supplies from the General Busbars to DC Essential Service Busbars.

The aircraft is equipped with two Pratt & Whitney Canada PT6A-45R turboprop engines. The control of each engine is afforded by three levers (power, fuel, and prop) mounted on the flight deck center console. The engines main controlling agents are the fuel control units which comprises gas generator governor, fuel metering, and pneumatic (computing) sections, and the propeller governor which embodies a propeller fuel governor, and a beta control valve.

The pilot's power lever sets the gas generator speed point and, when in the ground regime (Beta mode), will reset the propeller fuel governor to permit direct selection of propeller blade angle. The power lever is restricted from entering Beta mode from flight mode by the air/ground lever. This lever requires pilot input to press the lever down in order for the power levers to move into the ground range. In addition, the power levers are restricted from entering positions below GROUND FINE by the Reverse Thrust Baulk Lever which requires pilot action to push a spring loaded stop out of the way prior to moving the levers.

The fuel lever is employed to set the gas generator minimum governing speeds and provides a means of shutting off the metered fuel flow. When the fuel lever is selected to GROUND the speed range available is from 66.5% up to 104%. When the fuel lever is selected to FLIGHT the speed range available is from 76% to 104%. The PROP lever is employed to select the propeller governor speed set point and also provide a means of feathering the propeller.

The engines have two defined modes of operation. Propeller governing mode occurs when the power control lever is set in the "air" mode between FLIGHT IDLE and takeoff. In this mode propeller RPM will be maintained, when possible, at that selected by the PROP lever by automatic changes in blade pitch brought about by the propeller governor. The propeller speed range in this mode is between 1150 and 1675 RPM. Beta governing mode occurs when the power lever is set in the "ground" regime between just below FLIGHT IDLE and full REVERSE. In this mode propeller blade angle is directly scheduled by the power lever and thus propeller RPM will fall out as a combination of blade angle and power selected.

E. <u>DETAILS OF THE INVESTIGATION</u>

1.0 Accident Site Description

Measurements in this section were derived from both physical measurements obtained during the on-scene investigation as well as from data obtained by aerial imagery.[2] The start of the first centerline stripe on runway 5 was used as the reference point for many measurements discussed in this section. This centerline stripe began approximately 300 ft beyond the trailing edge of the runway threshold line.

The airplane impacted the runway at the centerline, exited the left side of the runway, traveled through the runway safety area, and went down a steep tree-covered slope before coming to rest (Figure 4). The first ground scar originated about 29 ft-6 in from the start of the centerline stripe and directly on the centerline seam. It was about 3.5 in wide and 16ft-4 in long, and oriented on a heading of about 16° when overlaid on Google Earth. Proceeding along the centerline, the next witness mark was a black scuff mark that originated about 82 ft-9 in from the start of the centerline stripe, and about 8 ft-6 in to the right of the centerline seam. This black mark was oriented on a heading of about 15°, and transitioned into a deep gouge as it crossed the runway centerline. The next witness mark was the first of 14 parallel marks consistent with propeller strikes. It was located about 89 ft-2 in from the start of the centerline stripe and about 4 ft-9 in to the left of the centerline seam. The first two strikes were about 16 in apart and the path of consecutive strikes was on a heading of about 27°. The last prop strike was a small chunk of missing pavement located about 108 ft-7 in from the start of the centerline stripe and about 11 ft-2 in to the left of the centerline seam.

Continuing along the centerline, there was an area of runway scarring, about 18 feet wide, that crossed the centerline seam. The first witness mark from this area was a scuff located about 93 feet from the start of the centerline stripe. There was a deep gouge, about 9 in wide, located about 95 feet-11 in from the start of the centerline stripe. A smaller gouge was located about 3 feet further down the centerline (as measured from the two closest edges of the gouges). The last witness mark from this area was heavy scuffing, about 11 in wide, with the far edge located about 111 ft from the start of the centerline stripe. This witness mark trail widened as it continued on a heading of about 14° to the edge of the runway, through the runway safety area, and to the edge of a steep drop off. The edge of the drop off was located about 178 ft from the left edge of runway 5.

The left wing and attached engine, left wing strut, left main landing gear, and the left landing gear fairing separated from the airplane and were found in the runway safety area on the left side of runway 5. Three aileron counterweights, propeller blade fragments, a strobe light, and one runway edge light were also found in the runway safety area. The left wing was located on the right side of the witness mark trail and approximately 85 ft to the left of the runway edge. The left main landing gear assembly containing the wheel, trunnion, and about 11 ft of the wing strut was located on the right side of the witness mark trail about 30 ft prior to the edge of the drop off. The left landing gear shock absorber and attach point structure was found about 103 ft northeast of the left main landing gear. The shock had about 7 inches of chrome extension. The landing gear fairing was separated into several pieces in the runway safety area.

---

[2] See the Aerial Imagery Factual report in the public docket for details.

The main wreckage was located about 550 feet from the beginning of the first runway stripe and about 380 feet to the left of the centerline in steep, heavily wooded terrain. The elevation of the main wreckage site was about 85 feet below the runway surface. The main wreckage site contained the fuselage, empennage, right wing, right main landing gear, and right engine.

Figure 4: Accident Site Overview and Points of Interest

1. Start of First Ground Scar on Centerline
2. First Black Scuff Mark to Right of Centerline
3. First Prop Strike
4. Far Edge of Last Heavy Scuff Mark on Centerline
5. Runway Departure Point
6. Left Wing and Engine
7. Left Landing Gear and Strut
8. Left Landing Gear Shock Absorber
9. Runway Safety Area Departure Point and Start of Drop Off
10. Main Wreckage Location

2.0 Main Wreckage Examination

Figure 5: Main Wreckage

The fuselage was resting on its left side with significant crushing damage and deformation noted forward of the location of the main landing gear (Figure 5). There was no evidence of fire on any of the wreckage or surrounding vegetation. The cockpit area was crushed and damaged on the left side. The nose structure and radome were separated from the fuselage near fuselage station (FS) 0 and recovered about 20 feet forward of the fuselage. The radome was essentially undamaged. There was a fracture in the fuselage along the lower right corner between about FS 89 and FS 250, and the fuselage was distorted and buckled throughout this area. The nose and right main landing gear remained attached and were in an extended position. The right stub wing, right main landing gear, and a portion of the right strut remained attached to the fuselage with little apparent damage. In the center wing area, both tie rods that couple the left flaps cable quadrant to the right flaps cable quadrant were intact and secure. Following aircraft recovery, it was noted that the flaps springpot was severed at the left side eye-end and that a control cable connected to the forward quadrant of the flaps input duplicated quadrant was broken. It was also observed that the left inner flap actuator chrome extension measured 3-1/8 in from the housing to the center of the attachment bolt and the right inner flap actuator chrome extension measured 3-3/8 in from the housing to the center of the attachment bolt. A discolored outline of the right inner flap surface was found on the right side of the fuselage corresponding with a flaps position of about 35°.

The right wing was fractured at the wing root and deformed forward and leading edge down. The right wing was intact, partially attached to the fuselage, and mostly undamaged. The right wing strut was broken about 66 inches above the lower attach lug. The right wing attach points were intact but the fuselage structure around them was fractured in multiple places. The right engine remained attached to the right wing. Both the control rod and damper positioned between the inboard flap and the connecting bellcrank were intact and connected at both ends. The control rod that extends from this bellcrank inboard to the wing root was also intact and connected at both ends, however the structure on the inboard end was separated from the rest of the aircraft. The control rods connecting the mid and outer flaps to their respective actuators were intact and connected at both ends. The link that interconnects the mid and outer flap structure was intact and the two flap surfaces remained coupled. The aileron control rod at the wing root break remained attached to structure on the inboard side, however the structure was separated from the rest of the aircraft. An aileron control rod was also severed at the wing hinge location. The aileron could only be moved a small amount and was positioned about 4 in up as measured from the trailing edge of the outboard wing tip to the trailing edge of the aileron surface. The four control rods between the aileron trim actuators and the aileron trim tab remained intact and connected. The aileron trim tab was deflected down but could not be measured.

The following observations of the right wing were made after aircraft recovery. All inspected control cable breaks were either cut or demonstrated features consistent with tensile overload such as having a splayed, broom straw appearance. The aileron trim control cable was over-traveled with the aft cable terminal pulled adjacent to the trim actuator drive gear. All aileron control rod connections were secure. The inboard flap position transmitter link was bent and severed but remained connected at the transmitter end. The mid flap control rod between the cable/control rod interconnect pulley and the actuator was bent and remained connected at both ends. The vertical input shaft to the mid flap actuator was fractured. The actuator was removed and the fractured shaft was retained for further analysis. The shaft fracture features were consistent with torsional overload.[3] The outer flap control rod between the cable/control rod interconnect pulley and the actuator was intact and connected.

The right vertical stabilizer and rudder, right horizontal stabilizer and elevator, and center elevator remained attached to the empennage. The top of the right vertical stabilizer and rudder assembly was rotated inboard due to deformation of the outboard right horizontal stabilizer. The right rudder was in an almost neutral position and the trim tab trailing edge was deflected to the right. The right elevator was displaced relative to the horizontal stabilizer but its deflection could not be determined. The trim tab on the right elevator was deflected down. The center elevator was deflected slightly trailing edge up. The left vertical stabilizer and attached rudder were separated from the left horizontal stabilizer and found about 20 feet uphill from the main wreckage. The left rudder could be moved freely. The left rudder trim tab was jammed with the trailing edge deflected approximately 1 inch to the right. The inboard 3 feet of the left horizontal stabilizer remained attached to the fuselage but was heavily damaged. The remaining portions of the left horizontal stabilizer were separated from the aircraft and crushed into several pieces in the main wreckage area. The left elevator was separated from the stabilizer and was lying on the ground next to the aft fuselage. The trim tab for the left elevator was deflected trailing edge down. The left propeller and reduction gearbox were found adjacent to the aft fuselage in the main wreckage area.

[3] See the NTSB Materials Lab examination report in the public docket for the details of the examination.

3.0 Left Wing Examination

Figure 6: Left Wing and Engine

The left wing was separated from the aircraft and found along the debris path in the runway safety area on the left side of runway 5 (Figure 6). The left wing was mostly intact with all three flaps, the aileron, a portion of the wing strut, and the engine still attached. The left propeller and reduction gearbox were fractured from the left engine. The wing separated at the side-of-body near wing station (WS) 45. The outboard left wing forward and aft spar attach pins were intact. The inboard left wing forward and rear spar attach point structure was torn from the wing and remained with the fuselage. The upper 4 feet of the left wing strut remained attached to the wing. The wing was free to move about the hinge point at WS 140.75. The inboard left wing was resting on the engine nacelle and the outboard left wing was resting on the lower surface such that the inboard wing was rotated up about the hinge point. The fairings around the hinge point were damaged consistent with the wing position. The forward end of the left wingtip fairing and strobe light were separated and the outboard portion of the wing leading edge was crushed rearward from about WS 343 to the tip. There was mud, dirt, and grass on and embedded in the leading edge and wing tip. The inboard aileron counterweight remained attached to the left aileron but the outboard aileron counterweight was separated from the aileron hinge.

All the control cables and control rods, electrical wiring, fuel lines, and hydraulic lines were severed near the area of wing separation at WS 45. An aileron control rod was also fractured near WS 140.75 where the wing was rotated about the hinge point, but otherwise aileron control continuity was established from the wing root at WS 45 to the aileron. The aileron was jammed about 6 in down as measured from the trailing edge of the outboard wing tip to the trailing edge of the aileron surface. The aileron control rod was binding on the connecting hardware that secured the outer flap control rod to the cable interconnect pulley. The four control rods between the aileron trim actuators and the aileron trim tab remained intact and connected. The aileron trim tab could not be moved and was deflected up 1 ¾ in as measured from the trailing edge of the trim tab to the trailing edge of the aileron surface. There was buckling damage to the inboard and outboard ends of the inner flap and the inboard end of the mid flap. The flaps appeared to be in a full down position. The trailing edge of the outer flap was about 8-1/2 in below the trailing edge of the aileron trim tab. The inner flap could move, and would slowly droop down when lifted. When the flap was moved the exposed flap control rod at the wing root break also moved. The outer and mid flaps could not be moved by hand. The interconnecting link on the mid flap and the adjacent slot on the outer flap remained intact, however, the two flap surfaces were decoupled. Both the control rod and damper positioned between the inboard flap and the connecting bellcrank were intact and connected at both ends. The extension of the damper measured 4-1/8 in from the center of the rod end attachment bolt to the piston housing. The control rod that extends from this bellcrank inboard to the wing root also remained connected to the bellcrank but was fractured near the wing break. The control rod connecting the mid flap to the actuator was bent and severed. The control rod connecting the outer flap to the actuator was intact and connected at both ends. The outboard flap position transmitter link was intact and connected at both ends.

The following observations of the left wing were made after aircraft recovery. All inspected control cable breaks were either cut or demonstrated features consistent with tensile overload such as having a splayed, broom straw appearance. The aileron trim control cable was over-traveled, with the aft cable terminal pulled adjacent to the trim actuator drive gear. The mid and outboard flap control rods between the cable/control rod interconnect pulley and the corresponding flap actuator were intact and connected.

4.0 Primary Flight Controls

Both control columns were broken at the base and had partial movement in the forward/aft and left/right directions. Both control wheels were jammed in a full right turn position. The Captain's rudder pedal assembly was broken, deformed, and the left pedal was missing. The position of the First Officer's rudder pedal assembly was about neutral, and the left pedal was also missing. Both pedal assemblies appeared to move together, although travel was severely limited. To facilitate aircraft recovery the structure and flight control rods were severed just aft of the flight deck seats. Following the aircraft recovery efforts, it was observed that the base of both control columns and the elevator flight control rod in the flight deck moved together. Both control wheels and the aileron flight control rod in the flight deck moved together. Also, both rudder pedal assemblies and the rudder flight control rod in the flight deck moved together.

Flight control continuity was checked either visually or by moving control rods and observing distant movement of a control rod or surface. In many cases, the movement was severely limited by binding and damage. The rudder system had flight control continuity from the pedals to the remaining rudder with the exception of a fractured control rod eye end that connected to the bellcrank where the control rods transition from the floor to the left wall (FS 264.77). The elevator system had flight control continuity from the columns to the remaining elevators with the exception of a control rod that was fractured about 8-½ feet aft of the flight deck bulkhead coincident with a break in the fuselage. The aileron system had continuity from the control wheels to the cabin ceiling below the wing with the following exceptions. The control rods in the fuselage were jammed due to structure deformation. The top bellcrank at the flight deck bulkhead was severed, but both rods remained attached to their respective ends. The rod just aft of this bellcrank was fractured coincident with adjacent structural deformation. The aileron control rods from the wing roots to the ailerons were also examined and are detailed in Sections 2 and 3 of this report. All of the control system fractures were examined and had a dull, grainy appearance and features consistent with overload separation.

5.0 Flight Deck Observations and Lever/Switch Positions:

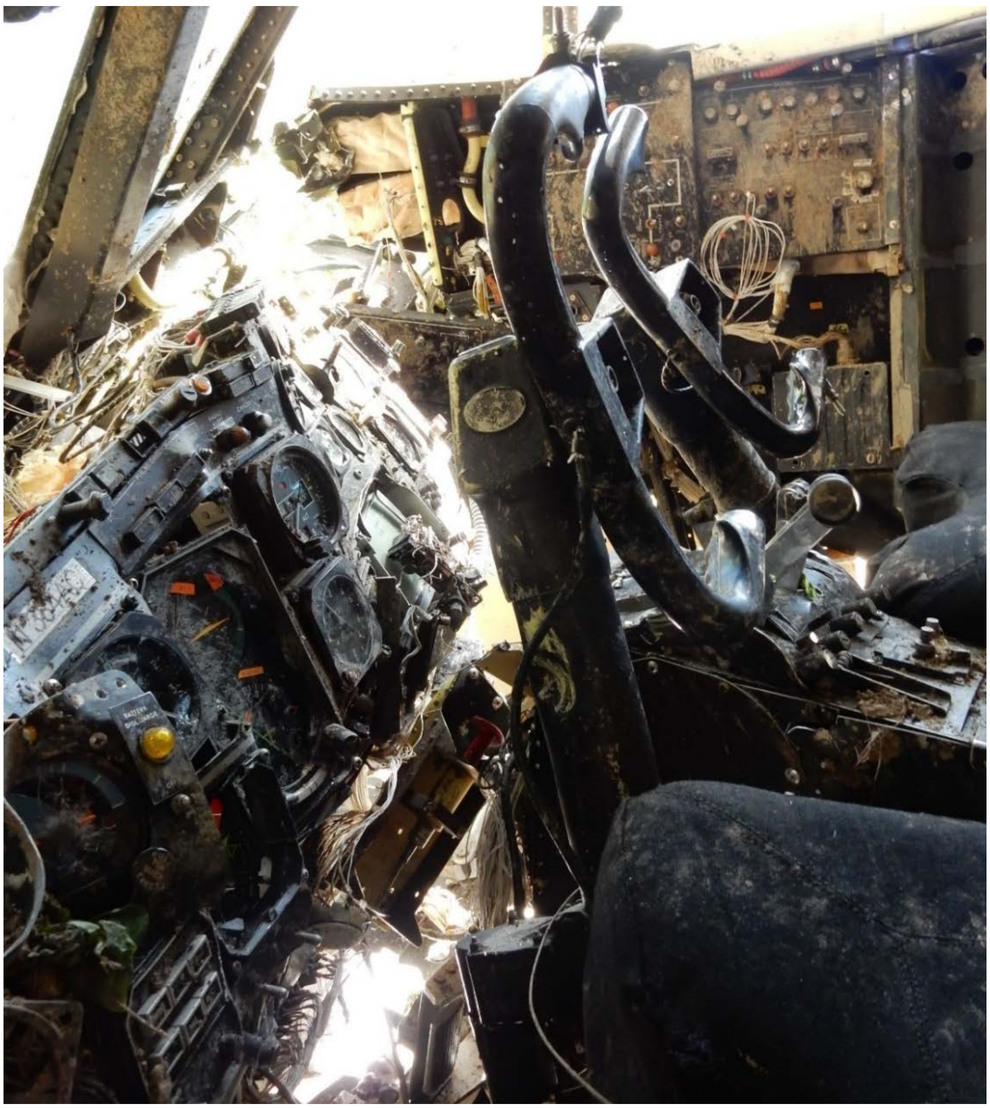

Figure 7: Flight Deck

The flight deck was damaged and distorted (Figure 7). The following observations were documented prior to aircraft recovery unless otherwise stated. It should be noted that emergency responders and investigators accessed the flight deck prior to the Airworthiness Group's documentation, and that it is possible that switches or levers were unintentionally moved at that time.

- Power Levers and Air/Ground Lever: Both power levers were set to "Flight Idle". The pedestal and lever slots were deformed. The following power lever and air/ground lever observations were made after aircraft recovery: The left power lever was stuck in the down position, and the lever could not be lifted over the gate at "flight idle". The lift spring was intact. The right power lever could be lifted over the gate and moved further aft. The lift spring was intact and returned the lever to the down position as expected. The air/ground lever was found not engaged with the power levers. The air/ground lever initially did not spring back into the normal position when the power levers were moved forward because the microswitch contact block on the lever was contacting the displaced microswitch assembly. Once the microswitch assembly was moved, the air/ground lever would spring back as expected. The torsion spring was wedged between the pedestal cover and the side of the air/ground lever, but appeared to be intact. The baulk spool spring worked properly and returned the baulk spool to the extended position. The Reverse Thrust Baulk Lever designed to prevent the levers from going into reverse also functioned normally.
- Propeller Levers: Left lever was in an aft position with about 5/8-in between the back of the lever and the aft edge of the slot. The right lever was full forward.
- Fuel Levers: Both levers set to "Ground".
- Flaps Handle: 35° detent
- Flaps Position Indicator: Found separated from the instrument panel and outside of the aircraft. Inner flaps position needle indicated 15°. Outer/mid flaps position needle was positioned in between 15° and 35°.
- Landing Gear Lever: The lever was in a neutral position. After recovery, the lever could be moved to the full up and full down positions. The actuation knob was missing and the shaft was bent upward. The lower side of the switch cover was deformed in an upward direction.
- Landing Gear Emergency Handle: extended[4].
- Left Generator Switch: "COUPLED" and in detent. This switch is designed to move from "ON" to "OFF" without interference of a detent, but requires the lever to be pulled out to be placed into the "COUPLED" position.[5]
- Right Generator Switch: "OFF" but could easily move between "OFF" and "ON".
- Left Shedding Bus Switch: "NORMAL"
- Right Shedding Bus Switch: "NORMAL"
- DC Power Master: "OFF"[6]
- Left Essential Service Transfer Bus: "NORMAL"

[4] The landing gear emergency handle spring will extend the landing gear emergency handle if a control cable within the emergency extension system is severed or has significant slack.
[5] In the event of a generator failure, procedures call for the failed generator switch to be placed in the "COUPLED" position.
[6] Observed after the wreckage was removed from impact site.

- Right Essential Service Transfer Bus: "NORMAL"
- Left Reserve Power Switch: "OFF" and the switch shaft was bent downward
- Right Reserve Power Switch: "OFF"
- Left Fuel Boost Pump: "OFF"
- Right Fuel Boost Pump: free to move
- Left Hydraulic Pump Inlet Valve: "OPEN" but the shaft was bent downward[7]
- Right Hydraulic Pump Inlet Valve: "OPEN"
- Left Anti-Ice Vane: "ON"
- Right Anti-Ice Vane: "OFF"
- Left Pitot Static & Boot Valve Heater: "ON"
- Right Pitot Static & Boot Valve Heater: "ON"
- Left Stall Wing Vane Heaters: "ON"
- Right Stall Wing Vane Heaters: "OFF"
- Left Intake Heat: "ON"
- Right Intake Heat: "OFF"
- Captain's Altimeter Setting: 29.45/46 inHg
- First Officer's Altimeter Setting: 29.39/40 inHg
- Elevator Trim Indicator: The trim wheel and the indicator window were broken. The indicator was in an approximately neutral position.
- Rudder Trim Indicator: One notch right of neutral
- Aileron Trim Indicator: Full left (max - left wing down)

6.0 Engines

The left engine was a Pratt & Whitney Canada PT6A-45R, S/N PC-E 84060. The engine remained attached to the left wing. The reduction gearbox and propeller separated as a unit at the fractured c-flange. The forward portions of the engine cowling were crushed and deformed. The propeller blades all exhibited leading edge chunking, spanwise curling, and significant abrasion damage to the forward faces. About 1/3 of one blade was fractured off. The left engine cowling was removed. Some grass and paint chips were noted on the air intake screen. The engine case was buckled at the upper forward end. The impeller spun freely by hand and grass and leading edge damage on the first stage impeller blades was observed. The sun gear exhibited gouging and damage on multiple teeth.

After aircraft recovery, the left engine anti-ice vane actuator piston extension measured about 5-½ in from the housing to the center of the attachment bolt. This corresponded with the anti-ice vane in the normal position. The fuel lever linkage was pegged at the forward stop on the left engine, corresponding to the fuel cutoff position. The power lever linkage was in the full up position corresponding with full reverse.

[7] Observed after the wreckage was removed from impact site.

The right engine was a Pratt & Whitney Canada PT6A-45R, S/N PC-E 84321. The engine remained attached to the right wing. The propeller blades all exhibited minor leading edge damage and aft bending. A portion of one blade was separated. The right engine cowling was removed. Some grass and dirt was noted on the air intake screen and ice deflector vane. The forward engine case was torsionally buckled.

After aircraft recovery, the right engine anti-ice vane actuator piston extension measured approximately 5-½ in from the housing to the center of the attachment bolt. This corresponded with the anti-ice vane in the normal position. The fuel lever linkage was pegged at the aft stop, corresponding to the max fuel position. The power lever linkage was in the partial up position corresponding with the fuel lever being in a partial beta position. The propeller lever linkage on the right engine was pegged against the max prop speed stop.

A detailed propeller examination was carried out after the engines were removed from the accident site by a representative from the manufacturer.[8]

7.0 Circuit Breakers

The DC Distribution 1D circuit breaker panel on the left side of the cockpit was on/in the ground and covered in mud. It was stepped on by rescue personnel and investigators prior to observation. After aircraft recovery the following circuit breakers were identified as open:

Generator Control (5 Amp)
Tail Battery Charge
DME
Torque (AC Distribution)
Engine Intake Heat

Prior to aircraft recovery, the following circuit breakers were found open on the 2D panel on the right side of the cockpit:

Boot Valve Heaters
Right Inverter U Volt
Engine Intake Heat
DC Transfer (observed after aircraft recovery)

In addition, the "Tail Battery Charge" circuit breaker was open on the Aft Cargo circuit breaker panel.

8.0 Cargo

The cargo was contained in the fuselage and the cargo net was secured to the D-rings. All of the cargo was removed from the airplane and weighed. Most of the boxes were intact and suffered various amounts of crushing damage. Some of the boxes were fuel soaked. A total weight of 3,745.35 lbs was obtained for the cargo initially removed. One large heavy piece of cargo later

[8] See the Hartzell Propeller report no. 170505 in the public docket for the details of the examination.

determined to be a laser printer, two small lightweight pieces of cargo, and two bags of pouches were removed later when the fuselage was cut for recovery. These items were subsequently weighed and added to the total. The total weight of cargo recovered was 3,849.5 lbs.

9.0 Emergency Locator Transmitter

The Emergency Locator Transmitter (ELT) did not alert after the accident. It did alert when the empennage was set down by the helicopter during wreckage recovery. The switch on the ELT was originally found to be in the "AUTO" position. The switch on the ELT was turned to "ON" and it alerted. The switch was returned to the "AUTO" position and alerted after bumping it with a hand. The ELT was made by Cessna, P/N C589511-0117, S/N 51070 or 51020 (4th number unreadable).

10.0 Maintenance Records

Air Cargo Carriers, LLC (ACC) purchased the accident airplane in December 1998 from Corporate Air who had purchased the airplane from an Australian operator in April 1998. The airplane had been registered (VH-LSI) and operated in the passenger configuration in Australia for an unknown amount of time prior to the purchase. After purchasing the airplane, ACC converted it to a cargo configuration by removing the passenger seats, cabin attendant seats, and the food and drink compartments, and through the installation of the following STCs.

SA7386SW – Heavy Duty Cargo Floor
SA7387SW – Gill Cargo liner
SA7388SW – Smoke Detector System
SA7750SW – Cargo Handling System
SA7751SW – Cargo Barrier Net

According to the operator, the CVR was removed from the airplane during this modification to cargo configuration. Upon completion of this work, the FAA issued a Standard Airworthiness Certificate in the Transport Category on December 17, 1998.

ACC maintained the airplane under an FAA approved aircraft inspection program (AAIP). The Shorts SD3-30 AAIP document was at Revision 27 at the time of the accident and had been approved by the FAA on February 2, 2016. The program provided for regular aircraft inspections in order to assure continuous airworthiness and availability to the operator based on the manufacturer's recommendations, the applicable regulations, and operator's experience with the SD3-30 airplane. The AAIP detailed phased letter inspections of the airplane for A through E inspections with a minimum time between inspections for the Line/A check of 30 hours or 14 days and a maximum time between inspections for the E check of 14,400 hours or 144 months. The AAIP also detailed 18 structural inspections of the airframe, one avionics inspection, one annual deice inspection, and one mid-life structural audit to be performed at specific times in the life of the airplane.

ACC provided the NTSB a digital copy of service records dating from May 4, 2015 to May 5, 2017. The files included maintenance discrepancy logs and records of recurring inspections. In addition, the maintenance log book was recovered from the airplane and was reviewed. The records indicated that the airplane flew an average of 12 flight cycles and 8.4 hours per week. There were no MEL's active during the accident flight. The most recent record was a maintenance discrepancy log documenting compliance with a "Line A" inspection on 4/28/2017. The left engine fuel nozzles were replaced following a flow check on 4/27/2017 and the left engine igniter box was replaced on 4/25/2017. The airplane had multiple writeups for the electrical system, including repeated right generator control unit replacements and repeated right starter/generator replacements. The right main battery was replaced on 4/11/2017. The left starter/generator was replaced on 3/14/2017. A flap cable on the right wing was found frayed and replaced on 9/21/2016. There were multiple attitude gyro and flight director writeups over the two year period. The left engine was last replaced on 9/27/2016 and the right engine was last replaced on 11/28/2016.

ACC also provided the NTSB a complete maintenance report for the accident airplane that detailed compliance with the AAIP, compliance with the regulations, status on life limited parts, and compliance status for all Airworthiness Directives.

The most recent weight and balance report for the airplane was prepared on June 24, 2016, when the airplane was physically weighed. The report listed an empty weight of 14,095 lbs, an arm of 30.36 in, and a moment of 427907.6 lb-in. The useful load for the airplane was calculated to be 8,339 lbs.

Clinton Crookshanks
Aerospace Engineer

Adam Huray
Mechanical Engineer