Aviation Investigation Final Report (

Location:	Temple, Texas	**Incident Number:**	CEN14IA329
Date & Time:	June 26, 2014, 15:02 Local	**Registration:**	N808LF
Aircraft:	Eurocopter AS 350 B3	**Aircraft Damage:**	Minor
Defining Event:	Loss of control in flight	**Injuries:**	3 None
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

After an uneventful emergency medical services flight, the commercial pilot landed the helicopter at an airport to refuel for the return flight to the helicopter's base. The pilot reported that his preflight checks were normal and that, immediately after takeoff, the helicopter started a counter-clockwise yaw. He added that the antitorque pedals were locked in the neutral position and felt jammed. He attempted to correct the rotation but was unable to do so. After the helicopter rotated several times, he descended it from about 15 to 4 to 5 ft and then executed a hovering autorotation. The helicopter hit the ground on its right front skid and then slid upright to a stop.

A postincident examination of the helicopter revealed no anomalies with its tail rotor and hydraulic systems. However, the yaw servo hydraulic switch on the collective was found in the "off" position even though the pretakeoff dual hydraulic system check requires that the yaw servo hydraulic switch be moved to the "off" position and then moved back to the "on" position before takeoff. After this incident, the helicopter manufacturer issued a safety information notice, which stated that, if the pilot fails to move the yaw servo hydraulic switch back to the "on" position before takeoff, there will be a complete lack of hydraulic boost to the tail rotor system because, before this part of the check, the yaw load compensator would have been discharged to verify proper operation of the hydraulic accumulator test switch and valve. This situation could be perceived by the pilot as a tail rotor control failure due to the increased load required to move the control pedals. If not quickly identified and corrected, this situation could lead to a loss of helicopter control, as occurred during the accident flight.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be:

The pilot's failure to reposition the yaw servo hydraulic switch to the "on" position during the pretakeoff hydraulic system check, which resulted in a complete lack of hydraulic boost to the tail rotor system and increased the load required to move the control pedals and led to the pilot's subsequent inability to manipulate the control pedals and his loss of yaw control.

Findings

Aircraft	Lateral/bank control - Not attained/maintained
Personnel issues	Forgotten action/omission - Pilot
Aircraft	(general) - Incorrect use/operation

Factual Information

History of Flight

Takeoff	Loss of control in flight (Defining event)

On June 26, 2014, at 1502 central daylight time, a Eurocopter AS350B3 helicopter, N808LF, experienced an anti-torque pedal anomaly during takeoff from the Draughon-Miller Central Texas Regional Airport (TPL), Temple, Texas. The pilot executed a precautionary hovering autorotation and the helicopter sustained minor damage. All three occupants, the pilot and 2 flight crew members, were not injured. The helicopter was registered to the PNC Bank NA Trustee, Boise, Idaho, and operated by Air Methods, Englewood, Colorado, under the provisions of 14 Code of Federal Regulations Part 91 as a positioning flight. Visual meteorological conditions prevailed at the time of the incident and the flight operated on a company flight plan. The helicopter was destined for Hamilton, Texas.

After an uneventful air medical flight, the pilot landed the helicopter at TPL at 1437 for refueling for the return flight to the helicopter's Hamilton, Texas, base. The pilot reported that his preflight checks were normal. After a courtesy radio call to Temple UNICOM, the pilot initiated the takeoff. Immediately after takeoff, the helicopter started a counter-clockwise yaw. The pilot stated that the anti-torque pedals were locked in the neutral position and felt jammed. He attempted to correct the rotation but was unable. After rotating several times, he reduced the helicopter's altitude from about 15 ft to 4 to 5 ft. From there, the pilot executed a hovering autorotation to the ground. The helicopter hit on its right front skid and slid upright to a stop. All of the occupants exited the helicopter uninjured after the pilot shut down the helicopter.

A post-incident examination of the helicopter and its hydraulic system was conducted at Grand Prairie, Texas, on July 15, 2014.

The helicopter was fitted with a dual-hydraulic system which provides hydraulic assistance to the main and tail rotor flight controls. The dual-hydraulic system consists of two independent hydraulic circuits, an upper hydraulic circuit and a lower hydraulic circuit. Each circuit has its own separate reservoirs, pumps, and filters. Each hydraulic circuit powers independent servos on each of the three main rotor servo controls; fore-aft, right roll, and left roll. However, only the lower hydraulic circuit powers the single-servo tail rotor servo control and the yaw load compensator.

The yaw load compensator contains an accumulator that is used as a hydraulic power reserve in the event of a depressurization of the lower hydraulic circuit. The accumulator contains a rubber bladder that is charged with nitrogen gas to about 15 bars of pressure (1 bar = 14.5 pounds per square inch).

Prior to performing a functional test of the hydraulic system, the investigative team examined and documented the condition of the lower hydraulic system, the tail rotor flight controls, and the positions of cockpit switches and fuses. A visual inspection of the system showed no damage or anomalies. Fluid levels in both reservoirs contained sufficient fluid to perform the functional test. The nitrogen charge within the yaw load compensator accumulator was measured to be about 15 bars of pressure, consistent with no hydraulic pressure within the yaw load compensator.

Control continuity from the control pedals to the tail rotor was confirmed. The pedals were too stiff to be manipulated by hand, but could be operated with foot pressure. The yaw servo isolate switch was observed in the "off" position. The switch is in the "off" position when it is pointed aft away from the switch guard. It is in the "on" position when it is pointed forward into the switch guard. The cockpit electrical fuses related to the hydraulic system were visually confirmed to be in the "in" positions.

Lower Hydraulic System Functional Test

The yaw servo isolation valve, mounted on the main transmission deck, is activated when the yaw servo isolation switch on the collective stick is in the "off" position, which electrically powers a solenoid that closes the valve. The valve is open when there is no electrical power applied to the valve (when the switch on the collective stick is in the "on" position), allowing hydraulic fluid to flow to the tail rotor servo and yaw load compensator.

During the functional test, the yaw servo isolate switch remained in the "off" position and electrical power was applied to the helicopter. Movement of the yaw servo isolation valve was confirmed by physical touch. Additionally, the magnetization of the solenoid was confirmed by touching a steel tool to the valve.

A hydraulic mule, which provided about 30 bars of hydraulic pressure, was installed into the lower hydraulic circuit via a fitting downstream of the hydraulic pump. The "HYD", "SERVO", and "LIMIT" lights on the caution-warning panel (CWP) illuminated, as would be expected due to the upper hydraulic circuit remaining unpowered. The cyclic and collective sticks were manipulated by hand with the expected forces consistent with hydraulic assistance. The pedals were manipulated by foot. Increased resistance occurred consistent with forces expected without hydraulic assistance. The yaw servo isolation switch was then placed in the "on" position and the pedals were manipulated by foot. The pedals moved with the expected forces consistent with normal hydraulic assistance.

The helicopter start up hydraulic checks, required by Section 4 of the AS350 B3 flight manual, were performed in order to functionally test the lower hydraulic circuit. The checks included a test of the yaw servo isolation valve by switching the yaw servo isolation switch to "off"; and a test of the yaw load compensator accumulator by depressing the "ACCU TEST" button. The checks were performed with no anomalous results. The hydraulic mule was subsequently powered off and the right pedal moved forward due to residual pressure from the yaw load compensator, a result that is normally expected during shutdown of the helicopter.

The hydraulic mule was powered on again in order to assess the position of the pedals when performing the pilot's stated shutdown procedure after the incident. The yaw servo isolation switch was placed in the "off" position and the hydraulic mule was powered off to simulate shutdown of the helicopter. The right pedal moved forward due to residual pressure from the yaw load compensator.

The hydraulic mule was powered on again in order to assess the position of the pedals when performing the helicopter start up hydraulic checks, but omitting the step of returning the yaw servo isolation switch to the "on" position. Once the lower hydraulic circuit was charged, the yaw servo isolation switch was placed in the "off" position. The "ACCU TEST" button was depressed to discharge the accumulator, and then depressed again to close the accumulator discharge valve. The yaw servo isolation switch was kept

in the "off" position and the hydraulic mule was powered off. The pedals remained stationary and the pedal forces were consistent with the expected forces without hydraulic assistance.

Hydraulic System Post-Test Examination

After the lower hydraulic system functional tests were performed, the hydraulic systems were visually examined for evidence of leaks; none were found. An unknown quantity of nitrogen pressure was lost from the yaw load compensator accumulator when a gauge was hooked up to the accumulator to measure the nitrogen charge; the nitrogen pressure measured about 7 bars. A normal accumulator charge is about 15 bars. The accumulator was re-pressurized with additional nitrogen until the gauge read 15 bars. The accumulator held the 15 bars of pressure, consistent with no significant leakage of nitrogen pressure from the accumulator. The hydraulic mule was powered on and the gauge, when attached to the accumulator, measured about 30 bars of pressure, consistent with the hydraulic pressure applied to the lower hydraulic circuit by the hydraulic mule. The hydraulic mule was subsequently powered off.

The hydraulic filter clogging indicator remained in the "in" position, consistent with the hydraulic filter not being clogged. The hydraulic filter element was removed and examined for debris; none was found on the filter element. However, very fine debris was observed in the bottom of the filter bowl.

The hydraulic pump drive belt from the lower hydraulic circuit was removed to verify engagement of the spline coupling connecting the drive pulley to the hydraulic pump. Spline coupling engagement was confirmed. The tail rotor pitch change links were disconnected from the tail rotor blades and the full range of pedal movement with corresponding movements of the pitch change was verified.

The AS350B3 with the dual hydraulic system checklist requires a hydraulic system check during the helicopter run up. The checklist calls for the following:
1. Servo Distributors Seizure Check:
a. [SERVO TEST] or [SERVO TST] – DEPRESS, SERVO light illuminates,
2. Yaw Servo Hydraulic Check:
a. Yaw servo hydraulic switch (collective grip) – OFF, pedal forces should remain low (yaw load compensator effect).
b. [HYD TEST] or [ACCU TST] – DEPRESS, check that forces are felt on yaw pedals.
c. [CWP]: Check HYDR light flashes.
d. Yaw servo hydraulic switch on collective grip; ON. Check no forces are felt on yaw pedals (boosted).
e. [HYD TEST] or [ACCU TST] – RESET in the up position. CWP – Check. HYDR light illuminates.

According to the helicopter manufacturer, if during the hydraulic system check, the pilot fails to restore the yaw servo hydraulic switch to "on" (forward position) prior to takeoff, there will be a lack of hydraulic boost to the tail rotor system, because earlier in the preflight checklist, the yaw load compensator will have been discharged to verify proper operation of the HYD/ACCU (Hydraulic Accumulator) Test switch and valve.

On August 21, 2014, Airbus Helicopters issued Safety Information Notice 2776-S-29 to remind pilots of the procedural differences that exist for the run-up hydraulic checks for the dual hydraulic system as compared to the single hydraulic systems, and to warn pilots of what can happen if the yaw servo hydraulic switch is not restored to the 'on" position during the Hydraulic Pressure Isolation Check. The notice also informed pilots of improvement to the dual hydraulic circuit to include incorporating

dedicated amber HYDR caution lights for each hydraulic circuit (HYDR1 and HYDR2) on the CWP and which integrates a flashing mode on the HYDR2 when the yaw servo hydraulic switch is in the "off" position, isolating the yaw hydraulic circuit through a solenoid valve. This modification has been incorporated on new production helicopters and will be introduced via a Service Bulletin to retrofit helicopters already in operation.

Additionally, the notice informed pilots that to mitigate the possibility of leaving the [ACCU TST] push button in the "on" position (currently the push button lights up when activated, but there is no HYDR caution on the CWP), Airbus Helicopters is developing a future modification to replace the two stable positions [ACCU TST] push buttons by a stable/momentary position [ACCU TST] push button similar to the design of the [CRANK] push button.

Pilot Information

Certificate:	Commercial	**Age:**	57,Male
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Unknown None	**Last FAA Medical Exam:**	
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	December 18, 2013
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	Eurocopter	**Registration:**	N808LF
Model/Series:	AS 350 B3	**Aircraft Category:**	Helicopter
Year of Manufacture:	2010	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	4983
Landing Gear Type:	Skid	**Seats:**	6
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	4960 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:	1004 Hrs at time of accident	**Engine Manufacturer:**	Turbomeca
ELT:		**Engine Model/Series:**	Arriel 2B1
Registered Owner:		**Rated Power:**	847 Horsepower
Operator:		**Operating Certificate(s) Held:**	On-demand air taxi (135)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	TPL,682 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	15:15 Local	**Direction from Accident Site:**	0°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	12 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	170°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.93 inches Hg	**Temperature/Dew Point:**	20°C / 21°C
Precipitation and Obscuration:			
Departure Point:	Temple, TX (TPL)	**Type of Flight Plan Filed:**	None
Destination:	Hamilton, TX	**Type of Clearance:**	None
Departure Time:	15:02 Local	**Type of Airspace:**	Class G

Airport Information (

Airport:	Central Texas Regional TPL	**Runway Surface Type:**	Asphalt
Airport Elevation:	682 ft msl	**Runway Surface Condition:**	Dry
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	3 None	**Aircraft Damage:**	Minor
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 None	**Latitude, Longitude:**	31.151666,-97.407501(est)

Administrative Information (

Investigator In Charge (IIC):	Lemishko, Alexander
Additional Participating Persons:	Ryan B Newman; Federal Aviation Administration; San Antonio, TX
Original Publish Date:	August 1, 2016
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=89569