MEMORANDUM FOR RECORD

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Air Safety Investigator
Eastern Region Aviation **June 17, 2019**

Subject: NTSB investigation ERA19FA191, N200BK, Agusta A109E, New York, New York, June 10, 2019. Airframe and Engine Examination

On Scene:

Building address 787 7th Avenue, Manhattan, NY

GPS Location:

040 45.70 N (40.761667)

073 58.91 W (-73.981833)

Building overall height 789 feet (per Building Engineer)

Debris field is 97 feet long, main wreckage fuselage oriented tail to nose heading 300 magnetic.

The helicopter was significantly fragmented and partially consumed by a post-crash fire. There was a strong fuel odor at the scene. All major components were located on the building roof. Some fragments of aluminum skin and rotor blade fragments were found on a lower building level and the street level.

The engines were found upside down and pointing backwards, towards the tail debris. Both engines remained largely intact. The tail boom was laying on its left-hand side.

The first debris along the path include a portion of the left hand aft pilot door post and rotor blade tip fragments.

Main impact crater about 12 ft in diameter, about 1 ft deep

The main rotor gearbox was fragmented; rotor head and mast were separated from gearbox.

The red and white main rotor blades were separated at hub, blue and yellow remained attached at hub.

The tail Rotor hub and blades remained attached to tail rotor gearbox. An 8ft long section of the trail rotor driveshaft remained attached to gearbox and rotated freely by hand. The tail rotor blade pitch links remained attached to the sliding assembly. The tail rotor blade pitch links were jammed and would not move.

Three of the main rotor pitch links remained attached to the rotating swashplate (red blue yellow), only the blue link remained attached to pitch control lever, the white pitch link remained attached to the rotor blade.

Wreckage Layout, 6/14/19

Laid out all wreckage on hangar floor

Airframe: extreme fragmentation, much consumed by post crash fire.

Sections of left and right passenger section doors were identified.

Tailboom aft of the cabin was mostly intact, heat damage to the forward end.

Horizontal stabilizers remained attached but exhibited significant impact damage.

Most of the components for all three landing gear were identified. The right hand gear struts were separated and broken. All actuator pistons were extended.

Main Rotor (M/R) Head:

Rotor head remained attached to the mast, the mast was separated from the main gear box.

M/R: 3 pitch links remained attached to rotating swash plate (red blue yellow), of these, only blue was also attached to blade. The white pitch link was attached to blade, but not to the swash plate.

Rotating scissors were present, lower scissor was separated from the rotating swashplate, the associated lower bearing was missing and the attaching bolt on the swashplate was sheared and partially missing.

Stationary swashplate scissors remained attached to the mast.

All 4 M/R blade elastomeric bearings were identified, one was completely debonded (red), another had elastomer consumed by fire, two remained in place. The metallic portion of the red elastomeric bearing assy remained attached to the fragmented portion of the tension link. The white bearing was fragmented and thermally damaged, was not attached to the tension link,

and only the metal portions (base and shim plates) remained. Blue, yellow and red bearings remained attached at their respective tension links.

Two (lead/lag) dampers remained attached to the rotor head (red and blue). Blue was also attached to the blade side (pitch control lever). White was fragmented and not attached at either end. Yellow remained attached at the blade side only (pitch control lever).

Main rotor blades:

Numerous sections of blade spar, leading edge erosion strip, and blade afterbody and blade skin were recovered, but could not be associated with a particular blade. One blade tip had a 1" diameter semicircular crush that folded the metal accordion style in 13 folds. Several fragments of other blade tip caps were found.

Red blade: p/n 709-0103-01-111, s/n aw695, tension link separated equidistant above and below 2" inboard of the pitch control lever. Pitch change link rod end fractured at the threads (in bending). Blade portions recovered extended 15 feet 5 inches, fractured in 2 locations, outboard half of the blade leading edge was not found. Afterbody outboard of the taper had separated from the spar. Leading edge was buckled about 4 ft outboard of the hub, blade damper rod end was attached to the bearing through-bolt.

White blade: (data tag not located) tension link separated equidistant above and below 2" inboard of the pitch change lever. Pitch change link attached to the pitch change lever, lower rod end bearing was missing, and the rod end was elongated straight and fractured on one side. Fracture in the leading edge 9'6" outboard of the hub, afterbody separated along the spar, approximately 14.5 feet of blade and spar were present/ identified. Damper rod end was attached and fractured about 1" below the rod end neck.

Blue blade: P/N 709-0103-01-109, s/n A3-2317, tension link remained attached to rotor head, afterbody separated along entire spar, leading edge and spar fracture 6'8" outboard of the hub, leading edge erosion strip separated from spar outboard of that fracture. Approx. 15 feet of blade was present/identified. Pitch link was attached to the pitch change lever and the rotating swashplate. Blade damper was attached to the blade and the rotor head. Blade was cut outboard of tension link during recovery.

Yellow blade: P/N 709-0103-01-109, s/n A5-2435, the tension link was cut by recovery personnel. It was attached to the head and the blade prior to recovery. Pitch change link rod end attached to pitch control lever, lower portion of rod end fractured in bending. Separated from swashplate. Blade damper remained attached to the tension link. Leading edge indentation 11'6" outboard of the hub, blade covered in black soot. Outboard section of spar fire damaged, and largely consumed, glass fabric rope-like strands remained. Approx. 12'7" of blade present/identified.

Flight Controls:

Pieces of the mixing unit were found fragmented; all rod ends were connected and cotter keys installed.

All 5 Stability Augmentation System (SAS) actuators were found, all fractured at their rod ends. (four cyclic were detached from their parent/mate)

Tail rotor actuator remained attached to the tail servo side.

Cyclic– left cyclic cockpit control base attachment and bellcrank were found.

Collective – control tube fragments were located in the building catwalk areas at the accident scene. The left collective head and lower bellcrank 3 main servo actuators were separated from the main gearbox. All 3 piston ends were fractured, all 3 actuator rod ends were attached to the stationary swashplate. Both hydraulic pumps were present.

Anti torque system:

Left and right cockpit pedal sets were found, and both sets were disconnected from their control linkages.

Tail rotor control tube fragments were located in the building catwalk areas at the accident scene.

Segments of the tail rotor control tubes were recovered, the tail rotor pitch change control tube section remained attached to the tail rotor gearbox. Pitch change links were attached to the sliding assembly and the blades. Scissors links remained attached. Tail rotor blades remained attached to the hub, one blade exhibited leading edge damage at midspan, the other blade had its tip fracture separated and was fire damaged.

Drive System:

Main Gear Box (MGB) , part number 109-0400-03-109 s/n F-7528-C, case was fragmented, rotor mast was separated from the MGB, left and right engine input clutches were present but separated from MGB, left clutch is seized, right clutch rotates by hand counterclockwise, seized in clockwise direction. The left engine input shaft recovered, half of the right engine input shaft was recovered (the remaining portion of the shaft had rotational scoring/twisting features), the left and right oil cooler fans were present. The Tail rotor drive shaft separated at 18” aft of the flex coupling (in bending) aft of the rotor brake plate.

The remaining shaft continued through tail section and connected to tail rotor gear box. The tail rotor shaft, gearbox and tail rotor blades moved in concert when turned by hand.

Cockpit Instruments:

One of the vertical speed indicators (VSI) showed a 600 FPM descent. The 2nd VSI was unreadable (the faceplate was separated) The radar altimeter needle was missing. The horizontal situation indicator heading was 230, The standby altimeter read 1,880 ft, The Kollsman setting was 30.20" / 1022.5mb (The main altimeter was photographed on scene as indicating 3200 ft on the numeric display, however the needle missing so value not determined, the Kollsman setting was 30.045). The magnetic compass was unreadable. One of the attitude gyros indicated about 50 degrees nose down and about 80-90 degrees left wing down. The second attitude gyro 2 indicated about 60-80 degrees nose down, and about 110-120 degrees left wing down.

The engine power lever quandrant was separated and not connected to any cables. The levers were in the MAX position and easily moved.

Engines:

Left Engine S/N BC0156

The engine had broken in two parts at the reduction gearbox rear housing at flange A. The engine inlet case, compressor and turbine sections had separated at the reduction gearbox rear housing.

Exhaust Duct: The turbine exhaust nozzle was intact and all of the T6 probes were present. There was some soot present, but no impact damage was noted in the turbine exhaust nozzle.

Gas Generator Case: The gas generator case had some dents and there was soot residue consistent with post-impact fire.

Reduction/Accessory Gearbox: The gearbox was broken into multiple pieces, and there was significant fire damage to the casing. Some sections had melted due to the heat damage.

The airframe output shaft coupling was fractured and showed evidence of overload under rotational forces.

Accessories:

Fuel Management Module (FMM) had impact and fire damage. The airframe's Power Lever Angle (PLA) input to the engine is mounted on an interface of the P&WC FMM and

is what provides the Power Lever (PL) input to the FMM. The FMM power lever was found to be aligned with the "flight" rigging position.

A portion of the oil filter case was missing. The oil filter contained extensive debris. The debris was black and non-magnetic. The portion of the oil filter which was exposed to the fire due to the missing case appeared clean. Aluminum remnants consistent with the damaged oil filter case were found in the oil filter housing.

The chip detector was removed and found full of non-magnetic debris.

The starter/generator was mechanically and thermally damaged.

Compressor Discharge Air line (P3): The P3 line and breather line were largely intact, but damaged/deformed.

FMM lines: There was impact damage to the fuel lines. Flow divider valve was present and intact. The fuel manifold was largely intact however sections of it were burned away.

Three fuel nozzles were removed. One of the nozzles was clean with traces of fuel still present. The other two nozzles contained burned debris.

Oil Scavenge tubes: These tubes were present and damaged.

Fuel Filter: Both engine fuel filters were present, however the labels were burned off of both filters, preventing identification of left vs right. One of the fuel filters could be removed and was found to be clean of contaminants.

Compressor Impeller inlet area including screen:

The inlet screen was deformed and had been crushed/pushed to the side of the inlet opening which allowed debris to be able to enter in the airpath. The inlet screen had no screen meshing damage and was intact.

There was debris in the inlet case and around the screen.

The compressor impeller leading edge blades exhibited bending in the opposite direction to of rotation.

The compressor impeller could be rotated freely by hand.

Power Turbine (PT)

The PT shaft was fractured in two parts. There was a rotational shear with the The fracture surface oriented on a 45° angle consistent with overload. At the fracture site there was

necking present and several rub marks where the shaft showed rotational scoring from contact with the impeller.

The trailing edge of the power turbine blades showed no signs of damage. The PT blades could not be rotated through the exhaust.

Compressor Turbine (CT)

Using a borescope the CT blades leading edges were accessed at three different locations showing the CT blades were intact and there was no impact damage. The blade notches for measuring blade creep were present and visible. There was minimal rubbing on the CT shroud.

Combustion chamber

The combustion chamber was borescoped and no visible coating loss or damage was noted in the sections accessed.

Right Engine S/N BC0154

This engine was intact and could not be separated into two pieces. This engine had extensive burn damage and had soot residue throughout.

Exhaust Duct: The turbine exhaust nozzle was intact and all of the T6 probes were present. There was some soot present, but no impact damage was noted in the turbine exhaust nozzle.

Gas Generator Case: There was some impact denting noted and there was soot as a result of a fire.

Reduction/Accessory Gearbox: The gearbox was broken into multiple pieces, and there was significant fire damage to the casing. Some sections had melted due to the heat damage.

The airframe output shaft coupling was fractured and showed evidence of overload under rotational forces.

Accessories:

The Fuel Management Module (FMM) was impact and fire damage and had partially detached from the gearbox. The Airframe's gearbox, which is mounted onto the Pratt and Whitney Canada (P&WC) FMM provides the Power Lever (PL) manual input to the FMM. The FMM power lever was found to be aligned with the "fly" rigging position.

The oil filter contained extensive debris. The debris was black and non-magnetic.

The chip detector was removed and found full of black, non-magnetic debris.

The starter/generator was mechanically and thermally damaged and would not rotate.

Compressor Discharge Air (P3): The P3 line and breather line were largely intact, but damaged/deformed.

A borescope examination of this cavity revealed some debris in the air path.

FMM lines: There was impact damage to the fuel lines. The FMM was partially separated from the gearbox. The flow divider valve was broken in half and separated from the engine. The fuel manifold was largely intact however sections of it were burned away.

Two fuel nozzles were removed. One of the nozzles located at the top dead center was clean and had traces of fuel. The other nozzle, located in the bottom quadrant of the engine, contained burned debris.

Oil Scavenge tubes: The tubes were present and damaged.

Fuel Filter: Both engine fuel filters were present, however the labels were burned off of both filters, preventing identification of left vs right. One of the fuel filters could be removed and was found to be clean of contaminants.

Compressor Impeller inlet area including screen:

The inlet screen was still mostly covering the inlet area, with a section where the screen displaced exposing a portion of the inlet area. The inlet screen had no screen meshing damage and was intact. There was extensive debris (fibrous and metallic) found on both sides of the inlet screen.

The compressor impeller leading edge blades showed signs of foreign object impact damage. The compressor impeller could not be rotated freely by hand.

Power Turbine (PT)

The PT was not visible without further disassembly.

The trailing edge of the power turbine blades showed no signs of damage. The PT blades could not be rotated through the exhaust.

Compressor Turbine (CT)

Using a borescope the CT blades leading edges were accessed at two different locations showing the CT blades were intact and there was no damage noted. The blade notches for measuring blade creep were present and visible. There was minimal rubbing noted on the CT shroud.

Combustion chamber

The combustion chamber was borescoped and no visible coating loss or damage was noted in the sections accessed.

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