



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Western Pacific Region

AIRFRAME AND ENGINE EXAMINATION

WPR20FA016

This document contains 35 embedded photos.

A. ACCIDENT

Location: Jordan Valley, Oregon
Date: October 25, 2019
Aircraft: Enstrom 280F, Registration N280F, Serial Number 1501
NTSB IIC: Elliott Simpson

B. EXAMINATION PARTICIPANTS:

Elliott Simpson
Senior Aviation Accident Investigator
National Transportation Safety Board
Western Pacific Region
Los Angeles, California

Rudy Rossi
Aviation Safety Inspector
Federal Aviation Administration FSDO
Boise, Idaho

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Director of Engineering
Enstrom Helicopters

Mark Platt
Senior Air Safety Investigator
Lycoming Engines

C. SUMMARY

Examination of the helicopter was conducted at the accident site on October 27, with a follow up examination performed at a hangar at Boise Air Terminal/Gowen Field, Boise, Idaho on October 28 through 30 2019.

D. DETAILS OF THE INVESTIGATION

1.0 Airframe Examination

The helicopter was located on its right side at the accident site (photo 1). The cabin area sustained crush damage, resulting in fragmentation of the entire canopy and the composite canopy structure, completely exposing the cabin contents. The lower cabin support structure including the flight controls, instrument panel, and seat bottoms had folded about 90° downwards (photo 2).

The lower seat assemblies exhibited crush damage downwards and to the right, while the seat backs had crushed aft and to the right (photo 3). The left seatbelts and shoulder straps had been cut by first response personnel to facilitate removal of the pilot. The right seatbelts had been unbuckled by the passenger during egress.

Aft of the cabin wall, the primary helicopter structure remained relatively intact. The tubular steel pylon members behind the aft cabin wall sustained compression damage to the lower righthand side, and just forward of the main transmission gearbox assembly.

The forward and aft skid beams were intact and straight. The left skid had bent about 15° upward at forward leg; the forward drag strut had detached from the leg, and the oleo strut remained attached to the leg and forward skid beam. The aft oleo and drag strut remained attached to the skid leg and aft skid beam.

The right skid had bent about 30° upward forward of the front leg; the drag strut had detached from the leg, and the oleo strut remained attached to the leg and forward skid beam. The aft oleo and drag strut remained attached to the leg, which had detached from the skid.

The tailboom was intact and remained attached to the airframe. The right horizontal stabilizer had bent down about 90° midspan. The tailrotor gearbox remained attached to the gearbox boom, but the entire assembly had rotated about 180° along the longitudinal axis (photo 4). Closer examination revealed that the boom mounting bolts within the tailcone had sheared, and there was a crack in the lower right-hand side of the gearbox clamp housing. The tail stinger was undamaged and did not display any evidence of ground contact.

At the accident site, with the helicopter resting on its right side, the left fuel tank appeared empty, and the right tank was full, but dripping fuel from its fuel cap. Neither tank exhibited any indications of breach, and all vent, crossover, and feed lines were intact. It was noted that with the helicopter on its right side, fuel was free to migrate from the left to right tank through the interconnecting fuel lines.

The main transmission clutch was found in the fully engaged position (photo 5), with the clutch light microswitch activated (photo 6). The main transmission drive belt was slightly slack, however bending damage was observed to tubular frame members above engine, indicating downward movement of main transmission. The clutch microswitch was subsequently tested for operation utilizing a multimeter, and the switch functioned appropriately.

The main transmission gearbox appeared undamaged, and rotation of the main rotor mast by hand, resulted in movement of the gearbox input shaft and the tailrotor blades. The movement felt smooth and unrestricted. The freewheeling clutch allowed for driveshaft lock in the driven direction, and rotation in the freewheeling direction. Five of the engine cooling fan blades had bent about 90° opposite the direction of rotation (photo 7), and rotational scoring and gouging was observed on the right side of the fan shroud adjacent to the blade tips (photo 8, 9).

The tailrotor drive shaft was continuous from the upper drivebelt pulley through to the tailrotor gearbox. All tailrotor drive couplings were intact, with the exception of the forward coupling which remained partially attached by one of the two spring legs (photo 24). Rotational scoring was observed in the upper pulley support structure, adjacent to the spring leg (photo 25). The tailrotor blades remained attached to the hub; one blade had bent about 30° from the root, the second blade appeared undamaged. Neither blade exhibited any indications of chordwise scratches, and both blade tip strike tabs were undamaged. Tailrotor pitch control continuity was

established from the pitch link assembly through to the aft cabin wall, where both cables appeared to have been severed in the area of the lower cabin floor separation. Forward of the separation, the cables were continuous to the foot pedals.

All three main rotor blades had been cut off during recovery. According to maintenance records, the helicopter was equipped with Air Wolf T-T straps, and this was corroborated by inspection. All three walking beams remained attached to their respective push-pull tubes at the top of the mast. The tubes were continuous through the main rotor mast down to the lower swashplate assembly. The swashplate assembly was intact and undamaged, and remained attached to the collective walking beam and the lateral cyclic interconnect tubes (photo 11). The collective walking beam had separated just forward of its hinge point, and control tube continuity was established through the cabin wall bellcrank, and down to the cabin wall and floor intersection, where it had separated at the area where the cabin floor had folded down. Cyclic left and right lateral control tube continuity had been established, with separation observed for the left and right tubes in the same cabin wall bend location. Forward of the cabin floor join, the cyclic and collective controls were continuous to their respective cabin flight controls, although they had been impinged against the crushed seat supports (photo 3).

The number one main rotor blade grip was level, but the lead-lag hinge cover had torn (photo 12), and gouges were observed on the pitch horn, indicating the blade had pitched up to approximately 90°. The pivot bracket for the walking beam had broken in an upwards direction, which was further consistent with a movement to high pitch (photo 13). The damper had partially opened; and the two bottom bolt heads in its cap had detached (photo 14). According to the Enstrom representative, such damage is consistent with rapid deceleration of the rotor blade after one of the other two blades strikes a solid object (such as the ground) while significant energy remains within the rotor system. The rotor blade was bent upward approximately 30° in a curve starting near the root (photo 15). It was also bent opposite the direction of rotation by about 5°; the bend appeared to start roughly 5 feet inboard from the tip. The top rivets on the tip cap were sheared, and most of the trailing edge had opened from the inboard trim tab to the tip. Chordwise abrasions and mud were present on the leading edge cap strip on the outboard 2 ft section of the blade.

The number two main rotor blade grip was pitched up about 75°, and the walking beam pivot bracket had broken (photo 16), and the damper was mostly compressed. The blade was bent upward approximately 40° in a curve starting near the root, and bent about 10° opposite the direction of rotation approximately in a curve starting at the inboard trim tab (photo 17). The tip cap was in place, and the trailing edge was open for the entire blade length; the inboard trim tab was detached. There were no observable rotational scratches to the upper blade surface, and 45° chordwise abrasions were present on the leading edge cap strip and the underside of the blade, starting 4 ft inboard from the tip (photo 18).

The number three main rotor blade grip had pitched down about 150°, and the pitch horn was detached with its bolts sheared (photo 19). The damper had partially opened, and its two bottom cap bolt heads had detached (photo 20), with damage similar to blade one. The blade was bent upward approximately 30° through to the inboard trim tab and then bent slightly downward outboard of the trim tab (photo 21). The blade was also bent opposite the direction of rotation

approximately 10° - 15°, outboard of the inboard tab. The trailing edge seam was open from the root to approximately 13 inches inboard of the outboard trim tab. Chordwise abrasions and mud were present on the upper surfaces of the leading edge cap strip on the outboard 2 ft of the blade (photo 22, 23).

The engine tachometer cable was continuous from the engine accessory case through to the tachometer in the instrument panel. The main rotor speed cable was similarly continuous from the tailrotor drive shaft drive unit through to the tachometer. The two rubber O-ring/drive belts were undamaged, and proximate to the drive shaft and drive unit (photo 10). The tachometer was retained for further examination.

The ELT was emitting an audio tone at the accident site. The airframe was cut open to facilitate access, and the ELT was found mounted to the left side of the floor within the baggage compartment. The unit was not utilizing an external antenna but instead its own antenna which had been mounted to the left baggage door wall. The antenna had disconnected from the ELT BNC connector, with only the red core wire remaining connected (photo 26). Fine brown deposits were present around the area of the BNC connector. It could not be determined if the BNC connector “shield” had dislodged during the accident, or as the cabin door skin was cut open to gain access. Irrespective, with the red core wire still connected, the unit should still have been able to transmit a signal.

About 2 quarts gallon of blue-colored fuel was drained from the right fuel tank. The fuel had the odor of aviation gasoline, was clear and free of debris, and no water was present when tested with water detecting paste (photo 27). All fuel supply lines were clear and did not display any evidence of blockage. Fuel was present in all fuel supply lines through to the gascolator and fuel injection servo. The forward inlet fitting of the gascolator had broken away. The gascolator screen was free of debris, and its installation clip was found to be installed back to front. The bowl contained about 3 tablespoons of blue-colored fuel; no water was present when the fuel was tested with water detecting paste.

2.0 Engine Examination

The engine sustained minimal damage during the accident sequence. There was no evidence of crankcase breach or catastrophic internal failure. The throttle and mixture controls were continuous from their respective control arms through to the cabin controls. At the accident site, the throttle was found just short of the idle position (photo 28), and the mixture control was about 1 inch short of the full forward position (photo 29). The inlet air filter was free of obstruction, and the filter assembly spring-loaded alternate air and backfire doors could be opened by hand. The induction air inlet tube, which connected the air filter assembly to the fuel injection servo inlet (attachment 1) sustained impact damage and was impinged against the bent airframe structure on impact (photo 30). The tube also exhibited multiple areas where the rubber surface had chaffed and delaminated away from the steel wound spring core (photo 31). The tube was retained for further examination.

Engine-to-magneto timing was checked, and the spark advance was found to be a 19° before tops dead center (TDC); the engine data plate specified 20° before TDC.

The top and bottom spark plugs were removed and examined. Their electrodes remained mechanically undamaged, coated in light grey deposits, and displayed normal wear signatures when compared with the Champion Spark Plugs AV-27 Check-A-Plug chart (photo 32). The spark plugs for cylinders two and four (the cylinders on the lower side at the accident site) were coated in oil. Visual inspection of the combustion chambers was accomplished through the spark plug bores utilizing a borescope; there was no evidence of catastrophic internal damage and all combustion surfaces exhibited light grey deposits consistent with normal operation.

The oil filter was removed and opened; its filter element was soaked in oil, and no discernable particles could be observed on its surface.

The inner surface of the exhaust pipe outlet exhibited light brown deposits and was free of oil residue. The crankshaft turned freely when rotated by hand at the output drive pulley, and cylinder “thumb” compression was noted on all cylinders in firing order. Mechanical continuity was established throughout the rotating group, valve train, and accessory section, and the rocker arms moved equal amounts during crankshaft rotation.

The dual magneto appeared intact and undamaged, and sparks were observed at the output leads on the magneto cap while the input shaft was rotated by hand. Disassembly of the magneto revealed that the points appeared to operate correctly and had appropriate gaps, there were no indications of arcing damage such as sooting, and all gears rotated smoothly with their teeth still intact (photo 33).

The turbo charger remained firmly attached to its inlet and exhaust pipes, and both respective V-band clamps were intact. The wastegate valve appeared in the open position, and its control rod remained connected to the throttle linkage assembly at the fuel injection servo. The turbo charger turbine and compressor sections remained interconnected and could be rotated freely by hand. All blades appeared intact and undamaged, with no evidence to suggest they had rubbed against the housing surface (photo 34, 35).

The fuel control components including the engine driven fuel pump, fuel injection servo, and manifold valve were removed for examination. Fuel issued from all fuel lines and components during disassembly. The fuel pump drive coupling was intact, and the drive vanes and rotor appeared undamaged. The fuel manifold diaphragm was intact, pliable, and no holes or cracks in its surface were noted. The fuel injection servo was retained for further examination.

The cabin heat tube was intact and remained attached between the exhaust shroud and cabin wall. The exhaust shroud appeared undamaged, and the inner surfaces of the tube were free of any sooting deposits.

3.0 Airframe and Engine Examination photos



Photo 1 – Helicopter at the Accident Site



Photo 2 – Cabin



Photo 3 – Seat Assemblies with Cushions Removed

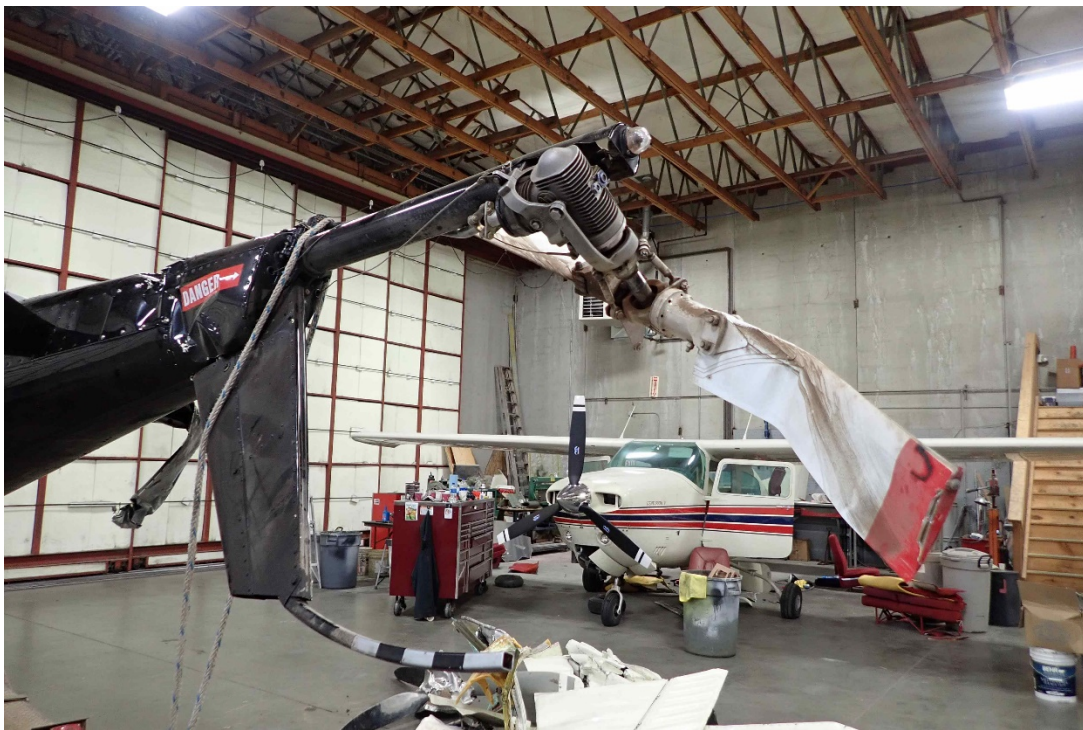


Photo 4 – Tail Rotor Assembly

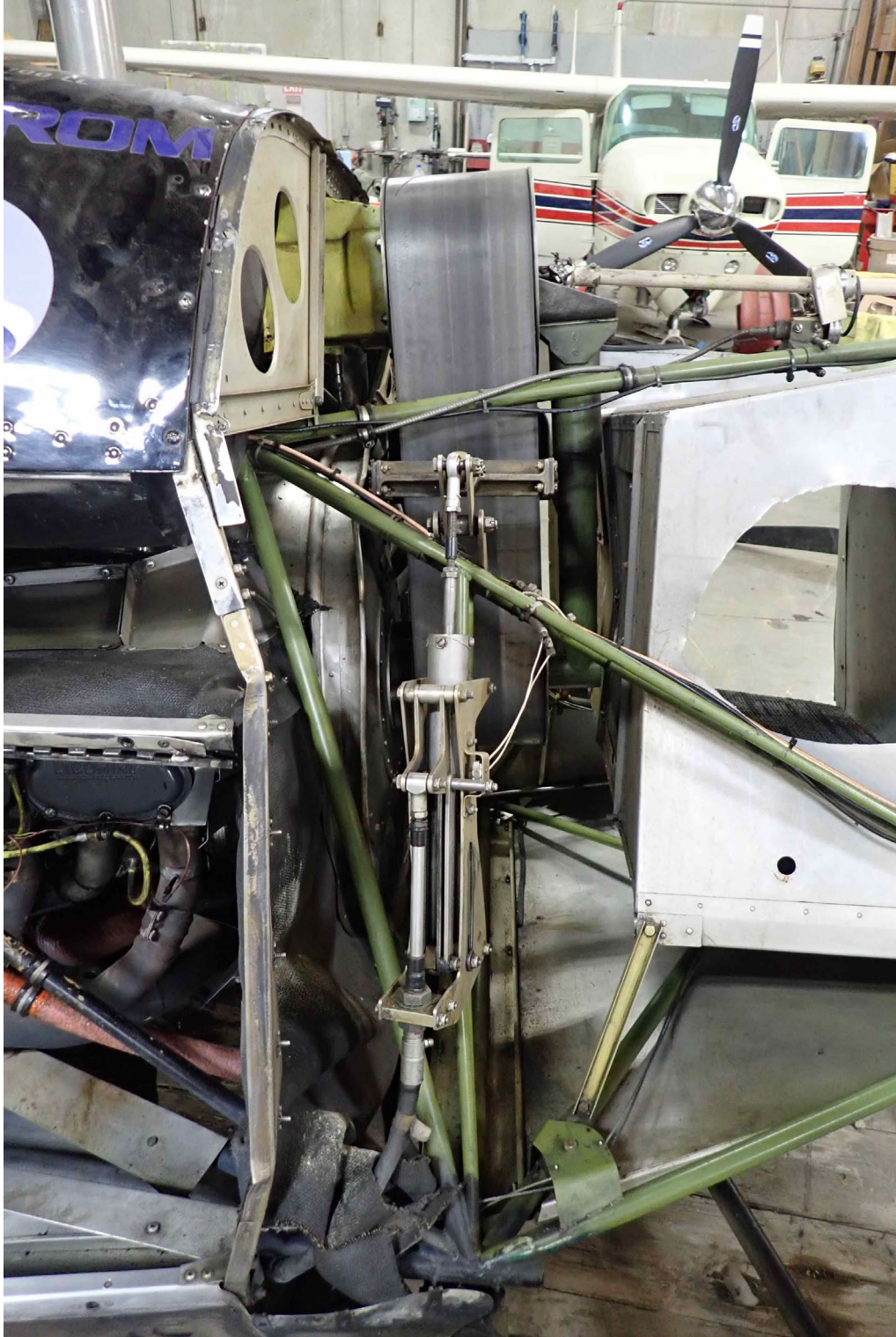


Photo 5 – Clutch and Drive Belt



Photo 6 – Clutch Light Microswitch

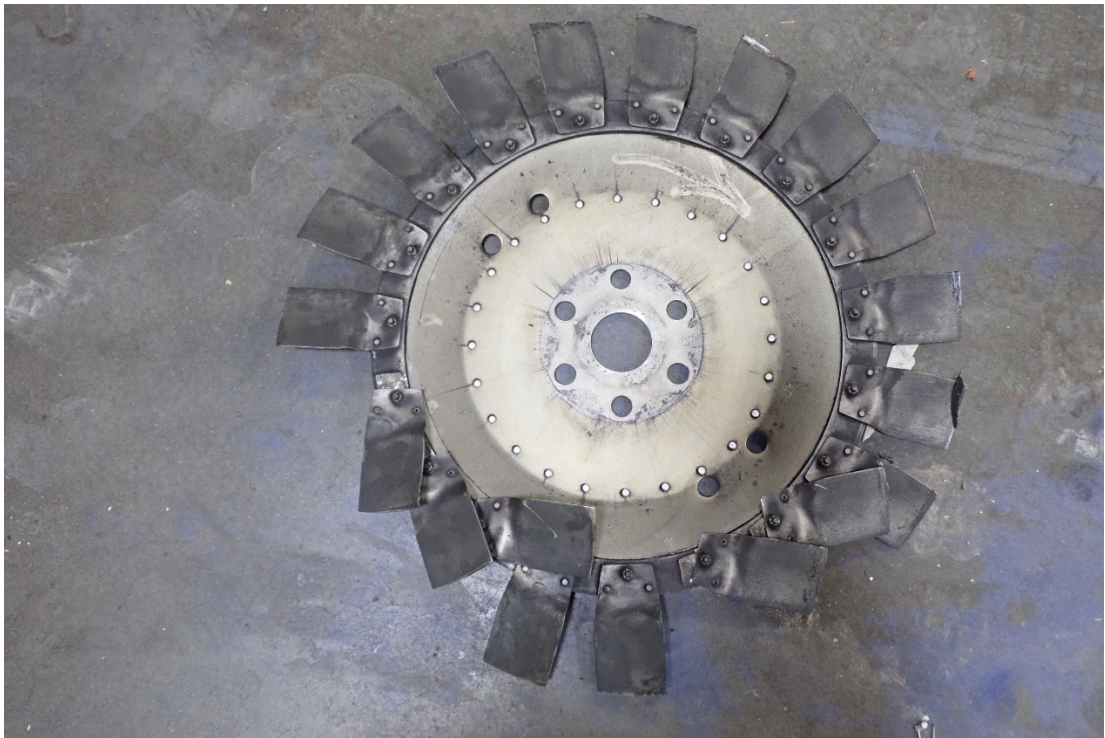


Photo 7 – Engine Cooling Fan



Photo 8 – Cooling Fan Shroud



Photo 9 – Cooling Fan Shroud

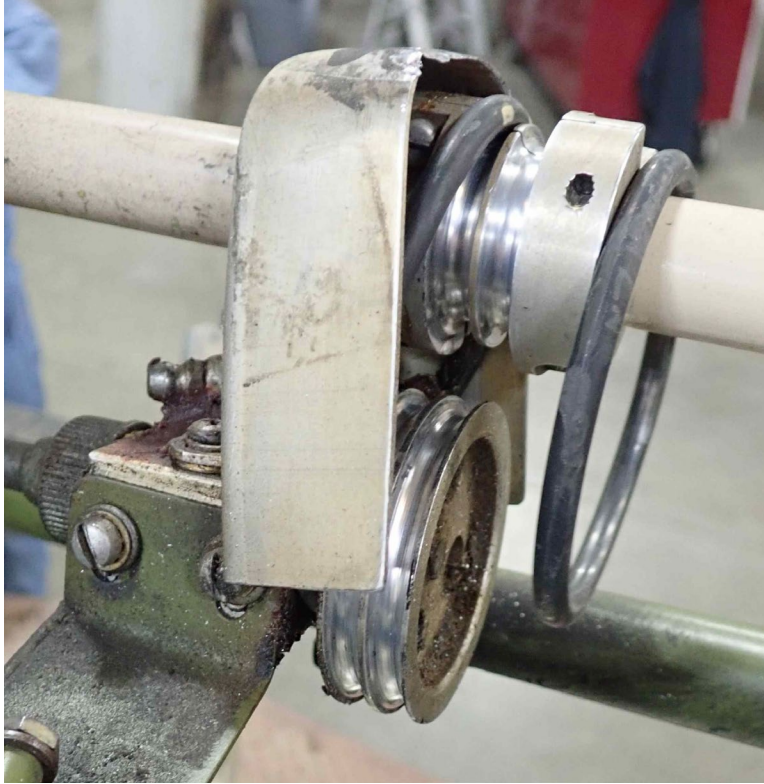


Photo 10 – Main Rotor Tachometer Drive

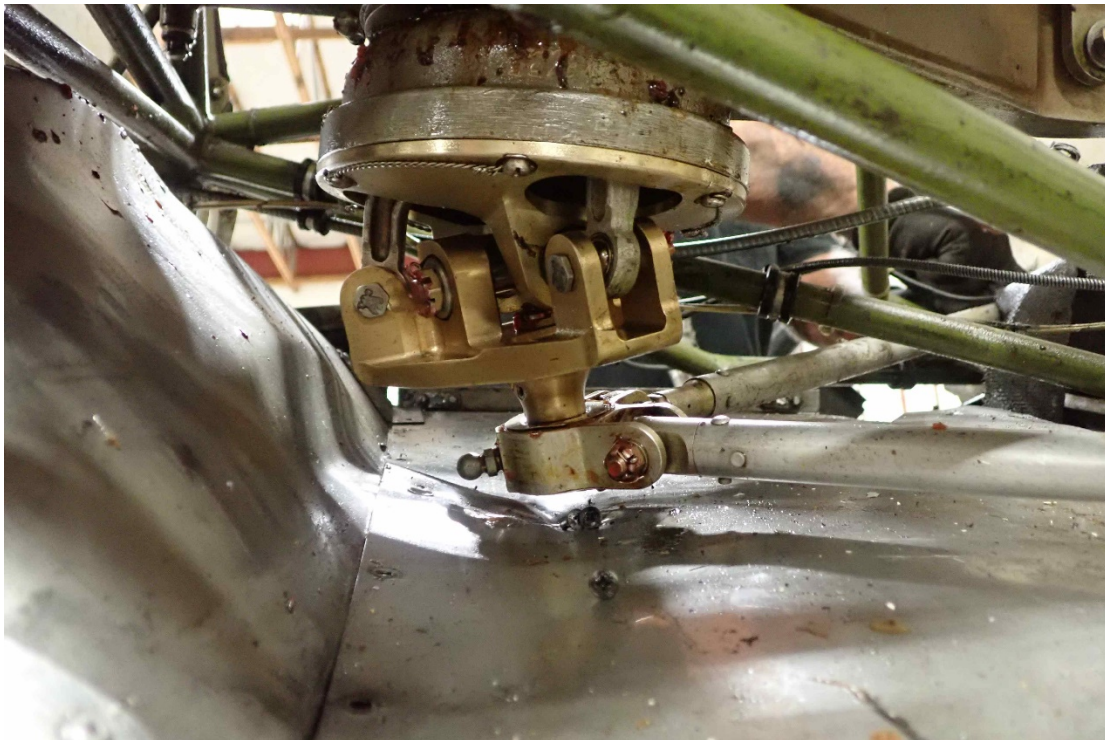


Photo 11– Swashplate Assembly

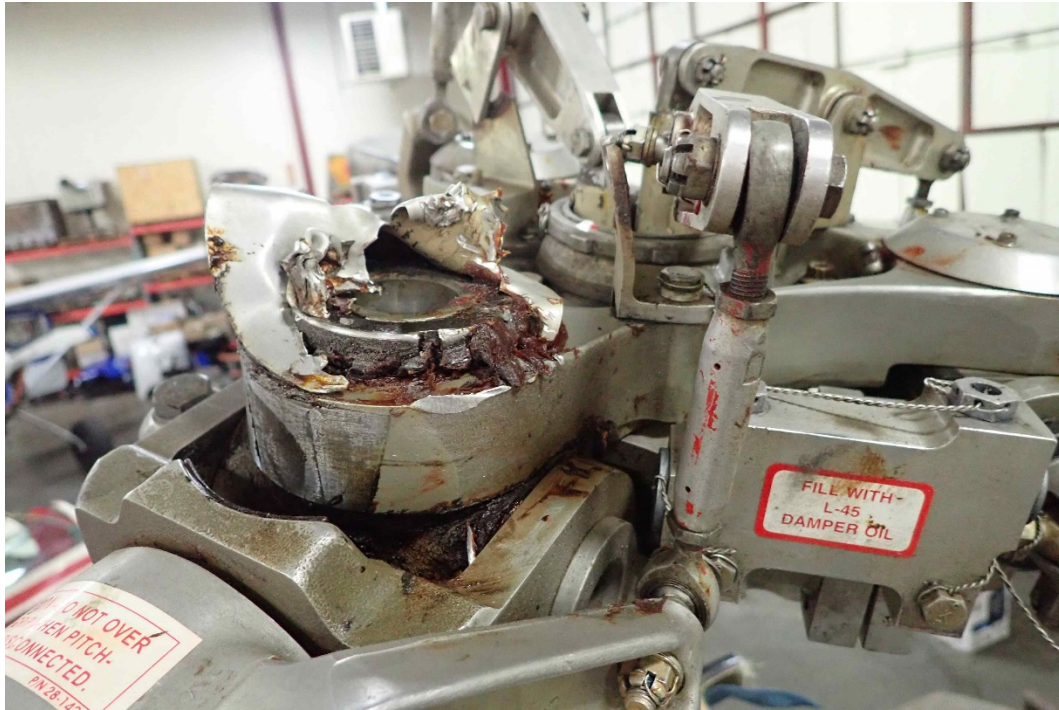


Photo 12 – Number One Blade Grip Assembly



Photo 13 – Number One Blade Grip Assembly

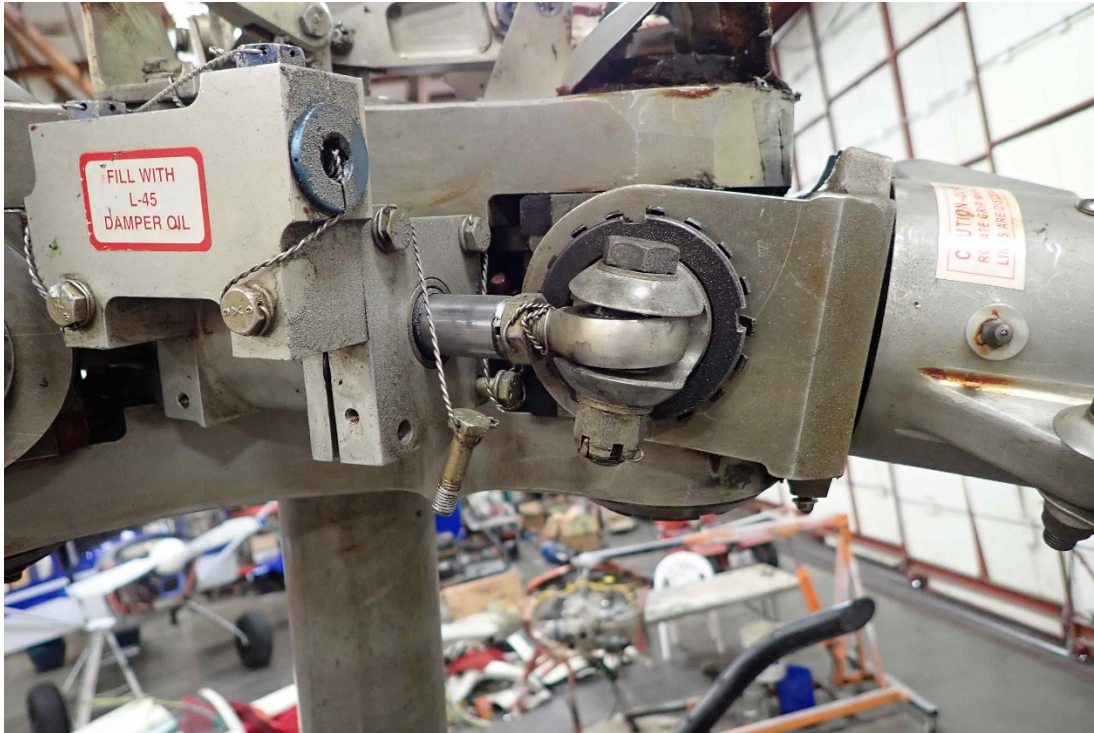


Photo 14 – Number One Blade Damper



Photo 15 – Number One Main Blade



Photo 16 – Number Two Blade Grip Assembly



Photo 17 – Number Two Blade



Photo 18 – Number Two Blade Underside

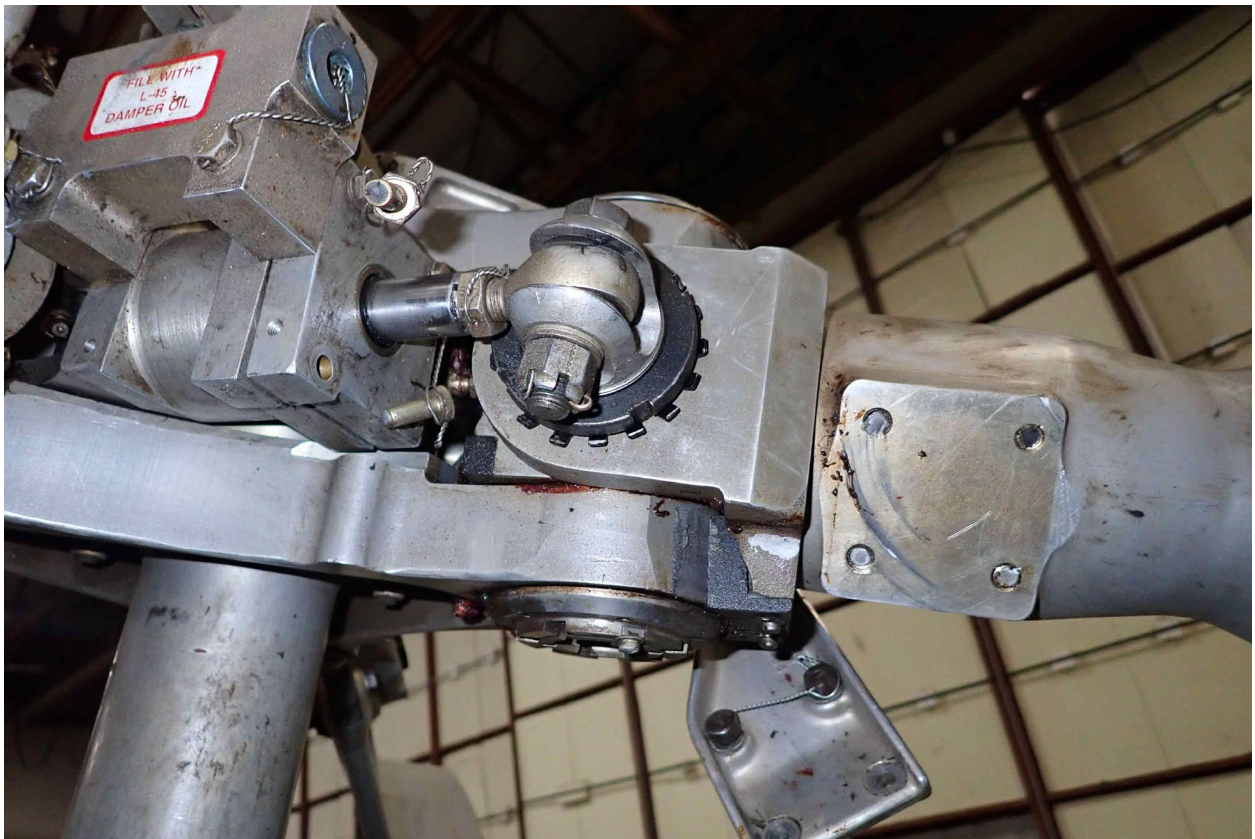


Photo 19 – Number Three Blade Grip Assembly

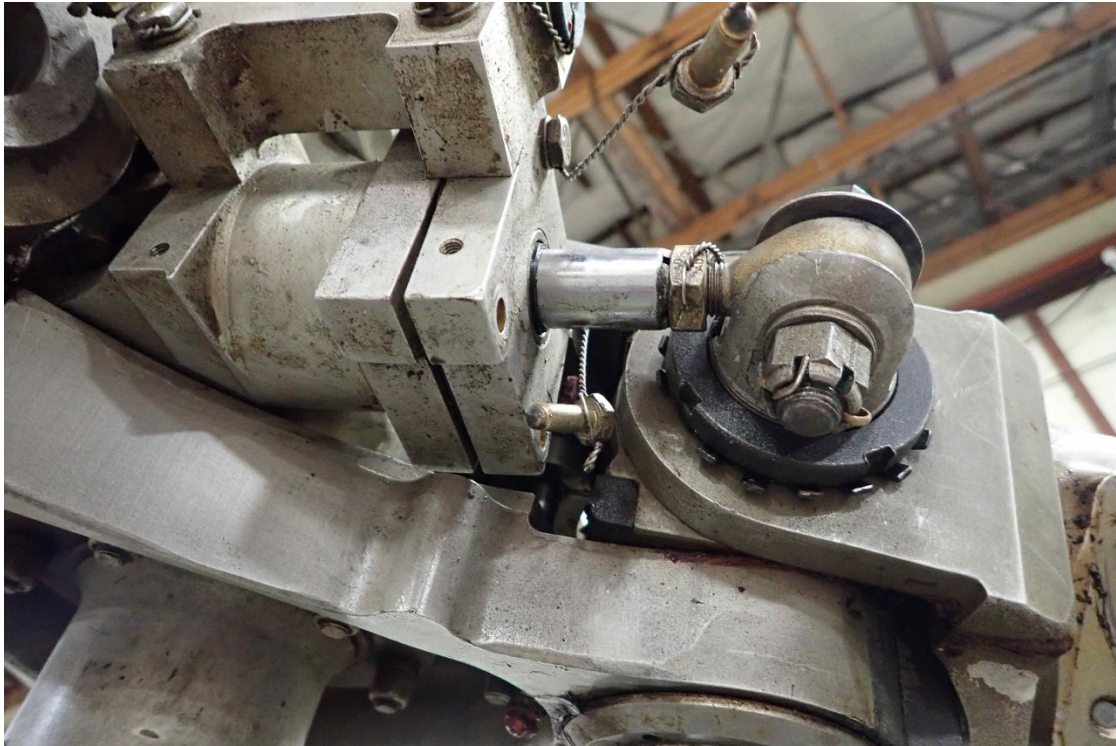


Photo 20 – Number Three Blade Damper



Photo 21 – Number Three Blade



Photo 22 – Number Three Blade Underside

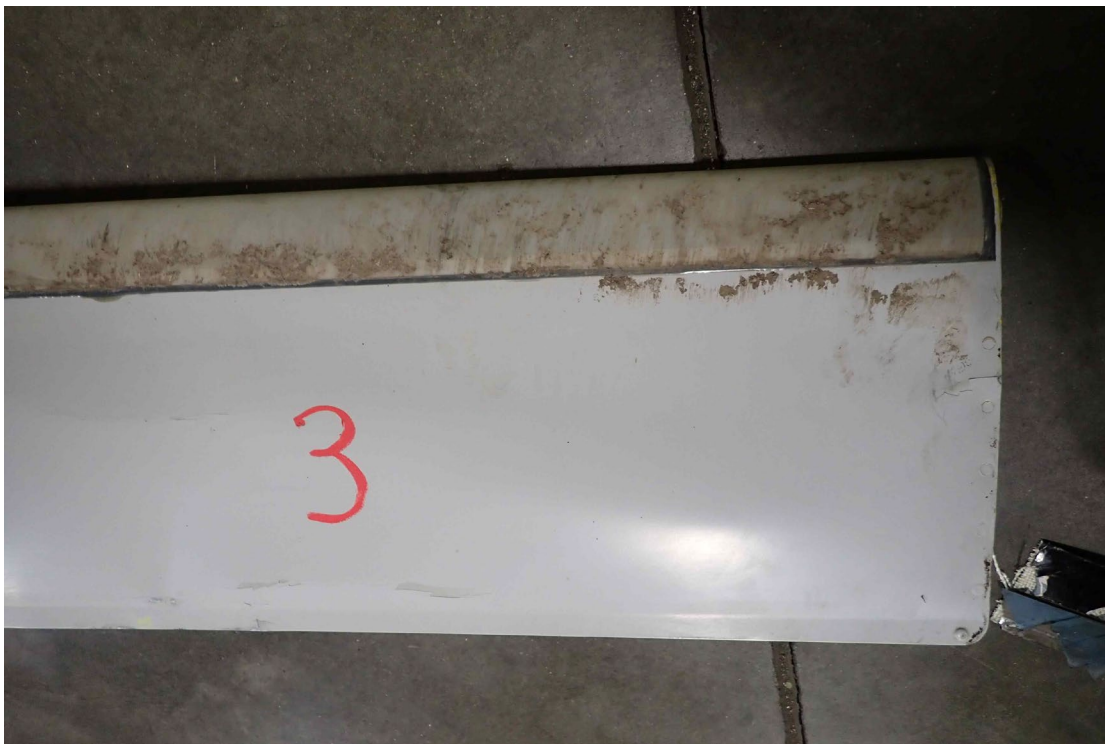


Photo 23 – Number Three Blade Upper side

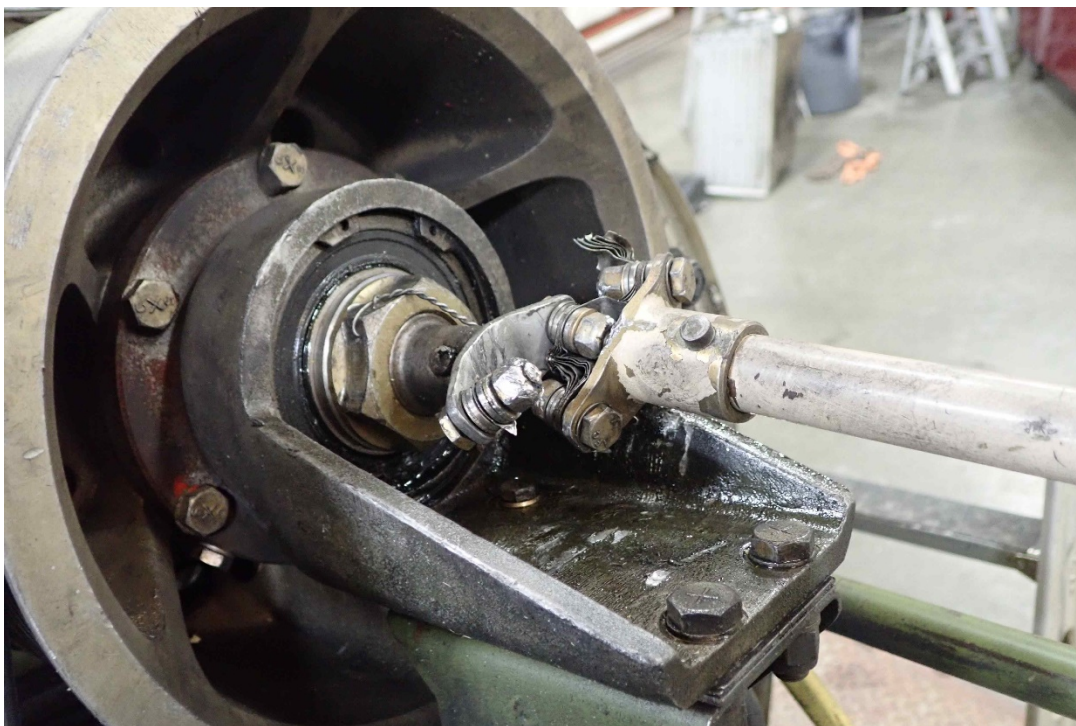


Photo 24 – Forward Tailrotor Coupling



Photo 25 – Forward Tailrotor Coupling



Photo 26 – ELT



Photo 27 – Fuel from Right Tank



Photo 28 – Throttle Control



Photo 29 – Mixture Control



Photo 30 – Engine Air Inlet Tube



Photo 31 – Engine Air Inlet Tube



Photo 32 – Top Spark Plugs

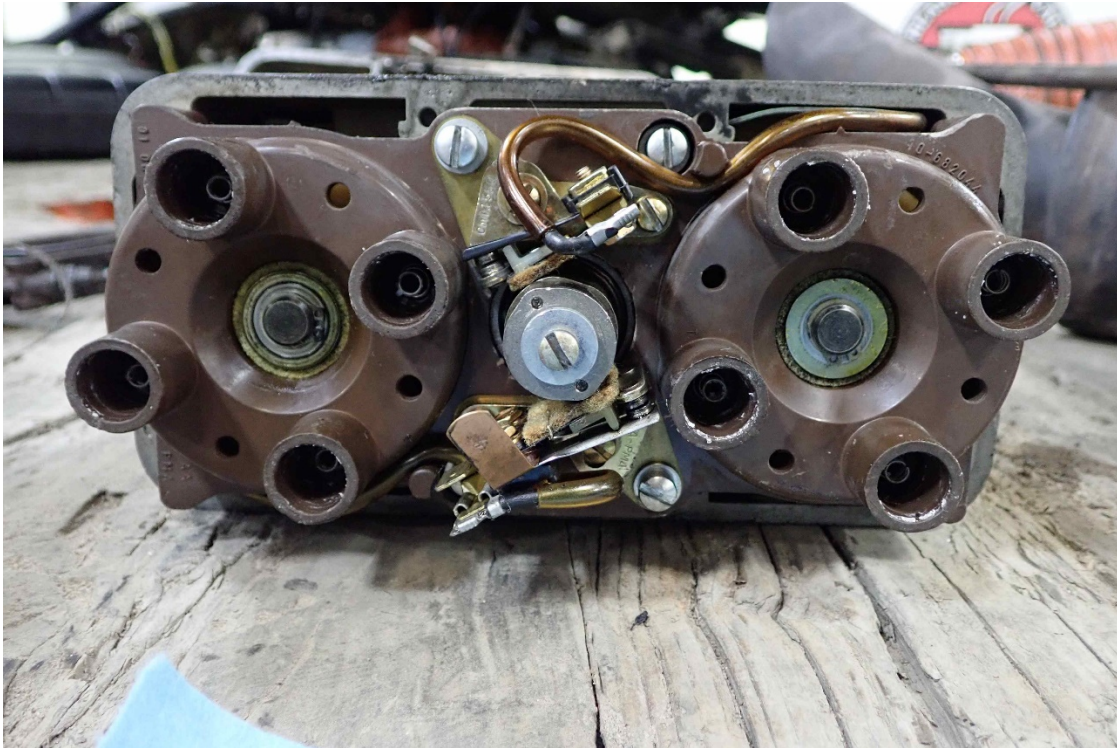


Photo 33 – Dual Magneto

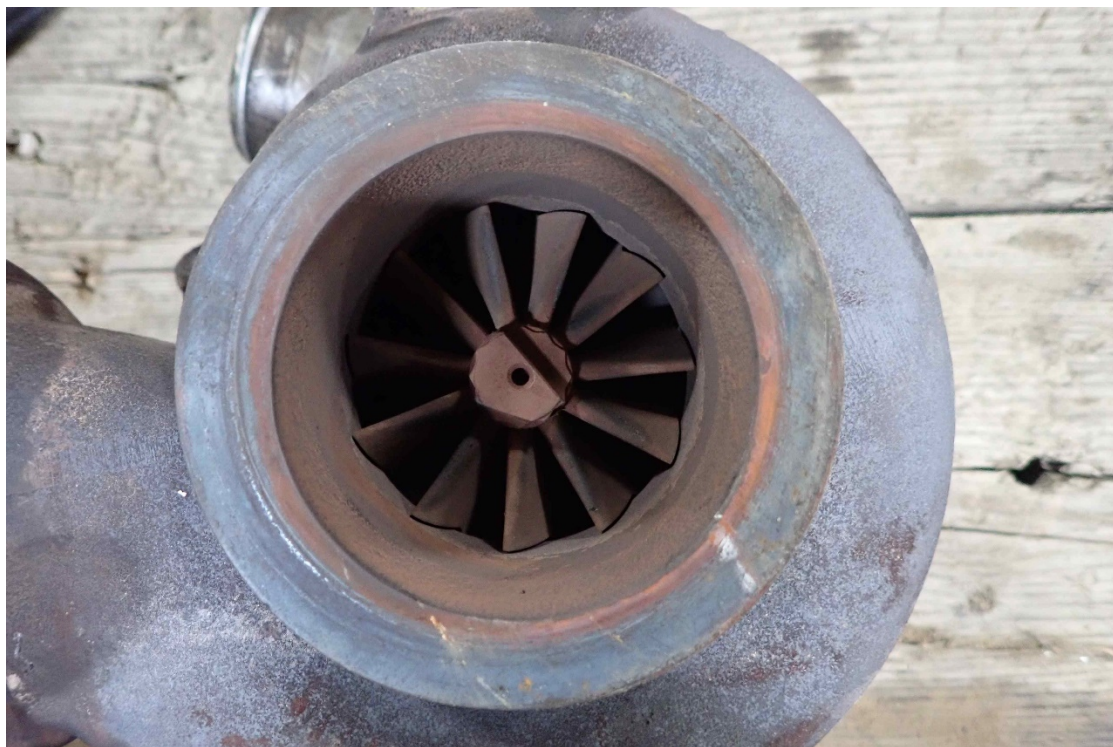


Photo 34 – Turbo Charger Turbine

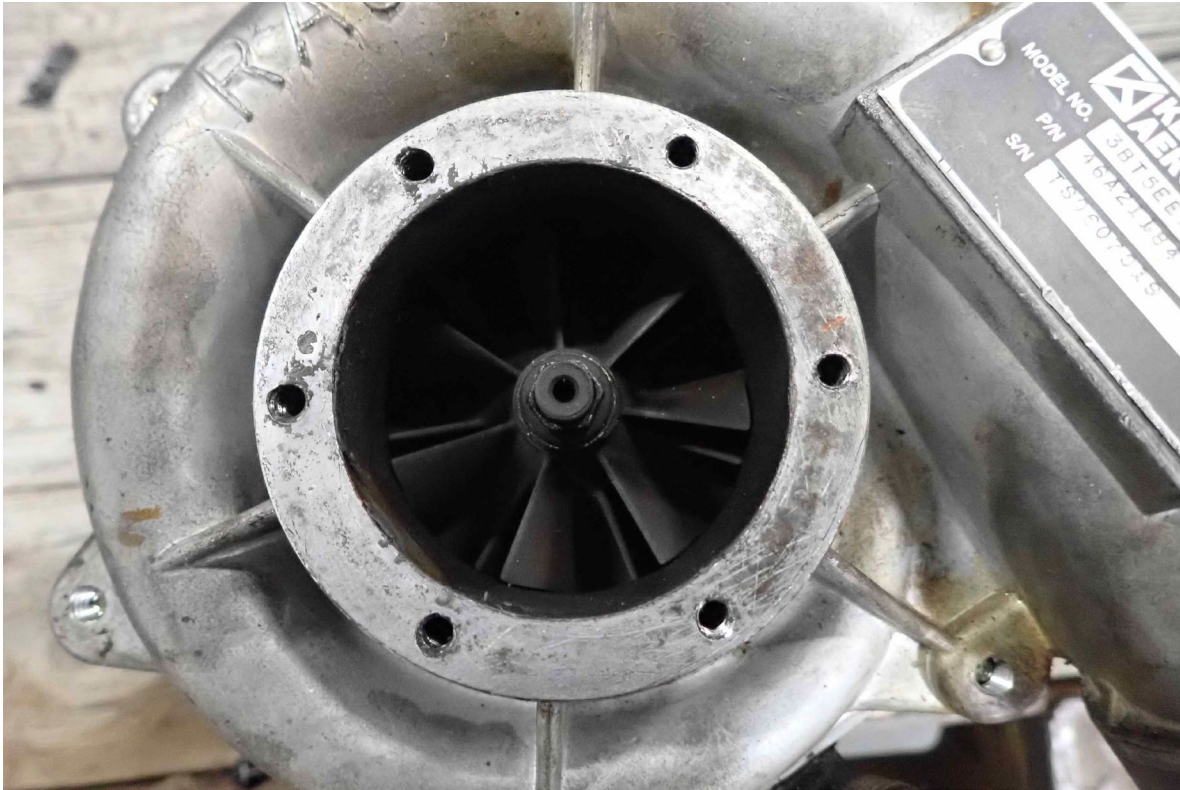


Photo 35 – Turbo Charger Compressor

Submitted by: Eliott Simpson