September 26, 2013

To: Boeing Accident Case File # **130812/369E/0535E**
N62PJ/ PJ Helicopters, LLC.
Burns, Oregon
Reference: **NTSB # WPR13GA374**

From: A. Booth, Boeing Accident Investigation
J. Hobby, MDHI Accident Investigation

Subject: Field Investigation Notes, 9 September 2013
PJ Hangar Facility, Red Bluff Municipal Airport
Red Bluff, California

Copies Furnished: Josh Cawthra (IIC), NTSB

1. <u>Onsite Participants to the Investigation.</u>

Josh Cawthra, IIC NTSB Western Pacific Region, Seattle, WA [redacted]
Mark Gunsauls, Dir Opns, PJ Helicopters, Red Bluff, CA [redacted]
Jon Michael, ASI, Rolls Royce, Indianapolis, Indiana [redacted]
John Hobby, ASI, MD Helicopters, Inc. Mesa, Arizona [redacted]
Adrian Booth, ASI, The Boeing Company, Mesa, Arizona [redacted]

2. <u>General Information.</u> The mishap aircraft, a McDonnell Douglas MD500E, Model 369E (SN: 0535E), U.S. Registration N62PJ, is owned and operated by PJ Helicopters, Red Bluff, California. On the day of the mishap, the helicopter was being used as a Nonscheduled 14 CFR Public Use flight. The flight crew consisted of a commercial rated pilot in the left crew seat and a mission technical observer occupying the right front seat. VMC conditions prevailed at the time of the mishap and the flight was conducted under visual flight rules. A VFR flight plan was not filed.

The mishap occurred on August 12, 2013, at about 2:00 PM Local (Pacific Standard Time), when the helicopter impacted the ground and sustained substantial damage during a forced landing initiated by a reported loss of engine power near Burns, Oregon. The helicopter had just taken off from a company staging area at approximately 12:45 PM. The pilot reported that during cruise flight at an altitude of about 400 feet above ground level over mountainous terrain, he heard a loud bang originate from the engine followed by an immediate loss of engine power. The pilot performed a 180-degree autorotation and attempted to land on a forest service logging road. During the hard landing, the helicopter sustained substantial damage to the fuselage, drivetrain and landing gear. The pilot and crew reported no injuries. The crew egress was normal and accomplished without assistance. There was no post crash fire. There was no reported fuel spill at the crash site. The helicopter was recovered to the PJ facility in Red Bluff and made available for NTSB inspection.

3. Aircraft/ Maintenance History. The aircraft approximate total time was reported as 10,449.6 hours with the Hobbs Meter usage time displayed 3,324.8 hours. Boeing Safety Records review indicated no previous mishaps for the airframe. The helicopter maintenance records were available at the time of the wreckage inspection.

A review of the records indicated that there were no systemic maintenance problems encountered with the airframe. The aircraft appeared to be in compliance with the appropriate manufacturer's Service Bulletins, Service Letters and Technical Bulletins. The aircraft records showed compliance with all appropriate FAA Airworthiness Directives. Airworthiness inspection entries referenced the Handbook for Maintenance Instructions-Volume 2 (HMI-2). The onsite inspection of the aircraft showed that the helicopter was in good mechanical condition.

4. Aircraft Performance and Weight & Balance Data:

a. Operational Performance Data. The aircraft performance was reviewed within the scope of available documents and data representing the approximate power available conditions and aircraft configuration at the time of the mishap. Data indicates that at the time of the mishap there was sufficient power available for the conditions and configuration to perform the planned mission. The aircraft was capable of being operated within published operational parameters.

b. Weight & Balance. The weight and balance review was made using the "worst case" estimates based on a known and/or estimated aircraft configuration at the time of the mishap. Allowing for minor deviations in weight and configuration, the aircraft had been operating within the published weight and balance constraints at the time of the mishap.

5. Systems Examination:

a. Airframe/ Fuselage/ Landing Gear. The onsite inspection was conducted on the helicopter in the operator's hangar facility at the Red Bluff Municipal Airport. The helicopter was removed from the recovery trailer. Due to the damaged landing gear, the helicopter was positioned upright, resting on the right landing gear and supported by jacks on the left FS 96.89 and aft FS 197.78 jack points due to the left landing gear damage.

Inspection of the helicopter revealed that the airframe/ fuselage had experienced a significant amount of damage which included structural distortion and loss of the tail boom and tail empennage assembly.
There were varying degrees of deformation and wrinkling/oil canning of the skin surface panels on most of the fuselage with a majority being to the underside of the fuselage from FS 44.65 aft to FS 137.50. The damage was more extensive on the left side. There was no visible damage on the lower FS 78.50 frame and the FS 124 canted frame. The transmission/static mast support structure appeared undamaged. The aft boom fairing exhibited wrinkling and oil canning of the exterior skin surfaces on both sides. The aft cabin was intact. There did not appear to be any visible damage to the keel beam at the forward and aft gear strut attaching points. The horseshoe shaped FS 137.50 frame exhibited no damage. The area in the vicinity of the left gear struts of the fuselage was damaged from gear strut flexing upward on ground contact. The upper pylon and composite air inlet fairing was intact with little distortion.

The tail boom was fractured into two sections in the vicinity of FS 255.0. The forward section of boom was still attached at the tail boom mount at the FS 197.78 frame on the aft boom fairing. The tail boom attaching points and mounting bolts appeared undamaged. The section of tail boom aft of FS 255.0 had separated with the tail empennage attached. There was visible evidence of contact marks and paint transference of rotor blade strikes to the aft portion of tail boom. The fractured and torn skin/structure and the bending of the boom were consistent with a low speed blade strike.

The tail empennage including the vertical stabilizer, horizontal stabilizers and tail rotor assembly was extensively damaged. The horizontal stabilizer was removed for recovery. The upper and lower stabilizer skin surfaces were torn and warped across the upper and lower surfaces. There was a 5X12 inch gouge at mid-span from an apparent blade strike that most probably was sustained during empennage separation. The vertical

stabilizer was firmly mounted to the tail boom with the upper and lower leading edges being dented and gouged and the upper/ lower skin surfaces were warped and wrinkled. The lower section displayed impact damage to the tail skid which was bent upward.

The landing gear exhibited deformation damage on the left side. The left gear struts, strut braces, dampers and keel beam mounts sustained varying degrees of damage as a result of high stress loads experienced from ground impact during the autorotational landing. The right gear struts appeared undamaged. The left gear struts splayed upward sufficiently to indicate a higher than normal rate of descent at touchdown. The left skid was torn off when both the fore and aft struts fractured. The left forward strut was fractured approximately 12 inches above the saddle mount. The left aft strut fractured at the elbow but remained attached to the fractured-off end of the left skid tube which had fractured just forward of the aft saddle mount. The right skid tube was intact and relatively undamaged.

b. Cockpit and Instruments. There was minimal damage to the cockpit structure. Cockpit door frame structure, glass windscreens transparencies and floor exhibited very little damage. The instrument panel was intact and securely mounted from the base support structure. The installed instruments, gauges, radios and controls appeared to be undamaged. The engine reignition system was functional. The instrument panel warning/ caution lights were test and were found functional. The TOT gauge and airframe wiring were inspected in accordance with the HMI-2 and found to be within acceptable limits. There was no damage to the seats and seat box structure. The cockpit restraint system was examined and found undamaged and functional. All damage was attributed to ground impact.

c. Engine. The aircraft was equipped with a Rolls-Royce 250-C20B Turboshaft engine, SN: CAE836896. The engine was reported to have accumulated 10,209.9 hours total engine time at the time of the mishap. There were no identified or reported problems with the engine performance during the mishap flight prior to the reported loss of power.

A Rolls-Royce ASI inspected the engine as installed in the airframe. The inspection of the engine revealed that the engine and related systems appeared to have sustained minimal damage from the hard landing. There was a readily visible rupture on the top half of the power turbine case that would indicate an uncontained failure internal to the engine power turbine section. Engine mounts were intact. There was no damage to the inlet opening on the FS 124 frame which would indicate little or no movement of the engine during the crash sequence. A check of engine air, fuel and oil lines found them to be intact with tight connectors. There were no indications of visible leaks to engine fuel or oil lines or fittings. A correlation check of the controls and the power governor and fuel control position indicators was accomplished. Both were found to be within limits. Oil samples were taken from the airframe reservoir and from the engine. Engine was removed for shipment to OEM facility for additional test and analysis. See Rolls-Royce engine report-TBP.

d. Main Rotor System. The main rotor system hub assembly and components displayed visible damage associated with a stoppage event with main rotor blade contact with the fuselage, ground and trees during the hard landing. There was visible damage to the hub upper and lower shoe, feather bearings, pitch change housings, lead-lag dampers and droop stops. Damage was consistent with the excessive blade flapping and lead-lag excursions of main rotor sudden stoppage at low rotor RPM.

The main rotor blades (HTC PN: 500P2100-105, SN: K486B-Green, K485B-Yellow, K487B-Blue, K484B-Red and K483B-White) were retained on the rotor hub during the mishap and were removed as part of the onsite inspection. Blade damage varied and included fractures, gouges, bent spars, cord-wise wrinkling, leading/ trailing edge damage, bending, separation and tip cap damage. There was contact evidence on several blades as a result of blade strikes to the fuselage/tail boom and trees/ground. All blade damage appeared to be the result of the hard landing and was consistent with that of a rotor system that was not being powered at the time of impact.

e. Main Transmission and Drivetrain. The main transmission showed no exterior damage. Transmission oil was present in the sight gauge and the transmission chip detectors were inspected and found clean of metal debris. The transmission rotated freely when actioned by hand. Hub rotation would indicate that the main rotor drive shaft was undamaged. Drive from the transmission to the tail rotor output pinion and tail rotor driveshaft was present. The engine to transmission interconnecting driveshaft and both Kaflex couplings were intact and appeared to be undamaged. The over-running clutch was removed for inspection and was undamaged and functional. The oil cooler blower assembly was undamaged and functional.

The tail rotor drive shaft was fractured into four segments. The forward section of tail rotor driveshaft was still attached to the transmission output pinion. The forward Kaflex drive shaft coupling was undamaged. The second section from approximately FS 190 to FS 230 and the third section from approximately FS 230 to FS 260 were fractured loose and ejected from the tail boom. The end section of driveshaft from FS 260 aft was inside the severed aft portion of the tail boom and was still connected to the input quill of the tail rotor gearbox. The aft Kaflex drive shaft coupling was intact and exhibited no visible damage. All of the driveshaft segments exhibited typical low rotation severance fracture and not the characteristic fractures and shaft roll up normally associated with sudden stoppage with engine power applied to the rotor system.

f. Tail Rotor System. The tail rotor system was still attached to the aft section of the severed tail boom at the FS 281 frame base. The tail rotor gearbox remained in place on the tailboom closeout. All four Rosanne fittings and retaining nuts were tight and there was no indication of gearbox movement on the mount. The case was intact except for the FS 285 bellcrank mounting flange which had fractured off. There was oil visible in the sight gauge. There was no internal grinding or ratcheting when the gear box was rotated by hand. The chip detector was removed and was found clean of metal debris. The pitch change housing and pitch change links were attached but damaged with some deformation and nicks/gouges. The pitch change housing moved easily on the undamaged output shaft when actioned. The drive fork, elastomer teetering bearings and the drive fork bolt exhibited some minor scratches and gouges. Both tail rotor blades were still connected to the hub. Although the tail rotor hub was in place, it had fractured at the Red tail rotor blade.

The tail rotor blades (HTC PN: 500P3100-105, SN's: Blue-B687, Red- B688) were substantially damaged. Both blades exhibited bent spars and warped/torn skin on the outer and inner blade surfaces. There was impact damage to the leading edge of both blades. Both abrasion strips were retained but exhibited contact/impact damage and some separation from the leading edge. Tip cap damage was evident on both blades. The Red blade pitch horn had fractured off. All damage to the tail rotor system was attributed to possible contact with the tail boom and ground/tree impact during the mishap sequence.

g. Flight Control System. The aircraft was configured in a normal duel pilot operation with the copilot station removable cyclic and pedal foot rests were not installed. Pilot cockpit control sticks were in place and undamaged. Cyclic lateral and longitudinal main rotor control linkage exhibited continuity throughout full range of movement from the cockpit controls up to the upper flight controls and to the rotor hub. Collective control linkage was also continuous. There was no apparent damage to the upper flight controls, rotating/non-rotating swashplate and pitch change links.

Anti-torque flight control linkage exhibited continuity from the yaw pedals back to the long control rod in the tail boom. The control rod was broken into four segments with fractures at approximately FS 220, FS 245 and FS 264. Continuity was again established at FS 264 back to the FS285 bellcrank that had fractured off the tail rotor gearbox. Manipulation of the fractured control rod resulted in the applicable pitch change to the tail rotor blades.

The control linkage for the lateral and longitudinal trim actuators and the N2 RPM control (Beep Switch) were intact and appeared undamaged. Power was applied to the systems and they both were functional throughout their entire range of movement.

h. Fuel System. There were no reported problems with the airframe fuel supply system. A fuel vacuum check was not attempted on the engine and airframe fuel supply system. All lines and fittings appeared to be tight and no visible

fuel leaks were identified. Visual inspection of the fuel system failed to identify any visible damage to the tanks, plumbing and fittings. Adequate fuel was onboard the aircraft for its intended mission.

6. Investigator Comments:

a. Visual inspection of the airframe failed to reveal any other damage not associated with the hard landing.

b. Damage to the aircraft powertrain was consistent with sudden stoppage to the main rotor and tail rotor systems as a result of low rpm main rotor strikes to the airframe and ground contact.

c. Damage to the airframe structure and displacement of landing gear would indicate a higher than normal rate of autorotative descent at touchdown. This would also indicate a low rotor rpm state during the later stages of the descent and landing.

d. At this point, pending the additional technical evaluation of the engine, the investigation has failed to identify any other fault or malfunction of any other helicopter system/component that could have contributed to the accident or loss of engine power.

e. The reason for the uncontained failure in the power turbine and subsequent loss of engine power is yet to be determined.