

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



WPR24LA319

AIRWORTHINESS

Specialist's Factual Report

August 20, 2025

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A ACCIDENT

Location: Fern Prairie, WA
Date: September 26, 2024
Time: 1540 Pacific daylight time (PDT)
Helicopter: Bell Helicopter 206L / N9984K

B AIRWORTHINESS

Specialist: Van S. McKenny IV
National Transportation Safety Board
Washington, DC

C SUMMARY

On September 26, 2024, about 1540 Pacific daylight time, a Bell 206L, N9984K, was substantially damaged when it was involved in an accident near Fern Prairie, Washington. The pilot was not injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 91 repositioning flight.

According to the pilot, he had departed a remote landing zone and was enroute to the Fly JLA Airport (OR72), Boring, Oregon. While in cruise flight about 1,000 ft above ground level, the helicopter experienced “a severe vertical hop” and began to shake violently. The pilot initiated an emergency descent, during which time the shaking subsided. The pilot performed a normal landing in an open field. After egressing, the pilot observed substantial damage to the helicopter’s tail boom (Figure 2) .

D DETAILS OF THE EXAMINATION

The helicopter was examined on Tuesday, January 21, 2025, at the operator’s facility in Boring, OR. Present at the examination were representatives from Bell Helicopter, the Federal Aviation Administration, JL Aviation, Van Horn Aviation, and Rolls-Royce.

1.0 Helicopter Information

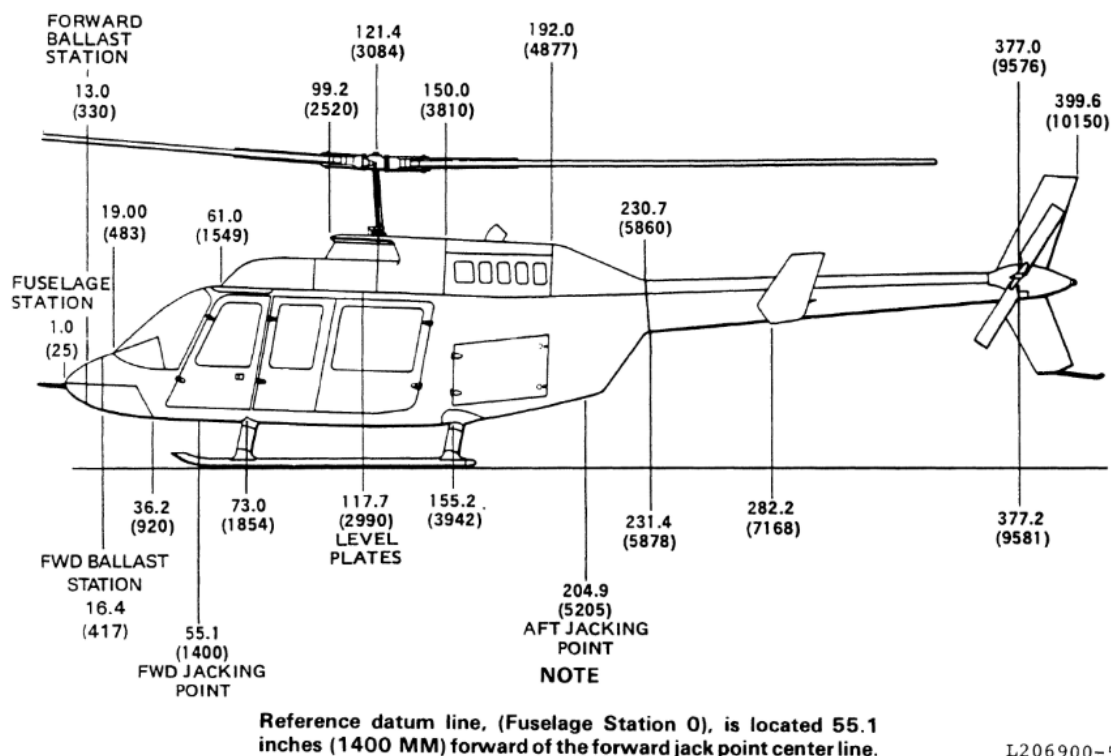


Figure 1. Station location diagram [Source: Bell 206L Flight Manual, 6-3]



Figure 2. The helicopter immediately after the emergency landing with damage to the tail boom. [Source: JL Aviation]

2.0 Fuselage¹

The forward fuselage consists of the crew and passenger compartments, fuel cell enclosures, and pylon supports. The major load carrying elements are constructed from aluminum honeycomb with fiber glass cloth facings and include the cabin roof shell, lower aft shell, and the lower forward shell. The aft fuselage consists of the baggage and heater compartments and is of semi-monocoque construction. Titanium and aluminum alloy panels provide a deck for the power plant assembly, oil tank, oil cooler, and oil cooler blower. The tailboom is full monocoque construction and supports the horizontal stabilizer, vertical fin, tail rotor drive shaft, and tail rotor gearbox.

2.1 Fuselage Examination

SN: 45054

Hobbs: 8,607.6

AFTT: 25,607.6

The helicopter was equipped with high skid landing gear and footsteps on the sides of the fuselage. It was also equipped with upper and lower wire strike cutters which exhibited no evidence of a wire strike. The tailboom had been removed from the aft fuselage attachment point during recovery. The tailboom was bent down just aft of the intercostal support and slightly to the right. The bend in the tailboom intercostal support but was otherwise intact (Figure 3). There was no damage or signs of ground contact to vertical tail or stinger. The main fuselage was intact with some minor buckling and loose rivets on the left aft fuselage. The cockpit was intact as were the windows and windscreens. The pilot inertial reel operated properly, and the shoulder harness and seat belts were intact. No fuel issues were suspected.

¹ BHT-206L-MM-1, Ch 53 - Fuselage, Sec 53-1



Figure 3. Tailboom downward buckle near boom station 42.59. [Source: JL Aviation]

The tail boom displayed buckling around its entire circumference about 13 inches aft of the intercostal support (station 231.486); it was displaced downward and about 15° and to the right. The tail rotor drive shaft could be rotated by hand and appeared undamaged. The elevators moved freely when the control rods were moved by hand.

The tail rotor gearbox and attached tail rotor blades had been removed from the tailboom during recovery. Visual examination did not reveal any damage to the tail rotor blades. The vertical stabilizer was intact and undamaged.

The upper aft fuselage adjacent to the engine deck displayed areas of wrinkling and paint flaking. The skids did not appear to be deformed or splayed outward.

3.0 Flight Control System Description²

The flight controls are mechanical linkages, actuated by conventional controls, and are used to control flight attitude and direction. The cyclic (fore, aft, and lateral) controls and collective controls have hydraulic boost. A synchronized elevator is linked into the fore and aft controls at the cyclic torque tube. The controls are routed

² BHT-206L-MM-1, Sec 27-1, Flight Controls

beneath the pilot's and passenger's seat, aft to the center of the helicopter and up to the cabin roof through the control column which also serves as primary cabin structure. Access doors located on the aft side of the control column and seat panels are provided for inspections of the control components, and for maintenance accessibility.

3.1 Flight Control Examination

Control continuity was established from the cockpit controls to their respective control servos.

The helicopter was equipped with single flight controls at the pilot right seat station. The copilot left seat station had covers installed over the quick disconnect cyclic stick and collective stick attachments and the tail rotor anti-torque pedals were locked out of the tail rotor control system at the copilot station. The cyclic stick was manipulated by hand in the longitudinal, lateral, and x-pattern planes resulting in proper movement through the main rotor servos and to the vertical cyclic control tubes at the base of the transmission. The collective stick exhibited free movement through the servos to the vertical control tube at the base of the transmission. The anti-torque tail rotor pedals moved freely by hand to the tube in the aft fuselage that was disconnected when the tailboom was removed during recovery. The long tail rotor control tube in the tailboom was intact but had been disconnected from the control tubes in the aft fuselage and at the tail rotor gearbox. The slider tube inside the tail rotor output shaft (i.e. "mast") was intact and moved freely when the tail rotor blade pitch change was activated by hand. No binding or obstructions were observed in the vertical tunnel (broom closet) at the cyclic and collective mixing unit and where the flight control tubes transit the airframe vertically. The swashplate assembly and collective lever remained attached to the mast at the lower splines and were intact. During the recovery and transport of the helicopter the main rotor pitch change links had been disconnected from the bottom rotating swashplate connection and the top surface at both main rotor pitch change horns. The pitch change links were intact. The elevator control tube actuated freely in the vertical tunnel and at the elevator trailing edge moveable airfoil on the horizontal stabilizer, free control movement was also observed.

The collective friction clamp, located under the left front seat, was tested by attaching a spring scale to the collective stick. The collective lever could be moved when 1.8 - 2.2 lbs of force in the free play region were applied near the center of the collective grip. Bell maintenance manual stipulates collective friction clamp force should be 4 to 4.5 lbs. The upper flight controls had been disassembled during recovery, precluding a full collective friction measurement.

4.0 Rotor Drive System Description³

The transmission for the 206L provides a two-stage reduction of 15.23 to 1.0 (6000 to 394 rpm). The first stage is a bevel gear arrangement with 3.26 to 1.0 reduction; the second stage reduction is obtained with a planetary gear train providing 4.67 to 1.0 reduction. A complete hydraulic system power pack is mounted forward of the transmission, and the hydraulic pump is driven by the transmission accessory gear. The accessory drive gear provides a 1.42 to 1.0 reduction. The transmission is mounted on the cabin roof and incorporates nodal beam suspension and transmission restraint. The transmission is mounted on two nodes, and the normal vibrations and vertical movement are absorbed by a flexure assembly.

4.1 Rotor Drive System Examination

The transmission remained mounted to the nodal beam structure (Figure 4). Visual examination of the nodal beam structure did not reveal any obvious defects. The freewheeling unit functioned as intended when the engine power turbine wheel and transmission main drive shaft were rotated manually.

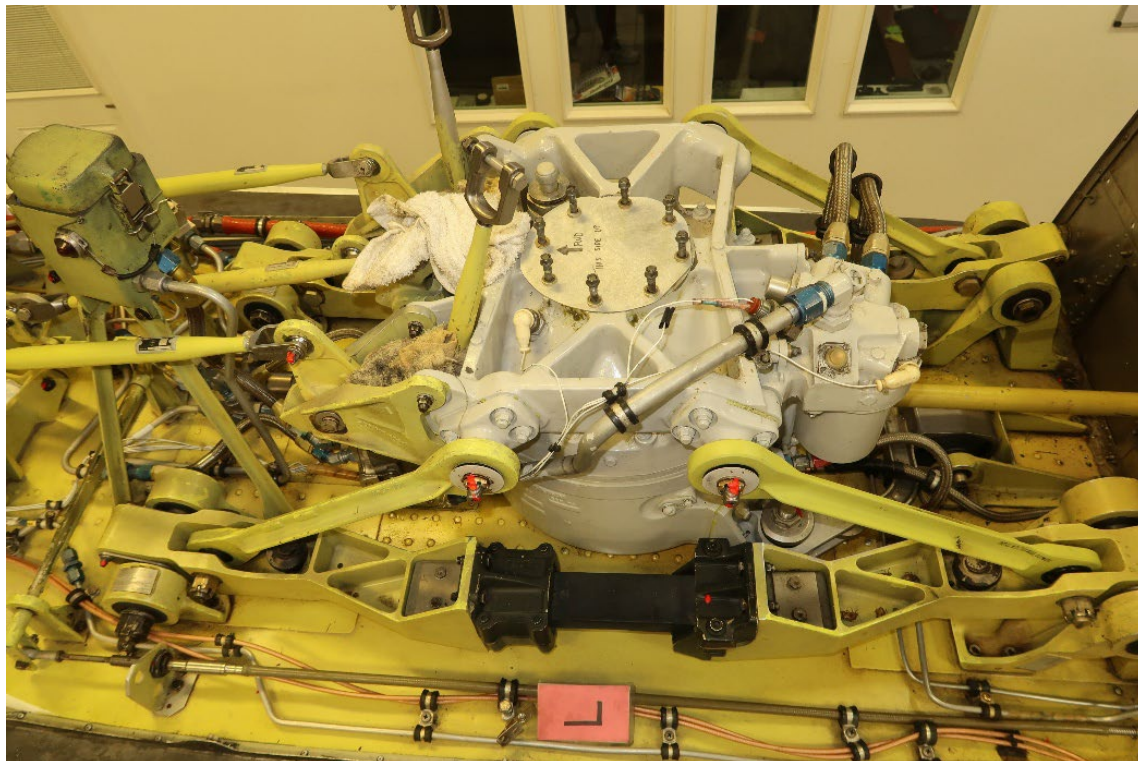


Figure 4. Main rotor transmission and transmission mounts.

³ BHT-206L-mm-1, Ch 66 - Power Train, Sec 66-12

5.0 Main Rotor Description⁴

The main rotor is classified as a two-bladed, semi-rigid, seesaw type, with underslung mounting. It consists of a hub and two blade assemblies. The blades are secured to the hub grips with hollow shank blade bolts. Lead slugs can be inserted in the blade bolts to spanwise balance the entire hub and blade assembly. When balancing the assembly, the blades must be aligned.

5.1 Rotor Head Examination

The rotor mast, rotor head, and main rotor blades had been removed from the helicopter to facilitate recovery. The rotor mast displayed witness marks from contact with the static stops; the paint had been removed by contact with the static stops, revealing the base metal. No mast deformation was observed when compared with a steel straight edge.

The rotor head appeared undamaged. The latch bolts had been previously loosened when removing each blade, which precluded the ability to make a blade sweep measurement. The droop stop block was removed and the trunnion centering was measured with calipers; one side measured .011 inches, and the opposite side measured .005 inches. The specification limit is 0.003 inches when measured using the appropriate work aid per the component repair and overhaul manual. No play was detected in the tension-torsion straps when the blade grips were rotated by hand. The interior of the yoke assembly had a vertical grease mark adjacent to the grip for the red main rotor blade.

5.1.1 Rotor Blade Examination

The main rotor blades were manufactured by Van Horn Aviation LLC. STC No. SR02684LA. Both blades were designated as part number 20633000-101 with individual identifying serial numbers. The blades had been removed from the rotor hub and stored in wood crates. Visual examination and tap testing did not reveal any defects (Figures 5 and 6).

⁴ BHT-206L-MM, Ch 65 Rotor System, Sec 65-2



Figure 5. Main rotor blade, SN: A453

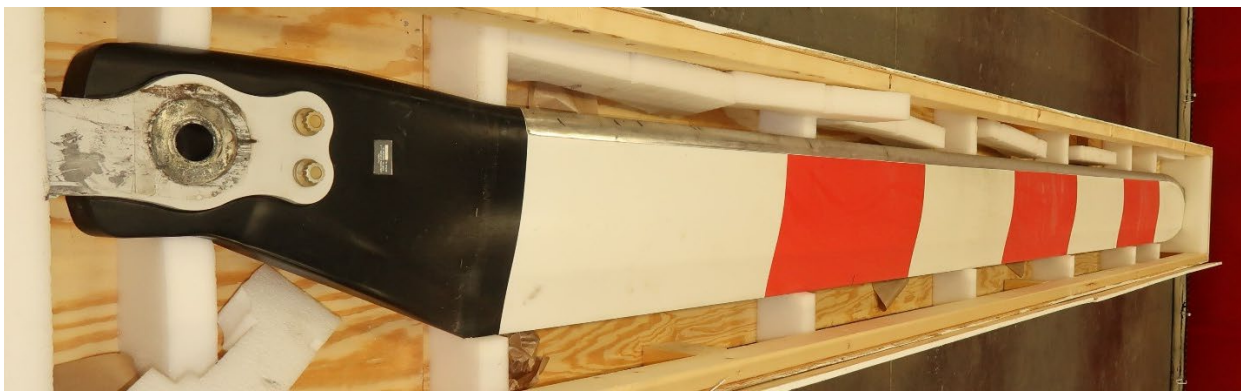


Figure 6. Main rotor blade, SN: A454

6.0 Tail Rotor System Description⁵

The tail rotor consists of a hub and blade manufactured of an aluminum alloy, forged yoke, and stainless steel blades. The blades are mounted in the yoke by means of spherical bearings which are mounted in the blades on the pitch change axis. The spherical bearings permit pitch change of the blades. The hub and blade are mounted on the 90° gearbox shaft by means of a splined trunnion, mounted in the bearings in the yoke, to provide a flapping axis for the assembly. At time of assembly, spanwise balance is done using washers on the blade retention bolts. Chordwise balance is done using weights and washers on the trunnion bearing housing retaining bolts.

⁵ BHT-206L-MM, Ch 65 Rotor System, Sec 65-44

6.1 Tail Rotor Examination



Figure 7. Tail rotor assembly attached to the tail rotor gearbox.

The forward short shaft (steel tail rotor driveshaft under the engine) remained connected to the engine gearbox on its forward end and the oil cooler shaft on its aft end. When rotated by hand, free drive movement was observed through the oil cooler shaft. The aft short shaft (first tail rotor driveshaft on the main fuselage) had been removed along with the tail boom from the helicopter during the recovery. The tail rotor drive shaft, Thomas couplings, and hanger bearings on the tailboom were intact. The hanger bearings rotated freely. The tail rotor gearbox exhibited free rotation by hand and corresponding rotation of the attached tail rotor hub and blades was observed. The tail rotor gearbox had been removed from the tailboom during recovery (Figure 7).

7.0 Engine Description⁶

The Rolls-Royce Model 250-C20B turboshaft engine consists of a multistage axial -centrifugal-flow compressor, a single combustion chamber, a two-stage gas producer turbine, and a two-stage power turbine.

The power plant assembly is horizontally mounted aft of the transmission and above the fuselage. The engine is supported by three bi-pod leg mounts to the service deck and is coupled to the main transmission through the freewheeling unit and main driveshaft.

7.1 Engine Examination

Engine Manufacturer:	Rolls Royce
Engine Model Number	M250-C20B
Engine Serial Number:	CAE 832197R
Engine Total Time:	15,310.0 hours
Gearbox Total Time:	10,946.0 hours

⁶ BHT-206L-MM-1, Ch 71 - Power Plant System, Sec 71-1

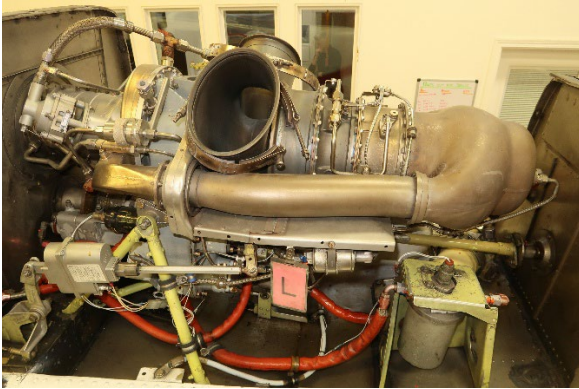


Figure 8. View of the left side of the engine.



Figure 9. View of the right side of the engine.

The engine remained mounted to the helicopter (Figures 8 and 9). External visual examination did not reveal any damage to the engine or engine mount. The engine inlet guide vanes appeared undamaged. The turbine moved freely when rotated by hand.

Collective pitch continuity to the power turbine governor (PTG) was confirmed. The PTG input control arm was disconnected from the trim actuator linkage. Full stop-to-stop travel of the PTG input shaft was confirmed along with corresponding pointer indicator on the scale. Throttle continuity to the fuel control unit (FCU) was confirmed from the collective arm twist grip to the input linkage at the FCU. The FCU control lever was achieving full stop-to-stop travel from the fuel cutoff position to max (FLY) position. Fuel was present to the fuel nozzle after first cracking the B-nut fitting on the flex line at the check-valve on the horizontal fire shield. Draining residual fuel in the line yielded approximately 1 tablespoon of fuel.

The upper & lower magnetic chip detectors and engine oil pressure filter were not removed or examined. The filter assembly did not have an impending bypass indicator button. The scavenge filter was not removed or inspected.

The N1 (gas producer) rotor and N2 (power turbine) rotor could be turned freely by hand and were smooth and quiet. The power turbine 4th-stage wheel was rotated by hand through the exhaust duct and continuity through the power output shaft to the main rotor transmission was observed. The tail rotor drive shaft section between the engine and aft firewall was also continuous and smooth turning, including the oil cooler blower. The power turbine 4th stage blades were all present and void of any noticeable impact damage or thermal distress. N1 drivetrain continuity was confirmed by hand rotating the compressor impeller through the inlet and observing concurrent rotation of the starter-generator cooling fan.

The compressor inlet support, guide vane struts, and 1st-stage rotor blades & vanes were free of impact damage.

8.0 Maintenance Record Review

The following table was constructed from a review of the maintenance records from the time of the accident back to the installation of the main rotor blades.

Date	AFTT (hours)	Maintenance Activity
9/12/2024	25,592.20	Removed G1 mount. Installed lower wire cutter and rear seats.
7/28/2024	25,566.90	Replaced engine fuel pump. Replaced left hand rotor brake.
7/23/2024	25,494.00	50 hr, 100 hr engine and airframe inspection. Replaced aft freewheel unit seal.
7/15/2024	25,463.20	Installed Airfilm G1 nose mount utility bracket. Left middle seat removed. Lower wire strike removed
6/28/2024	25,443.70	50, 100, 200, 300-hour airframe and engine inspection. Replaced starter generator. 600-hour input driveshaft inspection. Cleaned hydraulic filters. Replaced tail rotor gear box. ASB 206L-20-184 ASB 206L-24-189 ASB 206L-21-186 ASB 206L-24-189 ASB 206L-09-185 AD 2013-25-10 AD 96-18-05R1 Tail rotor track and balance
6/24/2024	25,439.10	Removed Airfilm G1 nose mount. Installed lower wire strike blade
	25,407.00	50-hour lube
6/10/2024	25,373.80	Removed lower wire strike blade. Installed Airfilm G1 mount utility bracket. Revised weight and balance and equipment list
6/10/2024	25,372.20	Performed 50-hour servicing

6/4/2024	25,360.20	Removed Lidar set up and ballast. Reinstalled lower wire strike blade. Performed 50- and 100-hour servicing. Performed 150-hour servicing and inspections. Performed 600-hour hydraulic fluid replacement.
5/20/2024	25,337.40	Removed lower wire strike blade. Installed Airfilm G1 nose mount utility bracket. Installed 18 lbs ballast station 282.7. Right center sear removed and computer rack was installed. Installed GPS antenna on tail. Revised weight and balance.
5/17/2024	25,337.00	ASB 206L-23-188 Replaced fuel pump (for overhaul). Installed cargo hook. Performed 50- and 100-hour airframe and engine inspections and servicing.
5/8/2024	25,334.50	Removed Paravion Tech hard point and camera. Reinstalled jack point.
5/8/2024	25,333.80	Removed left front jack point and installed Paravion Tech hard point. Installed camera on mount. Installed computer rack on rear seat. Weight and balance and equipment list revised
5/7/2024	25,333.80	Replaced turbine assembly. Replaced linear actuator. Performed ground run.
5/1/2024	25,325.50	Replaced leaky hose
4/26/2024	25,318.10	Installed dual controls.
4/1/2024	25,261.10	Mast nut and pillow block retorque
3/31/2024	25,258.80	Maintenance check and track and balance
3/30/2024	25,258.00	AD 2013-25-10 AD 96-18-05R1 Performed 50- and 100-hour airframe servicing and inspection. Performed 150-hour engine inspection and servicing. Replaced transmission link due to worn bearing. Installed overhauled oil filter housing unit. Overhauled transmission. Overhauled main rotor head. Replaced retention straps, retention strap pins, retention strap fittings, and retention strap bolts. Replaced main rotor blades with new Van Horn blades PN: 206633000-101, SN: A454 and A453

Tail boom history:

The historical service record of the tail boom shows that it was first installed on a helicopter at an unknown date with zero service hours, and then was removed on 12 March, 1994, with 10,522 hours total time since new (TTSN). It was then installed on two other helicopters. On 11 May, 2004, with 14,892.5 hours TTSN, it was removed due to damage incurred from a hard landing. On 1 August, 2014, with 20,516.3 hours TTSN, the tailboom was installed on N9984K. The following directives have been complied with:

Directive	Description	Date
Bell ASB 206L-92-84	Bearing support brackets	15 April, 1994
Bell TB-206L-94-169	Replacement of shims	6 December, 1999
AD 96-18-05	Visual inspection of tailboom skin	6 December, 1999
Bell TB-206L-96-191	Modification for interchangeability	6 December 1999
AD 99-13-12	Fluorescent dye penetrant inspection of skin around horizontal stabilizer	6 December. 1999
Bell ASB 206L-99-115C	Add doubler to left side of stabilizer-to-tailboom cutout.	14 December, 1999
AD 96-18-05	Visual inspection of skin areas around nutplates around drive shaft cover retention clips	2 July, 2004

8.1 Weight and Balance

The operator provided the weight and balance calculations for a 205-pound single pilot, 135 pounds of fuel (22.5 gal), and otherwise empty of passengers or cargo (Figure 9).

N9984k (Bell 206L Long Ranger)

Item	Entered Load	Weight lb	Long Arm "	Long Moment in-lbs	Lat Arm "	Lat Moment in-lbs
Basic Empty Weight		2359.6	130.40	307692	0.00	0
Pilot P1	205.0 lb	205.0	65.00	13325	14.00	2870
Fwd Left Pax	0.0 lb	0.0	65.00	0	-11.00	-0
Right Mid Pax	0.0 lb	0.0	91.00	0	12.90	0
Left Mid Pax	0.0 lb	0.0	91.00	0	-12.90	-0
Right Aft Pax	0.0 lb	0.0	129.00	0	15.80	0
Centre Aft Pax	0.0 lb	0.0	129.00	0	0.00	0
Left Aft Pax	0.0 lb	0.0	129.00	0	-15.80	-0
Baggage	0.0 lb	0.0	174.00	0	0.00	0
Right Front Door	yes	0.0	64.00	0	25.00	0
Left Front Door	yes	0.0	64.00	0	-25.00	-0
Right Rear Door	yes	0.0	122.00	0	22.00	0
Left Rear Door	yes	0.0	122.00	0	-22.00	-0
Dart Baggage Extender	0.0 lb	0.0	185.00	0	0.00	0
Zero Fuel		2564.6	125.17	321017	1.12	2870
Weight and CG OK (Long limits Fwd:118.00" Aft:128.50")						
Zero Fuel		2564.6	125.17	321017	1.12	2870
Main Fuel Tank	135.0 lb	135.0	136.89	18480	0.00	0
All Up		2699.6	125.76	339497	1.06	2870
Weight and CG OK (Long limits Fwd:118.00" Aft:128.50")						

Aircraft config Unlocked
 MaxTOW 4000.0 lb
 Loaded Fuel Weight 135.0
 Total Pax Weight 205.0
 Total Cargo/Bag Weight 0.0
 Computed by iBal Rotary 1.95 (build 1161): 2024-10-23 20:42:19 +0000

Figure 10. Weight and balance calculations

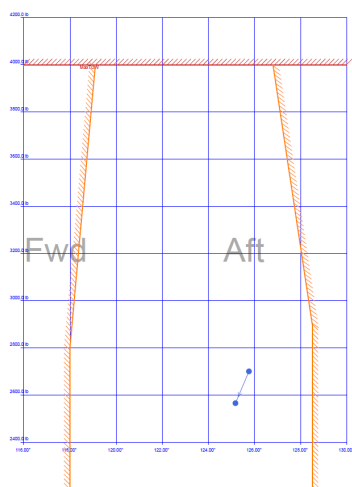


Figure 11. Longitudinal CG envelope

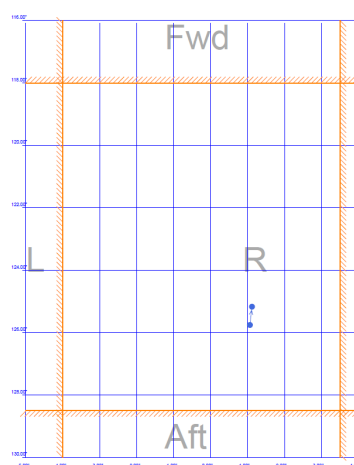


Figure 12. Lateral CG envelope

8.2 Van Horn Bulletins

Before the accident Van Horn Aviation had posted on their website, www.vanhornaviation.com, a memorandum titled "206L Vertical Hops on Lightly Loaded Aircraft," that states "...the helicopter can experience a severe vertical hop in turbulent conditions.....very light aircraft configuration can allow an interaction to occur between the rotor blades and the nodal beam mount."

An Information Letter dated 17 March 2025 (IL 33000-6R1) was released by Van Horn Aviation, addressing collective bounce.

8.2.1 Additional information from Van Horn Aviation

The Van Horn engineering team related that the first report of unusual vertical vibrations to them was in Sept 2019. The event occurred during single pilot operation with an estimate of 250 lbs of fuel, at an estimated airspeed of 120 kts. The second report came from the same operator in November 2021. A single pilot, 500 lbs of fuel, at 100-110 kts airspeed. The two reports occurred on two different helicopters, both 206L models. Van Horn Aviation then posted a note on their website about vertical vibrations and to pull in collective and enter a right turn to dampen out the vibration.

Van Horn Aviation has recently become aware of a particular flight condition that can set off **an extreme vertical hop on lightly loaded LongRangers** using VHA main rotor blades.

In cases where a 206L fitted with VHA main rotor blades is operating light—for example, with only a single pilot on board, less than a full tank of fuel and no cargo—the helicopter can experience a severe vertical hop in turbulent conditions. When initiated by a gust at high speed, this very light aircraft configuration can allow an interaction to occur between the rotor blades and the nodal beam mount. The resulting vertical hop can become very uncomfortable. This seems to be an unusual situation, but if the helicopter gets into this condition **the appropriate action is to load the rotor by banking**. By loading the disk, the frequency of the system is quickly changed, thereby resolving the issue.

Please pass this along to your pilots and operations crew. If you have any questions, please [contact us](#).

Figure 13: Vertical hops note copied from - www.vanhornaviation.com/2022/03/22/206l-vertical-hops

Since then, 11 additional reports (includes this event) have been received (as of 21 January 2025). Common factors appear to be single pilot, light weight (low fuel) and airspeed above 100 kts. The vibration events are not always repeatable even with the same aircraft.

Recently, an aircraft was found where the vibrations could be replicated. Testing found that the vibrations occurred when flying single pilot, less than 300 lbs of fuel, at

around 100 kts airspeed, and the vibration was characterized at 5 Hz. The vibrations could be induced by reducing collective and pushing forward on the cyclic or by making 5 rapid collective reversals. The vertical vibration characteristics are similar to the collective bounce phenomena, and recovery is the same, which loads up the rotor by pulling in collective and entering a right turn. This helicopter was found to have both blades swept forward 12 points (positive sweep), normal blade sweep is nominally zero. Additionally, the vibration phenomena occurred after some rotor head maintenance had been performed (blades were removed and replaced, and tension-torsion (TT) straps were replaced). It has been found that the vibrations could not be induced when two pilots were present (moving the CG forward), which is consistent with operator reports that the vibrations do not occur with two pilots or other ballast onboard. Operators have not reported damage to the helicopter as a result of these vibrations.

8.2.2 Operator Videos of vertical hop

Van Horn Aviation provided two videos that had been sent to them by an operator. The videos depict a cockpit view looking forward at the instrument panel, out the wind screen, and over the pilot's left shoulder. The vertical hops occur at an airspeed of about 120 kts, in level flight, and in non-turbulent conditions, with a sudden on-set and rapid increase in amplitude until the pilot slows below 100 kts. Once below 80 kts, the vertical vibration/hop dissipated rapidly.

Submitted by:

Van S. McKenny IV
Aerospace Engineer (Helicopters)