

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



CEN24FA049

AIRWORTHINESS

Specialist's Factual Report

July 16, 2024

A ACCIDENT

Location: Sterling City, Texas
Date: November 29, 2023
Time: 1430 central standard time
Helicopter: MD Helicopters 600N, registration N745MB

B AIRWORTHINESS SPECIALIST

Specialist Chihoon Shin
National Transportation Safety Board
Washington, District of Columbia

C SUMMARY

On November 29, 2023, about 1430 central standard time, a MD Helicopters 600N, N745MB, sustained substantial damage when it was involved in an accident near Sterling City, Texas (TX). The commercial pilot and the aerial lineman sustained fatal injuries. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 133 external load flight.

A review of Automatic Dependent Surveillance-Broadcast (ADS-B) data showed that the helicopter approached the target utility (powerline) pole, constructed of steel and about 133 ft tall, from the west. The helicopter maneuvered around the pole and the ADS-B data subsequently terminated at the pole. The pole had four arms on the same side, with the top-most arm (static arm) about 12 ft in length. Various impact marks were observed on the top-most arm and were located about 4 ft outboard from the base of the arm. The pole and attached wires were found to be intact.

The wreckage was examined at the accident site by the Investigator-in-Charge (IIC) and was subsequently recovered to Air Salvage of Dallas facilities in Lancaster, TX. From February 20-21, 2024, the accident engine was examined at Rolls-Royce facilities in Indianapolis, Indiana.¹ From April 9-10, 2024, the airframe wreckage was examined at Air Salvage of Dallas.

¹ For details of the engine examination findings, see the Powerplants Factual Report in the docket for this investigation.

D DETAILS OF THE INVESTIGATION

1.0 Helicopter Information

1.1 Helicopter Description

The MD Helicopters 600N has a six-bladed, fully-articulated main rotor system that provides helicopter lift and thrust. The 600N has an antitorque fan assembly, called a NOTAR for “NO Tail Rotor”, composed of an axial fan with 13 variable pitch blades that provides variable flow of low pressure, high volume air through the tail boom and thrusters, for directional control of the helicopter. The helicopter is equipped with one Rolls-Royce 250-C47M turboshaft engine. The helicopter is type certificated under FAA type certificate data sheet No. H3WE.

All left, right, up, and down orientations as well as clock positions referenced in this report are in the aft-looking-forward frame of reference unless otherwise specified.

1.2 Accident Helicopter History

The accident helicopter, serial number (S/N) RN067, was manufactured in 2002. At the time of the accident, the helicopter had an aircraft total time (ATT) of 9,056.8 hours and a Hobbs time of 2,756 hours.

2.0 Wreckage Examination

The airframe impacted the ground and came to rest on its left side. The empennage, containing the horizontal stabilizer, left and right vertical fins, and the aft end of the NOTAR, was found separated from the main wreckage (**Figure 1**). Multiple linear impact marks, in short succession of each other, were present on the static arm of the pole next to the accident site (**Figure 2**). The wreckage was subsequently recovered to Air Salvage of Dallas in Lancaster, TX. From April 9-10, 2024, the airframe wreckage was examined by three NTSB investigators, including the author of this report, at Air Salvage of Dallas.

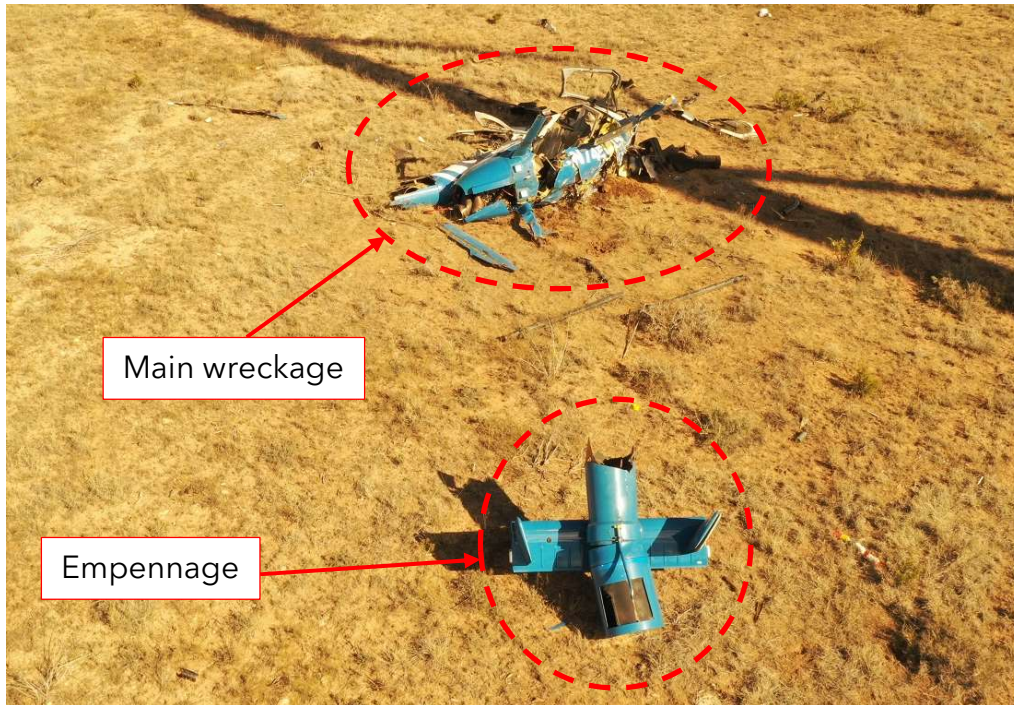


Figure 1. The helicopter at the accident site.

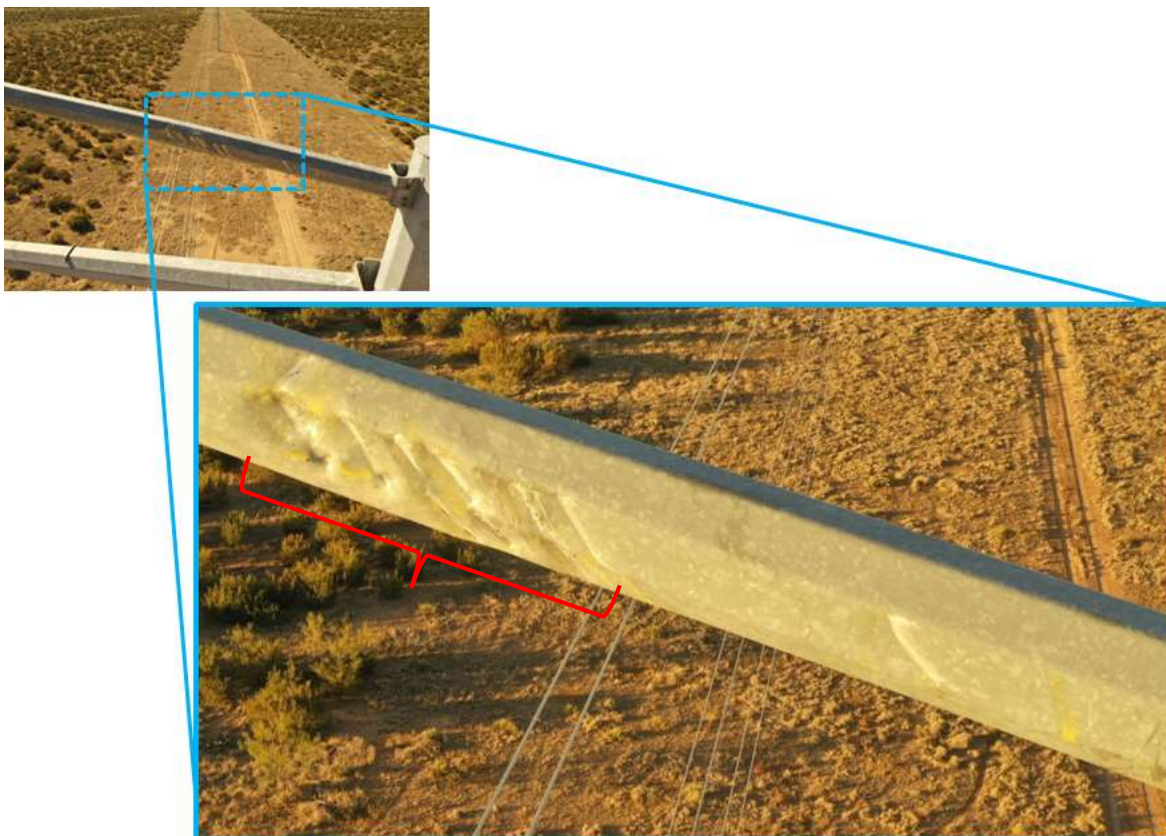


Figure 2. Multiple linear impact marks (red bracket) on the static arm of the pole next to the accident site.

2.1 Structures

The airframe had separated in three distinct groups: 1) the cockpit and cabin floor, 2) the transmission deck and aft cabin/engine compartment, and 3) the empennage. The fuselage wreckage exhibited significant deformation and crushing damage primarily to its forward and left sides. The forward portion of the tail boom exhibited an angled fracture (**Figure 3**). An angled fracture of the tail boom can be a signature of the main rotor contacting the tail boom. The landing gear aft struts remained attached to the fuselage but the forward struts and both longitudinal tubes were fractured and separated from the fuselage.

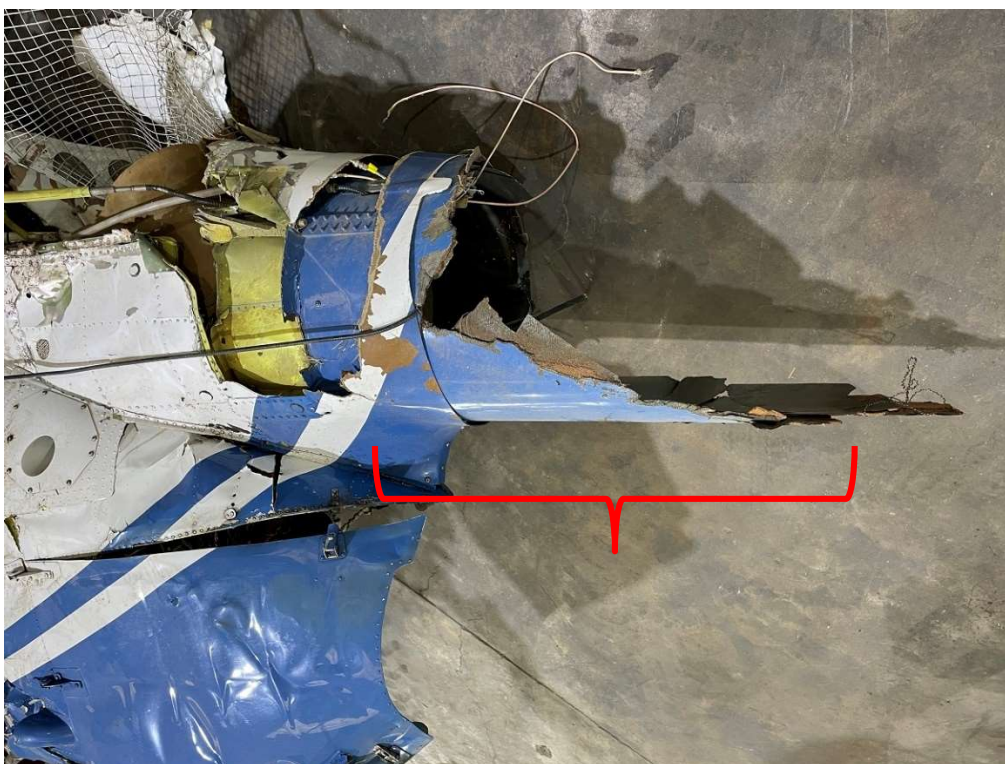


Figure 3. The forward end of the tail boom exhibiting an angled cut mark.

2.2 Main Rotor System

The forward end of the Kaflex drive shaft flange and the oil cooler belt drive gear remained installed on the main transmission input flange. The forward end of the Kaflex drive shaft was fractured at its flexible coupling with signatures consistent with overload. The main transmission remained installed on the airframe. The main rotor shaft and main rotor head remained installed on the main transmission. Rotation of the main rotor head resulted in a corresponding rotation of the engine-to-transmission (Kaflex) drive shaft flange and tail rotor output flange. The rotation was smooth with no evidence of restriction.

The main rotor hub exhibited multiple fractures, with only two main rotor blade [root end] cuffs remaining partially attached to the hub via partially fractured and deformed strap assemblies. Remnant strap assemblies for the four other main rotor blades were present, with the remainder of each strap assembly present with their separated blade cuffs. The main rotor blade dampers remained installed on five main rotor blade cuffs and blade pairs. One main rotor blade damper was fractured and separated on both ends, with the fractures exhibiting signatures consistent with overload.

All six main rotor blades exhibited significant deformation, fractures, and fragmentation of their outboard ends (**Figure 4**). All fractures observed exhibited signatures consistent with overload. The leading edges of two main rotor blades exhibited blue-colored paint transfer that was a close color match to the paint scheme of the tail boom (**Figure 5**). Three of the six main rotor blade tip weights were recovered at the accident site and exhibited impact damage. The remaining three tip weights were not found at the accident site.



Figure 4. The recovered main rotor blades.



Figure 5. Paint transfer observed on the leading edge of main rotor blade fragments.

2.3 Antitorque (NOTAR) System

The fan gearbox drive shaft was present but its forward flexible coupling's flex plates had fractured with signatures consistent with overload. The fan gearbox drive shaft was connected at its aft end to the fan gearbox input flange. The fan gearbox remained installed on the airframe and the fan interconnecting drive shaft was continuous to the antitorque fan assembly. The antitorque fan assembly remained installed on the airframe. The fan blades remained connected to its hub, but all blade spars were deformed in the forward direction (**Figure 6**). Additionally, all blade airfoils were missing from their root end to about $\frac{1}{2}$ to $\frac{3}{4}$ of their spans, with all tip ends present. Scoring and gouging was observed around the circumference of the fan shroud. The diffuser stator/cone was recovered separated from the airframe, and the majority of the stator vanes were fractured and separated from their root ends.



Figure 6. The antitorque fan assembly (aft looking forward).

Manual rotation of the fan gearbox drive shaft and the fan interconnecting drive shaft was not possible. Investigators disconnected the fan interconnecting drive shaft from the fan gearbox, and the fan output flange was then able to be manually rotated with a corresponding rotation of the fan gearbox drive shaft, confirming continuity of drive through the fan gearbox. Subsequently, manual rotation of the fan was possible via the fan interconnecting drive shaft, but rotation was difficult as the fan was off of its track.

The NOTAR exhaust structure remained attached to the aft end of the empennage. The drum assembly (exhaust duct) was able to be freely rotated in both directions.

2.4 Flight Control System

2.4.1 Cockpit Flight Controls

The left seat pilot's flight controls were the only set installed. The left cyclic control remained installed but the lateral interconnect torque tube was fractured with signatures consistent with overload. The left collective control and its twist grip remained installed. Multiple fractures were observed within the control tubes and rod end connections of the flight control system in the cockpit area; all observed fractured exhibited signatures consistent with overload. The collective control bungee spring remained installed.

The right seat pilot's cyclic and collective controls were not installed. The right seat pilot's pedals remained installed but were not connected to the pedal control torque tube. The right seat pilot's pedal set were secured via a plate that had a cutout labeled "ARS".

2.4.2 Fixed Flight Controls

Within the broom closet (the vertical space between and immediately behind the cockpit seats), the collective, longitudinal cyclic, and pedal control tube remained connected on the lower bellcranks, located immediately behind and underneath the cockpit seats, but were fractured with signatures consistent with overload at the upper ends. The lateral cyclic control tube was fractured with signatures consistent with overload at the lower end immediately above the rod end threads, but the rod end remained installed on its lower bellcrank. The lateral cyclic control tube was also fractured at its upper end and was recovered separated.

The upper bellcranks, immediately behind and above the cockpit seats, were present but the longitudinal cyclic and the lateral cyclic bellcrank attachments were separated from the upper bellcrank support; the fractures exhibited signatures consistent with overload. The four control tube from the upper bellcranks to the transmission bellcranks, immediately forward of the main transmission, were continuous and installed on both ends except for the pedal control tube, which was fractured at its aft rod end (**Figure 7**). The two trim motors remained installed at their upper ends.

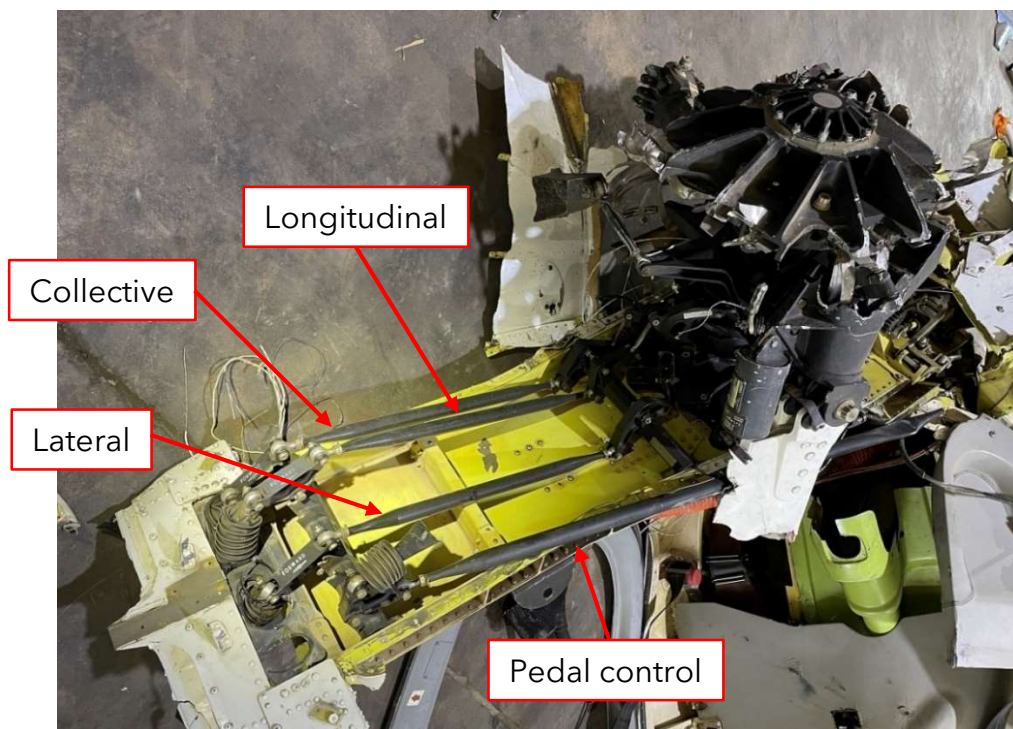


Figure 7. The upper flight controls leading to the swashplate assembly.

The swashplate assembly remained installed and exhibited normal rotation and movement along the main rotor shaft. The collective mixer bellcrank remained installed on the swashplate assembly. The longitudinal mixer bellcrank also remained installed on the swashplate assembly but the longitudinal link was separated from the longitudinal bellcrank at its lower attachment point's bearings, and the attaching bolt was present but deformed. The left portion of the lateral mixer bellcrank remained installed but the right portion had fractured and separated; the fracture exhibited signatures consistent with overload. The left mixer link remained connected to the [left portion of] the lateral mixer bellcrank but its upper end was partially fractured and separated from the stationary swashplate. The right portion of the lateral mixer bellcrank had the right mixer link connected, but the upper end of the right mixer link was fractured with signatures consistent with overload, with the upper end still attached to the stationary swashplate.

2.4.3 Rotating Flight Controls

Two main rotor pitch control links (PCL) remained connected between the rotating swashplate and their respective pitch horn, but their pitch horns were fractured and separated from their parent blades. Three PCLs were fractured at the link body, with each end connected to their parent blade's pitch horn and the rotating swashplate; these three PCLs fracture surfaces exhibited signatures consistent with overload. One PCL was fractured at the upper rod end threads, with the fracture exhibiting signatures consistent with overload.

2.4.4 NOTAR Flight Controls

The NOTAR splitter assembly, located to the aft and left of the main transmission, remained installed on the airframe (**Figure 8**). The longitudinal control tube, normally routed to the left of the main transmission, was present but had fractured near its aft rod end; the aft rod end remained connected to the splitter assembly. The pitch change control gear [for the anti-torque fan] remained installed and connected to the splitter assembly and the intermediate control tube, but the intermediate control tube was fractured near its forward end with signatures consistent with overload. The intermediate control tube's aft end remained connected to the bellcrank near frame station (STA) 137.5. The fan pitch control tube remained connected to bellcrank near STA 137.5. Manual pitch changes to the fan blades resulted in a corresponding movement of the intermediate control tube.



Figure 8. The splitter assembly. The green arrow points to the pitch change control gear. The red arrow points to the aft rod end of the longitudinal control tube. The blue arrow points to the forward cable connection to the splitter assembly.

The forward cable, for controlling the rotation of the drum assembly, was connected to the splitter assembly. This control cable was continuous until a fracture at its aft end, with the cable wiring exhibiting fraying at its fractured end. The aft-most end of the control cable remained installed on a bellcrank, within the aft end of the tail boom, that controlled both the left vertical fin and the drum assembly. The control for the left vertical fin assembly was continuous from the bellcrank. The control for the drum assembly was continuous up to the rod end that connects to the sector assembly.² This rod end remained connected to the support that was normally riveted to the sector assembly, but the support had separated from the sector assembly at its rivets; those rivets had fractured with signatures consistent with overload. Additionally, the rod end bearing was partially separated from its outer race and the bearing was not moveable by hand. The safety wiring for the rod end hardware was present on the sector assembly. The sector assembly remained installed with the pulley cables and turnbuckles in place. The right turnbuckle exhibited deformation while the left turnbuckle appeared undamaged. The right idler pulley was also damaged near its outboard groove wall and the left idler pulley did not exhibit

² The sector assembly is the horizontally-mounted pulley located near the aft end of the tail boom, below the horizontal stabilizer. Control inputs to the sector assembly, via the splitter assembly, results in movement of the sector assembly and its pull cable. The sector assembly pull cable is routed through idler pulleys that are subsequently connected to the drum assembly pulley.

anomalous damage. The pulley cable was routed correctly through the drum assembly pulley (**Figure 9**). Rotation of the sector assembly resulted in a corresponding rotation of the drum assembly. The yaw stability augmentation system (YSAS) actuator remained installed on the right side of the horizontal stabilizer and remained connected to the right vertical stabilizer.



Figure 9. The pulley cable installation for the drum assembly, after removal of the drum (aft looking forward). The yellow-colored pulley on the lower portion of the image is the drum assembly pulley. The red arrow points to the damaged idler pulley.

3.0 Maintenance

A review of the accident helicopter's maintenance records showed the last 100-hour inspection was completed on November 28, 2023, about 3.5 hours prior to, and the day before, the accident. The ATT was recorded as 9,053.3 hours at the time of this 100-hour inspection. A 25-hour special inspection of the main rotor strap

assembly³ and a 100-hour tunnel beam, web, and forward upper longeron inspection were also accomplished with no noted defects. Lastly, inspections of additional items installed on the helicopter, such as the radar altimeter, cargo mirror, and anti-collision light, were also accomplished. **Attachment 1** contains the aircraft logbook entry with the 100-hour inspection dated November 28, 2023.

In the aircraft logbook, an entry dated November 8, 2023, with an ATT of 9,013.2 hours, stated that 1 broken laminate was found in the lower trailing side of the strap assembly for the 'white' main rotor blade, with no other defects found. As a result, the 25-hour special inspection for the main rotor strap assembly was due in 25-hours. According to the aircraft logbook, a subsequent 25-hour special inspection of the white main rotor blade strap pack was accomplished on November 14, 2023 at an ATT of 9,033.1 hours with no noted defects.

According to aircraft records, four active and repetitive Airworthiness Directives (AD) were accomplished on the accident helicopter. **Table 1** shows the list of active ADs tracked by the operator for the accident helicopter.

Table 1. Active repetitive ADs tracked and accomplished on N745MB.

<i>AD No.</i>	<i>Period</i>	<i>Last done (ATT)</i>	<i>Next due (ATT)</i>
2019-05-04	100 hours	9,053.3	9,153.3
2000-08-22	300 hours	8,869.3	9,169.3
2021-22-11	300 hours	8,869.3	9,169.3
2013-03-03	5 years	March 29, 2019	March 29, 2024

E LIST OF ATTACHMENTS

Attachment 1 - N745MB aircraft logbook entry dated November 28, 2023

Submitted by:

Chihoon Shin
Aerospace Engineer - Helicopters

³ According to the MD 600N maintenance manual (CSP-HMI-2), if 1 laminate has failed in any one leg or togue area of any strap assembly, a special inspection at a 25-hour interval is required to be accomplished on the affected strap assembly.