



AVIATION



HIGHWAY



MARINE



RAILROAD



PIPELINE

Aviation Investigation Final Report

Location:	Cougar, Washington	Accident Number:	WPR22LA339
Date & Time:	September 7, 2022, 15:55 Local	Registration:	N66HJ
Aircraft:	Bell 205A-1	Aircraft Damage:	Substantial
Defining Event:	Loss of control in flight	Injuries:	1 Minor
Flight Conducted Under:	Public aircraft		

Analysis

The pilot of the helicopter was performing firefighting operations in mountainous terrain. He performed a series of water drops and crew relocation activities in the accident helicopter earlier in the day. Those flights were uneventful, and the helicopter's performance was nominal. The helicopter was refueled at a local airport and returned to the water dip location, which was a lake about 2 miles south and at a lower elevation than the fire.

By the time of the next series of water drops, a cold front had passed through the area and the winds had shifted to the north and increased in velocity. As a result, the pilot adjusted the approach path and water dip location accordingly. He then flew a series of uneventful dip and drop patterns between the lake and the fire.

On the fifth dip cycle, the pilot initiated a hover and began filling the water bucket, and as he was pulling it out of the water, the helicopter began to exhibit heavy airframe vibrations accompanied by a descent and yaw to the left. He stated that the vibrations were so extreme that he could not focus on the gauges. He lowered the collective control and was presented with a series of caution lights and a low-rotor RPM horn. He maneuvered the helicopter to the shore and attempted to release the water bucket. As the shoreline approached, the helicopter began to rapidly descend, and the pilot initiated a flare and applied collective to cushion the landing. The helicopter landed in the water, where the main rotor blades struck the airframe, and the tailboom detached. The pilot shut off the fuel and electrical power and egressed as the helicopter rolled over in the water.

The pilot determined that the event was initiated by a loss engine power, and his actions under such a condition were appropriate. However, no anomalies were found in the airframe, drive

system, fuel delivery system, engine or its ancillary components that would have precluded normal operation. Additionally, internal engine damage signatures indicated that it was producing power at impact, when it ingested a section of main rotor blade and fragments of the main driveshaft coupling that separated as the airframe struck the water.

The helicopter was equipped with a measured gas temperature (MGT) gauge, which was capable of continuously recording MGT to non-volatile memory (NVM). The unit recorded both the accident and the previous flight flown by the pilot. The gauge clearly showed nominal engine performance for the water dip and drop cycles for the previous flight along with an orderly decrease in MGT as the engine was shut down. The data for the accident flight closely mirrored the cycles observed on the previous flight. For the final cycle the MGT climb appeared nominal and showed an increase in temperature consistent with the helicopter maneuvering during the bucket dip and pickup sequence. However, the MGT then almost instantaneously dropped to shutdown temperature, at a rate much faster than the previous engine shutdown sequence. This drop was likely a result of impact.

The accident site was surrounded by mountainous terrain, particularly to the north where the fire was located a short distance away. Wind analysis indicated that downdrafts would have been present at the time of the accident, which were likely unpredictable and exacerbated by the proximity of the fire. The pilot had stated that the area was notorious for downslope katabatic wind, and that there was unusual turbulence in the area.

Furthermore, review of the MGT data indicated that for the three cycles leading up to the accident, less engine power was required to transition to the water dip hover, which indicated wind strength had likely increased during the short time leading up to the accident.

Rather than losing engine power, the helicopter likely encountered strong downdrafts that caused a rapid descent. The pilot attempted to release the bucket during the accident sequence, and while he was ultimately able to do so, up until release it was being dragged through the lakebed, and thus hindering the helicopter's maneuverability.

Water dip operations required that the single-engine helicopter be flown at a low height and speed such that it was operating within the "AVOID" range of its Height-Velocity Envelope. In this range, a safe landing could not be guaranteed following an engine failure. The pilot was able to demonstrate the presence of mind and helicopter control to maneuver towards the shore with limited altitude and time, and therefore avoid a more significant impact.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The helicopter's encounter with downdrafts during a low-altitude hovering maneuver while dipping for water.

Findings

Environmental issues

Downdraft - Effect on equipment

Aircraft

Directional control - Not attained/maintained

Factual Information

History of Flight

Maneuvering-hover	Other weather encounter
Maneuvering-hover	Loss of control in flight (Defining event)
Maneuvering-hover	Low altitude operation/event
Maneuvering-hover	Collision with terr/obj (non-CFIT)

On September 7, 2022, about 1555 Pacific daylight time, a Bell 205A-1, N66HJ, was substantially damaged when it was involved in an accident near Cougar, Washington. The pilot sustained minor injuries. The helicopter was operated as a public aircraft firefighting flight.

The privately owned helicopter was involved in firefighting operations under contract with the Bureau of Land Management (BLM), under the operational control of the US Forest Service in response to the Kalama Fire. The fire was located above a cliff at an elevation between 2,000 and 3,000 ft mean sea level (msl) on the southwest side of Mount St. Helens; at the time of the accident the fire was about four acres in size.

The pilot provided a summary of the event two days after the accident and an additional statement the following week. He stated that earlier on the day of the accident he performed a series of water drops and crew relocation activities in the helicopter using the north end of Merrill Lake and lasting about 2 hours. The flights were uneventful, and the helicopter performance was nominal. He then refueled at Southwest Washington Regional Airport, Kelso, Washington (KLS), using the same fuel truck as on the previous flight.

He returned to the lake, and by the time he was ready for the next mission, the winds had shifted and were now more northerly. As a result, he decided to dip from the northwest corner of the lake using the same approach he had taken during similar wind conditions the previous day. He flew oval approaches from the fire to the lake, flying a downwind leg around 60 kts over the northeast corner, and then circling while slowing and descending to arrive at the dip location with a headwind.

He stated that the area was notorious for downslope katabatic wind, and there was unusual turbulence in the area, but nothing of concern.

The bucket was set for 90% capacity, and he performed between 4 and 5 dip and drop cycles. On the final dip he slowed the helicopter to a hover about 130 ft above ground level (agl) and

began lowering the bucket into the water. The bucket touched the water and began to tip and fill, and as he was pulling it out of the water, "all hell broke loose."

In his initial statement he reported that the helicopter began to exhibit heavy airframe vibrations, and he had a strong sense of sinking coupled with an uncommanded yaw to the left. He stated that he could not specifically hear any engine tone change or interruptions and he did not know if the engine had failed, but the vibrations were so extreme that he could not focus on the gauges, and he lowered the collective control. The events happened very quickly, and he was presented with a series of caution lights and eventually a low rotor RPM horn. He pulled the collective control as the ground approached, and to guide the helicopter towards the shoreline he lowered the collective control again and pushed the cyclic forward. He stated that he has been flying for almost 30 years and these were all instinctive reactions.

He then got a sense of ground rush and pulled the collective up in a pumping action. The helicopter landed flat and hard. After impact everything had stopped, including the engine. He turned off the fuel valve and the battery; the helicopter then started rolling to the right. He unbuckled his seatbelt, removed his helmet, and egressed.

During a series of follow up questions as the investigation progressed, the pilot stated that he was certain the event had been initiated by a loss of engine power. He recalled that he ensured full throttle during the event, and attempted to release the bucket as he approached the shore, but it was likely still connected and may have slowed his progress.

Although there were many kayakers, fire crew, and Helitak crew members in the area, none of them observed the accident sequence until the helicopter was already in the water.

Pilot Information

Certificate:	Commercial	Age:	49, Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	Seat Occupied:	Left
Other Aircraft Rating(s):	Glider; Helicopter	Restraint Used:	4-point
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	
Medical Certification:	Class 2 Without waivers/limitations	Last FAA Medical Exam:	February 23, 2022
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	May 20, 2022
Flight Time:	6100 hours (Total, all aircraft), 89 hours (Total, this make and model), 5800 hours (Pilot In Command, all aircraft), 50 hours (Last 90 days, all aircraft), 24 hours (Last 30 days, all aircraft), 7 hours (Last 24 hours, all aircraft)		

On June 3, 2022, the pilot was issued a USDA/USDI Interagency Helicopter Pilot Qualification Card with authorization for external load; water/retardant, bucket; Helitack/PAX transport; low level & reconnaissance; and mountainous terrain. He reported total flight experience of 6,100 hours, with 2,774 in rotorcraft and 89 in the accident make and model. He stated that the make and model time involved training, utility work, and long line operations on wildfires. The remainder of his rotorcraft experience consisted of a mix of air tours, utility work, and mountain flying in Bell 206 and the Airbus Helicopters AS350 (H125).

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	Registration:	N66HJ
Model/Series:	205A-1	Aircraft Category:	Helicopter
Year of Manufacture:	1976	Amateur Built:	
Airworthiness Certificate:	Restricted (Special)	Serial Number:	30239
Landing Gear Type:	Skid	Seats:	11
Date/Type of Last Inspection:	September 3, 2022 AAIP	Certified Max Gross Wt.:	10200 lbs
Time Since Last Inspection:	28 Hrs	Engines:	1 Turbo shaft
Airframe Total Time:	23042 Hrs as of last inspection	Engine Manufacturer:	LYCOMING
ELT:	C126 installed, activated, did not aid in locating accident	Engine Model/Series:	T-53 SERIES
Registered Owner:	DELAWARE TRUST COMPANY TRUSTEE	Rated Power:	1150 Horsepower
Operator:	Kachina Aviation	Operating Certificate(s) Held:	Rotorcraft external load (133)

The helicopter operator, Kachina Aviation, provided fire-suppression services to support federal, state, and municipal operations. It was granted authority by the FAA to perform rotorcraft external load (Part 133), agricultural aircraft (Part 137), and commuter & on demand (Part 135) operations.

The helicopter was powered by a single Ozark Aeroworks T5317B turboshaft engine.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	KKLS, 20 ft msl	Distance from Accident Site:	23 Nautical Miles
Observation Time:	15:56 Local	Direction from Accident Site:	273°
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	11 knots / None	Turbulence Type Forecast/Actual:	None / None
Wind Direction:	290°	Turbulence Severity Forecast/Actual:	N/A / N/A
Altimeter Setting:	30.15 inches Hg	Temperature/Dew Point:	24°C / 15°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Cougar, WA	Type of Flight Plan Filed:	Company VFR
Destination:	Cougar, WA	Type of Clearance:	None
Departure Time:		Type of Airspace:	Class E

A High Resolution Rapid Refresh (HRRR) model sounding was created for the time and location of the flights performed by the pilot earlier in the day. With the modeled surface elevation at 1,982 ft msl and at an elevation of 2,223 ft msl, the sounding indicated the temperature was about 21.3 °C and the dewpoint was about 7.6 °C with 4-knot winds from 200°. The wind transitioned to the west through 3,323 ft with the velocity remaining the same.

A weak cold front passed through the area during the time leading up to the accident, and an updated HRRR model indicated that at the time of the accident flight, the wind had shifted and was now from 326° at 14 knots. The wind remained out of the northwest, but increased to 17 knots through 4,232 ft.

The models did not account for any wind field or flow induced by the fire.

Wreckage and Impact Information

Crew Injuries:	1 Minor	Aircraft Damage:	Substantial
Passenger Injuries:		Aircraft Fire:	None
Ground Injuries:		Aircraft Explosion:	None
Total Injuries:	1 Minor	Latitude, Longitude:	46.099922,-122.3311(est)

The helicopter came to rest partially submerged on its right side on the north end of the western shore of Merrill Lake, about 2 miles south of the fire. The lake was at an elevation of about 1,550 ft msl and along the southwest foothills of Mount St. Helens (elevation 8,363 ft). The lake was within a bowl-like depression surrounded by rising terrain (see Figure 1).



Figure 1 – Helicopter at the accident site with fire in the background.

The helicopter was largely intact except for the tailboom, which had bent forward and underneath the main cabin after partially detaching about 2 ft forward of the horizontal stabilizer (see Figure 2). The vertical fin exhibited diagonal crush features along with a cut on its right side consistent with tail rotor blade contact.



Figure 2 – Helicopter at the accident site (photo taken about 10 minutes after the accident).

Both main rotor blades remained attached to the rotor hub and mast, which was attached to the main transmission. The “white” main rotor blade was bent upwards about 5 ft outboard of its hinge. The leading-edge spar had severed, and the blade skin had torn open, exposing the internal honeycomb structure. The “red” blade was intact and bent slightly upwards at the tip. Both blades exhibited leading-edge and chordwise abrasions and gouges opposite the direction of rotation, along with skin buckling. The engine inlet cowling and barrier filter assembly exhibited a diagonal indentation on its left forward side.

The main driveshaft had fragmented into multiple pieces, distributing coupling and housing fragments into the surrounding areas and puncturing both the upper forward driveshaft cowling and engine inlet cowling. Drivetrain continuity was confirmed from the main transmission input through to the main rotor mast and tail rotor output.

The fuel supply system was intact and continuous from the tank through to the inlet of the engine fuel control unit (FCU). Clean fuel was found throughout the system, and both boost pumps were operational and able to maintain sufficient fuel pressure when tested.

Helicopter Water Bucket

The helicopter was equipped with a 240-gallon capacity, 2,130-lb gross weight Bambi Bucket, manufactured by SEI Industries Inc. in 2006. It was found about 20 feet away from the helicopter postaccident and had been released from the helicopter’s cargo hook.

Examination revealed that the bucket was intact and had been adjusted to 90% capacity. The bucket's purse, suspension, and trip lines were all intact, and the control head activated appropriately with the application of power.

The cinch strap, which controls the bucket's capacity, had severed at the location of the 90% cinch ring. The seam of the dump valve was torn along the entire length vertically and approximately 4 inches horizontally at the circumferential seam with the bucket. The bucket contained residual quantities of sand and gravel.

The water fill operation required that the helicopter be flown at a low height and speed, such that it was operating within the "AVOID" area of its Height-Velocity Envelope. In this range, a safe landing could not be guaranteed following an engine failure.

Tests and Research

The engine was removed and examined at the facilities of the manufacturer (Ozark Aeroworks), under the oversight of the NTSB.

During the examination, the engine was found to be intact and had sustained water intrusion throughout. There were no indications of fire or uncontainment. Initial examination following engine removal revealed that the compressor section could be rotated by hand.

Disassembly showed dents on both the fore and aft faces of the inlet guide vanes. All stages of the axial compressor had tears and nicks to the leading edges of all blades, and the blade tips were curled in both the direction and opposite direction of rotation. Two first-stage axial compressor blades had shifted aft. Impact marks were observed in both halves of the compressor housing, and the centrifugal impellor had impact marks on the inducer and exducer areas of the blades.

The output reduction carrier and accessory drive carrier could be rotated freely by hand-rotation of the compressor and power shaft. Both were clean and otherwise unremarkable. Continuity of rotation at the accessory gearbox was confirmed by observation of the gears for the FCU, starter-generator, and N1 tach-generator, all of which rotated in unison with the compressor. The N2 tach-generator and overspeed governor drive were confirmed to rotate with rotation of the power shaft, confirming N2 continuity.

Debris was found around the combustion chamber deflector and nozzle curl. The second-stage GP cylinder had a material transfer smear at the 11:00-12:00 o'clock position. The power turbine (PT) blades exhibited erosion on the leading edges and metal splatter on the aft faces.

A shiny 5 mm-wide fragment was observed at the root of the 2nd stage PT rotor. The fragment appeared to match the aluminum honeycomb material used within the main rotor blades.

The National Transportation Safety Board (NTSB) Materials Laboratory analyzed the debris found in the engine and determined that it was primarily high chrome steel, iron, chrome and nickel, with smaller amounts of magnesium, aluminum, silicon, manganese, molybdenum, carbon, oxygen, and sulfur, and trace amounts of calcium, titanium, and phosphorus. The main rotor blade skins, honeycomb, spar, inboard doublers, and trailing edge strip are made of aluminum, and the fragmented transmission driveshaft coupling was made of steel.

The FCU and PT governor were removed from the engine and tested. Both demonstrated nominal performance.

The helicopter was equipped with an engine measured gas temperature (MGT) gauge manufactured by Diamond J Inc. The unit was also capable of continuously recording MGT to NV) in 5-second intervals. The NTSB Vehicle recorders Laboratory successfully recovered the NVM data for both the accident flight cycle and the previous cycle flown by the pilot.

The data for the first flight cycle indicated that shortly after power up, MGT climbed from 20°C to about 690°C consistent with engine start. Over the next 18 minutes, MGT varied between about 505°C and 710°C. The then MGT began a series of repetitive cycles with temperatures varying between about 550°C and an average of 730°C, with nine cycles completed in one hour. Each cycle included a primary temperature spike of about 730°C that lasted about 2 minutes, followed by secondary shorter spike of about 1 minute at a lower average temperature of about 710°C. The temperature changes appeared to be consistent with the water pickup, dump, and return to hover cycles described by the pilot. The data continued for about 18 minutes after the final cycle, and was characterized by a series of downward trending temperature variations of between 670°C and 530°C. Over a 60-second period the temperature then dropped to 160°C, consistent with engine shutdown, and then for the final 90 seconds it began to climb back up to about 240°C consistent with postshutdown engine heat soak (see Figure 3).

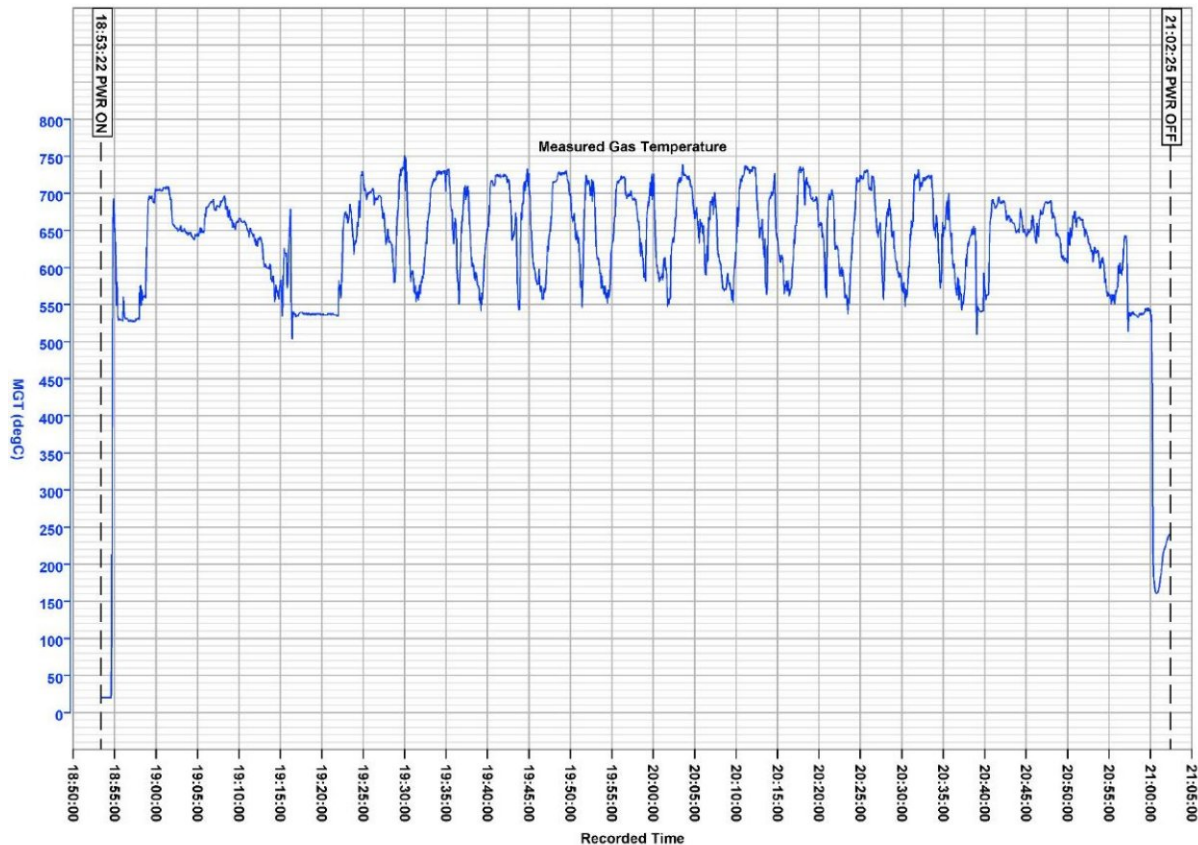


Figure 3 - MGT plot of the previous power cycle.

The second recording started at 1501 and revealed similar temperatures as the first engine start sequence. At 1534, a comparable set of five cycles began, with primary peaks of about 730°C. For the last three cycles before the accident, the secondary peaks were at a reduced temperature of about 640°C when compared to the previous flight cycles which indicated 710°C (see Figure 4). For the sixth cycle, MGT began to rise until it reached about 710°C when it suddenly dropped to 150°C 15 seconds before the data ended (see Figure 4).

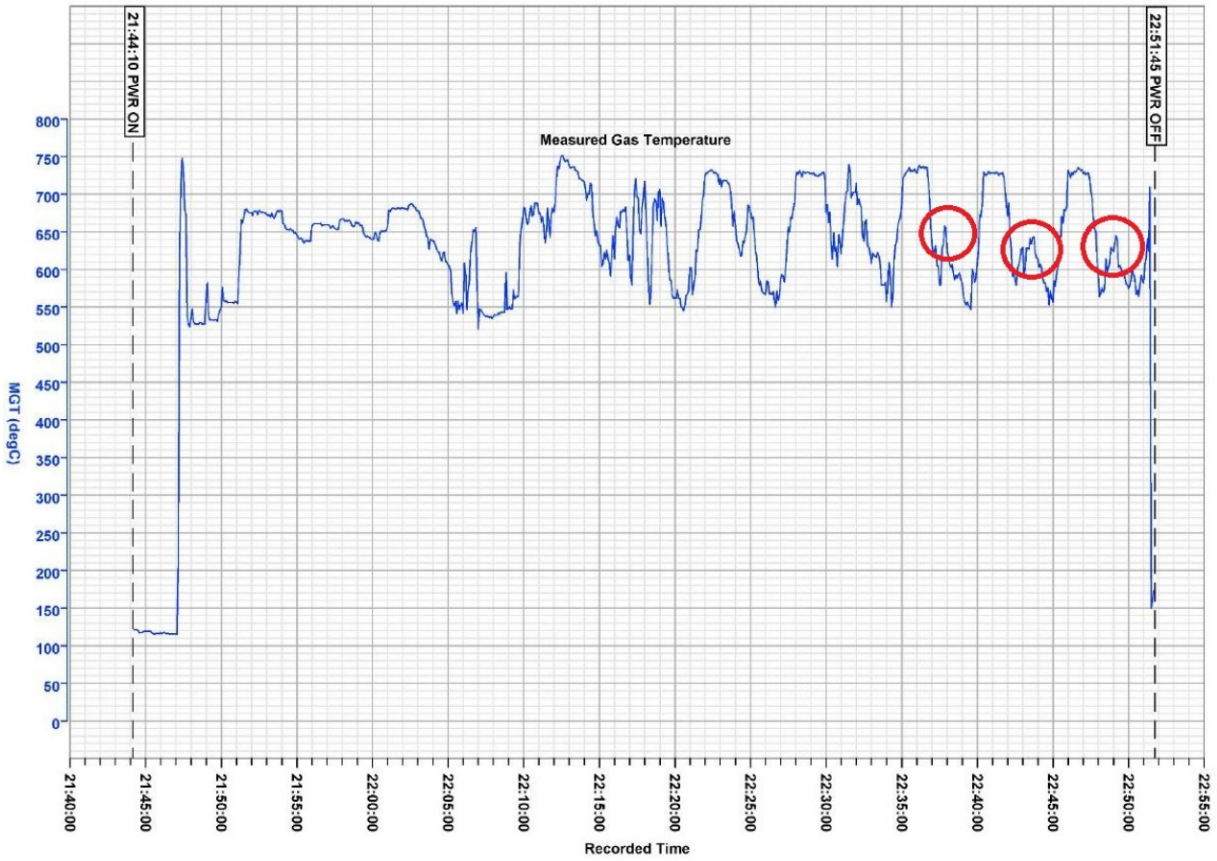


Figure 4 - MGT plot of the accident power cycle. Reduced MGT circled in red.

Administrative Information

Investigator In Charge (IIC):	Simpson, Elliott
Additional Participating Persons:	Shawn Kellar; Federal Aviation Administration; Portland, OR
Original Publish Date:	September 11, 2024
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=105894

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