Aviation Investigation Final Report

Location:	Homer Glen, Illinois	**Accident Number:**	CHI04GA130
Date & Time:	May 28, 2004, 14:30 Local	**Registration:**	N9548D
Aircraft:	Cessna T206H	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Public aircraft		

Analysis

The 1999 Cessna T206H was operated as a public aircraft when the pilot reported a loss of engine power during cruise flight about 1,150 feet above ground level. Spectrum analysis of air traffic control transmissions indicate that a propeller speed of 1,669 revolutions per minute was present following the loss of engine power. Visual meteorological conditions prevailed with recorded surface winds from the northeast. Witnesses reported that they heard several attempted engine restarts while the airplane was being positioned for a forced landing on a 500-foot long fallow agricultural field north of a house. A witness reported that black smoke would emanate from the airplane during each start attempt. The airplane's wing and horizontal stabilizer contacted trees near the house resulting in a steep descent into the garage adjacent to the house. A post crash fire/explosion then ensued. The Airframe & Powerplant Mechanics Handbook states that a mixture "too rich" is indicated by black smoke. Examination of the airplane systems and related components revealed that the turbocharger could not be rotated and a hydraulic press was utilized to effect the removal of the turbocharger turbine wheel. The engine crankcase halves exhibited fretting, and the nut of one crankcase thru-bolt was not in place. Maintenance records indicate that the crankshaft was replaced in response to airworthiness directives and service bulletins. No other anomalies that would have precluded normal operation were found. In 1994, the National Transportation Safety Board issued recommendation A-94-081 relating to emergency procedures for turbocharger failures to be included in airplane pilot operating handbooks (POHs) and airplane flight manuals. The Cessna T206H POH does not list emergency procedures for turbocharger failures. The Cessna T206H POH states, under emergency procedures, to advance the mixture control to the rich position if restart does not occur. The manufacturer's airplane pilot safety supplement, which was reissued in 1998 to incorporate turbocharger failures, states that "If a turbocharger failure results in a loss of power, it may be further complicated by an overly rich mixture." A review of the emergency exit procedures in Cessna 206 models shows that with the flaps lowered, the forward portion of the cargo door can only be opened approximately 4 inches to allow the aft portion of the cargo door to be opened during emergency egress. The

distance between the cabin roof and seat back was measured to be approximately 11 inches.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The seized turbocharger, the altitude/clearance not maintained/obtained during approach to a forced landing on an agricultural field, and the unsuitable landing area encountered by the pilot. Contributing factors were the inadequate emergency procedures by the manufacturer, the trees, and the residential area.

Findings

Occurrence #1: LOSS OF ENGINE POWER
Phase of Operation: CRUISE

Findings
1. (C) EXHAUST SYSTEM,TURBOCHARGER - SEIZED
2. (F) PROCEDURE INADEQUATE - MANUFACTURER

Occurrence #2: FORCED LANDING
Phase of Operation: EMERGENCY DESCENT/LANDING

Occurrence #3: IN FLIGHT COLLISION WITH OBJECT
Phase of Operation: EMERGENCY DESCENT/LANDING

Findings
3. (F) OBJECT - TREE(S)
4. (C) ALTITUDE/CLEARANCE - NOT OBTAINED/MAINTAINED - PILOT IN COMMAND
5. (F) TERRAIN CONDITION - RESIDENTIAL AREA

Occurrence #4: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: EMERGENCY DESCENT/LANDING

Findings
6. DOOR,EMERGENCY EXIT - OTHER
7. (C) UNSUITABLE TERRAIN OR TAKEOFF/LANDING/TAXI AREA - ENCOUNTERED - PILOT IN COMMAND
8. ENGINE ASSEMBLY,CRANKCASE - FRETTED
9. MAINTENANCE - UNKNOWN
10. TERRAIN CONDITION - GROUND

Factual Information

HISTORY OF FLIGHT

On May 28, 2004, at 1430 central daylight time, a Cessna T206H, N9548D, operated by the Drug Enforcement Administration, was destroyed on impact with a detached garage belonging to a single-family home in Homer Glen, Illinois. The pilot reported a loss of engine power to air traffic control during cruise flight. Visual meteorological conditions (VMC) prevailed at the time of the accident. The Title 14 Code of Federal Regulations (CFR) Part 91 flight was operating without a flight plan. The commercial pilot was fatally injured. The positioning flight originated from Chicago Midway International Airport (MDW), Chicago, Illinois, at 1423, and was en route to Spirit of St. Louis Airport (SUS), Chesterfield, Missouri.

According to an employee at the front counter of MDW Signature Flight Support, the airplane arrived at 1315-1330. The pilot approached the front counter and requested a "top off" and stated that he would be going "right back out." The employee, who saw the pilot a couple of times a week, said the pilot "seemed fine and his usual self" after talking to him for about 5-10 minutes. The employee stated that the pilot never complained about the airplane and did not report any mechanical related problems with the airplane to her. The pilot sat in the lobby for a "couple" of minutes with the passenger he arrived with.

The passenger, who accompanied the pilot on the flight to MDW, reported that pilot the did not indicate that there were any mechanical problems with the airplane. The passenger also reported that he did not notice any such problems during the flight to MDW.

A Signature Flight Support line service employee, who serviced the airplane, stated that the airplane arrived approximately 1300. The pilot asked him to "top off" the airplane. The line service employee then used the "100LL truck" to fill the right wing tank with 25.8 gallons of fuel and the left tank with 26 gallons of fuel.

According to the operator, the airplane was en route to SUS for a scheduled 50-hour maintenance inspection of the airplane.

At 1347, a person representing N9548D called Kankakee Automated Flight Service Station by telephone and obtained a standard preflight briefing for the MDW and SUS areas.

A partial transcript of transmissions by: N9548D; MDW Clearance Delivery (CD); MDW Air Traffic Control Tower, Ground 2 (GC); MDW Air Traffic Control Tower, Local Control 2 (LC); MDW Air Traffic Control Tower, Approach Control 2, (AP); and an Unknown entity follows.

1406:31, N9548D, "midway clearance cessna nine fi nine five four eight delta cessna two oh six at signature with victor i'll ah be v f r southbound two one seven degrees to bloomington"

1406:40, CD, "is it two one seven"

1406:42, N9548D, "ahh four eight delta correct two one seven degrees"

1406:49, CD, "kay can you pick a different heading that's not ah flying up the arrival corridor"

1406:55, N9548D, "okay would two seven zero be okay for now"

1406:58, CD, "okay standby and was that four eight delta"

1407:01, N9548D, "correct nine five four eight delta"

1407:07, CD, "four eight delta maintain v f r below two thousand in class charlie airspace departure frequency is one one niner point four five squawk five one seven five"

1407:17, N9548D, "(unintelligible) nine five four eight delta v f r below two thousand in charlie nineteen forty five and five one seven five on the squawk"

1407:23, CD, "readback correct"

1408:00, N9548D, "midway ground nine five four eight deltas a two oh six ready to taxi from signature"

1408:31, GC, "okay four six delta did you call me"

1408:34, N9548D, "nine five four eight delta from signature"

1408:36, GC, "okay four eight delta midway ground out of signature join the whiskey taxiway taxi to runway four left"

1412:45, N9548D, "midway tower nine five four eight delta ready in sequence four left"

1412:48, LC, "roger"

1418:07, LC, "four eight delta midway tower runway four left full length available taxi into position and hold"

1418:12, N9548D, "position and hold four eight delta"

1423:01, LC, "and four eight delta you want a two ninety heading"

1423:05, N9548D, "(unintelligible) four eight delta if it'll work out for you a two seventy'd be probably better"

1423:09, LC, "okay"

1423:19, LC, "and cessna four eight delta now turn left heading three six zero runway four left cleared for takeoff"

1423:27, N9548D, "three six zero four eight delta"

1424:53, LC, "four eight delta now turn left on course heading two niner zero"

1424:57, N9548D, "two niner zero four eight delta"

1424:59, LC, "and four eight delta i'm going to wait for a citation to depart three one center until you get over the ah three one center departure corridor so if you can ah give me your best forward speed ac across that"

1425:10, N9548D, "four eight delta"

1425:31, LC, "four eight delta contact chica midway approach on one one niner point four five"

1425:34, N9548D, "nineteen forty five four eight delta"

1425:43, N9548D, "midway radar nine five four eight delta one thousand four hundred"

1425:45, AP, "seven five four eight delta midway departure you're radar contact where you headed"

1425:50, N9548D, "nine five four eight delta bloomington"

1425:53, AP, "alright"

1426:12, AP, "nine five four eight delta you can fly heading two two zero now"

1426:16, N9548D, "two two zero four eight delta"

1427:00, AP, "cessna niner five four eight delta traffic for you's about ah ten o'clock three miles just crossed the final for four right northwest bound sixteen hundred feet a twin engine travelair"

1427:10, N9548D, "four eight delta's looking"

1427:33, AP, "cessna four eight delta that traffics about ah ten o'clock and two miles now

northwest bound one thousand seven hundred twin engine"

1427:41, N9548D, "four eight delta still looking no ah traffic in sight"

1427:45, AP, "traffic is ah you see you see the traffic four eight delta"

1427:47, N9548D, "four eight delta traffic in sight"

1430:56, AP, "cessna four eight delta you're ahh ten and a half miles southwest of midway airport you can resume your own navigation ah did you want to leave the frequency or stay on for advisories"

1431:03, N9548D, "four eight delta i'll leave frequency"

1431:05, AP, "four eight delta roger radar service terminated frequency change approved have a good flight today"

1431:08, N9548D, "four eight delta thank you"

1431:40, N9548D, "midway midway (unintelligible) cessna four eight delta (unintelligible) i just lost my engine"

1431:45, AP, "four eight delta say your intentions"

1431:48, N9548D, "four eight delta * (click) * (click)"

1431:54, AP, "check your fuel"

1431:58, N9548D, "four eight delta yes sir"

1432:10, AP, "check your is your fuel turned on down on the floor there four eight delta"

1432:14, Unknown, "(unintelligible)"

1432:16, Unknown, "affirmative"

A witness stated, "I observed the plane flying west going over Long Run Creek. I heard the pilot trying to start the engine at least two times. He then turned to the south and I could again hear the pilot trying to start the engine at least four or five times. The engine would kick over and die out immediately. The propeller was turning slowly because he was trying to start the engine. There was no smoke or fire that I observed. At that point I was unable to observe the plane because of the trees which obstructed my view. About a minute passed and then I heard a crash. It appeared that the pilot was trying to land in the farm field located on the north side of 139th Street."

A second witness stated that there was a small airplane flying north of his residence that drew his attention because the airplane was flying "low". The airplane started to fly eastbound and then banked "hard." He stated that there was no smoke or any "weird" noise.

A third witness stated that he was working about 100-150 feet from the accident site when the accident occurred. The sound of the airplane initially drew his attention to the airplane, and he then saw it "coming in and looping" in what was an attempt to land in a field across from the residence where the accident occurred. The airplane was just above the trees when he heard an attempted start for the third time and after each start attempt, the engine would "fire up" and "die down" a few seconds later. The airplane was at tree height at the property next to the accident site. The right wing clipped the closest southwest tree next to the garage and then "fell straight down," and the airplane immediately exploded. He added that black smoke would come out from the bottom sides of the airplane at each start attempt. He said that that the color of the smoke was similar to that emitted from an engine with a blown cylinder head or blown cylinder.

PERSONNEL INFORMATION

The pilot's employment duties with the operator included serving as a pilot-in-command on single-engine airplanes. He held a commercial pilot certificate with single-engine land, multiengine land, instrument airplane, helicopter, and instrument helicopter ratings. He also held a certified flight instructor certificate with airplane single-engine, airplane multiengine, and instrument airplane ratings. As of the last logbook entry dated May 20, 2004, the pilot accumulated a total flight time of 3,602.2 hours, of which 1,545.6 hours were in Cessna 206 airplanes. Of the total flight time in Cessna 206 airplanes, 658.7 hours were in Cessna 206 turbocharged models.

Logbook records indicate that the pilot's first flight in an airplane occurred on April 3, 1979. He was issued a private pilot certificate with a single-engine land rating on July 26, 1979.

On July 7, 1998, the pilot logged his first flight in a Cessna TU206F as a "familiarization flight," 1.6 hours in duration with 4 landings. The next flights using Cessna T206H and Cessna TU206F airplanes, occurred from December 13, 1998 to December 17, 1998, which had a total flight duration of 9.9 hours and an entry stating that the last flight in this period was a company standardization flight, 90-day VFR, and a flight review.

On July 18, 2002, the pilot received a standardization checkride conducted by the operator using a Cessna U206G. The standardization pilot stated that the pilot "met or exceeded the performance standards for the maneuvers performed as defined by the [practical test standards] (commercial standards)".

On November 8, 2003, the pilot last received training through operator sponsored training at

SIMCOM. Logbook records indicate the pilot received 12 hours of training using a PC-12 fixed motion simulator toward completion of phase three of the Federal Aviation Administration's (FAA's) Pilot Proficiency Award Program, an instrument proficiency check, and ground and flight instruction in high-altitude operations.

FAA records indicate the pilot was not involved in any previous accidents, incidents, or enforcement actions.

The pilot was issued a second-class airman medical certificate on November 13, 2003, with the following limitation: "must wear corrective lenses for near and distant vision".

AIRCRAFT INFORMATION

The 1999 Cessna T206H, serial number T20608062, was certificated as a normal category airplane on October 1, 1998, under Title 14 CFR Part 23 as listed in the airplane's type certificate data sheet. The airplane received an airworthiness certificate on July 12, 1999, and was registered to the operator on September 1, 1999. The airplane was subsequently operated as a public aircraft.

The airplane was powered by a Textron Lycoming TIO-540-AJ1A, serial number L-10190-61A, engine with a maximum continuous power rating of 310 brake horsepower at 39 inches of mercury (Hg) and 2,500 revolutions per minute (rpm). According to the Cessna T206H Pilot Operating Handbook (POH), the limitations section lists the powerplant instrument markings for the tachometer's green arc (normal operating range) as 2,000 - 2,400 rpm. The engine oil pressure minimum and maximum limitations are listed as 20 pounds per square inch (psi) and 115 psi, respectively. The engine oil pressure instrument's green arc (normal operating) ranges from 50-90 psi, a red line (minimum) of 20 psi, and a red line (maximum) of 115 psi.

The POH lists the airspeed indicator marking for the normal operating range's green arc as 59 - 149 knots indicated airspeed (KIAS).

The airplane was equipped with a 76 cubic foot capacity, 6-place, fixed oxygen system manufactured by B/E Aerospace, which was installed in the airplane when the operator took receipt of the airplane. The POH states that one permanent, microphone-equipped mask is provided for the pilot, and five disposable type masks are provided for the passengers. All the masks are the partial-breathing type, equipped with vinyl hoses and flow indicators.

The Cessna T206H Maintenance Manual, revision 6, includes a controller and turbocharger operational flight check at a cruise altitude of 17,000 feet pressure altitude. The steps that follow are listed in the maintenance manual as:

(4) Engine Speed - 2,400 RPM.
(5) Part-Throttle M.P. - 30 in Hg.

(6) Fuel Flow - Lean to 20.0 GPH.
(7) Propeller Control - (a) Slowly decrease engine RPM until manifold pressure starts to drop, indication the wastegate valve is closed. If the wastegate valve closes at engine speeds below the RPM shown in Figure 201, the turbocharger performance is normal. (b) Note the outside air temperature and RPM where the manifold pressure begins to drop. Refer to the chart in Figure 201 with these values and assure that no bootstrapping occurs above the line.

The controller and turbocharger operational flight check is not included in any of the aircraft manufacturer's maintenance inspection checklists, and it is not a required check.

Maintenance Information

On December 13, 2002, at a total time of 391.7 hours, the engine was removed from the airplane in order to comply with Airworthiness Directive (AD) 2002-19-03 by having a Lycoming representative extract six core samples from the crankshaft propeller flange. The samples were sent to Lycoming for metallurgical testing, the results of which found that the crankshaft was "rejected."

On February 30, 2003, the engine was disassembled "only enough" to facilitate replacement of the crankshaft affected by Lycoming Service Bulletins (SBs) 552 and 553. The engine was reassembled, test run, and returned to service.

On March 7, 2003, the engine was installed on the airplane, a ground run was performed, and no leaks were reported to have been found.

On April 20, 2004, at a total time of 589.1 hours, the engine and airframe were last inspected during an annual inspection. During the engine inspection, the number five cylinder, part number 05K22680, serial number 11, was removed due to low compression, repaired, and reinstalled. The engine oil was changed, the oil filer replaced, and the oil screen was cleaned. An oil sample was taken and normal lab results were reported of the sample. The left and right magneto harnesses were replaced. SB 342, SB 480D, SB 529B, and AD 2003-14-03 were complied with.

The airplane discrepancy log did not list any discrepancies pertaining to the airplane fuel system or powerplant over a year prior to the last discrepancy dated April 21, 2004.

The airplane accumulated a total time of 628 hours at the time of the accident.

The 50-hour maintenance interval items that were to be checked on the airplane upon its arrival at SUS were: check the battery electrolyte level, check brakes and brake lining for wear, check nose landing gear strut for leakage, check tire for wear and condition, change the oil, change the oil filter, and clean the oil sump screen. Additional inspection items included inspection of the alternator charging system and an oil sample and oil filter analysis.

There was no record that a controller and turbocharger operational flight check was performed on the airplane since its registration to the operator.

METEOROLOGICAL INFORMATION

The area forecast for the flight was for VMC.

The MDW Automated Surface Observing System (ASOS) recorded the following weather observations:

At 1420: wind 070 degrees at 10 knots; visibility 10 statute miles (sm); sky conditions clear; temperature 14 degrees Celsius (C); dew point 3 degrees C; altimeter setting 29.96 inches of Hg.

At 1425: wind 030 degrees at 13 knots; visibility 10 sm; sky condition clear; temperature 14 degrees C; dew point 3 degrees C; altimeter setting 29.96 inches of Hg.

At 1430: wind 040 degrees at 10 knots, gust 14 knots; visibility 10 sm; sky condition clear; temperature 15 degrees C; dew point 3 degrees C; altimeter setting 29.96 inches of Hg.

The SUS ASOS recorded VMC for the remainder of the day.

AIRPORT INFORMATION

MDW had an airport elevation of 620 feet mean sea level (MSL) and was served by class C airspace, the base of which was 1,900 feet MSL.

WRECKAGE AND IMPACT INFORMATION

The main wreckage, consisting of the majority of the airframe and engine, was located in the yard of a single-family home. The Global Position System (GPS) coordinates of the main wreckage were 41 degrees 38.080 minutes North and 87 degrees 58.858 minutes West, or 13.7 nautical miles and a true course of 228 degrees from MDW. The GPS accident site elevation was 728 feet MSL. A 500-foot long fallow corn field was located north of 139th Street and the house.

The airplane impacted a garage behind the house destroying the airplane and garage by fire.

The airplane was resting upright on a tail to nose heading of 328 degrees and was embedded within the remains of the garage and its contents. There were trees with broken branches located approximately 7 feet east, 48 feet south, and 90 feet south of the main wreckage.

The airframe consisted of a 6-foot long empennage section and 5 foot 9 inch left wing section. The right wing was consumed by fire. The propeller was attached to the engine, which was attached to the airframe.

There was clear plastic material consistent with the airplane landing light approximately 28 feet south of the main wreckage. The area around the left wing landing light was crushed inwards approximately 9 inches and contained burnt tree remains. The right horizontal stabilizer elevator horn contained tree debris. The right wing flap jack screw was extended 5.6 inches, and the elevator trim tab actuator was extended 1.55 inches between the actuator housing and the end of the actuating rod.

The cockpit throttle and mixture controls were connected to their respective engine control positions. The throttle and mixture positions were opposite those positions at the engine. The cockpit throttle control was melted, the cockpit propeller control was extended about 1-7/8 inches, and the cockpit mixture control was extended about 4-1/4 inches. The throttle idle mixture adjustment linkage was fractured through. The cowl flaps were closed. The fuel selector was in the left fuel tank position.

The engine examination revealed that the number three and five cylinders contained water and exhibited a color consistent with rust during a borescope inspection of each cylinder. There was no scoring evident on any of the cylinder head walls. All of the top spark plugs were able to be removed except for the number three cylinder spark plug. The propeller was rotated by hand through several complete revolutions and air was drawn in and expelled from only the number four cylinder top spark plug hole. There were no cracks in any of the cylinder head assemblies.

The exhaust system and respective clamps were intact and no preexisting cracks were noted. The turbocharger wheel could not be turned by hand pressure. The turbocharger oil tank drain was dented.

The propeller governor screen was removed and was noted to be covered with oil. A magnet was applied to the screen plug and debris from the screen became attached to the magnet.

During recovery of the wreckage, several quarts of a liquid consistent with oil was noted to drain out of a broken area in the oil sump housing.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy of the pilot was performed by the Coroner of Will County, Illinois, on May 29, 2004. The coroner's report stated that the pilot died of thermal injuries due to airplane fire.

The FAA Final Forensic Toxicology Fatal Accident Report on the pilot reported the following:

23 % carbon monoxide detected in blood
No cyanide detected in blood
No drugs were detected in urine

SURVIVAL ASPECTS

The airplane was equipped with a 2.5 lb Halon handheld fire extinguisher that was installed by the operator but was not required by the type of operation that the airplane was used for nor by regulation.

Cessna 206 entry and exit is accomplished through an entry door on the left side of the cabin at the pilot's seat position and through double cargo doors on the right side of the cabin at the center and rear seat passenger positions. In order to use the cargo door as an emergency exit with the flaps extended, the forward cargo door can only be opened approximately four inches to allow access to the aft door latch after which the procedures to open the aft cargo door is placard as:

EMERGENCY EXIT OPERATION
1. ROTATE FORWARD CARGO DOOR HANDLE FULL FORWARD THEN FULL AFT.
2. OPEN FORWARD CARGO DOOR AS FAR AS POSSIBLE.
3. ROTATE RED LEVER IN REAR CARGO DOOR FORWARD.
4. FORCE REAR CARGO DOOR FULL OPEN.

The aft cargo door is abeam the last row of seats, and the forward portion of the cargo door is abeam the second row of seats in airplanes with a six-seat arrangement. The approximate height from the top of the seat back to the roof of the cabin is 10 inches. Exterior and interior photos of a Cessna 206 with flaps extended and the aft portion cargo door open are included in the docket of this report.

According to Transport Canada Aviation Safety Letter (ASL) 2/1998, "The Cessna emergency-exit issue has been addressed extensively in the past by, among others, the [Transportation Safety Board] in 1985 and 1989; the ASL 7/90 article referred to above; Cessna SB SEB91-04, issued on March 22, 1991..." The ASL also states, "...when the flaps are down, the Cessna 206 emergency exit procedure remains a multistep procedure that can be difficult to execute under emergency conditions."

TESTS AND RESEARCH

Following the on-scene examination of the accident site, the engine was shipped to Textron Lycoming for a disassembly examination. Damage to the engine's related accessories precluded an operational test run and several of those accessories underwent Computerized Axial Tomography or CAT scan prior to their disassembly. These accessories included the fuel servo, engine driven fuel pump, turbocharger, and turbocharger oil tank. Metallurgical examinations were performed by the National Transportation Safety Board (NTSB) Materials Laboratory and sound spectrum analysis of the FAA air traffic control rerecordings was performed by the NTSB Audio Laboratory. Plots of the radar data are also included in this report.

Radar Data

Plots of FAA radar data show the airplane ground track, ground speed, altitude, and vertical speed. The ground speed plot shows a descent from the cruise altitude of approximately 1,800 feet msl to the last recorded radar data point of 1,000 feet msl. During this interval, the ground speed ranged from approximately 148 knots at 1,800 feet msl to approximately 65 knots msl at 1,000 feet msl.

Sound Spectrum Study of ATC Transmissions

An FAA certified cassette copy of air traffic control transmissions was sent to the National Transportation Safety Board's audio laboratory for a Sound Spectrum Study of any engine or propeller sounds that could be heard during radio transmissions from the accident airplane. A sound spectrum analyzer was used to identify any background signatures.

The first radio transmission, which was recorded on the CD frequency, contained sound signatures that were associated with the propeller rotating at a speed of approximately 1,669 rpm. The remainder of the propeller sounds that were heard while the airplane was on the ground either taxiing or holding for the runway, contained propeller sounds indicating a rotation speed of about 1,900 rpm.

The radio transmissions from the accident airplane, in which clearance for take off was acknowledged, contained propeller sounds indicating a rotation speed of about 2,100 rpm. The next radio transmission, after the airplane was airborne and the pilot acknowledged a left turn to a heading of 290 degrees, contained propeller sounds indicating a rotation speed of approximately 2,360 rpm. When the pilot was instructed to contact departure, the radio transmission contained propeller sounds indicating a rotation speed of 2,200 rpm.

The radio transmission in which the accident airplane checked in with AP contained propeller

sounds indicating a rotation speed of 2,239 rpm. The next transmission from the accident airplane was to acknowledge a traffic call. This radio transmission contained no discernable propeller sounds. The last long radio transmission from the accident airplane was when the pilot reported that he had lost his engine. This radio transmission contained propeller sounds indicating a rotation speed of about 1,639 rpm. Additionally, there were two very short radio calls from the accident airplane after the engine out radio call. No discernable propeller sounds could be identified during these two transmissions.

No background airplane warning tones or alarms were heard in any of the radio transmissions.

Propeller Examination

The propeller disassembly examination was performed by McCauley Propeller Systems at the Cessna Aircraft Company facility located in Wichita, Kansas, under the supervision of the FAA. The serial number of one blade was not legible due to damage, and the remaining two blades were identified as SH134 (number two) and SH146 (number three). The number two and three blades were seated in their respective hub sockets. The propeller attachment end (stud arrangement) was undamaged. The number one propeller blade did not have evidence of twisting or leading edge damage. A blade angle was not determined.

Engine Examination

A disassembly examination of the engine was performed at the Textron Lycoming facility in Williamsport, Pennsylvania, under the supervision of a National Transportation Safety Board (NTSB) Group Chairman.

To facilitate the placement of the engine into a disassembly stand, the fuel injection servo was removed. The air inlet housing, which exhibited heat distress and melting, remained attached to the fuel injection servo. The throttle and mixture arms were attached and the idle mixture adjustment linkage was sent to the NTSB Materials Laboratory for examination along with the aft link (mixture link). The fracture surface of the idle mixture adjustment linkage was consistent with overstress. The throttle arm link and threads were intact and the arm was twisted. The throttle arm was in the closed position. The throttle valve moved freely. A small amount of burned debris was found upstream of the throttle valve. The mixture linkage was attached but could not be moved. The fuel inlet tube was still attached to the fuel injection servo. The main fuel metering cover exhibited heat damage.

The turbocharger was removed from the engine. The exhaust transition assembly was intact, and the exhaust bypass valve moved freely. A visible line within the waste gate assembly corresponded with the bypass valve being in the closed position. This witness mark was reported as wear that occurs during normal operation and could not be used to indicate bypass valve position at impact. The waste gate actuator housing was not attached to the

waste gate assembly. The tailpipe was intact, and the outlet was crushed shut.

All of the cylinder assemblies were intact and their removal from the crankcase revealed that only the number one cylinder head exhibited thermal damage. The cooling fins located on the bottom of the cylinder and in the vicinity of the exhaust port were melted. Part of the rocker box cover attachment flange was melted and was missing a portion of the flange. All of cylinder piston domes had black deposits consistent with normal operation. All the valves were intact and no visible erosion around the valve seats were noted. The rocker assemblies were all intact and were not disassembled. All the push rods were intact and many of the push rod shroud tubes were blackened, covered with soot, and exhibited thermal damage. Both push rod shroud tubes on the number three cylinder and the intake push rod shroud tube on the number five cylinder were dented on the upper surface.

All of the spark plugs exhibited features consistent with normal operation. The number one cylinder top and bottom spark plugs, the number three cylinder bottom spark plug, and the number five top spark plug exhibited rust on the electrode tip.

No physical damage or unusual wear, pitting, or surface damage was noted on any of the pistons. All the piston heads exhibited combustion deposits consistent with normal operation. Pistons one, three, and five exhibited rust on the head and around the compression rings, and the remaining pistons were relatively rust free. All of the piston compression rings were intact. No anomalies were noted with any of the connecting rods. All but one of the pistons, piston pins, and piston pin plugs were manufactured by Textron Lycoming. The number five cylinder assembly was manufactured by Engine Components, Inc. The connecting rod bearing sleeves did not exhibit any unusual wear. All the connection bolts were intact and under an unmeasured torque.

The crankcase halves were intact, covered with soot, and did not possess any punctures. All the crankcase attachment bolts were intact. All the crankcase body fit thru studs were intact and secured except for the number one lower forward stud. The nut on the number one right hand side bottom (viewed aft to forward) thru-bolt was missing and the thru-bolt had moved left creating a gap between the left thru-bolt nut and the crankcase. The right threads on the number one cylinder bottom thru bolt were pushed outward. The number one cylinder thru bolt top and bottom and number three cylinder thru bolt top and bottom showed signs of heat damage.

The accessory housing was intact with no punctures and was covered with soot. All the accessory gears were intact and covered with oil. No visible damage was noted on any of the gears, and all the gears were rotated by hand.

The crankcase halves were separated and an examination of the crankshaft bearings revealed wear and color signatures consistent with normal operation. The forward bearing was melted and no discoloration was noted. Fretting was noted on the crankcase mating surface at the number three and four main bearing saddles. Three of the lower crankcase attachment bolt

nuts (in the sump area) were fractured and in place with safety wire, but when the safety wire was removed, the nuts separated from their respective bolts.

The crankshaft was intact and both counterweights remained attached. No anomalies were noted with the crankshaft. The coloration of the bearing journals was consistent with normal operation. The crankshaft timing gear was intact and no visible damage was noted. The camshaft was intact and possessed wear and coloration consistent with normal wear. The three forward most lobes of the camshaft and the two most forward connecting rod journals on the crankshaft were blackened and dry. Further aft, both camshaft lobes were covered with oil. The camshaft timing gear and the propeller governor drive gear were both intact and no visible damage of any of the gear teeth were noted.

Portions of the oil sump were melted, and the oil sump housing contained oil.

Fuel Servo Examination

The fuel servo, model RSA-10ED1, serial number 70149609, examination was conducted at Precision Airmotive's facility located in Everett, Washington, under the supervision of the FAA Principal Maintenance Inspector for the facility. The fuel servo's external condition revealed that the servo exhibited thermal damage. The throttle was able to be rotated through complete rotation. Rotation of the mixture control could not be performed, but a small amount of movement was noted. The mixture control was stuck in the near full rich position, and the mixture stop lever was melted. The inlet and outlet hose ends were attached. The throttle shaft bushings were melted, and the mixture control stop bushing was not attached. The damage to the servo precluded flow testing of the unit and a disassembly examination was then performed.

The O-rings associated with the fuel inlet screen were burned. The majority of the screen did not contain debris, but a small ball of fibrous material was present.

All components of the manual mixture control valve/plate/lever assembly were charred. The lever assembly spring tension exhibited "very little" tension, and the large bushing was not present. An outline of the plate on the valve was in the midrange position, which is "slightly" to the rich side.

The idle valve plate/lever assembly and fuel section O-rings were destroyed by thermal damage.

The regulator adjustments indicated that the regulator nut was 2-1/2 turns out from the inner nut and the constant head springs/shims were partially collapsed with no visible color and no shims. The position of the inner regulator nut was approximately 1-1/2 turns out from the bottom. The stem was separated from the diaphragms washers. The constant effort spring was partially collapsed, and no color was visible.

The regulator brass plug was melted, the regulator nuts were charred, and the air diaphragm remains consisted of ash. The center body bellows/seal was separated at its center. The fuel diaphragm remains consisted of ash, and the fuel servo seat with 0.092 inch shims was not present.

The venturi was charred and the remains of the O-rings were ash.

The flow divider part number 63B22636-A, serial number 0174214, was examined and noted to possess melted metal on top of the divider and a melted diaphragm. All of the nozzles were charred, and the O-rings were burned. Of the six restrictor outlets, only the number three was blocked. The number one body was partially open, the number three was blocked, the number four was blocked, and the number five was blocked.

Engine Driven Fuel Pump Examination

The Lear Romec, part number RG9080J8A, serial number D-9888, engine driven fuel pump examination was conducted at the Crane Aerospace facility located in Elyria, Ohio, under the supervision of the FAA. The examination revealed that the fuel pump was "extremely" blackened and a significant portion of the valve cap was melted. All of the pump's internal valve components were missing. The pump drive gear could be turned less than a 1/2 revolution by hand pressure.

An outside locknut could not be removed during the disassembly and was damaged during the attempt to do so. The remaining pump component parts were removed, accounted for, and inspected. There were no anomalies noted that would have precluded operation of the pump. There was no evidence of foreign objects or foreign object damage.

Magneto Examination

The Unison Industries, Slick Magnetos, both part numbers 6361, serial numbers 02050196 and 02041540, were examined at the Unison Industries facilities in Rockford, Illinois, under the supervision of the NTSB. The magnetos and associated wiring harness were damaged by fire and could not be operationally tested. A visual inspection of the magnetos revealed that the magneto did not contain the original screws used by the manufacturer to secure the housing to the frame. Internal inspection revealed that the rotor and shaft were intact. The impulse couplings were attached and all magneto parts were present in their respective locations.

Turbocharger Examination

The Garrett turbocharger, part number 46P22250B, serial number CBN00349, was sent to the

Kelly Aerospace facilities located in Fort Deposit, Alabama, where a disassembly examination was performed under the supervision of the NTSB. Two of the tubes housing mounting bolts, which mount the drain tank bracket, did not meet the manufacturer's original design specifications in length. The bolts were approximately 0.25 inches longer than design. The number two compressor blade was the only blade to rub at a blade tip to shroud clearance of 0.027 inches. Vane numbers 2, 3, and 4 rubbed at a compressor blade tip to shroud clearance of 0.028 inches. There was no evidence of circumferential scoring on the turbocharger shroud adjacent to the compressor blade tips. The shaft was cut near the compressor wheel in order to remove the wheel from the housing. Initial attempts to press the turbine wheel out using a hand press were unsuccessful and a hydraulic press was then used, which resulted in removal of the turbine wheel. The turbine wheel bearing surfaces did not exhibit circumferential wear on its surfaces. The Kelly Aerospace representative stated that the turbocharger exhibited evidence of oil starvation and that the bearings were seized. The FAA certification engineer from the FAA's Wichita Aircraft Certification Office, who attended the examination, agreed with the Kelly Aerospace representative's statements.

The turbocharger was sent to the NTSB Metallurgical Laboratory for examination.

The NTSB Materials Laboratory Factual Report of the turbocharger states that the shaft containing the bearing surfaces was ultrasonically cleaned in detergent. Visual examination of the two journal surfaces that corresponded to a bearing contained no evidence of heat tinting, circumferential gouges, metal transfer, or melting.

Axial saw cuts were made through the bearing housing to remove the two aluminum bearings and through the bearings to expose their internal surfaces. The internal surfaces of the bearings showed minor evidence of corrosion and no evidence of heat tinting, circumferential gouges, metal transfer or melting. The bearing radial holes were unobstructed. The bearings microstructure at the internal surface was similar to the microstructure at the core and external surfaces.

The oil check valve and adapter remained attached to the top of the bearing housing. The check valve inlet was pressure tested with air from a compressor. The inlet was tested with air pressure between 30 psi and 120 psi, at 10 psi intervals beginning at 30 psi and 10 second intervals. Air began to escape from the check valve at 50 psi. A sharp stainless needle was inserted into the exit port of the valve and several particles were dislodged. X-ray energy dispersive spectroscopy (EDS) analysis of the dislodged particles contained peaks of iron, bromine, and aluminum.

The internal surface of the compressor housing showed impression marks that were the same size as the tip of the compressor blades. Several of the compressor blades on one side of the assembly were deformed inboard. The compressor blade tips showed no evidence of rotational rubbing damage. The corresponding internal surface of the compressor housing showed no circumferential rubbing damage.

The turbine blades tips and corresponding internal housing surface showed no evidence of rotational rubbing damage.

The oil tank drain contained three ports, oil inlet, vent line, and oil outlet. The oil inlet and vent line were located on the top side. Oil from the turbocharger is fed into the inlet port, and pressure is vented through the vent line. According to Textron Lycoming engineering drawing for the oil tank drain, the external diameter and length of the oil outlet tube located within the tank was 0.625 and 1.500 inches, respectively.

A second turbocharger was removed from a Cessna 206 operated by the California Highway Patrol (CHP) after it was reported that smoke was emanating from the airplane during landing. The turbocharger was submitted to the NTSB Materials Laboratory for examination. The NTSB Materials Factual Report noted that when rotated by hand, the compressor and turbine wheels rotated together with ease. The turbine wheel contained a total of eleven blades, of which three were intact. The leading edge of three blades and the trailing edge outboard end of one blade were fractured and missing. The outboard end that extended between the leading edge and trailing edge of four blades also were fractured. The blades and exposed fracture faces were covered with a hard, solidified, black deposit. EDS analysis of a black deposit sample produced a spectrum that contained a major peak of lead, and minor peaks of bromine, carbon, and iron. The turbine wheel and turbine wheel housing inner wall was covered with oil. The compressor blades showed no evidence of fracture, deformation, impact, or burn damage. The compressor wheel was not covered with oil.

The turbocharger assembly was disassembled to expose the shaft that connected the turbine wheel to the compressor wheel. The tip of the compressor and turbine blades showed no evidence of rotational rubbing damage. The corresponding surfaces on the housing showed no circumferential rubbing damage.

Examination of the shaft after disassembly revealed the surface was covered with an abundance of oil. The two journal surfaces that correspond to the bearing locations showed no evidence of circumferential gouges, metal transfer, or melting. The journal surface that was located next to the turbine wheel contained several blue tinted scouring marks, whereas, the other journal surface showed no evidence of a blue tint.

The portion of the shaft that was located between the journal surfaces showed light tint that resembled a rainbow pattern. The rainbow pattern was closer to the journal that was located next to the compressor. The pattern appeared as straw, blue-purple, red, and yellow when moving from turbine journal side to compressor journal side. The journal surface that was located next to the turbine wheel contained isolated scouring marks that showed minor blue tinting. The journal surface that was located next to the compressor showed isolated circumferential scouring marks with a minor amount of straw tint.

The internal surface of the bearings showed no evidence of heat tinting, circumferential gouges, metal transfer or melting.

Check Valve Assembly

The check valve assemblies from the accident airplane and CHP airplane turbochargers were sent to the Lycoming Facilities, located in Williamsport, Pennsylvania, for testing under the supervision of the NTSB. The accident airplane check valve assembly was tested and would not hold 8 psi oil pressure. Oil and debris was observed to expel from the check valve assembly once it was placed under oil pressure.

The check valve assembly from the CHP airplane was tested and no leakage was noted when placed under 8 psi of oil pressure. The oil pressure was increased from 8 psi to 13 psi until oil was first observed to seep from the assembly. The oil started to flow from the valve at 14 psi.

Fuel Testing

A sample from the nozzle of the truck that was used to refuel the airplane was tested by ConocoPhillips. The test results were reported to meet ASTM D 910 specifications for 100 low lead aviation gasoline.

Signature Flight Support reported that two other aircraft were fueled from the same fuel truck that fueled the accident airplane. No anomalies that would have precluded normal operation of those two aircraft were reported.

Advisory Circular (AC) Information

AC 65-12A, Airframe & Powerplant Mechanics Powerplant Handbook, states in Table 10. Troubleshooting opposed engines, a mixture too rich is indicated by sluggish engine operation, red exhaust flame, and black smoke.

Airplane Emergency Procedures

The POH, Section 3, Emergency Procedures, lists the following:

Engine Failure During Flight (Restart Procedures)
1. Airspeed - 80 KIAS.
2. Fuel Selector Valve - BOTH.
3. Auxiliary Fuel Pump Switch - ON.
4. Engine Power - RESTARTED.
5. Mixture - RICH (if restart does not occur).
6. Ignition Switch - CHECK BOTH (or START if propeller is stopped).

NOTE: If propeller is windmilling, engine will restart automatically within a few seconds. If propeller has stopped (possible at low speeds), turn ignition switch to START, advance throttle slowly from idle, and (at higher altitudes) lean mixture from full rich.

7. Auxiliary Fuel Pump Switch - OFF.

NOTE: If the fuel flow indication immediately drops to zero, signifying an engine-driven fuel pump failure, return the auxiliary fuel pump switch to ON.

Emergency Landing Without Engine Power
1. Passenger Seats - AS FAR FORWARD AS PRACTICAL.
2. Passenger Seat Backs - MOST UPRIGHT POSITION.
3. Seat and Seat Belts - SECURE.
4. Airspeed - 85 KIAS (flaps UP)
- 75 KIAS (flaps DOWN)
5. Mixture - IDLE CUTOFF
6. Fuel Selector - PUSH DOWN and ROTATE to OFF.
7. Ignition Switch - OFF.
8. Wing Flaps - AS REQUIRED (40 degrees recommended)
9. Master Switch - OFF when landing is assured.
10. Door - UNLATCH PRIOR TO TOUCHDOWN.
11. Touchdown - SLIGHTLY TAIL LOW.
12. Brakes - APPLY HEAVILY.

The POH lists in Figure 3-1. Maximum Glide, best glide speeds for the following weights:

3,600 lbs; 80 KIAS
3,200 lbs; 75 KIAS
2,800 lbs; 70 KIAS

The POH, Section 3, Rough Engine Operation Or Loss of Power, lists only the following five subjects:

Spark Plug Fouling
Magneto Malfunction
Engine-Driven Fuel Pump Failure
Excessive Fuel Vapor Indications
Low Oil Pressure

NTSB Turbocharger Recommendation

On January 13, 1992, a Cessna T210L N22592, was involved in an accident at the Temple Bar

Airport, Temple Bar, Arizona, as the pilot attempted to execute an emergency landing. The pilot reported that the airplane had sustained a partial loss of engine power during cruise, but that he could not determine the nature of the problem. While descending to the airport, he turned the fuel boost pump on and the engine lost additional power. Just before arriving over the airport, the cockpit and cabin areas filled with smoke and the engine was secured. The Safety Board determined the probable causes of the accident to be fatigue failure of the turbocharger's turbine shaft due to inadequate maintenance, and the pilot's improper in-flight planning/decision after experiencing a turbocharger failure. Additionally, the lack of written instructions of an emergency procedure in the Cessna T210L Pilot's Operating Handbook (POH) relating to turbocharger malfunctions of failures was determined to be an important factor contributing to the accident.

On April 11, 1994, NTSB recommendation A-94-081 cited the following recommendation relating to emergency procedures for turbocharger failures:

"Require the amendment of pilot operating handbook and airplane flight manuals applicable to aircraft equipped with engine turbochargers by including in the Emergency Procedures section information regarding turbocharger failure. The information should include procedures to minimize potential hazards relating to fire in flight and/or loss of engine power."

On March 29, 1995, a letter addressed from Cessna Aircraft Company to the FAA Aircraft Certification Office, located in Wichita, Kansas, regarding NTSB Recommendation A-94-81. The letter stated that General Aviation Manufacturers Association (GAMA) is revising GAMA Specification 1, Specification for Pilot's Operating Handbook, dealing with POHs to address turbocharger failures. The letter then says: "Cessna will incorporate the GAMA changes at the next revisions of applicable POH/AFMs and to Cessna's Safety Supplement."

On October 18, 1996, GAMA Specification 1 was revised to incorporate turbocharger failures in the emergency procedures sections of flight manuals.

On November 9, 1998, the Cessna T206H POH was issued.

The Cessna Pilot Safety and Warning Supplements were originally issued on October 2, 1985, did not address turbocharger failures until its reissuance on June 1, 1998. The reissuance added the following regarding turbocharger failure:

"If a turbocharger failure results in power loss, it may be further complicated by an overly rich mixture. The rich mixture condition may be so severe as to cause a total power failure. Leaning the mixture may restore partial power. Partial or total power loss may also be caused by an exhaust system leak. A landing should be made as soon as practical for either an overboost or partial/total power loss."

FAA Aviation Concern Sheet (ACS)

On June 30, 2004, the FAA issued an ACS applicable to turbocharged Cessna airplanes: T182, T-R182, T206, T207, P210, T210, T303, T310, 320, T337, 340, 401, 402, 411, 414, 421. The ACS states that engine power loss or engine stoppage can be exacerbated due to the fuel mixture becoming excessively rich following the failure of the turbocharger system.

The ACS states that the POH may not contain adequate instructions to cope with in-flight turbocharger system failure. Additionally, the aircraft maintenance instructions may not adequately address the turbocharger system performance in order to detect an impending failure.

ADDITIONAL INFORMATION

The wreckage was released to the operator.

Parties to the investigation were the Cessna Aircraft Company, Crane Aerospace, Drug Enforcement Administration, FAA, Kelly Aerospace, L3 Communications, McCauley Propeller Systems, Precision Airmotive Corporation, Textron Lycoming, and Unison Industries.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	44,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 2	**Last FAA Medical Exam:**	November 1, 2003
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	November 1, 2003
Flight Time:	3602 hours (Total, all aircraft), 1546 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N9548D
Model/Series:	T206H	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	T20608062
Landing Gear Type:	Tricycle	**Seats:**	6
Date/Type of Last Inspection:	April 1, 2004 Annual	**Certified Max Gross Wt.:**	3600 lbs
Time Since Last Inspection:	38.9 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	628 Hrs at time of accident	**Engine Manufacturer:**	Textron Lycoming
ELT:	Installed, not activated	**Engine Model/Series:**	TIO-540-AJ1A
Registered Owner:	Drug Enforcement Administration	**Rated Power:**	310 Horsepower
Operator:		**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	MDW,616 ft msl	**Distance from Accident Site:**	14 Nautical Miles
Observation Time:	14:30 Local	**Direction from Accident Site:**	38°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots / 14 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	360°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.95 inches Hg	**Temperature/Dew Point:**	15°C / 3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Chicago, IL (MDW)	**Type of Flight Plan Filed:**	Unknown
Destination:	St. Louis, MO (SUS)	**Type of Clearance:**	
Departure Time:	14:23 Local	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	On-ground
Total Injuries:	1 Fatal	**Latitude, Longitude:**	41.634723,-87.980834

Administrative Information

Investigator In Charge (IIC):	Gallo, Mitchell
Additional Participating Persons:	Tom Duellman; Federal Aviation Administration; Dupage, IL Robert August; Cessna Aircraft Company; Wichita, KS Terry Chapman; Crane Aerospace; Elyria, OH Steve Baston; Drug Enforcement Administration; Fort Worth, TX Tom Knopp; McCauley Propellar Systems; Wichita, KS Peter Nielson; Precision Airmotive; Everett, VT Gregory Erickson; Textron Lycoming; Williamsport, PA Steve Carter; Unison Industries; Jacksonville, FL Robert Drews; Kelly Aerospace; Fort Deposit, AL Mike Seals; L3 Communications; Fort Worth, TX
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Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=59401