Aviation Investigation Final Report

Location:	Lexington, Kentucky	**Accident Number:**	ERA15LA134
Date & Time:	February 19, 2015, 14:40 Local	**Registration:**	N358CD
Aircraft:	CIRRUS DESIGN CORP SR22	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (partial)	**Injuries:**	3 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The private pilot reported that he conducted a preflight inspection and engine-run-up with no anomalies noted. The pilot then taxied the airplane to the runway and began the takeoff roll for his planned personal cross-country flight. The airplane lifted off the runway and climbed to about 200 ft above ground level, at which point, the engine "backfired" several times, followed by a partial loss of power. The pilot chose to discontinue the flight, retarded the throttle to idle, and initiated a descent to land on the remaining runway; however, the pilot was unable to stop the airplane, and it overran the runway and collided with the precision approach path indicator lights and a snowbank.

Postaccident test runs of the engine with a new set of magnetos and the original ignition harness revealed that the likely cause of the loss of engine power was related to the ignition harness. Subsequent examination of the ignition harness revealed the presence of radial carbon tracks on the sleeves of 8 of the 12 terminals on the harness. The harness and its terminal wells were in generally dirty condition, which likely resulted in spark plugs erratically misfiring. Although one of the engine's magnetos internal mechanisms was damaged, the damage was likely the result of the engine misfiring.

According to an engine manufacturer service bulletin (SB), the ignition harness spark plug terminals should be removed, inspected, and cleaned at each annual inspection. The engine logbook indicated that the spark plugs were "cleaned, gapped, and inspected" during the last annual inspection, which was completed about 14 flight hours before the accident. However, the logbooks did not note compliance with the SB or whether the ignition harness spark plug terminal, and not just the spark plugs, had been inspected and/or cleaned. Given the generally dirty condition of the ignition harness spark plug terminals, it is likely that maintenance personnel did not properly inspect and clean the ignition harness terminals in accordance with the SB.

Probable Cause and Findings

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

Maintenance personnel's failure to properly inspect and clean the engine ignition harness spark plug terminals, which resulted in a partial loss of engine power during an attempted takeoff.

Findings

Aircraft	Dist (ignition harness) - Malfunction
Personnel issues	Scheduled/routine maintenance - Maintenance personnel
Aircraft	(general) - Inadequate inspection
Environmental issues	Tree(s) - Contributed to outcome
Environmental issues	Snow/ice - Contributed to outcome

Factual Information

History of Flight

Takeoff	Loss of engine power (partial) (Defining event)
Takeoff-rejected takeoff	Collision with terr/obj (non-CFIT)
Landing-landing roll	Runway excursion

On February 19, 2015, about 1440 eastern standard time, a Cirrus SR22 airplane, N358CD, was substantially damaged during a runway overrun while attempting to depart from Bluegrass Airport (LEX), Lexington, Kentucky. The private pilot and both passengers were not injured. Visual meteorological conditions prevailed and an instrument flight rules (IFR) flight plan was filed for the cross-country flight that was destined for Oakland County International Airport (PTK), Pontiac, Michigan. The personal flight was conducted under the provisions of Title 14 Code of Federal Regulations Part 91 and was originating at the time of the accident.

According to the pilot, he did not observe any abnormalities with the engine during any of the five individual flights that he completed in the accident airplane about one week prior to the accident. The pilot reported that both the preflight inspection and subsequent engine run-up did not present any anomalies on the day of the accident. The pilot then taxied to runway 22 and began a takeoff roll. The airplane's initial climb appeared normal until it reached approximately 200 feet above ground level (agl). The engine "backfired" several times, which was immediately followed by a partial loss of power. The pilot elected to discontinue the flight, retarded the throttle to the idle position, and initiated a descent to land on the remaining runway. The pilot stated that he had "too much energy" to stop the airplane before it overran the end of the runway and collided with the precision approach path indicator lights and a snowbank. According to a police report, the pilot stated that the airplane touched down near the approach end of runway 04.

A Federal Aviation Administration (FAA) inspector interviewed a witness who was in his office, which was located about midfield on runway 22/4, at the time of the accident. According to the witness's recount, he did not observe any anomalies as the airplane began its climbout. However, once the airplane was "abeam his office window" and approximately 200 feet agl, the witness heard the engine surge, which was followed by a reduction in power and multiple loud "pop" sounds. The airplane then entered a nose-low attitude and began to descend. The witness observed the airplane begin a landing flare from approximately 30 feet agl. During the airplane's subsequent touchdown attempt, it bounced three times and then overran the runway.

The 1454 recorded weather observation at LEX included wind from 280 degrees at 12 knots, gusting to 15 knots, 10 statute miles visibility, overcast clouds at 3,400 feet, temperature -14 degrees C, dew point -23 degrees C; barometric altimeter 30.31 inches of mercury.

The four-seat, low wing, fixed-gear airplane was manufactured in 2004 and powered by a Continental Motors IO-550-N27, 310-horsepower reciprocating engine. According to the maintenance records, the airplane's most recent annual inspection was performed on December 5, 2014, at a total airframe time of

3,700 flight hours, 14 flight hours before the accident. At the time of the inspection, the engine had accumulated 1,598 total flight hours since its last overhaul, which took place on December 18, 2009 at 2,116 hours, total time in service. A 500-hour magneto inspection was completed at the time of the annual inspection.

According to the engine logbook, the ignition harness was replaced with a factory new unit on August 24, 2009, approximately 100 hours before the engine was overhauled. The logbook entry that pertained to the airplane's most recent inspection stated that the spark plugs were "cleaned, gapped, and inspected" and the engine was inspected in accordance with the manufacturer's maintenance manual. The ignition harness inspection and cleaning requirements were included in a service bulletin, but not in the manufacturer's maintenance manual. The most recent inspection logbook entry did not reference the service bulletin nor did it indicate that the ignition harness spark plugs terminals had been cleaned.

The airplane was equipped with an Avidyne multi-function display (MFD) that was capable of recording airplane and engine performance data to a compact flash card. The compact flash card was removed and successfully downloaded. The data contained recorded engine parameter data and GPS coordinates for the accident flight. The data were recorded at a rate of once every 6 seconds, and did not include altitude or airspeed; however, the airspeed was computed using time and the airplane's GPS-derived location. According to the data, the airplane began a takeoff roll at 1437:12 at which point the engine rpm increased from 1,470 rpm to 2,460 rpm, on its rise to takeoff power. In the 18 seconds that followed, the engine maintained 2,400 – 2,700 rpm, which corresponded to a fuel flow of about 30 gallons per hour (gph).

After the airplane passed the first third of the runway, the engine rpm, fuel flow, and cylinder exhaust gas temperatures (EGT) began to decline simultaneously; however, a precise rate of decline could not be captured due to the rate at which the data was recorded. The fuel flow decreased to 3 gallons per hour in the 12 seconds that followed the power reduction. The engine rpm and cylinder EGTs continued to decline as the airplane reached the departure end of the runway. At 1438:12 the engine rpm leveled out at approximately 450 rpm for about 12 seconds, when the airplane came to rest. The rpm then decreased to 0 rpm and the fuel flow was reduced to 0 gph almost simultaneously.

Postaccident examination of the airplane revealed that the spark plugs and ignition harness functioned normally when field tested, and electrical continuity was established through the magneto switch and primary leads. The magnetos had been timed to approximately 22 degrees below top dead center (BTDC), consistent with the manufacturer's specification. Both magnetos were subsequently field tested, but only the right magneto produced a spark at the ignition leads.

A set of new magnetos, furnished by the manufacturer, were installed and timed to 22 degrees BTDC and a set of test leads were attached to the disconnected primary leads to bypass the magneto switch. The ignition harness was not replaced. A subsequent engine test run revealed that the engine ran smoothly on both magnetos. When the right magneto was selected the engine lost approximately 20 rpms, but continued to run smoothly. Once the left magneto test lead was selected, the engine lost power and began to backfire.

All 6 fuel injectors were cleaned after an inspection showed that some of the injectors were contaminated and restricted. The injectors were reinstalled and another engine run was attempted;

however, the engine still lost power and backfired when the left magneto was selected. The airplane was secured until the engine could be re-run with new spark plugs and a new ignition harness.

A follow-up engine run was completed with a new set of spark plugs installed and a subsequent engine-run revealed that the engine lost approximately 200 rpm when the magneto switch was moved from BOTH to LEFT, but the engine did not backfire as it did during previous tests. After the ignition harness was replaced, the engine dropped only 20 rpm when the left magneto was selected and did not backfire.

The ignition harness and magnetos were submitted to the NTSB Materials Laboratory for further examination. An examination of the ignition harness revealed the presence of radial carbon tracks on the sleeves of 8 out of 12 terminals on the harness. The sleeves exhibited pitting, discoloration and flat spots consistent with wear contact. Black deposits were observed on the sleeve surfaces, including the areas that sealed against the spark plug insulator. Each terminal spring was covered in black deposits and several of the springs and sleeves were bent. Multiple leads displayed wear damage, and in one case the damage extended to the underlying metal braid.

Examination of the right magneto revealed that 11 teeth were fractured and two teeth were cracked. The left magneto exhibited 9 fractured teeth and one partially fractured tooth. A set of teeth from the right distributor gear were deliberately fractured under impact loading conditions and the resulting impact signatures were consistent with those observed in the teeth that had been previously fractured in both magnetos. Laboratory testing showed that each distributor gear had a Fourier-transform infrared spectrum consistent with the specific material prescribed by the magneto manufacturer.

Champion Aerospace Aviation Service Manual, AV6-R, dated August 2014, stated that if the terminal well in the spark plug became dirty with moisture or other foreign material, current could track through the dirty terminal well to ground on the shell, which could result in an erratic misfire of the spark plug. This condition was known as connector well flashover. The service manual further stated that spark plugs with dirty terminal wells should be replaced with serviceable units.

The Australian Civil Aviation Safety Authority Airworthiness Bulletin (AWB) 17-005, Issue 3, dated October 2014, listed a number of potential causes for nylon distributor gear failures, including propeller strikes, kick back during start-up events, and any other event that can cause shock on the gear train driving the distributor gear.

According to Service Bulletin (SB) SB-643B, published by Continental Motors, Inc. on April 6, 2005, all ignition harness outlet plates, covers, or cap assemblies should be cleaned and inspected in concurrence with the 500 hour magneto inspection. Any damaged parts, including those that were broken, brittle, cracked or burned, must be replaced. The SB required that all ignition harness spark plug terminals be removed, cleaned, and inspected during each 100 hour, annual inspection, or progressive maintenance inspection.

Pilot Information

Certificate:	Private	**Age:**	54,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	September 30, 2014
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	March 22, 2013
Flight Time:	1049 hours (Total, all aircraft), 366 hours (Total, this make and model), 1049 hours (Pilot In Command, all aircraft), 11 hours (Last 90 days, all aircraft), 9 hours (Last 30 days, all aircraft), 3 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	CIRRUS DESIGN CORP	**Registration:**	N358CD
Model/Series:	SR22	**Aircraft Category:**	Airplane
Year of Manufacture:	2004	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	0967
Landing Gear Type:	Tricycle	**Seats:**	4
Date/Type of Last Inspection:	December 5, 2014 Annual	**Certified Max Gross Wt.:**	3400 lbs
Time Since Last Inspection:	14 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	3714 Hrs at time of accident	**Engine Manufacturer:**	CONT MOTOR
ELT:	C91A installed, not activated	**Engine Model/Series:**	IO-550-N27
Registered Owner:	Optimal Aircraft Management LLC	**Rated Power:**	310 Horsepower
Operator:	Optimal Aircraft Management LLC	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	LEX,979 ft msl	**Distance from Accident Site:**	1 Nautical Miles
Observation Time:	14:54 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	12 knots /	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:	310°	**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	30.31 inches Hg	**Temperature/Dew Point:**	-14°C / -23°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Lexington, KY (LEX)	**Type of Flight Plan Filed:**	IFR
Destination:	PONTIAC, MI (PTK)	**Type of Clearance:**	IFR
Departure Time:	14:40 Local	**Type of Airspace:**	Class C

Airport Information

Airport:	BLUE GRASS LEX	**Runway Surface Type:**	Asphalt
Airport Elevation:	979 ft msl	**Runway Surface Condition:**	Dry;Ice
Runway Used:	22	**IFR Approach:**	None
Runway Length/Width:	7004 ft / 150 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	2 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 None	**Latitude, Longitude:**	38.033332,-84.605552(est)

Preventing Similar Accidents

Mechanics Manage Risk and Follow Procedures (SA-022)

The Problem

Mistakes made while performing aircraft maintenance and inspection procedures have led to in-flight emergencies and fatal accidents. System or component failures are among the most common defining events for fatal general aviation accidents.

What can you do?

- Remember that well-meaning, motivated, experienced technicians can make mistakes. Learning about and adhering to sound risk management practices can help prevent common errors that can lead to tragic consequences.
- Understand the safety hazards associated with human fatigue and strive to eliminate fatigue contributors in your life. Fatigue has been linked to forgetfulness, poor decision making, reduced vigilance, and other factors that can interfere with your ability to do your job safely.
- Pay particular attention to the safety and security of the items that undergo maintenance and any surrounding components that may have been disconnected or loosened (possibly to ease access) during that maintenance.
- Carefully follow manufacturers' instructions to ensure that the work is completed as specified. Always refer to up-to-date instructions and manuals when performing a task, and ask questions of another qualified person if something is unfamiliar to you.
- Have a qualified person, other than the person who performed the maintenance, inspect the safety and security of critical items that have received maintenance.
- Be thorough when performing routine inspections. Ensure that items needing immediate attention are addressed rather than deferred.

See https://www.ntsb.gov/Advocacy/safety-alerts/Documents/SA-022.pdf for additional resources.

The NTSB presents this information to prevent recurrence of similar accidents. Note that this should not be considered guidance from the regulator, nor does this supersede existing FAA Regulations (FARs).

Administrative Information

Investigator In Charge (IIC):	Stein, Stephen
Additional Participating Persons:	Fred Seals; FAA/FSDO; Louisville, KY Michael Council; Continental Motors, Inc.; Mobile, AL
Original Publish Date:	February 13, 2017
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=90768