Aviation Investigation Final Report

Location:	Homestead, Florida	**Accident Number:**	ERA12LA219
Date & Time:	March 9, 2012, 10:34 Local	**Registration:**	N444VR
Aircraft:	CIRRUS DESIGN CORP SR22	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	3 None
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

During cruise flight at 6,000 feet mean sea level (msl), the airplane's engine incurred a total loss of power. The flight instructor and the private pilot looked for a suitable place to land. Their first choice was an airport, but due to the prevailing wind, they were unable to make it to the airport. Their second choice was a highway, but it also proved to be unsuitable due to the amount of automobile traffic. As they descended through 2,000 feet msl, they considered deploying the Cirrus Aircraft Parachute System (CAPS) but noticed a light colored patch of ground, which appeared to be a hard dirt surface; they thought landing there would be a better option than deploying the CAPS. During the final approach, while in ground effect, the flight instructor observed a mound of dirt that was directly in front of the airplane, and he deployed 50-percent wing flaps to "balloon" the airplane over the obstacle. The wheels touched down on a water-filled marshy area, and the airplane slid over a mound of dirt and came to rest in the marshy area.

A review of onboard recorded data showed that fluctuations of the No. 2 cylinder's exhaust gas temperature were present beginning at engine start. Examination of the engine revealed that the engine had a hole in the top of the crankcase and that both magnetos had separated from their mounting locations. Further examination of the engine revealed that the No. 2 connecting rod bearing had been starved of oil and released from the crankshaft. The No. 2 main bearing had shifted and the lock slot in the crankcase was damaged, which indicated that the crankcase through bolts were not properly torqued. The No. 2 main bearing was fractured, and portions were missing from the steel backing, and the No. 2 and No. 3 piston pin bushings were also missing bushing material, which indicated that, during maintenance, a service bulletin had not been complied with. Review of the manufacturer's overhaul schedule also revealed that the recommended time between overhauls was 2,000 hours. At the time of the accident, the engine had accrued 2,978.1 total hours of operation without overhaul.

Review of the airplane and engine manufacturers guidance also revealed that because engine cooling was accomplished by discharging heat to the oil in the engine the engine should not be operated with less than 6 quarts of oil. The flight instructor however, stated that he added oil to the engine during the preflight to bring it up to 5 quarts. He also advised that was the level they always serviced it to, which

indicated that in addition to the engine having been inadequately maintained, the engine was also continuously operated below the minimum specified oil level.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The inadequate servicing and maintenance of the engine and the airplane owner and maintenance personnel's disregard of the manufacturer's recommended engine overhaul schedule and service bulletins, which resulted in an in-flight internal failure and seizure of the engine.

Findings

Personnel issues	Replacement - Owner/builder
Personnel issues	Repair - Maintenance personnel
Aircraft	Oil - Incorrect service/maintenance
Aircraft	Recip engine power section - Failure

Factual Information

History of Flight

Prior to flight	Aircraft maintenance event
Prior to flight	Aircraft servicing event
Enroute-cruise	Loss of engine power (total) (Defining event)
Emergency descent	Off-field or emergency landing
Landing	Collision with terr/obj (non-CFIT)

On March 9, 2012, about 1034 eastern standard time, a Cirrus SR22, N444VR, was substantially damaged during a forced landing near Homestead, Florida. The certificated flight instructor, private pilot, and passenger, were not injured. Day visual meteorological conditions prevailed, and an IFR flight plan was filed for the instructional flight conducted under 14 Code of Federal Regulations (CFRs) Part 91, which departed Opa-Locka Executive Airport (OPF), Miami Florida, destined for Key West International Airport (EYW), Key West, Florida.

According to the flight instructor, prior to departure from OPF he had the fuel tanks filled to capacity and he added oil to the engine to bring it up to 5 quarts.

They departed to the east from OPF at approximately 1000, and were given the MIAMI ONE DEPARTURE, MNATE TRANSITION (MIA1.MNATE) then direct to EYW. During the departure they were eventually cleared to 6,000 feet above mean sea level (msl). Once they were leveled off and in the approximate vicinity of Ocean Reef Club Airport (07FA), Key Largo, Florida, the engine incurred a total loss of power. The flight instructor believed however that at the time, the engine was still producing partial power. He then established best glide speed and turned towards 07FA, while the private pilot declared an emergency with Miami Air Traffic Control Center. They "quickly went through the troubleshoot checklist" but could not regain engine power. The airplane was now descending through 4,000 feet msl. The flight instructor then realized that there was a 20 knot headwind, that they were approximately 10 nautical miles from 07FA, and that they were descending at 1,000 feet per minute. He realized that they would not be able to make the airport, so he turned to the left to take advantage of the tailwind and headed for US Highway 1.

He could not recall the exact altitude but as they got lower, he noticed the amount of cars that were on the highway and decided that the risk was too great to attempt to land on it. At approximately 2,000 feet msl, they considered deploying the installed Cirrus Aircraft Parachute System (CAPS) but noticed a light colored patch of ground which appeared to be a hard dirt surface which landing on, seemed to be a better option than deploying the CAPS.

During the final approach while in ground effect the flight instructor then observed a mound of dirt that was directly in front of him and deployed 50 percent wing flaps to "balloon" the airplane over the obstacle. He then heard the stall warning horn, and the wheels touched down on water "like a soft seaplane landing" and slid over a long mound of dirt. The flight instructor then kept the control wheel all

the way back and held it till the airplane came to rest in a water filled marshy area.

Flight instructor Information

Certificate:	Commercial; Flight instructor	**Age:**	31,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	August 7, 2009
Occupational Pilot:	UNK	**Last Flight Review or Equivalent:**	February 3, 2012
Flight Time:	(Estimated) 2100 hours (Total, all aircraft), 300 hours (Total, this make and model)		

Pilot Information

Certificate:	Private	**Age:**	41,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	July 27, 2009
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	February 23, 2012
Flight Time:	(Estimated) 480 hours (Total, all aircraft), 60 hours (Total, this make and model)		

According to FAA and pilot records, the flight instructor held a commercial pilot certificate with ratings for airplane single-engine land, airplane single-engine sea, airplane multi-engine land, and instrument airplane. His most recent FAA first-class medical certificate was issued on August 7, 2009. He reported 2,100 hours of total flight experience.

The private pilot held a certificate with ratings for airplane single-engine land, and instrument airplane. His most recent FAA third-class medical certificate was issued on July 27, 2009. He reported 480 hours of total flight experience.

Aircraft and Owner/Operator Information

Aircraft Make:	CIRRUS DESIGN CORP	**Registration:**	N444VR
Model/Series:	SR22	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	0788
Landing Gear Type:	Tricycle	**Seats:**	4
Date/Type of Last Inspection:	December 20, 2011 Annual	**Certified Max Gross Wt.:**	3400 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	2888 Hrs as of last inspection	**Engine Manufacturer:**	CONT MOTOR
ELT:	Installed, not activated	**Engine Model/Series:**	IO-550-N
Registered Owner:	N444VR LLC	**Rated Power:**	310 Horsepower
Operator:	N444VR LLC	**Operating Certificate(s) Held:**	None

According to FAA and airplane maintenance records, the airplane was manufactured in 2003. The airplane's most recent annual inspection was completed on December 20, 2011. At the time of the inspection, the airplane had accrued 2,888 total hours of operation.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	HST,6 ft msl	**Distance from Accident Site:**	10 Nautical Miles
Observation Time:	10:55 Local	**Direction from Accident Site:**	315°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	12 knots / 15 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	110°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.2 inches Hg	**Temperature/Dew Point:**	26°C / 20°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Miami, FL (OPF)	**Type of Flight Plan Filed:**	IFR
Destination:	Key West, FL (EYW)	**Type of Clearance:**	IFR
Departure Time:	10:00 Local	**Type of Airspace:**	

The recorded weather at Homestead Air Reserve Base (KHST), Homestead, Florida, approximately 10 nautical miles northwest of the accident site, at 1455, included: wind 110 degrees at 12 knots gusting to 15 knots, visibility 10 miles, sky clear, temperature 26 degrees

C, dew point 20 degrees C, and an altimeter setting of 30.20 inches of mercury.

Wreckage and Impact Information

Crew Injuries:	2 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 None	**Latitude, Longitude:**	25.329999,-80.377777

Examination of the accident site revealed that the airplane had come to rest in mud and water. The bottom of the airplane was immersed to an approximate depth of 9 inches. No fuel residue was present on the water surrounding the airplane.

Landing Gear

Examination of the left and right main landing gear revealed that they had been separated from their mounting locations. The nose landing gear's fairings were torn off but, the nose landing gear strut and wheel assembly was still intact.

Wings

Examination of the left wing revealed that the left wing outboard leading edge was impact damaged, the TKS panel was dented and the leading edge of the upper and lower wing skins, were buckled aft. The wing flap was impact damaged. The fuel cap was closed and secured, and fuel was present to within1 to 2 inches of the top of the fuel tank. Examination of the right wing revealed that the right wingtip was impact damaged, the right navigation light and strobe were impact damaged, and the wing flap was impact damaged. The fuel cap was closed and secured and fuel was present to within 1 to 2 inches of the top of the fuel tank.

Fuselage

Examination of the fuselage revealed that a hairline crack was present along the aft seam cover over the left front CAPS harness attach point on the left side of the fuselage immediately aft of the firewall. Both cabin entry steps were bent aft, and the cowling was impact damaged.

Empennage

Examination of the horizontal stabilizer and elevators revealed no evidence of impact damage, to the horizontal stabilizer. However both elevators were impact damaged and both the left and right tips were bent and torn off. Examination of the rudder and vertical stabilizer revealed no evidence of damage.

Propeller and Engine

Examination of the propeller and engine revealed that the propeller was undamaged. The engine however, had a visible hole in the top of the engine case near the No. 1 and No. 2 cylinders.

Both magnetos were separated from their mounting locations. The left magneto was impact damaged and would not rotate however, internal examination revealed no evidence of any preimpact failure or malfunction. The right magneto would turn freely and the impulse coupling would engage. Bench testing of the right magneto revealed no anomalies and it would produce spark throughout its rpm range. The ignition harness was impact damaged but exhibited normal operating signatures, and the top and bottom sparkplugs exhibited normal wear signatures.

The fuel pump turned freely and no evidence of any abnormalities was present, and it functioned normally through its full range of operation when tested. The throttle, fuel control/ metering assembly functioned normally through its full range of operation when tested. The fuel nozzles were unrestricted and the fuel lines were intact and undamaged. The fuel lines, fuel nozzles, and fuel manifold valve assembly functioned normally through the full range of operation when tested and no leakage was observed from the fuel manifold valve cover vent port during the testing.

The oil sump exhibited minor impact damage. The oil sump drain plug was not safetied. The sump contained 2.5 quarts of oil. The oil was dark in color and contained fragments of engine components. The oil suction screen contained a small amount of debris. The oil filter contained metallic flakes and slivers. The oil pump cavity exhibited scratches but, the oil pump drive was intact, and the oil pump gear teeth exhibited normal operating signatures. The oil pressure relief valve and seat contained no obstructions and exhibited signatures consistent with proper seating. The oil cooler was undamaged.

Cylinder Nos. 1, 4, 5, and 6, exhibited normal operating signatures however, cylinder Nos. 2, and 3, exhibited mechanical damage to their cylinder skirts.

The pistons, piston rings, and piston pins from cylinder Nos. 1, 3, 4, 5, and 6, also exhibited normal operating signatures. The piston skirt, piston rings, and piston pin from cylinder No. 2 however, exhibited mechanical damage.

The crankshaft and counterweight assembly exhibited lubrication distress, thermal damage, and mechanical damage concentrated at the No. 2 connecting rod journal. The No. 2 connecting rod journal also exhibited signs of lubrication distress, thermal discoloration, mechanical damage, and displacement of the journal material.

The No.2 main bearings exhibited contamination imbedded in the surface layer. The bearings exhibited wear consistent with high time engines and the Babbitt layer had been worn through. The bearings were also fragmented and extruded from the bearing support. The bearing had shifted in the main bearing support and the lock slot in the crankcase was damaged indicating that inadequate torque of the crankcase through bolts existed.

The No. 2 connecting rod exhibited extreme thermal and mechanical damage and was fractured through

at the base of the I-beam, separating both sections of the bearing supports. Fragments of the connecting rod cap exhibited thermal and mechanical damage. Fragments of the connecting rod bolts and nuts were fragmented through and exhibited mechanical damage and thermal signatures. The piston pin bushing exhibited fractured sections and examination of the No. 3 connecting rod also revealed that it was missing portions of its piston pin bushing.

Flight recorders

The accident airplane did not have a flight recorder installed nor was one required to be installed under the applicable CFRs. It did however have data recording capability incorporated in the Primary Flight Display and Multi Function Display.

The Primary Flight Display (PFD)

The PFD unit included a solid state Air Data and Attitude Heading Reference System (ADAHRS) and displayed aircraft parameter data including altitude, airspeed, attitude, vertical speed, and heading. The PFD unit had external pitot/static inputs for altitude, airspeed, and vertical speed information. The PFD contained two flash memory devices mounted on a riser card. The flash memory stored information the PFD unit used to generate the various PFD displays. Additionally, the PFD had a data logging function, which was used by the manufacturer for maintenance and diagnostics. Maintenance and diagnostic information recording consisted of system information, event data and flight data.

The PFD recording contained records of 20 power cycles and approximately 16 hours of data. The accident flight was associated with the 16th power cycle. The duration of the 16th power cycle was approximately 45 minutes.

The Multi Function Display (MFD)

The MFD unit was able to display the pilot checklist, terrain/map information, approach chart information and other aircraft/operational information depending on the specific configuration and options that were installed. One of the options that were available was a display of comprehensive engine monitoring and performance data.

The MFD contained a CF memory card located in a slot on the side of the unit. This memory card contained all of the software that the MFD needed to operate. Additionally, this card contained all of the checklist, approach charts, and map information that the unit used to generate the various cockpit displays.

During operation, the MFD received information from several other units that were installed on the aircraft. Specifically, the MFD received GPS position, time and track data from the aircraft's GPS receiver. The MFD also received information from the aircraft concerning altitude, engine and electrical system parameters, and outside air temperature. This data was also stored on the unit's CF memory card.

The MFD CF card contained 103 data files. One data file was identified as being recorded during the

accident flight. The data file was approximately 39 minutes in duration.

Review of PFD and MFD Data

Review of the recorded data indicated that the airplane was initially powered up at 09:41:30 and departed OPF at 09:54:36. The airplane then climbed in an easterly direction passing north of North Miami Beach, Florida and out over the Atlantic Ocean, before turning southbound. At 10:13:36 the airplane reached a cruise altitude of 6,000 feet. Then approximately 5 minutes later at 10:18:29, while passing just to the west of Key Largo, Florida, a drop in engine rpm and an oscillation in lateral acceleration was recorded. The airplane then began to descend, turned approximately 180 degrees to the right until it was on a northeasterly heading. Moments later it turned left to a northwesterly heading while still descending, then turned right until it was above the remains of an old drainage canal and touched down with the last recorded position information occurring at 10:25:18.

Exhaust Gas Temperature (EGT) Data

Examination of the data revealed that from the time that power up occurred at 09:41:30 until the last position information was recorded at 10:25:18 that fluctuations of the No. 2 cylinder's EGT were present with fluctuations reaching a peak of approximately 1600 degrees Fahrenheit.

Tests and Research

Piston Pin Bushings

According to the owner of a local engine overhaul facility, about 6 weeks prior to the accident, the mechanic who maintained the airplane found a piece of connecting rod bushing (piston pin bushing) in the engine oil sump. When the piece was shown to personnel at the engine overhaul facility, the airplane owner and the mechanic were advised that there was a service bulletin concerning connecting rod bearings and that the engine case should be split for repair. Then when the owner of the engine overhaul shop was advised of the total time of operation that the engine had accrued, he recommended that the owner either get a major overhaul or purchase a new engine. He was then advised by the mechanic that the airplane was expected to be sold as is. Neither the mechanic, nor owner returned to the overhaul shop prior to the accident.

Service Bulletin (SB) 96-7C

According to Continental Motors Incorporated (CMI) SB96-7C, failure to torque through bolt nuts on both sides of the engine can result in a loss of main bearing "crush" with main bearing shift and subsequent engine failure.

Service Bulletin (SB) 07-1

According to Continental Motors Incorporated (CMI) SB07-1, which provided instructions for inspection of the connecting rod piston pin bushing installation, Continental had received reports of

piston pin bushing material being found in the sump or oil filter. If piston pin bushing material was recovered from an engine, all of the cylinders, pistons, and piston pins must be removed to allow access for inspection of the connecting rod piston pin bushing. Additionally the piston pin bushing must be inspected for condition each time a cylinder was removed for any reason.

Review of Maintenance Records

Review of maintenance records revealed that on December 1, 2006, the engine had received a propeller strike inspection at 927. 8 hours, and that on September 25, 2008 the engine had received a "top overhaul" utilizing CMI EQ7369 Cylinder kits. The last annual inspection was completed on December 20, 2011. At the time of the inspection, the airplane had accrued 2,888 total hours of operation. The last logbook entry was dated February 2, 2012, when an overhauled starter was installed at 2930.8 hours.

No record any other maintenance, or evidence of SB07-1 being complied with, was discovered.

Total time in service for the failed engine was 2,978.1 hours. According to the information contained in CMI SIL98-9A, time between overhauls was 2,000 hours.

Additional Information

During an interview with the flight instructor, he advised that during the preflight he discovered that the oil level was at 3 and ¾ quarts, so prior to departure, he added oil to the engine to bring it up to 5 quarts. He also advised that was the level they always serviced it to. He stated that this was based on his experience, and recommendations from the Cirrus Owners and Pilot Association (COPA), that anything over 5 quarts would blow out the breather.

The Cirrus Design SR22 Pilot's Operating Handbook and FAA Approved Airplane Flight Manual Section 4 (Normal Procedures), stated in part however; "Engine Oil …… Check 6-8 quarts".

Section 7 (Airplane Description), also contained a "Caution" which stated, "The engine should not be operated with less than six quarts of oil. Seven quarts (dipstick indication) is recommended for extended flights". Further review of section 7 also revealed that "Engine cooling is accomplished by discharging heat to the oil and then to the air passing through the oil cooler".

Review of the CMI, IO-550 Permold Series Engine Maintenance and Overhaul Manual also revealed that, with an 8 quart fill, when the airplane was in a 16 degree nose up attitude, usable oil with an 8 quart fill was 5 quarts. When the airplane was in a 10 degree nose down attitude, usable oil with an 8 quart fill was 4.5 quarts. Supplemental instructions for normal operation in the manual under "Pre-operational Requirements" also advised to; "check the oil level and verify quantity is within specified limits".

Administrative Information

Investigator In Charge (IIC):	Gunther, Todd
Additional Participating Persons:	Louis Arrazola; FAA/FSDO; Miramar, FL Brad Miller; Cirrus Design Corporation; Duluth, MN Jason Lukasik; Continental Motors Inc.; Mobile, AL Fredrick Barber; Avidyne Corporation; Lincoln, MA
Original Publish Date:	August 29, 2013
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=83084