Aviation Investigation Final Report

Location:	Coalinga, California	**Accident Number:**	WPR11LA374
Date & Time:	August 6, 2011, 19:06 Local	**Registration:**	N408FD
Aircraft:	SIAI-Marchetti F.260	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (partial)	**Injuries:**	4 Minor
Flight Conducted Under:	Part 91: General aviation		

Analysis

The day before the accident, the pilot flew himself and his family to an airport about 275 miles away for the purpose of positioning the airplane for filming. The airplane was flown by another pilot during that filming, which was accomplished on the day of the accident. After the filming, the airplane was fueled, and the pilot and his family departed on their return trip. En route to the destination, the pilot diverted to another airport because one of the children did not feel well. They spent about 20 minutes at that airport, and then re-boarded the airplane to complete the trip. Engine start, runup, and the takeoff roll were normal, but when the airplane was about 100 feet above ground level, the engine began to lose power. The pilot pushed the nose down to maintain his target airspeed, but the airplane continued to decelerate. The pilot then landed straight ahead in a plowed field off the end of the runway. Initial examination of the airplane and engine did not reveal any preimpact discrepancies that would have precluded continued flight.

Normal procedures call for the takeoff to be conducted with the electric fuel boost pumps operating and then switched off during the climb. The pilot reported that the boost pump switch was on for takeoff and that he did not turn it off before the engine power loss. Postaccident engine test runs revealed that the engine would not run at high rpm without the boost pumps operating. Further examination and testing revealed that a fuel check valve, designed to ensure sufficient fuel flow to the carburetor when the fuel boost pumps were not operating, did not function properly due to a deteriorated gasket. As a result, fuel from the engine driven pump could be pumped back into the fuel tanks instead of into the carburetor. Although the engine test runs demonstrated that, due to the failed check valve, the engine would not run at high rpm without the electric boost pumps, the investigation was unable to determine why the deteriorated check valve did not manifest itself on previous flights. Because the pilot reported that he did not turn off the boost pumps on the accident flight, the defective check valve likely did not cause the loss of engine power.

A chart for carburetor icing potential indicated that conditions were conducive to icing at glide and

cruise power. Even if the airplane had developed carburetor ice on the approach, it is likely that the 20 minutes spent on the ground, at an ambient air temperature of 33 degrees, would have melted that ice. The fact that the power loss occurred with the engine at takeoff power suggested that while takeoff carburetor ice might have been possible, it was not likely. The temporary nature of carburetor ice, combined with the fact that the airplane was not examined in detail immediately subsequent to the accident, precluded the investigation from determining whether carburetor icing was present at the time of the power loss.

Finally, because the fuel quantities in the low-wing airplane were relatively low, the resultant head pressure in the fuel lines would be low. This, in combination with the hot engine and the 20-minute ground time on a hot ramp at an airport with an ambient temperature of 33 degrees C, could have precipitated partial or full vapor lock in the fuel system, which did not manifest itself until the takeoff demanded full power and maximum fuel flow. The investigation was not able to determine whether the source of the power loss was fuel system vapor lock or carburetor ice.

Probable Cause and Findings

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

A partial loss of engine power immediately after takeoff for undetermined reasons.

Findings

Not determined	(general) - Unknown/Not determined
Aircraft	(general) - Malfunction

Factual Information

History of Flight

Initial climb	Loss of engine power (partial) (Defining event)
Initial climb	Off-field or emergency landing

HISTORY OF FLIGHT

On August 6, 2011, about 1906 Pacific daylight time, a SIAI Marchetti F.260, N408FD, was substantially damaged during an off-field forced landing immediately after takeoff from Harris Ranch Airport (3O8), Coalinga, California. The airline transport pilot and the three passengers received minor injuries. The business flight was operated under the provisions of Title 14 Code of Federal Regulations Part 91. Visual meteorological conditions prevailed, and no flight plan was filed.

The airplane was operated by Attitude Aviation, based at Livermore Airport (LVK), Livermore, CA. According to the pilot, he, his wife, and their two daughters flew in the airplane from LVK to Van Nuys Airport (VNY) Van Nuys, CA the day prior to the accident, for the purpose of positioning the airplane for filming. The airplane was flown by another pilot during that filming, which was accomplished on the day of the accident. Once the filming was completed, the airplane was fueled, and the pilot and his family departed VNY for LVK. En route to LVK, the pilot diverted to 3O8 because one of his daughters did not feel well. They spent about 20 minutes at 3O8, and then re-boarded the airplane for the leg to LVK. No fuel was uploaded to the airplane at 3O8.

The pilot stated that engine start, runup, and the takeoff roll on runway 14 were normal. When the airplane was about 100 feet above ground level, the pilot selected the landing gear to the 'up' position, and about the same time, he noticed that the engine seemed to lose power. He pushed the nose down to maintain a target airspeed of 100 knots, but the airplane continued to decelerate. He then selected the landing gear to the 'down' position, and decided to land straight ahead off-airport, since he did not believe that the airplane was capable of continued flight. The airplane came to rest upright, about 600 feet beyond the departure end of the runway.

PERSONNEL INFORMATION

According to Federal Aviation Administration (FAA) records, the pilot also held a flight instructor certificate, with ratings for single- and multi-engine airplane, and instrument airplane. His most recent FAA first-class medical certificate was issued in January 2011. The pilot reported a total flight experience of 5,900 hours, including 200 hours in the accident airplane make and model.

AIRCRAFT INFORMATION

According to FAA information, the airplane was manufactured in 1973, and was equipped with a Lycoming O-540 series engine.

The airplane was equipped with four separate fuel tanks, with a total capacity of 62 gallons. The engine was equipped with an engine-driven fuel pump. The fuel system design and as-found configuration incorporated two electric boost pumps plumbed in parallel with one another, and in series with (prior to) the engine driven pump. The two electric boost pumps were activated by a single cockpit switch. A check valve was installed in the engine compartment, between the pressure side of the fuel boost pumps and the engine-driven fuel pump. The purpose of this valve was to prevent the fuel from the engine-driven pump from returning to the fuel tank(s), instead of being supplied to the carburetor, when the boost pumps are not operating.

A review of the maintenance records indicated that the engine was overhauled in 1990, when it had accumulated about 640 hours in service. No significant problems with the fuel system were documented. As of the most recent annual inspection in April 2011, the airplane and engine had accumulated a total time in service of about 1,756 hours.

METEOROLOGICAL INFORMATION

The 1856 automated weather observation at an airport 15 miles east of 3O8 included winds from 360 degrees at 7 knots, temperature 33 degrees C, dew point 14 degrees C, and an altimeter setting of 29.83 inches of mercury.

When the intersection of the ambient air temperature and dew point values was located on a chart that depicted carburetor ice envelopes, the point was in the envelope labeled "Icing at Glide and Cruise Power."

AIRPORT INFORMATION

FAA information indicated that the 3O8 runway measured 30 feet wide by 2,820 feet long, with an elevation of 470 feet.

WRECKAGE AND IMPACT INFORMATION

After the accident, the airplane was essentially intact, with the exception of the landing gear, propeller, lower cowl, and portions of the wings and tip tanks. The airplane and engine were not examined in detail on scene. On-scent post-accident photographs indicated that the fuel selector valve was set to the left main tank. All four fuel tank caps were properly installed, and only the left tip tank had been breached by impact.

According to recovery personnel, the following approximate quantities of fuel were observed in the four tanks: Left tip 0 gallons (empty); Left main 12 gallons; Right main 4 gallons; Right tip 3 gallons. Some fuel was present in the gascolator, and water detection paste did not indicate the presence of water in that fuel. About 7 fluid ounces of fuel were recovered from the carburetor.

A detailed examination of the airframe and engine was conducted after the airplane had been partially disassembled (wings removed) and transported to a secure facility. Examination of the airframe did not reveal any pre-accident conditions or failures that could have contributed to the loss of engine power.

The overall appearance of the engine was clean and consistent with normal use and operation; no visual abnormalities were observed. With the exception of the carburetor heat cable and door, all engine cables,

lines, and wires were intact and undisturbed. The magnetos and all other accessories were securely mounted to the engine. The dipstick indicated that the engine contained 9 quarts of oil. The interior surfaces of the two exhaust pipes were nearly white; the coating was thin and did not wipe off easily by hand.

All 6 top spark plugs were removed; all electrodes were clean and gray-white in color, and the engine was rotated easily by hand. Thumb compressions and valve train motion was verified on all cylinders.

ADDITIONAL INFORMATION

Engine Run

Based on the engine condition and observations, it was decided to test run the engine on the airframe. The damaged carburetor air box was removed, and the top spark plugs were reinstalled. The damaged propeller was removed and replaced with an undamaged propeller. A temporary fuel container, located about mid-fuselage height, was plumbed into one of the airplane fuel lines on the left side.

An engine start using the airplane's battery and checklist was attempted; the engine rotated slightly but then stopped due to apparent lack of battery power. An auxiliary power supply was connected to the battery, and the engine started successfully. Engine instrument indications appeared normal; the engine smoothed out after about 20 seconds, and idled normally at about 1,000 rpm. The throttle was advanced to about 1,400 rpm, and shortly thereafter the engine stumbled and then stopped running. Total run time was estimated to be about 90 to 120 seconds.

No specific reasons for the stoppage were determined. A re-check of the fuel pressure with the electric boost pump switch on suggested that the pumps were not getting fuel, since a different pump sound was produced before and after the run, and 0 psi was observed on the fuel pressure gauge. The fuel shutoff cock and the fuel selector valve were cycled and returned to their normal positions while the electric boost pump switch was on, until the pump noise changed, and the fuel pressure rose to and stabilized at a pressure of about 6 psi.

The engine was re-started, and was run successfully to about 1,900 rpm, with a manifold pressure of about 29 inches of mercury. A magneto check indicated that the engine ran well on either magneto. With the engine operating between 1,500 and 1,900 rpm, switching off the electric boost pump switch resulted in an immediate decrease in fuel pressure. When the boost pumps were switched on, the fuel pressure returned to normal. When the boost pumps were left off, the engine ceased operation. These procedures were repeated several times, with similar results.

Engine-Driven Fuel Pump

The engine-driven fuel pump was removed and retained by the NSTB for further evaluation. The engine internal push rod which drove the engine-driven fuel pump was observed to be in place and appeared undamaged. Manual rotation of the engine resulted in motion of the push rod, which was determined by both visual and tactile observations. Testing of the engine-driven pump at the engine manufacturer's facility verified proper operation of that pump.

Fuel System Check Valve

The engine test runs and engine-driven fuel pump test results prompted a functional test and evaluation of the check valve installed between the pressure side of the fuel boost pumps and the engine-driven fuel pump. The purpose of the check valve is to ensure sufficient fuel flow to the carburetor by the engine-driven fuel pump when the boost pumps are not operating.

Examination of the airplane revealed that the valve was installed in the proper orientation. The airplane maintenance manual did not contain any instructions regarding inspection, testing, or maintenance of the valve. No records of valve replacement were located. The checklist used for the most recent (April 2011) annual inspection included an item "vapor return line and check valve," and the line item was initialed by the technician, but no further definition or details regarding that line item were available.

In response to NTSB inquiry, the type certificate (TC) holder (Alenia-Aermacchi) indicated that no specific maintenance actions regarding the subject check valve are required, but that during the 50- and 100-flight hour periodic inspections, a general inspection for fuel and oil leaks is required. The TC holder noted that no Service or Alert Bulletins have been issued for the valve. In addition, the TC holder reported that no valve-specific service difficulty information is known to them regarding "civil F260 aircraft."

On-airplane testing of the check valve revealed that it did not function properly; fluids (both air and 100LL avgas) were able to flow in either direction through the valve. The valve was removed from the airplane and examined. The valve mechanism was of the spring loaded 'flapper' or 'gate' type. A fine-wire coil spring provided the closing force. The spring was intact. A flexible O-ring-type gasket was affixed to a metal disc on the flapper, and that flapper assembly seated against the lip of an orifice/passage through the valve body cap. The gasket was not cracked or broken. Visual and dimensional checks indicated that the gasket did not contact the valve seat as intended; instead, the metal flapper disc made contact with the valve seat. The valve seat and the metal flapper disc both exhibited discolorations and light scoring consistent with metal-to-metal contact over a period of time.

In December 2001, the valve manufacturer issued a document which provided guidance regarding the life of "soft seals." The guidance was applicable to components whose life was not specified by "part specification, aircraft manufacturer or contract." The document recommended that "the shelf life of a new or overhauled unit be 5 years maximum," and 2 years "for repaired units." Once the shelf life has been met, "the unit should be tested and re-certified before placing into service. After 10 years (5 years for repaired items), replacement of all soft seals is recommended."

Detailed information can be found in the NTSB public docket for this accident.

Engine Monitor Data

The airplane was equipped with a JPI EDM-700 engine monitor which sensed and recorded engine exhaust gas temperature (EGT) and cylinder head temperature (CHT) values for each of the 6 cylinders. The unit also recorded battery voltage. Sample rate was set to 10 samples per minute; data for each of the cylinders (plus the battery) was captured every 6 seconds.

The EDM recording contained approximately 22 flights or power cycles, dating back to July 21, 2011. After the last flight there were 7 short power cycles of the event unit, including the engine test runs. The EDM data included a date and time stamp based on the unit's internal clock. That clock was set and

updated by the operator, was not synchronized to any external time source, and only advanced when the unit was operating.

Aside from an intermittent EGT data problem with the No. 4 cylinder, no anomalies were observed in the EDM data from the inbound flight, the accident flight, or the engine test runs. Comparisons of the EGT and CHT decrease rates for the engine shutdown and the power loss event did not yield any information regarding possible reasons for the power loss.

Vapor Lock

The Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25A) defines vapor lock as a "problem that mostly affects gasoline-fuelled internal combustion engines. It occurs when the liquid fuel changes state from liquid to gas while still in the fuel delivery system. This disrupts the operation of the fuel pump, causing loss of feed pressure to the carburetor ..., resulting in transient loss of power or complete stalling. ...The fuel can vaporize due to being heated by the engine, [or] by the local climate ..." The possibility of vapor lock increases with decreasing ambient or line pressure and increasing temperature.

Pilot Information

Certificate:	Airline transport; Commercial; Private	**Age:**	36
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	3-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	January 11, 2011
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	December 18, 2010
Flight Time:	(Estimated) 5900 hours (Total, all aircraft), 200 hours (Total, this make and model), 5800 hours (Pilot In Command, all aircraft), 200 hours (Last 90 days, all aircraft), 30 hours (Last 30 days, all aircraft), 4 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	SIAI-Marchetti	**Registration:**	N408FD
Model/Series:	F.260	**Aircraft Category:**	Airplane
Year of Manufacture:	1973	**Amateur Built:**	
Airworthiness Certificate:	Aerobatic; Utility	**Serial Number:**	2-61
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:	April 4, 2011 Annual	**Certified Max Gross Wt.:**	2430 lbs
Time Since Last Inspection:	57 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	1829 Hrs at time of accident	**Engine Manufacturer:**	Lycoming
ELT:	Installed, activated, did not aid in locating accident	**Engine Model/Series:**	O-540
Registered Owner:	Tomcat Aviation	**Rated Power:**	280 Horsepower
Operator:	Attitude Aviation	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KNLC,232 ft msl	**Distance from Accident Site:**	15 Nautical Miles
Observation Time:	18:56 Local	**Direction from Accident Site:**	90°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	7 knots /	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:	360°	**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	29.82 inches Hg	**Temperature/Dew Point:**	33°C / 14°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Coalinga, CA (3O8)	**Type of Flight Plan Filed:**	None
Destination:	Livermore, CA (LVK)	**Type of Clearance:**	None
Departure Time:	19:06 Local	**Type of Airspace:**	

Airport Information

Airport:	Harris Ranch 3O8	**Runway Surface Type:**	Asphalt
Airport Elevation:	470 ft msl	**Runway Surface Condition:**	Dry;Rough;Soft
Runway Used:	14	**IFR Approach:**	None
Runway Length/Width:	2820 ft / 30 ft	**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	3 Minor	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	4 Minor	**Latitude, Longitude:**	36.248054,-120.238334(est)

Administrative Information

Investigator In Charge (IIC):	Huhn, Michael
Additional Participating Persons:	Joshua Brown; FAA FSDO; Fresno, CA Mark Platt; Lycoming Engines; Williamsport, PA
Original Publish Date:	October 9, 2014
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=81409