National Transportation Safety Board
Aviation Accident Final Report

Location:	Las Cruces, NM	**Accident Number:**	CEN14FA462
Date & Time:	08/27/2014, 1903 MDT	**Registration:**	N51RX
Aircraft:	CESSNA 421C	**Aircraft Damage:**	Destroyed
Defining Event:	Aircraft servicing event	**Injuries:**	4 Fatal
Flight Conducted Under:	Part 135: Air Taxi & Commuter - Non-scheduled - Air Medical (Medical Emergency)		

Analysis

According to the line service technician who worked for the fixed-base operator (FBO), before taking off for the air ambulance flight with two medical crewmembers and one patient onboard, the pilot verbally asked him to add 40 gallons of fuel to the airplane, but the pilot did not specify the type of fuel. The line service technician drove a fuel truck to the front of the airplane and added 20 gallons of fuel to each of the multiengine airplane's wing tanks. The pilot was present during the refueling and helped the line service technician replace both fuel caps.

Shortly after takeoff, a medical crewmember called the company medical dispatcher and reported that they were returning to the airport because smoke was coming from the right engine. Two witnesses reported seeing smoke from the airplane Several other witnesses reported seeing or hearing the impact and then immediately seeing smoke or flames.

On-scene evidence showed the airplane was generally eastbound and upright when it impacted terrain. A postimpact fire immediately ensued and consumed most of the airplane. Investigators who arrived at the scene the day following the accident reported clearly detecting the smell of jet fuel.

The airplane, which was equipped with two reciprocating engines, should have been serviced with aviation gasoline, and this was noted on labels near the fuel filler ports, which stated "AVGAS ONLY." However, a postaccident review of refueling records, statements from the line service technician, and the on-scene smell of jet fuel are consistent with the airplane having been misfueled with Jet A fuel instead of the required 100LL aviation gasoline, which can result in detonation in the engine and the subsequent loss of engine power. Postaccident examination of the engines revealed internal damage and evidence of detonation. It was the joint responsibility of the line technician and pilot to ensure that the airplane was filled with aviation fuel instead of jet fuel and their failure to do so led to the detonation in the engine and the subsequent loss of power during initial climb.

In accordance with voluntary industry standards, the FBO's jet fuel truck should have been equipped with an oversized fuel nozzle; instead, it was equipped with a smaller diameter nozzle, which allowed the nozzle to be inserted into the smaller fuel filler ports on airplanes that used aviation gasoline. The FBO's use of a small nozzle allowed it to be inserted in the accident airplane's filler port and for jet fuel to be inadvertently added to the airplane.

Probable Cause and Findings

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

The misfueling of the airplane with jet fuel instead of the required aviation fuel, and the resultant detonation and a total loss of engine power during initial climb. Contributing to the accident were the line service technician's inadvertent misfueling of the airplane, the pilot's inadequate supervision of the fuel servicing, and the fixed-base operator's use of a small fuel nozzle on its jet fuel truck.

Findings

Aircraft	Fuel - Fluid type (Cause)
	Fuel - Incorrect service/maintenance (Cause)
	Engine (reciprocating) - Damaged/degraded (Cause)
Personnel issues	Lack of action - Pilot (Factor)
	Use of equip/system - Airport personnel (Factor)
	Incorrect action selection - Airport personnel (Factor)
Environmental issues	Fuel service/equipment - Awareness of condition (Factor)
	Fuel service/equipment - Effect on equipment (Factor)
	Fuel service/equipment - Contributed to outcome (Factor)

Factual Information

History of Flight

Prior to flight	Aircraft servicing event (Defining event)
Initial climb	Loss of engine power (partial)
Emergency descent	Loss of engine power (total) Collision with terr/obj (non-CFIT)
Post-impact	Part(s) separation from AC Roll over Cabin safety event Explosion (post-impact) Fire/smoke (post-impact)

On August 27, 2014, about 1903 mountain daylight time, a Cessna 421C airplane, N51RX, impacted terrain during initial climb near Las Cruces International Airport (LRU), Las Cruces, New Mexico. The pilot, two medical crewmembers, and one patient were fatally injured. The airplane was destroyed. The airplane was registered to Elite Medical Air Transport, LLC, El Paso, Texas, and was operated by Amigos Aviation, Inc., Harlingen, Texas, as a 14 Code of Federal Regulations Part 135 air ambulance flight. Day visual meteorological conditions prevailed at the time of the accident at the accident site, and an instrument flight rules flight plan had been filed. The airplane departed LRU destined for Phoenix Sky Harbor International Airport (PHX), Phoenix, Arizona.

The airplane arrived at LRU about 1822 to load the patient for a flight to PHX. According to the line service technician who worked for the fixed-base operator (FBO), both engines were shut down and the pilot was still seated in the cockpit when he asked the technician to add 40 gallons of fuel to the airplane; the pilot did not specify the type of fuel. The line service technician drove a fuel truck to the front of the airplane and then added 20 gallons of fuel to each wing tank. The pilot then helped the line service technician replace both fuel caps. The line service technician then printed the fuel ticket, which the pilot signed.

At 1901:45, shortly after departure, a medical crewmember onboard the airplane called the company medical dispatcher and reported that the flight was returning to LRU because smoke was coming from the right engine. A witness driving on the interstate highway near the airport reported seeing the airplane flying about 200 ft. above ground level (agl) with smoke coming from the right engine. The airplane then began descending and entered a left turn. Another witness driving on the highway reported seeing smoke trailing from the airplane when it passed over him about 100 ft. agl. He saw the descending airplane continue to turn left and then lost sight of it. Several other witnesses reported seeing or hearing the impact and then immediately seeing smoke or flames.

Pilot Information

Certificate:	Airline Transport	**Age:**	29, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Without Waivers/Limitations	**Last FAA Medical Exam:**	10/28/2013
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	05/15/2014
Flight Time:	(Estimated) 2432 hours (Total, all aircraft), 52 hours (Last 90 days, all aircraft), 22 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Pilot

The pilot held a Federal Aviation Administration (FAA) airline transport pilot certificate with airplane single-engine land and multiengine land ratings. He also held an FAA flight instructor certificate with airplane single-engine, multiengine, and instrument airplane ratings. The pilot was issued an FAA first-class airman medical certificate with no limitations on October 28, 2013.

The pilot's personal logbooks were not available for examination. Based on FAA records, pilot training documents, and other records from Amigos Aviation, the pilot's flight experience was estimated to be 2,432 total flight hours, of which 1,553 hours were in multiengine airplanes and about 1,379 hours were in Cessna 421 airplanes.

Line Service Technician

The line service technician had been employed by the FBO since April 7, 2014. He stated that he had no previous work experience in aviation, he did not hold an FAA airman certificate of any kind, and he was not a pilot or an aircraft mechanic. FBO records showed he had completed its on-job-training program and been issued an American Petroleum Institute Class C training certificate. At the time that he refueled the airplane, he was the only FBO employee on duty.

Aircraft and Owner/Operator Information

Aircraft Make:	CESSNA	**Registration:**	N51RX
Model/Series:	421C	**Aircraft Category:**	Airplane
Year of Manufacture:	1980	**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	421C0871
Landing Gear Type:	Retractable - Tricycle	**Seats:**	
Date/Type of Last Inspection:	03/05/2014, Annual	**Certified Max Gross Wt.:**	7450 lbs
Time Since Last Inspection:		**Engines:**	2 Reciprocating
Airframe Total Time:	8181 Hours as of last inspection	**Engine Manufacturer:**	Lycoming
ELT:	C91A installed, not activated	**Engine Model/Series:**	GTSIO-520-L
Registered Owner:	ELITE MEDICAL AIR TRANSPORT LLC	**Rated Power:**	375 hp
Operator:	AMIGOS AVIATION INC	**Operating Certificate(s) Held:**	On-demand Air Taxi (135)
Operator Does Business As:	AMIGOS AVIATION INC	**Operator Designator Code:**	VWYA

The low-wing, retractable-landing-gear, pressurized, multiengine airplane, serial number (S/N) 421C0871, was manufactured in 1981. It was powered by two 375-horsepower Continental Motors GTSIO-520-L turbo-charged engines. Engine S/N 292408 was installed on the left side, and engine S/N 292022 was installed on the right side. Each engine drove a three-bladed, variable pitch, full-feathering McCauley propeller.

A review of the aircraft maintenance records showed that an annual inspection had been completed on March 5, 2014, at an aircraft total time of 8,181.4 hours and an hour meter reading of 869.6 hours. A maintenance logbook entry dated August 24, 2014, showed the hour meter reading was 904.3 hours. FAA records showed that the airplane had been registered to Elite Medical Air Transport, LLC since April 15, 2010.

The airplane was equipped with Micro Aerodynamics vortex generators, which were installed in accordance with FAA-approved Supplemental Type Certificate SA5193NM.

Preaccident photographs of the airplane showed labels near the fuel filler ports that had black letters on a white background and stated, in part, "AVGAS ONLY." A postaccident review of refueling records and statements from the line service technician revealed that the airplane had been misfueled with 40 gallons of Jet A fuel instead of the required 100LL aviation gasoline.

The airplane was not equipped with, and was not required to be equipped with, either a cockpit voice recorder or a flight data recorder.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	KLRU, 4456 ft msl	**Distance from Accident Site:**	4 Nautical Miles
Observation Time:	1855 MDT	**Direction from Accident Site:**	64°
Lowest Cloud Condition:	/ 6500 ft agl	**Visibility**	10 Miles
Lowest Ceiling:	Broken / 6500 ft agl	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	40°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.16 inches Hg	**Temperature/Dew Point:**	-9°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Las Cruces, NM (LRU)	**Type of Flight Plan Filed:**	IFR
Destination:	PHOENIX, AZ (PHX)	**Type of Clearance:**	None
Departure Time:	1900 MDT	**Type of Airspace:**	Class G

At 1855, the automated weather observing system at LRU, located about 4 miles northeast of the accident location, reported wind from 040° at 5 knots, visibility of 10 miles, broken clouds at 6,500 ft., temperature 23°C, dew point 16°C , and an altimeter setting of 30.16 inches of m ercury.

Airport Information

Airport:	LAS CRUCES INTL (LRU)	**Runway Surface Type:**	Asphalt
Airport Elevation:	4456 ft	**Runway Surface Condition:**	Dry
Runway Used:	26	**IFR Approach:**	None
Runway Length/Width:	6069 ft / 100 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	3 Fatal	**Aircraft Fire:**	On-Ground
Ground Injuries:	N/A	**Aircraft Explosion:**	Unknown
Total Injuries:	4 Fatal	**Latitude, Longitude:**	32.255833, -106.982222 (est)

The airplane impacted desert grasslands operated by the United States Bureau of Land Management at a terrain elevation of about 4,420 ft. mean sea level. On-scent evidence showed that the airplane was generally eastbound and upright when it impacted terrain, which resulted in the separation of the left propeller blades and right aileron. The airplane came to rest inverted about 78 ft. east of the initial impact point on a wreckage debris path of about 93°, and an immediate postimpact fire consumed most of the airplane. The nose of the inverted fuselage was oriented to about 160°. All major components of the airplane were observed and accounted for at the scene. Investigators who arrived at the scene on the day following the accident reported clearly detecting the smell of jet fuel.

Both engines, most of the left wing, the inboard portion of the right wing, and all of the tail surfaces remained attached to the fuselage. The right aileron was completely separated from the airplane and came to rest about 55 ft. to the southeast of the main wreckage.

Control cable continuity was confirmed from the cockpit to the respective flight control surfaces except for cable separations consistent with either cable cuts by first responders or tensile overload. Thermal and impact damage prevented an assessment of any of the cockpit instruments.

The left aileron trim actuator extension was measured, and it was about 1/4 inch, which corresponded to a setting of about 21° trim tab trailing edge down (airplane nose up). The left and right elevators remained attached to their respective horizontal attachment points. The right elevator trim tab remained attached to the right elevator. The right elevator trim actuator extension was measured, and it was 11/16 inch, which corresponded to a setting of about 21° trim tab trailing edge down.

The rudder remained attached to the vertical stabilizer attachment points, and the rudder trim tab remained attached to the rudder. The rudder trim actuator extension was measured, and it was 2 1/4 inches, which corresponded to a neutral rudder trim position. Measurements of the flap mechanism corresponded to a flap extension of about 9° flaps down. All three landing gear assemblies remained attached and appeared to be in the retracted position.

The left propeller hub remained attached to the left engine crankshaft propeller flange; however, all three propeller blades were completely separated from the propeller hub. The propeller blade marked as "1" was found 502 ft. southwest of the main wreckage; the propeller blade marked as "2" was found 285 ft. east of the main wreckage; and the propeller blade marked as "3" was found 55 ft. southeast of the main wreckage. None of the propeller blades exhibited significant twisting, leading edge gouges, or chordwise scratches; however, the outer

12 inches of the No. 2 blade was bent toward the camber side, and the outer 8 inches of the No. 3 blade was bent toward the camber side.

The right propeller assembly remained attached to the right engine crankshaft propeller flange, and all three blades remained attached to the propeller hub. The propeller blade marked as "A" exhibited no significant twisting, leading edge gouges, or chordwise scratches. The propeller blade marked as "B" was melted into two sections about 16 inches from the blade root. The propeller blade marked as "C" exhibited no significant twisting, leading edge gouges, or chordwise scratches; however, the outer last 14 inches of the blade was bent toward the noncamber side.

The fuel caps were found securely fastened to their fuel tank filler ports. The fuel caps were then removed, and it was observed that the filler ports had been modified with smaller restrictive inserts about 2 inches in diameter that would prevent insertion of a larger refueling nozzle.

The engines were removed for further examination.

Medical And Pathological Information

The University of New Mexico Health Sciences Center, Office of the Medical Investigator, Albuquerque, New Mexico, conducted an autopsy of the pilot. The cause of death was listed as "thermal injuries, inhalation of products of combustion and blunt thoracoabdominal trauma."

The FAA's Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, conducted forensic toxicology testing on specimens from the pilot. The toxicology report stated that no listed drugs were detected in urine. The toxicology testing detected 17 ml/hg ethanol was detected in the urine, and an unquantified amount of n-propanol was detected in the urine. No ethanol was detected in blood or liver. Such low levels of ethanol are likely produced postmortem, particularly when not detected in the blood.

Tests And Research

Left Engine Examination

Examination of the left engine revealed that it exhibited significant fire and impact damage. The oil cooler, induction system, and intercooler were partially melted by the postcrash fire. All of the engine accessories were impact and thermally damaged. The right magneto case was melted, exposing the internal components. Both magnetos cases were melted, and only the rotating magnet remained attached to the engine. The fuel pump was thermally damaged and remained attached to the engine, and the drive coupling was intact. The alternator and propeller governor were thermally damage and remained attached to the engine. The

remainder of the external surfaces of the engine exhibited varying degrees of impact and thermal damage.

All of the internal components of the left engine exhibited thermal damage but no signs of lubrication distress. The cylinders exhibited heat damage and evidence of detonation. All pistons exhibited scuffing and heat signatures on the skirt. The Nos. 2, 5, and 6 pistons showed evidence of detonation on the face of the piston with portions melted away on the outer edge.

The main and rod bearings exhibited normal operating signatures and thermal damage from the postcrash fire. The crankshaft, camshaft, gears, connecting rods, and reduction gears all exhibited thermal damage and normal operating signatures. The crankcase exhibited normal operating signatures and impact and thermal damage. The fuel system components were impact and fire damaged. The engine accessories were intact and exhibited thermal damage.

Right Engine Examination

Examination of the right engine revealed that it exhibited significant fire and impact damage. The induction system and intercooler were separated. All of the engine accessories were impact and thermally damaged. The right magneto case was melted, exposing the internal components. The left magneto remained attached but exhibited thermal damage. The fuel pump was thermally damaged and remained attached to the engine. The drive coupling was intact. The alternator and propeller governor were thermally damaged and remained attached to the engine. The remainder of the external surfaces of the engine exhibited varying degrees of impact and thermal damage.

All the internal components of the right engine exhibited thermal damage due to the postcrash fire but no signs of lubrication distress. The cylinders exhibited heat damage and evidence of detonation. All pistons exhibited scuffing and heat signatures on the skirt. The Nos. 1, 2, and 5 pistons showed evidence of detonation on the face of the piston with portions melted away on the outer edge.

The main and rod bearings exhibited normal operating signatures and thermal damage from the postcrash fire. The crankshaft, camshaft, gears, connecting rods, and reduction gears all exhibited normal operating signatures. The crankcase exhibited normal operating signatures and impact and thermal damage. The fuel system components were impact and fire damaged with portions melted away. The engine accessories were intact and exhibited thermal damage. Only portions of the induction system remained attached to the right engine; the remainder was melted away by the postcrash fire.

Additional Information

Federal Guidance

According to the FAA Pilot Handbook of Aeronautical Knowledge, page 6-19:

Detonation is an uncontrolled, explosive ignition of the fuel/air mixture within the cylinder's combustion chamber. It causes excessive temperatures and pressures which, if not corrected, can quickly lead to failure of the piston, cylinder, or valves. In less severe cases, detonation causes engine overheating, roughness, or loss of power."

According to the FAA Airframe & Powerplant Mechanics Powerplant Handbook, AC 65-12A, Chapter 10,

Unless detonation is heavy, there is no cockpit evidence of its presence. Light to medium detonation may not cause noticeable roughness, observable cylinder head or oil temperature increase, or loss of power. However, when an engine has experienced detonation, we see evidence of it at teardown as indicated by dished piston heads, collapsed valve heads, broken ring lands or eroded portions of valves, pistons and cylinder heads. Severe detonation can cause a rough-running engine and high cylinder head temperature."

According to FAA Advisory Circular (AC) 20-122A, "Anti-Misfueling Devices: Their Availability and Use," paragraph 6.1 , "Aviation statistics indicate that the use of improper fuel has caused or contributed to an inordinate number of accidents and incidents. Most of these have involved single-engine aircraft (and some multiengine) that were misfueled with jet or turbine engine fuel instead of gasoline, which these aircraft use. Misfueling a reciprocating engine-powered aircraft with jet...fuel can and has produced catastrophic results when engines failed during the critical takeoff phase of flight."

Paragraph 6.3, states, "Fuel tank filler openings in reciprocating engine-powered aircraft may be equipped with pilot-installed adapter rings reducing the opening size from 3 inches to 2.3 inches in diameter. Jet or turbine engine fuel nozzle assemblies will be equipped with spouts with a minimum diameter of 2.6, thereby reducing the probability of introducing jet or turbine engine fuel nozzles into the filler openings of aircraft requiring gasoline."

Paragraph 7.3, states, in part, "in the interest of safety and standardization, it is recommended that Fixed Base Operators...equip their turbine fueling equipment...with the larger size nozzles...to prevent misfuelling."

According to FAA AC 150/5230-4B "Aircraft Fuel Storage, Handling, Training, and Dispensing on Airports," page 1, Paragraph 3, "Application," "This AC provides an acceptable means of complying with Title 14 Code of Federal Regulations (CFR) part 139 (hereinafter referred to as Part 139) for all Part 139 airport operators. Although non-certificated airports are not required to develop fuel standards, the FAA recommends these airports use the guidance contained in this AC to develop such standards for the continued enhancement of aviation safety."

Page 7, chapter 2, paragraph 1, e, states, "14 CFR §139.321 (b) places the responsibility of determining standards for fueling safety on the individual airport based on state, local, or municipality fueling regulations. The FAA does not intend this AC to replace airport procedures that are tailored to meet requirements imposed because of the use of special equipment or as a result of local regulations."

Industry Guidance

In 2005 , the Aircraft Owners and Pilots Association Air Safety Foundation issued Safety Brief Number 4 SB04-07/05, "Misfueling." The safety brief cautioned about the dangers of misfueling and recommended that pilots specify the fuel type and grade when ordering fuel, be present at the refueling and actively observe the fueling process, match the fuel truck color coding with the wing fueling decal, confirm that the fuel nozzle is compatible with the aircraft's fuel filler, and confirm that the fuel grade on the invoice matches the fuel grade ordered.

The July/August 2006 issue of National Air Transportation Association's "NATA Safety 1st eToolkit," Page 1, "Aircraft Misfueling – A Continuing Threat," recommended that an effective misfueling prevention program should be adopted into the standard practices at all fueling operations and that the prevention program should include the following: "Training; Grade Confirmation; Written Fuel Order Forms; Grade Decals for Aircraft and Fueling Equipment; Selective Nozzle Spouts; and Fuel Receipt Quality Control Procedures."

In March 2016, the NTSB issued a Safety Alert SA-050 "Pilots: Fueling Mistakes." The General Aviation Safety Alert cautioned pilots on the dangers of misfueling and gave several recommended preventive safety procedures.

In March 2016, the NTSB issued a Safety Alert SA-051 "Line Personnel: Fueling Matters". The General Aviation Safety Alert cautioned line personnel on the dangers of misfueling and gave several recommended preventive safety procedures.

In January 2017, the Energy Institute issued Publication EI 1597, "Procedures for Overwing Fueling to Ensure Delivery of the Correct Fuel Grade to an Aircraft," 2nd edition. The publication included recommended procedures for confirmation of the proper fuel grade, wing decals, fuel grade confirmation forms, use of selective nozzle spouts, fueling procedures, control of unattended fuelings, control of self-service fuelings, grade identification markings for refueling equipment, and training.

Administrative Information

Investigator In Charge (IIC):	Thomas Latson	**Report Date:**	05/03/2017
Additional Participating Persons:	John R DeWitt; FAA Albuquerque FSDO; Albuquerque, NM Ernest C Hall; Textron Aviation; Wichita, KS Michael Council; Continental Motors Inc; Mobile, AL Rick Roper; Ram Aircraft, LP; Waco, TX		
Publish Date:	05/03/2017		
Note:	The NTSB traveled to the scene of this accident.		
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=89965		