Aviation Investigation Final Report

Location:	Santa Monica, California	**Accident Number:**	WPR15FA121
Date & Time:	March 5, 2015, 14:22 Local	**Registration:**	N53178
Aircraft:	RYAN AERONAUTICAL ST3KR	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	1 Serious
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

Shortly after takeoff, the pilot advised the air traffic control tower controller that the engine had lost power, and the pilot requested an immediate return to the airport. The pilot initiated a left turn toward the airport; however, during the approach, he realized that the airplane was unable to reach the runway. Subsequently, the airplane struck the top of a tree and then impacted the ground in an open area of a golf course.

A postaccident examination of the airplane's engine revealed that the carburetor's main metering jet was unscrewed from its seat and rotated 90 degrees. The unseated jet would have allowed an increased fuel flow through the main metering orifice, producing an extremely rich fuel-to-air ratio, which would have resulted in the loss of engine power. It is likely that, over time, the jet gradually loosened from its seat, which allowed it to eventually rotate 90 degrees. No further mechanical failures or malfunctions were revealed that would have precluded normal operation.

A review of the airplane's maintenance records indicated that the carburetor was rebuilt during the airplane's restoration about 17 years before the accident. The carburetor maintenance instruction manual contained no pertinent instructions for the installation of the jet assemblies. Further, no maintenance entries in the engine logbook regarding carburetor maintenance were found. Had the carburetor maintenance instruction manual identified a means to ensure the security of the main metering jet, it is unlikely that the jet would have become unseated. There was no record of maintenance personnel inspecting the carburetor jets during the previous 17 years nor was there a requirement to do so.

The front and rear seats of the airplane were equipped with non-factory-installed shoulder harnesses. The pilot's shoulder harness was installed by mounting the end of the restraint to the lower portion of the seatback assembly, which was made of thin aluminum. No reinforcement material or doublers were installed at or around the attachment bolt hole in the seatback. The lack of reinforcement allowed the attachment bolt, washers, and stop nut to be pulled upward and through the seatback structure during the

impact sequence, which resulted in the pilot's loss of shoulder harness restraint. It is likely that the improperly installed shoulder harness contributed to the severity of the pilot's injuries.

As a result of this investigation, the NTSB is working with the pilot community to inform them of the lessons learned from this accident: the security of the carburetor's main metering jet and the security of the shoulder harness are both critical aspects of aviation safety.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: A total loss of engine power during initial climb when the carburetor main metering jet became unseated, which led to an extremely rich fuel-to-air ratio. Contributing to the accident was the lack of adequate carburetor maintenance instructions. Contributing to the severity of the pilot's injuries was the improperly installed shoulder harness.

Findings

Aircraft	Fuel control/carburetor - Failure
Aircraft	Seat/cargo attach fitting - Capability exceeded
Aircraft	Fasteners - Incorrect service/maintenance
Organizational issues	Maintenance records - Manufacturer
Aircraft	(general) - Not specified
Personnel issues	Installation - Other
Environmental issues	Tree(s) - Not specified

Factual Information

History of Flight

Initial climb	Loss of engine power (total) (Defining event)
Approach	Collision with terr/obj (non-CFIT)
Landing-flare/touchdown	Off-field or emergency landing

On March 5, 2015, about 1422 Pacific standard time, a Ryan Aeronautical ST3KR, N53178, sustained substantial damage during a forced landing following a reported loss of engine power shortly after takeoff and during initial climb-out from the Santa Monica Municipal Airport (SMO), Santa Monica, California. The airplane was registered to MG Aviation, Inc., and operated by the pilot under the provisions of 14 Code of Federal Regulations (CFR) Part 91. The private pilot, who was the sole occupant of the airplane, was seriously injured. Visual meteorological conditions prevailed and no flight plan was filed for the personal flight. The local flight originated from SMO about 1421.

During an interview with the National Transportation Safety Board (NTSB) investigator-in-charge, the pilot reported that, shortly after takeoff and about 1,100 ft mean sea level, the engine experienced a loss of power. He stated that he did not attempt an engine restart but maintained an airspeed of 85 mph and initiated a left turn back toward the airport; however, during the approach, he realized that the airplane was unable to reach the runway. The pilot did not recall anything further about the accident sequence. Subsequently, the airplane struck the top of a tree that was about 65 ft tall, and then impacted the ground in an open area of a golf course.

Examination of the accident site by an NTSB investigator revealed that the airplane came to rest upright adjacent to the 8th tee, about 800 ft. southwest of the approach end of runway 03 at SMO. The airplane sustained substantial damage to the wings, the right stabilizer, and the fuselage.

Multiple witnesses who were on the golf course reported hearing and observing the airplane overhead. Shortly thereafter, the witnesses heard the airplane's engine quit. The airplane was seen gliding toward the ground. Several witnesses observed the airplane strike the top of a tree and then descend to the ground.

The airplane was recovered to a secure location for further examination.

Pilot Information

Certificate:	Private	**Age:**	72
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Rear
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	May 23, 2014
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	December 13, 2014
Flight Time:	(Estimated) 5000 hours (Total, all aircraft), 75 hours (Total, this make and model), 3000 hours (Pilot In Command, all aircraft), 55.2 hours (Last 90 days, all aircraft), 17.7 hours (Last 30 days, all aircraft)		

The pilot, age 72, held a private pilot certificate with airplane multi-engine land, single-engine land, airplane single-engine sea, rotorcraft-helicopter, and instrument ratings. The pilot was issued a third-class airman medical certificate on May 23, 2014, with the limitation that he must wear corrective lenses. The pilot reported on his most recent medical certificate application that he had accumulated 5,200 total flight hours. The pilot reported that he had accumulated a total of 55.3 hours within the preceding 90 days, 17.7 hours within the preceding 30 days, and logged no flight hours within the previous 24 hours. The total time he had logged in the accident make/model airplane was over 75 hours.

Aircraft and Owner/Operator Information

Aircraft Make:	RYAN AERONAUTICAL	**Registration:**	N53178
Model/Series:	ST3KR NO SERIES	**Aircraft Category:**	Airplane
Year of Manufacture:	1942	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	1859
Landing Gear Type:	Tailwheel	**Seats:**	2
Date/Type of Last Inspection:	March 13, 2014 Annual	**Certified Max Gross Wt.:**	1885 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	169.2 Hrs at time of accident	**Engine Manufacturer:**	Kinner
ELT:	C91 installed, not activated	**Engine Model/Series:**	R-55
Registered Owner:	On file	**Rated Power:**	160 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The two-seat, low-wing monoplane, fixed-gear airplane, serial number (S/N) 1859, was manufactured in

1942. The military version of the airplane was known as the PT-22 Recruit. It was powered by a Kinner R-55 engine, serial number 07450, rated at 160 horsepower. The airplane was also equipped with a Sensenich model W90HASP-86, serial number AF 1893, fixed pitch propeller. The airplane is flown solo from the rear seat.

The accident make/model airplane was not equipped with shoulder harnesses when it was produced in 1942. However, the accident airplane was equipped with shoulder harnesses for both the forward and aft seats. No logbook entries, supplemental type certificate (STC), or documentation was located during the investigation that provided details on when the shoulder harnesses were installed in the airplane.

While it is typical to add shoulder harnesses in antique airplanes, most are performed under an STC installation or by a field approval from the Federal Aviation Administration (FAA). However, FAA guidance does allow for certain installations to be conducted under minor alterations as long as no welding or drilling of holes into the aircraft structure is performed. No evidence of drilling or welding was noted to the aircraft structure.

Review of the airframe and engine logbooks revealed that the most recent annual inspection was completed on March 13, 2014, at a recorded tachometer reading of 25 hours and an airframe total time of 163.5 hours since the restoration of the airplane.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	SMO,177 ft msl	**Distance from Accident Site:**	1 Nautical Miles
Observation Time:	13:51 Local	**Direction from Accident Site:**	230°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots / None	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:	220°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.2 inches Hg	**Temperature/Dew Point:**	23°C / -8°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Santa Monica, CA (SMO)	**Type of Flight Plan Filed:**	None
Destination:	Santa Monica, CA (SMO)	**Type of Clearance:**	VFR
Departure Time:	14:21 Local	**Type of Airspace:**	Class D

A review of recorded data from the SMO automated weather observation station, located near the accident site, revealed that, at 1351, conditions were wind from 220 degrees at 10 knots, visibility 10 statute miles, clear sky, temperature 23 degrees Celsius, dew point -8 degrees Celsius, and an altimeter setting of 30.20 inches of mercury.

Airport Information

Airport:	SANTA MONICA MUNICIPAL SMO	**Runway Surface Type:**	Grass/turf
Airport Elevation:	177 ft msl	**Runway Surface Condition:**	Dry;Vegetation
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	Forced landing

According to the FAA Digital Airport/Facility Directory, SMO is a continuously operated towered airport with a field elevation of 177 feet. The airport was equipped with one asphalt runway, runway 03/21 (4,973 ft long by 150 ft wide). Investigative personnel noted that the approach end of runway 03 of the airport was positioned on a plateau about 75 ft higher than the accident site.

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Serious	**Latitude, Longitude:**	34.014446,-118.45111(est)

Examination of the accident site revealed that the airplane impacted terrain about 800 ft southwest of runway 03 at an elevation of about 45 ft. Wreckage debris remained within about 10 ft of the main wreckage. The first identified point of contact was the top of a tree about 65 ft tall. The first area of ground impact consisted of an area of disturbed grass that extended to a small crater of disturbed dirt, which contained a portion of the propeller blade. The ground scars were about 25 ft in length.

The fuselage came to rest upright on a heading of about 44 degrees magnetic about 150 feet from the tree. The wings and engine remained partially attached to the main fuselage. Flight control continuity was established to all flight surfaces, with the exception of the right aileron; its control cable became separated when the right wing partially detached from the wing root. All major structural components of the airplane were located at the accident site.

Fuel was observed leaking from the front of the airplane, and the responding fire department reported shutting off the airplane's fuel supply from the cockpit.

Communications

According to FAA recorded communications, the SMO air traffic control tower local controller reported that, at 1419, the pilot requested a departure from runway 21 for left closed traffic. The pilot was cleared for takeoff about 1 minute later. About 1 minute after takeoff, the pilot

radioed that he had an engine failure and requested immediate return. The controller cleared the pilot to land on runway 21; the pilot responded with a request for runway 03. The controller subsequently cleared the pilot to land on runway 03 and then issued the wind information. There was no further transmission from the pilot after 1422.

Medical and Pathological Information

The FAA's Civil Aeromedical Institute (CAMI) in Oklahoma City, Oklahoma, performed toxicology tests on the pilot. No ethanol was detected in the blood. The following drugs were tested for: amphetamines, opiates, marijuana, cocaine, phencyclidine, benzodiazepines, barbiturates, antidepressants, and antihistamines. Positive results for morphine in the blood and ondansetron in the serum were present. Tests were negative for the remainder of the drugs.

A review of the pilot's postaccident medical care by the NTSB's Chief Medical Officer revealed that the pilot was administered amounts of morphine for pain during his evacuation from the accident scene and ondansetron for nausea during his evaluation at the emergency department. The positive toxicology results were consistent with the medications administered to the pilot during his postaccident treatment.

Tests and Research

Airframe Examination

Both the left and right wings were removed to facilitate wreckage recovery and subsequent transport. During postaccident examination, the airframe fuel filter (gascolator) was removed and subsequently disassembled. The gascolator bowl was free of debris. A very slight amount of debris was observed on the gascolator screen. Multiple fuel line fittings were impact damaged, and separated from the gascolator.

The fuel selector valve handles (forward and aft) were found in the "off" position. The fuel selector valve remained attached and secure to the selector valve handle shaft. The fuel selector valve was removed and disassembled. Internal examination of the fuel selector valve revealed that the valve was in the "off" position. Air was applied to the inlet port, and when the valve was moved to both the main and reserve positions, no restrictions were noted.

The fuel tank remained intact, but the fuel tank cap was separated. Impact damage was observed surrounding the fuel cap. Internal examination of the fuel tank revealed that no debris or contaminants were present. No fuel was observed within the fuel tank. Compressed air was applied to the main and

reserve outlet port fuel lines and the fuel vent line, and no restrictions were noted.

Examination of the aft cockpit seat revealed that the left and right seatbelt restraints remained attached to their respective mounts and seat structure. The shoulder harnesses were separated from the seat back assembly, but the attach bolt remained intact and secure to the shoulder restraint harness. The shoulder harness was attached using a bolt, two washers, and an elastic stop nut. A hole, similar to the size of the shoulder harness attach bolt, was observed on the back of the seat, about 2-3/8 inch above the seat bottom. The aluminum structure of the seat back was peeled away (outward and upward) from the shoulder harness bolt hole, consistent with the attach bolt being pulled through the metal structure. There was no evidence of reinforcement surrounding the shoulder harness bolt hole and the peeled away seatback structure.

Engine Examination

Examination of the recovered Kinner R-55 engine, serial number 07450, revealed that it remained attached to the airframe engine mount and was displaced downward at an approximate 45-degree angle. The starter was separated from the starter adapter, and the carburetor was displaced from its mounts. Impact damage was observed on the bottom side of the oil tank, and the outlet port was damaged and pulled away at the fitting, which resulted in a breach of the oil tank. When the engine was attached to an engine hoist, residual oil was observed draining from the oil tank outlet port. The oil shutoff valve was found separated from the oil tank outlet fitting and the associated oil line tubing. The oil shutoff valve was found in the open position, and the handle was bent, consistent with impact damage. When actuated by hand, the oil shutoff valve actuated normally between the open and closed positions. Several fuel and oil lines were found impact damaged and separated. The oil drain valve was intact and in the closed position.

The forward spark plugs on all five cylinders were removed. Both the left and right magnetos were also removed. The propeller was rotated by hand, and thumb compression was obtained on cylinder Nos. 1, 2, 4, and 5. All intake and exhaust rocker arms for all cylinders exhibited equal lift action. Damage to the No. 3 cylinder intake and exhaust push rod tubes resulted in a decreased clearance for the intake and exhaust valve rocker arms (0.004 inch and 0.002 inch, respectfully). Both of the intake and exhaust valve rollers would not rotate. The valve clearance adjustment nut was loosened, which allowed for further movement of the intake and exhaust valve rocker arms. The propeller was then rotated by hand, and thumb compression was obtained on the No. 3 cylinder. When the propeller was rotated, no internal binding or friction was noted within the engine and valve train.

The Holley 419 carburetor was found separated from its mounts. The mounting flange and a portion of the carburetor casing around the throttle valve/plate were separated. All safety wire were intact and secure. The carburetor was disassembled and examined. The fuel screen was intact and free of debris. The float bowl was free of debris and contained no residual fuel. The metal float was intact and free of damage. Compressed air was applied to the inlet port of the carburetor, and the float and needle valve were actuated with no anomalies noted. Solvent was poured into the float bowl and the accelerator pump was actuated; fuel was observed expelling from the nozzle. All internal components of the carburetor appeared to be intact and undamaged.

The main metering jet cover was removed from the housing at the bottom of the carburetor. The main

metering jet was found unscrewed from its seat and rotated laterally about 90 degrees. The internal cap, main metering jet, and seat appeared to be bright in color and polished. Portions of the jet threads appeared to be rounded off. No gasket was observed within the main metering jet housing. In addition, no evidence of thread locking compound was observed on the threads of the main metering jet or the threads of the seat.

According to the 1943 Holley Aircraft Carburetors Instruction Manual for Models 419 and 429, the actual metering of the fuel is accomplished by the main metering jet located in the passage between the discharge nozzle and the float chamber. The metering system provides a constant mixture ratio over the cruising range of engine operating speeds.

A review of the maintenance logbooks revealed that an extensive restoration of the airplane and engine overhaul was completed on May 21, 1998. At the time of the accident, the airframe and engine had accumulated approximately 169 hours since the restoration. An entry stated that a new float and gasket were installed in the carburetor during this time. The airplane was issued a standard-normal airworthiness certificate on June 4, 1998. Review of the Holley Aircraft Carburetors Instruction Manual for Models 419 and 429, revealed that there were no pertinent instructions regarding the installation or continued maintenance of the jet assemblies. Further, no maintenance entries were located in the engine logbook regarding carburetor inspections since the overhaul.

For further details of the airframe and engine examination, see the NTSB Airframe, Engine, and Maintenance Records Examination Summary Report within the public docket for this accident.

The postaccident examination of the airframe and engine revealed no additional evidence of a mechanical malfunction that would have precluded normal operation.

Additional Information

Review of Advisory Circular (AC) 21-34, dated June 4, 1993, provides basic principles regarding design and installation of combined shoulder harness and safety belt restraint systems. Section 4, Installation Geometry, item D, of AC 21-34 states in part "spinal compression is likely to occur when the upper end of the shoulder belt is mounted an excessive amount below the occupant's shoulder level…the shoulder belt pulls down and back on the torso as it resists the forward motion of the occupant. The resultant restraint force…will place the spinal column in compression, and will add to the stresses in the column caused by the vertical component of the impact deceleration force.

AC 21-34, Section 7, Structural Attachments provides three design concepts that are intended to create an understanding of the features needed in the attachments.

"Concept 1: The first concept is to spread attachment loads into as much surrounding structure as possible and as gradually as possible. Gradual dissipation of loads minimizes stress concentrations at abrupt changes in material cross section which promote local failures, either immediately or upon a

subsequent accident load cycle.

Concept 2: The second concept is to minimize local structural bending by attachment loads. Semimonocoque structure generally offers poor resistance to bending, but is good in tension and shear applications. Airframe bending, buckling, or collapse adds to forward movement of the occupant.

Concept 3: The third concept is to ensure that fastener type, strength, and number are adequate in tension, shear, and bending, depending on the application. Airframe buckling under restraint loads will result in compound loading of connector plates as well as fasteners. Concurrently, material thickness is important in preventing fastener pull-out, and continued security (safety wire or equivalent) of threaded fasteners should be considered."

Item C of Section 7 states in part, "…some existing aircraft will already have shoulder harness attachment points, often called "hard points," which were installed during production. As an alternative, it is fortunate to be able to attach shoulder belts to reasonably rigid structure where only a doubler may be needed to replace the material removed for fastener holes. Most often, it is necessary to attach shoulder belts to relatively thin formed sections, or even skin panels, of semimonocoque construction to achieve a satisfactory geometric configuration of the belts when in use. In most cases, attachment points need reinforcement. Attachments to welded tube and wood frame construction present a special problem in selecting the attachment point and the hardware for attachment of shoulder belts."

Administrative Information

Investigator In Charge (IIC):	Nixon, Albert
Additional Participating Persons:	Donald Griffin; Federal Aviation Administration; Los Angeles, CA
Original Publish Date:	August 6, 2015
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=90823

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The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties … and are not conducted for the purpose of determining the rights or liabilities of any person" (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available here.