Aviation Investigation Final Report

Location:	Borrego Springs, California	**Accident Number:**	WPR12LA407
Date & Time:	September 8, 2012, 12:35 Local	**Registration:**	N21MX
Aircraft:	MOORE EDWARD R MXS	**Aircraft Damage:**	Substantial
Defining Event:	Flight control sys malf/fail	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

During the aerobatic practice flight, the airplane departed controlled flight. The pilot opened the canopy, which then separated from the airplane, and exited the airplane. Due to the low altitude, the pilot's parachute did not fully deploy before he impacted the ground.

The accident airplane was 1 of 14 MX-model airplanes. It was the only model built from a kit as an experimental, amateur-built aircraft, and it was constructed differently than the other MX-model airplanes. Postaccident examination of the torque tube assembly revealed that the forward bulkhead holding the torque tube assembly in place was constructed in a way that allowed the bulkhead to flex, which subsequently led the torque tube assembly to detach from the forward bearing during the accident flight and resulted in the loss of aileron and elevator control. Examination also revealed that the forward and aft bearing houses were installed opposite of the correct direction, which allowed the bearings to detach from the torque tube assembly when the front bulkhead flexed.

Probable Cause and Findings

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

The pilot's inability to maintain control of the airplane following the loss of aileron and elevator control due to the forward flight control torque tube assembly's detachment from the forward bearing. Contributing to the accident was the inadequate construction of the forward bulkhead that held the flight control torque tube assembly in place and the improper installation of the thrust bearings.

Findings

Aircraft	Pitch control - Attain/maintain not possible
Aircraft	Lateral/bank control - Attain/maintain not possible
Personnel issues	Modification/alteration - Other
Aircraft	(general) - Malfunction
Aircraft	(general) - Failure

Factual Information

History of Flight

Maneuvering-aerobatics	Flight control sys malf/fail (Defining event)
Maneuvering-aerobatics	Loss of control in flight
Uncontrolled descent	Collision with terr/obj (non-CFIT)

HISTORY OF FLIGHT

On September 8, 2012, about 1235 Pacific daylight time (PDT), an experimental Edward R. Moore MXS, N21MX, departed controlled flight and impacted terrain near Borrego Valley Airport (L08), Borrego Springs, California. The pilot was operating the airplane under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91. The commercial pilot was fatally injured; the airplane sustained substantial damage by impact forces. The local personal aerobatic flight departed L08, about 1225. Visual meteorological conditions prevailed, and no flight plan had been filed.

The owner/builder of the airplane had loaned the airplane to the pilot to "try out" his airplane. The pilot did own another make and model of aerobatic airplane.

Witnesses reported that during an aerobatic flight the airplane appeared to have departed controlled flight, and the pilot was observed leaving the airplane followed by his parachute deploying. The parachute did not fully deploy before the pilot impacted the ground.

On scene examination and documentation was performed by investigators, and the airplane was recovered for further examination.

PERSONNEL INFORMATION

A review of Federal Aviation Administration (FAA) airman records revealed that the 58-year-old pilot held a commercial pilot certificate with ratings for airplane single-engine land and instrument airplane.

The pilot held a third-class medical certificate issued on April 17, 2012. It had the limitations that the pilot must wear corrective lenses for near and distant vision.

No personal flight records were located for the pilot. The IIC obtained the aeronautical experience listed in this report from a review of the FAA airmen medical records on file in the Airman and Medical Records Center located in Oklahoma City, Oklahoma. The pilot reported on his medical application that he had a total flight time of 4,500 hours with 50 hours logged in the last 6 months.

AIRCRAFT INFORMATION

The airplane was an experimental amateur built-Edward R Moore- MXS, serial number 008. A review of the airplane's logbooks revealed that the airplane had a total airframe time of 311.8 hours at the last

annual condition inspection. The logbooks contained an entry for the annual condition inspection dated March 30, 2012.

The engine was a Lycoming-Ly-Con, AE10-540EXP, serial number L-52636-08E. Total time recorded on the engine at the last 100-hour annual condition inspection was 311.8 hours.

The builder/owner reported the total time on the airplane as 351 hours at the time of the accident. No Hobbs meter was recovered at the accident site.

The airplane was completed and issued an amateur built experimental airworthiness certificate on March 11, 2009.

A logbook entry dated March 11, 2009, stated that the airplane had been assembled using the kit and plans supplied by MXR Technologies. The entry was made by an Airframe & Power Plant (A&P) Mechanic who was not the builder of record of the airplane per the FAA records.

On March 21, 2009, the builder of record made a logbook entry stating that the airplane had completed Phase I of the operating limitations. He also recorded that the airplane had a total time of 42.5 hours.

No logbook entries were made in the logbooks for the year of 2010.

On March 5, 2011, a logbook entry for an annual condition inspection was completed with a recorded total time of 225.52 hours.

The last entry was on March 30, 2012, for an annual condition inspection with a total time of 311.8 hours.

WRECKAGE AND IMPACT INFORMATION

Investigators examined the wreckage at the accident scene. The airplane wreckage was located about 200 yards north of the Borrego Springs Airport runway 08/26. The accident site was level sandy desert terrain with sparse vegetation. The airplane was recovered and transported to storage for further examination.

MEDICAL AND PATHOLOGICAL INFORMATION

The San Diego County Coroner completed an autopsy of the pilot on September 10, 2012. The FAA Civil Aerospace Medical Institute (CAMI), Oklahoma City, performed toxicological testing of specimens of the pilot.

Analysis of the specimens contained no findings for carbon monoxide, cyanide, and volatiles. The drug "Minoxidil" was detected in the urine, but not detected in the blood.

The medication "Minoxidil" found during the pilot's toxicological testing does not cause impairment or incapacitation.

TESTS AND RESEARCH

Investigators examined the wreckage at Aircraft Recovery Service, Littlerock, California, on September 18, 2012.

The engine was examined with no mechanical anomalies identified. A copy of the examination report is attached to the docket.

The airframe was examined, and no evidence of any airframe structural failure was noted. The control systems including the push rods, bearings, rudder controls, elevator controls, and ailerons were present with no abnormalities that would have precluded normal operations.

The flight control Torque Tube Assembly was examined, and all major components of the torque tube assembly were present and accounted for. Visual inspection of the torque tube assembly had witness marks that indicated that the torque tube was not engaged in the forward bearing prior to accident impact. In addition, the structure that supported the forward bearing had been constructed in an alternate manner than the other MXS airplanes by using aluminum sheet of approximately 0.040 thickness, and attaching them to the side rails using AN type hardware. Two pieces of aluminum extruded channel had been placed on either side of the forward torque tube bearing. A copy of the examination report is attached to the accident docket.

The torque tube assembly was sent to the NTSB materials laboratory for examination.

The complete NTSB materials laboratory factual report number 12-118, dated October 12, 2012, is attached to the accident docket.

Findings in the factual report indicated that the forward and aft bearing housings were installed in reverse of the proper direction of installation, and aluminum alloy flanges were used to attach the bearing support panel to the sidewalls, which allow the panel to flex.

According to representatives of MX aircraft, the aluminum flanges were inconsistent with the other MXS airplanes as built. Examination of photographs of an exemplar airplane with a reportedly proper installation of the bearing support panel showed flanges located on the aft side of the forward bearing support panel, and the flanges were made of composite material.

The other 13 aircraft which were manufactured by or for MX Aircraft were built with the front bulkhead for the torque tube assembly made with a glass reinforced epoxy laminate and attached to the side rails with carbon fiber structural brackets which were bonded to the fuselage structure.

The forward face of the flight control torque tube had a number of sliding contact marks, and the sides of the face were bent aft in the areas of contact. The location and shape of the contact marks were consistent with sliding contact with the aileron control stop assembly on the forward bearing support panel. The aft faces of the aileron control stop assembly also showed missing paint and evidence of contact damage.

VIDEO RECORDER

The accident airplane had a GoPro HD2-14 "Hero2" camera that had been mounted to the left side of the airplane, and was recovered at the accident site. The camera was submitted to the NTSB vehicle

recorders laboratory for download. A copy of the On Board Image Recorder Factual Report is included in the accident docket.

The specialist's factual report was dated January 25, 2013. The report identified that the camera had sustained minor damage, and the removable 32 GB SD card was intact. The video information was copied from the SD card for review.

The accident video was recorded at 1280x960 resolution, at 30 frames per second. The video was 16 minutes 17.1 seconds in length.

The view of the recording included the left side of the airplane from forward of the tail section of the airplane. The complete left wing was visible including the aerobatic sight gauge, which was installed on the left wingtip, with a small piece of yarn attached to the aft portion of the sight gauge.

The video times were converted into local Pacific daylight time (PDT.) The video started at 1219 PDT. The video was continuous from start up, taxi to takeoff, takeoff, and continued through the pilot's aerobatic flight maneuvers until the end of the video.

The airplane began a series of aerobatic maneuvers at 1228:10 PDT, which continued until the end of the recording. During the aerobatic flight maneuvers, the power varied, and the left aileron was observed to move up and down consistent with the flight maneuvers.

At 1235:26, the airplane nosed up from level upright flight, and the left aileron began to deflect up as the airplane rolled rapidly to the left. The left aileron deflection achieved its full upward deflection before 90 degrees of bank. After the airplane had rolled through inverted to about a 60-degree right bank, the left aileron deflection began to decrease. By 1235:28, the airplane was in level flight, and the left aileron was neutral again.

At 1235:30.9, the airplane began another pitch up, similar to that at 1235:26. The left aileron began a downward displacement, and the airplane began to roll rapidly to the right, similar to the prior roll to the left. After the airplane passed inverted flight by about 45 degrees and was in about a 135-degree left bank, the left aileron displacement reduced. By the time the airplane rolled to about 120 degrees left bank, the left aileron was about to neutral, and the airplane's rolling motion stopped. The nose began to drop towards the horizon at 1235:32.7, as the pilot could be seen moving his head in either direction in the cockpit. The nose continued to drop below the horizon; the airplane was in about a 120-degree left bank turn, and the airplane was facing runway 8 at L08, at 1235:35.

At 1235:43, the pilot's hand moved towards the left side of the cockpit, as the nose was still below the horizon, and the left bank angle had reduced to about 90 degrees. The left aileron was still about neutral, and not moving.

At 1235:44, the canopy began to crack open, and then quickly opened towards the right. It separated from the airplane, and moved back along the fuselage. Within about 1 second, the canopy left the field of view of the camera to the aft. While the canopy was visible, pieces of materials, similar to Plexiglas, were observed, as was some insulation-like material. As the canopy was separating, the left aileron deflected momentarily sharply up and then back to neutral.

From about 1235:45 until the end of the recording at 1235:49, the pilot's head was visible and moving forward in the wind stream. The bank angle decreased to about a 60-degree left bank; the pitch attitude became less nose down, though still slightly below the horizon. The needle on the airspeed indicator moved from about the 8 o'clock position on the indicator to about the 4 o'clock position.

Garmin GPSMAP 496

The accident airplane was equipped with a GARMIN GPSMAP 496 installed in the panel. The GPS unit was recovered post accident, and sent to the NTSB Vehicle Recorders Lab for data recovery. A copy of the factual report is located in the accident docket.

The accident flight was the last recorded session in the GPS. The recording started at 19:16:03 UTC and ended at 19:36:39 UTC on September 8, 2012, there were a total of 207 data points recorded.

At 19:35:32, the airplane was heading westerly, at 4,216 feet msl. At 19:35:36, the airplane began to lose altitude while changing direction by 360 degrees to the left. By the end of the 360-degree turn, the airplane had descended to 2,743 feet at 19:35:44. The airplane then continued to descend, and calculated ground speed slowed, as it began to change direction towards the south. The last point with a reasonable altitude reported was at 19:36:05 at 709 feet msl.

Electronics International MVP-50P

The accident airplane was equipped with an Electronics International MVP-50P. The MVP-50P unit was recovered post accident, and sent to the NTSB Vehicle Recorders Lab for data recovery. A copy of the factual report is located in the accident docket.

The recording began at 19:20:24. Before the presumed takeoff, there was a brief period of RPM values of about 1,700 between 19:24:22 and 19:24:57. The presumed takeoff was at 19:26:12, when CHT, EGT, RPM, MP, Fuel Flow, Oil Pressure, and HP all increased. During the flight, MP, RPM, Fuel Flow, and Oil Pressure all fluctuated. The manifold pressure and RPM decreased at 19:35:35; thereafter the RPM increased slightly as the recording ended.

ADDITIONAL INFORMATION

According to FAA Advisory Circular AC 20-27F, Certification and Operation of Amateur-Built Aircraft, "Amateur builders are free to develop their own designs or build from existing designs. We do not approve these designs and it would be impractical to develop design standards for the wide variety of design configurations, created by designers, kit manufacturers, and amateur builders."

A review of the FAA aircraft registration records in Oklahoma City, revealed that there were a total of 14 model MXS airplanes produced, 9 of them were manufactured by MXR Technologies, Inc., 3 of them were manufactured by MX Aircraft LLC, and 1 of the airframes was exported out of the USA as a kit. The accident airplane was sold as a kit to the owner/builder, and was the only MXS model manufactured as an experimental amateur built that was reported to be built by an individual.

On January 28, 2009, MX Aircraft sent an e-mail to the owner/builder and to Angel Fire Aero to warn them that they had concerns regarding the construction of the accident airplane, specifically the torque tube assembly. On January 29, 2009, Angel Fire Aero replied to the e-mail and assured the owner that

there was no issues with the concerns raised by MX Aircraft, and stated regarding the torque tube, "Seem highly unlikely that the part would ever come loose, let alone cause life threatening results."

The January e-mail was dated 3 months prior to the accident airplane being certified airworthy which occurred on March 11, 2009.

Post accident, MX Aircraft, LLC notified all of the remaining operators of the MXS series airplanes that an inspection of the torque tube assemblies should be completed to insure proper installation and security. In September 2013, there was an article published regarding the proper inspection procedures for the MXS series airplanes. A copy of the article is attached to the accident docket.

Pilot Information

Certificate:	Commercial	**Age:**	58
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Single
Other Aircraft Rating(s):	None	**Restraint Used:**	5-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:**	April 17, 2012
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	4500 hours (Total, all aircraft), 1 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	MOORE EDWARD R	**Registration:**	N21MX
Model/Series:	MXS	**Aircraft Category:**	Airplane
Year of Manufacture:	2009	**Amateur Built:**	Yes
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	008
Landing Gear Type:	Tailwheel	**Seats:**	1
Date/Type of Last Inspection:	March 30, 2012 Annual	**Certified Max Gross Wt.:**	1840 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	311.8 Hrs as of last inspection	**Engine Manufacturer:**	LYCOMING
ELT:		**Engine Model/Series:**	AEIO-540 SER
Registered Owner:	MOORE EDWARD R	**Rated Power:**	260 Horsepower
Operator:	MOORE EDWARD R	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	TRM,-115 ft msl	**Distance from Accident Site:**	23 Nautical Miles
Observation Time:	12:52 Local	**Direction from Accident Site:**	20°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	140°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.78 inches Hg	**Temperature/Dew Point:**	39°C / 18°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Borrego Springs, CA (L08)	**Type of Flight Plan Filed:**	None
Destination:	Borrego Springs, CA (L08)	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	Class E

Airport Information

Airport:	Borrego Valley Airport L08	**Runway Surface Type:**	
Airport Elevation:	520 ft msl	**Runway Surface Condition:**	Unknown
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	33.260555,-116.324447(est)

Administrative Information

Investigator In Charge (IIC):	Jones, Patrick
Additional Participating Persons:	Matthew Nachreiner; Federal Aviation Administration; San Diego, CA Chris Meyers; MX Aircraft; North Wilkesboro, NC
Original Publish Date:	February 23, 2015
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=84971

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