



# Aviation Investigation Final Report

<b>Location:</b>	Scottsdale, Arizona	<b>Incident Number:</b>	WPR15IA252
<b>Date &amp; Time:</b>	August 27, 2015, 14:05 Local	<b>Registration:</b>	N915TD
<b>Aircraft:</b>	Cirrus SR22	<b>Aircraft Damage:</b>	Minor
<b>Defining Event:</b>	Landing gear collapse	<b>Injuries:</b>	3 None
<b>Flight Conducted Under:</b>	Part 91: General aviation - Instructional		

## Analysis

*\*\*\*This report was modified on August 1, 2018. Please see the docket for this incident to view the original report.\*\*\**

While the pilot receiving instruction was landing the airplane, the main landing gear touched down first; as he was slowly lowering the nose landing gear (NLG) to the runway, he felt a "shimmy" in the NLG. Despite applying back pressure to lift the weight off the NLG, the airplane's nose slowly started falling forward, and the nosewheel collapsed.

Postincident examination of the airplane revealed that the NLG was fractured through the strut tube adjacent to the forward edge of the gusset tube attachment welds. Metallurgical testing revealed that the failure was the result of high-stress fatigue cracking due to sideways bending from one side. No mechanical or metallurgical anomalies were noted with the NLG.

After the incident, the airplane manufacturer conducted structural testing of the NLG, which revealed that shimmy events or nonstandard towing could result in cracks and the eventual separation of the NLG. As a result, the airplane manufacturer issued two service advisory letters, which outlined appropriate towing and inspection procedures. The airplane manufacturer also issued a series of service bulletins, which, in part, recommended that all NLG on the affected airplanes be inspected for cracks in the welds between the strut tube and the gusset tubes and that postshimmy inspections also be conducted to look for cracks in this area. Additionally, the airplane manufacturer updated the design of the NLG to increase the strength of the strut tube.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be:  
The failure of the nose landing gear due to unanticipated fatigue loads.

### Findings

<b>Aircraft</b>	Nose/tail landing gear - Fatigue/wear/corrosion
<b>Aircraft</b>	Nose/tail landing gear - Capability exceeded
<b>Aircraft</b>	Nose/tail landing gear - Failure

## Factual Information

### History of Flight

Landing-landing roll	Landing gear collapse (Defining event)
Landing-landing roll	Miscellaneous/other
Landing-landing roll	Attempted remediation/recovery

On August 27, 2015, about 1405 mountain standard time, a Cirrus SR22, N915TD, experienced a nose landing gear collapse during landing roll at Scottsdale Airport (SDL), Scottsdale, Arizona. The certified flight instructor (CFI), the pilot receiving instruction, and one passenger were not injured. The airplane received minor damage. The airplane was registered to ESPBC LLC of Scottsdale, and operated by Scottsdale Executive Flight Training as a 14 *Code of Federal Regulations* Part 91 instructional cross-country flight. Visual meteorological conditions prevailed, and a flight plan was not filed. The flight originated from Flagstaff, Arizona about 1300, and was destined for SDL.

According to the CFI, the pilot receiving instruction made the landing. The main landing gear touched down first, and slowly the nose gear was lowered onto the runway's surface. The CFI reported that at this time they felt a shimmy in the nose gear, during which the pilot receiving instruction applied back pressure on the stick to lift the weight off the nose gear. As the nose gear came down a second time, it appeared that the shimmy had stopped, and that they were level on all three wheels. However, after a few seconds the nose slowly started falling forward until it had completely collapsed.

The nose landing gear consists of a main strut tube and two gusset tubes near the top portion of the main strut tube. The landing gear was observed fractured through the strut tube adjacent to the forward edge of the gusset tube attachment welds.

The National Transportation Safety Board Materials Laboratory examined the nose landing gear strut and determined that the failure of the landing gear was the result of high stress fatigue cracking due to sideways bending from one side. No mechanical or metallurgical anomalies were noted with the landing gear.

On March 7, 2016, Cirrus Design Corporation issued Service Advisory Letter SA 16-03, entitled "Nose Landing Gear Strut Assembly Inspection, which denoted the following:

- Cracks have been discovered on the nose landing gear strut assembly at the welds between the strut tube and the LH and RH gusset tubes.
- A visual inspection of the welds between the strut tube and the LH and RH gusset tubes for cracks must be performed every time the engine cowling is removed.
- If cracks are found, the aircraft is prohibited from flight until the nose landing gear strut assembly is replaced. (Refer to AMM-32-20)

On April 12, 2016, Cirrus Design Corporation issued Service Advisory Letter SA 16-05, entitled "Aircraft Towing Guidance." The SA was based on the potential for damage to the nose landing gear due to loading from non-standard and abusive tug operation. The SA was released offering aircraft towing guidance. This guidance included the following;

- When towing aircraft, do not stop/start abruptly, especially when the tow bar is at an angle greater than 45° either side of center.
- When positioning the aircraft with a towing vehicle, the angle of the tow bar must be less than 45° either side of center for both pulling and pushing. Hand towing must be used if angles greater than 45° either side of center are needed for positioning.
- Do not tow aircraft at speeds higher than 15 mph.

Additionally, Cirrus Design Corporation performed structural testing of the nose landing gear.

Based on the data provided by the NTSB metallurgy lab, and a video of an incident in Japan where an airplane experienced a nose landing gear shimmy, Cirrus explored two different methods of producing side loads in the nose landing gear. The first was through taxi and towing, the second through shimmy. Flight testing showed that significant side loads on the nose landing gear would develop during a shimmy event.

As a result of the testing, Cirrus did the following:

On April 12, 2016, Cirrus Design Corporation Service Bulletin SB2X-32-22, entitled "NOSE GEAR – Nose Landing Gear Strut Assembly Inspection," was issued. The bulletin, which Cirrus considers mandatory, was issued with instructions to inspect all nose landing gear in the field for cracks in the welds between the strut tube and the LH and RH gusset tubes. In addition to the one-time inspection required by the Service Bulletin, Cirrus added a post-shimmy inspection to Chapter 5-50 Unscheduled Maintenance Checks of the Aircraft Maintenance Manual (AMM). Similar to the hard/overweight landing inspection, this post-shimmy inspection would look specifically for cracks at the gusset welds exactly as noted in the Service Bulletin. (For additional information, refer to the Service Bulletin, which is appended to the docket for this report.)

On July 14, 2017, Cirrus Design Corporation Service Bulletin SB2X-32-22R1 was issued. The bulletin, which Cirrus considers mandatory, was revised to update Compliance, Effectivity, Purpose, Manpower Requirements, and Accomplishment instructions. The bulletin specifically states, "Operators who have successfully complied with the original release of this service bulletin, dated April 12, 2016, must complete Revision 1 of this Service Bulletin in its entirety, and must continue to perform this Service Bulletin every 50 hours thereafter until termination action occurs. (For additional information, refer to the revised Service Bulletin, which is appended to the docket for this report.)

On January 5, 2018, Cirrus Design Corporation Service Bulletin SB2X-32-22R2 was issued. The bulletin, which Cirrus considers mandatory, was revised to update Compliance and Effectivity. The bulletin specifically states, "Operators who have successfully complied with the original release of this service bulletin, dated April 12, 2016, must complete Revision 2 of this Service Bulletin in its entirety, and must continue to perform this Service Bulletin every 50 hours thereafter until termination action

occurs. (For additional information, refer to the revised Service Bulletin, which is appended to the docket for this report.)

On July 14, 2017, Cirrus Design Corporation Service Bulletin SB2X-32-23, which Cirrus considered to be mandatory, entitled "NOSE GEAR – Nose Wheel Shimmy Reduction," was issued. The bulletin noted that on affected airplanes, nose wheel shimmy may exist on aircraft equipped with Beringer wheels. The bulletin states that a nose tire vibration due to imbalance or tire damage can be mistaken for NLG shimmy. However, it is advisable that both conditions be examined closely and considered tandem during aircraft inspection. The bulletin contains instructions for the adjustment of the nose tire pressure and force required to rotate the nose wheel fork. (For additional information, refer to the Service Bulletin, which is appended to the docket for this report.)

On January 5, 2018, Cirrus Design Corporation issued revised Service Bulletin SB2X-32-23R1. The bulletin, which is considered mandatory, was revised to update Effectivity, Purpose, and Accomplishment Instructions. The bulletin states that operators who have successfully complied with the original release of this Service Bulletin, dated July 14, 2017, must complete Revision 1 of this Service Bulletin in its entirety. The Service Bulletin contains instructions for the adjustment of the nose tire pressure and the verification of the force required to rotate the nose wheel fork. (For additional information, refer to the revised Service Bulletin, which is appended to the docket for this report.)

On July 14, 2017, Cirrus Design Corporation issued Cirrus Service Advisory (SA) SA17-08, entitled "Possible Cracking at Nose Land Gear Fillet Welds." The SA revealed that cracks had been discovered on some nose landing gear (NLG) strut assemblies at the fillet welds between the strut tube and the LH and RH gusset tubes. These cracks had led to the collapse of the NLG assemblies. The SA further revealed that each of the aircraft involved had a history of excessive nose wheel shimmy following touchdown of the nose landing gear. The SA defined "nose wheel shimmy" as "a lateral oscillation or wobble of the NLG resulting in a shaking feeling throughout the cabin of the aircraft that can vary in intensity." This is normally encountered during the landing roll-out and will subside as speed is reduced. Cirrus noted in the "Actions" section of the SA that nose wheel shimmy can be reduced or eliminated by lowering the tire pressure. Prior to the next flight, adjust the tire pressure on the nose landing gear to 40 – 50 psi (276 – 344 kPa). (For additional information, refer to the Service Advisory, which is appended to the docket for this report.)

On January 5, 2018, Cirrus Design Corporation issued revised Service Advisory SA17-08R1 (revision 1). The Advisory was issued to update Effectivity and the NLG tire pressure as outlined in SA17-08, dated July 14, 2017. Cirrus noted in the "Actions" section of the SA that nose wheel shimmy can be reduced or eliminated by lowering the tire pressure. Prior to the next flight, adjust the tire pressure on the nose landing gear to 30 – 35 psi (207 – 241 kPa). (For additional information, refer to the Service Advisory, which is appended to the docket for this report.)

Cirrus Aircraft also incorporated specific emphasis and recommendations on how to further discourage shimmying on landing and actions to be taken if the situation occurs on landing in their pilot training program. These incorporations are included in the Landing Standardization Course. Maintenance guidance is also available to mechanics following a shimmy event.

To increase the strength of the weld in the critical area on the nose landing gear, the thickness of the main strut tube was analyzed with an increased wall thickness from 0.125-inch to the full thickness of

0.156-inch. The result of the analysis was an increase (3-5%) in the local stress levels in the static analysis. This design change has been made for all new and replacement gear.

### Flight instructor Information

<b>Certificate:</b>	Commercial; Flight instructor	<b>Age:</b>	29, Male
<b>Airplane Rating(s):</b>	Single-engine land	<b>Seat Occupied:</b>	Right
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	3-point
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	Airplane multi-engine; Airplane single-engine; Instrument airplane	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 3 With waivers/limitations	<b>Last FAA Medical Exam:</b>	June 11, 2014
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	January 20, 2015
<b>Flight Time:</b>	783 hours (Total, all aircraft), 60 hours (Total, this make and model), 699 hours (Pilot In Command, all aircraft), 326 hours (Last 90 days, all aircraft), 88 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

### Student pilot Information

<b>Certificate:</b>	None	<b>Age:</b>	52, Male
<b>Airplane Rating(s):</b>	None	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	3-point
<b>Instrument Rating(s):</b>	None	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	None	<b>Last FAA Medical Exam:</b>	June 11, 2014
<b>Occupational Pilot:</b>	No	<b>Last Flight Review or Equivalent:</b>	January 20, 2015
<b>Flight Time:</b>	500 hours (Total, all aircraft), 365 hours (Total, this make and model), 17 hours (Last 90 days, all aircraft), 9 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Cirrus	<b>Registration:</b>	N915TD
<b>Model/Series:</b>	SR22	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>	2014	<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Normal	<b>Serial Number:</b>	4098
<b>Landing Gear Type:</b>	Tricycle	<b>Seats:</b>	4
<b>Date/Type of Last Inspection:</b>	May 27, 2015 100 hour	<b>Certified Max Gross Wt.:</b>	3600 lbs
<b>Time Since Last Inspection:</b>	93 Hrs	<b>Engines:</b>	1 Reciprocating
<b>Airframe Total Time:</b>	391.4 Hrs at time of accident	<b>Engine Manufacturer:</b>	Continental Motors
<b>ELT:</b>	C126 installed, not activated	<b>Engine Model/Series:</b>	IO-550
<b>Registered Owner:</b>	On file	<b>Rated Power:</b>	310 Horsepower
<b>Operator:</b>	On file	<b>Operating Certificate(s) Held:</b>	None

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Day
<b>Observation Facility, Elevation:</b>	SDL, 1510 ft msl	<b>Distance from Accident Site:</b>	
<b>Observation Time:</b>	13:53 Local	<b>Direction from Accident Site:</b>	
<b>Lowest Cloud Condition:</b>	Clear	<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	None	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	3 knots /	<b>Turbulence Type Forecast/Actual:</b>	/ None
<b>Wind Direction:</b>	70°	<b>Turbulence Severity Forecast/Actual:</b>	/
<b>Altimeter Setting:</b>	29.93 inches Hg	<b>Temperature/Dew Point:</b>	40°C / 14°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	Flagstaff, AZ (FLG)	<b>Type of Flight Plan Filed:</b>	None
<b>Destination:</b>	Scottsdale, AZ (SDL)	<b>Type of Clearance:</b>	VFR flight following
<b>Departure Time:</b>	13:00 Local	<b>Type of Airspace:</b>	Class D

## Airport Information

<b>Airport:</b>	Scottsdale SDL	<b>Runway Surface Type:</b>	Asphalt
<b>Airport Elevation:</b>	1510 ft msl	<b>Runway Surface Condition:</b>	Dry
<b>Runway Used:</b>	210	<b>IFR Approach:</b>	None
<b>Runway Length/Width:</b>	8249 ft / 100 ft	<b>VFR Approach/Landing:</b>	Traffic pattern

## Wreckage and Impact Information

<b>Crew Injuries:</b>	2 None	<b>Aircraft Damage:</b>	Minor
<b>Passenger Injuries:</b>	1 None	<b>Aircraft Fire:</b>	None
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	3 None	<b>Latitude, Longitude:</b>	33.622776,-111.910552(est)



## Administrative Information

<b>Investigator In Charge (IIC):</b>	Little, Thomas
<b>Additional Participating Persons:</b>	Steven L Meisner; Federal Aviation Administration; Scottsdale, AZ Brannon Mayer; Cirrus Aircraft Design Corp; Duluth, MN
<b>Original Publish Date:</b>	June 5, 2018
<b>Last Revision Date:</b>	
<b>Investigation Class:</b>	<a href="#">Class</a>
<b>Note:</b>	The NTSB did not travel to the scene of this incident.
<b>Investigation Docket:</b>	<a href="https://data.nts.gov/Docket?ProjectID=91881">https://data.nts.gov/Docket?ProjectID=91881</a>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

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](#).