Aviation Investigation Final Report

Location:	Gulf Shores, Alabama	**Accident Number:**	ERA22LA275
Date & Time:	June 15, 2022, 16:20 Local	**Registration:**	N432CD
Aircraft:	CIRRUS DESIGN CORP SR22	**Aircraft Damage:**	Substantial
Defining Event:	Sys/Comp malf/fail (non-power)	**Injuries:**	2 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot reported that, about two months before the accident, the airplane's brakes felt soft after landing. Maintenance personnel bled the brake system and returned the airplane to service. After picking up the airplane from maintenance, the pilot felt that the brakes were "dragging" during taxi; while subsequently bringing the airplane to a stop to contact the maintenance facility, the rudder/brake pedals "went to the floor." The same maintenance facility replaced the piston O-rings and brake pads on both brake calipers. The pilot flew the airplane for about two months without issue until he returned the airplane to the maintenance facility for its annual inspection. During the annual inspection, which was completed the day before the accident, the maintenance facility replaced the brake pads on both calipers and bled the brake system.

On the day of the accident (the first flight following the annual inspection), the pilot performed a preflight inspection and taxied the airplane to the runway. He initiated the takeoff and then realized that the airplane was not accelerating. He aborted the takeoff, exited the runway, and brought the airplane to a stop. When the pilot attempted to taxi back to the maintenance facility, he lost all braking effectiveness. The pilot shut down the engine and the airplane rolled to a stop. After seeing smoke coming from under the airplane, the pilot and his passenger egressed. The pilot was able to extinguish the right main landing gear fire with the onboard fire extinguisher, but was unable to put out the fire on the left main landing gear, and the airplane sustained substantial damage to the left side of the fuselage and the left wing.

The airplane utilized a free-castering nosewheel that relied on aerodynamic forces and differential braking for directional control while taxiing. The airplane manufacturer advised that proper braking practices were critical to avoid potential damage to the brakes and that the most common cause of brake damage and/or failure was the creation of excessive heat

through improper braking practices; however, review of recorded data did not indicate that the pilot used engine power settings during taxi that would have required excessive braking to slow or steer the airplane. Additionally, the airport was mostly flat and there was no appreciable downslope or upslope gradient that would have caused him to excessively use the brakes.

The airplane was equipped with organic brake linings at the time of manufacture. The manufacturer had issued a service bulletin that allowed for an upgrade to metallic brake linings, which also required upgrade of the wheel and brake assemblies. Review of maintenance logs revealed no evidence that the accident airplane had been modified in accordance with this service bulletin, and examination of the brakes and wheel assemblies revealed a mixture of parts from both organic lining brake assemblies and metallic lining brake assemblies. There are major differences between how organic and metallic brake assemblies are designed, and the components of each system are not interchangeable.

Examination of the accident airplane revealed that the installed brake linings were metallic, but the brake pistons were not equipped with the piston insulators used with metallic linings. The right brake housing shim was not made from the original equipment manufacturer's insulative (phenolic) material and therefore did not provide the thermal insulation that the phenolic shim provided. Additionally, the installed brake discs did not meet thickness specifications for use with metallic linings.

Based on the available information, maintenance personnel's improper use of metallic linings in the brake assemblies without piston insulators, with improper brake housing insulative shim material, and with undersized brake discs, greatly increased the probability of overheating and likely resulted in the brake fire.

Probable Cause and Findings

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

The improper maintenance of the brake system, which resulted in the brakes overheating and catching fire and subsequent substantial damage to the airplane.

Findings

Aircraft	Landing gear brakes system - Incorrect service/maintenance
Personnel issues	Scheduled/routine maintenance - Maintenance personnel

Factual Information

History of Flight

Takeoff-rejected takeoff	Miscellaneous/other
Taxi-from runway	Sys/Comp malf/fail (non-power) (Defining event)
Standing	Fire/smoke (non-impact)

On June 15, 2022, about 1620 central daylight time, a Cirrus SR22, N432CD, was substantially damaged when it was involved in an accident in Gulf Shores, Alabama. The pilot and passenger were not injured. The airplane was operated as a Title 14 *Code of Federal Regulations (CFR)* Part 91 personal flight.

The accident occurred at Gulf Shores International Airport/Jack Edwards Field (JKA), Gulf Shores, Alabama. The flight was destined for Destin Executive Airport (DTS), Destin, Florida.

On April 7, 2022, the pilot landed at JKA. He felt that "the brakes were a little soft," so he asked a maintenance shop at the airport to look at them. The description of the work on the receipt that he received was "Trouble shoot brake problem - Bled brakes and ops check good." When the pilot returned to pick up the airplane, he performed a preflight inspection and proceeded to taxi. He noticed that the airplane required more power than usual in order to taxi, and he felt that the brakes were "dragging." As the pilot parked and shut down the airplane, the rudder/brake pedals "went to the floor." Personnel from the maintenance facility examined the brakes and told the pilot that they would need to be rebuilt. The airplane was towed back to the maintenance facility, where the brake piston O-rings and the brake pads on both calipers were replaced.

The pilot subsequently operated the airplane on approximately 21 more flights, and on May 27, 2022, flew the airplane to JKA for an annual inspection by the maintenance facility that performed the brake rebuild. During the annual inspection, maintenance personnel once again replaced the brake pads on both calipers and bled the brake system, stating in the maintenance log entry, "Operational check good" and "No further defects noted."

On the day of the accident, the pilot returned to the maintenance shop to pick up the airplane. Following a preflight inspection, he taxied the airplane to the runway for takeoff. The pilot reported that the airplane felt "a little sluggish" taxiing onto the runway, and that after applying takeoff power, the airplane was not accelerating normally. The pilot aborted the takeoff and taxied the airplane off the runway.

The pilot then called the maintenance shop, and they asked him to try taxiing the airplane slowly back to the facility. When he attempted to move the airplane forward, he once again lost

all braking effectiveness. He immediately shut off the magnetos and the airplane rolled to a stop just off the corner of the taxiway.

The pilot saw smoke coming from under the airplane, exited the airplane to check on the smoke, and told his passenger to exit also. He observed a fire on the right main landing gear and used the fire extinguisher on board the airplane to put out the fire. He realized that the left main landing gear had caught fire as well. He then reached back into the airplane and grabbed two water bottles that he had in the airplane and used them to try to extinguish the fire on the left main landing gear, but was unsuccessful. He then called 911 and moved away from the airplane.

Pilot Information

Certificate:	Private	**Age:**	37,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 3 Without waivers/limitations	**Last FAA Medical Exam:**	June 14, 2021
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	December 22, 2021
Flight Time:	168 hours (Total, all aircraft), 145 hours (Total, this make and model), 95 hours (Pilot In Command, all aircraft), 47 hours (Last 90 days, all aircraft), 9 hours (Last 30 days, all aircraft)		

Passenger Information

Certificate:		**Age:**	Female
Airplane Rating(s):		**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	4-point
Instrument Rating(s):		**Second Pilot Present:**	No
Instructor Rating(s):		**Toxicology Performed:**	
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	CIRRUS DESIGN CORP	**Registration:**	N432CD
Model/Series:	SR22	**Aircraft Category:**	Airplane
Year of Manufacture:	2004	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	0941
Landing Gear Type:	Tricycle	**Seats:**	4
Date/Type of Last Inspection:	June 14, 2022 Annual	**Certified Max Gross Wt.:**	3400 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	2399 Hrs at time of accident	**Engine Manufacturer:**	CONT MOTOR
ELT:	Installed, not activated	**Engine Model/Series:**	IO-550-N
Registered Owner:	On file	**Rated Power:**	310 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The airplane used a free-castering nose wheel and relied on aerodynamic forces and differential braking for directional control while taxiing.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	JKA,16 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	15:57 Local	**Direction from Accident Site:**	0°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.03 inches Hg	**Temperature/Dew Point:**	31°C / 26°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Gulf Shores, AL (JKA)	**Type of Flight Plan Filed:**	VFR
Destination:	Destin, FL (DTS)	**Type of Clearance:**	VFR
Departure Time:	16:20 Local	**Type of Airspace:**	Class D

Airport Information

Airport:	Gulf Shores International Airport / Jack Edwards Field JKA	**Runway Surface Type:**	Asphalt
Airport Elevation:	17 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	27	**IFR Approach:**	None
Runway Length/Width:	6962 ft / 100 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 None	**Aircraft Fire:**	On-ground
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	2 None	**Latitude, Longitude:**	30.289639,-87.671778

Postaccident examination of the airplane by the NTSB revealed that the left side of the fuselage and the left wing had been substantially damaged by the fire. The hydraulic fluid reservoir contained brake fluid. The parking brake was functional and was not engaged. The hydraulic plumbing in the cockpit did not display any evidence of leakage, and all four master cylinders (one on each rudder pedal) and their associated plungers were intact.

The right main landing gear wheel could be rotated by hand, and the brake caliper displayed surface discoloration on the top 1/3rd of the caliper. The brake caliper and brake pads were thermally damaged, and the brake line fitting could be moved by hand.

The left main landing gear wheel was separated from the rest of the landing gear assembly as a result of thermal damage. The tire was fire-damaged along with the brake caliper, which displayed cracking. One of the two pistons was partially extended. The caliper was missing its fittings, and the brake pads were not present. The brake line swage fitting was present, but required very little torque to remove.

Flight recorders

The airplane was not equipped with a flight data recorder, nor was it required to be. It was, however, equipped with an Avidyne Entegra avionics suite, which was capable of recording event data, flight data, engine monitoring data, and performance data.

According to the recorded data, the airplane powered up at approximately 1559:00 and began taxiing at approximately 1609:00.

At 1611:36, the airplane had reached taxiway A and followed taxiway A due east to taxiway A5.

At 1611:52 it took about 1,250 rpm to get up to 15 kts after turning onto the taxiway. Once the airplane was rolling down the taxiway, it maintained 15 kts for 30 seconds with only about 1,040 rpm.

At 1612:22 engine power had increased to 1,260 rpm and the airplane was moving at approximately 20 kts.

At 1612:58, power was reduced to 1,100 rpm and the ground speed slowed down gradually over a 60-second period to around 12 kts, which was slower than the first 15-kt reference point.

At 1613:52, power increased to 1,450 rpm and the ground speed increased to 18 kts but no higher, indicating that brakes might have been applied. Power was then reduced to 1,300 rpm, but it gradually increased again up to 1,500 rpm, even as the ground speed decayed. Then as the airplane made the 90-degree turn into the hold short position while also decelerating, power decreased to 1,200 rpm going into the turn, increased to 1,400 rpm through the turn, and then decreased to idle range, with the airplane coming to a stop after the turn.

About 1617:44, the airplane lined up on runway 27. At approximately 1618:00, the airplane began to accelerate, reaching 62 kts airspeed before it began to decelerate.

At approximately 1618:52, the airplane exited the runway at taxiway A3.

Tests and Research

Brake System

The main wheels were equipped with hydraulically operated, single-disc type brakes. A parking brake mechanism held induced hydraulic pressure on the disc brakes for parking. The brake system consisted of a master cylinder for each rudder pedal, a hydraulic fluid reservoir, a parking brake valve, a single-disc brake assembly on each main landing gear wheel, and associated hydraulic plumbing. Braking pressure was initiated by depressing the top half of a

rudder pedal (toe brake). The brakes were plumbed so that depressing either the pilot's or copilot's left or right toe brake would apply the respective (left or right) main wheel brake. The reservoir was serviced with MIL-H-5606 hydraulic fluid.

According to the airplane manufacturer, brake system malfunction or impending brake failure would be indicated by a gradual decrease in braking action after brake application, noisy or dragging brakes, soft or spongy pedals, excessive travel, and/or weak braking action. They advised that should any of these symptoms occur, immediate maintenance was required.

The airplane manufacturer also advised that proper braking practices were critical to avoid potential damage to the brakes and that the most common cause of brake damage and/or failure was the creation of excessive heat through improper braking practices. Pilots unaccustomed to free-castering nose wheel steering may be inclined to "ride" the brakes to maintain constant taxi speeds and use the brakes excessively for steering.

When taxiing, directional control was accomplished with rudder deflection and intermittent braking (toe taps) as necessary. The airplane manufacturer advised to only use as much power as necessary to achieve forward movement and deceleration and that taxi speed control using brakes without a reduction in power would result in increased brake temperatures.

Manufacturer guidance indicated that engine speed should not exceed 1,000 rpm for taxi operations on flat, smooth, hard surfaces. Power settings slightly above 1,000 rpm were permissible to start motion and for turf, soft surfaces, and on inclines. The manufacturer cautioned that, "riding the brakes" while taxiing is similar to driving a car with one foot on the brake and one foot on the gas. This causes a continuous buildup of energy that would otherwise be moving the airplane.

Examination of Brake Assemblies and Brake Discs

Examination of the brake assemblies and brake disks was conducted at Aircraft Wheel and Brake LLC (formerly Parker Hannifin's Aircraft Wheel & Brake Division), in Avon, Ohio.

Both brake housings exhibited evidence of extreme heat exposure. The paint was completely burned off and the brake housings appeared dark gray to chalky white in color. The identifying brake assembly name plates were no longer present.

Examination of the left brake assembly revealed that it had been serviced with metallic linings. Although no linings were present, it was determined that metallic linings were used because the back plates and the pressure plate had lining pins installed. Lining pins are only used with metallic brake linings.

The left brake housing displayed extreme cracking, and the section of the brake housing containing the anchor bolts was completely broken off. The backplates and pistons were still present in the left brake assembly. As noted during the wreckage examination, one of the pistons was partially extended.

The left brake disc exhibited an absence of paint and dark, non-metallic coloring consistent with exposure to extreme heat. The brake disc was made of steel alloy and was plastic-media blasted to clean it for better identification.

The left brake disc was manufactured by Rapco Inc, part number RA164-01501, a parts manufacturer approval (PMA) equivalent to Aircraft Wheel and Brake disc 164-01501. This brake disc part number was not designed to be paired with metallic linings; it was designed for use with organic linings. Wheels and brakes designed and manufactured by Aircraft Wheel and Brake LLC are FAA technical standard order (TSO) qualified together as paired assemblies. Wheel assembly 40-75P is FAA TSO qualified to be used with the 30-52 brake assembly.

FAA TSO assembly components cannot be switched or substituted. The original equipment manufacturer (OEM) components for the Cirrus SR22 supplied by Aircraft Wheel and Brake, LLC up to serial number 1740, which included the accident airplane, was the 30-52 brake assembly, which utilizes organic linings and the 40-75P wheel assembly. The 40-75P wheel assembly comes standard with brake disc 164-01501. Serial number 1740 and higher were fitted with the 30-233B brake assembly, which utilizes metallic linings, and the 40-406 wheel assembly.

A Cirrus service bulletin (SB 2X-32-13), along with an Aircraft Wheel and Brake, LLC (Parker) service bulletin (SB 7085), allows an upgrade from the 30-52 brake assembly to the 30-233B brake assembly, but performing the brake upgrade also requires that the wheel be upgraded per the service bulletin. The wheel assembly upgrade to part number 40-406 includes the appropriate brake disc, 164-02504, that is qualified with the 30-233B brake assembly. The 164-02504 brake disc is .108” thicker than the 164-01501 disc that was utilized.

The brake disc acts as a heat sink to the brake assembly. The mass of the brake disc is calculated to establish the kinetic energy capacity of the brake assembly. The minimum allowed thickness of the 164-02504 brake disc that is paired with metallic linings is .445”.

The left brake disc flange thickness was measured in three places and the measurements recorded were .118” to .124” below the minimum wear limit of the 164-02504 brake disc.

The right brake disc and right brake assembly were also examined. The right brake assembly included metallic brake linings, a short supply hose and a shim that fits between the brake housing and the back plates.

The right brake disc was plastic media blasted for identification purposes and was found to be a Parker 164-01501 disc, the disc designed for use with organic linings.

The right brake disc was also measured in three locations, and found to be between .102” to .107” below the minimum wear limit (.445”) of the 164-02504 brake disc which is typically paired with metallic linings.

The right brake metallic linings were measured and found to be consistent with new lining thicknesses. The linings were then cleaned to reveal their part identification. The right brake

linings were all marked APS66-06200, which are PMA metallic linings equivalent to Aircraft Wheel and Brake, LLC part number 066-06200 metallic linings.

The shim that was present with the right brake assembly was not an OEM shim. It appeared to be made from aluminum. The OEM shim that is part of the 30-233B metallic lining brake assembly is made from an insulative material and helps to prevent heat build-up in the brake housing.

The shim present with the right brake was material tested and found to be 6061 aluminum alloy. The aluminum shim measured .0208”. The correct 068-01100 shim that is part of the 30-233B brake assembly measures .036”. The 30-52 organic lining brake assembly does not include a shim.

The left and right brake assemblies were disassembled. The back plates were removed from the left brake assembly. The pistons from each brake assembly were removed. Once the pistons were removed, O-ring material was visible. The full O-ring was not present in either assembly due to thermal damage.

The O-ring material removed from the right brake assembly contained a larger percentage of the full O-ring. It was also slightly more pliable than the left brake O-ring material, indicating that it may have been exposed to slightly less heat.

O-rings used in the 30-52 organic lining brake assembly differ from O-rings used in the 30-233B metallic lining brake assembly. Both O-rings are rated for +275°F performance, but the O-rings in the 30-233B metallic lining brake are improved high-temperature performance O-rings. Based on their condition, the O-ring material could not be determined.

The pistons found in both the left and right brake assemblies did not have the recessed cut out to accommodate a piston insulator used with metallic linings and resembled pistons designed for organic linings. The piston insulator is a key component used in a metallic lining brake assembly to help prevent heat transfer from the pressure plate into the brake housing and brake fluid.

Brake Maintenance

According to the airplane manufacturer, the brake assemblies and linings should be checked at every oil change (50 hours) for general condition, evidence of overheating, and deterioration. For parts with serial numbers 0002 thru 3450, before SB 2X-05-01, at every annual/100-hour inspection the brakes should be disassembled, the brake linings should be checked, and the O-rings must be replaced.

Maintenance History

A review of maintenance documents indicated:

- Cirrus Service Bulletin SB 2X-32-13 was not documented as having been performed, indicating that the airplane had not been upgraded for the use of metallic brake linings.

- The right brake disc was replaced in 2005 with part number 164-01501, which was compatible with original equipment/organic brake linings.

- SB 2X-32-13-R1 was completed in 2006 (Installation of temperature decals and addition of viewing hole in the wheel pant).

- The right brake disc was replaced again in 2017 – No part number was recorded.

- The brake linings were replaced during a June 2021 annual inspection – No part number was recorded.

- The brake linings were replaced during the annual inspection one day before the accident – No part number was recorded.

Administrative Information

Investigator In Charge (IIC):	Gunther, Todd
Additional Participating Persons:	Clay Caessens ; FAA/FSDO; Birmingham, AL Brad Miller; Cirrus Aircraft; Duluth, MN Nicholas Kacludis; Kaman Corporation; Avon, OH
Original Publish Date:	August 21, 2024
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=105282