



Submission of the
NetJets Association of Shared Aircraft Pilots (NJASAP)
to the National Transportation Safety Board (NTSB)
regarding the accident involving

EJA322
N322QS
EMB-505S
CEN14LA505
Conroe, TX

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Executive Summary

On Sept. 19, 2014, at approximately 0847 CDT, N322QS overran Runway 1 at Lone Star Executive Airport (CXO), in Conroe, Texas. IFR conditions required the crew to complete the RNAV approach to Runway 1 where the pilots reported they broke out at 600 feet. They continued to a normal landing with a touchdown at approximately 903 feet from the threshold at a speed of 118 knots, which was five knots over the touchdown speed specified by NetJets, Inc., (NJA) Standard Operating Procedure (SOP) of 113 (calculated V_{ref}).

The crew initiated main braking after nose wheel touchdown in accordance with the NJA SOP and thereafter began moderate main braking in line with the technique trained to them. According to the PIC's statement, the crew "began at half pressure and progressed to maximum braking, which is a normally accepted braking technique." At or near midpoint of the runway, the PM (PIC) remarked the PF (SIC) needed to slow down. At this point, the PF indicated he did not have main braking. This corresponded to him being at full deflection on the brakes, the braking pressures not increasing due to the fully modulating anti-skid system and the braking effectiveness being reduced to $\sim .15$ G from $\sim .17$ G.

Both crewmembers perceived the main brakes as being failed and consistent with their training reverted to emergency braking. In the PIC's statement he said, "We didn't even get an indication of anti-skid cycling from first application ... " to validate his perception the brakes had failed.

The emergency brake system is actuated through the parking brake handle on the center pedestal. The PF reported after both pilots had tried main braking to no avail that he pulled the emergency brake. With limited training and with the end of the runway fewer than 2,000 feet away, he pulled the parking brake handle slightly and when no apparent deceleration occurred he pulled it to the maximum up position, sending full main hydraulic pressure (3000 psi) to the brake calipers causing the brakes to lock. The wet runway and locked wheels created a steam cushion that the tires rode the rest of the way down the runway, approximately 1,877 feet; the distance was calculated based on steam marks measured after the accident.

The aircraft continued into soft turf and down an incline where the nose wheel hit a silt barrier (construction fence) and detached from the aircraft. The remainder of the strut and nose then dug into the ground and the aircraft came to rest halfway down a drainage ditch. The damage to the aircraft was substantial. Neither of the two crewmembers onboard were injured.

1.0 INFORMATION

1.1 History of Flight

The flight originated in Nashville, Tenn., (KBNA) with a departure of 0710 CDT. This was a 14 CFR Part 91 positioning leg and the first leg flown by this flight crew. The destination was Conroe, Texas (KCXO) and the alternate filed was Dallas (KDAL).

Both had been transported into BNA the day prior via airline and had a show time of 0600. This was day two of their rotation, and neither crewmember reported fatigue as a factor.

This was the first flight for both Pilots on N322QS.

NOTE: Many of our pilots believe that each serial number has unique braking characteristics.

1.2 Aircraft (N322QS)

The accident aircraft, N322QS [serial number: 50500165], was an EMB-505S with approximately 840 hours. The 10-day maintenance history showed an MEL, three MCOs and two maintenance discrepancies that had been cleared related to FADEC faults on the engine.

Damage sustained during the accident was substantial. The nose landing gear was sheared off the strut, and there was extensive damage to the nose and radome all the way to the fire wall. The fuselage was torn just forward of the landing and taxi lights, the fuel tank ruptured by the right main wheel well, and both main tires showed evidence of reverted rubber hydroplaning. The emergency junction box sustained electrical damage among other structural damage. The insurance company determined the aircraft was a total loss.

When the cockpit inspection was completed many of the switches had been moved. A fuel leak led the recovery team to attempt to limit environmental impact, motivating them to transfer fuel when able. The left Engine Fire Switch was found depressed, but all other switches appear to have been secured in accordance with the normal shutdown protocol.

System checks were completed after the accident. Tire pressures on the nose tire was 150, left main was 180 and right main was 180. The last accumulator pressure check was noted on Sept. 10, 2014, which was within the 15-day requirement. The VOR check was noted on Sept. 3, 2014. Brake wear pins showed adequate pad thickness with between one and two mm / millimeters remaining prior to being flush.

Hydraulic system checks were completed using a mobile hydraulic power unit. The unit produced system pressures of 2950 psi (3000 psi system). The brake system and spoiler were checked with no anomalies noted.

1.3 Weather

The weather reported by the ASOS at 0841 CDT was calm winds, two miles of visibility in heavy rain and mist, few clouds at 500 and a ceiling of 8,000 broken with a temperature of 23 and a dew point of 22 degrees Celsius. Showery precipitation had been in the area all morning, but total precipitation was less than half an inch.

Both Pilots reported light rain at the time of the accident.

1.4 The Airport

Lone Star Executive Airport in Conroe, Texas is a towered, general aviation airfield serving Conroe and the North Houston area. The airport has two main concrete runways that are untreated in that they are neither porous course friction nor grooved. Runway 1/19 and Runway 14/32 were available for use, but 14/32 had much of its usable distance shortened by construction and the approaches to the runway were NOTAM'd out of service.

Prior to construction, Runway 14/32 had 5,411 feet of runway available. The construction project was designed to lengthen the runway to its current length of 7,500 feet. On Sept. 19, 2014, the runway had the Northwest 1,300 feet of runway NOTAM'd closed. This reduced the available runway to 4,111 feet. Runway 1/19 was also available and had 5,000 feet available. The instrument approaches to 14 were also NOTAM'd out of service. RNAV procedures to runways 1 and 19 were available, however the PAPI to both runways were NOTAM'd out of service.

The overrun for Runway 1 was approximately 200 feet followed by a hill and a drainage ditch that amounted to 350 to 400 feet. At the bottom of the hill and prior to the drainage ditch was a silt fence with iron stakes, four-and-a-half feet tall with three feet above the ground, spaced approximately six feet apart. The drainage ditch had a landing on the side nearest to the departure end of Runway 1 and a shear face on the far side.

The runway evaluation conducted in conjunction with the performance report indicated Runway 1 was no more than wet at the time of the accident.

1.5 Performance

The aircraft performance report provides the performance details of the runway, conditions and expected aircraft performance far better than we could. Therefore, NJASAP will limit its comments to two points.

First, while it may be technically feasible for the aircraft to stop, assuming decelerations similar to those at maximum braking all the way to the end, we cannot assume that even at full braking the crew would have experienced similar brake effectiveness. It was just prior to the crew's reversion to emergency braking that they saw a marked decrease in deceleration. This was while increasing pressure on the brake pedals.

Second, the aircraft performance was described as similar in nature to that of a contaminated runway rather than one that was wet. It must be noted pilots are oftentimes held accountable for incomplete and/or incorrect runway condition information. Neither the N322QS pilots nor the CXO controllers made any statement to suggest they knew or suspected the runway was contaminated. Quite the contrary, they asserted it was wet and the performance report reinforced those statements.

1.6 EMB-505 Phenom 300 Previous Accidents & Incidents

The EMB-505 and EMB-500 have a history of runway excursions. While most have not caused loss of life, they have been catastrophic to the aircraft involved. Some incidents remain under investigation. The table featured below provides some information specific to previous accidents and incidents with an incredibly pertinent detail that is often overlooked, but consequential to understanding why these accidents and incidents are occurring and how to prevent them in future.

Date	Tail	Location	Description
09/10/10	N226CP	11R	BCU Component Failure
05/25/11	N224MD	KSEZ	Runway Excursion due to Unstabilized Approach

02/03/12	PR-PHE	SBCG	Anti-Skid and Brake Failure
08/06/12	CN-MBR	LSZR	Runway Excursion with Flap Fail
04/05/13	N196EC	KMEI	Anti-Skid and Brake Control Fail on Landing
08/05/13	N327FL	KFCM	Runway Excursion/ During Landing Roll Brake Fail
10/15/13	N610AS	KICT	Loss of Control on Landing Due to Brake Use
11/21/14	N584JS	KSGR	Pilot Reported Loss of Main Braking
11/23/14	C-GJOL	KPSP	Failure of the Rudder Gust Lock Solenoid
12/08/14	N100EQ	KGAI	Loss of Control Inflight
07/31/15	HZ-IBN	BBS/EGLK	Steep/ Fast Approach Leads to Overrun
07/26/16	N362FX	KSGR	Pilot Reported Loss of Main Braking

Several reports of Phenom Brake Control Unit (BCU) problems were found in news reports, but a search of the NTSB database for this information did not return any records. Specifically, comprehensive BCU failure data is not available despite several accidents and incidents having occurred after a crew perceived a loss of main braking. As a side note, NetJets aircraft have experienced BCU problems, but were not investigated because limited or no damage occurred.

2.0 ANALYSIS

2.1 AOM vs. AFM

The Aircraft Operating Manual (AOM) is the procedures manual for aircraft operation at NJA. The AOM, which only allows for deviation from procedures “in the case of an emergency,” claims any instance in which a procedure was modified from the OEM’s established guidance “provides an equivalent level of safety.”

When this accident occurred, there were several areas where the procedures the flight crews were asked to utilize did not match the conditions on which the performance data was predicated. Many of these procedures have since been rectified. Examples below.

- AFM performance is predicated on max braking at main wheel touchdown.
- AOM procedures required the crew to have the nose wheel in contact with the runway prior to initiating braking.
- AFM performance is predicated on being over the threshold at 50’ with power at idle and at Vref speed resulting in a touchdown at less than Vref.
- AOM procedures required a touchdown at Vref speed.

2.2 Simulator Fidelity

The EMB-505S simulator used to train pilots is owned by NJA and located in Columbus, Ohio, however simulator training is administered by Flight Safety International. The simulator does not have the fidelity for a pilot to experience braking conditions similar to what he or she would experience when piloting the aircraft. In fact, braking performance on a slick runway will feel the same as on one that is dry. The unique braking characteristics of the Phenom 300 brake system is not in any way replicated in the simulator.

2.3 Training on the Anti-Skid System

The fully modulating anti-skid system in conjunction with the brake-by-wire system creates a very dangerous combination for unsuspecting pilots/pilots who have not been trained on what to expect in these scenarios. There are three types of anti-skid systems: 1) adaptive (fully modulating), 2) on-off systems, and 3) modulating (quasi-modulating) systems. All three types have unique characteristics of which operators must be aware so they can understand their strengths, weaknesses and characteristics. For pilots transitioning from traditional brake systems with on-off or quasi-modulating systems to the Phenom system and its unique characteristics, it is vital they be fully trained on landing scenarios that feature wet and/or slippery runways.

2.4 Braking Technique

The Phenom and its brake-by-wire system are different than other small cabin NetJets aircraft. In the interests of limiting tire or brake pad wear, pilots new to the fleet were taught a unique braking technique that involved setting an undefined “intermediate brake position” or “moderate brake position.” Pilots were instructed not to expect deceleration initially, rather as the rollout continued they would feel braking begin and adjustments could be made from that point for optimal braking. This technique often required additional runway and was not in line with the AFM-prescribed braking procedure.

2.5 Unique Brake Characteristics of the Phenom 300

Why is it that so many competent pilots report a loss of main braking when no loss has occurred? The Phenom has a unique braking characteristic of which our instructors, managers and pilots were unaware at the time of the accident. We suspect the characteristic is also not well known or understood at other operators.

The unique characteristic involves the deceleration created by the combination of BCU logic and anti-skid on a wet or slippery runway. For a pilot, it is logical that as the aircraft gets weight on wheels with the same or increasing brake pressure, the aircraft braking effectiveness and deceleration would increase. Because of the adaptive anti-skid system and the BCU logic, that is not always the case in the Phenom 300. On occasion, braking on a wet and/or slippery runway will result in deceleration that degrades initially and only recovers when at slower speeds. The problem is a pilot can perceive the decrease in deceleration as an acceleration – especially when he or she does not sense feedback in his or her feet from either hydraulic pressure or anti-skid.

The accidents that continue to occur, one as recently as July 2016, begin when a highly trained and competent pilot believes he or she has lost main braking. At that point, he or she reverts to emergency braking, and, seeing the end of the runway quickly approaching, is often unable to resist the urge to pull as hard as possible. The end result is reverted rubber hydroplaning.

3.0 Conclusion

The facts of this accident are clear: A highly competent flight crew flew a stabilized approach, landed in the touchdown zone on a runway that was wet, not contaminated, and with more than adequate runway to stop according to performance numbers. Because Embraer had not provided adequate awareness training to their operators, the crew experienced a unique deceleration pattern that, despite each having more than 400 hours in the airplane, they had not previously encountered. While increasing pressure on the brakes, they received neither the feedback nor pulsating of the anti-skid to which they were accustomed. Instead, the crew felt a drop in deceleration they perceived as an acceleration.

With the end of the runway fast approaching, they proceeded to the only backup system they had: the emergency/parking brake. With the handle pulled up slightly and no perceptual increase in deceleration, the pilot flying continued to pull the emergency brake resulting in reverted rubber hydroplaning down the next 1,877 feet of the runway.

Additional accident contributors included:

- 1) the lack of simulator fidelity for the Embraer 505's unique brake system,
- 2) the braking technique taught to the crew,
- 3) the differences between AOM and AFM procedures,
- 4) insufficient training on the anti-skid and the brake system, and
- 5) an FAA allowance that permits OEMs to use a safety margin over dry-for-wet conditions and requires no contaminated performance data for aircraft certified under this part of the FARs.

Note: With regard to the final contributor, this oversight should require much higher margins. Indeed, although these aircraft are flown in common carriage under 14 CFR Part 135, a significantly elevated risk level is allowed to remain.

4.0 RECOMMENDATIONS

4.1 Recommendation for NetJets, Inc.

NetJets, Inc., has already aligned AOM procedures with the AFM, put procedures in place to address untreated runways when wet, enhanced brake system and emergency brake training and enhanced awareness of factors related to wet and contaminated runways.

Additionally, NJA should:

- continue to enhance understanding of the brake system and anti-skid system,
- work with Flight Safety International and Embraer to increase simulator braking fidelity in the EMB505 simulator,
- adopt dispatch performance planning protocols that account for contaminated runways, and
- adopt a tire wear program that ensures maximum friction coefficients are available when necessary.

4.2 Recommendations for Flight Safety International

Flight Safety International (FSI) has worked with NJA to implement additional training for the brake and anti-skid systems. They are also discussing runway overrun prevention as well as performance considerations.

Additionally, FSI should:

- work with Embraer and NJA to bring EMB505 simulator fidelity in line with the aircraft's braking characteristics.

4.3 Recommendations for the FAA

The FAA should:

- continue to monitor the Phenom BCU for evidence of software or hardware concerns,
- consider certification standards for Part 23 to include performance numbers for all approved conditions or consider requiring any aircraft flown in operations under 14 CFR Part 135 be required to be certified under 14 CFR Part 25, and
- continue to work toward understanding the performance that should be expected on each approved runway surface when dry, wet or contaminated and to publish correction factors for those surfaces that fail to meet established parameters.

4.4 Recommendations to Embraer

Embraer released a flight information letter to its operators after this accident that discussed the logic in the BCU and anti-skid system.

Embraer should:

- work with FSI and NJA to address simulator fidelity issues associated with the brake system,
- provide their operators and the NTSB with data only they have available to them with a better picture of the brake system issues and previously occurring un-reported incidents
- provide modeled performance data for wet runway conditions, and
- offer additional training through Simuflite, FSI training centers and to our instructors on the aerodynamic, BCU and anti-skid factors that lead to the unique deceleration profile on wet and/or slippery runways.