Aviation Investigation Final Report

Location:	Houston, Texas	**Accident Number:**	CEN15LA140
Date & Time:	February 9, 2015, 22:07 Local	**Registration:**	N953UW
Aircraft:	Embraer ERJ 190 100 IGW	**Aircraft Damage:**	Substantial
Defining Event:	Sys/Comp malf/fail (non-power)	**Injuries:**	1 Minor, 55 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

The crew reported that the flight was normal until the landing gear handle was selected down during final approach when they received a landing gear amber caution and red warning messages on the Engine Indication & Crew Alerting System (EICAS). The flight crew accomplished the applicable Quick Reference Handbook checklist items, including the Alternate Landing Gear Extension checklist. They then performed two low passes of the control tower, which confirmed the nose landing gear was not extended. The crew then accomplished the Partial Gear Up Landing Preparation checklist and landed with the nose gear retracted. After landing the captain called for an evacuation after the cockpit filled with smoke.

Post accident examination of the airplane found substantial damage to the lower forward fuselage that included abraded and missing skin. The nose landing gear (NLG) was found rotated and jammed within the nose gear bay. The nose landing gear and several other components were removed for examination and testing. There were no faults found to the nose wheel steering hydraulic manifold and selector valve, and proximity sensor electronic module.

The nose wheel steering control module (NWSCM) was also removed for download and testing. The NWSCM nonvolatile memory (NVM) indicated that there were numerous drift monitor activations after takeoff and continued after the nose landing gear was retracted. (The drift monitor keeps the nose gear at an electrical neutral position [i.e. centered] during the time between nose gear liftoff and when the gear is stowed.) The NVM flight history data recorded a NWSCM failure approximately 37 minutes after takeoff during the accident flight. Following the NVM download, an acceptance test was performed on the NWSCM with no faults found. Review of maintenance records showed that the NWSCM was installed 11 months prior to the accident to comply with a manufacturer Service Bulletin. The installation procedures required maintenance personnel to rig the steering feedback sensors (0 degrees ± 1 degree) after installation and then to record the rigging values in the Central Maintenance Computer on the airplane's multi-function display in the cockpit. This task was stamped as accomplished in the airplane maintenance records. Although the NWSCM NVM flight history data matched the installation date in the

maintenance records, there was no rigging data saved in the NVM, likely indicating that the rigging process was improperly completed.

On the accident flight, the nose gear retracted normally after takeoff and then, about 37 minutes after takeoff, an undetermined fault occurred in the NWSCM and it failed to reach a “safe” mode condition. Because the nose gear steering feedback sensors were not rigged properly when the NWSCM was installed, a drift monitor steering command remained active as the "last command." When the flight crew commanded the landing gear to extend during the approach, the steering hydraulic pressure became active and the NLG rotated, responding to the "last command" from the NWSCM. This rotation resulted in the NLG becoming jammed in the nose landing gear bay, which prevented it from extending. The flight crew conducted the appropriate checklists, however, no inflight actions would have resulted in the NLG extending prior to landing.

As a result of this accident and three other similar events, the airplane manufacturer issued two service bulletins in July 2016 to upgrade the NWSCM to address the failure scenario.

Probable Cause and Findings

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

An undetermined malfunction of the nosewheel steering control module, which resulted in the nose landing gear being jammed in the gear bay. Contributing to the accident was the improper rigging of the nosewheel steering feedback sensors during installation.

Findings

Aircraft	Landing gear steering system - Malfunction
Personnel issues	(general) - Maintenance personnel

Factual Information

History of Flight

Landing	Sys/Comp malf/fail (non-power) (Defining event)
Landing-flare/touchdown	Landing gear not configured

On February 9, 2015, about 2207 central standard time, an Embraer ERJ-190-100-IGW airplane, N953UW, landed with the nose landing gear not extended at the George Bush Intercontinental Airport (IAH), Houston, Texas. The 4 crew and 51 passengers were not injured; one passenger received minor injuries during the subsequent airplane evacuation. The airplane was registered to and operated by US Airways under the provisions of Title 14 *Code of Federal Regulations* Part 121, as a scheduled domestic passenger flight. Night visual meteorological conditions prevailed for the flight, which operated on an instrument flight rules flight plan.

US Airways flight 1825 departed Philadelphia International Airport (PHL), Philadelphia, Pennsylvania, about 1706, destined for George Bush Intercontinental Airport (IAH), Houston, Texas. According to the operator, the flight crew reported that when they placed the landing gear lever in the down position near IAH, they received amber caution and red warning messages on the engine indication and crew alerting system. After accomplishing quick reference handbook items, the crew could not determine the position of the landing gear and conducted two passes by the air traffic control tower; tower personnel indicated that the nose landing gear (NLG) was not down. The crew declared an emergency, and the captain landed the airplane on runway 27 with the NLG retracted; the forward fuselage contacted the runway, and the flight deck filled with smoke.

After the accident it was discovered that the nose landing gear (NLG) was rotated within the nose gear bay, which jammed the NLG within the bay and did not allow the nose gear to extend normally. Several components related to the NLG and nosewheel steering system were removed for examination and testing.

The failure of the NLG to extend was related to an inadvertent nosewheel steering command from the nose wheel steering control module (NWSCM) following an undetermined failure. The NWSCM contains a drift monitor function to keep the nose gear centered from the time between nose gear liftoff and when the gear is stowed after retraction. The drift monitor operates continuously when the NLG is weight off wheels but cannot command a steering response when the NLG is fully retracted due to lack of steering hydraulic pressure when the NLG is stowed. Once the landing gear was commanded to extend, steering hydraulic pressure was restored and the nose landing gear rotated due to the inadvertent command from the NWSCM. The command was related to the following combination of factors.

- The nose gear steering feedback sensors (resolvers) were misrigged to the point that the nosewheel steering control module's (NWSCM) drift monitor function became active, as the digital voice and data recorder (DVDR) data indicated deflection of the NLG resolvers after

lifting off the runway. (The drift monitor function, which aligns the NLG before retraction into the wheel well, remains active when the NLG is fully retracted but does not turn the gear when stowed due to the lack of hydraulic pressure.) As designed, the drift monitor function remained active during flight with the landing gear retracted.

- The NWSCM experienced an undetermined failure during cruise flight that resulted in the NWSCM control channel halting internal communication. However, the NWSCM did not fail in a "safe" mode; a steering command (electrical current) remained active as a "last command."

- When the flight crew commanded the landing gear extension during the approach to landing, an uncommanded steering actuation occurred as hydraulic pressure was applied to the NLG steering actuator. The hydraulic pressure caused the NLG to prematurely rotate; it then became jammed inside the landing gear bay. The transition of the discrete weight off wheels (WOFFW) from TRUE to FALSE indicated the gear had turned.

- The NWSCM showed “no fault found” when subjected to the manufacturer's acceptance test protocol.

- No nosewheel steering rigging data was found in the contents of the NWSCM's nonvolatile memory. However, US Airways maintenance documentation related to an engineering order for the NWSCM installation on the airplane indicated that a successful rigging was accomplished. A successful nosewheel rigging would have included recording the rigging data recorded into the NWSCM memory.

The investigation determined general commonalities between this accident event, two previous events, and one event that occurred after this event.

During the course of the investigation, Embraer issued service bulletins with actions to prevent the circumstances that led to the failure scenario that occurred in this event. Service Bulletins 1 and 2, below, were issued for a check of steering rigging condition and adjustment, if necessary:

1. Service Bulletin 170-32-0076: Original issue date 09/Mar/15; Current Revision 03 dated 29/Apr/2016.
2. Service Bulletin 190-32-0063: Original issue date 09/Mar/15; Current Revision 03 dated 29/Apr/2016.

Service Bulletins 3 and 4, below, were issued to replace the existing NWSCM part numbers with Part Number 1855A0000-06, which incorporated modified software:

3. Service Bulletin 170-32-0082: Original issue date 08/Apr/16; Current Revision 01 dated 24/Jun/2016.
4. Service Bulletin 190-32-0070: Original issue date 08/Apr/16; Current Revision 01 dated 24/Jun/2016.

Pilot Information

Certificate:	Airline transport	**Age:**	40,Male
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	August 21, 2014
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	July 27, 2014
Flight Time:	12463 hours (Total, all aircraft), 3720 hours (Total, this make and model), 873 hours (Pilot In Command, all aircraft), 182 hours (Last 90 days, all aircraft), 47 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Co-pilot Information

Certificate:	Airline transport	**Age:**	32
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	January 15, 2015
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	April 2, 2014
Flight Time:	7810 hours (Total, all aircraft), 467 hours (Total, this make and model), 0 hours (Pilot In Command, all aircraft), 140 hours (Last 90 days, all aircraft), 40 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Embraer	**Registration:**	N953UW
Model/Series:	ERJ 190 100 IGW NO SERIES	**Aircraft Category:**	Airplane
Year of Manufacture:	2007	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	19000133
Landing Gear Type:	Retractable - Tricycle	**Seats:**	105
Date/Type of Last Inspection:	February 9, 2015 Continuous airworthiness	**Certified Max Gross Wt.:**	114100 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:	16216 Hrs at time of accident	**Engine Manufacturer:**	General Electric
ELT:	C126 installed, not activated	**Engine Model/Series:**	CR3410E6
Registered Owner:	US AIRWAYS INC	**Rated Power:**	17390 Lbs thrust
Operator:	US AIRWAYS INC	**Operating Certificate(s) Held:**	Flag carrier (121)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night
Observation Facility, Elevation:	IAH	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	05:53 Local	**Direction from Accident Site:**	360°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.04 inches Hg	**Temperature/Dew Point:**	15°C / 3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	PHILADELPHIA, PA (PHL)	**Type of Flight Plan Filed:**	IFR
Destination:	Houston, TX (IAH)	**Type of Clearance:**	IFR
Departure Time:	18:06 Local	**Type of Airspace:**	

Airport Information

Airport:	GEORGE BUSH INTERCONTINENTAL IAH	**Runway Surface Type:**	Concrete
Airport Elevation:	96 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	27	**IFR Approach:**	Unknown
Runway Length/Width:	10000 ft / 150 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	4 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Minor, 51 None	**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Minor, 55 None	**Latitude, Longitude:**	29.984443,-95.341392

Administrative Information

Investigator In Charge (IIC):	Brannen, John
Additional Participating Persons:	James D Moore; FAA - Houston FSDO; Houston, TX
Original Publish Date:	May 6, 2021
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=90712