

Aircraft Accident Investigation Bureau of Myanmar

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For aviation related investigations, the AAIB conducts the investigations in accordance with Myanmar Aircraft Act and Myanmar Aircraft Accident and Incident Investigation Rules and Annex-13 to the Convention on International Civil Aviation.

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Accordingly, it is inappropriate that AAIB reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

**FINAL REPORT OF SERIOUS INCIDENT OF NOSE LANDING GEAR
FAILURE EMERGENCY LANDING OF MYANMAR NATIONAL AIRLINES,
EMBRAER-190 AIRCRAFT (REG: XY-AGQ) AT MANDALAY
INTERNATIONAL AIRPORT, ON 12 MAY, 2019**

SYNOPSIS

At 09:06 (Local time) on 12 May 2019, Myanmar National Airlines Embraer-190 aircraft, registered (XY-AGQ) performing flight UB-103 from Yangon to Mandalay made an emergency landing on runway 17 of Mandalay International Airport where the nose landing gear failed to extend. On board the Embraer-190 aircraft were the Pilot in command (PIC), first officer (FO), Safety Pilot, 4 cabin crew and 82 passengers. There were no injuries and the aircraft sustained substantial damage. The Aircraft Accident Investigation Bureau of Myanmar classified the occurrence as a serious incident.

Aircraft Details

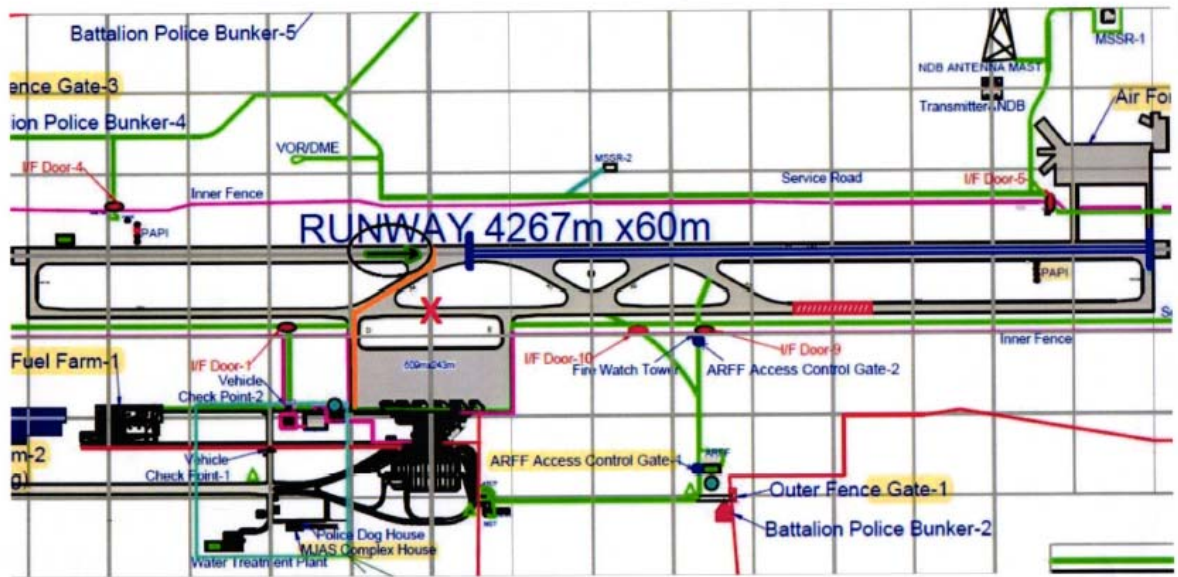
Registered owner and operator	: Myanmar National Airlines
Aircraft type	: Embraer-190
Nationality	: Myanmar
Registration	: XY-AGQ
Place of Occurrence	: Mandalay International Airport (VYMD), N 2° 42' 25", E 95° 58' 35"
Date & Time	: 12 May 2019 at (09:06) Local time
Type of operation	: Scheduled Passenger Flight
Phase of operation	: Landing on Runway 17
Persons on Board	: Seven Crew and eighty-two passengers

1. FACTUAL INFORMATION

All times used in this report are Myanmar times. Myanmar time is six hours and thirty minutes ahead of Coordinated Universal Time (UTC).

1.1 History of the flight

At 07:15 on 12 May 2019 an Embraer 190 aircraft (XY-AGQ), with 89 persons onboard piloted by a trainee pilot (First Officer) flew the Yangon-Mandalay sector. The flight crew comprised of the Pilot-in-command (PIC), a safety pilot and a trainee pilot. The line trainee pilot was the pilot flying all the way to Mandalay International Airport. He made an RNP approach to runway 17 when he was 7 nm away from the runway. Twenty seconds after he commanded the landing gear control lever to DOWN, a LG LEVER DISAG warning message appeared on the Crew Alerting System (CAS), accompanied by triple aural chimes. At that time the pilot in command took the control from the line trainee pilot and the safety pilot from the jump seat took the copilot seat. At 08:26 the aircraft informed Air Traffic Control (ATC) of the nose landing gear failure and requested the ATC's permission to fly an altitude 2000 ft with heading 270°. The flight crew tried to perform an abnormal landing gear extension procedure as per the Quick Reference Handbook (QRH) two times and requested the ATC to monitor the landing gears situation. It was found that the nose landing gear door was ajar and landing gears could not be down. At 08:38 the aircraft declared May Day Call (State of Emergency) to the ATC and performed Partial or Gear Up Landing Procedure. The aircraft flew away 35nm from the Mandalay International Airport with heading 320° to dump the aircraft fuel. At the same time the pilot in command announced to the passengers the emergency situation and requested to follow flight attendant's instructions. At 08:52 the aircraft made a RNP approach to the runway 17 of Mandalay International Airport and requested the airport fire station to stand by to respond to the emergency situation. At 09:06 the aircraft made the emergency landing with the nose landing gear failed to extend. The aircraft came to stop 4800ft from runway 17 threshold on the runway near exit taxiway A4 with smoke coming from the cockpit. All the passengers on board disembarked from the emergency slides according to the emergency evacuation procedure with the help of airport firefighters and crew. There were no injuries and no fire broke out in this serious incident.



Figure(1) Layout of Serious Incident Site

1.2 Injuries to Persons

1.2.1 Myanmar National Airlines

Injuries	Crew	Passengers	Other	Total
Fatal	0	0	0	0
Serious	0	0	0	0
None	7	82	0	89
Total	7	82	0	89

1.3 Damage to Aircraft

- Fuselage Lower Skin at Nose Landing Gear Section between FR3 and FR8 and STGR 26LH and 26RH
- Lower Skin and Lip Skin of Left Air Inlet Cowling
- Nose Landing Gear Door
- Forward Avionic Compartment Access Hatch
- Control Wire and Circuit Breakers at Cockpit Console



Figure (2) The final position of the aircraft on the runway of Mandalay International Airport



Figure (3) Closer view of the aircraft nose contact with the runway



Figure (4) Left engine Cowling contact with the runway



Figure (5) Closer view of the nose landing gear in the wheel well



Figure (6) Damage to the aircraft Nose Landing gear section



Figure (7) Damage to the aircraft Nose Landing gear section



Figure (8) The Impact Marks on the runway



Figure (9) Disabled aircraft removal action

1.4 Other Damage

There was no other damage due to this serious incident.

1.5 Personnel Information

Pilot in Command (Myanmar National Airlines)

Age	: 45 years
Licence	: Air Transport Pilot Licence
Licence issued date	: 18 July 2011
Total hours	: 11018:56 hrs
On type	: 3700:00 hrs
Medical expire	: 31 July 2019
Line check date	: 26 November 2018
Type rating check date	: 8 February 2013
Last 90 days	: 158:24 hrs
Last 30 days	: 51:37 hrs
Last 24 hours	: Nil
Rest before duty	: 24 hrs

Trainee-Pilot (Myanmar National Airlines)

Age	: 26 years
Licence	: Commercial Pilot Licence
Licence issued date	: 31 January 2017
Total hours	: 445:20hrs
On type	: 3hrs
Medical expire	: 31 October 2019
Line Check date	: Under Training
Type rating check date	: 12 April 2019
Last 90 days	: 3hrs
Last 30 days	: 3hrs
Last 24 hours	: 3hrs
Rest before duty	: 48hrs

Safety Pilot (Myanmar National Airlines)

Age : 25 years
 Licence : Commercial Pilot Licence
 Licence issued date : 23 March 2017
 Total hours : 1386:21hrs
 On type : 1300 hrs
 Medical expire : 31 October 2019
 Line Check date : 30 March 2019
 Type rating check date : 3June 2017
 Last 90 days : 264:57hrs
 Last 30 days : 117:12hrs
 Last 24 hours : 6:24hrs
 Rest before duty : 13hrs

1.6 Aircraft information**Myanmar National Airlines**

Manufacture : Brazil
 Type : EMBRAER 190
 Serial number : 19000231
 Date of Manufacture : 1-12-2008
 Total Airframe hours : 19476:13 hrs
 Certificate of Registration : XY-AGQ
 C of A issue date : 10-12-2019
 Last Time Check : 5 May 2019
 Total flying hours : 19476:13hrs

1.7 Meteorological Information

The METAR weather reported at Mandalay International Airport on the 12th at 09:00 local time was variable wind direction at 10 knots from 180 degrees with Gust wind of 25 knots, visibility 6000 meter, few clouds at 2500 ft, Temperature 35°C, Dew point 24°C and regional atmospheric pressure 1007 hpa.

1.8 Aid to Navigation

The availability and use of navigation aids were not relevant to this incident.

1.9 Communication

Radio communications between the aircraft and Mandalay Tower were normal and were not a factor in this incident.

1.10 Aerodrome Information

Mandalay International Airport has one main runway 17/35 with a length of 14000ft at an elevation of 200ft above mean sea level and is certified for both VFR and IFR flight. Runway Strength (PCN) is 55/R/A/W/T and the airport has an ATC control tower, controlling class B airspace with radar surveillance facilities.

It is a certificated aerodrome and aerodrome manual has been developed and implemented since 2012. The operation hours are 24 hours. The aerodrome category for the firefighting is CAT 9. Because of this serious incident the aerodrome operations had to stop for about two and a half hours and then reopened with some restrictions and some flights had to divert to adjacent airports and some were cancelled and delayed.

1.11 Recorders

The aircraft's Digital Voice Recorder (DVDR) was removed and read out in Transport Safety Investigation Bureau of Singapore (TSIB).

1.11.1 Digital Voice Data Recorder

Digital Voice Data Recorder (DVDR), Part Number 980- 6025-001 and Serial Number 02931.

The recording quality of the FDR data was of good quality. The FDR contained 27 hours and 13 minutes and 47 seconds of flight data that encompassed 23 flights prior to the incident flight. The FDR had 1027 parameters in the data frame file.



Figure (10) Digital Voice Data Recorder



Figure (11) Digital Voice Data Recorder

1.12 Wreckage, Site and Impact Information

The coordinates of serious incident site is Latitude N 21° 42' 25", Longitude E 95° 58' 35". When Aircraft Accident Investigation Bureau (AAIB), Myanmar investigators arrived at the occurrence site the aircraft was on the runway 4800ft from the runway 17 threshold. The weather was fine and the sun was shining brightly. Firefighters, airport and airlines personnel were busy with their respective activities for the disabled aircraft removal process and reopening the airport operation and necessary action.

Measurements and photographs were taken of the occurrence site, and ground markings and tracks were inspected and casual interviews were conducted among witnesses.

1.13 Medical and Pathological Information

The pilots underwent a medical and toxicological test after the occurrence. The test revealed no abnormality.

1.14 Fire

There was no fire before and after the incident. However, a large amount of smoke originated from the cockpit, reached the cabin and came outside.

1.15 Survival Aspects

As soon as the aircraft came to stop, the cabin crew deployed the emergency slides and over wing exits. All the passengers on board disembarked from the emergency slides according to the instructions of cabin crew. Airport fire fighters who arrived at the incident site in standby helped in the evacuation process. The airport fire fighters extinguished the heat and smoke in the cockpit by applying foam.

DCA personnel, the airport personnel, the aviation police and the airline personnel arrived at the scene and provided care and assistance as necessary. The survivability of the incident was due to (1) the decision of making of the flight crew members and their crew resource management during the incident sequence (2) the use of an airplane that was equipped with emergency slides (3) the performance of the cabin crew members while expediting the evacuation process

(4) the cooperation of the passengers and (5) the readiness of the airport fire fighters to the incident site.

1.16 Organizational and Management Information

1.16.1 Myanmar National Airlines

Myanmar National Airlines, is a state-owned airline and the flag carrier of Myanmar, based in Yangon. Founded in 1948, the airline operates scheduled services to all major domestic destinations and to regional destinations in Asia. Its main base is Yangon International Airport. Myanmar National Airlines provides ground-handling services for other airlines charter, scheduled and non-scheduled flights. It had 19 numbers of fleet such as Boeing 737-800, ATR 72-500, ATR 72-600, Cessna 208 Caravan and Embraer 190. Myanmar National Airlines served 28 domestic destinations and 5 were international destinations.

The airline operator has established and maintained a flight data analysis program as part of its safety management program since 2015. The Safety Action Group (SAG) meeting is held once a month and the Safety Review meeting every three months respectively.

1.17 Additional Information

1.17.1 Testimony of a Pilot

He stated that on 8 May 2019 on a schedule passenger flight from Yangon to Mandalay, after having retracted the nose landing gear, WOW SYSFAIL message appeared on the Crew Alerting System (CAS). Therefore, according to Quick Reference Handbook (QRH) procedure, he turned back to Yangon, the nearest airport. He entered this fault message into the Technical Log book. The aircraft engineer rectified the fault shortly meanwhile there were passengers on board. After that he flew again according to the schedule. He also stated that this fault message appeared intermittently during these days.

For another occasion, on 11 May 2019 he flew this aircraft on a schedule passenger flight from Yangon to Sittwe. During the take-off roll he

felt that the nose landing gear was shaking a bit. He entered that fault "**Nose Wheel Tension is stronger than the normal during take-off and landing rolling.**" into the Technical log book.

1.17.2 Testimony of a Aircraft Maintenance B2 Engineer

He stated that he was a qualified aircraft maintenance engineer; on 8 May 2019 the aircraft (XY-AGQ) encountered Landing Gear WOW System fault just after take-off from Yangon and returned to Yangon and the Pilot-in-command entered a Landing Gear WOW System fault message into the Technical Logs book. The engineer said that the maintenance action performed was cleaning the Nose Landing Gear sensors, connector and targets according to Fault Isolation Manual (FIM) (32-61-00-810-890-A00). After that he checked CMC of the aircraft, that there were no WOW SYS fault messages active. The aircraft returned to service shortly.

1.17.3 Testimony of a Aircraft Maintenance B1 Engineer

He stated that he was a qualified aircraft maintenance engineer and on 11 May 2019 he and his team was on duty for Daily Inspection and Preflight Inspection for that aircraft. He informed that the maintenance action performed for the condition, "**Nose wheel tension is stronger than normal during take-off and landing rolling**" was the Nose Landing Gear shock Strut N2 Chamber Servicing, according to Aircraft Maintenance Manual (AMM) 12-12-09-600-804-A. He also stated this condition, was not included in Fault Isolation Manual. Therefore, he decided on the appropriate maintenance action for this fault based on his experience. After that he checked the Dimension H of sliding tube of Nose Landing Gear based on the temperature 30°C, it was within limit in the graph of (AMM) 12-12-09-600-804-A. In this way he rectified the snag.

1.17.4 Landing Gear retraction system of the Embraer 190

The landing gear retraction system of the Embraer 190 aircraft is following:

- There are 6 WoffW sensors installed in the aircraft, two per MLG and NLG leg;

- When the NLG shock absorber is fully extended the WOffW sensors indicate “WOffW = TRUE”;
- With only around 13mm of shock absorber compression (i.e. not fully extended by 13mm) the WOffW sensors indicate “WOffW = False”;
- If at least one WOffW sensor (from any of the MLG or NLG legs) indicates “WOffW = False”, the LGCL cannot be moved up, which is a safety feature to prevent inadvertent landing gear operation on ground;

Note: In this case it is still possible to move the LGCL to the “gear up” position by using an override button that is located in the LGCL.

Analysing the Flight data, it can be seen that initially all 6 WOffW sensors had indicated a transition to “WOffW = TRUE” after the takeoff. See figure 12, below:

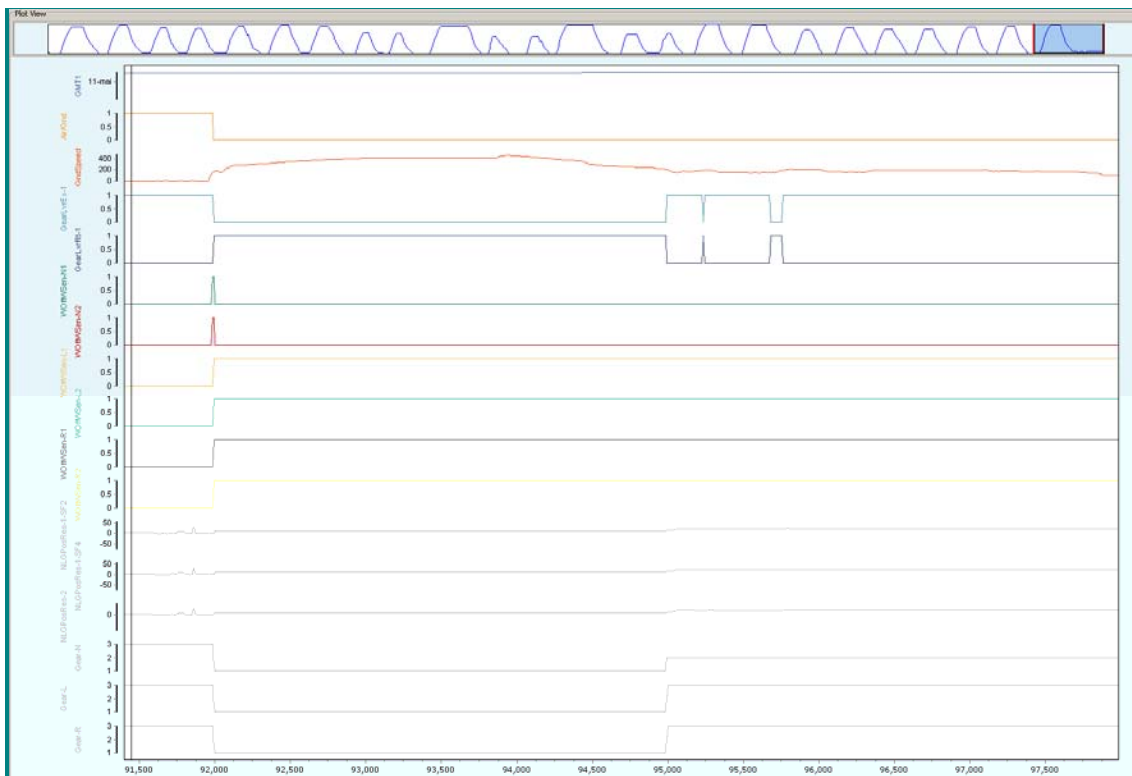


Figure (12) Event Flight Data – WoffW Sensors Signals

With all 6 WOffW sensors indicating “WOffW = TRUE”, the LGCL could be commanded to “gear up” in order to command the landing gears to retract. It can be seen in the data that this command happens just after WOffW is established. See Figure 13, below:

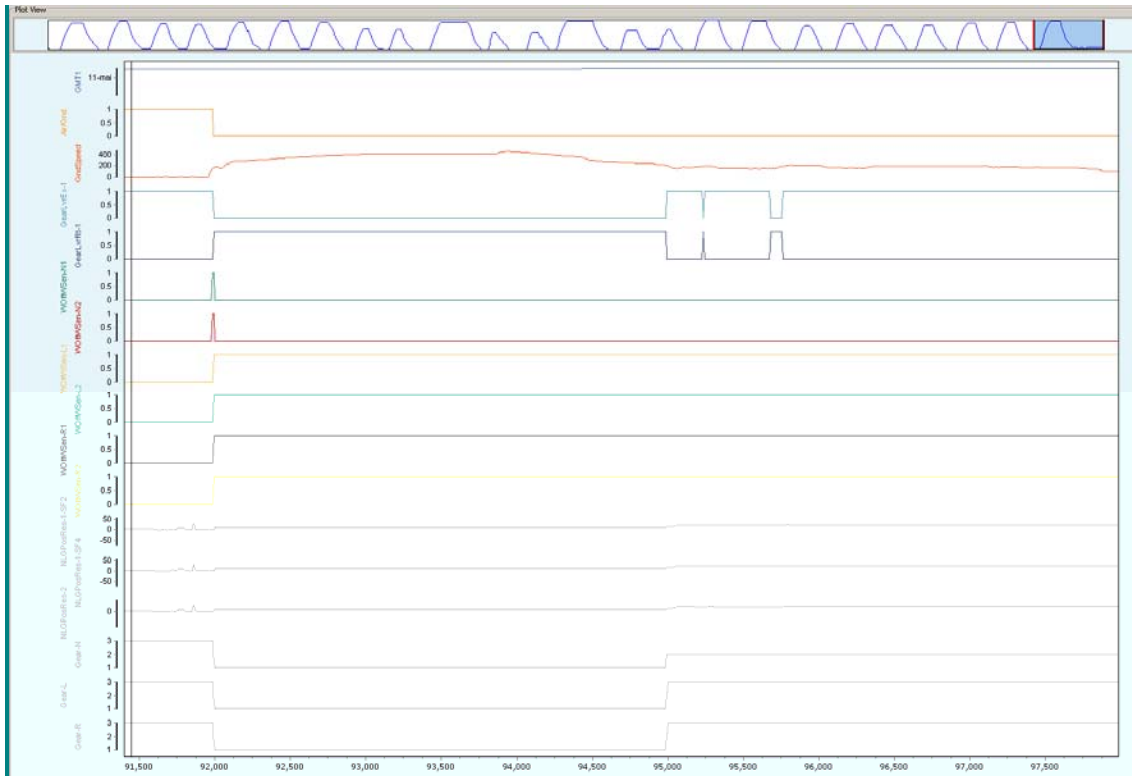


Figure (13) Event Flight Data - Gear Retract and Gear Extend Signals

It can be seen that, right after gears retraction command is given, all three gear position indications transition from “down and locked” to “in transit”.

At the same moment, it can be seen that, right after gears retraction command is given, both NLG WOffW sensors transition to “WOffW = FALSE”, which indicates that the NLG shock absorber compressed at least 13mm.

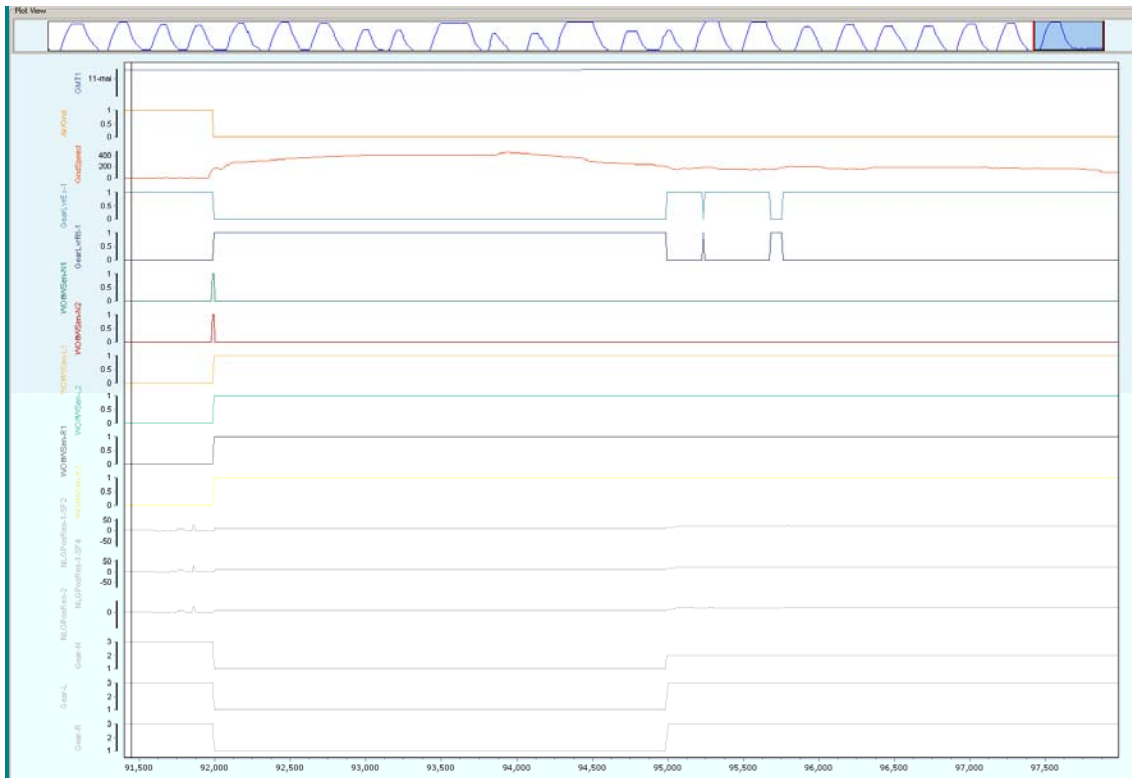


Figure (14) Event Flight Data - NLG WoffW Sensors and Gear Position Signals

With these data points in mind, please consider also the following information regarding the ERJ190 design:

- When landing gear retraction is commanded, hydraulic power is cut from the steering system;
- The NLG is equipped with a mechanical feature called self-centering cam that guarantees that the NLG steering angle will be centered when the shock absorber is fully extended. (i.e. it is expected that the NLG steering angle would be between -1° and $+1^\circ$ if the NLG shock absorber is fully extended)
- If the NLG steering angle is lower than -8° or higher than $+8^\circ$, there is not enough clearance for the NLG to enter or leave the NLG wheel bay

Referring back to the flight data; seconds after the NLG WoffW sensors transitioned to “WoffW = FALSE” the NLG steering position can be seen to shift from around 0° to around 20° . And just moments after that, all three gear

2 ANALYSIS

2.1 Introduction

The analysis by the investigation team has focused on the following areas:

- a) Maintenance Action
- b) Visual Inspection at the incident site
- c) Failure of Nose Gear to Extend
- d) Impact of Improper Maintenance

2.2 Maintenance Action

A technical log entry on 8 May 2019 indicated that there was a WOW SYS FAIL, during the pervious flight. From the technical log records, the maintenance action performed was that of cleaning the Nose Landing Gear WOW sensors, connector and targets before returning the aircraft to service. On 11 May 2019, a set of flight crew entered into the technical log records that " **the Nose Wheel tension was stronger than normal**". This prompted a maintenance action on 11 May 2019 to service the NLG. This incident flight was the first flight after this maintenance action.

2.3 Visual Inspection at the incident site

When the investigation team arrived at the incident site, the disabled aircraft was on the runway of Mandalay international airport. The investigation team took the visual inspection of the aircraft itself and the impact marks on the runway. The nose landing gear door was found open ajar but the nose landing gear itself was misaligned and stuck in the wheel well. For the disabled aircraft removal, they discharged Nitrogen from the oleo of the nose landing gear and managed to lever it out.

2.4 Failure of Nose Gear to Extend

When the aircraft took off for the event flight, the NLG WOffW signal changed from "WOffW=False" to "WOffW=True" as soon as the aircraft lifted off from the ground. The "WOffW=True" signal indicate that the NLG was sufficiently extended so that the NLG self-centering cam was engaged, thus guaranteeing that the NLG was centered at the beginning of the retraction phase.

The data shows that the NLG WOffW position signal transitioned from “WOffW=True” to “WOffW=False” between the time when the NLG position was last recorded as DOWN & Locked and first recorded as Up & Locked. (Note that that sample rates of the recorded data do not permit conclusion to the precise timing and sequence of the events). The “WOffW=False” signal indicated that the NLG was sufficiently compressed to disengage the self-centering cam, allowing the nose gear tyre to rotate freely.

Two seconds after the “WOffW=False” signal was recorded, the NLG steering angle changed from approximately 1 degree to 11.7 degrees. The exact reason for why the nose gear compressed during retraction, which allowed the tires to be rotated, could not be identified as the NLG gas and oleo chambers had to be bled for the aircraft recovery, this factual information supporting this aspect of the investigation was lost.

Due to the limited opening into the NLG wheel well, the maximum nose gear tyre angle limit for the NLG to be able to enter or exit the wheel well is 8 degrees in either the left or right direction. For the event flight, as this maximum nose gear tyre angle was exceeded, there would not have been enough clearance for the NLG to leave the wheel well and it remained stuck for the rest of the flight. This resulted in the failure of the NLG to extend when repeatedly selected by the flight crew and requiring the eventual landing to be performed, with the NLG stuck in the wheel well.

2.5 Impact of Improper Maintenance

The flight data stored on the FDR included information on 23 additional flights prior to the event flight. In all these flights, the data shows that the NLG WOffW position signal transitioned from, “WOffW=True” to “WOffW=False” between the time when the NLG position was last recorded as DOWN & Locked and first recorded as Up & Locked. The “WOffW=False” signal indicated that the NLG was sufficiently compressed to disengage the self-centering cam, allowing the nose gear tyre to rotate freely.

While all these flights were operated uneventfully, the risk of the nose gear tyre rotating beyond the limit and getting stuck in the wheel well was present. This risk due to improper servicing of the NLG to rectify the “LG WOW SYS FAIL” message.

This event highlights the importance for maintenance crew to follow the maintenance and troubleshooting guidance from the aircraft manufacturer. This will allow defects to be rectified as soon as possible, to eliminate potential flight safety consequences.

3 CONCLUSIONS

3.1 Findings

From the evidence available, the following findings are made. These findings should not be read as apportioning blame or liability to any particular organization or individual:

- (a) On 17 August 2017 Nose Wheel Steering Control Module(NWSCM)for the aircraft(XY-AGQ) was replaced and complied with the Service Bulletin 190.32.0070 issued by the Embraer regarding uncommanded movement of the nose landing gear steering actuator in flight.
- (b) On 8 May 2019 the aircraft on route from Yangon-Mandalay, on the way WOW SYS FAIL Message appeared on the CAS system just after gears retraction was commanded, after take-off from Yangon airport. Therefore, the aircraft turned around and made landing on Yangon airport as per Quick Reference Handbook(QRH).And then maintenance action was performed on the NLG WOW sensors by the aircraft maintenance engineer and the aircraft was returned to service shortly on that day again.
- (c) On 11 May 2019 while that aircraft, on the route from Yangon to Sittwe, took off from Yangon airport, the pilot felt that the nose landing gear was shaking obviously during take-off roll and retracting landing gears .On the other hand, the pilot felt the nose landing gear was shaking obviously during extending landing gears. Therefore the pilot entered that fault into the technical log book by "**Nose Wheel Tension is Stronger than Normal During Take off and Landing Rolling**".

- (d) At the night of 11 May 2019 maintenance action for" **Nose Wheel Tension is Stronger than Normal During Take-off and Landing Rolling**" was done by the aircraft maintenance engineer. The incident flight was the first flight after this maintenance action.
- (e) On 12 May 2019 the Preflight Departure Inspection (PDI) was routinely done by the aircraft maintenance engineer just before the flight.
- (f) On 12 May 2019 the aircraft flew the Yangon-Mandalay sector. The aircraft made a RNP approach to runway 17 of Mandalay International Airport. While the aircraft was on downwind 17nm from the runway 17, landing gears were put down by the trainee pilot. At that time **Landing Gear Lever Disagree Message** appeared on Engine Indication and Crew Alert System (EICAS) with Three Red Warning Sign.
- (g) The FDR contained 27 hours and 13 minutes and 47 seconds of flight data that encompassed 23 flights prior to the incident flight. The flight data recorder only had recorded flights from 9 May 2019 onwards. All flight data stored on the FDR shows that the both NLG weight off wheels sensors indicated that the aircraft Nose landing gear (NLG) position transitioned from "NOT ON GROUND" to "ON GROUND" after the Landing Gear Control Lever was commanded to "UP" and before the NLG position transitioned to UP& locked. This was observed for all recorded flights. However, there was no indication that this abnormal condition had affected the extension and retraction and retraction of the NLG as the NLG operated normally for the preceding 23 flights.
- (h) Even though all flight data stored on the FDR showed that the WOWSYS FAIL CAS message became active after gear retraction on all flights, most of the pilots did not enter that fault into the Technical Log Book.

3.2 Probable Cause

Maintenance actions were not properly done as per the fault isolation manual in rectifying the intermittent Weight off Wheels System Fail fault and in

addition, poor workmanship in performing the Nose Landing Gear Strut N2 servicing.

4 SAFETY RECOMMENDATIONS

To reduce and eliminate of accidents and serious incidents, AAIB recommended the followings:

- (1) Maintenance action should be properly done as per the Fault Isolation Manual (FIM), if necessary close coordination with Embraer the aircraft manufacture.
- (2) Flight crew should enter fault messages into the Technical log book in a systematic and thorough manner, and let maintenance engineers know about it as soon as possible.

Investigator-in-charge