LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Administration des enquêtes techniques

FINAL REPORT
ON THE ACCIDENT OF 24 SEPTEMBER 2003
IN LUXEMBOURG
TO THE LUXAIR EMBRAER E145
REGISTERED LX-LGZ

Final issue: December 2010

ADMINSTRATION OF TECHNICAL INVESTIGATIONS

CIVIL AVIATION – RAIL – MARITIME - RIVER

Ministry of Sustainable Development and Infrastructures
Department of Transport

Administration of Technical Investigations

Report N° AET-2010/AC-01

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ON THE ACCIDENT OF 24 SEPTEMBER 2003
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FOREWORD

In accordance with Annex 13 to the Convention relative to the International Civil Aviation Organization, with Directive 94/56/CE of the Commission and to the Luxembourg law dated 30 April 2008 on technical investigations in relation to accidents and severe incidents which happened in the domains of civil aviation, maritime transport and railways, it is not the purpose of the aircraft accident investigation to apportion blame or liability.

The sole objective of the investigation and its final report is the prevention of future accidents.

Consequently, the use of this report for purposes other than prevention may lead to wrong interpretations.

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LIST OF FIGURES

ABBREVIATIONS

AFM	Aircraft flight manual
AMM	Aircraft Maintenance Manual
AOM	All Operator Message / Aircraft Operating Manual
ATC	Air Traffic Control
ATP	Acceptance test procedure
CMM	Component maintenance manual
CRM	Crew resource management
CVR	Cockpit voice recorder
DFDR	Digital Flight Data Recorder
EHSV	Electro Hydraulic Servo Valve
EICAS	Engine Indicating and Crew Alerting System
FDR	Flight Data Recorder
ILS	Instrument Landing System
kts	Knots
LH	Left Hand
MHz	Megahertz
MLG	Main landing gear
ms	Millisecond
NLG	Nose landing gear
NW	Nose Wheel
OEM	Original equipment manufacturer
QNH	Pressure setting to indicate elevation above mean sea level
RH	Right Hand
RWY	Runway
SB	Service Bulletin
TAF	Terminal aerodrome forecast
TWY	Taxiway
UTC	Universal Time Coordinated
WOW	Weight on wheel

SYNOPSIS

Date of accident
Wednesday 24 September 2003 at 08 H 38[(1)]
Accident site
Luxembourg Airport

Aircraft
Embraer E145 LU – registration: LX-LGZ
S/N 145-258
Owner
LUXAIR
Operator
LUXAIR

Type of flight
Public transport of passengers
Flight LG8852 Vienne - Luxembourg

Persons on board: 12 total
2 cockpit crew, 2 cabin crew, 8 passengers

Summary

After landing on runway 06, directional control is lost during deceleration and the aircraft departs the runway to the right, to be finally stopped by the airport perimeter fence.

Persons on board	**Persons**			**Aircraft**	**Load**	**Third parties**
	Fatal	Injured	Not injured	Damaged	-	Airport perimeter fence
Crew	0	0	4			
Passengers	0	0	8			

1 Unless otherwise specified, times mentioned in this report are UTC times.

ORGANISATION OF THE INVESTIGATION

According to article 26 of the Chicago convention of the ICAO and its annex 13, the Grand-Duchy of Luxembourg, country of occurrence, started a technical investigation. An investigation commission was created by ministerial decree.

Investigators assisted by technical staff from the operator removed the flight data recorders. A survey on the accident site revealed some extensive damage to the airframe without impairing the airframe structural integrity.

Upon completion of these first actions, the aircraft was towed into a hangar for further tests and a complete assessment of the damages assisted by the operator staff and representatives of the Embraer Paris office.

At the same time, the flight data recorders were taken to the French BEA for read-outs and analyses.

Brazil, as State of manufacture of the aircraft nominated an accredited representative. The United States of America, as State of manufacture of numerous OEM components, also nominated an accredited representative from the NTSB.

A number of components and equipments, removed from the aircraft were taken to the manufacturers for examination and additional tests. These activities were done in the presence of the investigation team, the NTSB and on two occasions the FAA.

1 FACTUAL INFORMATION

1.1 History of the flight

An Embraer 145 registered LX-LGZ and operated by Luxair departed Vienna (Austria) on 24 September 2003 at 07:18 on flight LG 8852 with destination Luxembourg (ELLX). The flight was uneventful up to the landing on RWY 06 at 08:39, when on rollout directional control was lost and the aircraft departed the runway to the right approximately 1500 m beyond threshold 06 at the intersection with TWY's E and I.

1.2 Injuries to persons

Injuries	Crew	Passengers	Other persons
Fatal	-	-	-
Serious	-	-	-
Minor / None	0	0	0
Total	0	0	0

1.3 Damage to the aircraft

The aircraft was damaged when it hit the airport perimeter fence with its RH side. Severe damage occurred from the nose cone along the RH fuselage to the right wing root, wing leading edge and flaps.

1.4 Other damage

The airport perimeter fence was destroyed on a length of about 200 meters.

1.5 Personnel information

1.5.1 Captain

Male: 37 years, airline transport pilot licence

Total flight hours: 9396:52
Hours on type: 3274:48
Last 3 days: 10:38
Last 28 days: 63:36
Last 30 days: 70:00
Day of the accident: 1:12 before the last flight
Preceding rest time: 14:52

Last checks:
Proficiency check: OPC 06.09.2003 / LPC 15.03.2003
Line check: 30 April 2003
Medical check: Class 1 dated 12.09.2003 / expires 24.10.2004.

1.5.1.1. Licenses
Swiss ATPL, CH-25556 issued 28.05.1999

1.5.1.2 Qualifications
TR captain E145 on 25.4.1999

1.5.2 Co-pilot

Male: 24 years, commercial pilot licence

Total flight hours:	851:27
Hours on type:	429:58
Last 3 days:	6:13
Last 28 days:	65:11
Last 30 days:	64:43
Day of the accident:	1:12 before the last flight
Preceding rest time:	14:52

Last checks:

Proficiency check:	OPC: 13 September 2003 / LPC: 9 March 2003
Line check:	2 May 2003
Medical check:	Class 1 dated 10 December 2002 / exp. 31 December 2003

1.5.2.1 Licenses
French CPL license N° F-LCA00210956 issued 18.12.2001

1.5.2.2 Qualifications
E145 Copilot issued 19.03.2003

1.5.3 Cabin crew

	Purser	Stewardess
Female:	32 years	27 years
Entry date at Luxair:	1998	2001
Last Safety recurrent checks:	12 Nov 2002	26 Feb 2003

1.6 Aircraft information

1.6.1 Airframe

- Manufacturer: Embraer 145 (Brazil)
- Type: EMB 145 LU
- Serial N°: 145-258
- Registration certificate Nr. 685 dated 10 September 2003

Airworthiness certificate N° 7618:

- Delivered:05 June 2003
- Valid until:08 May 2006

Flight hours up to 24 September 2003: 7875,46

Cycles up to 24 September 2003: 6489

Engines
Manufacturer: Allison Rolls - Royce

Engine	Type	Serial Number	Operating hours	Cycles
Left	AE-3007A1	CAE 310115	8584,01	7428
Right	AE-3007A1	CAE 311176	8703,32	7398

1.6.2 Mass and balance

Certified maximum takeoff mass is 21 990 kg. The aircraft was within the approved weight and balance envelope.

1.7 Meteorological information

The Terminal Area Forecast and Metrological Aerodrome Reports at the time of the accident provided following details:

METAR	08:20	05010		CAVOK	9	4	1030	NOSIG
	08:50	05010	020V090	CAVOK	10	5	1031	NOSIG

TAF0716 06008KT CAVOK

1.8 Aids to navigation

At the time of the accident at Luxembourg airport, all navigation aids were functioning without any remarks.

1.9 Communications

The flight crew was in radio contact with Luxembourg Tower (ATC) on frequency 118.100 MHz during the event. There were no communication problems between the aircraft and ATC. Communications between ATC and the aircraft were recorded and used in the investigation.

1.10 Aerodrome information

The airport has a single runway oriented 241° / 061° of a length of 4000 meters. Threshold elevation of runway 06 is 1158 feet. The two runway orientations are each equipped with,

- ILS category 1 on runway 06
- ILS category 3 on runway 24.

The fire protection category of the airport is category 8, in accordance with ICAO Annex 14.

All technical equipments of the airport worked normally.

1.11 Flight recorders

1.11.1 Cockpit Voice Recorder (CVR)

The aircraft was equipped with a Honeywell CVR, type SSCVR part number 980 – 6022 – 001 serial number 2543. The CVR was removed from the aircraft on the day of the accident and secured by the investigation commission. The data from the CVR was of good quality and was used in the investigation.

1.11.2 Flight Data Recorder (FDR)

The aircraft was equipped with a Honeywell FDR, type SSFDR part number 980-4700-019 serial number 5017. The FDR was removed from the aircraft on the day of the accident and secured by the commission. The data from the FDR was of good quality and was used in the investigation.

Final validated data is shown in appendix 1.

1.11.3 Read out results

The recorders have been taken to the French BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile) for read outs. Extractions of the tapes and the readings have been done in the presence of the investigation commission and the Luxair Embraer fleet chief.

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Recorded data was of good quality and was used during the investigation.

1.12 Wreckage and impact information

1.12.1 General

The aircraft landed on RWY 06 and 5 seconds after touch down the aircraft veered to the right and departed the runway into the grass area. It was stopped by the airport perimeter fence on the edge of a downslope embankment.

Figure 1. Tire marks on the runway

Rubber marks from all tires were visible throughout the roll-out phase, some more pronounced than others. Immediately apparent were the rubber marks from the nose gear. The aircraft departed the runway in a right skidding motion, which was reversed in the grass area.

Figure 2. Aircraft was arrested by the airport boundary fence

1.12.2 Wreckage examination

The aircraft was severely damaged on its RH side, the fuselage being punctured in several places, the whole leading edge of the RH wing was damaged when it knocked down the fence posts and some flap damage occurred as well by the posts and the fence sliding underneath the wing.
All tires except one (LH inner punctured when colliding with a runway edge light) remained inflated.
The nose landing gear remained pointed to the right at a substantial angle. EMBRAER analysed the skid marks and estimated the wheel angle between 30-40°.

Figure 3. Close-up view of aircraft halted by fence

1.12.3 Evacuation of the aircraft

Once the aircraft came to rest, the captain ordered the cabin crew to evacuate the aircraft. This was swiftly done onto the service road, where the airport fire brigade just arrived and took over with the passenger guidance and coordinated busses for transportation to the main terminal.

1.12.4 Runway inspection

After the accident, the airport has been closed. Prior to returning to operational status, a runway inspection was performed to check for possible debris. No objects were found.

1.13 Medical and pathological information

It has been decided not to undertake any medical or pathological investigations.

1.14 Fire

There was no fire.

1.15 Survival aspects

As the loss of directional control on the runway was instantaneous and the pilots were struggling to regain control of the aircraft, the cabin crew could not be briefed upon the eventual outcome of this rollout. All cabin crew and passengers had their safety belts fastened.

1.16 Tests and research

Directional control was lost during rollout and, after analyses of available CVR and FDR data, it became apparent that it was an uncommanded directional input. The investigation commission concentrated on analysing and testing all the components directly linked to the nose wheel steering systems.

Due to the irregular tire marks left on the runway, it was decided to have the main gear braking system tested and analysed as well.

1.16.1 Nose gear steering system

1.16.1.1 Steering system description

The nose wheel steering system permits moving the nose landing gear when the aircraft is on the ground. The hydraulic system supplies power to operate the steering actuating cylinder. A steering handle and the rudder pedals control the steering operation.

The electrical system supplies electrical power to control the steering system. The hydraulic system supplies hydraulic power to operate the steering at a pressure of 3000 psi.

Control of the nose wheel steering system is performed through the steering handle installed on the LH console and/or through the pilot’s and copilot’s rudder pedals.

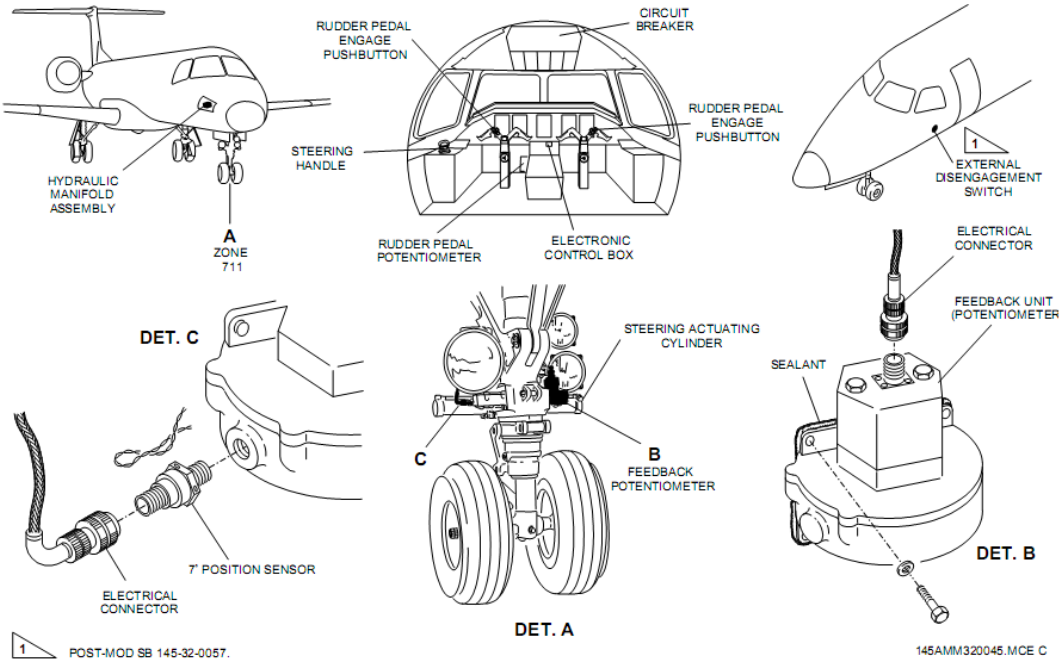
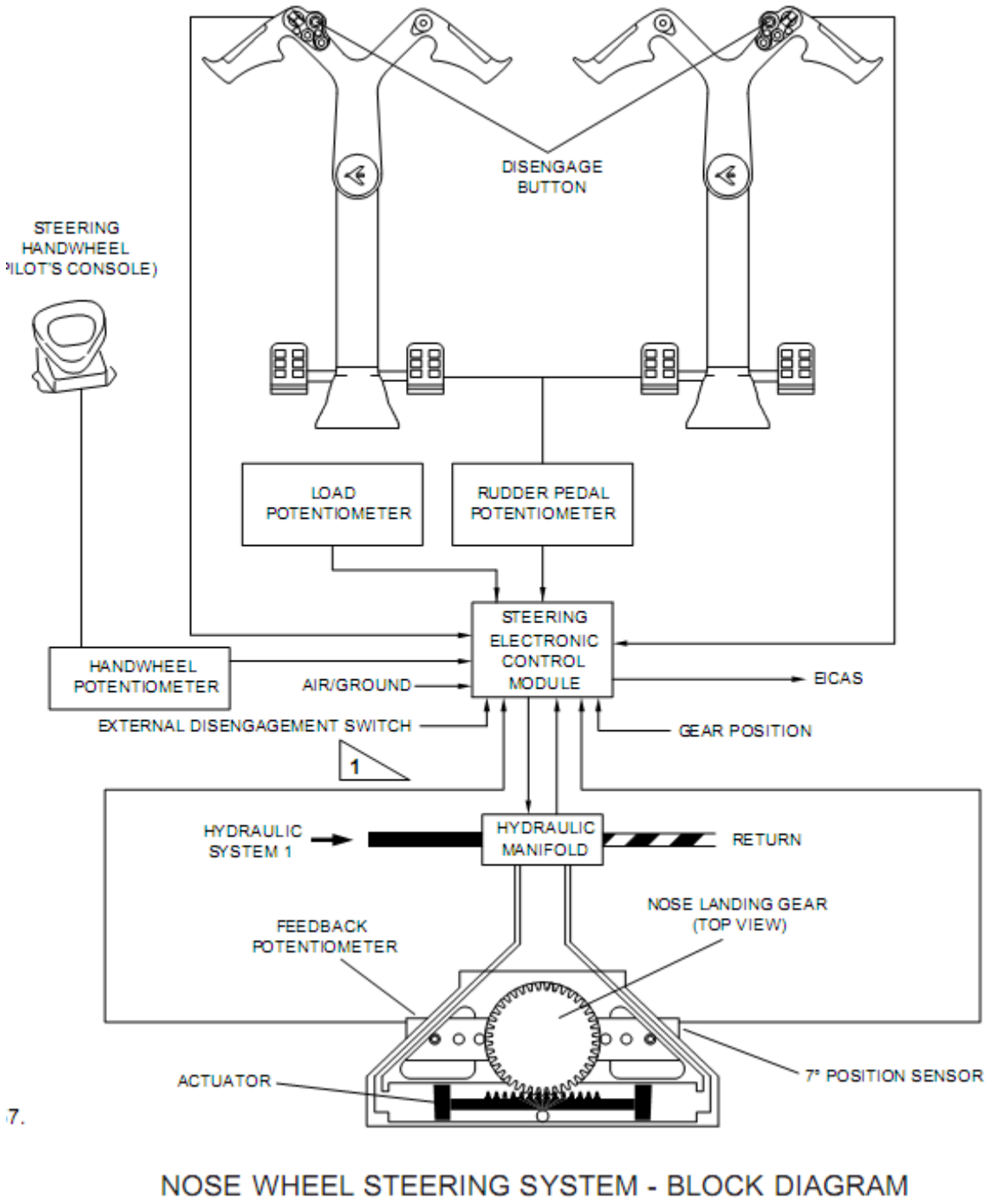


Figure 4. Nose wheel steering system – component location

1.16.1.2 Component description

The steering system comprises:

1. A steering handle (potentiometer and control switch).
2. Rudder pedals (pilot's potentiometer).
3. Control wheel disengagement pushbuttons.
4. External steering disengagement switch (optional).
5. Feedback Unit Potentiometer.
6. 7° position sensor.
7. Load potentiometer.
8. Steering Electronic Control-Module (SECM).
9. NLG proximity switch
10. Hydraulic manifold assembly.
11. Steering actuating cylinder.



NOSE WHEEL STEERING SYSTEM - BLOCK DIAGRAM

Figure 5. Nose wheel steering system-block diagram

1.16.1.2.1 Steering handle

The steering handle controls the steering of the nose landing gear wheels during the taxiing of the airplane. This handle controls the changes of direction of the NLG wheels to the left and to the right sides. The limit of movement is 71° to each side, from the potentiometer centre position.

The steering handle has two movements of actuation. The first one permits operating the steering select reset switch. It occurs when a small forward down pressure is applied on the steering handle.

The second movement causes the actuation of the potentiometer. It occurs through transmission gears and a turning movement of the steering handle.

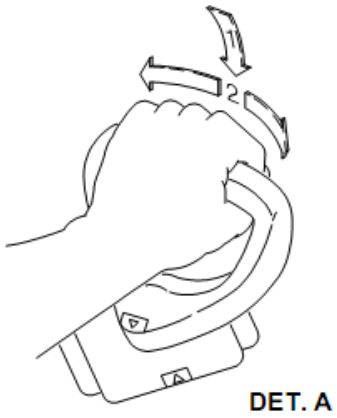


Figure 6. Steering handle commands

1.16.1.2.2 Rudder pedals

The rudder pedals control the rudder, the brakes, and the direction of the nose wheel. The directional control is possible, during the takeoff or landing phases, up to 5° ± 0.5° to the right and left sides. The rudder pedal potentiometer, installed on the pilot's pedal mechanism, has the function of sending electrical signals to the "SECM". These signals are proportional to the rudder pedal movement. The bellcrank torque-tube gear of the pedals operates the potentiometer gear.

1.16.1.2.3 Control wheel disengage pushbuttons

The press-on press-off type disengagement switches on the pilot's and copilot's control wheels disengage the steering control system. The disengage pushbutton is normally used for the towing push-back procedures. The pilot (left control wheel) or the copilot (right control wheel) can use the pushbuttons individually.

1.16.1.2.4 External steering disengagement switch (optional)

The two-position external disengagement switch provides an alternative procedure to disengage the steering control system. This switch permits the nose wheel steering system disengagement by the ground personnel.

1.16.1.2.5 Feedback Unit Potentiometer

The Feedback Unit Potentiometer is a rotary potentiometer which makes a clockwise or counter clockwise voltage signal used in the NLG steering control loop. The voltage given by the potentiometer is relative to the position of the Strut axle. The maximum controlled steering range is +/-57°. It supplies the SECM with the nose wheel position signals.

1.16.1.2.6 7 degree position sensor

The Feedback Unit Sensor is a target ring, assembled with a shaft and gear in two part housing. It is installed on the Nose Landing Gear strut steering system. Its function is to give a target, related to the position of the Strut wheel axle, for use with the proximity sensor. Movement of the steering pinion turns the gear and target ring of the Feedback Unit Sensor.

This position sensor detector is installed on the aircraft during Nose Landing Gear assembly by EMBRAER and is connected opposite to the Feedback Unit Potentiometer. This proximity sensor senses the operation limits for the rudder pedal commands. It sends a signal to the nose wheel steering system to disengage the system if the wheel turning angle is more than ± 7 degrees (see Figure 4 Detail C for location).

1.16.1.2.7 Load potentiometer

The load potentiometer is of the multi-turn type. It sends a constant signal load to the handwheel input during operation of pedals. It gives precision zero centring adjustment to the nose wheel.

1.16.1.2.8 Steering electronic control module (SECM)

The "SECM" controls the nose wheel steering system and receives signals from:

- The electrical potentiometers:
  - Steering handle
  - Pedals
  - Feedback
  - Load
- The rudder-pedal disengagement pushbutton.

After processing these signals, it sends the resulting signal to the hydraulic manifold solenoid valve and servo valve.

1.16.1.2.9 NLG Proximity Switch

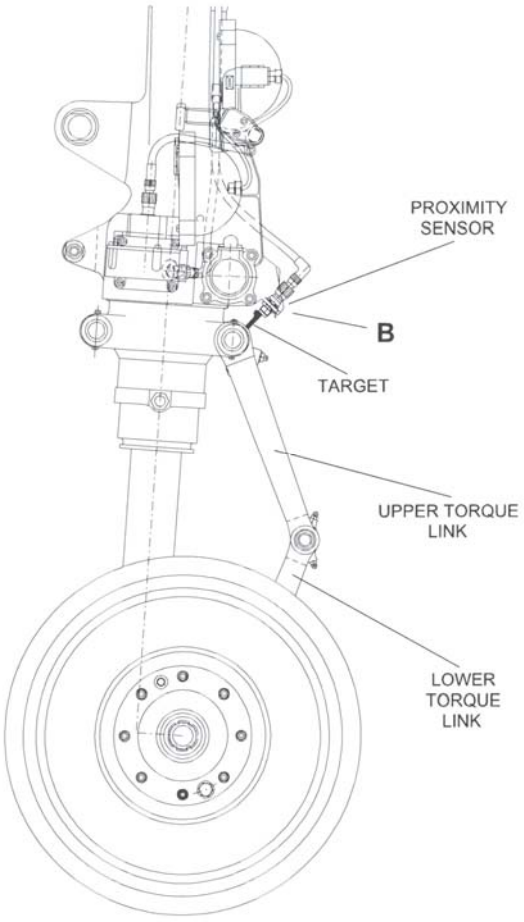


Figure 7. NLG Proximity Switch

There are a total of five WOW proximity switches installed on the aircraft which are responsible to detect the shock absorber extension/compression movements. Four are installed on the Main Landing Gear and one on the Nose Landing Gear which sends the AIR/GROUND indication signal directly to the interface relays related to logic of the thrust reverser, steering and gust lock system and to the logic of the landing gear control lever downlock release button.

The proximity switch assembly is a hermetically sealed proximity sensor and electronic switch assembly. The switch has two active output states that represent mechanical position status. When the target is near, the switch output is closed (sensor actuated) providing a ground return for the output load. When the target is far, the switch output is open (sensor deactivated) terminating current flow through the output load.

1.16.1.2.10 Hydraulic manifold assembly

The hydraulic manifold assembly is installed in the airplane nose hydraulic compartment. It controls the hydraulic pressure fluid that goes to the steering actuating cylinder.

The NW steering manifold assembly is an electro-hydraulic (EHSV) unit that provides fluid pressure to the actuator that controls the nose wheel steering system. The manifold supports and contains an EHSV, solenoid, three check valves, a bypass valve, an electrical connector, a filter and a compensator.

Operation of the servo valve can be seen by referencing the schematic diagrams inserted hereafter.

The basic function of the servo valve is to control the flow of hydraulic fluid at the cylinder ports. The input is in the form of an electrical signal to the torque motor, and within the specified range, the hydraulic output flow is directly proportional to the signal applied.

The servo valve is comprised of two main assemblies; the first stage torque motor and the second stage, or power stage. The torque motor is the electromechanical portion of the valve and is designed to produce a mechanical deflection of the flapper, which is proportional to the electrical input signal. The flapper interacts with the first stage nozzles, causing an increased restriction at one nozzle while decreasing the restriction at the other. Pressure in one circuit branch is increased while being diminished in the other. Connecting these pressures to the ends of the power stage spool controls the motion of the spool.

Spool motion varies the size of the load flow metering slots of the power stage. Flow proportional to input current is achieved by the use of rectangular metering slots (area proportional to spool displacement) and by restraining the spool with a spring referenced directly to the torque motor armature. This force feedback produces a torque on the armature proportional to spool displacement. This torque opposes the torque produced by the input current. The balance of these torque result in spool displacement (and hence, load flow) proportional to input current.

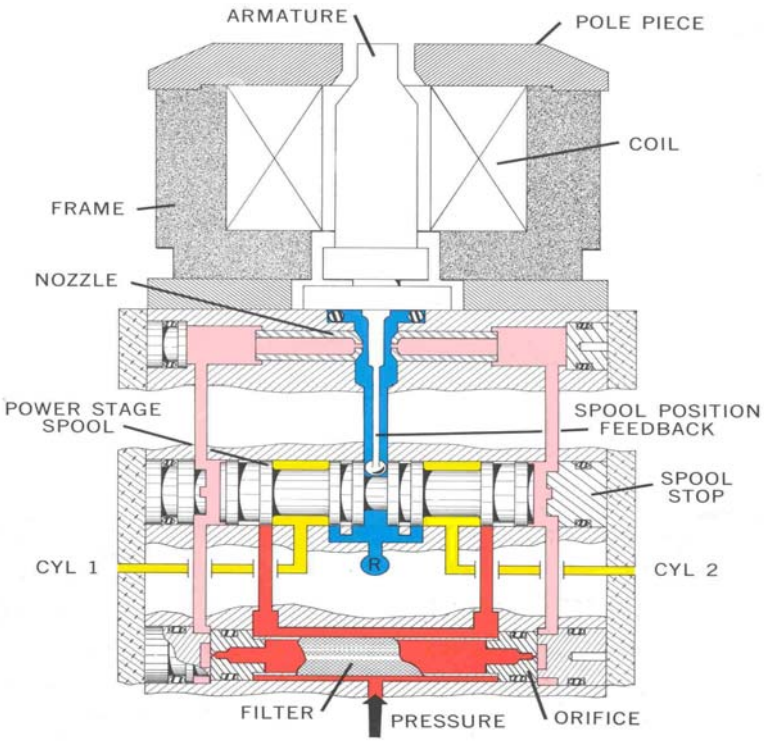


Figure 8. Hydraulic Schematic

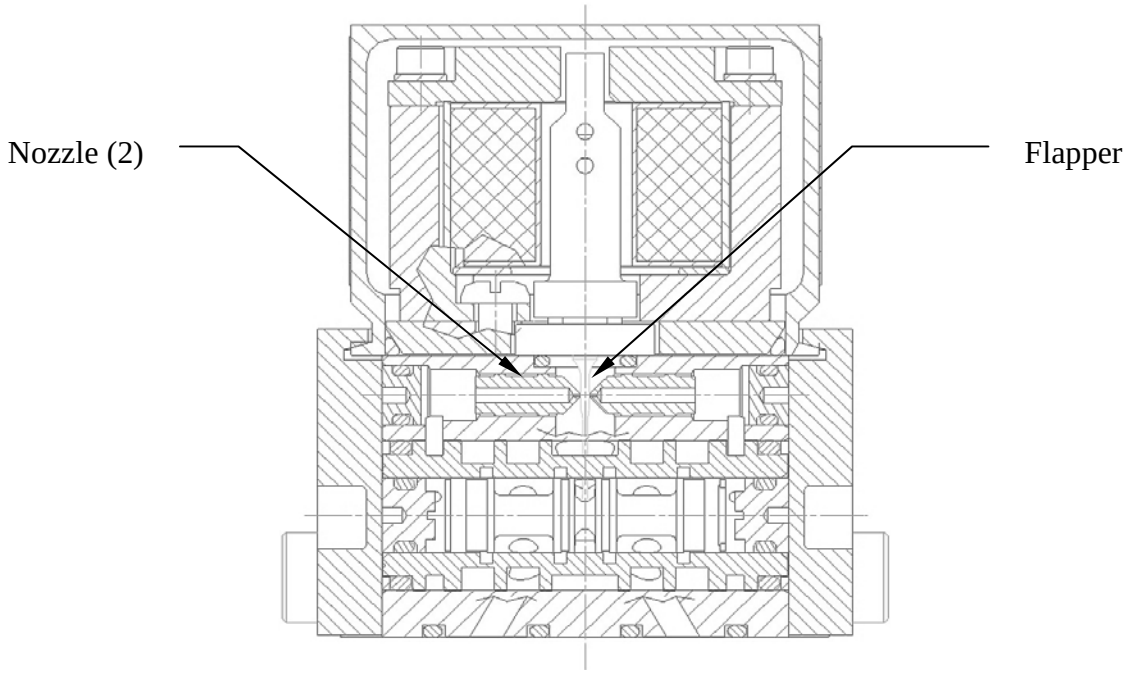


Figure 9. EHSV Cross Section

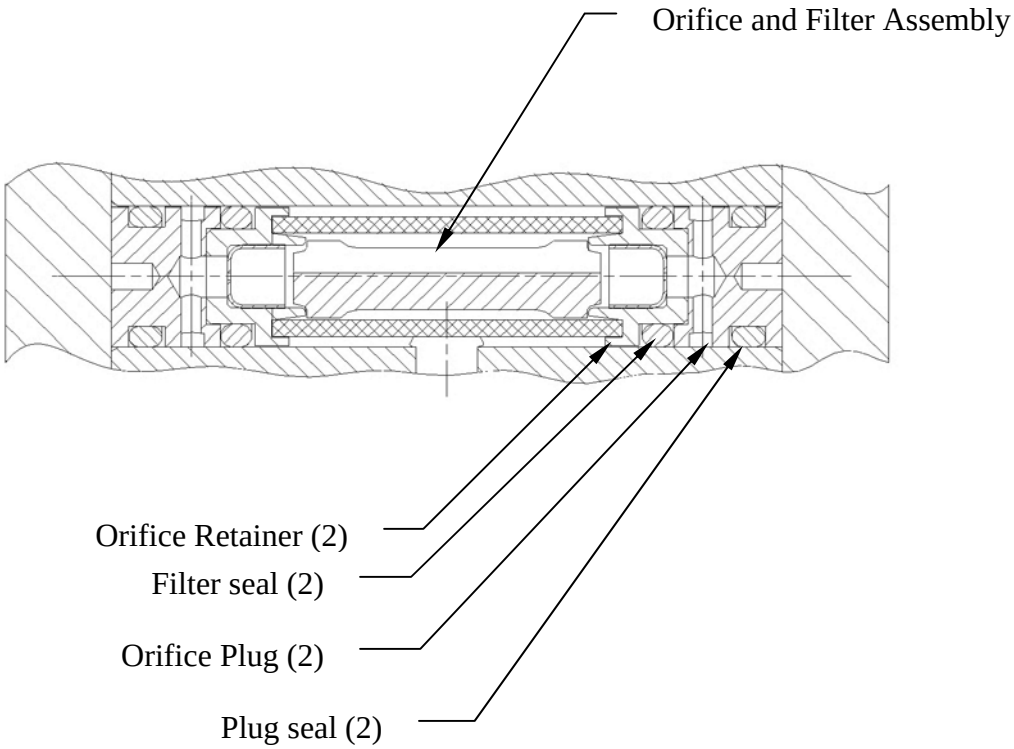


Figure 10. Filter Bore Cross Section

1.16.1.2.11 Steering actuating cylinder

The steering actuating cylinder, installed on the nose landing gear, controls the nose landing gear wheel direction. The actuating cylinder receives hydraulic pressure fluid from the electro-hydraulic servo valve. The pressure moves the piston, which moves the strut cylinder/piston tube.

1.16.1.2.11.1 Operation

The operation of the steering actuating cylinder is commanded by the steering handle.
The control signals from the steering handle and pedal potentiometers supply the electronic control module. The SECM sends a signal to the hydraulic manifold to pressurize the steering actuator in the commanded direction. A feedback potentiometer, installed in the nose landing gear leg, sends a signal to the SECM. This signal refers to the nose wheel displacement for the monitoring function.

The position sensor of the landing gear leg permits the system disengagement. It occurs if the nose wheel angle is above ± 7° when the operation is through the rudder pedals. To re-engage the system, it is necessary to start the command through the handle. The nose wheel steering system can be manually disengaged, through switches on the pilots' control yokes.

The system stops the circuit operation as soon as the airplane is airborne. A cam puts the nose wheel in the centre position when the nose gear shock absorber extends.

If a failure of the electronic control module occurs, the EICAS shows a caution message.

1.16.1.2.11.2 Hydraulic operation

HYDRAULIC MANIFOLD SOLENOID VALVE DE-ENERGIZED - Steering handle wheel and rudder pedal in neutral.
In this condition, the bypass valve is at the bypass mode. It permits one actuating cylinder chamber to be connected to the other. A compensator in the hydraulic manifold maintains up to 50 psi in the hydraulic circuit to provide damping and prevent cavitation while in bypass mode.

HYDRAULIC MANIFOLD SOLENOID VALVE ENERGIZED - Steering handle or rudder pedals operated.
In this condition, the hydraulic fluid from hydraulic system 1, less than 3,000 psi, goes through the solenoid valve. At the same time, it goes to the bypass valve and to the servo valve. The bypass valve closes and stops the connection between the two actuating cylinder chambers.
Moving the steering handle or rudder pedals to make a turn commands the servo valve torque motor to create an imbalance in pressure across the power stage spool. The power stage spool displaces proportionally to one side, directing system pressure to one side of the steering gear actuating cylinder. The low-pressure side of the actuating cylinder piston is routed through the hydraulic manifold compensator relief valve to return.

1.16.1.2.11.3 Electrical operation

The solenoid valve energizes through electrical signals from these relays:

- K0025 - WOW system (air/ground).
- K0352 - Nose shock absorber.

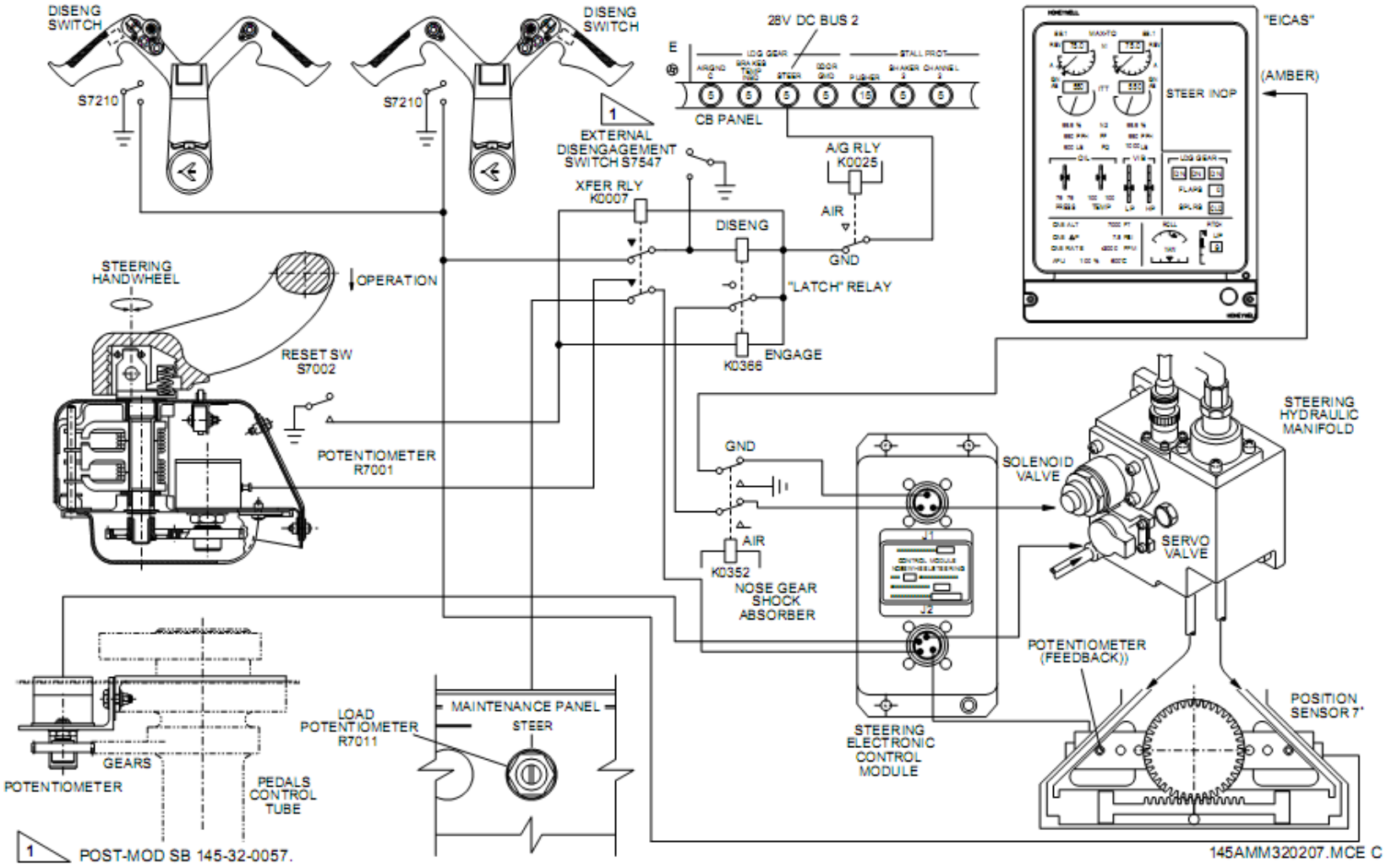
This configuration keeps the airplane under the “On-Ground” condition. In this condition, the current comes from DC Bus 2, goes through engage/disengage latch relays K0366, K0025, and K0352, and energizes the “SECM” (Steering Electronic Control Module).

The “SECM” control circuit energizes the steering solenoid valve and provides proportional command to the servo valve. When the steering control handle is pushed down, through switch S7002, relay XFER K0007 energizes. XFER K0007 relay disconnects load potentiometer R7011 from the “SECM” and connects the potentiometer R7001 signals. It permits the steering handle control. From this condition on, the steering handle sends signals, proportional to its movements, to the servo valve. The servo valve releases hydraulic fluid to the steering actuator.

When the nose gear wheels get the angle set through the handle (max 71°), the feedback potentiometer signals, through the “SECM”, de-energizes the servo valve. In this condition, the steering handle keeps its position and the wheels will stay in turn.

When the steering handle is released, the switch S7002 goes back to the inoperative position. With the wheels above 7°, the position sensor energizes latch relay K0366. The “SECM” de-energizes and the solenoid valve closes the inlet pressure in the hydraulic manifold. A “STEER INOP” message, on the EICAS, comes into view. It shows that the steering control through the pedals is not operating. To start the system again, with the wheels turned less than 7°, the steering handle must be pushed. It operates latch relay K0366. This relay permits energizing the “SECM” and the solenoid valve. After the system starts again, the “STEER INOP” message, on the EICAS, goes out of view.

Pilot's Rudder Pedal Operated - In this condition, the system uses the same electrical circuit to energize the "SECM". The pedal movement proportionally sends electrical signals from the potentiometer (R7000) to the servo-valve through the "SECM". The "SECM" control box keeps the wheels at that angle given by the pedal position. If the wheels exceed 7°, the position sensor de-energizes latch relay K0366. The "SECM" de-energizes and the solenoid valve closes the hydraulic supply. The message "STEER INOP" comes into view on the EICAS. All the system is off. To stop the steering control through the pedals, it is enough to push switch S7210 (disengage pushbutton), or the external disengagement switch S7547 (Post-Mod. SB145-32-0057). These switches energize latch relay K0366. As a result, the manifold solenoid valve deenergizes and closes the hydraulic supply. At the same time, the "STEER INOP" message comes into view on the EICAS. It shows that the steering control through the pedals is not operating.



NOSE WHEEL STEERING SYSTEM - ELECTRICAL OPERATION

Figure 11. Nose wheel steering system – Electrical operation.

1.16.1.3 In situ component tests and checks – findings

After the accident, the aircraft was preserved inside a hangar in an “as is” condition. However, before towing could be started, the LH inboard MLG wheel assembly (wheel/tire) had to be replaced due to a flat tire caused after collision with a runway light when the aircraft departed the runway.

Luxemburg authorities, LUXAIR engineering/maintenance staff and an engineering team dispatched by EMBRAER were present during these tests accomplished and described below.

1.16.1.3.1 Visual inspection

This report will focus only on landing gear, brakes and steering system findings.
Visual inspection of the aircraft and associated components was initially accomplished:

- MLG legs and associated hardware did not present any abnormal condition.
- MLG tires did not present any flat spot indication or abnormal wear.
- NLG leg did not present any abnormal condition.
- NLG wheels did not present any direct contact with the runway, excluding the LH wheel that presented a dent (probably damaged during the incident).
- NLG harnesses in general good condition, excluding the 7° proximity sensor harness that was severe damaged (probably during the incident).
- NLG tires presented excessive shoulder wear.
- Feedback potentiometer unit and 7° sensor unit did not present any abnormal condition.
- Steering system adjusted at 0° (scale placard indication with system not energized)

1.16.1.3.2 Test sequence – investigation

The test started with a touchdown in order to simulate a landing and to observe any steering system discrepancy. The aircraft was initially on jacks and was lowered with hydraulic systems 1 and 2 powered. The Main Landing Gear was lowered until the shock absorbers were completely compressed and then the Nose Landing Gear was brought down - it was lowered over two metal plates with grease between them on the ground (to preserve the tires).

The steering system was energized when the nose shock absorber was compressed and the nose wheel remained centred. No discrepancies were observed.

After the touchdown, the feedback potentiometer harnesses were intentionally shaken and applied force pushing and pulling the feedback potentiometer electrical connector. No erratic movement of the nose wheel was detected.

Following the touchdown, the disengagement switches were tested. When the disengagement switch on the control wheel was actuated, the system disengaged and the message STEER INOP came into view on the EICAS, as expected.

With the steering system engaged, the centre position was verified with the handle wheel pressed and centred and with the handle wheel not pressed down. In both situations, the nose wheel deflection was zero degree, which indicated that the nose wheels were electrically centred with no pedal/handle wheel command. During this verification, the harnesses were intentionally shaken and force applied to the connectors. No movement of the nose wheels was detected.

The operation of the system was verified in accordance with the AMM and produced the following deflection of the nose wheels:

Device	**Right turn angle (degrees)**	**Left turn angle (degrees)**
Rudder pedal	4	3 ½
Handle wheel	75	71
Handle wheel + rudder pedals	75	75

No erratic movement was detected during this test, even while vibrating the system harnesses and forcing the connectors.

Steering disengagement with 7° degree proximity switch occurred as expected in accordance with AMM. No discrepancies were found.

Additional rudder pedal applications with simultaneous vibration on the feedback potentiometer harnesses (accessed through the electronic compartment) were performed without any steering discrepancies observed.

For fault detection test purpose, the feedback potentiometer connector was disconnected with the steering system powered and the “STEER INOP” message on the EICAS came into view, as expected.

For fault detection test purpose, the hydraulic manifold unit connector was disconnected with the steering system powered and the “STEER INOP” message on the EICAS came into view, as expected.

For fault detection test purpose, the steering electronic control module (SECM) connector was disconnected with the steering system powered and the “STEER INOP” message on the EICAS came into view, as expected.

The tests performed above are equivalent and/or exceed the AMM tasks below:

- TASK 32-50-00-600-801-A (Nose Wheel Position Indication Mark Placard – Inspection)
- TASK 32-50-00-700-801-A (Nose Wheel Steering System Disengagement - Operational Check)
- TASK 32-50-00-700-803-A (Nose Wheel Steering System Actuation - Operational Check)
- TASK 32-50-06-700-801-A (7° Degree Proximity Switch – Functional Check).

Note: It was not necessary to accomplish AMM TASK 32-50-00-700-802-A (Nose Wheel Steering System – Adjustment) since the steering system was considered adjusted and centred. No discrepancies were found.

Harnesses insulation checks were performed (WM 32-53-50 - Sheet 2/2 – Page 1) as indicated on the figure below:

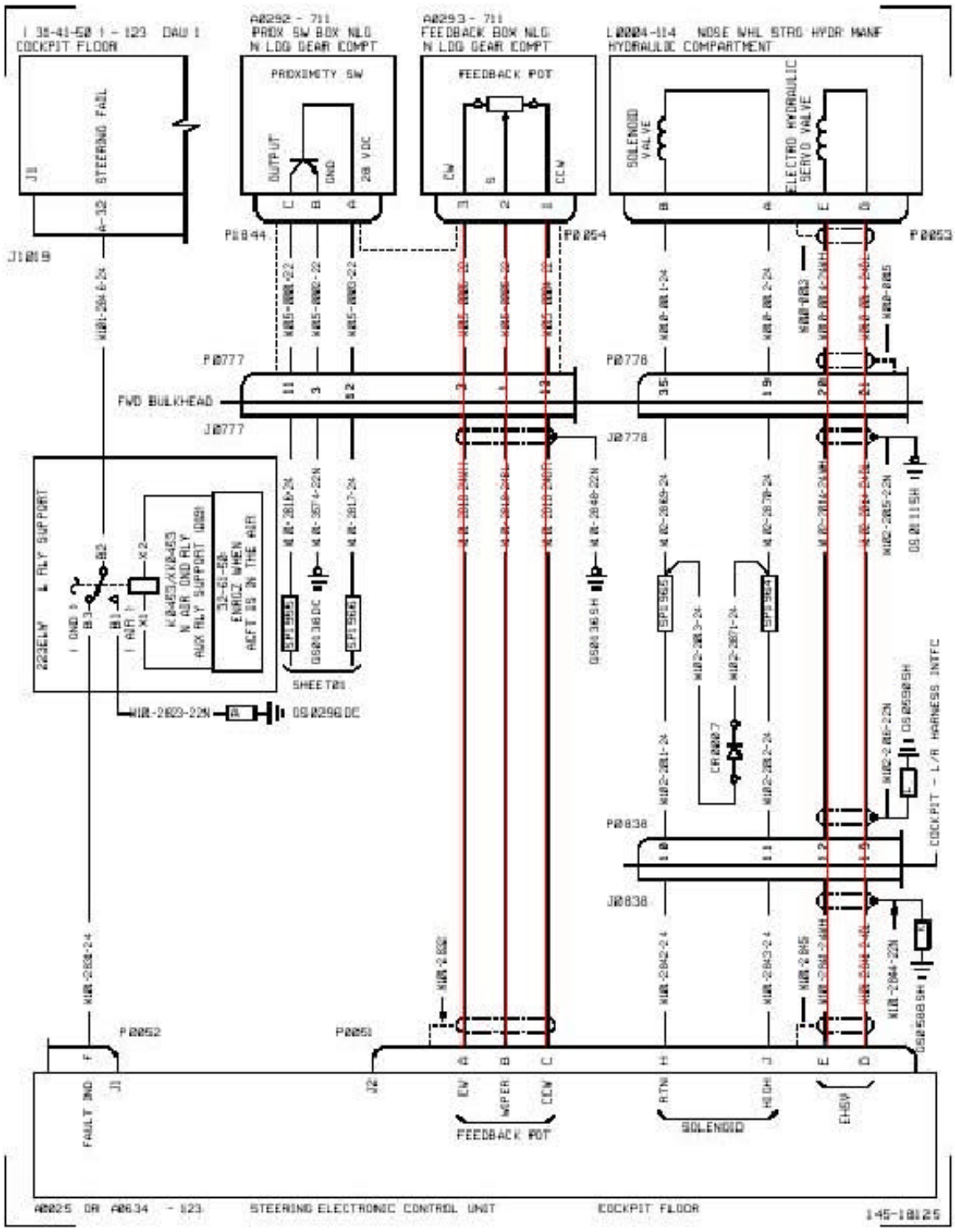


Figure 12. Harness connections

Connector P0051 (SECM) / connector P0054 (Feedback potentiometer)
Connector P0053 (Hydraulic Manifold) / Ground

No discrepancies were found.

Steering hydraulic manifold functional test was performed in order to check the servo valve current as per AMM TASK 32-50-04-700-801-A (Steering Manifold - Functional Test). No discrepancies were found.

Rudder pedal potentiometer linearity was tested. No discrepancies were found.

Brake control system was tested using the brake software (laptop field tester – GSE 095). No discrepancies were found on the brake system.

1.16.1.3.3 Conclusions

According to the above described findings, no discrepancies were found in the steering/brake system of ERJ145 S/N 145-258 that could explain the event.

Therefore it was decided to remove the components related to the steering/brake system for further investigation and have them analysed in-depth at their respective manufacturer facilities.

1.16.2 Manufacturer tests performed on the nose gear steering system

Following components and equipments were removed from the aircraft and secured by the commission. All the tests were performed and witnessed in the presence of the investigation team, representatives from Embraer, from the NTSB and, during two occasions, also FAA inspectors for manufactures located in the United States of America.

1.16.2.1 Steering Control handwheel

Manufacturer: EMBRAER
P/N: 123-02328-401, S/N: 466505-01
Model Nr: 7029
SN: 1737
Date / code: 97 / 52
The unit was tested by EMBRAER and passed all functional tests.

1.16.2.2 Feedback unit potentiometer and unit sensor

Manufacturer: LIEBHERR
Potentiometer: P/N: 1170A1800-01, S/N: 00356
The visual inspection, insulation resistance, resistance and the potentiometer voltage graph linearity tests were successfully performed in accordance with Liebherr PR-1170-1 test procedure.
Sensor: P/N 1170A2900-01
Due to the mechanical working method of the Feedback Unit Sensor, no functional test was necessary. Visual inspection was performed to make sure that the unit was complete and not damaged.
The built-in potentiometer P/N 9070B0007-01, S/N 1208 is manufactured by Betatronix and could not be tested at Liebherr.

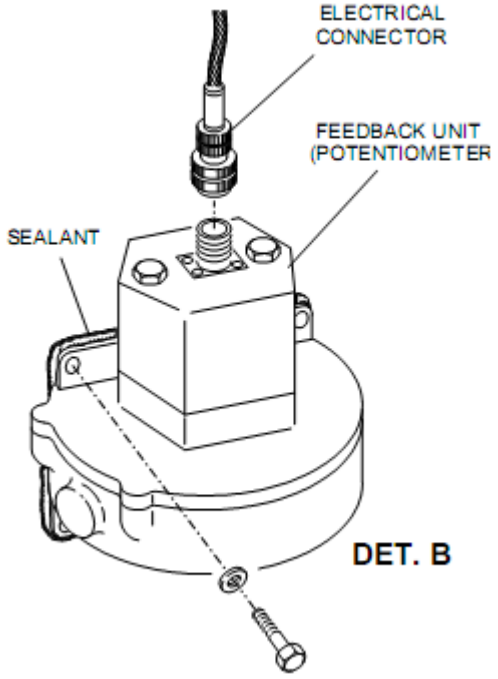


Figure 13. Feedback Unit located on the nose gear

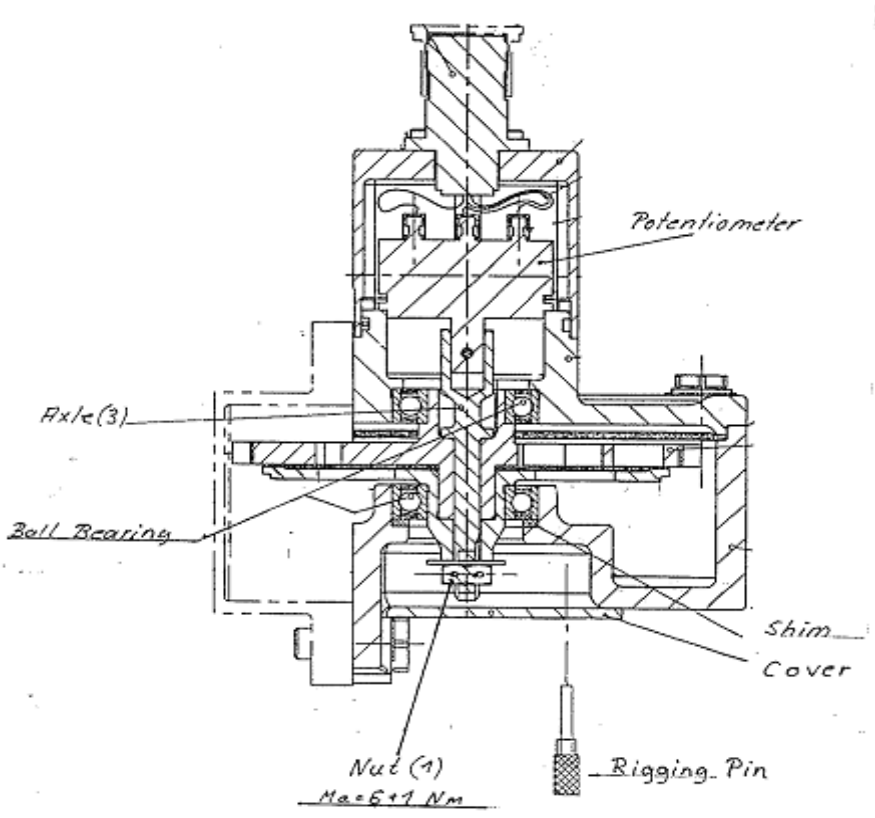


Figure 14. Cross section of feedback unit

1.16.2.3 7° position sensor

Manufacturer: LIEBHERR
P/N 1170A2900-01
This unit is installed at Embraer and calibrated during the Nose Landing Gear installation.

1.16.2.4 Load potentiometer

Manufacturer: BI Technologies Corporation
P/N 8146R5KL25SL, Date code 9845
Installed inside the left aft maintenance panel in the cockpit.
The unit was tested on its resistance tolerance, output smoothness, linearity and voltage output. The testing of this potentiometer was found to meet all standard specifications and a failure could not be duplicated.

1.16.2.5 Steering Electronic Control Module (SECM)

Manufacturer: PARKER Aerospace
P/N 308560 – 1013, S/N 0518
Steering Electronic Control Module installed in the cockpit floor.
Description: The SCEM controls the nose wheel steering system and receives signals from the electrical potentiometers: steering handle, pedals, feedback, load and the rudder disengage pushbutton.
After processing these signals, it sends the resulting signal to the solenoid valve and to the hydraulic manifold servo valve.

The unit was tested at the manufacturer premises according to the abbreviated component maintenance manual (ACMM) and passed all functional tests.

1.16.2.6 Hydraulic manifold

Manufacturer: PARKER Aerospace
P/N 308570 – 1003, S/N 0096 installed in the airplane nose hydraulic compartment. It controls the hydraulic pressure fluid that goes to the steering actuating cylinder.

All hydraulic liquid had been drained from the unit prior shipping and carried in a special container for further analysis. The fluid sample was examined for contamination and found to meet cleanliness requirements of NAS 1638 class 8 (acceptable) for particle count. No metal or other abnormal particles were noted (see appendix 2).
The unit was tested in the manufacturer premises in accordance with component maintenance manual 32-50-15 and passed all functional tests (see appendix 3).
The proof pressure tests were not performed since they are outside of normal operation parameters and may disrupt a failure condition that could be present.
During the internal leakage test it was noted that the Electronic Hydraulic Servo Valve (EHSV) P/N 22253282-103 S/N 102 pressure was fluctuating ± 100 psi around neutral. This has been considered to be an anomaly and was specified in the test record. A first reaction was that the EHSV would get an unstable flow which might result in an oscillating nose gear.
The manifold was disassembled, witnessed also by an FAA inspector, for a precautionary visual inspection for any abnormalities. The only finding was that the inlet check valve (P/N 72900-301) cap retention fingers had all four broken off, but retained in the cavity. As implied above, the check valve was still functioning properly during test. No secondary damage was noted in the Nose Wheel Steering assembly as a result of the cap failure.
It was therefore decided to remove the Electro Hydraulic Servo Valve from the manifold and have it tested by HR Textron, the valve manufacturer.

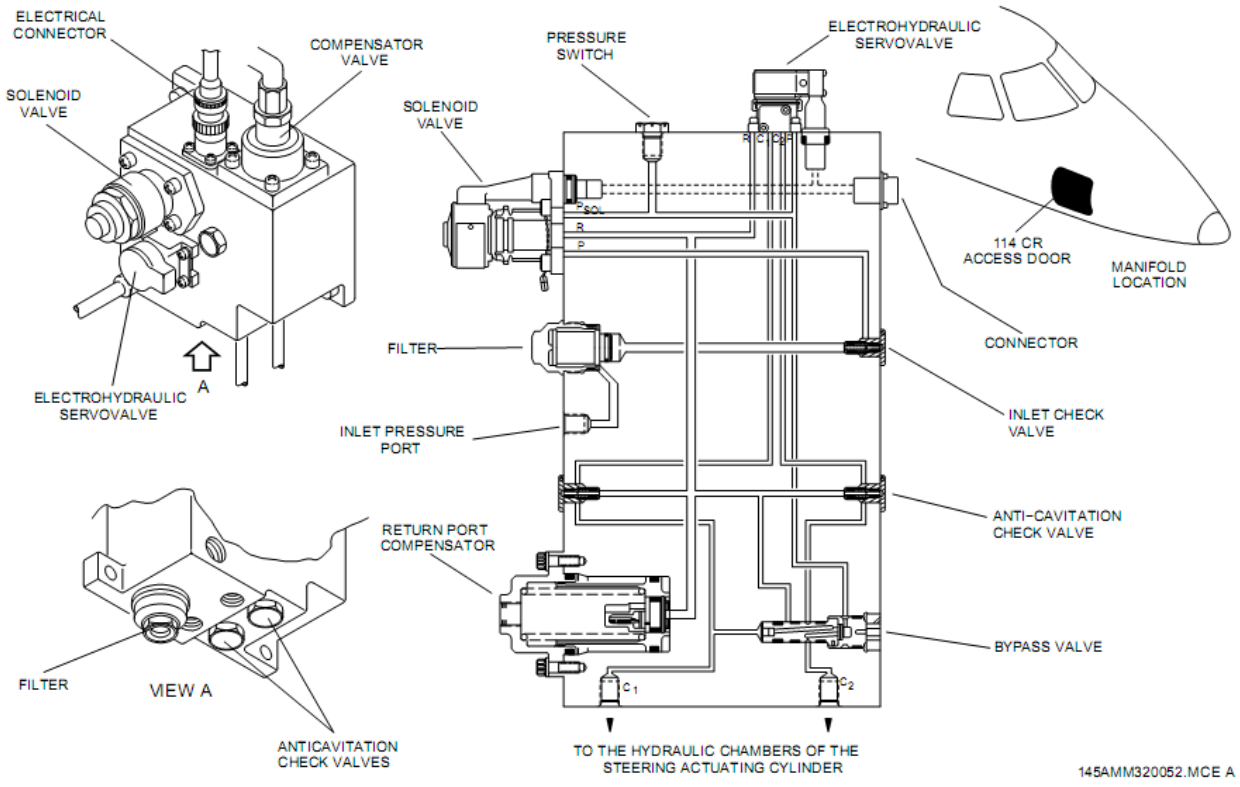


Figure 15. Hydraulic manifold assembly

Figure 16. NW steering hydraulic manifold SN 0096

1.16.2.6.1 Electro Hydraulic Servo valve (EHSV) P/N: 22253282 – 103 / S/N 102

Manufactured in February 1996, 6 years in service, 7877 service hours, returned in December 2003.

This Servo valve is part of the Hydraulic manifold PN: 308570-1003 / SN 0096 and could not be tested at PARKER. It was taken and supervised by the NTSB accredited representative to the manufacturer HR Textron for the following functional tests.

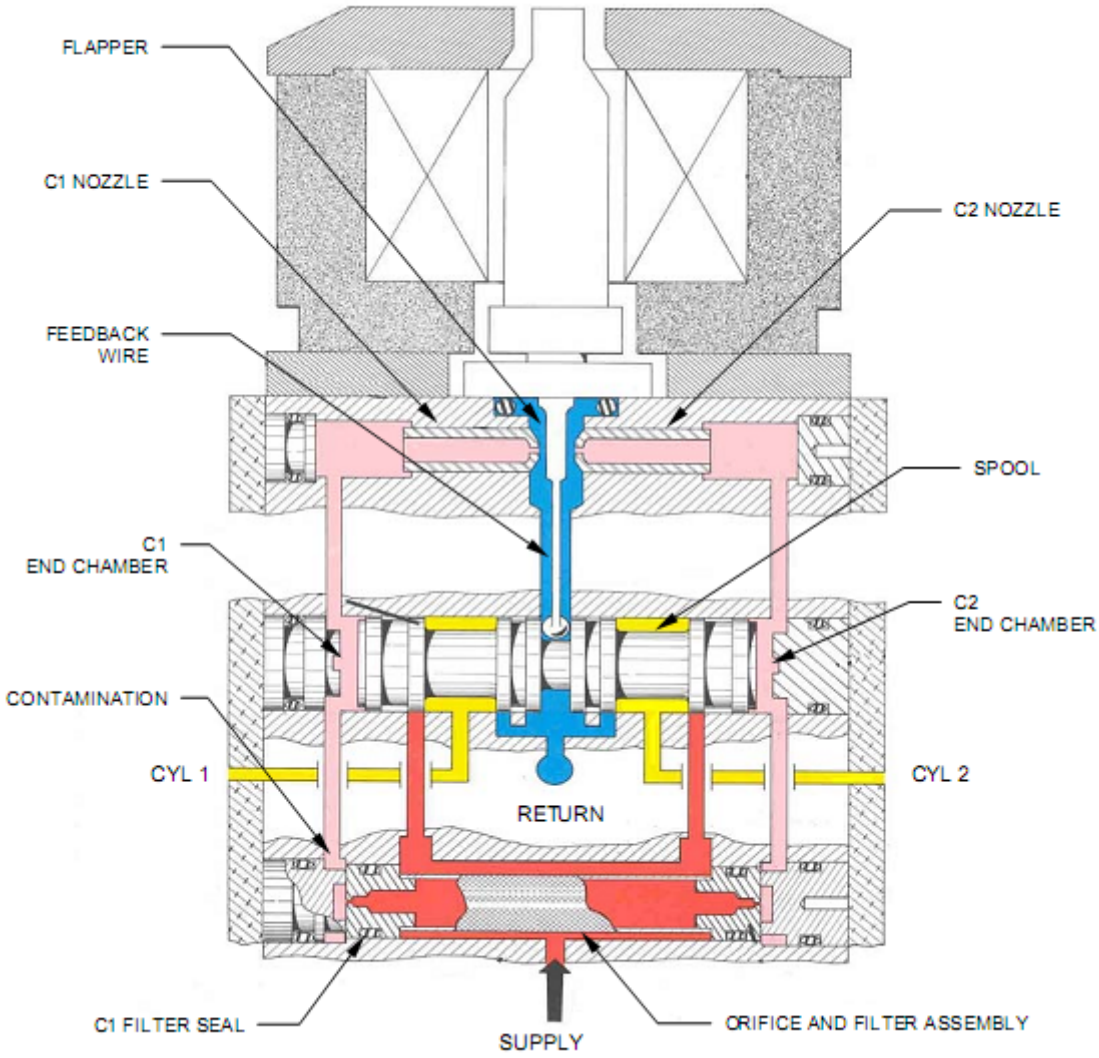


Figure 17. Hydraulic schematic showing location of contamination

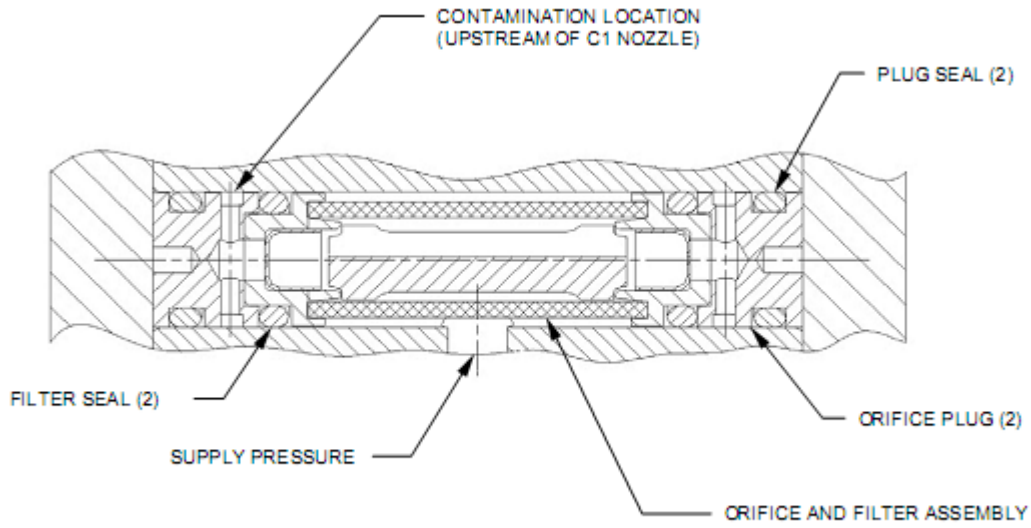


Figure 18. Filter Bore Cross-Section

Summary of findings

- Functional check revealed that the unit was not operating correctly
- Low internal leakage indicated a restriction in the first stage.
- C1 nozzle behaved as if blocked, however, no contamination was recovered from the C1 nozzle when the unit was disassembled
- Rubber-like contamination was found in the C1 first stage cavity upstream of the C1 nozzle
- Damage (nibbling / extrusion) was found on the C1 filter seal
- Material composition of the contamination was found to be consistent with the C1 filter seal
- Filter bore was found to be oversize by 0.0018 inch

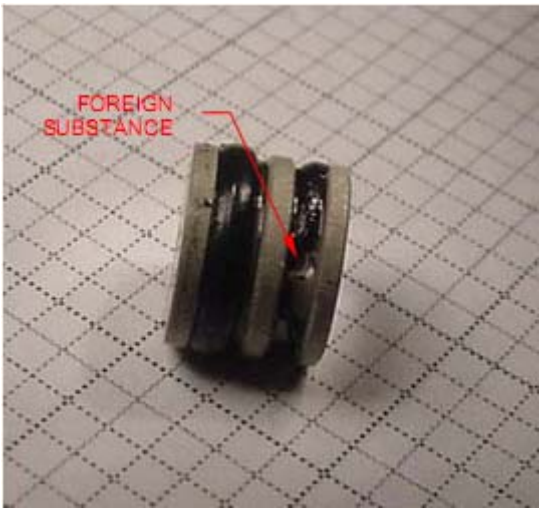


Figure 19. C1 Orifice plug

Figure 20. C1 Filter Seal

Evaluation

Full evaluation and test is shown in Appendix 4.

1.16.2.7 Relays

All relays are located in the left relay support.
The following electrical schematics illustrate their interactivity in the system.

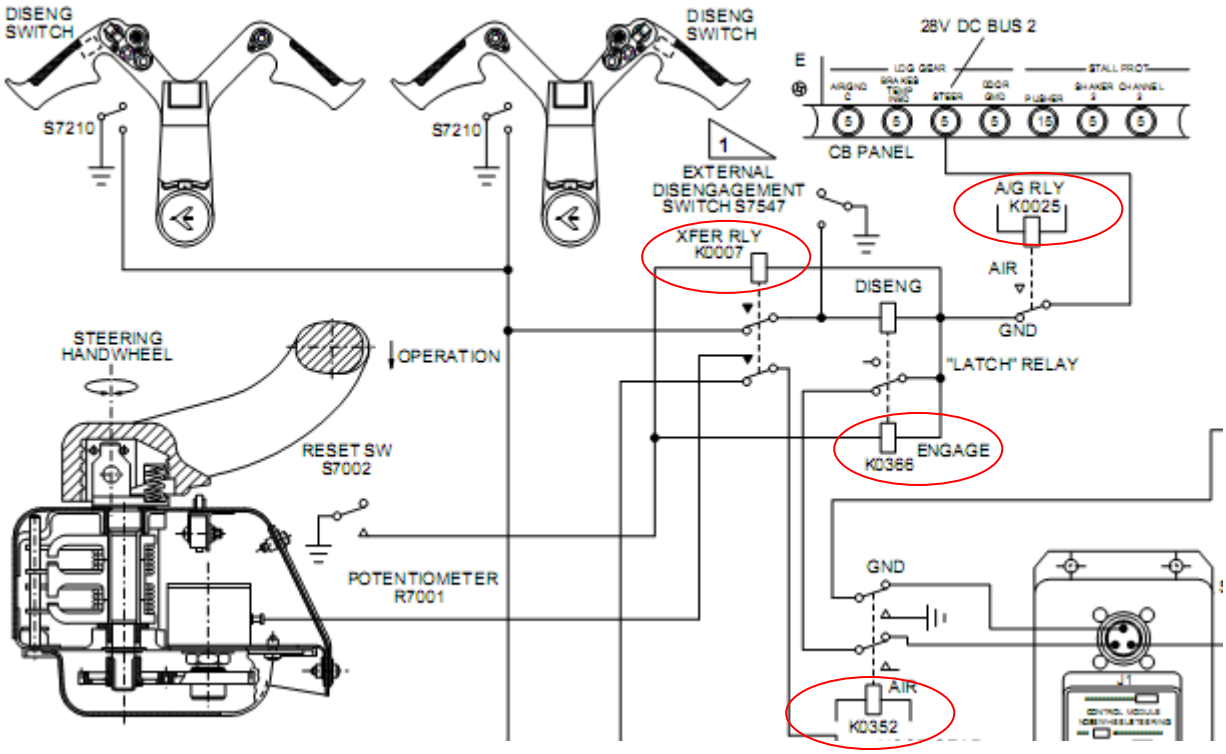


Figure 21. Schematic of electrical relays

1.16.2.7.1 Relays manufactured by DEUTSCH RELAYS INC.

K0453 (K0352) P/N M83536/6-022L (EL4050402BGL) Date code 9932
K0366 P/N M83536/13-008L (ELS2100403CGL) Date code 9933
K0025 P/N M83536/6-022L (ES4050402BGL) Date code 9825 from the weight on wheel (WOW) system, triggers the air/ground condition of the airplane. When on the ground the steering handle is energized.

Visual inspection.

K0025 and black dot marked on top of the relay housing, minor tool marks on the mounting flanges, minor scrapping of the gold plating on the terminals. No other anomalies were noted.
K0366 and black dot marked on top of the relay housing, minor scrapping of the gold plating on the terminals. No other anomalies were noted.
K0453 and black dot marked on top of the relay housing, minor tool marks on the mounting flanges, the two-hole flange was distorted (bent). No other anomalies were noted.

Tests.

The relays were subjected to the manufacturers Acceptance Test Procedure (ATP) 6452.

a. All relays passed the electrical tests,
b. All relays were subject to the gross leak test. Relay K0366 exhibited an extremely small leak at the header to housing weld area. K0025 and K0453 passed the gross leak test.
c. The relays were subjected to a 2500 run-in (miss test) as defined in ATP 6452 paragraph 4.3.1., except the test temperature was room ambient. All three relays passed the run-in test.
d. The relays were subjected to the sinusoidal vibration test as defined in ATP 6452 paragraph 4.1. All relays passed the vibration test.

During the debriefing session, all test results were discussed and it was agreed that the minor leak on K0366 did not affect the operation of the relay. This was substantiated by the test data obtained during the electrical test.
All three relays successfully passed the tests performed at the manufacturer premises.

1.16.2.7.2 Relay manufactured by LEACH

Manufacturer: LEACH, France
Relay K0007
P/N: M210-D4N-003
Visual inspection
No damage or anomaly was noted,
Tests:
The relay successfully passed the following tests at the manufacturer premises:

- functional on/off test
- dielectric test
- electrical parameter test
- water tightness test

1.16.2.8 Rudder pedal potentiometer

Manufacturer: BETATRONIX
P/N: 13BF7184
Potentiometer P/N 9070B0007-01; S/N 1208
Ref 25413 – 13SF7841
This potentiometer is installed inside the LIEBHERR feedback unit potentiometer P/N 1170A1800-01; S/N 00356

Feedback potentiometer:
The unit passed successfully the following tests:

1. visual test
2. resistance mode
3. continuity test
4. noise mode
5. linearity check
6. dielectric strength
7. insulation resistance

1.16.2.9 Harnesses

1.16.2.9.1 Feedback unit potentiometer harness

Manufacturer: EMBRAER
W015 PN: 145-21491-405 (feedback & 7° sensor) SN 350
Continuity and isolation tests performed on the manufacturer premises and passed all functional tests.

1.16.2.9.2 NLG WOW harness

Manufacturer: EMBRAER
W019 P/N: 145-21495-403 (NLG proximity sensor Air/ground) SN 258
Continuity and isolation tests performed on the manufacturer premises and passed all functional tests.

1.16.3 Brake Control Unit

Manufacturer: CRANE Hydro-Aire
Brake control unit P/N 42-951-3, S/N 221, date MFD 08-98.
The Brake Control Unit (BCU) works with the other components of the Brake Control Antiskid System to supply the aircraft with optimum braking efficiency under all runway conditions.

Two functions of the Brake Control Unit supply brake control: data acquisition and pressure control. The command processor processes wheel speed and pedal position inputs to calculate a composite brake pressure signal. The BCU continuously examines the pressure command and pressure feedback to make sure of loop closure and hydraulic integrity.

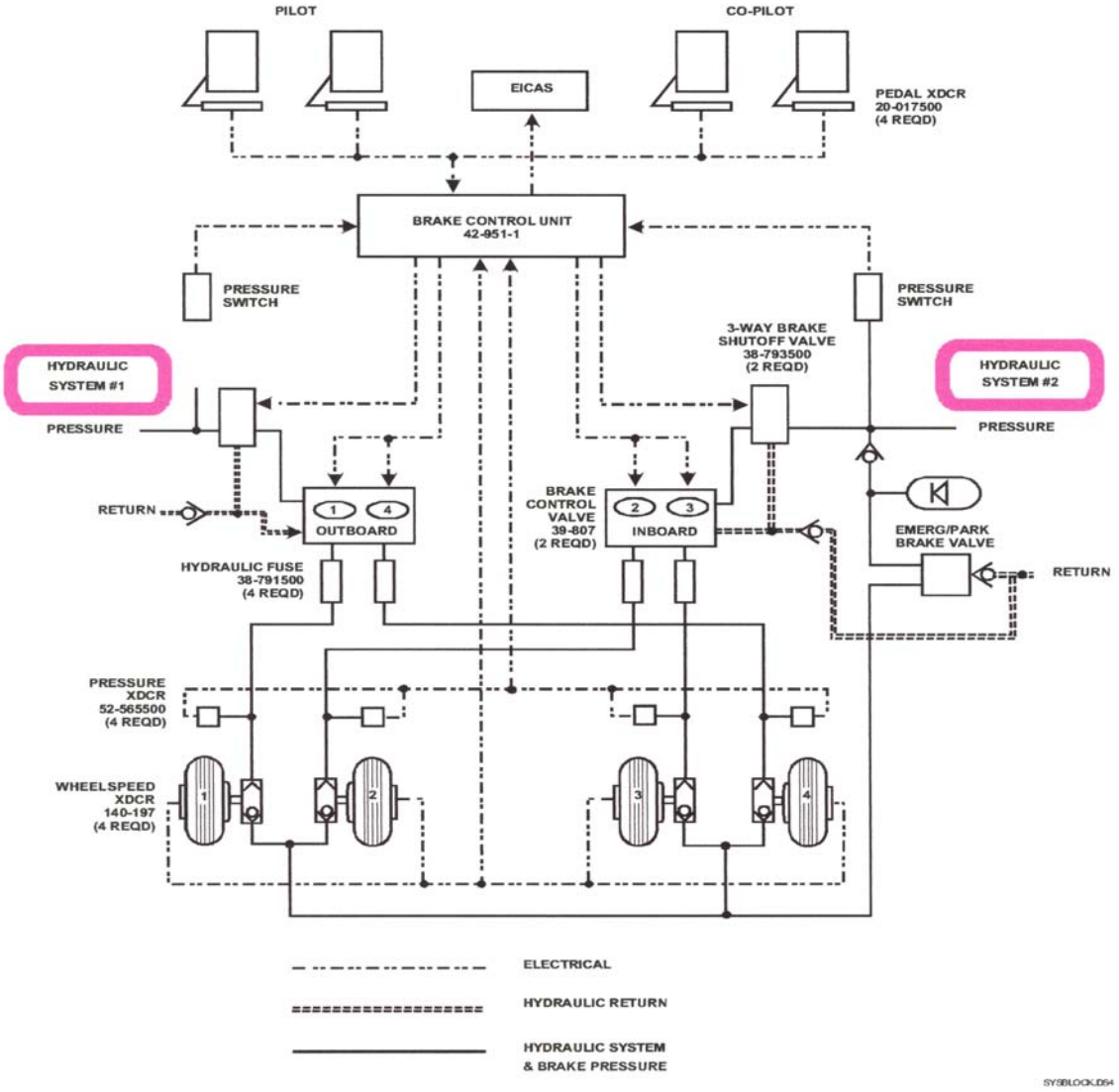


Figure 22. Brake Control Antiskid System Functional Block Diagram

The BCU was tested in accordance with the manufacturers applicable test procedure and passed all functional tests with no failures found.

1.16.4 NLG Proximity Switch

Manufacturer: ELDEC Corporation, a Crane Aerospace division
P/N 8-527-01 S/N A13212
ELDEC document FTP8-527 functional test procedure, paragraph 3.8 functional test, steps 1-15 was used to verify the following:

1. actuation/de-actuation using a dial stand and target
2. leakage current
3. output saturation voltage
4. short circuit protection

During the visual inspection, a small dent in metal ring of the sensing surface was noted. The examination under microscope revealed that the marks were minor and did not influence its functionality.
At a later date, the investigator in charge decided to have an additional vibration test done. This test was supervised by a local FAA inspector and successfully performed to 30 g's per MIL-Std-810C, 514.2, procedure category b.l and c.

1.17 Organisational and Management information

At the time of the accident, Luxair was operating, amongst others, 8 Embraer 135/145 aircraft.

Spare parts maintenance pool.
The spare parts maintenance pool was and still is assured by EMBRAER Aviation International in Paris. The Spare Parts Representative will work within the customer organization to ensure that all needed parts and tooling are available for all scheduled and non-scheduled maintenance services. Customers send their unserviceable parts and get replacement parts in exchange.
Almost all of the hydraulics and electrical components have at one time or another been returned to the maintenance pool for corrective actions.
Returned parts were from the pool stock and had different serial numbers.

The issue of the NLG steering problems was never traced, and the returned hydraulic manifolds had still the same dormant malfunction.

History of SHM:

The Steering Hydraulic Manifold S/N 0096 was initially removed from A/C 145-076 on 01/03/2001 with 5240 hours due to A/C steering to the left. The unit was shipped to PARKER for repair and the SHM inlet filter was replaced and tested.
The unit was then shipped back to EMBRAER Paris to be placed in the pool stock.
This same manifold was shipped back to Luxair on 29/06/2001 to be installed on the accident A/C on 12/07/2001 and was then removed on the day of the accident.
The manifold had accumulated a total of 10.415 hours on both aircraft.

Crew Training:

Simulator Training was developed by EMBRAER to reproduce uncommanded swerving situations where pilots are able to practice the correct procedure to be applied in these cases. Luxair implemented already those exercises in their simulator training in 2004.
The EMBRAER mandatory exercises came into the simulator programs by summer 2005.

1.18 Additional information

1.18.1 Service bulletin situation at the time of the accident

A history of nose wheel steering anomalies throughout the Luxair Embraer fleet was documented over the years. Although a number of related service bulletins have been issued by Embraer, it appears that the issue had not yet been solved at that time.

Identification	1. Description / 2. Reason / 3. Compliance	First Issue
SB 145-32-0069	1. Protection of the proximity switches and electrical connectors against corrosion	05.07.2001

	2. to protect the proximity switches and the electrical connectors of the wires located in the main and nose gear legs against corrosion	
	3. incorporation recommended within 4000 flight hours or 3 calendar years, whichever occurs first	
SB 145-32-0069R01	Revision 01 was issued to change Service Bulletin effectivity and add similar material	20.12.2002
SB 145-32-0071	1. Modification of the nose wheel steering control module	13.08.2001
	2. During evaluations of customer returned goods of Control Module, P/N 308560-1013, a trend of intermittent electrical conductivity through the test connections was identified. These intermittent conductivity problems were corrected by replacing the affected connector on the printed wiring assembly, P/N 308575-103, with an approved connector.	
	3. within 4000 flight hours	
SB 145-32-0078	1. Inspection / rework of steering disengagement yoke trigger housing	25.04.2002
	2. Investigation has revealed the possibility of the steering disengagement yoke trigger support rupturing due to mechanical load caused by improper, forced support assemblage.	
	3. any time at operator's discretion	
SB 145-32-0081	1. Feedback unit potentiometer modification - P/N 1170A1800-32-01	30.08.2002
	2. Owing to the possibility of water penetrating into the feedback unit potentiometer and/or fluid resulting from grease separation passing through the ball bearing into the potentiometer shaft area, a functional disturbance in the system could occur. To avoid this, the feedback unit potentiometer is being modified into a new one with an improved sealing concept with the introduction of new potentiometer an alternative ball bearings. Pressure relief valves are introduced in the feedback unit potentiometer to prevent the ingress of water.	
	3. any time at operator's discretion	
SB 145-32-0081R01	Revision 01 was issued to change effectivity	13.12.2002
SB 145-32-0082	1. Feedback unit sensor modification – P/N 1170A2900-32-01	27.11.2002
	2.a. feedback unit sensor has an improved sealing concept with the introduction of alternative ball bearings 2.b. pressure relief valves are introduced in the feedback unit sensor to prevent ingress of water	
	3. Incorporation of S.B is recommended at the operator's discretion	

1.18.2 SB's issued subsequent to the accident to reinforce the corrective actions

taken as a result of the event.

SB 145-32-0099R01 to R03	1. Upgrade of Nose Wheel Steering Manifold – P/N 308570-1003 to -1007	03.09.2004 R03 08.04.2005
	2. Instances of aircraft uncommanded swerving on the ground have been reported and in three of them a failure in the Nose Wheel Steering Hydraulic Manifold Electro Hydraulic Servo Valve (EHSV) has been confirmed.	
	3. at the earliest possible convenience	
SB 145-32-100	1. Improvement in design of feedback unit potentiometer	01.09.2004
	2. shop findings revealed some quality deviations in the feedback unit potentiometer assemblage process that could result in a functional disturbance in the steering system	
	3. recommended at the earliest opportunity	
SB 145-32-110	1. second supplier of potentiometer for feedback unit potentiometer	27.01.2006
	2. to make a new feedback unit potentiometer from a second source supplier	
	3. at the operator's discretion	

LX-LGZ implementation status of the SB's at the time of the accident and thereafter.

Identification	Status	Date
SB 145-32-0069	Accomplished	25.08.2003
SB 145-32-0071	Accomplished	23.01.2003
SB 145-32-0078	Accomplished	16.09.2003
SB 145-32-0081	Accomplished	13.02.2004
SB 145-32-0082	Accomplished	13.02.2004
SB 145-32-0099	Accomplished	May 2005

The main topic seems to have been concerns on corrosion of steering components, leading to erratic functioning of the nose wheel steering system.

1.18.3 Previous occurrences with Luxair

Many reports have been filed by Luxair pilots on steering problems on the ground. There has been no visible technical commonality between all these occurrences and they happened regardless of type of weather and aircraft serials of the fleet.

Following table gives an excerpt of pilot notified steering anomalies:

Date	Problem description	Remark
17.07.2000	STEER INOP message before takeoff	
17.07.2000	steering is not centred on neutral position, towards left hand side	
19.11.2000	steering is sticky, turn only step by step	
02.01.2001	after touchdown, A/C veered again violently to the left. This	

	time captain was landing, he used full rudder and differential braking but A/C remained uncontrollable, applied close to T/O power on engine 1 to bring back A/C to centreline.	
03.01..2001	loss of directional control during landing roll when nose was lowered A/C veered to the right	accident A/C
03.01.2001	loss of control at landing roll, A/C veered right, unable to taxi	accident A/C, steering hydraulic manifold replaced on 17.01.2001
04.01.2001	Loss of Nosewheel steering on landing	accident A/C, found bad insulation on harness of the feedback potentiometer
22.06.2001	with NWS in neutral, A/C pulls to the right	accident A/C
28.06.2001	during taxi, A/C steering to the right, constant left steering input necessary to keep straight	accident A/C
03.07.2001	during taxi A/C has tendency to veer to the right, lot of rudder pedal and steering handle applied to keep aligned	accident A/C
12.07.2001	unable to engage NWS during taxi out	accident A/C
05.05.2002	During taxi out nose wheel steering very sluggish and did not react all the time. Impossible to turn to the right, only to the left. At the holding point steering became suddenly completely inoperative.	Steering handle was replaced
02.07.2002	After landing the “STEER INOP” caution occurred and the steering was confirmed to be inoperative.	Relay K0007 was replaced and steering harness and plugs replaced due to corrosion
11.07.2002	After push back “STEER INOP” caution occurred and unable to reset system	Fault was traced to NWS harness and replaced
25.11.2002	During line-up for take-off low frequency vibration was heard and “STEER INOP” caution occurred. A/C evacuated runway back to stand.	Fault was traced to faulty steering potentiometer
26.02.2003	During landing “STEER INOP” message occurred with a violent pull to the right at approx. 60 KIAS.	Steering feedback potentiometer replaced
01.05.2003	During taxi out NWS activation caused strong noises, followed by “STEER INOP” message and uneven steering response. A/C returned to stand.	Steering hydraulic manifold replaced

Actions by Luxair maintenance have been visual and operational checks without findings and replacement of practically all system components. Additionally to improving component sealing and harnesses have also been replaced.

Despite all these efforts, the steering problems remained intermittently existent over the entire fleet.

Those replaced parts were part of a maintenance pool handled by the Embraer Aviation International Paris office, which dispatched them to the manufacturer for repair.

As there were some Service Bulletins from Embraer dealing with humidity issues in electrical components from the nose gear steering, suspicions were strong that a faulty nose gear steering command could be the origin of these steering anomalies.

As a result, all electrical and hydraulic components of the nose wheel steering system were removed from the aircraft to have them thoroughly tested at the manufacturer premises.

1.18.4 Previous occurrences surveyed with other European airlines

A first operator notified 22 incidents during a 16 months period, giving following reasons:

- Feedback potentiometer contamination
- Handwheel switch intermittent engagement
- Steering manifold noise

A second operator notified 28 incidents over a three year period, of which 6 occurrences where uncommanded steering inputs on takeoff and landing, giving following reasons:

- Tiller steering out of limits
- Water ingress into connectors
- Feedback potentiometers and harness problems

A third operator notified 10 incidents during a one year period, giving following reasons:

- Water into connectors
- Wiring harness problems

1.18.5 Previous occurrences with other operators

1. US airline A, March 23 2004, reported “STEER INOP” message at touchdown. AC pulled to the right through the landing roll. The crew could not keep it on the runway with left brake and left rudder and engaged the NW steering in an attempt to steer the AC left. According to the crew, the AC immediately swerved hard to the right when the NW steering was engaged. The AC right main and nose wheel left the runway surface. The left main was still on the surface but only by inches. No damage to AC and no injuries to occupants.
Inspection of the landing system revealed that the nose landing gear steering was off-centre about 2 degrees with the tiller engaged. A subsequent adjustment to the nose gear steering was performed. Next, they removed and replaced the steering feedback potentiometer iaw EMB 145 AMM 32-50-07, which was followed by a satisfactory high-speed taxi. The aircraft was ferried to a maintenance facility where a steering system disengagement test was performed. No faults were found during this test. The system potentiometers were also measured using the GSE-365, the results showed higher than normal impedance. The steering transfer relay, K007, was removed and replaced as a precautionary measure.

2. US airline B reported on March 30 2004 that aircraft pulls to the left during taxi.
Maintenance reported that the NW steering feedback potentiometer was replaced.

EMBRAER provided additional information on four similar events, where corrective maintenance actions performed were the feedback potentiometer replacement. The components were sent to the manufacturer to conduct an in depth analysis.

The investigation commission had the full support of Embraer and of the individual manufacturers as it appeared that so far, no conclusive findings had transpired from the preceding incidents or accidents and the manufacturers were eager to have the causes for these uncommanded steering inputs identified.

1.18.6 New occurrences with Luxair aircraft after the accident flight

18.04.2004 – when nose wheel touched down, with rudder pedals in neutral position, the A/C moved suddenly to the right side (18°) and *STEER INOP" message was displayed. During taxi, steering handle had to be pushed to the left in order to drive the A/C straight forward. Troubleshooting revealed that feedback potentiometer was faulty due to erratic signals.

12.07.2004 – during landing rollout at +/- 80knots aircraft suddenly veering to the right, full rudder pedal input was required to keep aircraft on centreline. No EICAS message. Captain took over control at 60 knots and disconnected steering manually. "After full stop, reengaged steering with steering handle advancing very slowly; left steering handle input required to taxi straight to stand". Initial investigation showed a 5° right turn with oscillating movement. Feedback potentiometer replaced, electrical harness checked for damage & insulation, resistance and adjustment check performed.

12.06.2010 – After taxi-out from parking stand light left veering tendency of the nose wheel was noticed. After several hundred meters however this left veering tendency was so important that nearly full rotation to the right of the steering handle was needed to maintain A/C going straight. A/C returned to the ramp. After several tests in accordance with Luxair Maintenance the nose wheel was still found in an angle of +/- 60° deflected to the left. "Unable to get it into centre". "STEER INOP" message was also on the EICAS. Steering feedback potentiometer confirmed faulty, out of adjustment. Same replaced and steering system adjustment and functional check carried out.

1.18.7 AFM of the EMB145

At the time of the accident, the AFM did not address this issue of abnormal steering runaway issue, leading to a loss of directional control.

On 03 February 2004 Luxair received AFM Temporary Revision 59.2 publishing the abnormal procedure for *Uncommanded Swerving on Ground*. This TR was issued by EMBRAER and approved by CTA on January 20, 2004, replacing the interim guidelines dated 29 September 2003.

EMBRAER issued then on 06 April 2004 AFM revision 70, CTA approved, concerning the "uncommanded swerving on ground". The same revisions were issued and approved by the FAA and JAA. (see Appendix 5)

2 ANALYSIS

2.1 Flight crew

The flight crew was properly licensed.

2.2 Aircraft

The aircraft had a valid certificate of airworthiness and the centre of gravity was within the envelope. The aircraft maintenance records were in compliance with the established maintenance program.

2.3 Weather

The weather at the time of the accident was VMC and did not influence the sequence of events.

2.4 Passenger briefing

After being cleared for a normal landing, no special passenger briefing was necessary. As soon as the Nose wheels touched the ground, the aircraft veered to the right off the runway. The passengers and crew were shaken very strongly, but no one panicked. As the aircraft came to a standstill, the Captain ordered the evacuation. The overwing exit on the left hand side was opened, but as the front cabin door was not obstructed, the passengers swiftly evacuated normally the A/C without their belongings. The cabin crew assured themselves that none of the passengers was injured.

2.5 ATC Information

At 08:37:00 Flight LGL8852 was established visual on runway 06 and contacted Luxembourg Tower on 118.100 MHz.
At 08:37:06 Tower gave the clearance to land on runway 06, wind 030 degrees, 8 knots. This was confirmed by the flight crew at 08:37:12.
At 08:38:43 Flight LGL8852 asked the Tower if they could vacate the runway via taxiway C, which was approved 4 seconds later.
At 08:40:35 Flight LGL8852 called the Tower for MAYDAY. This was confirmed by the Tower 4 seconds later.

2.6 FDR review

The readout of the FDR was performed by the BEA in presence of the investigation team and representatives from Luxair. The decoding of the data was performed in accordance with EMBRAER revision E of document number 145-IN-317, entitled Conversion Factor for recorded Data on Flight data recorder. Several curves covering the flight time from 200 feet above ground altitude until the full stop of the A/C could be traced and can be seen in Appendix 1.

Among the studied parameters, the *groundspeed and rudder position* parameters could be considered as invalid. The recording of the *seconds UTC* was also incoherent (values which are not strictly increasing during the recording time), however the UTC time shown on the attached curves was exploitable. (from 08:39:03 to 08:40:03)

2.7 CVR review

The readout was performed by the BEA, in presence of the investigation team and representatives from Luxair, with software furnished by the recorder manufacturer. The raw files obtained in dlu format were then decompressed and converted to an audio wav format.
The synchronisation between FDR and CVR was done with the UTC time and the VHF peaks recorded on the FDR.
The transcription of the CVR recording was written by the investigation team. The readout did not provide any additional information on already known facts.

2.8 Survival aspects

During the accident phase, lateral acceleration varied from 0.36 to – 0.45 g, longitudinal acceleration varied from -0.36 to + 0.23 and back to - 0.66 g, vertical acceleration varied from 0.65 to 1.43 g.

Finally, impact forces into the perimeter fence were rather light. The resulting damage did not impair the fuselage structural integrity and no harm was sustained by anyone on board of the aircraft.

2.9 Accident scenario

An Embraer 145 registered LX-LGZ and operated by Luxair departed Vienna (Austria) on 24 September 2003 at 07:18 on flight LG 8852 with destination Luxembourg. The flight was uneventful up to the landing on RWY 06 at 08:39:29 when during roll-out, the aircraft started to veer off to the right and departed the runway approximately 1500m beyond threshold 06 at the intersection with TWY's E and I.

The pilot used differential braking and left rudder input to counteract this tendency but could not stop the diverging movement.

Despite these actions, approximately 5 seconds after touch down, the magnetic heading could no longer be maintained aligned with the runway centre line.

In the final stages of the roll out the thrust reversers were deployed at 08:39:45 and differential reverse power was also used at 08:39:51, reducing substantially the veer-off angle. Already in the grass, normal applied braking didn't slow down the aircraft enough to prevent it hitting the perimeter fence.

After shutting down all systems, the aircraft was evacuated through the normal access door onto the airport internal service road.

One of the first observations at the site was the substantial steering angle of the nose gear to the right. Measurements were taken and they were later, during the technical investigation, confirmed to be close to a nose gear steering "hard over".

2.10 Crew performance

This steering issue was a known problem within Luxair and other operators. However, the pilots were left on their own, as the AFM did not address this issue of abnormal steering runaway, leading to a loss of directional control.

As in similar occurrences within the company, the pilots did what they thought to be appropriate to control the swerving of the aircraft. However, in this case and for the first time within the company, the aircraft could not be maintained on the runway.

With existing evidence, it could not be excluded that the hard over condition appeared for the first time on this particular flight.

3 CONCLUSIONS

3.1 Findings

1. The crew possessed the necessary licences and qualifications to perform the flight,

2. The aircraft possessed a valid Certificate of airworthiness,

3. The aircraft weight and balance were in the approved range.

4. Radio navigation aids functioned normally

5. There were no known aircraft system malfunctions and the crew did not notify any.

6. Nose gear steering malfunctions have occurred on numerous occasions with this operator and other operators all over the world.

7. The AFM did not address the abnormal steering runaway issue, leading to a loss of directional control.

3.2 Causes

The investigation has demonstrated that the veering off of the aircraft started with an uncommanded right turn, effectively being a hard over to the right of the nose gear.

The fault was traced to the hydraulic manifold of the nose gear steering unit commanding the left or right turns either through the rudder pedals or the steering handwheel.

It has been discovered that within this hydraulic manifold, o-ring seals started to disintegrate and these tiny bits of rubber being carried through the conduits of the manifold finally blocked one of the 2 orifices, (one for left turns and one for right turns) delivering the oil pressure imbalance to the steering cylinder. The resulting pressure differential across the steering cylinder drove the steering hard over.

PARKER engineering confirmed that the C1 nozzle corresponds to the C1 of the manifold outlet, which corresponds to the left-turn cylinder. Therefore, if only the C2 can get pressure, then it would appear that only a right turn is possible.

In fact, to produce a steering hard over, it is not sufficient to have one of the orifices blocked. The EMB 145 features a steering hard over protection, which cuts all hydraulic pressure to the

manifold when a nose wheel deflection greater than 7 degrees is detected. This protection is disabled when the steering control handwheel is pressed. Thus, producing a hard over requires one of the two manifold orifices blocked and the steering tiller to be pressed.

4 SAFETY RECOMMENDATIONS

4.1 Safety measures taken since the accident

On 26 September 2003, Embraer issued a flight operation support notification SEO/EMB-145/03/03, providing interim guidance for E145 crews on airplane uncommanded swerving after touchdown. Luxair Operations Department forwarded this notice to all their EMB pilots the same day. (see appendix 6)

The investigation commission issued a recommendation, dated 4 November 2003, to have an airworthiness directive published, stipulating that:

- SB 145-32-0081 (appendix 11) and
- SB 145-32-0082 (appendix 12)

be made mandatory for all Luxembourg registered EMB 135 / 145 aircraft.

On 11 November 2003 were published:

- Airworthiness directive LUX-2003-02 (appendix 7) covering the SB 145-32-0082 issue and
- Airworthiness directive LUX-2003-03 (appendix 8) covering the SB 145-32-0081 issue.

Both Airworthiness Directives were complied with on Luxair fleet by 13 February 2004.

On 6 April 2004, Embraer published an Alert S.B: No.145-32-A095, (Appendix 13) whereby they strongly recommend the installation of a decal on the glareshield panel in the cockpit, stating:

“WARNING: DO NOT ACTUATE THE STEER HANDLE IN CASE OF UNCOMMENDED SWERVING OR INADVERTENT "STEER INOP" MSG”.

On 13 April 2004, following a recent similar event with another US operator, Embraer issued an Operational Bulletin (OB 145-002/04) to provide information related to the operational procedures to be followed in the event of an uncommanded swerving during high speed taxi, takeoff and landing, and also to inform about the AFM revision (Appendix 9).

On 04 May 2004, Embraer issued a follow-up # O145-32-012 on the Nose wheel steering system being investigated due to occurrences of uncommanded swerving on ground during taxi, takeoff run or right after touchdown (Appendix 10).

4.2 Improvements in the design of the Nose Gear steering system

Embraer has been working with the feedback potentiometer and hydraulic manifold manufacturers to assess the failure modes and design corrective actions, which led to following service bulletins:

On 01 September 2004, Embraer published SB 145-32-0100 on improvement in design of feedback unit potentiometer P/N 1170A3500-01. Shop findings revealed some quality deviations in the feedback unit potentiometer assemblage process that could result in a functional disturbance in the steering system. To avoid this, the units are being modified to feature an enhanced sealing concept and assured quality (Appendix 15).

On 03 September 2004, Embraer issued SB 145-32-099, Upgrade nose wheel steering manifold. Luxair accomplished this service bulletin on six out of eight aircraft between January and September 2005. The remaining two new aircraft were equipped by EMBRAER prior delivery (Appendix 14).

On 27 January 2006, Embraer published SB 145-32-0110 providing a second source supplier available of potentiometer for the feedback unit potentiometer P/N 1170A1800-01 and P/N 1170A3500-01 (Appendix 16).

5 APPENDICES

Appendix 1. FDR read out

Appendix 2. Hydraulic fluid sample analysis

Appendix 3. Hydraulic manifold test dated 17.11.2003

Appendix 4. Evaluation report of the EHSV at HR Textron

Appendix 5. AFM revisions

Appendix 6. SEO/EMB 145/03/03

Appendix 7. AD LUX-2003-002

Appendix 8. AD LUX-2003-003

Appendix 9. OB 145-002/04

Appendix 10. O 145-32-012

Appendix 11. SB 145-32-0081

Appendix 12. SB 145-32-0082

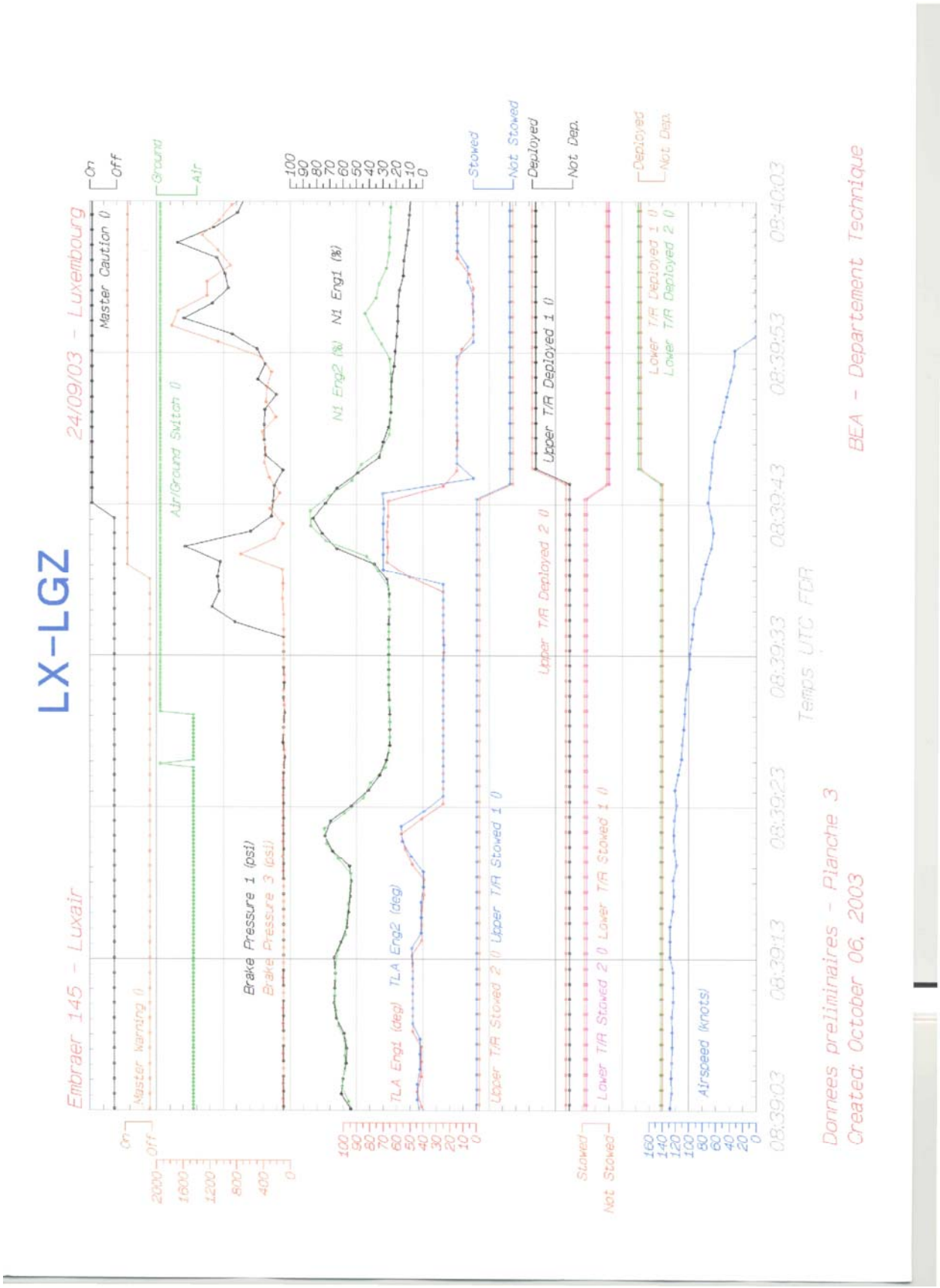
Appendix 13. SB 145-32-A095

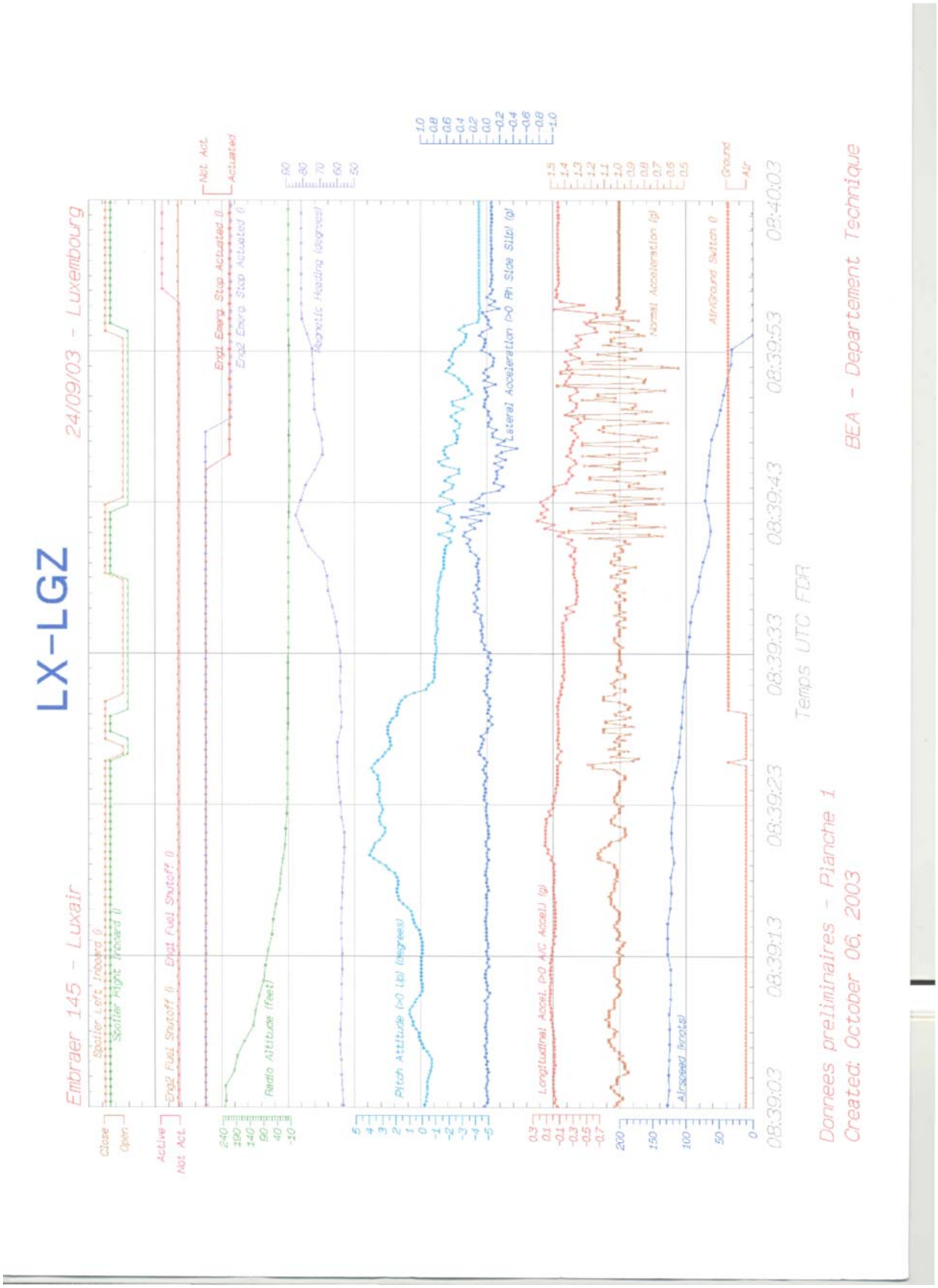
Appendix 14. SB 145-32-099

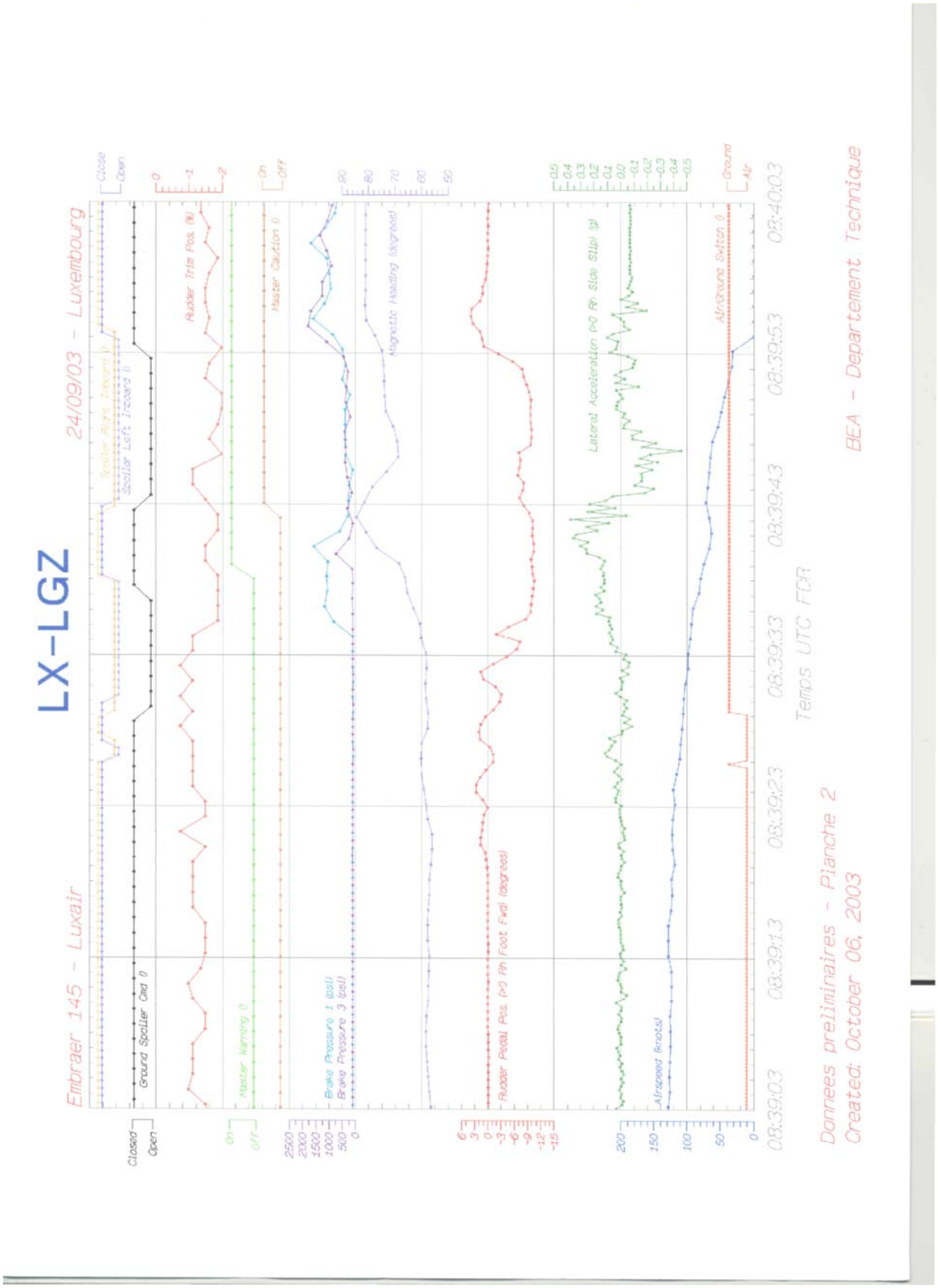
Appendix 15. SB 145-32-100

Appendix 16. SB 145-32-110

Appendix 1.


LX-LGZ
Embraer 145 - Luxair
24/09/03 - Luxembourg
Master Caution 0
Master Warning 0
Air/Ground Switch 0
Ground
Air
On
Off
Brake Pressure 1 (psi)
Brake Pressure 3 (psi)
N1 Eng2 (%)
N1 Eng1 (%)
TLA Eng1 (deg)
TLA Eng2 (deg)
Upper T/R Stowed 2 0
Upper T/R Stowed 1 0
Upper T/R Deployed 2 0
Upper T/R Deployed 1 0
Lower T/R Stowed 2 0
Lower T/R Stowed 1 0
Lower T/R Deployed 1 0
Lower T/R Deployed 2 0
Stowed
Not Stowed
Deployed
Not Dep.
Not Deployed
Airspeed (knots)
08:39:03
08:39:13
08:39:23
08:39:33
08:39:43
08:39:53
08:40:03
Temps UTC FDR
Donnees preliminaires - Planche 3
Created: October 06, 2003
BEA - Departement Technique


LX-LGZ
Embraer 145 - Luxair
24/09/03 - Luxembourg
Spoiler Left Indicated ()
Spoiler Right Indicated ()
Eng1 Fuel Shutoff ()
Eng2 Fuel Shutoff ()
Eng1 Emerg Stop Actuated ()
Eng2 Emrg Stop Actuated ()
Radio Altitude (feet)
Magnetic Heading (degrees)
Pitch Attitude (+0 Up) (degrees)
Lateral Acceleration (+0 Rt Side Slip) (g)
Longitudinal Accel. (+0 A/C Accel) (g)
Normal Acceleration (g)
Airspeed (knots)
Air/Ground Switch ()
Close
Open
Active
Not Act.
Not Act.
Actuated
Ground
Air
08:39:03
08:39:13
08:39:23
08:39:33
08:39:43
08:39:53
08:40:03
Temps UTC FDR
BEA - Departement Technique
Donnees preliminaires - Planche 1
Created: October 06, 2003


LX-LGZ
Embraer 145 - Luxair
24/09/03 - Luxembourg
Ground Spoiler Cmd 0
Spoiler Right Feedback
Spoiler Left Feedback
Rudder Trim Pos. (°)
Master Warning 0
Master Caution 0
Brake Pressure 1 (psi)
Brake Pressure 3 (psi)
Magnetic Heading (degrees)
Rudder Pedal Pos. (+) Rh Foot Fwd (degrees)
Lateral Acceleration (+) Rh Side Stick (g)
Airspeed (knots)
Air/Ground Switch 0
Closed
Open
Close
Open
On
Off
Ground
Air
08:39:03
08:39:13
08:39:23
08:39:33
08:39:43
08:39:53
08:40:03
Temps UTC FDR
Donnees preliminaires - Planche 2
Created: October 06, 2003
BEA - Departement Technique

Appendix 2.

Parker

M & P

LABORATORY REPORT – CONTAMINATION - RSI 097 - MULTI-PROGRAM

J/N R623785 P/N 308570-1003 S/N 0096

Fluid Skydrol Sys/N 017 Program EMB-145

Date 11-17-03 Time 2:10 P.M. ☐ Other Test Stamp CSO 143 F70

Sample Taken From Return ☐ CSD ☒ CSO ☐ OGD

Sample ☒ Receiving ☐ Shipping ☐ Board Clearance ☐ Pre-Test ☐ Dynamic Leakage ☐ Evaluation

Specification R.S.I. 097 Class _____

____ H20 ____ Chlorine ____ Monthly ____ Weekly Comments Eng. investigation

C-95/4541 R8/00

Particle Count Per ☐ _____ mL ☒ 100 mL

Micron Size Range	Particle Count	Maximum Allowable (per 100mL)	Particle Count
5 - 10	47,546	128,000	
10 - 25	13,787	42,000	
25 - 100	934	7,500	
Over 100	3	92	
Fibers		15	

Water (PPM)		
Specific Gravity		
Viscosity		
Neutralization		
Chlorine (PPM)		

REMARKS _____

ACCEPT ☐ REJECT ☐

M&P TECH: _____ STAMP: _____ DATE: 11-18-03

LTF 129.3, Rev N/C

Appendix 3.

Part No:	308570 -1003	Serial No.:	0096	Test Date:	11-17-03
Part Name:	Nose Wheel Steering Manifold Assembly	Work Order:	R623785	Inspector:	M.M.

☐ OVERHAUL | FLUID TYPE: Skydrol | ☒ IN-SERVICE

3.E BYPASS MODE TEST	(5) The flow from port C2 must be 0.21 gpm minimum. (9) The flow from port C1 must be 0.21 gpm minimum.	.52 gpm .37 gpm	CSO 143 FTO	
3.F PROOF PRESSURE TEST	**C 1 position** (5) No external leakage or permanent deformation is allowed. **C 2 position** (12) There must not be any external leakage or permanent deformation.	Pass ☐ Fail ☐ Pass ☐ Fail ☐	CSO 143 FTO	
3.G RETURN PROOF TEST	(5) There must be no external leakage or permanent deformation.	Pass ☐ Fail ☐	CSO 143 FTO	
3.H INTERNAL LEAKAGE	**C 1 position** (5) Leakage must not exceed 0.150 gpm. **C 2 position** (8) Leakage must not exceed 0.150 gpm. **Disengage** (11) Leakage must be 1 cc/min maximum.	.066 gpm .071 gpm 0 cc/min % SHSV PRESSURE FLUCTUATING APPROX ± 100 PSI @ NEUTRAL	CSO 143 FTO	

RECEIVING TEST

Form 1132-3 Rev H

T.D.R. Rev. -D-

Part No:	308570 -1003	Serial No.:	0096	Test Date:	11-17-03
Part Name:	Nose Wheel Steering Manifold Assembly	Work Order:	R623785	Inspector:	M.M.

☐ OVERHAUL | FLUID TYPE: Skydrol | ☑ IN-SERVICE

3.I NO LOAD FLOW RATE AND PHASING	**C 1 position** (6) Verify flow is from port C1, measure and record flow from port R.	C1 Flow : Yes ☑ No ☐ 1.470 gpm		
	(8) For the –1001 configuration, port R flow minus internal leakage must be 1.02 to 1.28 gpm. (9) For the –1003 configuration, port R flow minus internal leakage must be 1.26 to 1.54 gpm.	-1001 ☐ -1003 ☑ 1.404 gpm	GSO 143 FTO	
	C 2 position (11) Verify flow is from port C2, measure and record flow from port R.	C2 Flow : Yes ☑ No ☐ 1.488 gpm		
	(13) For the –1001 configuration, port R flow minus internal leakage must be 1.02 to 1.28 gpm. (14) For the –1003 configuration, port R flow minus internal leakage must be 1.26 to 1.54 gpm.	-1001 ☐ -1003 ☑ 1.417 gpm		
3.J COMPENSATOR CRACKING PRESSURE	(5) Return flow must crack with supply pressure between 45 to 60 psig.	52 psig	GSO 143 FTO	
3.K COMPENSATOR PISTON LEAKAGE	(6) Leakage must not exceed 4 drops maximum in 2 minutes.	1 drops	GSO 143 FTO	
3.L INLET CHECK VALVE AND LOW PRESSURE EXTERNAL LEAKAGE	(6) Leakage must not exceed 1 drop maximum in 1 minute. RECEIVING TEST	1 drops	GSO 143 FTO	

Form 1132-3 Rev H

Page 3 of 3

T.D.R. Rev. -D-

Part No:	308570 -1003	Serial No.:	0096	Test Date:	11-17-03
Part Name:	Nose Wheel Steering Manifold Assembly	Work Order:	R623785	Inspector:	M.A.

☐ OVERHAUL | FLUID TYPE: Skydrol | ☒ IN-SERVICE

3.C DIELECTRIC STRENGTH	(a) Combination I (Positive Lead); A,B,C,D,E and F and Combination II (Ground Lead) Manifold. (b) Combination I (Positive Lead); A,B and Combination II (Ground Lead); C,D,E,F and Manifold. (c) Combination I (Positive Lead); D,E and Combination II (Ground Lead); A,B,C,F and Manifold. There must be no arcing, breakdown or insulation failure. Leakage current must not exceed 1 mA.	Pass ☑ Fail ☐ Pass ☑ Fail ☐ Pass ☑ Fail ☐ < 1 mA	CSO 122	
3.D INSULATION RESISTANCE	(a) Combination I (Positive Lead); A,B,C,D,E and F and Combination II (Ground Lead) Manifold. (b) Combination I (Positive Lead); A,B and Combination II (Ground Lead); C,D,E,F and Manifold. (c) Combination I (Positive Lead); D,E and Combination II (Ground Lead); A,B,C,F and Manifold. Resistance must be 100 megohms minimum. (10 megohms in-service)	Pass ☑ Fail ☐ Pass ☑ Fail ☐ Pass ☑ Fail ☐ > 100 megohms RECEIVING TEST	CSO 122	

Form 1132-3 Rev H

Page 1 of 3

T.D.R. Rev. -D-

Appendix 4.

ERS098 Rev B
Date: 2004-04-01
PN: 22253282-103, S/N 102

HR TEXTRON

HR Textron Inc.
a Subsidiary of Textron Inc.

25200 West Rye Canyon Road
Valencia CA 91355-1265
661/294-6000
FAX 661/259-9622

EVALUATION REPORT

CUSTOMER Parker Hannifin P.O. NO. _____ REJ. NO. 45612

PART NO. 22253282-103 SER. NOS. 102

CUSTOMER REASON FOR RETURN:

Unit returned for routine engineering evaluation.

The evaluation was part of an NTSB / Luxembourg government / Embraer investigation of an Embraer 145 nose wheel steering system that was involved in an incident.

The incident was attributed to an un-controllable partial right turn of the aircraft after the Embraer 145 aircraft landed in Luxembourg. System level tests performed days after the incident, and later at Parker, did not reveal any problems with the actuation system.

ANALYSIS, RESULTS, AND CORRECTIVE, ACTION:

SUMMARY OF FINDINGS (see page 3 for evaluation details).

- Functional check revealed that the unit was not operating correctly.
- Low internal leakage indicated a restriction in the first stage.
- C1 nozzle appeared to be blocked, however, no contamination was recovered from the C1 nozzle when the unit was disassembled.
- Rubber-like contamination was found in the C1 first stage cavity upstream of the C1 nozzle.
- Damage (nibbling/extrusion) was found on the C1 filter seal.
- Material composition of the contamination was found to be consistent with the C1 filter seal.
- Filter bore was found to be oversize by 0.0018 inch.

DISCUSSION (see hydraulic schematic in Figure 1 and filter bore cross section in Figure 2 for reference)

The anomaly observed in the operation of the unit, when tested at HR Textron, is consistent with contamination obstructing the first stage flow through the C1 nozzle.

In normal operation, as the torque motor input current increases the flapper moves to the right closing the C2 nozzle and opening the C1 nozzle. The spool moves to the left connecting supply pressure to cylinder 1, in response to the increase in the C2 end chamber pressure and decrease in the C1 end chamber pressure, pulling the feedback wire until a balance is achieved.

DATE	SIGNATURES	TITLE
04-01-19		Project Engineer
04-01-19		Manufacturing Engineer
04-01-19		Quality Engineer

QA 024

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

DISCUSSION (continued)

If contamination was present in the C1 nozzle, the C1 end chamber pressure could not decrease enough to allow the spool to travel to its commanded position and the first stage flow was restricted. In the case of the subject unit, the reduced second stage flow output observed in Figure 3 is evidence that the spool did not travel far enough to the left to fully open supply pressure to cylinder 1 and the low internal leakage is further evidence that the first stage was restricted.

Although a particle could not be retrieved from the C1 nozzle and, therefore, could not be analyzed, it is very likely that the source of the contamination obstructing the C1 nozzle was the C1 filter seal. This has been deduced from the fact that contamination was found upstream of the C1 nozzle and the C1 filter seal was found to be missing some material. The material composition of the contamination, the location where it was found, and the damage on the C1 filter seal are positive indications that the source of the contamination was the C1 filter seal. It is likely that a piece of the damaged seal broke off and flowed downstream to the C1 nozzle area where it became trapped between the C1 nozzle and the flapper.

Damage to the seal may have been caused by (1) damage during assembly and/or (2) seal extrusion. The C1 filter seal may have been damaged during assembly leaving the severed piece of o-ring in the cavity upstream of the C1 nozzle. Or, the C1 filter seal extruded during service producing the contamination found in the cavity upstream of the C1 nozzle. In either case, the contamination would have traveled downstream to the C1 nozzle area where it became trapped between the C1 nozzle and the flapper. It is likely that a combination of these scenarios took place.

The failure could not be reproduced in the laboratory. Not being able to reproduce the failure is not necessarily an indication that the hypothesis is incorrect. However, it is likely an indication that the probability of this type of failure occurring is small because the exact conditions are necessary for it to initiate.

CONCLUSION

Internal contamination obstructed the proper functioning of the servovalve. The internal contamination resulted from seal damage produced during assembly of the unit or by in-service extrusion of the seal.

The obstruction in the first stage caused the anomaly observed in the flow output of the unit when the unit was tested at HR Textron. It is not known if this anomaly contributed to, or is consistent with, the un-controllable partial right turn of the aircraft implicated in the Luxembourg incident.

CORRECTIVE ACTION(s)

1. Retrain relevant personnel on the orifice/filter seal assembly and first staging procedures and emphasize that it is critical to:
    a. Install orifice/filter seals using the proper tools (T12-1 with T-250000-4A-1).
    b. Inspect seals 100% after they are installed in the filter bore.
    c. Maintain clean and damage-free installation tools.
    d. Open return valve on test bench prior to removing first stage tooling
    e. Re-install, or replace seals, using proper technique and tools if assembly is disrupted.
2. Retrain relevant personnel on the housing manufacturing procedure and emphasize that it is critical to:
    a. De-burr filter bore using proper technique and tools; sandpaper is prohibited.
    b. Inspect filter bore 100% with pin gauge.

Corrective actions are scheduled to be completed by March 11, 2004.

2

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

EVALUATION

The following personnel witnessed the evaluation conducted at HR Textron on December 16, 2003.

– NTBS Aerospace Engineer

ker Customer Service Sr. Engineer

Sr. Quality Engineer

1. Visually examined unit for external damage – No anomalies were noted.
2. Ran flow gain, internal leakage and pressure gain – Flow gain and pressure gain did not meet specification, see Figures 3 and 4. Figures 5 and 6 show the as shipped functional test plots for comparison.
3. Removed adapter, unsoldered coil leadwires, removed torque motor cover and inspected torque motor area - No anomalies were noted. Torque motor was found to be free of contamination and appeared to be in good working condition.
4. Removed end plates and nozzle plugs and inspected area behind nozzles – C1 nozzle appeared to be blocked (flapper could not be seen), C2 nozzle was found to be free of contamination (flapper was visible).
5. Removed poles, coil, magnet and frame assembly, and armature assembly and inspected nozzles – C1 nozzle appeared to be obstructed, C2 nozzle was found to be free of contamination. Type of material obstructing C1 nozzle could not be identified.
6. Removed C1 orifice plug – Foreign material was found on plug, see Figure 7. See Figure 8, C2 orifice plug, for comparison.
7. Removed filter seals and orifice and filter assembly – Damage was found on C1 filter seal, see Figure 9. See Figure 10, C1 filter seal, for comparison.
8. Removed end chamber plugs and checked spool travel – Spool was found to move freely without resistance.
9. Removed spool and inspected metering edges for damage – No anomalies were noted.
10. Inspected sleeve bore – No anomalies were noted.
11. Checked material composition of contamination found on C1 orifice plug and the filter seal – Material was found to be consistent with the filter seal material (ethylene propylene), see Metallurgy Report MLR 19308.
12. Checked filter bore, orifice plug, and orifice retainer dimensionally – Filter bore diameter was found to be 0.2123 inch (bore diameter drawing limit are 0.2095-0.2105). No other anomalies that may have contributed to the failure were found.
13. Attempted to reproduce cutting the filter seal during assembly – Did not succeed in cutting the seal when installing it without the correct tools (installation tool, thin tube that covers k-cut, was not used).
14. Attempted to reproduce cutting the filter seal during first stage operation - Did not succeed in displacing the seal from its installed location when first stage tooling was removed while residual return pressure was present (pressure pushed out orifice plug but did not disturb filter seal).
15. Inspected C1/C2 orifice plug seals and C2 filter seal – The C1/C2 orifice plugs met the as-new print requirements. The C2 filter seal ID measured 0.1225 (print is 0.125-.135). The reduced ID was likely caused by service conditions (permanent set). The groove diameter of the filter seal is smaller (0.142-.143) than that of the orifice plug seal (.148-.150).

3

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

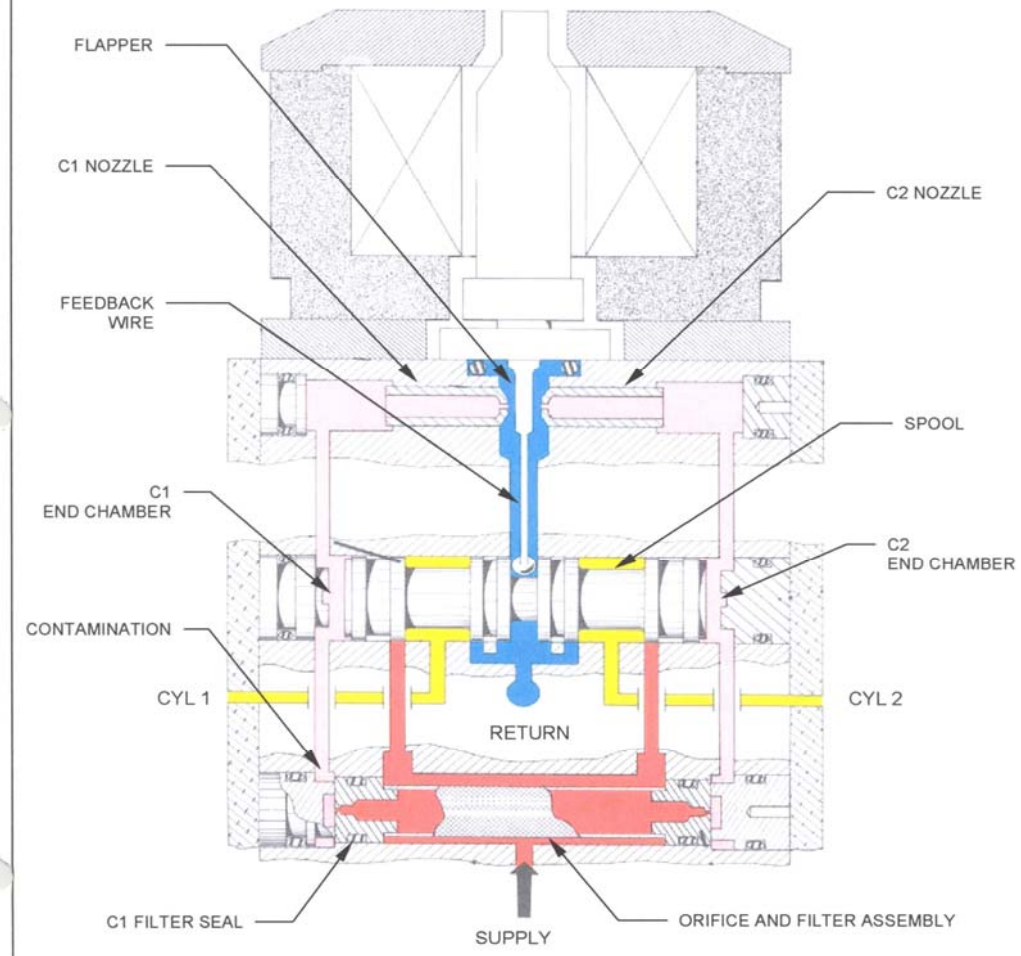


Figure 1 – Hydraulic Schematic

4

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

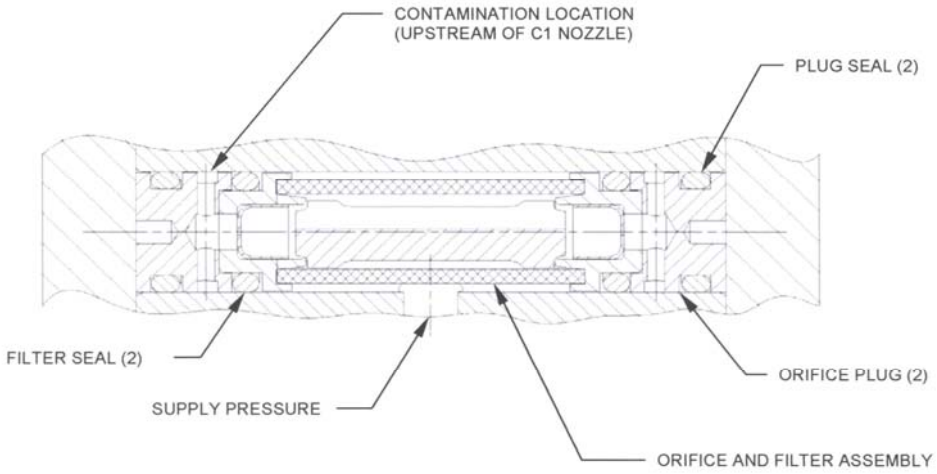


Figure 2 – Filter Bore Cross-Section

5

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

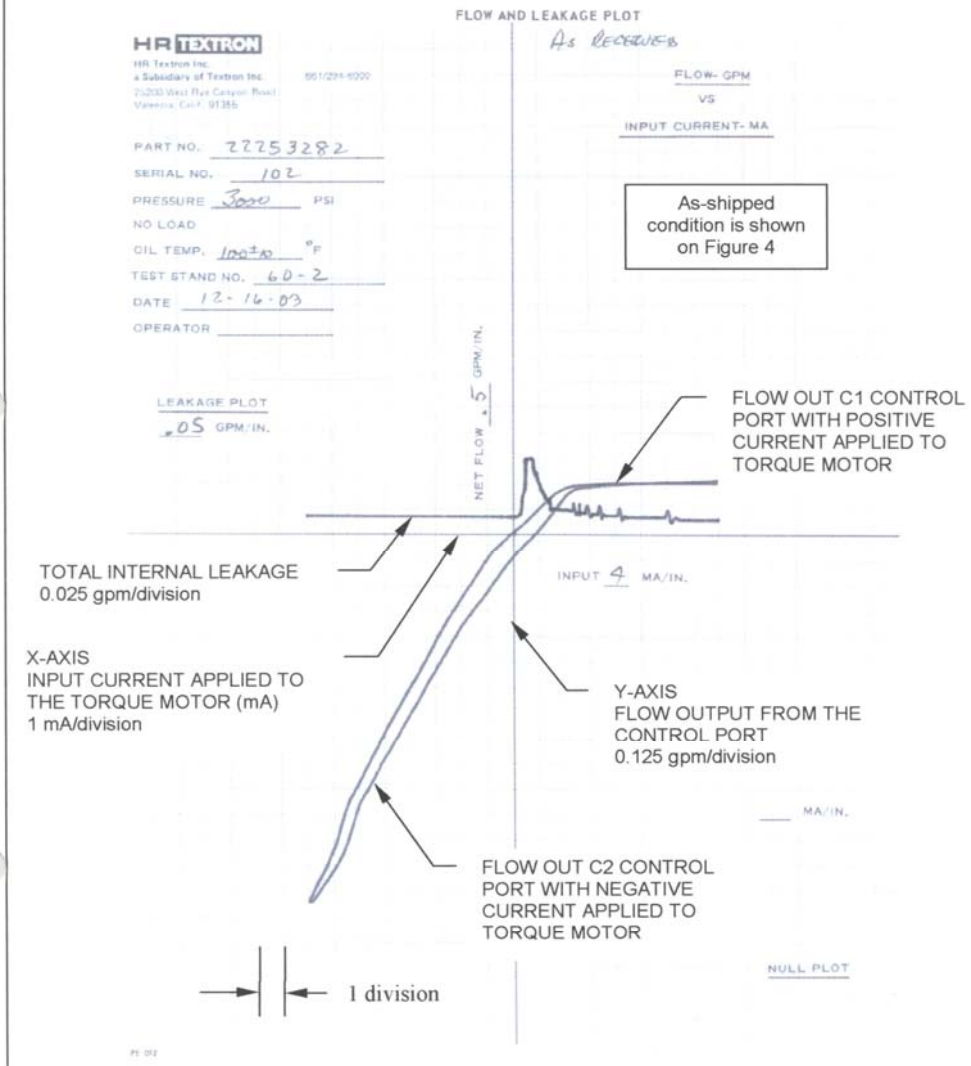


Figure 3 – As Received Flow Gain and Internal Leakage Plot

6

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

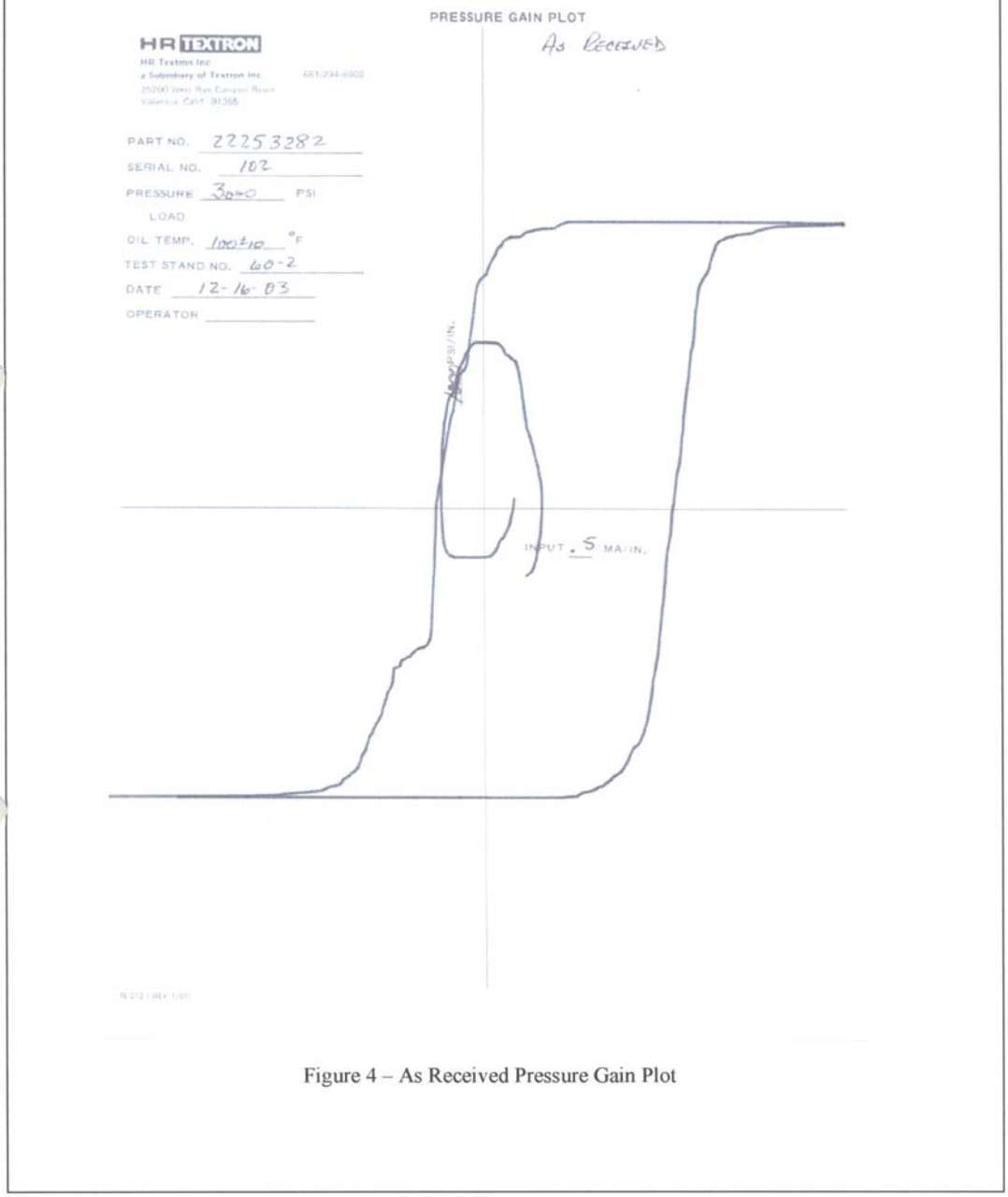


Figure 4 – As Received Pressure Gain Plot

7

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

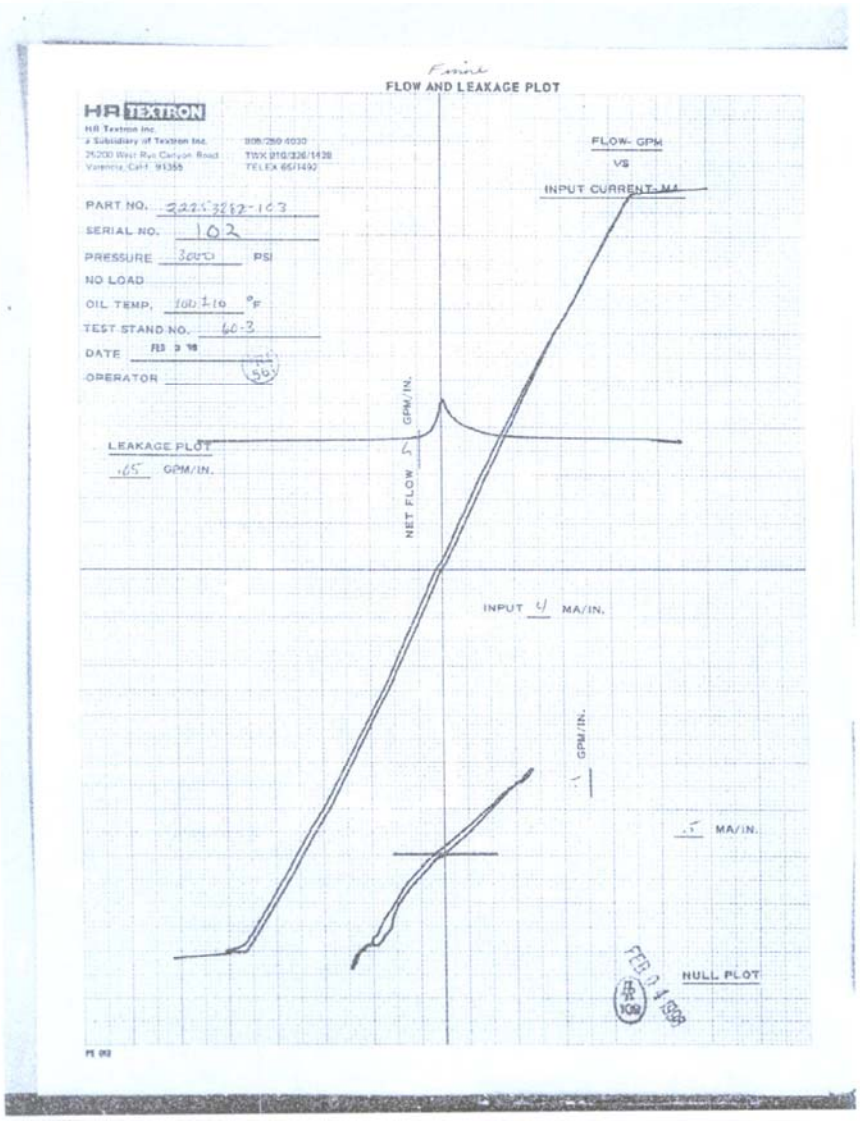


Figure 5 – As Shipped Flow Gain and Internal Leakage Plot

8

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

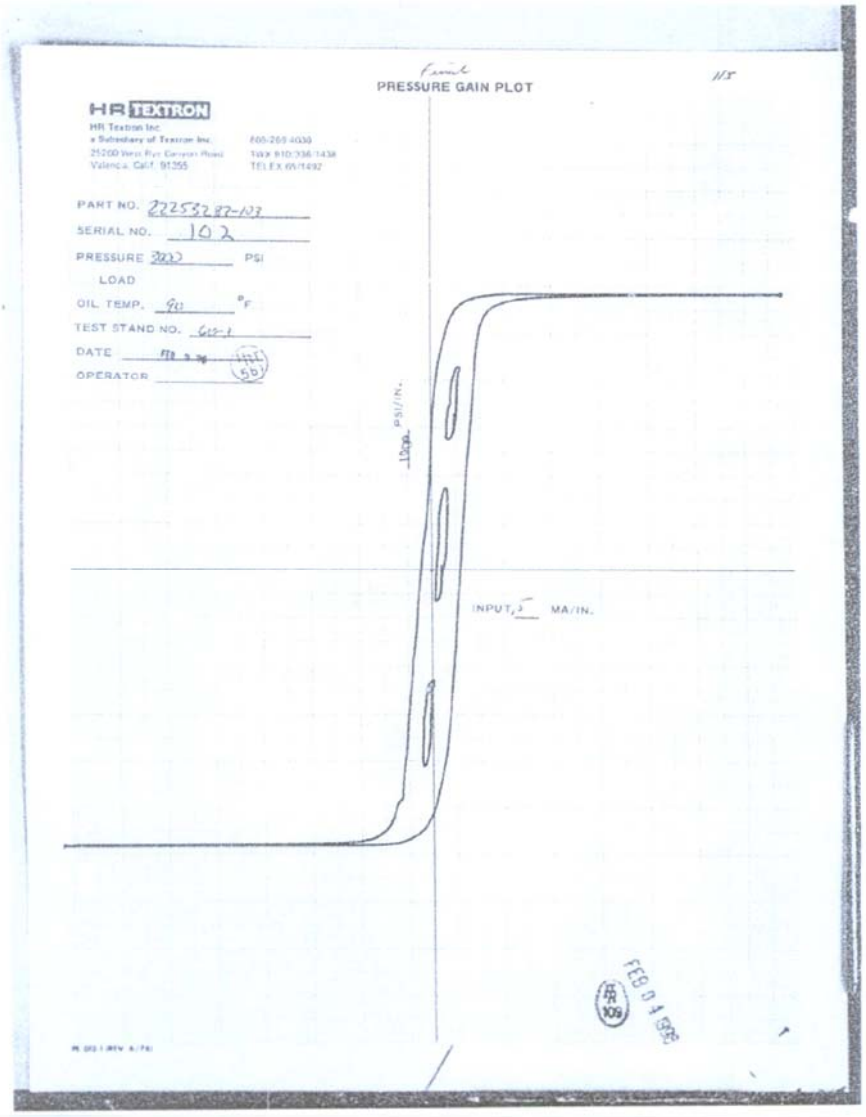


Figure 6 – As Shipped Pressure Gain Plot

9

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

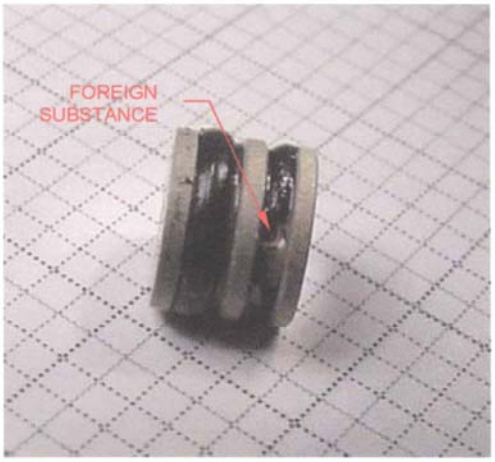


Figure 7 – C1 Orifice Plug

Figure 8 – C2 Orifice Plug

10

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

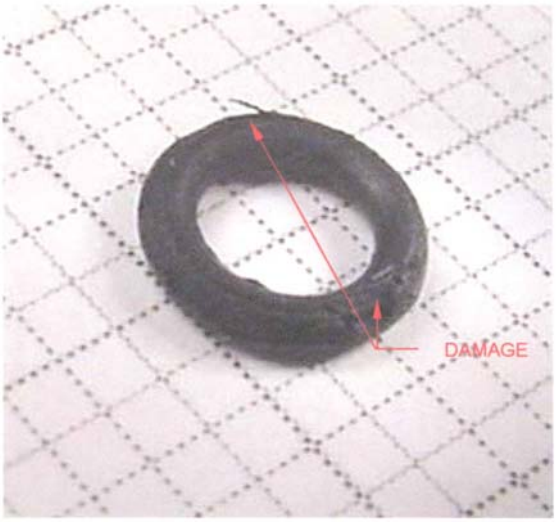


Figure 9 – C1 Filter Seal

Figure 10 – C2 Filter Seal

11

HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

APPENDIX A
MLR 19308

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HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

HR TEXTRON

25200 WEST RYE CANYON ROAD ■ VALENCIA, CALIFORNIA 91355
PHONE (805) 294-6000 ■ FAX (805) 259-9622

METALLURGICAL LABORATORY REPORT

DATE: 12/19/03		**MLR NUMBER:** 19308
TO: O. Arguelles		**FROM:** S. Myron
SUBJECT Identification of Contaminate Particle		
PART NUMBER: 82005512-034	**WORK ORDER NUMBER:**	**TRAVELER NUMBER:** RO00078849
DESCRIPTION AND TYPE OF MATERIAL:		

A small contaminant particle was submitted to the Metallurgy Laboratory for the purpose of identification. Two samples, representing possible sources for the particle, were also provided to the laboratory. The samples were labeled 1) C1 Filter Seal, and 2) P/N82005512-034 Rev BF (Phosphate Ester, Ethylene Peropylene). All three samples were submitted to Pacific Testing Laboratories (Santa Clarita, CA) for FTIR analysis. Figures 1-3 are the FTIR spectra determined for the Individual samples.

The spectra for all three specimens are similar, suggesting that they are made basically from the same material. However, the contaminant has a closer match with the C1 filter seal specimen, indicating that there is a good probability that this P/N is the source of the contamination.

Stuart M. Myron

S. Myron
Metallurgy Laboratory

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HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

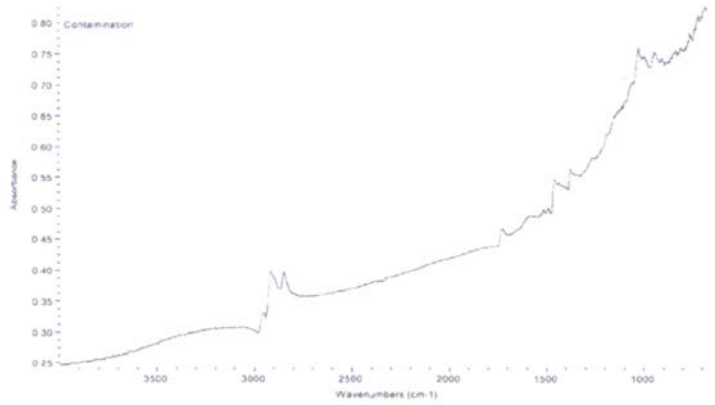

Figure 1

FTIR Spectrum for Contaminate particle

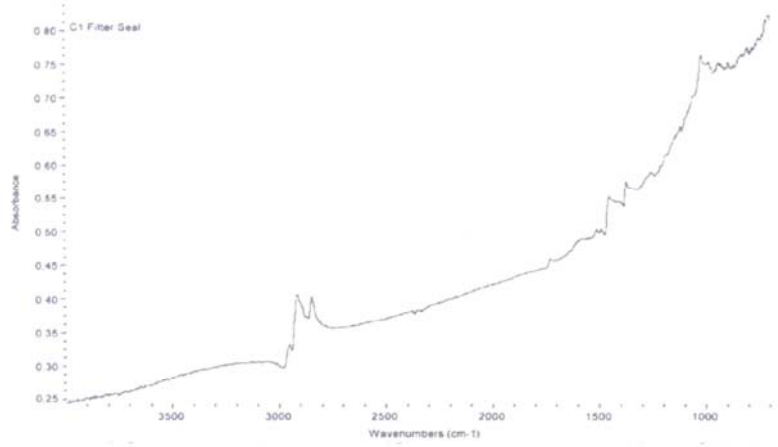

Figure 2

FTIR Spectrum for C1 Filter Seal Specimen

Page 2 mlr19308

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HR TEXTRON

ANALYSIS, RESULTS, AND CORRECTIVE ACTION: (Continued)

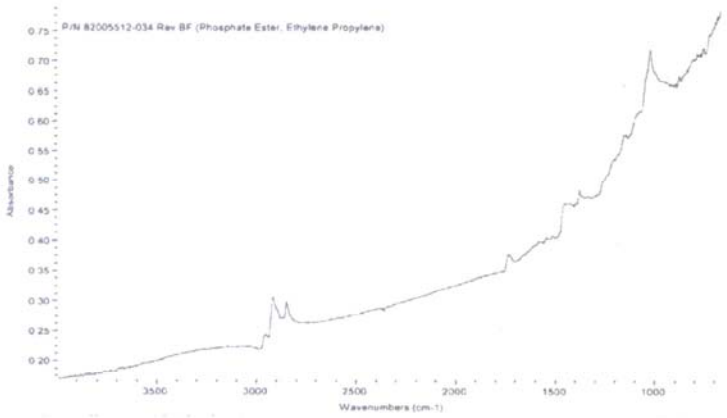

Figure 3

FTIR Spectrum for P/N 8200512-034 specimen

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Appendix 5.

LANDING GEAR AIR/GROUND SYSTEM FAILURE

EICAS CAUTION: LG AIR/GND FAIL

If not in icing conditions:
Icing Conditions.....AVOID

If in icing conditions:
Anti-icing System.....MONITOR
If any anti-ice valve does not open or anti-ice failure messages appear, leave and avoid icing conditions.

After exiting icing conditions, proceed as follows:
Maximum Bank Angle.....30°
Minimum Airspeed for
Flaps up or 9°.....190 KIAS
Landing configuration:
Flaps.....45°
Airspeed.....$V_{REF\ 45}$

CAUTION: TO DETERMINE THE MINIMUM SUITABLE LANDING DISTANCE, MULTIPLY THE UNFACTORED LANDING DISTANCE FOR FLAPS 45° BY 1.45.

Report to the maintenance personnel.

NOTE: - Thrust Reversers, and Ground Spoiler may not be available. Depending on the failed condition, Ground Idle may not be selectable. Refer to the associated abnormal procedures.
- If message is presented on ground, one pair of brakes (below 10 kt ground speed) and Steering may not be available. Refer to the associated abnormal procedures.

UNCOMMANDED SWERVING ON GROUND

Control the airplane using rudder command and differential brakes.
Steering Handwheel.....DO NOT USE

If unable to control the airplane, as an additional action:
Steering Disengagement Button.....PRESS
Consider the use of differential thrust reverser if serviceable.

EMERGENCY/PARKING BRAKE LOW PRESSURE

EICAS CAUTION: EMRG BRK LO PRES

If necessary to use the emergency/parking brake, apply it in advance.
When parking the airplane, use wheel blocks.

STEERING SYSTEM INOPERATIVE

EICAS CAUTION: STEER INOP

Prior to takeoff, do not takeoff.
During landing, steer the airplane using differential braking, rudder and asymmetric thrust.
In case of only pedal steering inoperative, the use of steering handle must be avoided above 40 KIAS.

UNCOMMANDED SWERVING ON GROUND

Control the airplane using rudder command and differential brakes.
Steering Handwheel ..... DO NOT USE

If unable to control the airplane, as an additional action:
Steering Disengagement Button ..... PRESS
Consider the use of differential thrust reverser if serviceable.

EMERGENCY BRAKING TECHNIQUE

Pull the emergency brake handle carefully and continuously until the first airplane reaction. Use the parking brake light as a reference for brake application. Modulate brake application until the airplane achieve the desired deceleration.
In case of airplane skidding, release the handle and pull it again as required.

NOTE: Anti-skid protection is not available for emergency/parking brake.

EMERGENCY/PARKING BRAKE LOW PRESSURE

EICAS Message: EMRG BRK LO PRES

If necessary to use the emergency/parking brake, braking response may be delayed.
When parking the airplane, use wheel blocks.

STEERING SYSTEM INOPERATIVE

EICAS Message: STEER INOP

Prior to takeoff, do not takeoff.
During landing, steer the airplane using differential braking, rudder and asymmetric thrust.
In case of only pedal steering inoperative, the use of steering handle must be avoided above 40 KIAS.

UNCOMMANDED SWERVING ON GROUND

Control the airplane using rudder command and differential brakes.
Steering Handwheel ..... DO NOT USE
If unable to control the airplane, as an additional action:
Steering Disengagement Button ..... PRESS
Consider the use of differential thrust reverser if serviceable.

EMERGENCY/PARKING BRAKE HANDLE DISAGREE

INDICATION: BRAKE ON light illuminated with Emergency/Parking Brake handle not actuated.
Park the airplane as soon as possible.
Do not takeoff. Report to the maintenance personnel.

Appendix 6.

EMBRAER

SEO/EMB-145/03/03

São José dos Campos, September 26th, 2003

TO: LUXAIR S.A.

FROM: EMBRAER – FLIGHT OPERATIONS SUPPORT

Subject: Airplane Uncommanded Swerving after touchdown

Dear Sirs,

This is an interim guidance for the ERJ 145 crews.
This guidance shall be superseded by procedures based on more thorough analysis of the Nose Wheel Steering system that is still ongoing.
This guidance does NOT imply that EMBRAER so far has any indication of a Nose Wheel Steering System problem that would result in an uncommanded swerving.

If the pilot notices an uncommanded airplane swerving, the following actions should be taken:

- STEERING DISENGAGE BUTTON ..... PRESS AND HOLD
- CONTERACT AIRPLANE TENDENCY BY USING RUDDER PEDALS.
- DIFFERENTIAL BRAKING..... APPLY
- DIFFERENTIAL THRUST REVERSER ..... APPLY
- STEERING WHEEL ..... DO NOT USE.

Use this technique as necessary to maintain the aircraft within runway limits. The use of maximum differential brakes, maximum rudder pedals and maximum differential reverse thrust may be needed and should be used thoroughly until the airplane has come to a full stop.

Once the airplane is stopped,

- PARKING BRAKE ..... AS REQUIRED
- STEERING DISENGAGE BUTTON ..... RELEASE

Best regards,

EMBRAER Flight Operations Support

EMBRAER - EMPRESA BRASILEIRA DE AERONÁUTICA S/A
CAIXA POSTAL 343 / CEP 12227-901 SÃO JOSÉ DOS CAMPOS - SÃO PAULO - BRASIL
opereng@embraer.com.br

Pag. 1 / 1

N° OF-E-M-250/KRE
DATE 26 SEP 03
SUBJECT UNCOMMANDED AIRPLANE SWERVING AFTER TOUCHDOWN

Retain until revoked

URGENT

Dear colleagues,

As response to our LX LGZ accident, we have received interim guidelines (attached on the verso) by Embraer Flight Operations Support and they are applicable until revoked.

As supplementary precautions we would like to ask you to:

- Make sure the airplane lands on the middle of the runway
- Open Thrust Reversers clam shells at every landing
- Do not extend landing rollout unnecessarily in order to shorten taxi time

Many thanks for your co-operation and best regards,

Appendix 7.

AIRWORTHINESS DIRECTIVE

AD : LUX-2003-002

Grand-Duché de Luxembourg
Ministère des Transports
Direction de l'Aviation Civile
(DAC)

Applicability : EMBRAER EMB-145( ) and EMB-135( ) series airplanes; certificated in any category.

Note 1 : This AD applies to each airplane identified in the preceding applicability provision, regardless of whether it has been modified, altered, or repaired in the area subject to the requirements of this AD.

Compliance : Required as indicated, unless accomplished previously.

Corrective action

- LANDING GEAR – FEEDBACK UNIT SENSOR MODIFICATION – Instructions to modify the feedback unit sensor of the nose landing gear - EMBRAER Service Bulletin No. 145-32-0082 dated 27/11/2002.

Reference

- LIEBHERR ELEB S.B. 1170A2900-32-01 – LANDING GEAR – FEEDBACK UNIT SENSOR P/N 1170A2900-01 – DESIGN IMPROVEMENT OF FEEDBACK UNIT issued 05/09/2002.

- A.M.M. 145/( ) – "Aircraft Maintenance Manual" – Chapter 29-10-00 – Hydraulic Power.

- A.M.M. 145/( ) – "Aircraft Maintenance Manual" – Chapters 32-00-01 and 32-50-06 – Landing Gear.

Effective Dates

This amendment becomes effective on February 11th, 2004.

Issued in Luxembourg, on November 11th, 2003.

Airworthiness office, Civil Aviation Authority.

Appendix 8.

AIRWORTHINESS DIRECTIVE

AD : LUX-2003-003

Grand-Duché de Luxembourg
Ministère des Transports
Direction de l'Aviation Civile (DAC)

Applicability : EMBRAER EMB-145( ) and EMB-135( ) series airplanes; certificated in any category.

Note 1 : This AD applies to each airplane identified in the preceding applicability provision, regardless of whether it has been modified, altered, or repaired in the area subject to the requirements of this AD.

Compliance : Required as indicated, unless accomplished previously.

Corrective action

- LANDING GEAR – FEEDBACK UNIT POTENTIOMETER MODIFICATION – Instructions to modify the feedback unit potentiometer of the nose landing gear - EMBRAER Service Bulletin No. 145-32-0081 Revision 01 dated 13/12/2002.

Reference

- LIEBHERR ELEB S.B. 1170A1800-32-01 – LANDING GEAR – FEEDBACK UNIT POTENTIOMETER P/N 1170A1800-01 – DESIGN IMPROVEMENT OF FEEDBACK UNIT POTENTIOMETER issued 29/08/2002.

- A.M.M. 145/( ) – "Aircraft Maintenance Manual" – Chapter 29-10-00 – Hydraulic Power.

- A.M.M. 145/( ) – "Aircraft Maintenance Manual" – Chapters 32-00-01 and 32-50-07 – Landing Gear.

Effective Dates

This amendment becomes effective on February 11th, 2004.

Issued in Luxembourg, on November 11th, 2003.

Airworthiness office, Civil Aviation Authority.

Appendix 9.

EMB145 EMBRAER

OPERATIONAL BULLETIN

O.B. N°: 145-002/04
DATE: Apr 13, 2004

I - DOCUMENT EFFECTIVITY: **ALL EMB-145, ERJ-140 AND EMB-135 AIRPLANES**

This bulletin is issued by Embraer Flight Operations Engineering Section, DSF/GSO/SEO, as the need arises to quickly transmit technical and operational information. It is distributed to EMB-145, ERJ-140 and EMB-135 operators and to any personnel who need early advice of this information.
The matter published in this bulletin may not be approved by Airworthiness Authorities at the time of issuance. In the event of a conflict with the approved publications (AFM, WB, MMEL, or CDL) the approved information shall prevail.

II - SUBJECT: **NOSE WHEEL STEERING SYSTEM MALFUNCTION AND UNCOMMANDED SWERVING EVENTS**

III - REASON: To provide operators with a brief description of the steering system and to further provide operators with the operational procedures to be followed in the event on an uncommanded swerving during high speed taxi, takeoff and landing.

IV - BACKGROUND INFORMATION:

Embraer has received reports from operators of instances of uncommanded swerving during landing roll. According to the reports, a few seconds after nose wheel touchdown, the airplane experienced an uncommanded tendency to veer away from the runway centerline, sometimes followed by a STEER INOP caution message. It was further reported that during these events the pilots attempted to control the airplane by applying rudder pedal and differential braking. It was also observed that if the steering handwheel was used while the airplane was still at high speed the swerving of the airplane worsened due to the re-activation of the steering system.

EMBRAER – Empresa Brasileira de Aeronáutica S.A.
Av. Brigadeiro Faria Lima, 2170 – CEP 12227-901 – S. J. dos Campos – Brasil
PHONE: (55 12) 3927-1706 – FAX: (55 12) 3927-2477 – E-Mail: opereng@embraer.com.br

V - OPERATING INFORMATION:

Nose Wheel Steering System

The nose wheel steering system is electronically controlled and hydraulically operated. It is powered by the hydraulic system 1. The Electronic Control Module is energized when the landing gear is down and in a locked position, with the airplane on the ground. In this condition, steering can be controlled by either the pedals or the steering handle. In either situation, the wheel displacement is measured by a potentiometer box, which transmits the signal to the Electronic Control Module. The Electronic Control Module signals the hydraulic manifold to pressurize the steering actuator in the commanded direction.

Steering Handle

The steering handle allows pilots to control the direction of the nose wheels during taxi. The steering handle can be moved downward and to either side. When it is moved downward the handle potentiometer output signal is connected to the Electronic Control Module. When the steering handle is lowered and moved left or right, the handle potentiometer transmits the turning signal, allowing a range of movement of up to 71° to each side.

Rudder Pedals

The rudder pedals control the rudder, brakes, and the direction of the nose wheel. Directional control of the airplane during takeoff or landing is possible up to 5° to each side, using the rudder pedals. A position sensor set to 7° disengages the system if the nose wheel is rotated above this limit by using the rudder pedals.

Steering Disengage Button

The Steering Disengage Button located on each pilot control wheel provides quick steering system disengagement and allows free steer of the nose wheel. The STEER INOP message appears when the Steering Disengage Button is pressed. To reengage the nose wheel steering, the steering handle must be lowered.

NOTE: For purpose of conducting a push-back or flight controls check, the steering system is disengaged through the Steering Disengage Button and the STEER INOP message is displayed on the EICAS. This is a system characteristic and not a malfunction.

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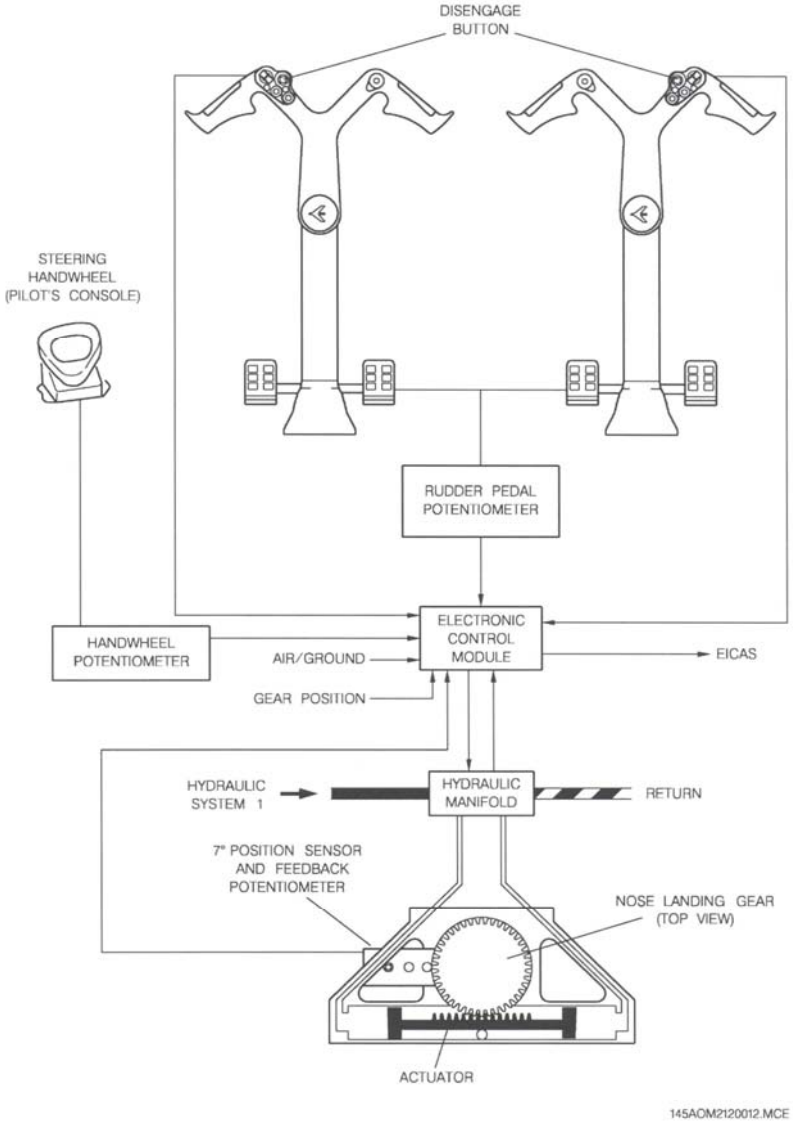
EMB145 EMBRAER

OPERATIONAL BULLETIN

O.B. N°: 145-002/04
DATE: Apr 13, 2004



NOSE WHEEL STEERING SCHEMATIC

Page 3 of 4

EMBRAER – Empresa Brasileira de Aeronáutica S.A.
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The steering system is disabled and nose wheel centering occurs automatically as soon as the airplane become airborne. On the ground and with the system disengaged, the nose wheel is centered by caster effect.

If the Electronic Control Module detects a failure, the EICAS caution message STEER INOP appears, indicating that the steering system is inoperative. Should this situation occur, the airplane can be directionally controlled by using rudder and differential braking. The nose wheel will center by caster effect.

NOTE: The STEER INOP message is presented only on the ground, being inhibited in air by the weight-on-wheel system.

AFM Abnormal Procedure

The abnormal procedure for UNCOMMANDED SWERVING ON GROUND is included in the CTA, FAA and JAA AFMs (see CTA AFM informative copy attached).

If during a high speed taxi, takeoff or landing an uncommanded swerving is presented, whether or not it is followed by a STEER INOP message on EICAS, the AFM abnormal procedure for UNCOMMANDED SWERVING ON GROUND must be strictly followed. Do not actuate the steering handwheel since it will reengage the steering system and will disable the 7° maximum nose wheel deflection protection. This may cause the nose wheel to be steered up to its limit of 71° and may exacerbate the swerving effect.

Alert Service Bulletin SB 145-32-A095 has been issued to include a placard on the glareshield panel with the following wording:

WARNING: DO NOT ACTUATE THE STEER HANDLE IN CASE OF UNCOMMANDED SWERVING OR INADVERTENT STEER INOP MSG.

VI - TECHNICAL PUBLICATION INFORMATION:

None.

EMBRAER – Empresa Brasileira de Aeronáutica S.A.
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UNCOMMANDED SWERVING ON GROUND

Control the airplane using rudder command and differential brakes.
Steering Handwheel ..... DO NOT USE

If unable to control the airplane, as an additional action:
Steering Disengagement Button ..... PRESS
Consider the use of differential thrust reverser if serviceable.

Appendix 10.

EMBRAER

ERJ-145
Follow-up #: O145-32-012

Aircraft System ATA 32-50 Landing Gear | Status: Investigation | Date opened: 29/04/2004

Subject: Nose wheel steering performance

Issue description:
Nose wheel steering system is being investigated due to occurrences of uncommanded swerving on ground during taxi, takeoff run or right after touchdown.

Status summary:
Investigation

- Embraer is investigating recent events where uncommanded swerving on ground has occurred.

Flight Operations

- AFM Temporary Revision (CTA, FAA and JAA) was issued including the Uncommanded Swerving on Ground procedure:

UNCOMMANDED SWERVING ON GROUND
Control the airplane using rudder command and differential brakes.
Steering Handwheel.....DO NOT USE
If unable to control the airplane, as an additional action:
Steering Disengagement Button.....PRESS
Consider the use of differential thrust reverser if serviceable.

- An Operational Bulletin (OB 145-002/04) has been issued in order to provide all information related to the operational procedures to be followed in the event on an uncommanded swerving during high speed taxi, takeoff and landing.
- As a precautionary action due to recent events, Alert SB 145-32-A095 has been issued on April 6, 2004 to install the following placard in the cockpit: "WARNING: Do not actuate the steer handle in case of uncommanded swerving or inadvertent STEER INOP msg".

LATEST UPDATE

- Embraer is monitoring worldwide fleet steering performance with focus on the feedback potentiometer and steering manifold.
- Simulator training is being developed to reproduce uncommanded swerving situations where pilots will be able to practice the correct procedure to be applied in these cases. New failure software will be developed and then installed in a simulator in order to have Embraer pilots checking if it is reproducing the failure correctly. After this development phase, upgrade will be available for both Flight Safety International and CAE simulators.

EMBRAER proprietary information 04/05/2004

Appendix 11.

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

TRANSMITTAL LETTER

1. DESCRIPTION

This sheet transmits Revision 01 to Service Bulletin 145-32-0081.

NOTE: This is a complete reissue of the Bulletin.

2. ADDITIONAL ACTION

Aircraft that have complied with the previous issue of this Bulletin do not need additional action.

3. RECORD OF REVISION

Basic issue: 30/Aug/2002.
Revision 01: 13/Dec/2002.

4. HIGHLIGHTS

SUBJECT/PAGE	DESCRIPTION OF CHANGE
A. EFFECTIVITY/01	Changed the effectivity.
B. REASON/02	Added reason for Revision 01.

5. LIST OF EFFECTIVE PAGES

Page	Date	Rev.
01	13/Dec/2002	01
02	13/Dec/2002	01
03	13/Dec/2002	01
04	13/Dec/2002	01
05	13/Dec/2002	01
06	13/Dec/2002	01
07	13/Dec/2002	01

Page	Date	Rev.
08	13/Dec/2002	01
09	13/Dec/2002	01
10	13/Dec/2002	01
11	13/Dec/2002	01
12	13/Dec/2002	01
13	13/Dec/2002	01
14	13/Dec/2002	01

S.B. No.: 145-32-0081
PAGE: 1 of 1

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN

LANDING GEAR – FEEDBACK UNIT POTENTIOMETER MODIFICATION

1. PLANNING INFORMATION

A. EFFECTIVITY

Aircraft affected:

MODEL	SN
EMB-145( ) and EMB-135( )	145003 thru 145362, 145364 thru 145411, 145413 thru 145461, 145463 thru 145483, 145485 thru 145494, 145496 thru 145504, 145506 thru 145515, 145517 thru 145527, 145529 thru 145539, 145541 thru 145548, 145550 thru 145554, 145556 thru 145585, 145587 thru 145589, 145592 thru 145598, 145601 thru 145619, 145621 thru 145624, 145626 thru 145630, and 145632 thru 145634, equipped with the affected component.

Affected component:

Nose Landing Gear Struts PN 1170B0000-01, 1170C0000-01, 1170C0000-02 and 1170C0000-03 including all modification plate markings and 1170C0000-04 up to SN 775, installed to the aircraft or in stock.

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN

B. REASON

Owing to the possibility of water penetrating into the feedback unit potentiometer and/or fluid resulting from grease separation passing through the ball bearing into the potentiometer shaft area, a functional disturbance in the system could occur.
To avoid this, the feedback unit potentiometer is being modified into a new one with an improved sealing concept with the introduction of new potentiometer and alternative ball bearings.
Pressure relief valves are introduced in the feedback unit potentiometer to prevent the ingress of water.

REVISION 01: To change the effectivity.

C. DESCRIPTION - TIME FOR ACCOMPLISHMENT

(1) DESCRIPTION

This Service Bulletin presents LIEBHERR/ELEB S.B. 1170A1800-32-01, dated 29 August 02, which gives instructions to modify the feedback unit potentiometer of the nose landing gear.

(2) TIME FOR ACCOMPLISHMENT

This modification may be incorporated at any time, at the operator's discretion.

D. APPROVAL

The technical aspects of this bulletin are approved by: CTA/IFI - Divisão de Homologação Aeronáutica.

E. ESTIMATED MANPOWER

Refer to paragraph 1.G Manpower of LIEBHERR/ELEB S.B. 1170A1800-32-01.

F. TOOLING - COST AND AVAILABILITY

Not applicable.

G. WEIGHT AND BALANCE

Refer to paragraph 1.H Weight and Balance of LIEBHERR/ELEB S.B. 1170A1800-32-01.

H. REFERENCES

LIEBHERR/ELEB S.B. 1170A1800-32-01 - LANDING GEAR - FEEDBACK UNIT POTENTIOMETER P/N 1170A1800-01 – DESIGN IMPROVEMENT OF FEEDBACK UNIT POTENTIOMETER.

A.M.M. 145/( ) - “Aircraft Maintenance Manual“ – Chapter 29-10-00 – Hydraulic Power.

A.M.M. 145/( ) - “Aircraft Maintenance Manual“ – Chapters 32-00-01 and 32-50-07 – Landing Gear

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SERVICE BULLETIN

I. AFFECTED PUBLICATIONS

Not applicable.

2. MATERIAL - COST AND AVAILABILITY

Refer to paragraph 2. Material Information LIEBHERR/ELEB S.B. 1170A1800-32-01.

3. ACCOMPLISHMENT INSTRUCTIONS

The steps below outline the general accomplishment instructions.

A. Make sure that the aircraft is safe for maintenance.

WARNING: MAKE SURE THAT THE LANDING GEAR SAFETY PINS ARE CORRECTLY INSTALLED. REFER TO "AIRCRAFT MAINTENANCE MANUAL" – CHAPTER 32-00-01 (TASK 32-00-01-901-801-A) – LANDING GEAR.

B. On the circuit breaker panel, open the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and attach DO-NOT-CLOSE tags to them.

C. For aircraft pre-mod S.B. 145-32-0036, make sure that the pressure in hydraulic system number 1 is fully released, according to the "Aircraft Maintenance Manual" – Chapter 29-10-00 (Task 29-10-00-860-802-A) – Hydraulic Power.

D. For aircraft post-mod S.B. 145-32-0036, install the safety pin to the Nose Landing Gear door solenoid valve, according to the "Aircraft Maintenance Manual" – Chapter 32-00-02 (Task 32-00-02-910-801-A) – Landing Gear.

E. Carry out the modification prescribed in paragraph 3. Accomplishment instructions of LIEBHERR/ELEB S.B. 1170A1800-32-01.

NOTE: This modification is accomplished to the feedback unit potentiometer on a bench, which requires the removal of the component from the nose landing gear. The removal and installation of the feedback unit potentiometer may be performed according to the applicable "Aircraft Maintenance Manual" – Chapter 32-50-07 (Task 32-50-07-000-801-A for removal and 32-50-07-400-801-A for installation) – Landing Gear or according to LIEBHERR-AEROSPACE Component Maintenance Manual 32-21-10, as prescribed in paragraph 3. Accomplishment instructions, item A.(1) of LIEBHERR/ELEB S.B. 1170A1800-32-01.

F. On the circuit breaker panel, close the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and remove the DO-NOT-CLOSE tags from them.

G. Restore the aircraft to normal.

H. Enter the accomplishment of this bulletin in the applicable documents.

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SERVICE BULLETIN
1170A1800-32-01

LANDING GEAR - Feedback Unit Potentiometer P/N 1170A1800-01
Design Improvement of Feedback Unit Potentiometer

M1170-12

1. Planning Information

A. Effectivity

Embraer ERJ 145/135 aircraft fitted with Feedback Unit Potentiometer P/N 1170A1800-01.

B. Concurrent Requirements

Not applicable.

C. Reason

(1) Due to possibility of a water ingress into the feedback unit potentiometer and/or fluid resulting from grease separation passing through the ball bearing into the potentiometer shaft area, a functional disturbance could occur.

(2) The new feedback unit potentiometer has an improved sealing concept with the introduction of new potentiometer and alternative ball bearings.

(3) Pressure relief valves are introduced in feedback unit potentiometer to prevent the ingress of water.

D. Description (refer to Figure 1 thru Figure 3)

This Service Bulletin describes the procedure to modify the feedback unit potentiometer.

E. Compliance

Incorporation of this Service Bulletin is recommended at the operator's discretion.

F. Approval
- CTA/IFI - Divisão de Homologação Aeronáutica

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S.B. No.: 145-32-0081
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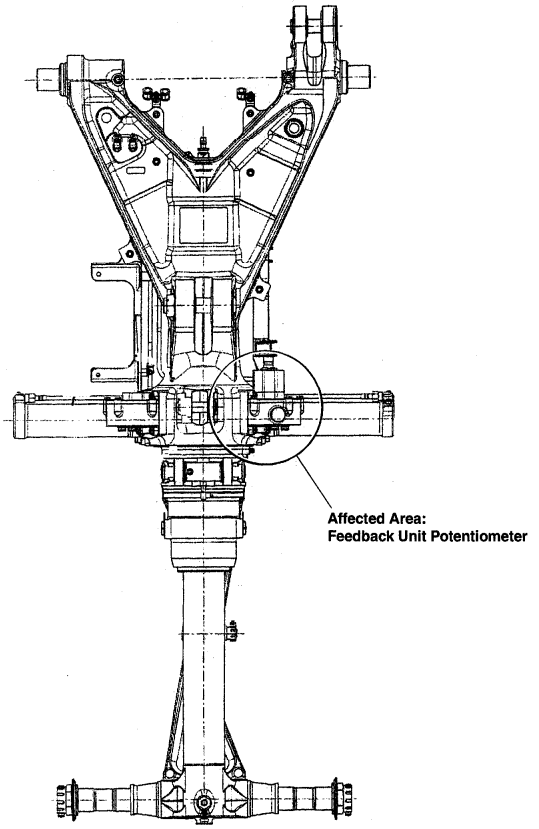

Nose Landing Gear Strut
Figure 1

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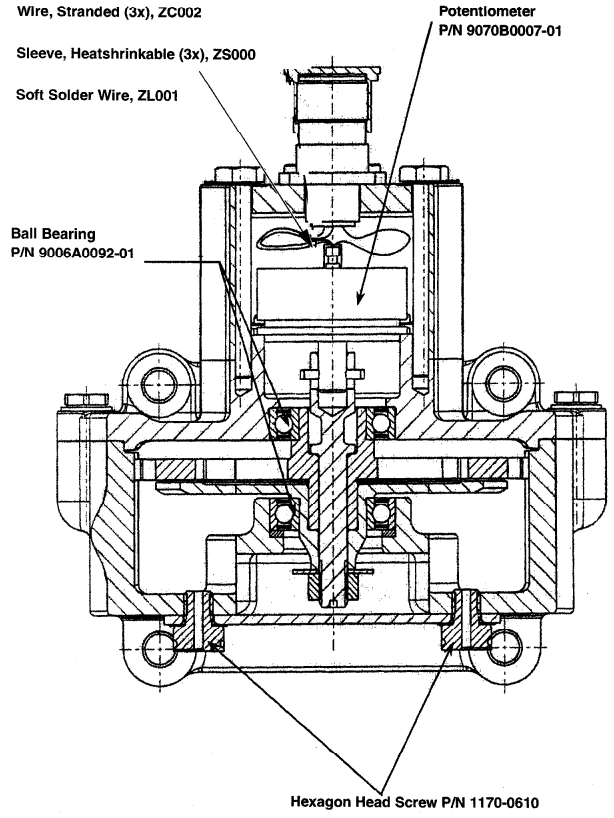
Feedback Unit Potentiometer
P/N 1170A1800-01



Feedback Unit Potentiometer Before Modification
Figure 2

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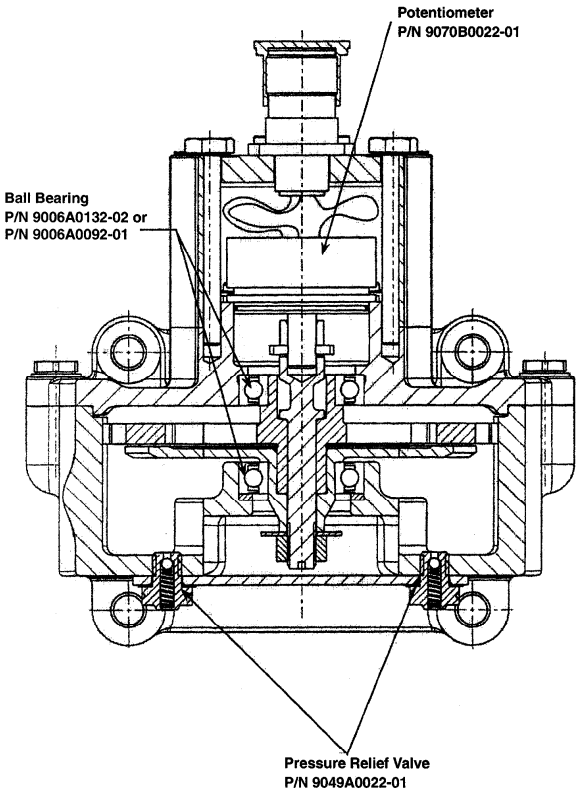
Alternative Feedback Unit Potentiometer
P/N 1170A3500-01



Feedback Unit Potentiometer After Modification
Figure 3

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G. Manpower

To do this Service Bulletin will take:

9.0 man-hours as an estimate.

H. Weight and Balance

Not affected.

I. Electrical Load Data

Not affected.

J. Software Accomplishment Summary

Not applicable.

K. References

- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-10, NLG Strut
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-12, Feedback Unit Potentiometer
- EMBRAER ERJ 145/135 Aircraft Maintenance Manual (AMM)
- LIEBHERR-AEROSPACE Service Information Letter 144 for the NLG Strut
- LIEBHERR-AEROSPACE Service Bulletin SB 1170A2900-32-01, Feedback Unit Sensor

L. Other Publications Affected

- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-10
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-12
- EMBRAER ERJ 145/135 Aircraft Maintenance Manual (AMM)

M. Interchangeability and Intermixability

(1) Interchangeability

The interchangeability between Feedback Unit Potentiometer P/N 1170A1800-01 and P/N 1170A3500-01 is two-way.

(2) Intermixability

Refer to LIEBHERR-AEROSPACE Service Information Letter 144, paragraph 8.A., Appendix.

2. Material Information

A. Material - Price and Availability

NOTE: The prices quoted are at the economic conditions of 2002.

(1) The price of the modification kit P/N M1170-12-01 is $US 1,241.96.

(2) The price of the Ball Bearings P/N 9006A0092-01 is $US 405.70 each.

B. Industry Support Information

Not applicable.

C. Material Necessary for Each Component

(1) To modify each Feedback Unit Potentiometer P/N 1170A1800-01 one modification kit P/N M1170-12-01 is required.

(2) Each modification kit P/N M1170-12-01 consists of the following items:

Part Number	Keyword	Qty
9070B0022-01	Potentiometer	1
9049A0022-01	Pressure Relief Valve	2
M39029-56-348	Pin Contacts	4
MS9581-09	Locking Washer	2
M83461-1-032	Preformed Packing	1
MS171467	Spring Pin	1
1170-1808	Washer	1
MS21083C4	Self-Locking Nut	1
099A0106-01	Identification Plate	1
Table 1 - Modification Kit P/N M1170-12-01		

(3) If required, you can also replace the Ball Bearings P/N 9006A0092-01 with the alternative Ball Bearings P/N 9006A0132-02.

D. Material Necessary for Each Spare

Refer to paragraph 2.C.

E. Re-identified Parts

The modified Feedback Unit Potentiometer is re-identified as P/N 1170A3500-01.

New P/N	Keyword	Old P/N	Qty	Disposition
1170A3500-01	Feedback Unit Potentiometer	1170A1800-01	1	Modify
9070B0022-01	. Potentiometer	9070B0007-01	1	New
9006A0132-02 or	. Ball Bearing	9006A0092-01	2	New
9006A0092-01				Unchanged
----	. Hexagon Head Screw	1170-0610	2	Deleted
9049A0022-01	. Pressure Relief Valve	----	2	New
----	. Stranded Wire	ZC002	3	Deleted
----	. Heatshrinkable Sleeve	ZS000	3	Deleted
----	. Soft Solder Wire	ZL001	3	Deleted

Table 2 - Re-identified Parts

3. Accomplishment Instructions

A. Procedure

NOTE: Unless specified differently, refer to CMM 32-21-12 for the applicable procedures and figure/item numbers.

(1) Remove the Feedback Unit Potentiometer P/N 1170A1800-01 (1-005A) from the Nose Landing Gear Strut in accordance with either:

(a) EMBRAER ERJ 145/135 Aircraft Maintenance Manual or

(b) LIEBHERR-AEROSPACE Component Maintenance Manual 32-21-10, page block 300 DISASSEMBLY.

(2) Remove and discard the Hexagon Head Screws P/N 1170-0610 (1-20A) from the feedback unit potentiometer.

(3) Remove and discard the Stranded Wire P/N ZC002, Heatshrinkable Sleeve P/N ZS000 and Soft Solder Wire P/N ZL001.

(4) Remove and discard the Potentiometer P/N 9070B0007-01 (1-240A).

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(5) If you install the Ball Bearings P/N 9006A0132-02, then remove and discard the Ball Bearings P/N 9006A0092-01 (1-120A) and (1-150A).

(6) Assemble the Feedback Unit Potentiometer with the changes that follow:

(a) Install the new Potentiometer P/N 9070B0022-01 and the new Pressure Relief Valve P/N 9049A0022-01 from modification kit P/N M1170-12-01.

(b) If necessary, install the new Ball Bearings P/N 9006A0132-02 (1-120A) and (1-150A).

(c) Use the new identification plate P/N 099A0106-01 to identify the modified feedback unit potentiometer correctly.

(7) Test the modified feedback unit potentiometer.

(8) Install the modified Feedback Unit Potentiometer P/N 1170A3500-01 on the Nose Landing Gear Strut in accordance with either:

(a) EMBRAER ERJ 145/135 Aircraft Maintenance Manual or

(b) LIEBHERR-AEROSPACE Component Maintenance Manual 32-21-10, page block 700 ASSEMBLY.

1 Test the NLG Strut and feedback unit potentiometer (refer to CMM 32-21-10, page block 101 TESTING AND FAULT ISOLATION).

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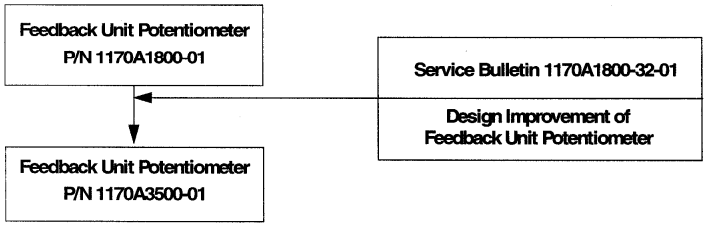
4. Appendix

A. Family Tree Chart of Modification Relationships



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Approved by: Prepared by:

(F.-J. Deuring) (B. Köster)

Appendix 12.

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN

LANDING GEAR – FEEDBACK UNIT SENSOR MODIFICATION

1. PLANNING INFORMATION

A. EFFECTIVITY

Aircraft affected:

MODEL	SN
EMB-145( ) and EMB-135( )	145003 thru 145362, 145364 thru 145411, 145413 thru 145461, 145463 thru 145483, 145485 thru 145494, 145496 thru 145504, 145506 thru 145515, 145517 thru 145527, 145529 thru 145539, 145541 thru 145548, 145550 thru 145554, 145556 thru 145585, 145587 thru 145590, 145592 thru 145624, 145626 thru 145630, and 145632 thru 145634, equipped with the affected component.

Affected component:

Nose Landing Gear Struts PN 1170B0000-01, 1170C0000-01, 1170C0000-02 and 1170C0000-03 including all modification plate markings and 1170C0000-04 up to SN 775, installed to the aircraft or in stock.

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B. REASON

Owing to the possibility of water penetrating into the feedback unit sensor and/or fluid resulting from grease separation passing through the ball bearing into the sensor area, a functional disturbance in the system could occur.
To avoid this, the feedback unit sensor is being modified into a new one with an improved sealing concept with the introduction of alternative ball bearings.
Pressure relief valves are introduced in the feedback unit sensor to prevent the ingress of water.

C. DESCRIPTION - TIME FOR ACCOMPLISHMENT

(1) DESCRIPTION

This Service Bulletin presents LIEBHERR/ELEB S.B. 1170A2900-32-01, dated 05 Sept 02, which gives instructions to modify the feedback unit sensor of the nose landing gear.

(2) TIME FOR ACCOMPLISHMENT

This modification may be incorporated at any time, at the operator's discretion.

D. APPROVAL

The technical aspects of this bulletin are approved by: CTA/IFI - Divisão de Homologação Aeronáutica.

E. ESTIMATED MANPOWER

Refer to paragraph 1.G Manpower of LIEBHERR/ELEB S.B. 1170A2900-32-01.

F. TOOLING - COST AND AVAILABILITY

Not applicable.

G. WEIGHT AND BALANCE

Refer to paragraph 1.H Weight and Balance of LIEBHERR/ELEB S.B. 1170A2900-32-01.

H. REFERENCES

LIEBHERR/ELEB S.B. 1170A2900-32-01 - LANDING GEAR - FEEDBACK UNIT SENSOR P/N 1170A2900-01 - DESIGN IMPROVEMENT OF FEEDBACK UNIT SENSOR

A.M.M. 145/( ) - "Aircraft Maintenance Manual" – Chapter 29-10-00 – Hydraulic Power.

A.M.M. 145/( ) - "Aircraft Maintenance Manual" – Chapters 32-00-01 and 32-50-06 – Landing Gear

I. AFFECTED PUBLICATIONS

Not applicable.

2. MATERIAL - COST AND AVAILABILITY

Refer to paragraph 2. Material Information LIEBHERR/ELEB S.B. 1170A2900-32-01.

3. ACCOMPLISHMENT INSTRUCTIONS

The steps below outline the general accomplishment instructions.

A. Make sure that the aircraft is safe for maintenance.

WARNING: MAKE SURE THAT THE LANDING GEAR SAFETY PINS ARE CORRECTLY INSTALLED. REFER TO "AIRCRAFT MAINTENANCE MANUAL" – CHAPTER 32-00-01 (TASK 32-00-01-910-801-A) – LANDING GEAR.

B. On the circuit breaker panel, open the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and attach DO-NOT-CLOSE tags to them.

C. For aircraft pre-mod S.B. 145-32-0036, make sure that the pressure in hydraulic system number 1 is fully released, according to the "Aircraft Maintenance Manual" – Chapter 29-10-00 (Task 29-10-00-860-802-A) – Hydraulic Power.

D. For aircraft post-mod S.B. 145-32-0036, install the safety pin to the Nose Landing Gear door solenoid valve, according to the "Aircraft Maintenance Manual" – Chapter 32-00-02 (Task 32-00-02-910-801-A) – Landing Gear.

E. Carry out the modification prescribed in paragraph 3. Accomplishment instructions of LIEBHERR/ELEB S.B. 1170A2900-32-01.

F. On the circuit breaker panel, close the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and remove the DO-NOT-CLOSE tags from them.

G. Restore the aircraft to normal.

H. Enter the accomplishment of this bulletin in the applicable documents.

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1170A2900-32-01

LANDING GEAR - Feedback Unit Sensor P/N 1170A2900-01
Design Improvement of Feedback Unit Sensor

M1170-12

1. Planning Information

A. Effectivity

Embraer ERJ 145/135 aircraft fitted with Feedback Unit Sensor P/N 1170A2900-01.

B. Concurrent Requirements

Not applicable.

C. Reason

(1) The new feedback unit sensor has an improved sealing concept with the introduction of alternative ball bearings.

(2) Pressure relief valves are introduced in the feedback unit sensor to prevent the ingress of water.

D. Description (refer to Figure 1 thru Figure 3)

This Service Bulletin describes the procedure to modify the feedback unit sensor.

E. Compliance

Incorporation of this Service Bulletin is recommended at the operator's discretion.

F. Approval
- CTA/IFI - Divisão de Homologação Aeronáutica

G. Manpower

To do this Service Bulletin will take:

7.0 man-hours as an estimate.

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DATE: 27/Nov/2002
CHANGE No.:

S.B. No.: 145-32-0082
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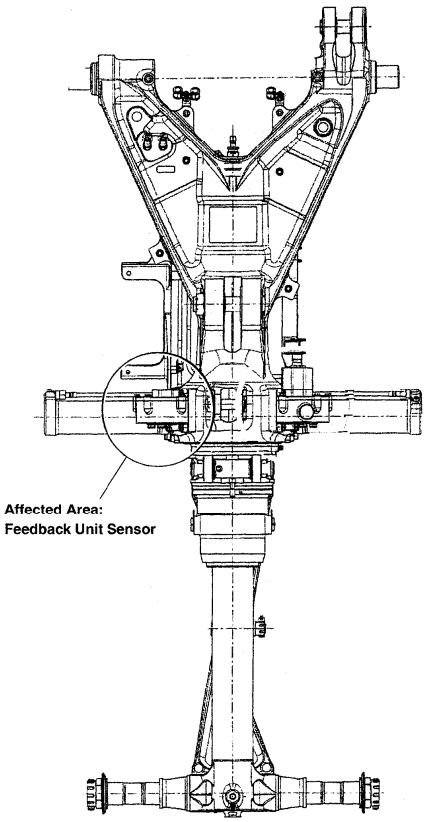

Nose Landing Gear Strut
Figure 1

Issued: 05 Sept 02
Rev. 0

1170A2900-32-01
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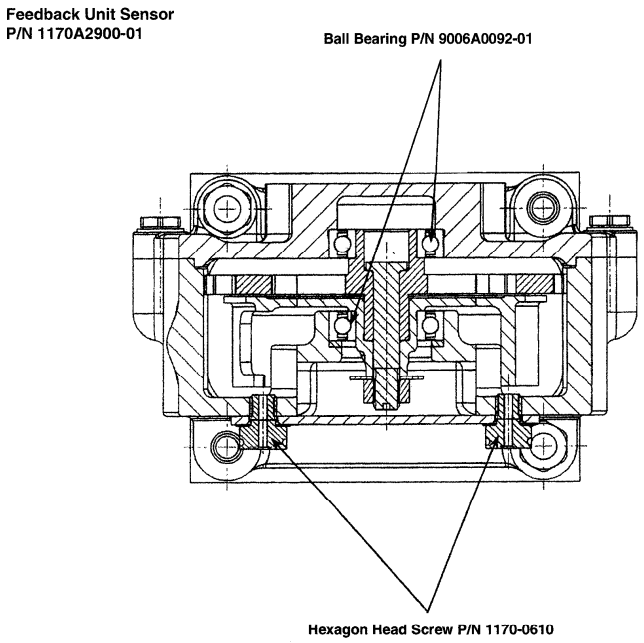

Feedback Unit Sensor Before Modification
Figure 2

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

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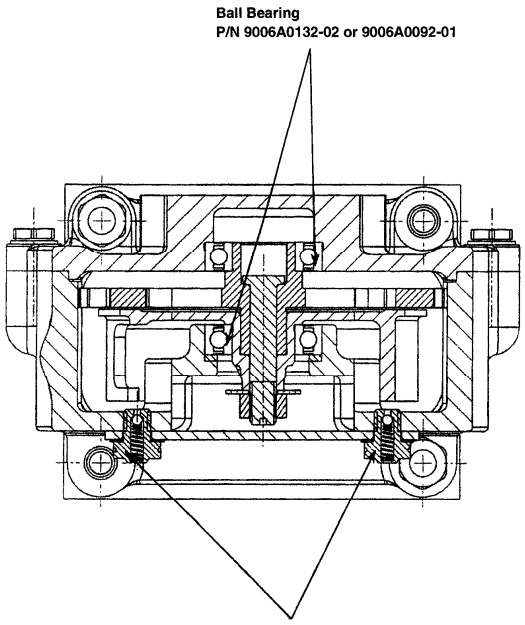
Alternative Feedback Unit Sensor
P/N 1170A3600-01



Feedback Unit Sensor After Modification
Figure 3

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

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H. Weight and Balance

Not affected.

I. Electrical Load Data

Not affected.

J. Software Accomplishment Summary

Not applicable.

K. References

- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-10, NLG Strut
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-13, Feedback Unit Sensor
- EMBRAER ERJ 145/135 Aircraft Maintenance Manual (AMM)
- LIEBHERR-AEROSPACE Service Information Letter 144 for the NLG Strut
- LIEBHERR-AEROSPACE Service Bulletin SB 1170A1800-32-01, Feedback Unit Potentiometer

L. Other Publications Affected

- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-10
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-13
- EMBRAER ERJ 145/135 Aircraft Maintenance Manual (AMM)

M. Interchangeability and Intermixability

(1) Interchangeability

The interchangeability between Feedback Unit Sensor P/N 1170A2900-01 and P/N 1170A3600-01 is two-way.

(2) Intermixability

Refer to LIEBHERR-AEROSPACE Service Information Letter 144, paragraph 8.A., Appendix.

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2. Material Information

A. Material - Price and Availability

NOTE: The prices quoted are at the economic conditions of 2002.

(1) The price of the modification kit P/N M1170-12-02 is $ US 26.00.

(2) The price of the Ball Bearings P/N 9006A0092-01 is $US 405.70 each.

B. Industry Support Information

Not applicable.

C. Material Necessary for Each Component

(1) To modify each Feedback Unit Sensor P/N 1170A2900-01 one modification kit P/N M1170-12-02 is required.

(2) Each modification kit P/N M1170-12-02 consists of the following items:

Part Number	Keyword	Qty
9049A0022-01	Pressure Relief Valve	2

Table 1 - Modification Kit P/N M1170-12-02

(3) If required, you can also replace the Ball Bearings P/N 9006A0092-01 with the alternative Ball Bearings P/N 9006A0132-02.

D. Material Necessary for Each Spare

Refer to paragraph 2.C.

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E. Re-identified Parts

The modified Feedback Unit Sensor is re-identified as P/N 1170A3600-01.

New P/N	Keyword	Old P/N	Qty	Disposition
1170A3600-01	Feedback Unit Sensor	1170A2900-01	1	Modify
9006A0132-02 or	. Ball Bearing	9006A0092-01	2	New
9006A0092-01				Unchanged
----	. Hexagon Head Screw	1170-0610	2	Deleted
9049A0022-01	. Pressure Relief Valve	----	2	New

Table 2 - Re-identified Parts

3. Accomplishment Instructions

A. Procedure

NOTE: Unless specified differently, refer to CMM 32-21-13 for the applicable procedures and figure/item numbers.

NOTE: This step is only necessary if you install the alternative Ball Bearings P/N 9006A0132-02.

(1) Remove the Feedback Unit Sensor P/N 1170A2900-01 (1-020A) from the Nose Landing Gear Strut in accordance with LIEBHERR-AEROSPACE Component Maintenance Manual 32-21-10, page block 300 DISASSEMBLY.

(2) Remove and discard the Hexagon Head Screws P/N 1170-0610 (1-20A) from the feedback unit sensor.

(3) If you install the alternative Ball Bearings P/N 9006A0132-02, then remove and discard the Ball Bearings P/N 9006A0092-01 (1-130A) and (1-160A).

(4) Assemble the Feedback Unit Sensor with the changes that follow:

(a) Install the new Pressure Relief Valves P/N 9049A0022-01 from the modification kit P/N M1170-12-02.

(b) If necessary, install the new alternative Ball Bearings P/N 9006A0132-02.

(5) Re-identification of the modified Feedback Unit Sensor

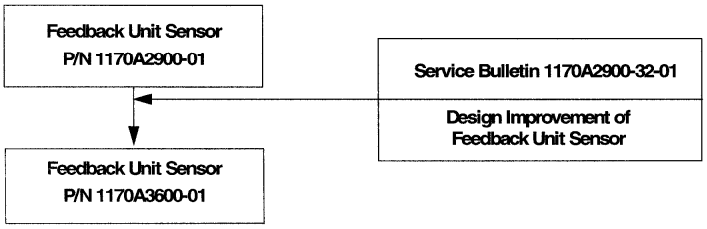
(a) Identify the modified feedback unit sensor correctly changing the new part number painted on the side of the feedback unit sensor body.

(6) If removed, install the modified Feedback Unit Sensor P/N 1170A3600-01 on the Nose Landing Gear Strut in accordance with LIEBHERR-AEROSPACE Component Maintenance Manual 32-21-10, page block 700 ASSEMBLY.

(a) Test the NLG Strut and Feedback Unit Sensor (refer to CMM 32-21-10, page block 101 - TESTING AND FAULT ISOLATION).

4. Appendix

A. Family Tree Chart of Modification Relationships



EMBRAER — EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN

LIEBHERR
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ELEB

SERVICE BULLETIN

LIEBHERR-AEROSPACE LINDENBERG GmbH

Customer Service

Approved by: (T. Hummel)

Prepared by: (B. Köster)

Appendix 13.

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN

ALERT

LANDING GEAR – STEERING HANDWHEEL – DECAL INSTALATION ON THE GLARESHIELD PANEL

1. EFFECTIVITY

Aircraft affected:

MODEL	SN
EMB-145 ( ) and EMB-135 ( )	145004 thru 145189, 145191 thru 145362, 145364 thru 145373, 145375, 145377 thru 145411, 145413 thru 145461, 145463 thru 145483, 145485 thru 145494, 145496 thru 145504, 145506 thru 145515, 145517 thru 145527, 145529 thru 145539, 145541 thru 145548, 145550 thru 145554, 145556 thru 145585, 145587 thru 145590, 145592 thru 145624, 145626 thru 145636, 145638 thru 145641, 145643, 145645 thru 145647, 145649 thru 145670, 145672 thru 145677, 145679 thru 145685, 145687 thru 145693, 145695 thru 145698, 145700, 145702 thru 145705, 145707 thru 145710, 145712 thru 145716, 145718 thru 145722, 145724 thru 145728, 145731 thru 145754, 145756, 145758 thru 145769, 145771 thru 145774, 145776 thru 145779, 145782 thru 145788, 145790 thru 145794, 145795, 145797, and 145798.

2. REASON

Instances have been reported concerning improper actuation of the steering handwheel during ground roll/run in case of uncommanded swerving or inadvertent "steer inop" message. This action may lead to unexpected change on the aircraft heading.

In order to alert the crew not to actuate the steering handwheel upon such occurrences, a decal addressing this issue is being installed on the glareshield panel.

DATE: 06/Apr/2004
CHANGE No.:

ALERT

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EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN ALERT

3. DESCRIPTION - TIME FOR ACCOMPLISHMENT

3.1. DESCRIPTION

This bulletin consists of the installation of a decal on the glareshield panel located in the cockpit.

Accomplishment instructions

The steps below outline the general accomplishment instructions.
The detailed sequence is given as notes in the figure.

a) Make sure the aircraft is safe for maintenance.

b) Install decal PN 145-09764-001 on the glareshield panel according to figure 01, as well as to instructions in the applicable "Aircraft Maintenance Manual" – Chapter – 20-12-01 – Standard Practices – Airframe.

c) Enter the accomplishment of this bulletin in the applicable document.

3.2. TIME FOR ACCOMPLISHMENT

Embraer strongly recommends that this bulletin be accomplished within the next 150 flight hours or 4 months, whichever occurs first.

4. APPROVAL

The technical aspects of this bulletin are approved by: CTA/IFI - Divisão de Homologação Aeronáutica.

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN ALERT

5. MATERIAL - COST AND AVAILABILITY

Decal PN 145-09764-001 required for the accomplishment of this bulletin should be requested directly from Embraer at the address below.

EMBRAER – Empresa Brasileira de Aeronáutica S.A.
Av. Brig. Faria Lima, 2170 - São José dos Campos/SP
12227-901 - Brasil
Fax: (55 12) 3927-6665
Phone: (55 12) 3927-2233 or (55 12) 3927-1732

6. REFERENCES

A.M.M. 145/( ) - "Aircraft Maintenance Manual" - Chapter 20-12 - Standard Practices – Airframe.

7. AFFECTED PUBLICATIONS

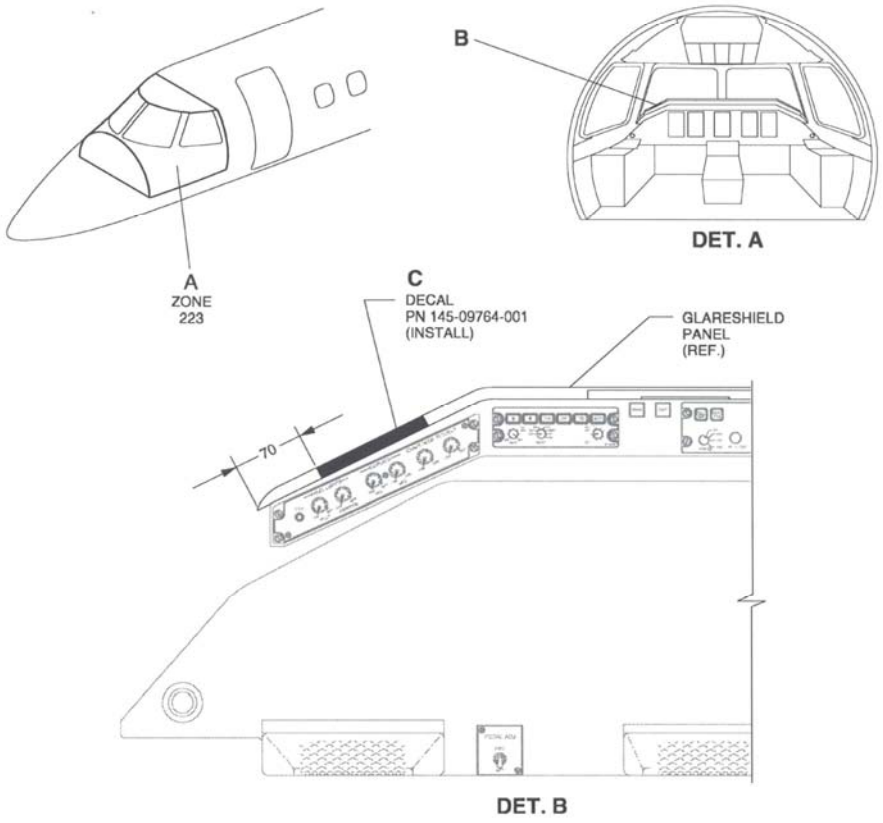
I.P.C. 145/( ) - "Illustrated Parts Catalog" - Chapter 11-31-00 – Placards and Markings.

A.M.M. 145/( ) - "Aircraft Maintenance Manual" - Chapter 11-31-00 - Placards and Markings

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN

ALERT



WARNING: DO NOT ACTUATE THE STEER HANDLE IN CASE OF UNCOMMANDED SWERVING OR INADVERTENT "STEER INOP" MSG

DET. C

DIMENSIONS IN mm.

145SB320320.MCE

FIGURE 1: DECAL INSTALLATION
(SHEET 01 OF 01)

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ALERT

DATE: 06/Apr/2004
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Appendix 14.

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

TRANSMITTAL LETTER

1. DESCRIPTION

This sheet transmits Revision 03 to Service Bulletin 145-32-0099.

NOTE: This is a partial reissue of the Bulletin.

2. ADDITIONAL ACTION

Aircraft that have complied with the previous issue of this bulletin do not need any additional action.

3. RECORD OF REVISION

Basic issue: 03/Sep/2004.
Revision 01: 08/Nov/2004.
Revision 02: 25/Jan/2005.
Revision 03: 08/Apr/2005.

4. HIGHLIGHTS

SUBJECT/PAGE	DESCRIPTION OF REVISION
A. EFFECTIVITY/01	Changed Service Bulletin effectivity.
B. REASON/02	Added reason for Revision 03.

S.B. No.: 145-32-0099
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EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

TRANSMITTAL LETTER

5. LIST OF EFFECTIVE PAGES

Page	Date	Rev.
01	08/Apr/2005	03
02	08/Apr/2005	03
03	03/Sep/2004	00
04	03/Sep/2004	00
05	03/Sep/2004	00
06	03/Sep/2004	00
07	03/Sep/2004	00
08	03/Sep/2004	00
09	03/Sep/2004	00
10	03/Sep/2004	00
11	03/Sep/2004	00
12	03/Sep/2004	00

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EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN

LANDING GEAR – UPGRADE OF NOSE WHEEL STEERING MANIFOLD

1. PLANNING INFORMATION

A. EFFECTIVITY

Aircraft affected:

MODEL	SN
EMB-145( ) and EMB-135( )	145003 thru 145362, 145364 thru 145411, 145413 thru 145461, 145463 thru 145483, 145485 thru 145494, 145496 thru 145504, 145506 thru 145515, 145517 thru 145527, 145529 thru 145539, 145541 thru 145548, 145550 thru 145554, 145556 thru 145585, 145587 thru 145590, 145592 thru 145624, 145626 thru 145636, 145638 thru 145641, 145643, 145645 thru 145677, 145679 thru 145685, 145687 thru 145698, 145700 thru 145705, 145707 thru 145710, 145712 thru 145716, 145718 thru 145729, 145731 thru 145769, 145771 thru 145774, 145776 thru 145779, 145781 thru 145788, 145790 thru 145795, 145797 thru 14500801, 14500803 thru 14500808, 14500810 thru 14500817, 14500819 thru 14500824, 14500826 thru 14500831, 14500833 thru 14500838, 14500840, 14500842 thru 14500847, 14500849, 1400850, and 14500852, equipped with the affected component. See note below.

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SERVICE BULLETIN

Affected component:

Nose Wheel Steering (NWS) Hydraulic Manifold PN 308570-1003, installed to the aircraft or in stock.

NOTE: This effectivity list includes the aircraft originally equipped with the affected component. Since this component is a "line replaceable unit" (LRU), it may be necessary to refer to the fleet maintenance control record and verify whether the component has been transferred to another aircraft SN during a routine maintenance.

In-production effectivity:

EMB-145( ) and EMB-135( ) aircraft SN 145002, 14500839, 14500848, 14500851, 14500853 and on have an equivalent modification factory-incorporated.

B. REASON

Instances of aircraft uncommanded swerving on the ground have been reported and in three of them a failure in the Nose Wheel Steering Hydraulic Manifold Electro Hydraulic Servovalve (EHSV) has been confirmed. In all cases, the Nose Wheel Steering system did not respond to steering commands in the cockpit.

The manifold failures have been traced back to a premature deterioration of an O-ring in the electro-hydraulic servovalve (EHSV), which converts the electrical steering command into hydraulic pressure.

In order to prevent the repetition of such occurrences, the nose wheel steering hydraulic manifold is being upgraded from PN 308570-1003 to PN 308570-1007.

REVISION 01: To change the Service Bulletin effectivity.

REVISION 02: To change aircraft SN 145002 from Service Bulletin effectivity to In-production effectivity.

REVISION 03: To change aircraft SN 14500839 and 14500848 from Service Bulletin effectivity to In-production effectivity.

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN

C. DESCRIPTION - TIME FOR ACCOMPLISHMENT

(1) DESCRIPTION

(a) “PART I”:

“PART I” of this bulletin presents instructions to replace the identification plate of Nose Wheel Steering (NWS) Hydraulic Manifold PN 308570-1003 that has the electro hydraulic servovalve (EHSV) already reworked.
It is necessary to open access door 114CR and verify if the serial number of the Nose Wheel Steering (NWS) Hydraulic Manifold installed is listed in table 2 of PARKER S.B. 308570-32-111.
The instructions for this replacement and the list of the Nose Wheel Steering (NWS) Hydraulic Manifold serial numbers affected are presented in PARKER S.B. 308570-32-111, dated Aug 23/2004.

(b) “PART II”:

“PART II” of this bulletin presents instructions to replace Nose Wheel Steering (NWS) Hydraulic Manifold PN 308570-1003 with a new one bearing PN 308570-1007.
To carry out this replacement it is necessary to open access door 114CR.
This upgrade is presented in PARKER S.B. 308570-32-111, dated Aug 23/2004.

(2) TIME FOR ACCOMPLISHMENT

Refer to paragraph 1 E. Compliance of PARKER S.B. 308570-32-111.

D. APPROVAL

The technical aspects of this bulletin are approved by: CTA/IFI - Divisão de Certificação de Aviação Civil.

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E. ESTIMATED MANPOWER

(1) Applicable to “PART I”:

- Disassembly: Not applicable.
- Modification: Refer to paragraph 1.G Manpower of PARKER S.B. 308570-32-111.
- Assemblage: Not applicable.
- Test: Not applicable.

(2) Applicable to “PART II”:

- Disassembly: 0.5 man-hours.
- Modification: Refer to paragraph 1.G Manpower of PARKER S.B. 308570-32-111.
- Assemblage: 0.6 man-hours.
- Test: 0.5 man-hours.

F. TOOLING - COST AND AVAILABILITY

Refer to paragraph 2. F. Tooling - Price and Availability of PARKER S.B. 308570-32-111.

G. WEIGHT AND BALANCE

Refer to paragraph 1.H. Weight and Balance of PARKER S.B. 308570-32-111.

H. REFERENCES

PARKER S.B. 308570-32-111 - LANDING GEAR – STEERING HYDRAULIC MANIFOLD – UPGRADE OF NOSE WHEEL STEERING FROM A 308570-1003 TO A 308570-1007. ADDRESSES OCCURANCES OF UNCOMMANDED STEERING.

A.M.M. 145/( ) - "Aircraft Maintenance Manual" – Chapter 06-41-01 – Dimensions and Areas.

A.M.M. 145/( ) - "Aircraft Maintenance Manual" – Chapter 32-50-04 – Landing Gear.

I. AFFECTED PUBLICATIONS

I.P.C. 145( ) – "Illustrated Parts Catalog" – Chapter – 32-50-00 – Landing Gear.

2. MATERIAL - COST AND AVAILABILITY

Refer to paragraph 2. Material Information in PARKER S.B. 308570-32-111.

3. ACCOMPLISHMENT INSTRUCTIONS

The steps below outline the general accomplishment instructions.

A. Make sure that the aircraft is safe for maintenance.

B. Open access door 114CR. Refer to the applicable “Aircraft Maintenance Manual” – Chapter 06-41-01 – Dimensions and Areas.

C. Applicable to “PART I”:

(1) Verify if the Nose Wheel Steering (NWS) Hydraulic Manifold serial number is presented in the first column of Table 2 of PARKER S.B. 308570-32-111. Refer to figure 1.

(a) If the serial number is presented in Table 2, replace the Nose Wheel Steering (NWS) Hydraulic Manifold identification plate according to 3.B. Accomplishment Instruction of PARKER S.B. 308570-32-111.

(b) If the serial number is not presented in Table 2, do according to “PART II”.

D. Applicable to “PART II”:

(1) Remove Nose Wheel Steering (NWS) Hydraulic Manifold PN 308570-1003 according to “Aircraft Maintenance Manual” – Chapter 32-50-04 (Task 32-50-04-000-801-A) – Landing Gear.

(2) Do according to 3.A. Accomplishment Instructions of PARKER S.B. 308570-32-111.

(3) Install new Nose Wheel Steering (NWS) Hydraulic Manifold PN 308570-1007 according to “Aircraft Maintenance Manual” – Chapter 32-50-04 (Task 32-50-04-400-801-A) – Landing Gear.

E. Close access door 114CR. Refer to the applicable “Aircraft Maintenance Manual” – Chapter 06-41-01 – Dimensions and Areas.

F. Restore the aircraft to normal.

G. Enter the accomplishment of this bulletin in the applicable documents.

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SERVICE BULLETIN

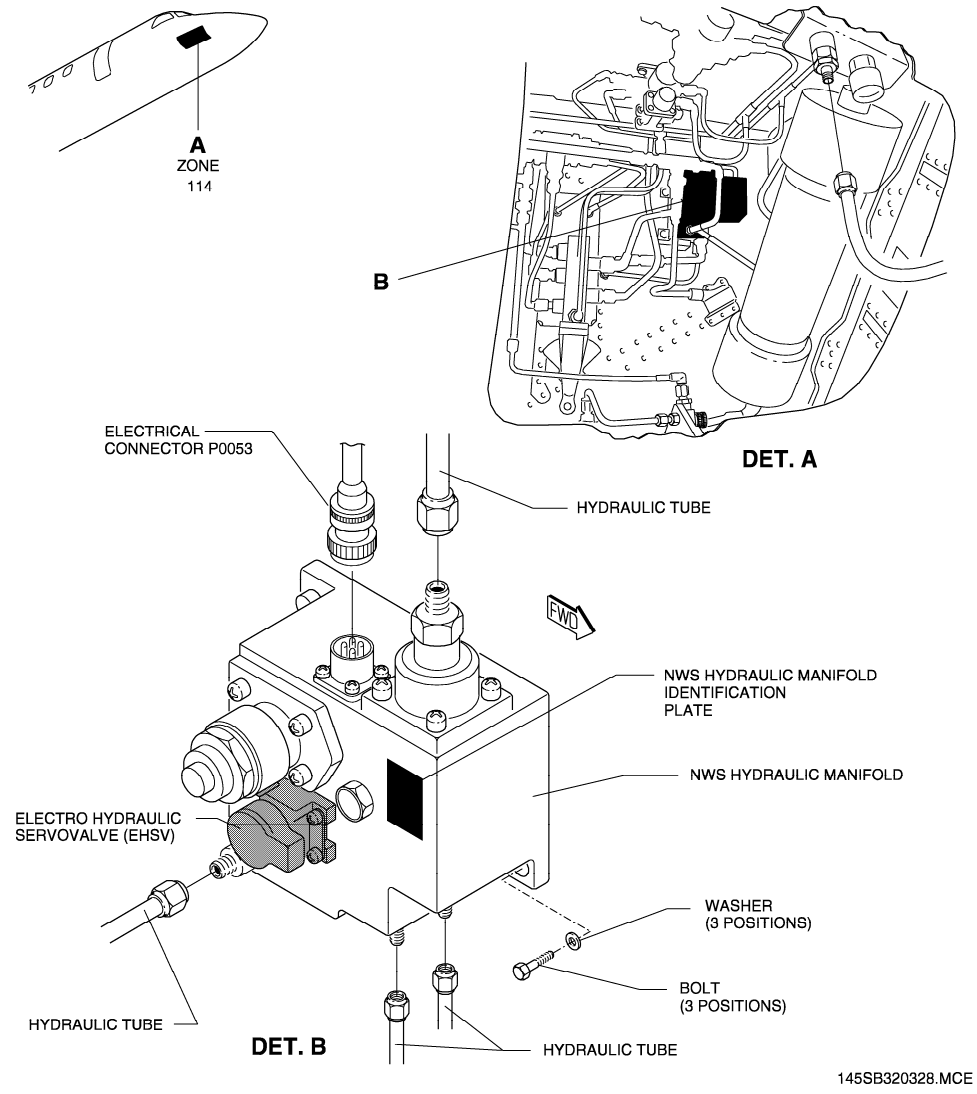

FIGURE 01 – NOSE WHEEL STEERING (NWS) HYDRAULIC MANIFOLD
(SHEET 01 OF 01)

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SERVICE BULLETIN

Parker
Customer Support Inc.

SERVICE BULLETIN

LANDING GEAR	STEERING HYDRAULIC MANIFOLD	UPGRADE OF NOSE WHEEL STEERING MANIFOLD FROM A 308570-1003 CONFIGURATION TO A 308570-1007 CONFIGURATION. ADDRESSES OCCURRENCES OF UNCOMMANDED STEERING.

1. PLANNING INFORMATION

A. Effectivity

This service bulletin is applicable to Parker Nose Wheel Steering (NWS) Hydraulic Manifold, 308570-1003, installed on the Embraer 135 and 145-series aircraft.

B. Concurrent Requirements

Not applicable.

C. Reason

There have been three (3) confirmed occurrences of an aircraft swerving off the runway upon touch-down of the nose landing gear during landing. In each case, the nose wheel steering did not respond to steering commands from the aircraft tiller. Also, in each case, the loss of steering control was determined to be due to a failure in the NWS Hydraulic Manifold. The manifold failures were traced to premature deterioration of an O-ring in the electro hydraulic servovalve (EHSV), which converts the electrical steering command to hydraulic pressure.

D. Description

(1) This service bulletin informs operators of the potential for the NWS hydraulic manifold, 308570-1003, to be unable to respond to the steering commands from the aircraft tiller and provides instructions to return the NWS Hydraulic Manifold, 308570-1003, to Parker inspection, repair, and re-identification of the NWS Hydraulic Manifold to the 308570-1007 configuration or higher.

(2) The workscope consists of repair or replacement of the EHSV, 308598-1003. Compliant EHSV's will have the suffix letter "A" following the serial number.

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(3) Some of the NWS hydraulic manifolds, 308570-1003, fitted with compliant EHSV's were shipped prior to the approval of the -1007 designation. While these EHSV's do not have the "A" serial number suffix, they are considered airworthy on these top assemblies. Operators with manifolds identified in Accomplishment Instructions Table 2 should install new nameplates on them to identify them as the 308570-1007 configuration.

NOTE: Table 2 is located in paragraph 3. ACCOMPLISHMENT INSTRUCTIONS.

E. Compliance

It is recommended that this service bulletin be accomplished at the earliest possible convenience.

NOTE: Initially, there will be a limited supply of exchange "seed" units available while additional units are being manufactured. It is important to coordinate the return of manifolds, with Parker CSO, in an orderly basis for timely compliance.

F. Approval

This service bulletin has been reviewed by Embraer and the cognizant airworthiness authorities. The modifications described herein are approved for incorporation on the EMB 135 and 145-series aircraft.

G. Manpower

This service bulletin may be accomplished, by a crew of one (1), in the following approximate man-hours:

NOTE: This service bulletin assumes the NWS hydraulic manifold has been removed from the aircraft.

WORK PHASES	MAN-HOURS
Replace EHSV with new or re-worked EHSV.	0.5
Test the NWS hydraulic manifold per CMM 32-50-15.	1.0
Re-identify the NWS hydraulic manifold per this service bulletin.	0.5
Total Man-Hours	**2.0**

H. Weight and Balance

None.

I. Electrical Load Data

Not affected.

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J. Software Accomplishment Summary

Not applicable.

K. References

Parker Hannifin, Component Maintenance Manual (CMM), 32-50-15.

L. Other Publications Affected

The information in this service bulletin will be incorporated into Parker Hannifin Corporation CMM 32-50-15 during the next scheduled revision.

M. Interchangeability or Intermixability of Parts

NWS Hydraulic Manifold, 308570-1007 configuration supersedes the 308570-1003 configuration. (One-way interchangeable)

2. MATERIAL INFORMATION

A. Material Price and Availability

Upgrade of NWS Hydraulic Manifold, 308570-1003, is available to operators at no charge, with a delivery time of 20 days from receipt of unit and purchase order. Return applicable unit to the address listed below:

PARKER HANNIFIN CORPORATION	PHONE:	(949) 833-3000
Customer Support Inc.	FAX:	(949) 809-8390
14300 Alton Parkway	SITA:	SNAPHCR
Irvine, California 92618	REPAIR STATION NO.:	AU4R063M
USA		

B. Industry Support Information

(1) Operators are requested to contact their respective Parker Hannifin Customer Service Administrator to schedule no-charge implementation of this service bulletin.

(2) Initially, a limited number of exchange units will be available to support this modification program.

(3) The no charge prices and provisions contained in this service bulletin apply only to the work described herein and are valid until March 31, 2006. After that date, request a quotation from Parker Hannifin Corporation, Customer Support.

(4) Damage from mishandling and/or abnormal use is subject to time and materials charges.

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C. Material Necessary for Each Component

(1) Parts required to upgrade one NWS hydraulic manifold, 308570-1003, configuration to a 308570-1007 configuration are listed in Table 1:

Parts Required Table 1

NEW P/N	IPL/ITEM	KEYWORD	OLD P/N	QTY	DISPOSITION
308598-1003 ("A"-S/N suffix)	1/15A	Electro Hydraulic Servovalve	308598-1003	1	Re-work
5-194E692-75	1/30	O-Ring	5-194E692-75	4	Scrap
59169-1	1/35	Gasket	59169-1	1	Scrap
360401-3	1/195	Nameplate	360401-3	1	Scrap

(2) The following materials and/or equipment must be procured from operator's stock or sources indicated:

NOTE: Equivalent substitutes may be used for items listed below.

NOMENCLATURE	PART NO./TYPE	SOURCE
Isopropyl Alcohol	Federal Specification, TT-I-735	Commercially Available
Clear Polyurethane	Military Specification MIL-PRF-85285	Commercially Available

D. Material Necessary for Each Spare

Not applicable.

E. Re-identified Parts

Parker Hannifin will identify the reworked and upgraded NWS hydraulic manifold, 308570-1003, to a 308570-1007 configuration.

F. Tooling - Price and Availability

All tooling required is listed in Parker Hannifin, Component Maintenance Manual, 32-50-15.

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3. ACCOMPLISHMENT INSTRUCTIONS

A. Return the applicable NWS Hydraulic Manifold, 308570-1003, to the address listed in Paragraph 2.A for inspection, repair, testing, and re-identification to the 308570-1007 configuration.

B. For operators in possession of the applicable NWS Hydraulic Manifold identified in Table 2, contact Parker Customer Support for a replacement nameplate. Install the nameplate as follows.

(1) Remove the old nameplate, 360401-3, from the manifold.

(2) Clean the area with Isopropyl Alcohol, TT-I-735, and a lint-free cloth.

(2) Use a black filled impression stamp to identify the new configuration number "308570-1007" onto the new nameplate, 360401-3. Copy the remaining data from the old nameplate onto the new nameplate.

NOTE: Impression stamping must not cause abrasion, flattened areas, or other visible marks on the reverse side of the stamped surface.

(3) Remove the backing from the new nameplate and install in the same location.

(4) Coat nameplate with clear polyurethane per MIL-PRF-85285. Coating shall extend 0.08 inch (2.0 mm) minimum beyond all edges of the nameplate.

Manifolds Requiring Nameplate Replacement
Table 2

Nose Wheel Steering Top Assembly S/N's	Installed Electro Hydraulic Servovalve S/N's
0073	294A
0117	041A
0173	179A
0210	567A
0247	446A
0636	202A
0784	169A

Appendix 15.

EMBRAER EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

SERVICE BULLETIN

LANDING GEAR – IMPROVEMENT IN DESIGN OF FEEDBACK UNIT POTENTIOMETER

1. PLANNING INFORMATION

A. EFFECTIVITY

Aircraft affected:

MODEL	SN
EMB-145( ) and EMB-135( )	145002 thru 145362, 145364 thru 145411, 145413 thru 145461, 145463 thru 145483, 145485 thru 145494, 145496 thru 145504, 145506 thru 145515, 145517 thru 145527, 145529 thru 145539, 145541 thru 145548, 145550 thru 145554, 145556 thru 145585, 145587 thru 145590, 145592 thru 145624, 145626 thru 145636, 145638 thru 145641, 145643, 145645 thru 145677, 145679 thru 145685, 145687 thru 145698, 145700 thru 145705, 145707 thru 145710, 145712 thru 145716, 145718 thru 145729, 145731 thru 145769, 145771 thru 145774, 145776 thru 145779, 145781 thru 145788, 145790 thru 145795, 145797 thru 14500801, 14500803 thru 14500808, 14500810 thru 14500817, 14500819 thru 14500824, 14500826 thru 14500831, 14500833 thru 14500840 equipped with the affected component. See note below.

Affected component:

Feedback Unit Potentiometer PN 1170A3500-01, installed to the aircraft or in stock.

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NOTE: This effectivity list includes the aircraft originally equipped with the affected component. Since this component is a "line replaceable unit" (LRU), it may be necessary to refer to the fleet maintenance control record and verify whether the component has been transferred to another aircraft SN during a routine maintenance.

In-production effectivity:

EMB-145( ) and EMB-135( ) aircraft SN 14500842 and on have an equivalent modification factory-incorporated.

B. REASON

Shop findings revealed some quality deviations in the feedback unit potentiometer assemblage process that could result in a functional disturbance in the steering system.

To avoid this, the feedback unit potentiometers are being modified to feature an enhanced sealing concept and assured quality.

C. DESCRIPTION - TIME FOR ACCOMPLISHMENT

(1) DESCRIPTION

This Service Bulletin presents LIEBHERR/ELEB S.B. 1170A3500-32-03, dated Aug 13/04, which gives instructions to modify the feedback unit potentiometer.

(2) TIME FOR ACCOMPLISHMENT

Refer to paragraph 1 E. Compliance of LIEBHERR/ELEB S.B. 1170A3500-32-03.

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D. APPROVAL

The technical aspects of this bulletin are approved by: CTA/IFI - Divisão de Homologação Aeronáutica.

E. ESTIMATED MANPOWER

(1) For modification to feedback unit potentiometer in stock:

- Disassembly: Not applicable.
- Modification: Refer to paragraph 1.G Manpower of LIEBHERR/ELEB S.B. 1170A3500-32-03.
- Assemblage: Not applicable.
- Test: Not applicable.

(2) For on-aircraft feedback unit potentiometer modification:

- Disassembly: 0.2 man-hours.
- Modification: Refer to paragraph 1.G Manpower of LIEBHERR/ELEB S.B. 1170A3500-32-03.
- Assemblage: 0.3 man-hours.
- Test: 0.5 man-hours.

(3) For off-aircraft feedback unit potentiometer modification:

- Disassembly: 0.5 man-hours.
- Modification: Refer to paragraph 1.G Manpower of LIEBHERR/ELEB S.B. 1170A3500-32-03.
- Assemblage: 0.6 man-hours.
- Test: 0.5 man-hours.

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F. TOOLING - COST AND AVAILABILITY

Refer to paragraph 2. Material information of LIEBHERR/ELEB S.B. 1170A3500-32-03.

G. WEIGHT AND BALANCE

Refer to paragraph 1.H. Weight and Balance of LIEBHERR/ELEB S.B. 1170A3500-32-03.

H. REFERENCES

LIEBHERR/ELEB S.B. 1170A3500-32-03 - LANDING GEAR - Feedback Unit Potentiometer PN 1170A3500-01 - Design Improvement of Feedback Unit Potentiometer

A.M.M. 145/( ) - "Aircraft Maintenance Manual" – Chapter 29-10-00 – Hydraulic Power

A.M.M. 145/( ) - "Aircraft Maintenance Manual" – Chapters 32-00-01 and 32-60-00– Landing Gear.

I. AFFECTED PUBLICATIONS

Not applicable.

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2. MATERIAL - COST AND AVAILABILITY

Refer to paragraph 2. Material Information in LIEBHERR/ELEB S.B. 1170A3500-32-03.

Sealant PN PR1440A1/2 (Spec. MIL-S-8802, Type II, Class A1/2), required for the accomplishment of this bulletin, should be procured from the operator's inventories or from a local supplier.

NOTE: The expendable or consumable parts presented in the tasks referred to in this bulletin, which are necessary for its accomplishment, should be procured from the operator's inventories or ordered as spares.

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3. ACCOMPLISHMENT INSTRUCTIONS

The steps below outline the general accomplishment instructions.

A. For modification to feedback unit potentiometer in stock, do as follows:

(1) If the feedback unit potentiometer is installed on a spare nose landing gear, carry out the feedback unit potentiometer modification according to paragraph 3. Accomplishment Instructions, item (3) of LIEBHERR/ELEB S.B. 1170A3500-32-03.

(2) If the feedback unit potentiometer is a spare part, carry out the feedback unit potentiometer modification according to paragraph 3. Accomplishment Instructions, item (2) of LIEBHERR/ELEB S.B. 1170A3500-32-03.

(3) Apply sealant PR1440A1/2 to the feedback unit, at the interface between the cap assembly and the housing, and over the bolts. Refer to figure 1.

(4) Enter the accomplishment of this bulletin in the applicable documents.

B. For on-aircraft feedback unit potentiometer modification, do as follows:

(1) Make sure that the aircraft is safe for maintenance.

WARNING: MAKE SURE THAT THE LANDING GEAR SAFETY PINS ARE CORRECTLY INSTALLED. REFER TO "AIRCRAFT MAINTENANCE MANUAL" – CHAPTER 32-00-01 (TASK 32-00-01-910-801-A) – LANDING GEAR.

(4) Install the landing gear safety pins. Refer to the applicable "Aircraft Maintenance Manual" - Chapter 32 (TASK 32-00-01-910-801-A) - Landing Gear.

(5) On the circuit breaker panel, open the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and attach DO-NOT-CLOSE tags to them.

(6) For aircraft pre-mod S.B. 145-32-0036, make sure that the pressure in hydraulic system number 1 is fully released, according to the "Aircraft Maintenance Manual" – Chapter 29-10-00 (Task 29-10-00-860-802-A) – Hydraulic Power.

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(7) For aircraft post-mod S.B. 145-32-0036, install the safety pin to the nose landing gear door solenoid valve, according to the "Aircraft Maintenance Manual" – Chapter 32-00-02 (Task 32-00-02-910-801-A) – Landing Gear.

CAUTION: BE CAREFUL WHEN YOU REMOVE THE HEAT-SHRINKABLE BOOT SO AS NOT TO DAMAGE THE ELECTRICAL CABLE AND ITS CONNECTOR.

(8) If installed, remove the heat-shrinkable boots from the connectors. Refer "Aircraft Maintenance Manual" – Chapter 32-60-00 (Task 32-60-00-910-801-A) – Landing Gear. Refer figure 1.

(9) Disconnect electrical connector P0054. Refer figure 1.

NOTE: If the electrical connector presents signs of damage, contamination or corrosion, do the maintenance procedures on it. Refer to "Aircraft Maintenance Manual" – Chapter 32-60-00 (Task 32-60-00-910-801-A) – Landing Gear.

(10) Carry out the feedback unit potentiometer modification according to paragraph 3. Accomplishment Instructions, item (1) of LIEBHERR/ELEB S.B. 1170A3500-32-03.

WARNING: DO NOT GET LUBRICANT AND ANTICORROSIVE FILM PN LEKTRO-TECH SUPER CORR-B-12350 IN YOUR MOUTH OR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM MEK. PUT ON A PROTECTIVE SPLASH GOGGLE AND GLOVES WHEN YOU USE LUBRICANT AND ANTICORROSIVE FILM PN LEKTRO-TECH SUPER CORR-B-12350. KEEP LUBRICANT AND ANTICORROSIVE FILM PN LEKTRO-TECH SUPER CORR-B-12350 AWAY FROM SPARKS, FLAME, AND HEAT. LUBRICANT AND ANTICORROSIVE FILM PNLEKTRO-TECH SUPER CORR-B-12350 IS A POISONOUS AND FLAMMABLE SUBSTANCE.

(11) Connect electrical connector P0054. Refer to figure 1.

NOTE: Before the connection of the connector, apply Lektro-Tech Super Corr-B-12350 into the plug-type connector to prevent corrosion and clean the contacts.

(12) Do the protection of the feedback unit potentiometer electrical connector against corrosion. Refer to "Aircraft Maintenance Manual" – Chapter 32-60-00 (Task 32-60-00-910-801-A) – Landing Gear.

(13) On the circuit breaker panel, close the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and remove the DO-NOT-CLOSE tags from them.

(14) Adjust the nose wheel steering system according to "Aircraft Maintenance Manual" – Chapter 32-50-00 (Task 32-50-00-700-802-A) – Landing Gear.

(15) Apply sealant PR1440A1/2 to the feedback unit, at the interface between the cap assembly and the housing, and over the bolts. Refer to figure 1.

(16) For aircraft post-mod S.B. 145-32-0036, remove the safety pin from the nose landing gear door solenoid valve, according to the "Aircraft Maintenance Manual" – Chapter 32-00-02 (Task 32-00-02-910-801-A) – Landing Gear.

(17) Restore the aircraft to normal.

(18) Enter the accomplishment of this bulletin in the applicable documents.

C. For off-aircraft feedback unit potentiometer modification, do as follows:

(1) Make sure that the aircraft is safe for maintenance.

WARNING: MAKE SURE THAT THE LANDING GEAR SAFETY PINS ARE CORRECTLY INSTALLED. REFER TO "AIRCRAFT MAINTENANCE MANUAL" – CHAPTER 32-00-01 (TASK 32-00-01-910-801-A) – LANDING GEAR.

(2) Install the landing gear safety pins. Refer to the applicable "Aircraft Maintenance Manual" - Chapter 32 (TASK 32-00-01-910-801-A) - Landing Gear.

(3) On the circuit breaker panel, open the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and attach DO-NOT-CLOSE tags to them.

(4) For aircraft pre-mod S.B. 145-32-0036, make sure that the pressure in hydraulic system number 1 is fully released, according to the "Aircraft Maintenance Manual" – Chapter 29-10-00 (Task 29-10-00-860-802-A) – Hydraulic Power.

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(5) For aircraft post-mod S.B. 145-32-0036, install the safety pin to the nose landing gear door solenoid valve, according to the "Aircraft Maintenance Manual" – Chapter 32-00-02 (Task 32-00-02-910-801-A) – Landing Gear.

(6) Remove the feedback unit potentiometer according to "Aircraft Maintenance Manual" – Chapter 32-50-07 (Task 32-50-07-000-801-A) – Landing Gear.

(7) Carry out the feedback unit potentiometer modification according to paragraph 3. Accomplishment Instructions, item (2) of LIEBHERR/ELEB S.B. 1170A3500-32-03.

(8) Reinstall the modified feedback potentiometer unit according to "Aircraft Maintenance Manual" – Chapter 32-50-07 (Task 32-50-07-400-801-A) – Landing Gear.

(9) Apply sealant PR1440A1/2 to the feedback unit, at the interface between the cap assembly and the housing, and over the bolts. Refer to figure 1.

(10) On the circuit breaker panel, close the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and remove the DO-NOT-CLOSE tags from them.

(11) For aircraft post-mod S.B. 145-32-0036, remove the safety pin from the nose landing gear door solenoid valve, according to the "Aircraft Maintenance Manual" – Chapter 32-00-02 (Task 32-00-02-910-801-A) – Landing Gear.

(12) Restore the aircraft to normal.

(13) Enter the accomplishment of this bulletin in the applicable documents.

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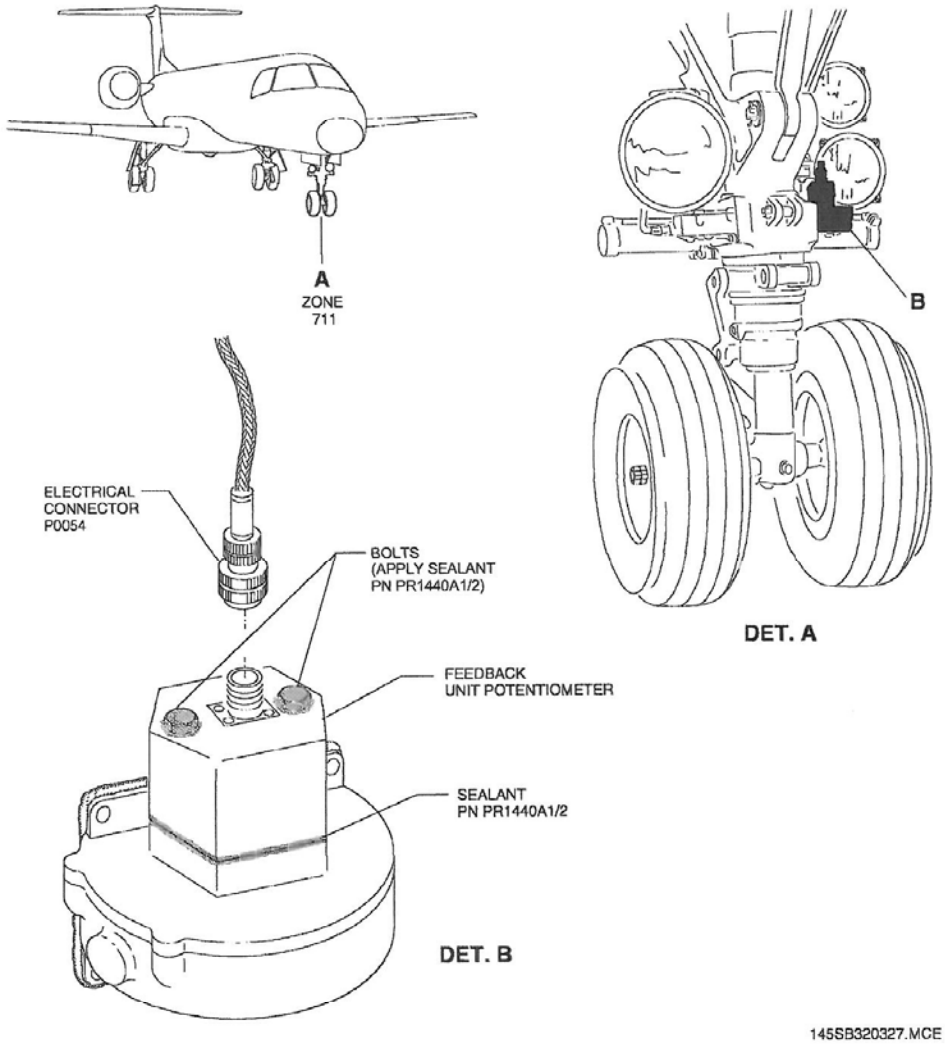

FIGURE 01 – FEEDBACK UNIT POTENTIOMETER
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LANDING GEAR - Feedback Unit Potentiometer PN 1170A3500-01
Improved Feedback Unit Potentiometer

1. Planning Information

A. Effectivity

Embraer ERJ 135/140/145 aircraft fitted with Feedback Unit Potentiometer PN 1170A3500-01.

B. Concurrent Requirements

Not affected.

C. Reason

Quality issues related to the assembly process.

D. Description (refer to Figure 1 and Figure 2)

(1) This Service Bulletin gives the procedure to change the Feedback Unit Potentiometer.

(2) New series production potentiometers have a serial number more than 3000.

E. Compliance

Incorporation of this Service Bulletin recommended at the earliest opportunity.

F. Approval
- CTA/IFI - Divisão de Homologação Aeronáutica

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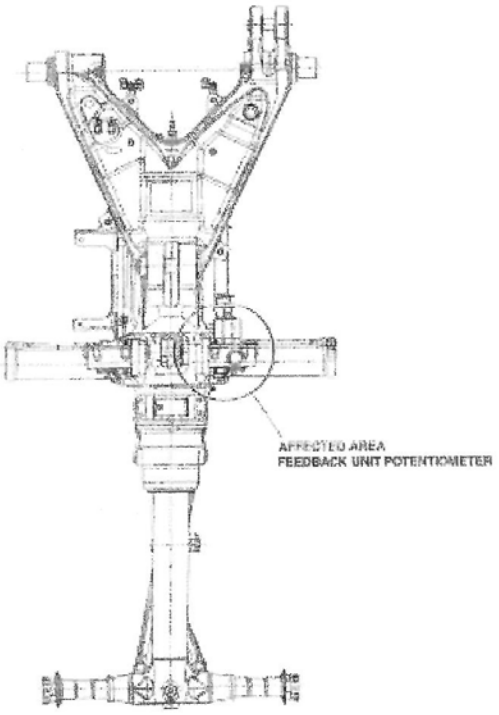

Nose Landing Gear Strut
Figure 1

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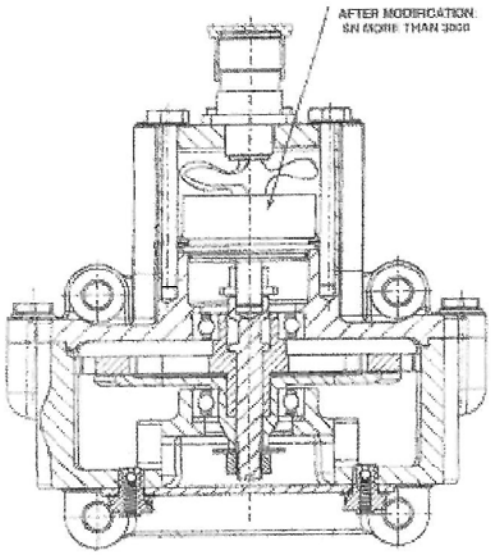
ALTERNATIVE FEEDBACK UNIT POTENTIOMETER
PN 1170A3500-01

* POTENTIOMETER PN 9070B5022-01
BEFORE MODIFICATION:
SN LESS THAN OR EQUAL TO 3000

AFTER MODIFICATION:
SN MORE THAN 3000



Feedback Unit Potentiometer
Figure 2

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G. Manpower

The time necessary to incorporate the Service Bulletin is 1.0 man-hour.

H. Weight and Balance

Not affected.

I. Electrical Load Data

Not affected.

J. Software Accomplishment Summary

Not applicable.

K. References

- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-10, NLG Strut
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-12, Feedback Unit Potentiometer
- EMBRAER ERJ 145/140/135 Aircraft Maintenance Manual (AMM)

L. Other Publications Affected

- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-10
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-12
- EMBRAER ERJ 145/140/135 Aircraft Maintenance Manual (AMM)

M. Interchangeability and Intermixability

(1) Interchangeability

The interchangeability between Feedback Unit Potentiometer PN 1170A3500-01 and PN 1170A3500-01 including modification plate marking is two-way

(2) Intermixability

Not affected.

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2 Material Information

A. Material - Price and Availability

The modification kit PN M1170-12-02 is FOC (free of charge) for the operator on orders quoting this Service Bulletin. Costs related to the mentioned modification kit will be borne by Liebherr or Embraer.

B. Industry Support Information

Fiberglit 414 (alternative material: CA 1000, Courtaulds Aerospace, P.O. Box 1800, 5464 San Fernando Road, Glendale, California 91209)

C. Material Necessary for Each Component

(1) Modification of Feedback Unit Potentiometer PN 1170A3500-01 into PN 1170A3500-01 including modification plate marking "P"

(a) To change each Feedback Unit Potentiometer, one modification kit PN M1170-12-02 is required.

(b) Each modification kit PN M1170-12-02 consists of the items that follow:

Part Number	Keyword	Qty
9070B0022-01 *	Potentiometer	1
09147-1	Preformed Packing	1
MS9029 S4-348	Pin	3
MS0581-09	Locking Washer	2
MS3461-1-032	Preformed Packing	1
MS171467	Boring Pin	1

Table 1 - Modification Kit PN M1170-12-02

* Refer to Figure 2. The PN of the new potentiometer stays the same. Potentiometers made with a potted assembly procedure have a SN equal or more than 3000.

D. Material Necessary for Each Spare

Refer to paragraph 2.C.

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E. Re-identified Parts

New PN	Keyword	Old PN	Qty	Disposition
1170A3500-01**	Feedback Unit Potentiometer	1170A3500-01	1	Modify
907EB0022-01*	L Potentiometer	907EB0022-01	1	New

Table 2 - Re-identified Parts

NOTE 1: The part number of the Feedback Unit Potentiometer stays the same. ** Re-identification with "F" after the serial number.
NOTE 2: Potentiometer PN 907EB0022-01: * See Figure 2. The PN of the improved potentiometer stays the same. Potentiometers made with a better assembly procedure have a SN equal or more than 0090.

3. Accomplishment Instructions

A. Procedure

NOTE: The new potentiometer can be installed
- on-aircraft (refer to procedure 1) or
- on the work bench to the Feedback Unit Potentiometer (refer to procedure 2) or
- on the work bench to the NLG Strut (refer to procedure 3).

(1) Procedure 1 / on-aircraft

NOTE: The figure item numbers refer to LIEBHERR-AEROSPACE CMM 32-21-12.

(a) Look at the identification plate (1-330B) of the Feedback Unit Potentiometer and find the serial number. If there is a letter "F" after the serial number, no procedure is necessary.

(b) Bend back tabs of the two washers (1-180), remove the bolts (1-170) and tab washers.

(c) Lift the cap assembly (1-150) up and away from the housing (1-320).

(d) Remove the four cleats (1-250) from the housing (1-320).

(e) Use a standard pin extractor tool to remove the potentiometer (1-240B) with the wires and pins (1-205) and the plugs (1-210) from the connector (1-190).

NOTE: To help you with assembly, make a note of the position of the wires and the pins.

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(f) Install the new Spring Pin PN MS171457 (1-260) to the new Potentiometer PN 9070B0022-01 (1-240B) from the modification kit PN M1170-12-02.

(g) Install the new Preformed Packing PN 09147-1 (1-255) to the new Potentiometer PN 9070B0022-01 (1-240B) from the modification kit PN M1170-12-02.

(h) Install the three new Pins PN M39029-58-348 (1-205) to the wires of the potentiometer (1-240B).

(i) Install the potentiometer (1-240B) with the wires and pins (1-205) to the connector (1-190).

(j) Install the potentiometer (1-240B) with the four cleats (1-250) to the housing (1-320).

(k) Pre-adjust the potentiometer:

1 On the Feedback Unit Potentiometer connector (1-190), measure the resistance between pins 1 and 2 (value 1) and between pins 2 and 3 (value 2).

2 Write down the values and calculate the difference between value 1 and value 2.

3 The difference (value 1 minus value 2) must be less or equal 100 Ω (Ohms). If necessary, loosen the four cleats (1-250) again and turn the potentiometer with your hand in the clockwise or in the counterclockwise direction to adjust the resistance difference.

(l) Adjust and test the Feedback Unit Potentiometer. Refer to the Aircraft Maintenance Manual.

(m) Carefully install the cap assembly (1-140) on the housing (1-320). Make sure the wires of the potentiometer do not get caught between the cap and the housing.

(n) Temporarily attach the cap assembly (1-140) to the housing (1-320) with the two bolts (1-170) and the tab washers (1-180).

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(c) Re-identify the Feedback Unit Potentiometer

1 Use an engraving tool to write "P" after the serial number of the identification plate.

(2) Procedure 2 / on the Workbench (Installation in the Feedback Unit Potentiometer)

NOTE: The figure item numbers refer to LIEBHERR-AEROSPACE CMM 32-21-12.

(a) Look at the identification plate (1-330B) of the Feedback Unit Potentiometer and find the serial number. If there is a letter "P" after the serial number, no procedure is necessary.

(b) Bend back tabs of the two washers (1-180), remove the bolts (1-170) and tab washers.

(c) Lift the cap assembly (1-160) up and away from the housing (1-320).

(d) Remove the four cleats (1-250) from the housing (1-320).

(e) Use a standard pin extractor tool to remove the potentiometer (1-240B) with the wires and pins (1-205) and the plugs (1-210) from the connector (1-190).

NOTE: To help you with assembly, make a note of the position of the wires and the pins.

(f) Install the new Spring Pin PN MS171467 (1-260) to the new Potentiometer PN 9070B0022-01 (1-240B) from the modification kit PN M1170-12-02.

(g) Install the new Preformed Packing PN 0014/-1 (1-255) to the new Potentiometer PN 9070B0022-01 (1-240B) from the modification kit PN M1170-12-02.

(h) Install the three new Pins PN M39029-56-348 (1-205) to the wires of the potentiometer (1-240B).

(i) Install the potentiometer (1-240B) with the wires and pins (1-205) to the connector (1-190).

(j) Install the potentiometer (1-240B) with the four cleats (1-250) to the housing (1-320).

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(k) Apply a layer of Elesit 414 (alternative material: CA 1000) to the threads of the two bolts (1-170).

NOTE: The bolts (1-170) and tab washers (1-180) do not require a torque tighten and safety procedure as the Feedback Unit Potentiometer is adjusted and set when installed on-aircraft. Refer to the AMM.

(l) Install the cap (1-160) on the housing (1-320). Attach the cap to the housing with two bolts (1-170) and tab washers (1-180). Make sure the wires of the potentiometer do not get caught between the cap and the housing. Tighten the bolts hand tight. Do not bend the tabs of the lock washers at this time.

(m) Re-identify the Feedback Unit Potentiometer:

1 Use an engraving tool to write "P" after the serial number of the identification plate.

(n) Test the modified Feedback Unit Potentiometer. Refer to LIEBHERR-AEROSPACE CMM 32-21-12, page block 100, TESTING AND FAULT ISOLATION.

(3) Procedure 3 / on the Workbench (installation on the M.G Strut)

NOTE: The removal of the Feedback Unit Potentiometer from the NLG Strut is not necessary to do this procedure.

NOTE: The figure item numbers refer to LIEBHERR-AEROSPACE CMM 32-21-12.

(a) Look at the identification plate (1-330B) of the Feedback Unit Potentiometer and find the serial number. If there is a letter "P" after the serial number, no more procedure is necessary.

(b) Bend bent tabs of the two washers (1-180), remove the bolts (1-170) and tab washers.

(c) Lift the cap assembly (1-160) up and away from the housing (1-320).

(d) Remove the four plants (1-250) from the housing (1-320).

(e) Use a standard pin extractor tool to remove the potentiometer (1-240B) with the wires and pins (1-205) and the plugs (1-210) from the connector (1-190).

NOTE: To help you with assembly, make a note of the position of the wires and the pins.

(f) Install the new Spring Pin PN MS171467 (1-250) to the new Potentiometer PN 9070B022-01 (1-240B) from the modification kit PN M1170-12-02.

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(g) Install the new Preformed Packing PN D5147-1 (1-255) to the new Potentiometer PN 9070B0022-01 (1-240B) from the modification kit PN M1170-12-02.

(h) Install the three new Pins PN MS9029-58-348 (1-205) to the wires of the potentiometer (1-240B).

(i) Install the potentiometer (1-240B) with the wires and pins (1-205) to the connector (1-190).

(j) Install the potentiometer (1-240B) with the four cleats (1-250) to the housing (1-320).

(k) Apply a layer of Elastall 314 (alternative material: CA 1000) to the threads of the two bolts (1-170).

NOTE: The bolts (1-170) and tab washers (1-180) do not require a torque tighten and safety procedure as the Feedback Unit Potentiometer is adjusted and set when installed on aircraft. Refer to the AMM.

(l) Install the cap (1-160) on the housing (1-320). Attach the cap to the housing with two bolts (1-170) and tab washers (1-180). Make sure the wires of the potentiometer do not get caught between the cap and the housing. Tighten the bolts hand tight. Do not bend the tabs of the lock washers at this time.

(m) Re-identify the Feedback Unit Potentiometer:

1. Use an engraving tool to write "B" after the serial number of the identification plate.

(n) Test the modified NLG Strut. Refer to LIEBHERR-AEROSPACE CMM 32-21-10, page block 100, TESTING AND FAULT ISOLATION.

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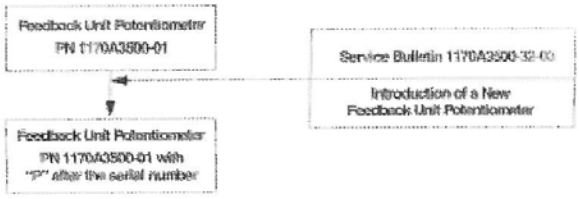
4. Appendix

A. Family Tree Chart of Modification Relationships



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Approved by: Prepared by:

(R. Beyer) (M. Renk)

Appendix 16.

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LANDING GEAR – SECOND SUPPLIER OF POTENTIOMETER FOR FEEDBACK UNIT POTENTIOMETER

1. PLANNING INFORMATION

A. SB EFFECTIVITY

Aircraft affected:

MODEL	SN
EMB-145( ) and EMB-135( )	145002 thru 145362, 145364 thru 145411, 145413 thru 145461, 145463 thru 145483, 145485 thru 145494, 145496 thru 145504, 145506 thru 145515, 145517 thru 145527, 145529 thru 145539, 145541 thru 145548, 145550 thru 145554, 145556 thru 145585, 145587 thru 145590, 145592 thru 145624, 145626 thru 145636, 145638 thru 145641, 145643, 145645 thru 145677, 145679 thru 145685, 145687 thru 145698, 145700 thru 145705, 145707 thru 145710, 145712 thru 145716, 145718 thru 145729, 145731 thru 145769, 145771 thru 145774, 145776 thru 145779, 145781 thru 145788, 145790 thru 145795, 145797 thru 14500801, 14500803 thru 14500808, 14500810 thru 14500817, 14500819 thru 14500824, 14500826 thru 14500831, 14500833 thru 14500840, 14500842 thru 14500850, 14500852, 14500853, 14500855 thru 14500862, 14500864 thru 14500866, 14500868 thru 14500872, 14500874 thru 14500879, 14500881 thru 14500883, 14500885 thru 14500890, 14500892 thru 14500900, 14500902, 14500904 thru 14500909, 14500911, 14500912, 14500914, 14500915, 14500917, 14500918, 14500920 thru 14500924, 14500926 thru 14500932, 14500934 thru 14500936, 14500938, 14500940, 14500943, 14500945, 14500947, 14500949, 14500951, and 14500953, equipped with the affected component. See note below.

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Affected component:

Feedback Unit Potentiometer PN 1170A1800-01, PN 1170A3500-01, and PN 1170A3500-01 (with "P" in the serial number), installed to the aircraft or in stock.

NOTE: This effectivity list includes the aircraft originally equipped with the affected component. Since this component is a "line replaceable unit" (LRU), it may be necessary to refer to the fleet maintenance control record and verify whether the component has been transferred to another aircraft SN during a routine maintenance.

In-production effectivity:

None.

B. CONCURRENT REQUIREMENTS

None.

C. REASON

(1) History

This service bulletin presents the feedback potentiometer of a new supplier.

(2) Objective

To make a new feedback unit potentiometer PN 1170A3500-02 available with a new potentiometer from a second source supplier.

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(3) Expected Benefits

This modification allows the introduction of a quality improved potentiometer.

(4) Revision History

None.

D. DESCRIPTION

This Service Bulletin presents LIEBHERR/ELEB S.B. 1170C-32-10, dated Dec 14/2005, which gives instructions to modify or replace the feedback unit potentiometer.

E. COMPLIANCE

This bulletin may be accomplished at any time, at the operator's discretion.

F. APPROVAL

The technical aspects of this Service Bulletin are approved by: CTA/IFI – Divisão de Certificação de Aviação Civil.

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G. ESTIMATED MANPOWER

This estimate is for direct labor only, performed by experienced personnel, and does not include the time to plan, prepare, or inspect the work.

It is assumed that all the tools, parts, and other means are promptly available when necessary.

This estimate does not include the sealant, paint, or adhesive curing time.

(1) For on-aircraft feedback unit potentiometer modification:

- Disassembly: 0.2 man-hours.
- Modification: Refer to paragraph 1.G Manpower of LIEBHERR/ELEB S.B. 1170C-32-10.
- Assemblage: 0.3 man-hours.
- Test: 0.5 man-hours.

(2) For off-aircraft feedback unit potentiometer modification:

- Disassembly: 0.5 man-hours.
- Modification: Refer to paragraph 1.G Manpower of LIEBHERR/ELEB S.B. 1170C-32-10.
- Assemblage: 0.6 man-hours.
- Test: 0.5 man-hours.

H. WEIGHT AND BALANCE

Refer to paragraph 1.H Weight and Balance of LIEBHERR/ELEB S.B. 1170C-32-10.

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I. REFERENCES

LIEBHERR/ELEB S.B. 1170C-32-10 - LANDING GEAR - NOSE LANDING GEAR STRUT PN 1170C0000-0X, PN 2233A0000-0X OR PN 2666A0000-0X into Unchanged Second Source of Potentiometer of Feedback Unit Potentiometer.

AMM-145/( ) – Aircraft Maintenance Manual – Chapter 29-10-00 – Hydraulic Power.

AMM-145/( ) – Aircraft Maintenance Manual – Chapters 32-00-02, 32-50-00, 32-50-07 and 32-60-00 – Landing Gear.

J. AFFECTED PUBLICATIONS

IPC-145/( ) – Illustrated Parts Catalog - Chapter 32-50-07 – Landing Gear.

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2. MATERIAL INFORMATION

A. MATERIAL – PRICE AND AVAILABILITY

Refer to paragraph 2. Material Information LIEBHERR/ELEB S.B. 1170C-32-10.

NOTE: The expendable or consumable parts presented in the tasks referred to in this bulletin, which are necessary for its accomplishment, should be procured from the operator's inventories or ordered as spares.

B. REIDENTIFIED PARTS

Refer to paragraph 3. Accomplishment Instructions LIEBHERR/ELEB S.B. 1170C-32-10

C. TOOLING – PRICE AND AVAILABILITY

None.

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3. ACCOMPLISHMENT INSTRUCTIONS

The steps below outline the general accomplishment instructions.

A. Make sure that the aircraft is safe for maintenance.

WARNING: MAKE SURE THAT THE LANDING GEAR SAFETY PINS ARE CORRECTLY INSTALLED. REFER TO AIRCRAFT MAINTENANCE MANUAL – CHAPTER 32-00-01 (TASK 32-00-01-910-801-A) – LANDING GEAR.

B. For on-aircraft feedback unit potentiometer or potentiometer modification, do as follows:

(1) On the circuit breaker panel, open the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and attach DO-NOT-CLOSE tags to them.

(2) For aircraft pre-mod S.B. 145-32-0036, make sure that the pressure in hydraulic system number 1 is fully released, according to the Aircraft Maintenance Manual – Chapter 29-10-00 (Task 29-10-00-860-802-A) – Hydraulic Power.

(3) For aircraft post-mod S.B. 145-32-0036, install the safety pin to the nose landing gear door solenoid valve, according to the Aircraft Maintenance Manual – Chapter 32-00-02 (Task 32-00-02-910-801-A) – Landing Gear.

CAUTION: BE CAREFUL WHEN YOU REMOVE THE HEAT-SHRINKABLE BOOT SO AS NOT TO DAMAGE THE ELECTRICAL CABLE AND ITS CONNECTOR.

(4) If installed, remove the heat-shrinkable boots from the connectors. Refer Aircraft Maintenance Manual – Chapter 32-60-00 (Task 32-60-00-910-801-A) – Landing Gear. Refer figure 1.

(5) Disconnect electrical connector P0054. Refer figure 1.

NOTE: If the electrical connector presents signs of damage, contamination or corrosion, do the maintenance procedures on it. Refer to Aircraft Maintenance Manual – Chapter 32-60-00 (Task 32-60-00-910-801-A) – Landing Gear.

(6) Carry out the potentiometer modification according to paragraph 3. Accomplishment Instructions, of item (B) LIEBHERR/ELEB S.B. 1170C-32-10.

WARNING: DO NOT GET LUBRICANT AND ANTICORROSIVE FILM PN LEKTRO-TECH SUPER CORR-B-12350 IN YOUR MOUTH OR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM MEK. PUT ON A PROTECTIVE SPLASH GOGGLE AND GLOVES WHEN YOU USE LUBRICANT AND ANTICORROSIVE FILM PN LEKTRO-TECH SUPER CORR-B-12350. KEEP LUBRICANT AND AN-TICORROSIVE FILM PN LEKTRO-TECH SUPER CORR-B-12350 AWAY FROM SPARKS, FLAME, AND HEAT. LUBRICANT AND ANTICORROSIVE FILM PNLEKTRO-TECH SUPER CORR-B-12350 IS A POISONOUS AND FLAMMABLE SUBSTANCE.

(7) Connect electrical connector P0054. Refer to figure 1.

NOTE: Before the connection of the connector, apply Lektro-Tech Super Corr-B-12350 into the plug-type connector to prevent corrosion and clean the contacts.

(8) Do the protection of the feedback unit potentiometer electrical connector against corrosion. Refer to Aircraft Maintenance Manual – Chapter 32-60-00 (Task 32-60-00-910-801-A) – Landing Gear.

(9) On the circuit breaker panel, close the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and remove the DO-NOT-CLOSE tags from them.

(10) Adjust the nose wheel steering system according to Aircraft Maintenance Manual – Chapter 32-50-00 (Task 32-50-00-700-802-A) – Landing Gear.

(11) For aircraft post-mod S.B. 145-32-0036, remove the safety pin from the nose landing gear door solenoid valve, according to the Aircraft Maintenance Manual – Chapter 32-00-02 (Task 32-00-02-910-801-A) – Landing Gear.

(12) Restore the aircraft to normal.

(13) Enter the accomplishment of this bulletin in the applicable documents.

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C. For off-aircraft feedback unit potentiometer or potentiometer modification, do as follows:

(1) Remove the feedback unit potentiometer or potentiometer according to Aircraft Maintenance Manual – Chapter 32-50-07 (Task 32-50-07-000-801-A) – Landing Gear.

(2) Carry out the feedback unit potentiometer or potentiometer modification according to paragraph 3. Accomplishment Instructions, of LIEBHERR/ELEB S.B. 1170C-32-10.

(3) Reinstall the modified feedback potentiometer unit or potentiometer according to Aircraft Maintenance Manual – Chapter 32-50-07 (Task 32-50-07-400-801-A) – Landing Gear.

(4) On the circuit breaker panel, close the ELEC PUMP1, CMD, IND1, IND2 and STEER circuit breakers and remove the DO-NOT-CLOSE tags from them.

(5) For aircraft post-mod S.B. 145-32-0036, remove the safety pin from the nose landing gear door solenoid valve, according to the Aircraft Maintenance Manual – Chapter 32-00-02 (Task 32-00-02-910-801-A) – Landing Gear.

D. Restore the aircraft to normal.

E. Enter the accomplishment of this bulletin in the applicable documents.

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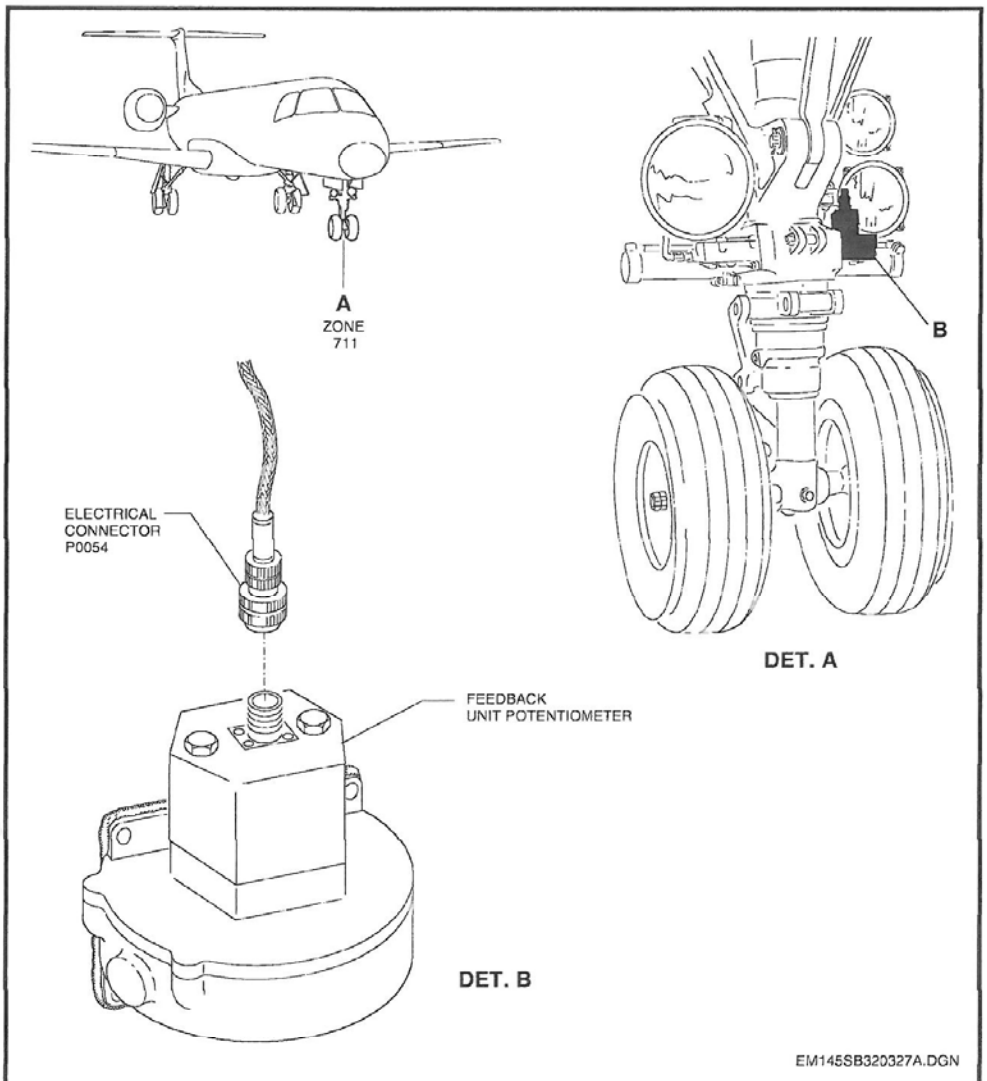

FIGURE 01: FEEDBACK UNIT POTENTIOMETER
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(D9893)
1170C-32-10

LANDING GEAR - NOSE LANDING GEAR STRUT PN 1170C0000-0X, PN 2233A0000-0X or PN 2666A0000-0X into Unchanged
Second Source of Potentiometer of Feedback Unit Potentiometer

1. Planning Information

A. Effectivity

Embraer ERJ 135/140/145 aircraft fitted with Nose Landing Gear Strut PN 1170C0000-0X *, PN 2233A0000-01 or -02 or PN 2666A0000-01 or -02, all serial numbers (with Feedback Unit Potentiometer PN 1170A1800-01 or PN 1170A3500-01).

NOTE: * including any modification plate marking

B. Concurrent Requirements

Not affected.

C. Reason (refer to Figure 1 thru Figure 4)

To make a new Feedback Unit Potentiometer PN 1170A3500-02 available with a new potentiometer from a second source supplier

D. Description

An alternative Potentiometer PN 2000A1067K01 is introduced to the feedback unit potentiometer. All feedback unit potentiometers listed below can be used alternatively:
- Feedback Unit Potentiometer PN 1170A3500-02 with Potentiometer PN 2000A1067K01
- Feedback Unit Potentiometer PN 1170A3500-01 or PN 1170A3500-01 "P" with Potentiometer PN 9070B0022-01
- Feedback Unit Potentiometer PN 1170A1800-01 with Potentiometer PN 9070B0007-01

E. Compliance

The modification referred to in this Service Bulletin is recommended at the operator's discretion.

F. Approval

CTA/IFI - Divisão de Homologação Aeronáutica

LIEBHERR-AEROSPACE LINDENBERG GmbH
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D-88153 Lindenberg
Germany
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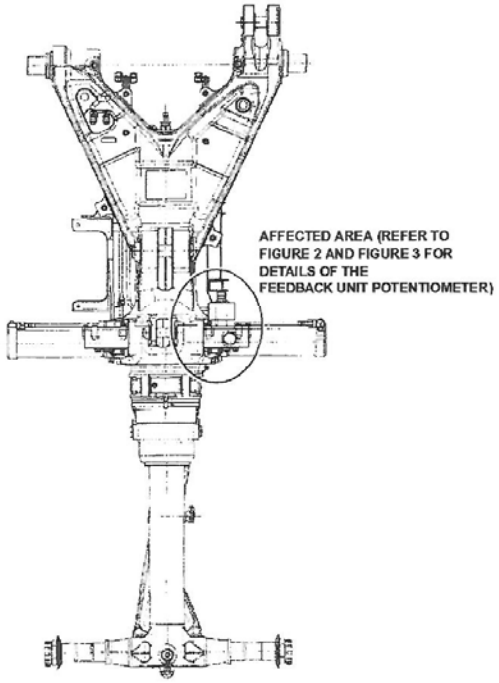
BEFORE MODIFICATION
NLG STRUT PN 1170C0000-0X *
NLG STRUT PN 2233A0000-0X or
NLG STRUT PN 2666A0000-0X
* incl. any modification plate marking

AFTER MODIFICATION
NLG STRUT PN 1170C0000-0X *
NLG STRUT PN 2233A0000-0X or
NLG STRUT PN 2666A0000-0X
* incl. any modification plate marking



Nose Landing Gear Strut With Affected Area
Figure 1

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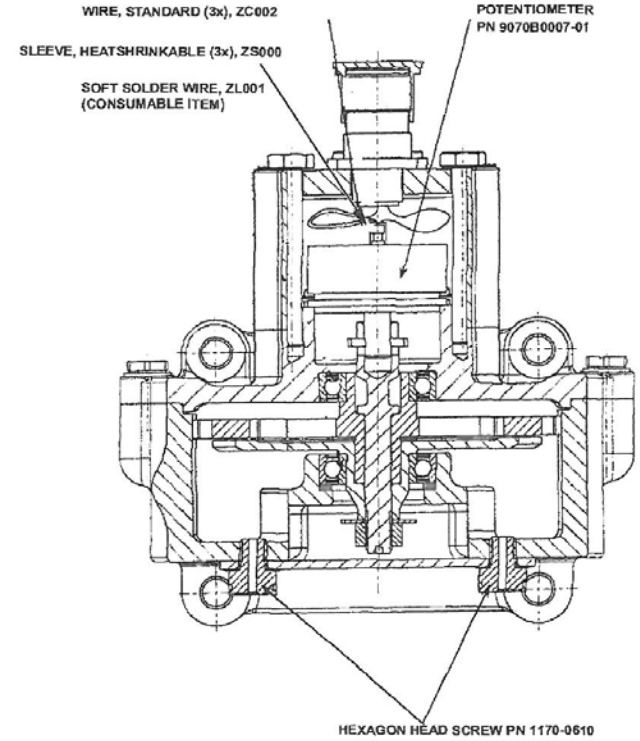
BEFORE MODIFICATION
FEEDBACK UNIT POTENTIOMETER PN 1170A1800-01



Feedback Unit Potentiometer PN 1170A1800-01 Before Modification
Figure 2

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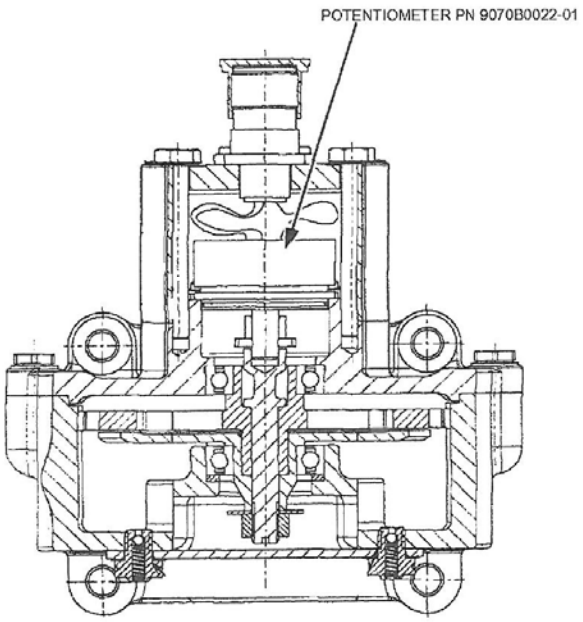
BEFORE MODIFICATION
FEEDBACK UNIT POTENTIOMETER PN 1170A3500-01



Feedback Unit Potentiometer PN 1170A3500-01 Before Modification
Figure 3

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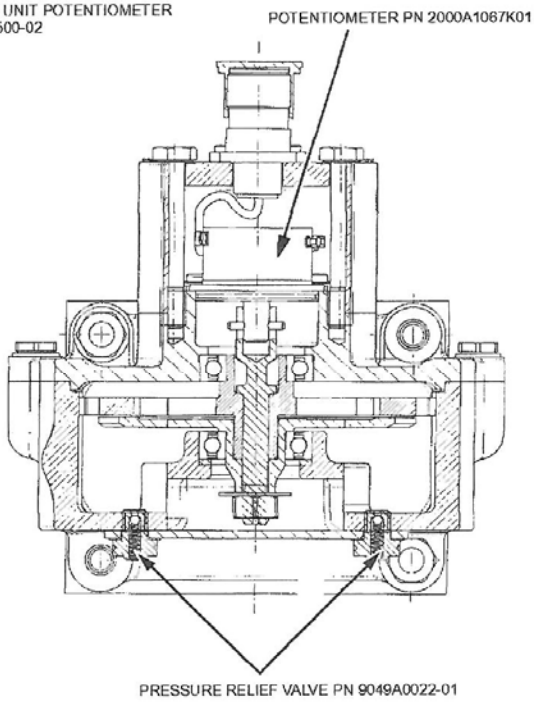
AFTER MODIFICATION
FEEDBACK UNIT POTENTIOMETER
PN 1170A3500-02



Feedback Unit Potentiometer PN 1170A3500-02 After Modification
Figure 4

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G. Manpower

The estimate to do this Service Bulletin is approximately 1.5 manhours excluding testing.

H. Weight and Balance

Not affected.

I. Electrical Load Data

Not affected.

J. Software Accomplishment Summary

Not applicable.

K. References
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-10
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-11
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-12
- Embraer Cover Service Bulletin 145-32-0081 (refer to LIEBHERR-AEROSPACE Service Bulletin 1170A1800-32-01)
- Embraer Cover Service Bulletin 145-32-0100 (refer to LIEBHERR-AEROSPACE Service Bulletin 1170A3500-32-03)
- Aircraft Maintenance Manual

L. Other Publications Affected
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-10
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-11
- LIEBHERR-AEROSPACE Component Maintenance Manual (CMM) 32-21-12

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M. Interchangeability and Intermixability

(1) Interchangeability

(a) The interchangeability between the Feedback Unit Potentiometers PN 1170A1800-01, PN 1170A3500-01 or PN 1170A3500-01 including "P" and PN 1170A3500-02 is two-way.

(b) The interchangeability on Nose Landing Gear Strut level is unchanged (no part number change).

(2) Intermixability

Not affected.

2. Material Information

A. Material - Price and Availability

(1) The price of the alternative Feedback Unit Potentiometer PN 1170A3500-02 is the same as for the Feedback Unit Potentiometer PN 1170A3500-01 or PN 1170A1800-01.

(2) The price of the new Potentiometer PN 2000A1067K01 *** is 1,410.07 $US (economic conditions of 2005).

NOTE: *** including ...Spring Pin, ...Pin, ...Standard Wire and ...Heatshrinkable Sleeve already installed

B. Industry Support Information

For more information contact LIEBHERR-AEROSPACE or ELEB repair facilities at the following addresses:

(1) For European and Asian Operators

Customer Service
Liebherr-Aerospace Lindenberg GmbH
Pfaenderstrasse 50-52
88161 Lindenberg, Germany

Tel.: +49 (0) 8381 46 4304 4424
Fax: +49 (0) 8381 46 4103
AOG Hotline: +49 (0) 171 852 7304
AOG Fax: +49 (0) 8381 46 4182
SITA: FDHLEXD

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(2) or for North American Operators

Customer Service
Liebherr-Aerospace Saline
1465 Woodland Drive
Saline, Michigan 48176 - 1259, USA

Tel.: +1 734 429 7225
Fax: +1 734 429 5357
AOG: +1 313 580 7262
SITA: DTWLACR

(3) or for South American Operators

Customer Service
Embraer-Liebherr Equipamentos do Brasil
Rua Itabaiana, 40
12237-540 - S. Jose dos Campos SP, Brasil

Tel.: +55 (12) 3935-5290
Fax: +55 (12) 3935-5268

C. Material Necessary for Each Component

(1) For NLG Strut with Feedback Unit Potentiometer PN 1170A1800-01

(a) In case of replacement:

A new Feedback Unit Potentiometer PN 1170A3500-02 is necessary.

(b) In case of modification:

1 The new Potentiometer PN 2000A1067K01,

2 two new Pressure Relief Valves PN 9049A0022-01, and

3 a new Identification Plate PN 099A0106-01 is necessary.

(2) For NLG Strut with Feedback Unit Potentiometer PN 1170A3500-01 or PN 1170A3500-01 "P"

(a) In case of replacement:

A new Feedback Unit Potentiometer PN 1170A3500-02 is necessary.

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(b) In case of modification:

1 The new Potentiometer PN 2000A1067K01, and

2 a new Identification Plate PN 099A0106-01 is necessary.

NOTE: The Pressure Relief Valve PN 9049A0022-01 is already included in the Feedback Unit Potentiometer PN 1170A3500-01.

D. Material Necessary for Each Spare

Refer to paragraph 2.C. of this Service Bulletin.

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E. Re-identified Parts

New PN	Keyword	Old PN	Qty	Disposition
Series Production:				
1170C0000-08	Nose Landing Gear Strut	1170C0000-08	1	Modify
1170A3500-02	. Feedback Unit Potentiometer	1170A3500-01 *	1	Modify
----	.. Pin, Spring	MS171467	1	Deleted
----	.. Pin	M39029-56-348	3	Deleted
2000A1067K01	.. Potentiometer ***	9070B0022-01	1	Scrap / New
MS171467	... Pin, Spring	—	1	New
M39029-56-348	... Pin	—	3	New
For inservice:				
1170A3500-02	. Feedback Unit Potentiometer	1170A1800-01	1	Use up / New
----	.. Potentiometer	9070B0007-01	1	Use up
----	.. Pin, Spring	MS171467	1	Use up
----	.. Pin	M39029-56-348	3	Use up
----	.. Standard Wire	ZC002 OPT M16878-4DEE9	**	Use up
----	.. Heatshrinkable Sleeve	ZS000 OPT M23053-5-103-0	3	Use up
9049A0022-01	.. Pressure Relief Valve	—	2	New
2000A1067K01	.. Potentiometer ***	—	1	New
MS171467	... Pin, Spring	—	1	New
M39029-56-348	... Pin	—	3	New

Re-identified Parts NLG Strut PN 1170C0000-08 - Table 1.A. (continued next page)

NOTE: * PN 1170A3500-01 including "P" after serial number
NOTE: ** as necessary
NOTE: *** including ...Spring Pin, ...Pin, ...Standard Wire and ...Heatshrinkable Sleeve already installed

The alternative Feedback Unit Potentiometer can be used in all previous NLG strut build standards incl. any combination of ModPlate Marking without PN change.

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SERVICE BULLETIN

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SERVICE BULLETIN

New PN	Keyword	Old PN	Qty	Disposition
	or for inservice:			
1170A3500-02	. Feedback Unit Potentiometer	1170A3500-01 *	1	Use up / New
—	.. Pin, Spring	MS171467	1	Deleted
—	.. Pin	M39029-56-348	3	Deleted
2000A1067K01	.. Potentiometer ***	9070B0022-01	1	Scrap / New
MS171467	... Pin, Spring	—	1	New
M39029-56-348	... Pin	—	3	New

Re-identified Parts NLG Strut PN 1170C0000-08 - Table 1.A. (continued)

NOTE: * PN 1170A3500-01 including "P" after serial number
NOTE: ** as necessary
NOTE: *** including ...Spring Pin, ...Pin, ...Standard Wire and ...Heatshrinkable Sleeve already installed

The alternative Feedback Unit Potentiometer can be used in all previous NLG strut build standards incl. any combination of ModPlate Marking without PN change.

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New PN	Keyword	Old PN	Qty	Disposition
Series Production:				
2233A0000-02	Nose Landing Gear Strut	2233A0000-02	1	Unchanged
1170A3500-02	. Feedback Unit Potentiometer	1170A3500-01 *	1	Modify
----	.. Pin, Spring	MS171467	1	Deleted
----	.. Pin	M39029-56-348	3	Deleted
2000A1067K01	.. Potentiometer ***	9070B0022-01	1	Scrap / New
MS171467	... Pin, Spring	---	1	New
M39029-56-348	... Pin	---	3	New
For inservice:				
2233A0000-01 or -02	Nose Landing Gear Strut	2233A0000-01 or -02	1	Modify
1170A3500-02	. Feedback Unit Potentiometer	1170A3500-01 *	1	Modify
----	.. Pin, Spring	MS171467	1	Deleted
----	.. Pin	M39029-56-348	3	Deleted
2000A1067K01	.. Potentiometer ***	9070B0022-01	1	Scrap / New
MS171467	... Pin, Spring	---	1	New
M39029-56-348	... Pin	---	3	New

Re-identified Parts NLG Strut PN 2233A0000-01 or -02 - Table 1.B.

NOTE: * PN 1170A3500-01 including "P" after serial number
NOTE: *** including . Spring Pin, . Pin, . Standard Wire and . Heatshrinkable Sleeve already installed

The alternative Feedback Unit Potentiometer can be used in all previous NLG strut build standards incl. any combination of ModPlate Marking without PN change.

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New PN	Keyword	Old PN	Qty	Disposition
Series Production:				
2666A0000-02	Nose Landing Gear Strut	2666A0000-02	1	Unchanged
1170A3500-02	. Feedback Unit Potentiometer	1170A3500-01 *	1	Modify
----	.. Pin, Spring	MS171467	1	Deleted
----	.. Pin	M39029-56-348	3	Deleted
2000A1067K01	.. Potentiometer ***	9070B0022-01	1	Scrap / New
MS171467	... Pin, Spring	----	1	New
M39029-56-348	... Pin	----	3	New
For inservice:				
2666A0000-01 or -02	Nose Landing Gear Strut	2666A0000-01 or -02	1	Modify
1170A3500-02	. Feedback Unit Potentiometer	1170A3500-01 *	1	Modify
----	.. Pin, Spring	MS171467	1	Deleted
----	.. Pin	M39029-56-348	3	Deleted
2000A1067K01	.. Potentiometer ***	9070B0022-01	1	Scrap / New
MS171467	... Pin, Spring	----	1	New
M39029-56-348	... Pin	----	3	New

Re-identified Parts NLG Strut PN 2666A0000-01 or -02 - Table 1.C.

NOTE: * PN 1170A3500-01 including "P" after serial number
NOTE: *** including . Spring Pin, .. Pin, .. Standard Wire and .. Heatshrinkable Sleeve already installed

The alternative Feedback Unit Potentiometer can be used in all previous NLG strut build standards incl. any combination of ModPlate Marking without PN change.

F. Tooling - Price and Availability

Not affected.

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3. Accomplishment Instructions

A. Procedure Feedback Unit Potentiometer Replacement

(1) Removal of Feedback Unit Potentiometer PN 1170A1800-01 or PN 1170A3500-01 and Installation of New Feedback Unit Potentiometer PN 1170A3500-02

(a) Remove the Feedback Unit Potentiometer PN 1170A1800-01 or PN 1170A3500-01 from the Nose Landing Gear Strut. Refer to the LIEBHERR-AEROSPACE Lindenberg Component Maintenance Manual (CMM) 32-21-10 or 32-21-11, page block 300, DISASSEMBLY, and send it back to one of the addresses given in paragraph 2.B. or modify it according to the accomplishment instructions given in paragraph 3.B.

(b) Install the new Feedback Unit Potentiometer PN 1170A3500-02.

(c) Test the unit in accordance with LIEBHERR-AEROSPACE Lindenberg Component Maintenance Manual (CMM) 32-21-10 or 32-21-11.

B. Procedure Potentiometer Replacement

NOTE: For Disassembly and Assembly, refer to LIEBHERR CMM 32-21-12.

(1) Feedback Unit Potentiometer PN 1170A1800-01

(a) Remove and discard the Potentiometer PN 9070B0007-01 with Standard Wire PN ZC002, Heatshrinkable Sleeve PN ZS000 and Soft Solder Wire PN ZL001.

(b) Remove and discard the Hexagon Head Screws PN 1170-0610 from the feedback unit potentiometer.

(c) Install the new Pressure Relief Valves PN 9049A0022-01.

(d) Install the new Potentiometer PN 2000A1067K01.

(2) Feedback Unit Potentiometer PN 1170A3500-01

(a) Remove and discard the Potentiometer PN 9070B0022-01.

(b) Install the new Potentiometer PN 2000A1067K01.

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(3) Re-identification

(a) Use the new Identification Plate PN 099A0105-01 to identify the modified Feedback Unit Potentiometer correctly.

(4) Do a test. Refer to the LIEBHERR-AEROSPACE Lindenberg Component Maintenance Manual (CMM) 32-21-12, page block 150, TESTING AND FAULT ISOLATION.

(5) Install the modified and tested FBU to the Nose Landing Gear Strut. Refer to the relating Aircraft Maintenance Manual / Component Maintenance Manual.

LIEBHERR-AEROSPACE LINDENBERG GmbH
Customer Service

Approved by: Prepared by:

(P. Schneider)

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