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THE AIR ACCIDENT INVESTIGATION
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CIVIL AVIATION AUTHORITY

REPUBLIC OF SUDAN

FINAL AIRCRAFT SERIOUS INCIDENT REPORT

AIRCRAFT TYPE	**MD 83**
REGISTRATION	**SU-BOZ**
DATE OF OCCURRENCE	**23/06/06**
LOCATION	**Juba Airport**
AIRCRAFT LOCATION	N 04 51 54 E 031 36 33.76

The sole objective of this report is the prevention of accidents and incidents and not to apportion blame.

This report is issued in accordance to the available information at time of issue and may be amended if a concrete evidence appears later in future.

SYNOPSIS

On 23/06/06 the aircraft MD-83, serial number 53192, Registration SU-BOZ wet leased by Sudan Airways, was on a scheduled flight en-route Khartoum- Juba- Nairobi- Juba- Khartoum. On its return flight from Nairobi, it landed Juba Airport. The weather condition convoyed to the aircraft by Juba ATC was:-

wind	180/03 Kt.,
temperature	31 C,
dew	22
Visibility	10 Km
QNH	1014.

The aircraft landed R/W 31 with landing weight 54 tons and speed of 130 Kts. with reverse being immediately deployed. The touch down point was 752 meters beyond R/W 31 threshold. Five seconds after touch down left wing spoilers suddenly return to stow position and aircraft entered into lateral acceleration condition. The aircraft managed to decelerate to 48 knots, then speed started to increase gradually. Forty eight second after touch down the PIC felt that the aircraft might not come to a full stop he deployed the reverse once again and aircraft speed increased rolling in a curved path to the right and came to total stop about 360 meters (1181 feet) beyond the threshold of R/W 13 (that is end of R/W 31) with left wing touching the muddy ground and retracted nose and left landing gear.

The Egyptian Authority was notified and an Accredited Representative

arrived Khartoum and joined the Investigation Board which comprised of :

Engineer : Abdelsamie Adam Ali

A/port Officer: Mohamed Elhassan Taha

Engineer : Dafalla Saeed

Egyptian Accredited Representative :

Engineer : Gebaly Husain

The Investigation Board visited the accident site on 24/06/06 and interviewed eye witnesses and crew, took photos and collected the CVR and FDR.

The flight Recorders were read-out at the Egyptian Central Investigation Directorate Facility.

Notification was send to the concerned states.

1. FACTUAL INFORMATION

Type and registration of aircraft	:	Boeing MD 83, SU-BOZ
Date of manufacture and serial Number	:	1996, SN 53192
Number and type of engines	:	2 , JT8D-219, SN P728107D, P728108D
Date and type of last check	:	14/05/06, check A
Owner	:	AMC/ 5 El-Nasr St. Elnozha Elgedida Heliopolis, Cairo.
Operator	:	Sudan Airways
Flight phase	:	Landing
Date and time	:	23/06/06, 10:35 UTC
Location	:	Juba Airport R/W 31 at N 04 51 54 E 031 36 33.76
Damage to aircraft	:	The aircraft sustained substantial damage
Number on board	:	12 crew members, 12 passengers
Injuries	:	Crew Nil Passengers Nil
Pilot-in-Command license	:	Male age 52 years, had Egyptian ATPL
Total flying experience	:	7673 hrs.
Total on type	:	2179 hrs.

1.1 **HISTORY OF FLIGHT**

The aircraft MD-83, serial number 53192, registration SU-BOZ leased by Sudan Airways was assigned for schedule flight to carry passengers to Nairobi (Kenya) via Juba. The aircraft took off from Khartoum Airport on 23/06/06 at 03:25 UTC en-route to Nairobi carrying 94 passengers from which 76 passengers were embarked at Juba.
The aircraft, Su-BOZ arrived Nairobi at 07:05 UTC on 23/06/06 with 18 passengers. The trip was uneventful.

After carrying out Before Flight Check at Nairobi Airport the aircraft left Nairobi back to Khartoum Airport via Juba with 12 passengers on board and 17 tons of Jet A1.
The aircraft took off from Nairobi Airport at 09:10 UTC on 23/06/06 cruising at FL 350. The aircraft started descend at about 115 Nautical Miles to Juba Airport and as being stated by the crew the flight was normal. Weather at juba was:

Wind	180/03 Knots
Temperature	31
Dew	22
Visibility	10 Km
QNH	1014

All times in (UTC) with difference of one minute between Juba actual time and the aircraft clock (below Juba time in UTC).

10 ;27:40 The PIC instructed F/O to contact Juba Airport ATC : if traffic permitted to request straighten approach VOR VOR/DME Runway One Three
10:27:49 F/O contacted Juba ATC : Sudan Air Three Two Five if traffic permitted request straighten approach Runway One Three
10:27:55 Juba ATC : Sudan Air Three Two Five insight for straighten approach Runway One Three…. Three One
10:28:03 F/O : Which Runway in use Sudan Air Three Two Five
10:28:06 ATC : Three One
10:28:10 F/O : Runway Three One
10:28:12 ATC : Roger Runway Three One report establish
10:28:17 F/O : Report establish Sudan Air Three Two Five
10:30:10 F/O : Juba Sudan Air three Two Five field inside request descend to minimum

10:30:13 ATC : Descend to minimum next call final Runway Three One
10:30:46 : Speed was checked by crew and Slats extended

10:31:07 : Flaps Eleven selected
10:32:00 : VOR captured
10:32:03 : Flaps were set fifteen degrees
Approach check lasted for five minutes twelve seconds. Flaps lowered to 28 degrees before lowering landing gear. Undercarriage was lowered and Flaps were set to forty degrees, then the crew started their before landing check which lasted for thirty eight seconds ensuring brake was sufficient, undercarriage three greens, flaps forty, spoilers armed, VOR armed, Auto throttle and Autopilot off.
10:34:12 F/O : Juba tower Sudan Air Three Two Five final
10:34:18 TWR : Sudan Air Three Two Five clear to land runway in use Three One
10:35:00 Landing commenced
10:35:04 F/O : Speed brake up, reverse four lights
!0:35:13 The PIC asked the F/O if he is doing anything with the control as he felt a sort of instability on the aircraft track and some lateral movement and F/O answer was negative.
10:35:28 Observer who was the second Captain said : It is veering
10:35:29 PIC : Veering and shaking
10:35:31 PIC : Brakes, No brakes, No brakes
10:35:35 PIC : No brakes… No brakes…No brakes…No reverse.. there is nothing
10:35:36 Observer : Easy…easy
10:35:41 TWR : Sudan Air Three Two Five clear to back track report marsheller insight
10:35:46 PIC Repeating There is nothing…….
10:35:51 : Central Microphone sounds indicating landing gear up

As stated by the crew members the touch down point was about 400 meters from the beginning of Runway 31(eye witnesses said touch down point about 500-700 meters from beginning of R/W 31). Then reverse was selected and the aircraft speed reduced to about 80 Knots and at that moment the Pilot –in -Command felt some lateral instability and shaking of the

aircraft while rolling and he asked F/O if he is doing anything with the rudder and the answer was negative, and thus he decided to use manual brakes by pressing the brake peddles. The brakes did not have any effect as he stated and the aircraft did not decelerate efficiently.
When the speed of the aircraft was about 60 Knots and the aircraft was approaching the end of Runway 31 the PIC (according to his statement) as the only solution for him, he deployed the reverse once again and the aircraft speed suddenly increased and the aircraft veered to the right and went off the Runway 31 and came to total stop 300 meters (984 feet) from the end of paved extension of Runway 31 on a muddy area with retracted left undercarriage leg and left wing touching the ground.
The crew and passengers evacuated the aircraft safely by usage of the emergency exits over the wing. The Fire Brigade arrived immediately at the accident site and helped in evacuation. No fire broke out.

1.2 **Injuries**

INJURIES	CREW	PASSENGERS	OTHERS
Fatal	None	None	None
Serious	None	None	None
Minor/none	None	None	None

1.3 **Damage to aircraft**

Both retracting jacks of nose and left landing gear were sheared off. the left engine reverse partially deployed. The left hydraulic system return pipe Part number 7936907-711 damaged at its connection with the reservoir.

1.4 **Other Damages**

Two lambs at the end of Runway 31 were damaged.

1.5 **Personnel Information**

1.5.1 **The Pilot-in -command**

Male age 52 years, of Egyptian nationality

Total flying experience	:	7673 hrs.
Total on type	:	2179 hrs.
Total last three months	:	231 hrs.
Total last 28 days	:	68 hrs.
Total last 7 days	:	15 hrs.
Total previous day	:	2 hrs.
Last Proficiency check date	:	20/02/2006
Last medical check date	:	31/05/2006
Instrument Rating validity up to	:	28/02/2007
License validity up to	:	30/09/2006

Release to fly foreign aircraft in Sudan from 20/06/06 to 31/08/06

1.5.2 **First Officer**

Male age 43 years, of Egyptian nationality

Total flying experience	:	433 hrs.
Total on type	:	260 hrs.
Total last three months	:	107 hrs.
Total last 28 days	:	50 hrs.
Total last 7 days	:	10 hrs.
Total previous day	:	2 hrs.
Last Proficiency check date	:	06/03/2006
Last medical check date	:	18/01/2006
Instrument Rating validity up to	:	31/07/2006
License validity up to	:	28/07/2006

Release to fly foreign aircraft in Sudan from 20/06/06 to 31/08/06

1.5.3 **Observer (second Captain**)

Male age 42 years, of Egyptian nationality

Total flying experience	:	8497 hrs.
Total on type	:	1135 hrs.
Total last three months	:	226 hrs.
Total last 28 days	:	60 hrs.
Total last 7 days	:	10 hrs.
Total previous day	:	3 hrs.
Last Proficiency check date	:	04/01/2006
Last medical check date	:	18/01/2006

Instrument Rating validity up to : 31/01/2007
License validity up to : 14/07/2006
Release to fly foreign aircraft in Sudan from 20/06/06 to 31/08/06

1.6 **Aircraft Information**

The aircraft MD-83 serial number 53192 is powered by two Pratt and Whitney JT8D axial flow turbofan engines aft mounted and an auxiliary power unit. The aircraft hydraulic power is provided by two separate systems known as left system and right system.
The right system provides hydraulic power to the rudder, aft passenger entrance stairway and the landing gear actuating subsystem, while the left system provides hydraulic power to the elevator augmenter. All other hydraulic subsystems are served by both systems through separate valves actuators.
Both systems are powered by two separate engine driven pumps with an auxiliary pump in the right system. A power transfer unit is used to transfer full available power between the two systems. The unit mechanically connects both systems enabling hydraulic pressure to be transferred in case of one system failure. The unit is controlled by a motor operating two shutoff valves, one in each system. The shutoff valves will automatically close if either system reservoir quantity fall below a safe level. Subsystems that normally receive pressure from both hydraulic systems will operate at a reduced rate if one system is inoperative. (Ref. Chapter 11 section 4, Attachment “A”).

A hydraulic fluid quantity limiter is installed in each brake line downstream of each antiskid servovalve to protect against total loss of fluid if a line rupture or break by isolating the open line from the main hydraulic system to prevent loss of hydraulic fluid.
The MD-83 is provided with spoiler system consists of hydraulically operated flight/ground spoiler panels on the upper surface of each wing, forward of the flaps. The flight spoiler system aids lateral control and also serves as a speed brake during flight. Also used with the ground spoilers after landing to reduce stopping distance.
The aircraft Maintenance Programme was approved by the Egyptian Airworthiness Department under the approval number ECAA/MP/2004/AMC/MD-83/REV.1 on 29/09/2004.

The Pre-flight (BF) check to be carried out just before departure.
Service check to be carried out every three days not to exceed 72 flight hours.
Check A and Multiples to be carried out at intervals not exceeding 450 flight hours.
Check C and Multiples to be carried out at intervals not exceeding 3600 flight hours or 15monthes which occurs first.
Last check was Check A carried out on 14/05/06. Check C was carried out on 29/03/06.
Aircraft total flying hours till 23/06/o6 was 22931:42 hrs.
Flying hours since last check C 675:25 hrs.
Flying hours since last check A 256:00 hrs.

1.6.1 **Aircraft Engines**

The MD-83 was powered by two Pratt and Whitney JT8D axial flow Turbofan engines.

Engine 1

Date of manufacture	18/09/96
Serial number	P728107D
Total flying hours	17498 hrs.

Engine 2

Date of manufacture	18/09/96
Serial number	P728108D
Total flying hours	20952 hrs.

Last maintenance check was check A1 carried out on 14/05/06.

1.6.1.1 **Thrust Reversers**

The thrust reverser system for both engine is identical and independent, consisting of two thrust reverser doors, thrust reverser control and indicating system. The control levers are hinged to throttle levers and will not operate unless the throttles are in the idle position. The reverse system also comprises a hydraulic accumulator which provides sufficient pressure to extend and partially stow the reverser door

1.7 **Meteorological Information**

Weather at juba was:

Wind	180/03 Knots
Temperature	31
Dew	22
Visibility	10 Km
QNH	1014

1.8 **Aids to Navigation**

VOR and DME

1.9 **Communication**

VHF frequency 118.4 MHz

1.10 **Aerodrome Information**

Juba Airport is located at 045219.22 N, 0313604.02 E. Its elevation is 1513 feet (461 meters) and is equipped with fire fighting equipment estimated as Cat 5. The Airport has two Runways characterized as R/W 13 and R/W 31 both of length 2400 meters (7874 feet) and width of 45 meters (147.65 feet) with clear area of 60 meters (197 feet) at both ends. Runway 13 threshold elevation 458.1 meters (1503 feet) and that of Runway 31 is 468.7 meters (1538 feet).

The Airport radio navigation aids VOR co-located with DME and its communication facility VHF frequency 118.4 MHz

1.11 **Flight Recorders**

The aircraft MD-83, SU-BOZ is equipped with two on board recorders.

The **Cockpit Voice Recorder** type Fairchild Model A100A,

Part Number	93-A100-80
Serial Number	55729
Weight	23.9 lbs.
Power	17 Watts
Manufactured	09/1989
Recording time	30 minutes reversible.

The **Flight Data Recorder** is of a Solid State Memory manufactured by AlliedSignal on 01/01/1996

Part Number	980-4700-002
Serial Number	1488
Weight	18 lbs.
Nom voltage	115 VAC 400Hz
Power	10 Watts

Both recorders were read and decoded at the Egyptian Central Aircraft Accident Investigation Directorate Facility. The FDR read-out result obtained was as follows:-

a) Time taken by the aircraft after touch down till it came to a full stop was 56 seconds and sound of landing gear horn came on once again 49 seconds after touch down indicating undercarriage retraction.

b) 2.5-3 seconds after touch down Thrust reversers were deployed for about 26 seconds and deployed again later after 23 seconds and lasted for 6 seconds. At this stage only right engine reverser was deployed while the left engine reverser was partially deployed.

c) Brakes were activated by the Left Hydraulic system and the aircraft decelerate to 48 knots on 30 seconds.

d) 3 seconds after touch down the aircraft experienced lateral acceleration which increased by time.

4 seconds after touch down (right wing shown by FDR readout) left wing spoilers suddenly were stowed and that of the (left wing from FDR readout) right wing remained deployed.

The FDR read out shows that flap setting was 38 degrees and landing heading was 304.8 degrees instead of the actual setting of flaps 40 degrees and actual R/W 31 heading 310.2 degrees. Same variation occurred on Radio Altimeter. Those variation on read-out might be due to malfunction of sensors which should be stated during the yearly calibration so as to take the deviation factor into consideration during read-out. Those variations may give a glue that even the readout landing speed was not the actual landing speed. Variation factor for heading found to be 1.0174 and that for flap setting is 1.05. If this variation is taken into consideration for the whole readout , the landing speed will rise to 134 Kts instead of 130 Kts.

1.12 **Wreckage and Impact Information**

The accident site area is a muddy soft cotton soil. The aircraft after passing runway 31 threshold rolled on the soft muddy ground about 300 meters and came to a total stop with the right undercarriage extended and locked. the aircraft on its rolling off the runway passed through ditches of water of about 10 meters in length and about one meter in depth.

The aircraft came to total stop wresting on the extended right undercarriage with the left wing whole length resting on the ground surface. Also the aircraft front portion stuck into the muddy ground with both nose and left undercarriage seem retracted. Both retracting jacks of nose and left undercarriage were sheared off which lead to retract both struts and caused the left wing to touch the ground.

The left hydraulic system return pipe found damaged at its

connection with the hydraulic reservoir due to severe tightening. The left hydraulic system reservoir found empty while the right system reservoir was full with hydraulic fluid.

1.13 **Medical and Pathological Information**

Crew members and passengers were subjected to medical check and all found in good condition.

1.14 **Fire**

No fire broke out

1.15 **Survival Aspect**

the accident was survivable as the aircraft dashed into a muddy soft cotton soil with small bushes and grass full of water due the rainy season at that time.

1.16 **Test and Research**

As the return hydraulic pipe P/N 7936907-711, hydraulic Pipe Clip and actuator rod of left main undercarriage landing gear were found damaged they were send to Egyptian Central Metallurgical Research and Development Institute to determine the cause of failure. Investigation and analysis were carried out including complete examination of the fractured surfaces using stereoscope, optical and scanning electron microscopes and energy dispersive spectroscopy in addition to chemical analysis, cross-section microstructure, hardness and X-ray fluorescent analysis.

The result of investigation for the hydraulic pipe P/N 7936907-711 revealed that the damage was due to over tightening during regular check up by the workers.

The hydraulic Pipe Clip failed due to formation of microvoids coalescence that being formed around the second phase particle.

Actuator Rod End of left main landing gear failed due to sudden shearing high velocity projectile impact.

Reference Attachment “B”

1.17 **Organization and Management Information**

The Organization , AMC, had a valid Egyptian AOC and Approved Maintenance (Repair) station to carry maintenance up to Check C for all types of aircraft owned by the organization and Line maintenance

for their aircraft respective engines. All documents regarding aircraft and operation procedures were recently being amended. All of its crew were properly qualified. The organization had a proper procedure.

1.18 **Additional Information**

The aircraft was recovered four months later during the dry season and pulled back to the apron for repair.

1.19 **Useful or Effective Investigation Technique**

None

2. ANALYSIS

2-1 General

As there was a difference between the statements given by the eye witnesses and the Pilot-in-Command and other crew members regarding the distance of touch down point from the threshold of Runway 31, and as the indicated airspeed does not differ much from the true airspeed on ground (wind vector is negligible), two methods were used to calculate the whole distance covered by the aircraft on ground. First method used is by means of average velocity and time that is ($S= t(V_1+V_2)/2$) and the second method by using speed variation by time. By those methods the total distance covered by the aircraft on ground and Runway 31till it came to total stop is 2008 meters. The distance covered by the aircraft off the Runway 13 threshold found to be 360 meters (1181 feet) and off R/W 31 paved extension by 300 meters (984 feet), thus the distance covered by the aircraft on Runway and paved extension of R/W 31 is 1760 meters (5775 feet). The resultant of this calculation coincides with the eye witnesses statements that the aircraft touch down point was in the range of 500 - 700 meters (1641-2297 feet) from the beginning of Runway 31. Thus the actual touch down point is 752 meters (2467 feet) from Runway 31 threshold.

2-1-1 Operation of aircraft

Reference Flight Crew Operation Manual page 13/14(shown below) regarding landing field length and speed for either dry or wet runway with 40 degrees flaps and slats extended is being consulted to calculate the length of landing run for an aircraft of landing weight of 54 tons and airport of pressure altitude of 1513 feet and wind of 3 knots speed.

Anti-skid inoperative case was not taken into consideration due the facts being studied during the aircraft rolling time and distances covered on ground. It is found that the required run length at speed of about 127 knots for dry runway is 1400 (4593.4 feet) meters and that for wet runway is 1600 meters. On the other hand if the landing speed is 130 knots the length required on dry runway will be 1500 meters (4921.5 feet) and on

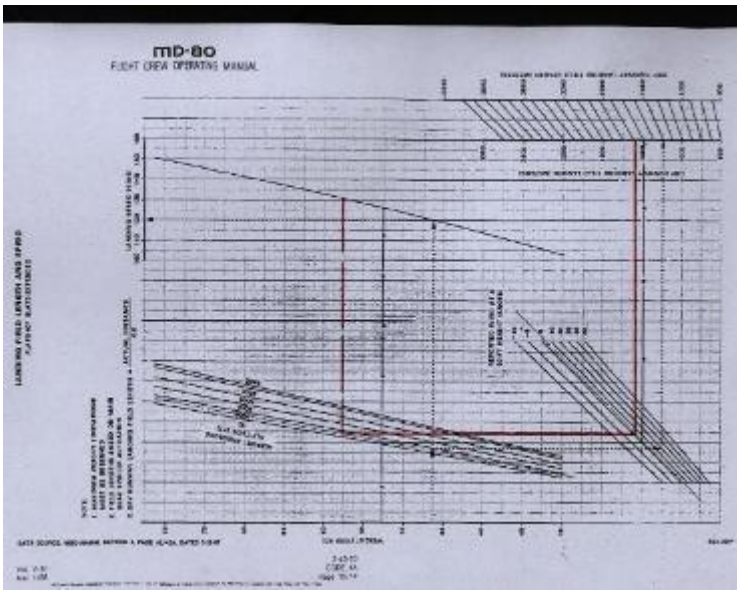
wet runway will be 1700 (5577.7 feet) meters. Thus from the above

calculation as the aircraft MD-83 landed 752 meters after the beginning of runway 31 with speed of 130 knots the remaining distance available will be:-

For dry Runway : 2400 – 1500 - 752 = 148 meters to track back and

For wet Runway : 2400 – 1700 - 752 = - 52 meters off runway

if everything is normal.



As the season is rainy season the runway might be contaminated due to rain falls. In accordance to FDR read-out aircraft landing speed was 130 Kts.(ref FDR frame No. 483) at which radio altimeter read 0 feet.

Figures of radio altimeter shown by frames (484-543) were due either to malfunction of sensors or calibration deviation.

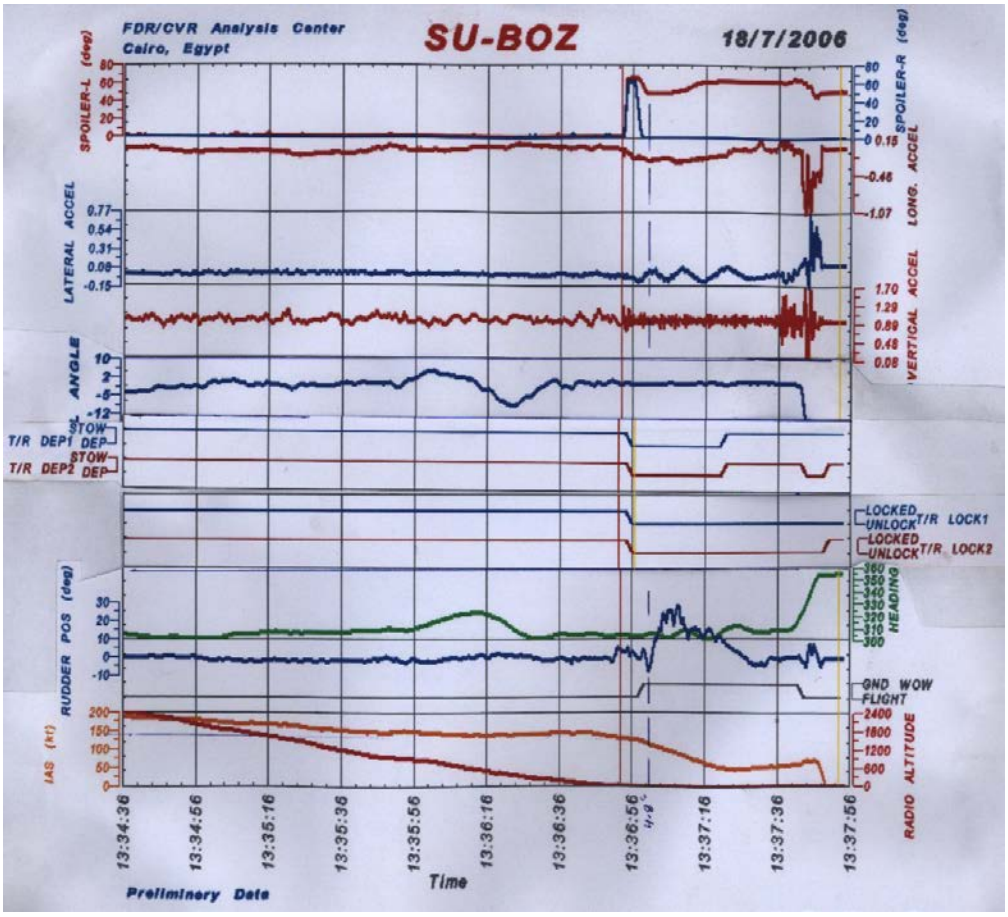
The nose wheel was lowered down 6 seconds after touch down and both engines thrust reversers were unlocked and deployed 2 seconds after touch down and kept unlocked till once again being deployed as was stated by the PIC and indicated by the read out of the FDR. The PIC stated that he did not return the T/R to lock position for both engines after stowing for the first time as if he was expecting an unexpected event and might be due to high landing speed putting

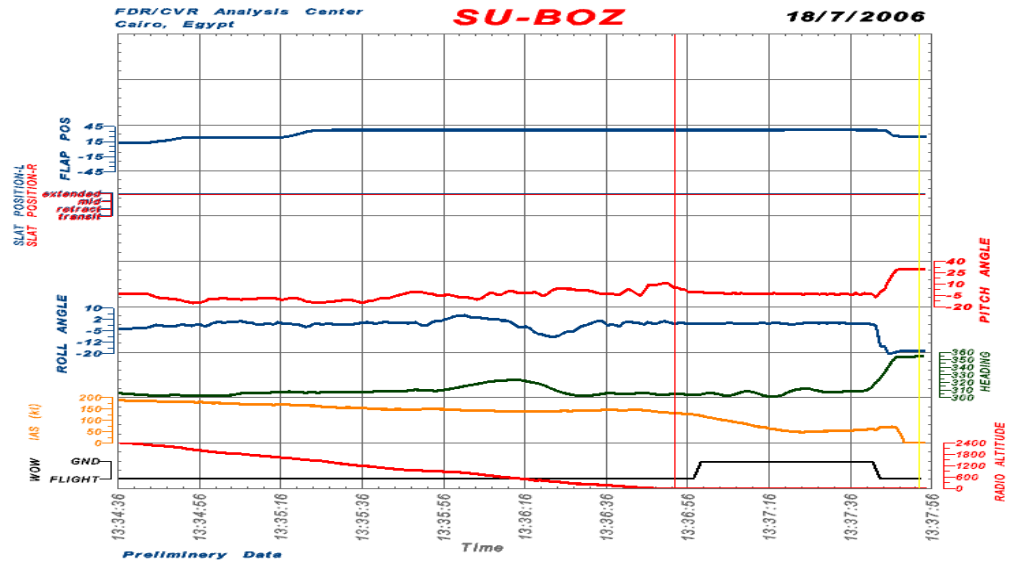
in mind he is going to deploy the T/R once again.
Both engines T/R (for the first time) remained deployed for a period of 27 seconds after touch down and then stowed but kept unlocked.
During investigation and inspection of aircraft parts and systems it was found that the left hydraulic system reservoir drained and no traces of hydraulic fluid while the right one is full with hydraulic fluid. In the same time damage to pipe no. 7936907- 11 (ref 1.16 above) was detected which lead left hydraulic system to loose its fluid to atmosphere which lead to stowage of the left wing spoilers after exhausting its accumulators pressure within 4 seconds after touch down and resulted in putting the aircraft in a lateral acceleration and tendency of aircraft to veer to the right due to braking effect of the right wing extended spoilers. This effect was being counteracted by the movement of the rudder which operates only from the right hydraulic system, and this gives a concrete evidence that the operated hydraulic system was the right hydraulic system thus the readout of the FDR regarding aircraft wings, hydraulic systems and brake pressure were reversed. Changing of flaps setting from 38 degrees to 25 degrees 52 seconds after touch down (ref to Egyptian Authority Comments) was due to the fact that the aircraft was rolling on the soft muddy ground with the left wing skidding on the ground due to retraction of the left landing gear. Forty five seconds, and at a distance of 1837 (6027 feet) meters, after touch down point the aircraft encountered the first hard impact after which by one second landing gear horn sound indicating undercarriage up.

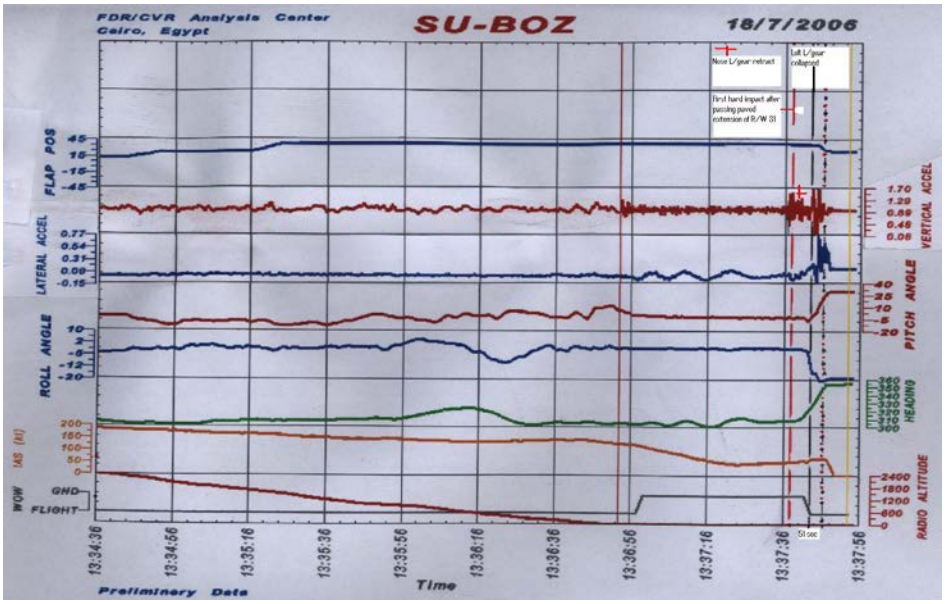
2.1.2 **The FDR read-out**

The FDR read –out show that spoilers of right wing were stowed after landing and that brakes were operated by the left hydraulic system. During physical investigation of both hydraulic systems it was found that left hydraulic system reservoir was empty with a damaged return line pipe (refer to 1.16) while the right hydraulic system reservoir was found full with hydraulic fluid and on the same time the aircraft rudder and the right engine reverser were operating which indicate that the operating hydraulic system was the right hydraulic system as the rudder operates only from the right hydraulic system as per aircraft manuals. This gives concrete evidence that the FDR readout was reversed. Also another point derived from the aircraft crew and CVR read-out the aircraft at touch down flap setting was 40 degrees

and autobrake was being armed but the FDR read-out show that flaps setting was 38 degrees and heading during landing was 304.8 degrees., thus there was difference between the actual values for heading and flap setting and the read out values. The same variation occurred on radio altimeter read-out which means that those variations might be due to either to malfunction of sensors or due calibration not being done. This might give a glue that even the actual landing speed was not that was given on read-out. The variation factor for heading is about 0.01741 and that for flaps setting is 0.05. If the above factors are taken into consideration for the whole read-out of the FDR the landing speed may rise to 134 Kts. instead of the read 130 Kts.







.2.1.2 **Landing of aircraft**

During the Before landing Check the Auto-brake was selected to Minimum and armed and according to the aircraft operation Manual the automatic braking is delayed for approximately 4 seconds after spoiler deployment. The aircraft touched down at speed of 130 knots, 752 meters (2467 feet) from the threshold of R/W 31 and ground spoilers were deployed with the spin of landing gear tires. Suddenly 3 to 4 seconds from touch down at speed of 127 knots the left wing spoilers were stowed (right wing on the FDR readout) and the aircraft

entered into lateral acceleration which lead the PIC to ask the F/O if he is doing any thing and realized that the F/O was doing nothing. Stowing of ground spoilers released brake pressure (supplied by the right hydraulic system) without disarming the Automatic Brake System. Brakes pressure was supplied by the right hydraulic system (left hydraulic system on the FDR readout) only. About 4 seconds from touch down brake pressure started building up reaching 342 psi and then dropped to 15 psi for 3 seconds which indicate no braking effect in the first 7 seconds. The PIC felt that the deceleration of the aircraft is slow and not stable in its heading and shaking so he started to press the peddles overriding the automatic brake. Brake pressure started building up and in 14 seconds time reach 660 psi reducing aircraft speed to 94 Kts. The brake pressure continued building up to 670 psi and aircraft speed reduced to76 Kts. and by the time the aircraft speed reduced to 48 Kts. brake pressure was exhausted dropping to 311 psi. Reducing aircraft speed to 48 Kts. took 30 seconds from touch down.

Inefficient braking , dropping and rising of brake pressure might be due to a defect within the power transfer unit or the unit being closed due to leakage of hydraulic fluid from the left system. At that moment the right Hydraulic System was exhausted and the aircraft was rolling down slope of R/W 31 the speed started to increase due to its inertia force and passed the paved extension of runway 31 with speed of 58 Kts., and rolled into the soft ground with increasing speed of 69 knots and warning horn sound indicating landing gear up at a distance of 129 meters (423 feet) from the end of paved extension of R/W 31. The crew were being puzzled and disoriented the Pilot-in-command deployed the reverse once again to stop the aircraft, but unexpectedly aircraft speed increased and aircraft veered to the right while moving forward and in the same time banking left due to left landing gear not in a proper condition either broken or immersed into the muddy ground and came to stop 360 meters from the end of R/W 31 heading 360 degrees.

During aircraft landing and after touch down immediately engines thrust reversers were deployed for 27 seconds and kept unlock. Within that time the aircraft rolled for a distance of 1261.5 meters (4139 feet) on runway and the aircraft speed reduced to 52 Kts. Up to that moment the available remaining distance of R/W 31 was about 386 meters (1267 feet). Three seconds later the speed reduced to 48 Kts and still 308 meters of runway was available. Due to diminishing

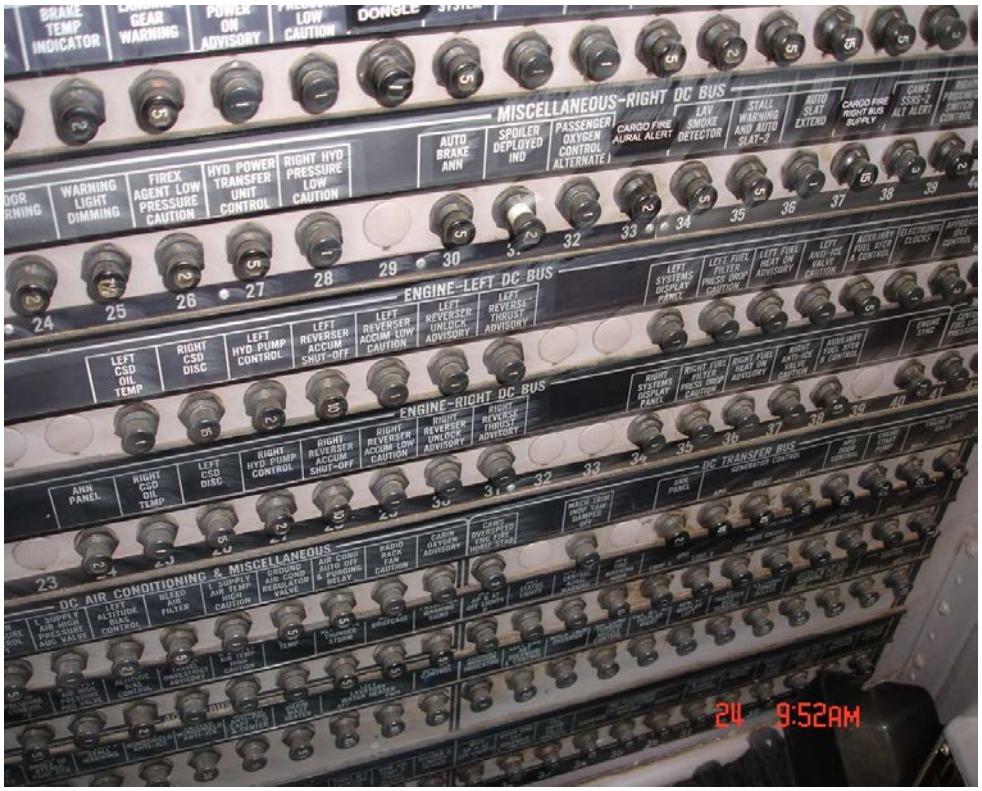
brake pressure at that moment and rolling of aircraft down slope of R/W 31, gradually aircraft speed started to increase and passed the end of R/W 31 with speed of 54 Kts. within forty one seconds after touch down. Within two seconds time after reaching the end of the paved extension of R/W 31 engines EPR increased to above 2 for a period of five seconds increasing aircraft speed to above 59 Kts. and aircraft rolled for a distance of 203 meters (666 feet) passing the paved extension of R/W 31 by 129 meters (423 feet) where landing gear warning horn sound indicating nose gear up and that occurred at speed above 60 Kts. and EPR above 1.8. Nose landing gear was forced to retract due to high impact and muddy soft ground resistance in which it was immersed while aircraft passing the end of the paved extension with speed of 58 Kts. After one second of horn sound the Pilot-in command deployed reverse for the second time hoping to stop the aircraft , but speed increased to above 70 Kts. and aircraft veered to the right with left wing skidding on the ground and came to a full stop 360 meters (1181 feet) from the threshold of R/W 13 that was 300 meters (984 feet) from the end of the paved extension of R/W 31.

Approximately forty nine seconds after touch down left landing gear actuator sheared off due to a second hard impact and the left landing gear retracted inwards causing left wing to contact the ground forcing flaps to change its setting to 28 degrees. Lateral acceleration imposed and shaking of aircraft and sudden increase of engines EPR above 2 for five seconds, forty three seconds after touch down, that increased aircraft speed puzzled the crew. No one noticed the position of the aircraft within the runway. Reasons for EPR increase might be due to high vibration and shaking of aircraft in addition to PIC holding the throttles which might caused the throttles moving forward unintentionally due to the first hard impact on leaving paved ground. Deployment of reverse for the second time which last for 4 seconds commenced 48 seconds after touch down and at a distance of 1868 meters (6129 feet) from touch down point after landing gear warning horn sound. Deployment of reverse occurred of 69 Kts. with an ineffective brakes which might be due to wear of brake discs and exhausted hydraulic system working on reduced power. Deployment of reverse caused the aircraft to roll for a distance of 175 meters (574 feet) turning the aircraft to 360 heading. The aircraft came to complete stop resting on the extended right gear and left wing resting on the ground.

By the time the PIC selected deploying of the reverse the Left hydraulic System thrust reverser accumulator pressure was already being exhausted during first deployment after touch down due to the fact that the left system already lost its hydraulic fluid to atmosphere as the return pipe connection to the reservoir is being damaged due to severe tightening. Operation of brakes was supplied by the right hydraulic system and thrust reverser of the left engine was actuated for the first trial from its accumulators. left engine reverse might not being completely stowed after being deployed at landing due to insufficient available pressure from the left hydraulic system and thus was kept partially deployed. During the second time selection of reverse deployment the Right Hydraulic System fully deployed the right engine reverse and thus the aircraft speed increased due to thrust from the left engine. The aircraft came to stop resting on its belly and left wing touching the ground with right engine reverse doors stowed and that of left engine partially deployed.

During the investigation role, the R/W 31 was inspected for traces of hydraulic fluid but no traces were found which means no spillage of hydraulic fluid occurred during landing or rolling of aircraft on runway. It is probable that the system defused amount of fluid during flight which was unnoticeable by the crew. Spillage of hydraulic fluid during flight might be due to the imposed vibration acquired by the hydraulic pipe of P/N 7936907-711 due to breakage of the clip securing the pipe to the undercarriage bay due increased strain that

occurred due to loose tightening. The vibration of the pipe lead to movement of the pipe flattened end at the connection with the reservoir thus disseminating fluid to atmosphere.
Stowing of left wing spoilers after landing might be due to a malfunction of the selector valve as the circuit breaker in the upper right bus panel found on -off position either due to a short circuit within the unit or its electrical circuit.



Stowing of spoilers might inhibited the automatic brake system without being indicated to the crew and thus automatic brake were not being activated, (as shown by FDR read-out there was no brake effect within the first seven seconds) and was disarmed after landing and the aircraft entered in a lateral acceleration which puzzled the PIC and he concentrated all his effort to counteract the lateral acceleration without taking notice of the un-effective deceleration of the aircraft due to insufficient braking action and fast approaching of runway end..

Flaps forced up by ground reaction

Track of aircraft

On May 2005 MD-83, SU-BOZ overrun the runway on landing at Poznan, Poland which might be for the same reason but no information from Poland regarding that incident or reply to our inquiry. Also there is no laid down procedure by the company regarding such emergency condition.

3- COCLUSION

3-1 Findings

3.1.1 The aircraft had a valid C of A

3.1.2 Maintenance carried out in accordance with an approved maintenance Schedule.

3.1.3 The crew were properly licensed.

3.1.4 The aircraft landed R/W 31 at a point 698 meters from threshold.

3.1.5 Unexpectedly stowage of right wing ground spoilers lead to lateral acceleration .

3.1.6 Selection of reverse for the second time occurred after the aircraft rolled about 92 meters on the muddy cotton soft ground.

3.1.7 Aircraft came to total stop resting on its belly and left wing 306 meters from R/W 31 end.

3.1.8 The FDR read-out was reversed regarding wings positions, hydraulic systems with some variation in heading magnitude and flap setting about 5.2 degrees less for heading and 2 degrees less for flaps setting due to FDR calibration.

3.1.9 It appears that Juba Tower has no clear vision of the runway as the ATC cleared the aircraft to track back the moment it was stuck into the mud.

3-2 Cause of the Serious Incident

Late touch down point down sloped R/W 31, reduced brake effect and imposed lateral acceleration that puzzled the PIC and attracted his attention to counteract the unexpected phenomena is the main reason to this serious incident.

3.2.1 Poor maintenance and improper before flight and landing checks are considered to be a contributory factor to this serious incident.

4. SAFETY RECOMMENDATIONS

4.1 Manufacturer and aircraft hydraulic system design organization should introduce a unit to cancel the effect of spoilers stowage on the Automatic Brake System operation.

4.2 The operator should add inspection of the hydraulic system components in the Before Flight Check procedure.

4.3 Sudan Civil Aviation should install recording facilities to record Communication between all ATS Units and aircraft and between ATS Units as well at all Sudan airports.

4.4 Airport ATC Tower location within the aerodromes should be situated in such a place to give a clear vision of the whole Runway length.

Eng/ A.A.Ali

Investigator-in-Charge


129 meters I/C horn sound
in one second PIC deployed
reverse once again
Touch down point 752 meters
beyond R/W 31 threshold
speed 130 as per RTR


emark
Location 360 meters off R/W 13 threshold That is 300 meters off R/W 31 paved extension
Horn sound U/C
UP

ATTACHMENT "A"

CHAPTER 11

HYDRAULICS

GENERAL

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HYDRAULIC RESERVOIR

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HYDRAULIC PUMPS

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An auxiliary pump, incorporated into the right system, provides hydraulic pressure for landing gear operation, flight backup, preflight, and maintenance operations. The pump is electrically powered and is designed for continuous operation at 3000 psi.

A power transfer unit mechanically connects left and right hydraulic systems and enables hydraulic pressure to be transferred from the highest to the lowest side (the high pressure side operates as a motor and the low pressure side operates as a pump). The unit is controlled by a single motor operating two shutoff valves, one in each hydraulic system. Operation is controlled by a switch on the First Officer's instrument panel. The shutoff valves will automatically close if either system reservoir quantity falls below a safe level.

Airplane systems that normally receive pressure from both hydraulic systems will operate at a reduced rate if one system is inoperative. Complete fluid supply to a system can be stopped by pulling the fire shutoff handle on the upper instrument panel for the engine desired. Pump operation is controlled by switches on the First Officer's instrument panel. Annunciations, one for each system, will come on whenever either system pressure is low.

A hand pump, installed in each main hydraulic system and located in the main gear well, supplements the standard power sources for ground actuation of the various subsystems. The quick disconnect fittings in the inlet suction line of each hand pump and/or auxiliary pump may be connected to a ground source of hydraulic fluid to manually fill the reservoirs. These pumps make the hydraulic systems completely self-sufficient. Hydraulic ground connections are provided in the forward end of each main gear well for servicing and testing each main hydraulic system.

Attachment "B"

CENTRAL METALLURGICAL RESEARCH AND DEVELOPMENT INSTITUTE

FAILURE ANALYSIS REPORT ON

- **Hydraulic Pipe P/N 7936907-711**
- **Hydraulic Pipe Clip**
- **Actuator Rod End of Left Main Landing Gear Of AMC – SU-BOZ Model MD-83**

February 2007

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1-Background

Responding to a request from the Egyptian Ministry of Civil Aviation (EMCA), research team from the Central Metallurgical Research and Development Institute (CMRDI) investigated the fractured parts. The accident was reported on 23 / 6 / 06 during landing at Goba airport-SUDAN. The airplane was belonging to AMC Co. and registered under SU-BOZ Model MD-83. The fractured parts were:

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- Hydraulic Pipe Clip
- Actuator Rod End of Left Main Landing Gear

Fractured parts were submitted to CMRDI to determine the type of failure and possible causes.

The received failed parts were analyzed at CMRDI laboratories to determine the cause of failure. The investigation work was carried out in contact with EMCA. These analyses included complete examination of the fracture surface using stereoscope, optical and scanning electron microscopes and energy dispersive spectroscopy. Also, chemical analysis, cross-section microstructure, hardness, and X-ray fluorescent analysis were carried out.

2- Investigation Procedures

Investigation of the received fracture parts were carried out according to the following sequences:

- Visual survey of the received failed parts to obtain an overall understanding of the fracture.
- Macroscopic investigation of the fracture parts to determine the type of fracture.
- Locating the most possible fracture origin or origins.
- Understanding the manner of loading, the relative stress level and the stress orientation based on the observed fracture features.
- Selection of areas for further examination by SEM to determine the fracture mode and to confirm the fracture mechanism.
- Hardness measurement
- Chemical analysis

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- Metallographic cross section examination to detect any microstructural changes that promoted or caused fracture initiation, and to determine the crack propagation mode (intergranular or transgranular).

3- Results and Discussions

3-1 Hydraulic Pipe P/N 7936907-711

3.1.1 Visual and light Macroscopic Examinations:

The failed hydraulic pipe is shown in Fig.1. One end is seemed to be flattened due to severe tied force. The surface does not contain any markings typical of cutting or shearing. Detailed investigation of surface from inside and outside of the received pipe showed the presence of deformation strain bands. Therefore, the decision was taken after the approval from Egyptian Ministry of Civil Aviation, to cut specimens in order to carry out further metallurgical analyses on this part. Samples were cut using automatic (slow speed) cutting machined cooled by water jet.

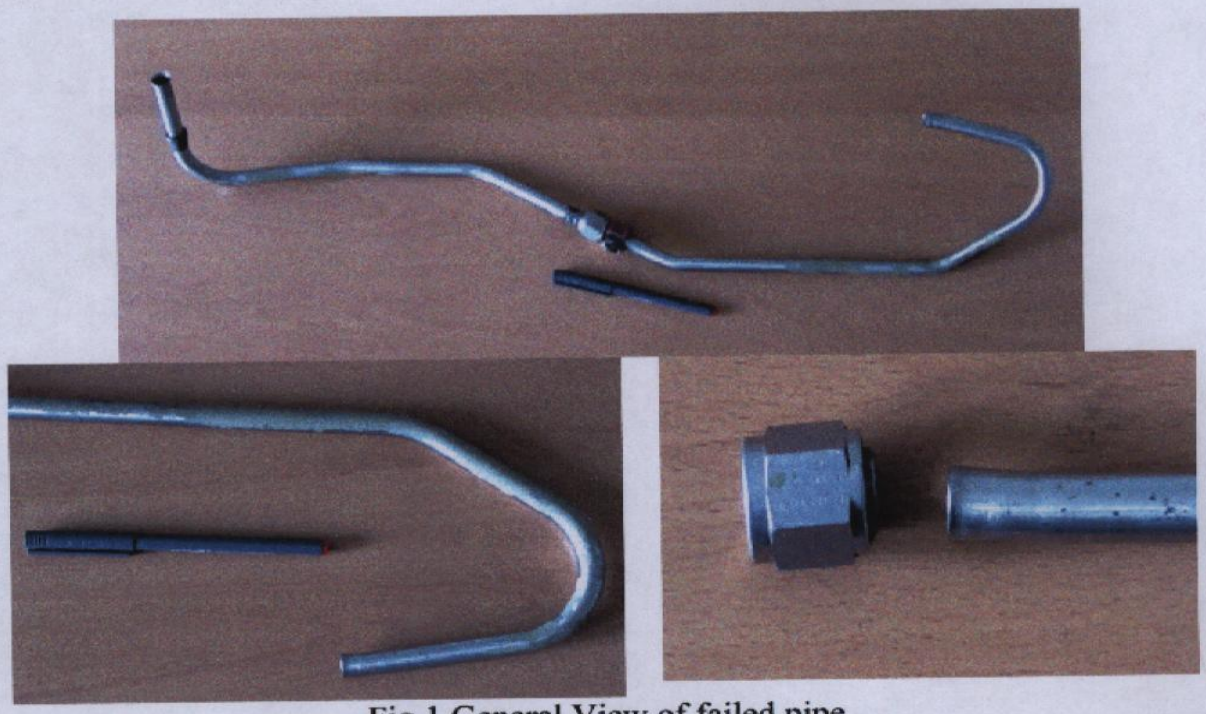

Fig.1 General View of failed pipe

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This sample has been used for SEM investigation and chemical analysis.

3.1.2 Chemical analysis

The chemical analysis is shown in Table 1. By comparing this composition to the international standards, it can be classified as X12CrMnNiN18-9-5 which is more suitable for such application

Table 1 Chemical analysis of hydraulic pipe material.

	C	Si	Mn	P	S	Cr	Ni	Fe
Received pipe	0.05	0.17	8.58	0.001	0.001	19.35	6.21	Bal.

3.1.3 Scanning Electron Microscopy Investigation

Close-up investigation by SEM was carried out and the results are shown in Fig.2. Generally, the presence of such strain hardening bands revealed the occurrence of plastic deformation which could be resulted from the over tightening during the regular check up by the workers.

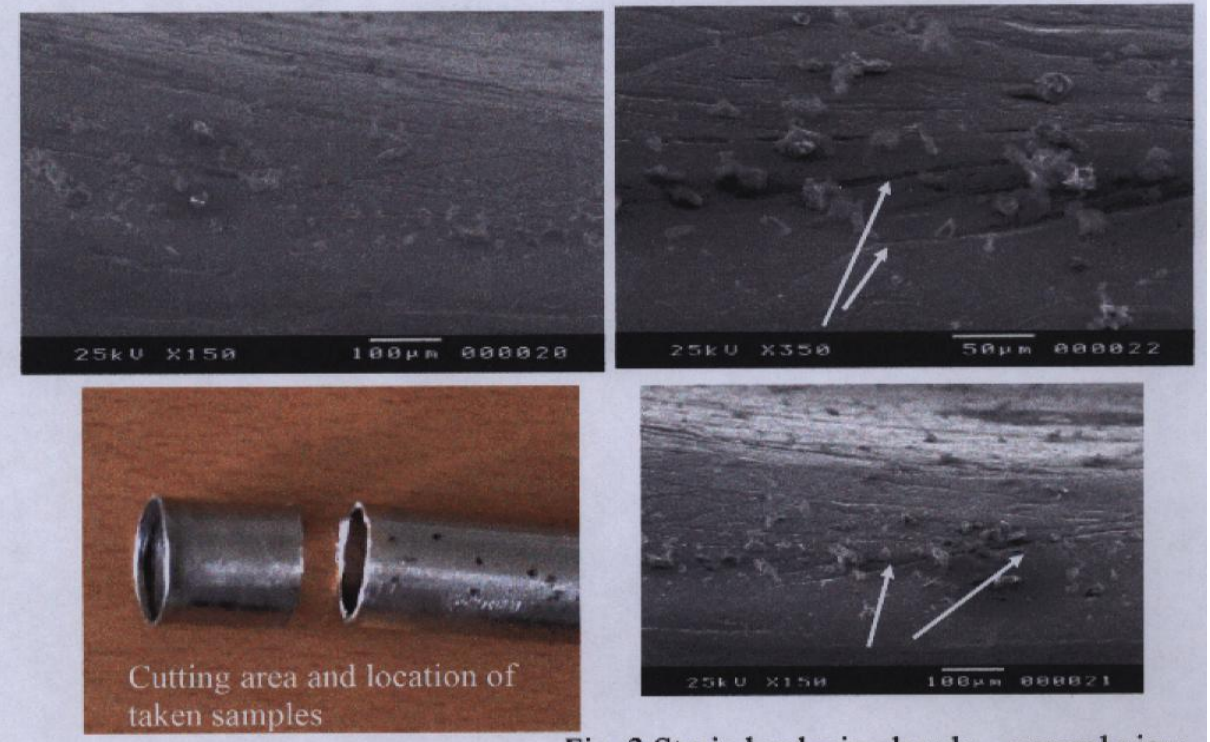

Fig. 2 Strain hardening bands – general view

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The failed hydraulic pipe is shown in Fig.3. The other part of the clip was lost during the accident. The fracture surface does not contain any markings of typical fatigue or shearing failure. Detailed investigation of surface showed the presence of voids or dimple fracture.

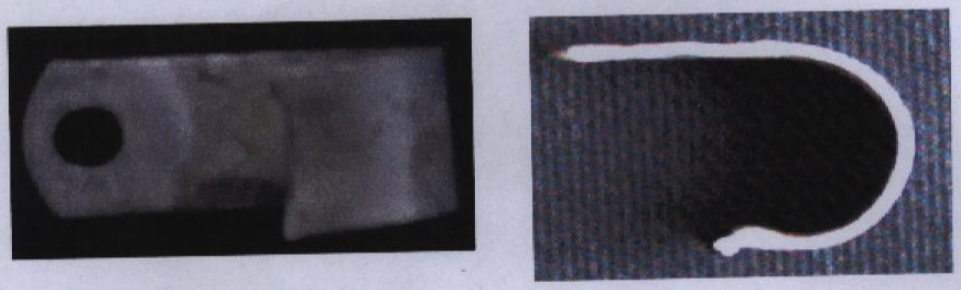

Fig.3 General view of fracture clip

3.2.2 Chemical analysis

The chemical analysis is shown in Table 2.

Table 2 Chemical analysis of wheel flange material.

	Si	Fe	Cu	Mn	Mg	Zn	Al
Received clip	0.11	0.5	4.67	0.5	1.38	0.13	Bal.

3.2.3 Scanning Electron Microscopy Investigation

The general view of the fracture surface that investigated by using SEM is shown in Fig. 4. The fracture surface is characterized by microvoid coalescence. The microvoids nucleate at regions of localized strain discontinuity, such as that associated with second phase particles. As the strain in the material increases, the microvoids grow, coalesce, and eventually form a continuous fracture surface. This type of fracture exhibits numerous cuplike depressions that are the direct result of

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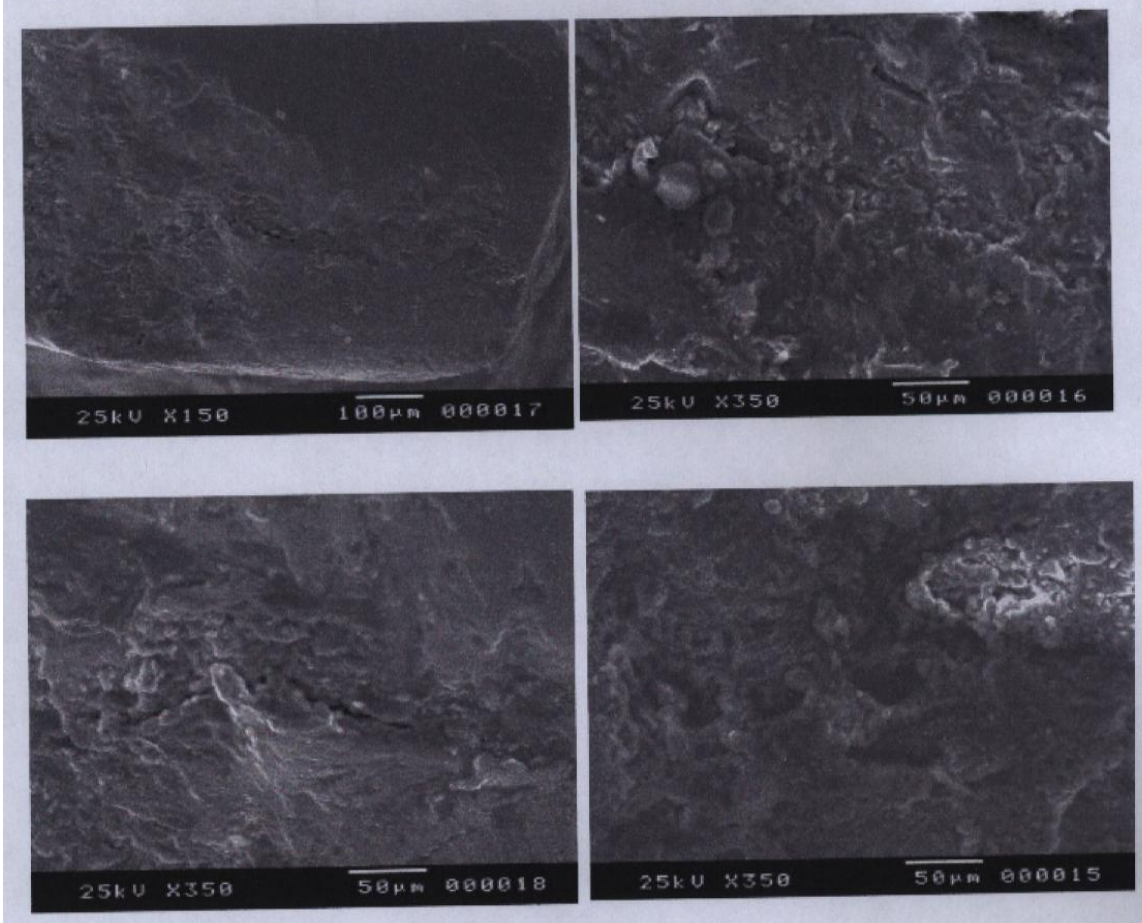

Fig. 4 General overview of the fracture surface showing voids formation due to the presence of nonmetallic particles.

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The shape of and type of failure occurred in this case suggested that this part suffered from sudden severe impact led to fracture. This can be indicated from the deformed part on the edge due to impact and the formation of cracks just below the fracture. Meanwhile, the fracture surface exhibited the presence of a highly localized deformation shear bands, such as those observed during certain-shearing operations, high velocity projectile impacts or explosive rupture.

CONCLUSION

Based on the investigation results the following could be concluded:

- Hydraulic Pipe P/N 7936907-711, failed due to over tightening force during routine check
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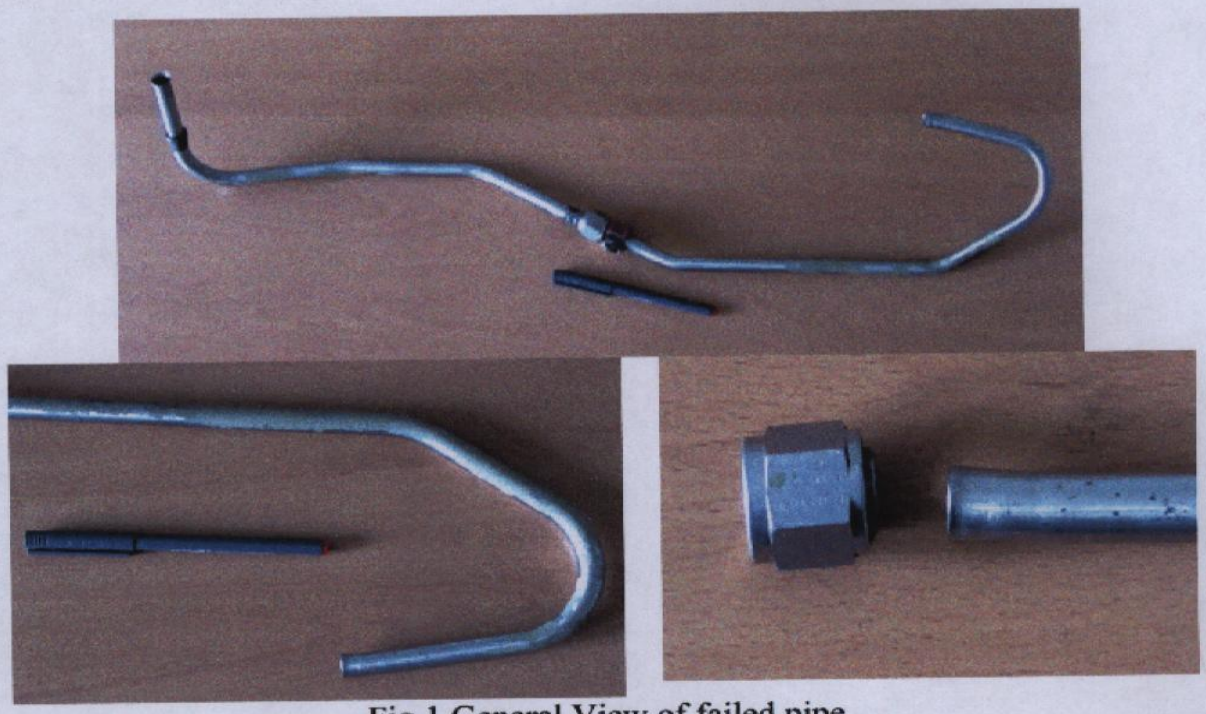

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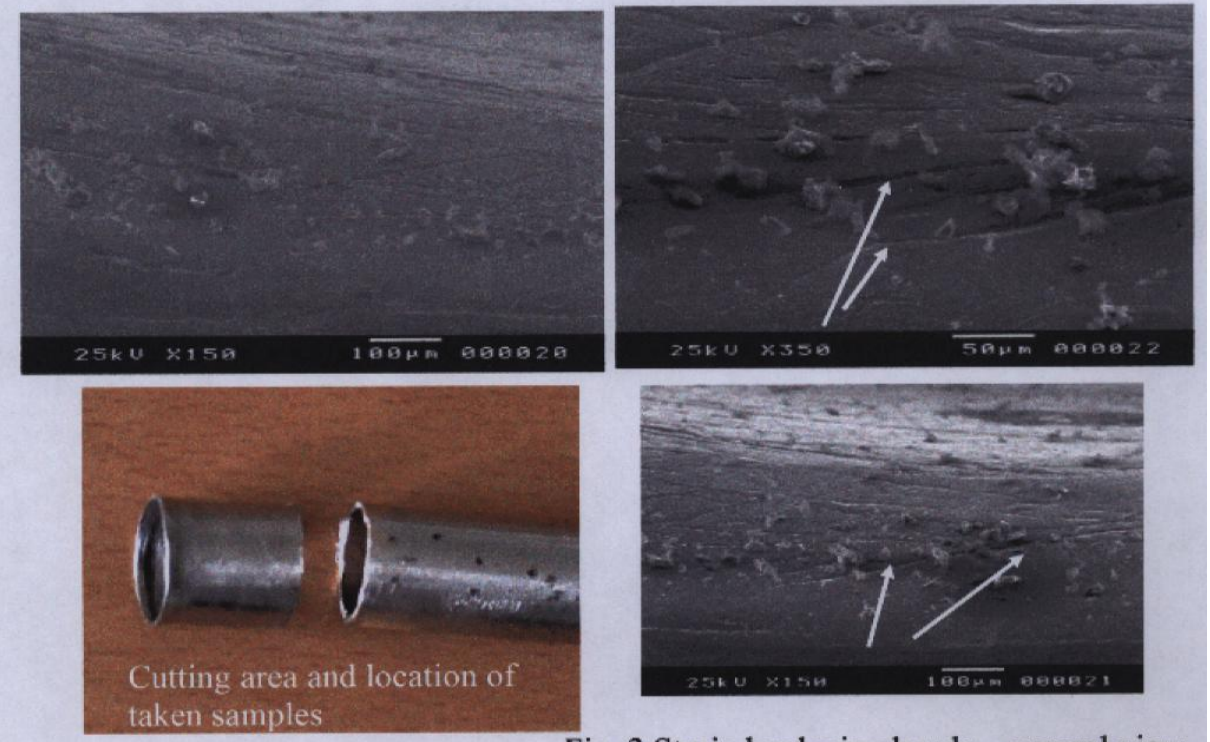

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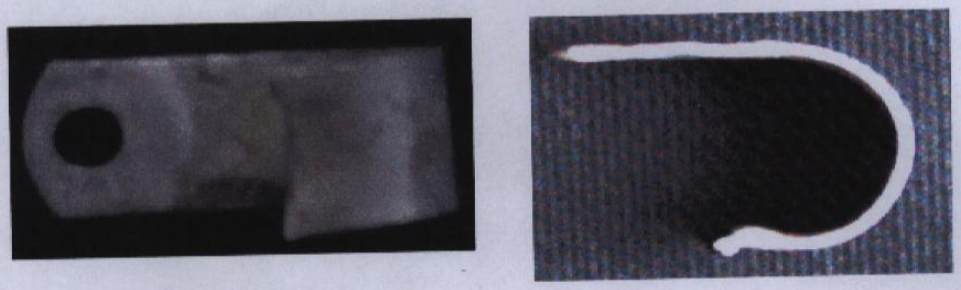

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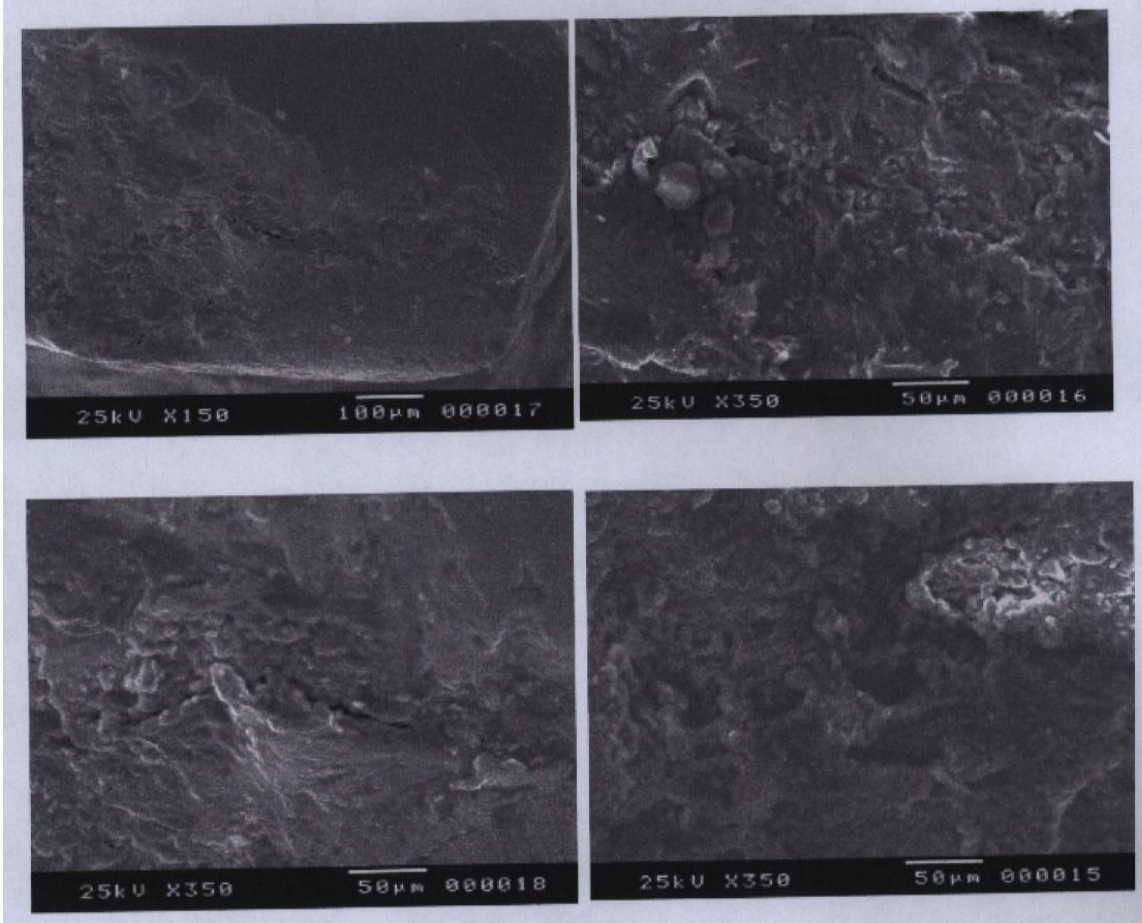

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APPENDIX (A)

ABSTRACTS FROM THE COLLECTED DOCUMENTATION FOUND IN THE AIRCRAFT (OPERATION PROCEDURE MANUAL , SYSTEMS DESCRIPTION MANUAL AND PERFORMANCE MANUAL)

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The left and right hydraulic system reservoirs are located in left and right main gear wheel wells, respectively. Each reservoir supplies fluid to its own system exclusively. A manifold on the bottom of the reservoir ports fluid to supply lines for the engine-driven hydraulic pump, the electrically driven auxiliary hydraulic pump, and a ground service hydraulic hand pump. Internally the reservoir utilizes system pressure of 3000 or 1500 psi to maintain a pressure head of approximately 30 or 15 psi. This pressure head ensures positive transfer of fluid to the pumps. The reservoir is protected against over-pressurization by a relief valve set for 47 psi. A temperature pickup in the reservoir will cause the applicable (L or R) hydraulic high-temperature annunciation to come on when the hydraulic fluid temperature is above normal. An instruction plate provides filling instructions and direct fluid level indications for both system pressurized and unpressurized conditions. A fluid quantity transmitter, located at each reservoir, transmits fluid quantity information to the applicable hydraulic quantity indicator on the First Officer's instrument panel.

HYDRAULIC PUMPS

The left hydraulic system is pressurized by a system pump mounted on the left engine; a system pump mounted on the right engine powers the right system. Each pump is capable of providing pressure up to 3000 psi during all flight modes; 1500 psi can be selected for cruise flight operation.

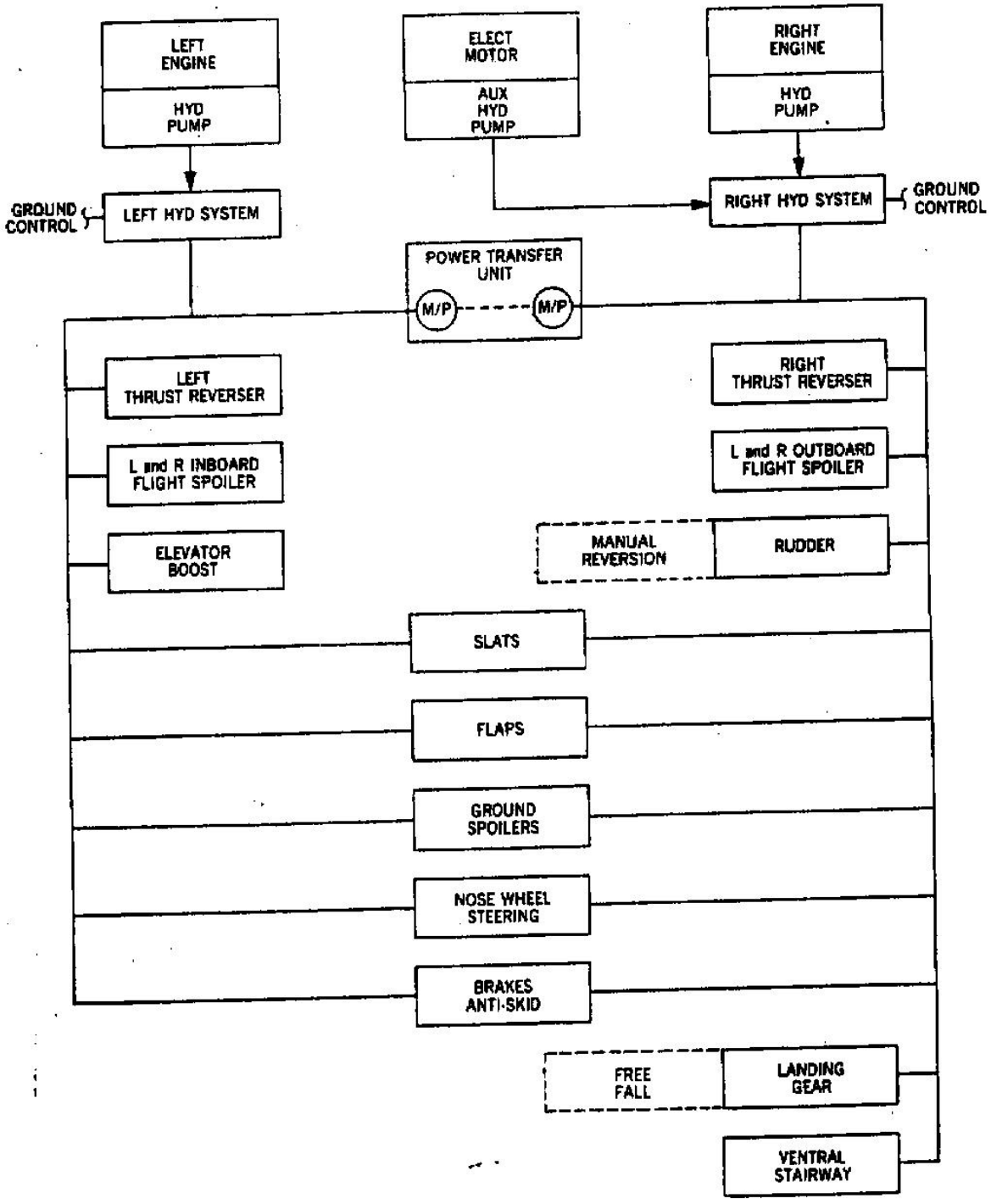
An auxiliary pump, incorporated into the right system, provides hydraulic pressure for landing gear operation, flight backup, preflight, and maintenance operations. The pump is electrically powered and is designed for continuous operation at 3000 psi.

A power transfer unit mechanically connects left and right hydraulic systems and enables hydraulic pressure to be transferred from the highest to the lowest side (the high pressure side operates as a motor and the low pressure side operates as a pump). The unit is controlled by a single motor operating two shutoff valves, one in each hydraulic system. Operation is controlled by a switch on the First Officer's instrument panel. The shutoff valves will automatically close if either system reservoir quantity falls below a safe level.

Airplane systems that normally receive pressure from both hydraulic systems will operate at a reduced rate if one system is inoperative. Complete fluid supply to a system can be stopped by pulling the fire shutoff handle on the upper instrument panel for the engine desired. Pump operation is controlled by switches on the First Officer's instrument panel. Annunciations, one for each system, will come on whenever either system pressure is low.

A hand pump, installed in each main hydraulic system and located in the main gear well, supplements the standard power sources for ground actuation of the various subsystems. The quick disconnect fittings in the inlet suction line of each hand pump and/or auxiliary pump may be connected to a ground source of hydraulic fluid to manually fill the reservoirs. These pumps make the hydraulic systems completely self-sufficient. Hydraulic ground connections are provided in the forward end of each main gear well for servicing and testing each main hydraulic system.

HYDRAULICS - Block Diagram



RA1-124B

MAIN GEAR

The airplane has two main gear assemblies consisting of dual wheels mounted on a shock strut. When extended, each main gear assembly is locked in the extended position by overcenter linkage. When retracted, the main gear assemblies will be held up by hydraulic pressure providing the engine driven hydraulic pumps are selected to provide 3000 psi. If the pumps are selected to provide 1500 psi, the main gear will rest upon the doors. If hydraulic pressure is not available for gear extension, the main gear door latches may be released by the emergency gear extension lever.

MAIN GEAR DOOR

Each main gear wheel well enclosure consists of a hydraulically operated main gear door and a mechanically operated outboard door. The main gear doors are mechanically latched when closed and support the main gear during flight. The main gear doors cycle to the closed position after the main gear approaches the fully extended position. The main gear doors may also be mechanically released and opened on the ground.

VISUAL/AURAL INDICATING AND WARNING SYSTEM

Landing gear position and main landing gear door status is indicated by annunciator lights on the upper instrument panel. Landing gear position lights come on green to indicate that the landing gear and landing gear handle are in the down-and-locked position. The lights come on red when the landing gear is in any intermediate position between up-and-locked and down-and-locked or individually, when the associated landing gear assembly is not in the position that corresponds to the position of the landing gear handle and either one or both throttles are less than one-half inch from idle stop position. The main landing gear door annunciator will come on anytime either one or both main gear doors are not closed.

The landing gear warning horn and vocal warning will sound when either one or both throttles are less than approximately one-half inch from idle stop position and the landing gear is not down-and-locked or the landing gear is down and locked but the landing gear handle is not in the DOWN detent. The landing gear warning horn and vocal warning will sound when the airplane's airspeed is less than 210 KIAS. The aural/vocal warnings will also sound anytime the landing gear is not down-and-locked and the flaps are extended beyond approximately 26 degrees. The aural/vocal warnings may be silenced by pressing a button on the pedestal except when the landing gear is not down-and-locked and the flaps are extended beyond the approach flaps position.

Reference markings on each main gear overcenter link may be viewed from inside the airplane to confirm gear fully extended and locked. Nose gear verification is provided by an indicator on the pedestal in the flight compartment.

BRAKES

Airplane wheel brakes may be applied by depressing the brake pedals. When either set of brake pedals are depressed, hydraulic pressure from both the left and right hydraulic brake system is applied to the main wheel brakes. A fully automatic, pressure modulating anti-skid system is installed. The anti-skid system will reduce hydraulic pressure, if necessary to prevent tire skidding and provide maximum braking. The anti-skid system is electrically controlled and has a touchdown wheel protection circuit that prevents braking action prior to main gear wheel spinup. The system is deactivated whenever the landing gear handle is not in the DOWN detent, parking brakes set, arming switch at OFF, or airplane is at low taxi speeds. When the system is deactivated, braking action is controlled by pilot input at the pedals.

Each main gear wheel is equipped with a disc type power brake actuated by two independent sets of pistons (4 in each set); each set is powered by one of the hydraulic systems. In addition, each system has an accumulator that will supply reserve brake pressure in the event of normal hydraulic pressure failure. A dual pointer pressure gage provides visual indication of hydraulic pressure in each system.

A gage and an overheat light provide visual indication of brake temperature. If main gear tires are exposed to excessive brake temperature, fuse plugs in the wheel will melt releasing tire pressure. Each brake assembly is equipped with wear indicators so that visual checks can be made of brake wear.

The parking brakes are set by depressing the brake pedals, pulling up on the park brake control knob (located in the center of the nose-gear steering wheel), and releasing the brake pedals. This mechanically opens the brake control valves and closes the anti-skid return lines in both hydraulic systems, trapping accumulator pressure in the wheel brake system. When the park brake knob is raised, it actuates a switch that disables the anti-skid system and turns on the PARKING BRAKES ON annunciation. If parking brakes are not set and one to four ANTI-SKID annunciation(s) are on, a parking brake or anti-skid malfunction is indicated. If throttles are advanced to a takeoff setting with the parking brake set, the aural/vocal warning system will be activated.

AUTOMATIC BRAKE SYSTEM (ABS)

When armed, the automatic brake system (ABS) will automatically apply brakes during landing and takeoff modes of flight. The ABS landing mode is armed prior to landing after the landing gear is extended by selecting MIN, MED, or MAX by the AUTO BRAKE selector switch and placing the AUTO BRAKE ARM/DISARM switch to ARM. The anti-skid system must be armed and operational as a condition for ABS operation. ABS landing mode is activated when spoilers are deployed either automatically or manually with throttle levers retarded and brake pedals released. Automatic braking is delayed after spoiler deployment for approximately 1 second in MAX position and approximately 3 seconds in MIN or MED positions to allow for normal nose wheel touchdown while maintaining a predictable stopping distance. ABS landing mode is inhibited if throttles are not retarded below 22 degrees. Pilot takeover can be initiated at any time and the ABS will disarm and revert to normal anti-skid braking if either brake pedal is depressed beyond approximately 25 percent of travel, if throttle lever 1 or 2 is advanced beyond +22 degrees, or if the ARM-DISARM switch is placed in the DISARM position. The ARM-DISARM switch will drop to the DISARM position and the ABS lights will come on for the above conditions. The ABS will also disarm and the ABS lights will come on if flaps are raised to less than 26 degrees with airplane speed above 70 knots. Stowing the ground spoilers will release brake pressure without disarming the ABS. The ABS lights will remain off and automatic braking will again be available if spoilers are re-deployed.

The ABS takeoff mode is armed by selecting T.O. on the AUTO BRAKE selector switch and placing the ARM-DISARM switch in the ARM position. The speedbrake/spoilers lever must be retracted and flaps must be selected to less than 26 degrees.

XILIARY POWER UNIT (APU)

The gas turbine powered APU supplies pneumatic and electrical power for ground operation and electrical power while in flight. The APU is located in the aft accessory compartment and is surrounded by a fireproof enclosure. The unit is protected by a fire detection and a fire extinguishing system which can be operated either from the flight compartment or the external ground control panel located in the left aft fuselage.

COMMUNICATIONS

The airplane is equipped with air-to-ground and air-to-air voice flight communication systems. Cockpit/cabin/ground service interphone, passenger address and voice recorder systems are provided. Cabin attendant, pilot, mechanic and passenger call systems are installed in the airplane. Provisions are made for a separate passenger entertainment system.

ELECTRICAL

ıe airplane is equipped with an ac and dc electrical power system. The systems are divided into two independent systems designated left and right. Two engine-driven ac generators, one on each engine, are normally the primary source of ac power. In the event that engine-driven ac generators fail in flight or when external power is not available on the ground, auxiliary electrical power may be supplied by an auxiliary power unit driven generator installed in the tail section. The 28-volt dc electrical power is normally supplied by four transformer rectifiers installed in the forward accessory compartment. These units are supplied 115/200-volt ac power from the airplane generators or from external power source. Battery power is supplied by two 14-volt, nickel-cadmium batteries connected in series.

ENGINES

The airplane is powered by two Pratt and Whitney JT8D axial-flow turbofan engines. In addition to powering the airplane, the engines supply pneumatic power for pressurization, air conditioning, anti-icing and de-icing. The engines are protected by a fire detection and fire extinguishing system.

FIRE WARNING AND PROTECTION

The fire warning and protection system provides for continuous detection of engine and/or APU fire and crew member notification through visual, aural and vocal warnings. The airplane is equipped with fire extinguishing capability for each engine nacelle area and/or for the auxiliary power unit compartment.

FLIGHT CONTROLS

Primary flight controls consist of conventional aileron, rudder and elevator control surfaces. Secondary flight controls consist of lift augmenting leading-edge slats, spoilers (lateral control/speedbrake and ground spoilers), inboard and outboard flaps and horizontal stabilizer. The primary flight controls are cable connected to the control surfaces and are aerodynamically actuated via control tabs. When the secondary flight controls are hydraulically actuated, both the left and right hydraulic systems supply operating power. During powered rudder operation, rudder hydraulic power is supplied by the right hydraulic system. When elevator boost is required, hydraulic power is supplied by the left hydraulic system.

FUEL

The fuel system consists of three integral tanks; one in each wing and one in the wing center section. The airplane is also equipped with two auxiliary fuselage fuel tanks. One is installed in the mid cargo compartment and one is installed in the aft cargo compartment. The tanks are normally filled through a single-point, pressure-fueling adapter, located approximately mid-span of the right wing leading edge. The pressure-fueling control panel is located just inboard of this adapter. A manual defueling valve is located just inboard of the pressure-fueling control panel to permit defueling through the pressure-fueling adapter.

An overwing gravity fueling adapter is located on top of the outboard section of each wing tank.

HYDRAULICS

Hydraulic power is provided by two separate, hydraulically closed-circuit systems identified as the left system and the right system. The right system

provides hydraulic power to the rudder, aft passenger entrance stairway and the landing gear actuating subsystem; the left system provides hydraulic power to the elevator augmentor. All other hydraulic subsystems are served by both systems through separate valves and actuators. The primary source of hydraulic power for each system is an engine driven pump with an auxiliary pump in the right system. There is a power transfer unit between the right and left systems with adequate capacity to transfer full available power between systems.

ICE AND RAIN PROTECTION

Ice and rain protection is provided for various areas and components of the airplane by the following systems:

- Airfoil leading edge, ram air scoop, and forward strakes anti-icing and horizontal stabilizer de-icing system
- Engine and engine nose cowl anti-icing system
- Windshield and window anti-icing and anti-fogging system
- Pitot tubes, static ports, and stall warning lift transducer anti-icing system
- Windshield wipers
- Rain repellent system.

The anti-icing system prevents an accumulation of ice and the de-icing system removes accumulated ice. The leading edge wing slats and forward strakes are anti-iced and the horizontal stabilizer is de-iced. The ram air scoop, engine and engine nose cowl are continuously anti-iced when their respective ice protection system switches are on. Hot air from the pneumatic system is used for anti-icing the wing slats, ram air scoop, forward strakes, engine and engine nose cowl. Pneumatic air is also used to de-ice the horizontal stabilizer when selected. An electrical anti-icing system is provided for the windshields, pitot tubes, static ports and the stall warning lift transducers. Anti-fogging of the windshield and windows is also accomplished electrically.

INSTRUMENTATION AND NAVIGATION

Instrumentation and navigation equipment and systems are provided to permit flight under limited visibility conditions. The navigation equipment and systems encompass both ground dependent and independent systems.

The equipment and systems provide instrument and annunciator displays for the flight crew to determine airplane attitude, airspeed, altitude, vertical speed, heading, course, geographical location, weather avoidance, time and guidance during approach and landing.

LANDING GEAR

The airplane has a fully retractable tricycle landing gear. The nose gear assembly is a dual-wheel, steerable assembly with an oleo strut mounted in the forward, lower section of the fuselage. The main gear assembly consists of two oleo struts with a set of dual wheels and brakes attached to each strut. The struts are mounted in the wing root area, aft of the right and left rear wing spar. Each wheel well is completely enclosed by doors when the landing gear is retracted.

PNEUMATICS

The pneumatic system supplies bleed air for air conditioning, cabin pressurization, potable water pressurization and ice protection. Normally, engine bleed air is used to supply the system. In addition to engine bleed air, an external ground connector is installed to permit connection of a ground pneumatic power source for engine starting and air conditioning operation. Also, a separate external ground connector is installed to allow connection of a ground source to supply preconditioned air to the airplane during ground operations if required. The APU, when operating, can also supply the pneumatic requirements while the airplane is on the ground.

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APPENDIX ‘B’

EGYPTIAN AUTHORITY COMMENTS

Eng./ A.A. Ali
The Air Accident Investigation Central Directorate, Civil Aviation Authority, Republic Of Sudan

Mr. / Jones Dennis
U.S.Accredited Representative
NTSB

Mr. /Willam C.Steelhammer
Sr.Flight Safety Investigator,
Boeing Long Beach Division

Subject: SU-BOZ AIRCRAFT SERIOUS INCIDENT DRAFT RPORT

Central Directorate of Aircraft Accident Investigation, Ministry of Civil Aviation in its pursuit for avoidance of future Aircraft type incidents and for the sake of enhancing airplane type safety level and its concern to reach the probable cause (s) that led to the serious incident scenario reviewed all the relevant documents including:

- FDR Data
- Final Aircraft Serious Incident Report, issued by the Air Accident Investigation Central Directorate, Civil Aviation Authority, Republic Of Sudan
- Boeing Report

Central Directorate of Aircraft Accident Investigation, Ministry of Civil Aviation feels that there are several technical issues that are not totally analyzed and need further analysis.

Attached herewith, a list of the major incident events and the technical issues that need further analysis. Other files that support MCA study are also attached including:

- FDR processed data and charts (Two files)
- Technical description of relevant aircraft systems (extracts from MD-83 manuals)

Looking forward for your cooperation, awaiting yr response in the nearest possible future.

Best Regards
Captain/ Ibrahim Omran
Chief, Central Directorate of Aircraft Accident Investigation, Ministry of Civil Aviation ,Cairo,Egypt

SU-BOZ AIRCRAFT SERIOUS INCIDENT:
:

I- Main events:

- At FN 484 the Radio Altimeter showed -1 ft for the 1st time (A/C is considered to be on Ground starting the Ground Roll at Frame Number 484[1]) (With The WOW showing A/C on Ground, the RA shows a value of -1 to -2 ft through most of the landing roll), . At FN 526 to FN 530 the RA showed positive values (0- 2 ft). At FN 532 the RA showed again ground condition up to the end of the ground roll (-2 ft)

- At FN 488 the, the WOW showed Ground for the 1st time. at 523 the WOW changed to "A/C in the Air" and remained "A/C in the Air" up to the end of the ground roll

- At FN 484 engine # 1 T/R showed unlocked condition, remaining unlock up to the end of the ground roll

- At FN 484 engine # 1 T/R showed deployed condition, at FN 510 engine # 1 T/R showed ~~stowed~~ "not Deployed" condition, remaining ~~stowed~~ "not Deployed" to the end of the ground roll

- At FN 485 engine # 2 T/R showed unlocked condition, remaining unlock up to the end of the ground roll.

- At FN 485 engine # 2T/R showed deployed condition At FN 509 engine # 2 T/R showed ~~stowed~~ "not Deployed" condition, remaining ~~stowed~~ "not Deployed" to FN 531, then engine # 2 T/R showed deployed condition the duration between 533 to FN 537. The engine # 2 T/R showed ~~stowed~~ "not Deployed" condition again at FN 539 and up end of the ground roll.

- At FN 484 the left Brake Pressure started building up reaching a value of 350 psi at FN 487 (rise is almost linear) and then decreased back to almost zero at FN 488. The left brake pressure started increasing again from 15 psi at FN 490, to about 694 psi at FN 598. The pressure dropped again to 347 at FN 347. A sharp increase in press to 1032 psi occurred at FN 530. Then A sharp decrease in press to 24 psi occurred at FN 532, with no further press rise to the end of the ground run

- No rise in Right Brake Pressure throughout the whole ground roll

[1] Frame Number used in this analysis is the Frame Number in the FDR Data -97000

- Both left and right spoilers were deployed at FN 483. At FN 487 the Right Spoilers retracted and remained retracted to the end of the ground roll.

- Both left and right spoilers were deployed at FN 483. The left spoilers showed some slight movement downwards from about 66 degrees to about 50 degree at FN 488 then moved again to about 63 degrees at FN 507. The right spoilers moved again to about 46 degrees at FN 534 and then to about 52 degrees at FN 537 remaining at almost 52 degree to the end of the ground roll.

- At FN 488 the Hydraulic Press Low 2 Came on (At FN 530 the Hydraulic Press Low condition was changed back to normal)

- At FN 489 the Hydraulic Press Low 1 Came on. (The Hydraulic Press Low Showed Low condition up to the end of the ground roll)

- EPR and N1 for both engines showed several increases (1st with the T/R's deployed, then with the T/R's stowed)

- Master Warning showed no warning condition and remained unchanged throughout the whole landing roll.

- Selected landing flaps was 38 degrees. The flap setting was changed to 25 degree at FN 537. This setting remained unchanged up to the end of the landing roll.

- Left and Right slats were extended throughout the whole landing roll

- At almost FN 528 the heading started increasing from about 309 degree to about 354 degree at FN 537 (indicating that the A/C made a right yaw of about 45 degrees)

- Roll angle changes were very small up to FN 531 then it changed to -20 degree at FN 543 then to about -18 degree at FN 537, remained unchanged up to the end of the landing roll.

- Pitch angle changes were very small up to FN 530 then it changed to -29.5 degree at FN 537, remained unchanged up to the end of the landing roll.

- The rudder showed two considerable movements. The 1st max rudder travel was 28 degree at FN 497 (right). The 2nd max rudder travel was 8 degree at FN 533 (right)

- The lateral acceleration is almost consistent with the rudder movement.

Analysis:

- The two Hydraulic Low press for the Left and Right systems indicated Low Press, almost at the same time. (A pressure switch in each main gear wheel well provides indication of low hydraulic pressure by illumination of the master caution lights and left or right hydraulic pressure low caution lights on the annunciator panel in the flight compartment whenever hydraulic system pressure falls below 900 (±100) psi). The two systems are completely independent. No single failure will cause failure of both systems. (Referring to the factual information report, the left hydraulic system return pipe was found damaged at its connection with the reservoir)
  Factual information has no data about the hydraulic quantity in each hydraulic reservoir, values of last hydraulic press (including the brake accumulator's press)
  Requesting further analysis

- The Master warning logic did not change with the hydraulic Press Low condition which is not consistent with the operation logic of the Master Warning.
  Requesting further analysis

- The left brake system was responding (brake press reached a max value of 694 psi at FN 498 although the left system was showing Low Press (pressure below 900 psi (±100) psi). The source of this press might be the left hydraulic system or the left brake accumulator.
  Requesting further analysis
  The pressure increased again to a value of 1032 psi at FN 530 and then suddenly dropped to 24 psi at FN 532. This is not consistent with the case of left Hydraulic Low Press (if this case is true). Press source might be from the brake accumulator.
  Requesting further analysis

- The right hydraulic brake system was not responding. This is consistent with the case of right hydraulic system Low Press only if the right brake accumulator is depleted. No available data in the factual information report regarding the right accumulator.
  Requesting further analysis

- The right brake hydraulic system was almost lost at FN 532 (press was about 39 psi). However, the engines powers were increased two times before this time frame (FN 532). At FN 532, the engines powers were reduced. The timing of engines power increase is not consistent with the timing for brake press loss. Also, the timing for brake press loss is not consistent with the hydraulic loss timing.
  Requesting further analysis

- Both T/R were unlocked and deployed up to FN 508, 509. This is not consistent with cases of Hydraulic Low Press. (The T/R accumulators press are not shown in the Factual Information Report)
  Requesting further analysis

- At FN 519, 620, both engines EPR increased, the T/R were not at deployed condition, both T/R's were unlocked. The IAS had slightly increased. This is consistent with a FWD Thrust condition. According to the T/R design, the interlock mechanism prevents power from being applied until the thrust reverser doors are fully deployed. This means that the interlock mechanism did not function correctly.
  Requesting further analysis

- Both engine EPR increased again from about 1.14, 1.17 at FN 523 to about 2.1, 2.1 up to FN 531. Both T/R remained not at deployed condition up to FN 531; both T/R's were unlocked. This means that there were fwd thrust from both engines through this period of time. The IAS showed considerable rise which is consistent with the case of fwd thrust. This means that the interlock mechanism did not function correctly
  Requesting further analysis

- The right engine T/R was deployed at FN 533 and remained deployed up to FN 537, while the left engine T/R remained ~~stowed~~ "not Deployed" but unlocked throughout the whole remaining ground run. Both EPR values were dropping at this time. This suggests that the left engine was still developing fwd thrust and the right engine was developing reverse thrust. The left EPR was much higher than the right engine EPR. The heading change and increase of IAS are consistent with that condition. This also suggests that the right hydraulic system was still pressurized to deploy the right engine T/R. This is not consistent with the right brake system loss during this time.
  Requesting further analysis

- At 539 the right engine T/R showed ~~stowed~~ "not Deployed" and locked condition. The left engine remained stowed and unlocked. The engines EPR's were totally reduced after FN 539. This again suggests that the right hydraulic system was still pressurized

- The engines N1 changes were almost consistent with the EPR changes.

- Both left and right spoilers were deployed at FN 483. At FN 487 the Right Spoilers retracted and remained retracted to the end of the ground roll. Asymmetric movement of the ground spoilers is not consistent with the system normal operation. (The hydraulic pressure to the ground spoiler tandem actuator is supplied from the ground spoiler control valves which

are powered by both the left and right hydraulic systems. Actuators will extend and retract the ground spoiler panels with only one valve and/or one hydraulic systems functioning).
Requesting further analysis

- Factual information report showed that the Autobrake was selected to minimum and armed.
  Logic for Brake-On Initiation
  (1) ABS Armed (as above)
  (2) Throttles retarded below +20 degrees
  (3) Brake pedals released
  (4) Ground spoiler handle deployed (greater than approximately 5 degrees out of stowed position) - either by wheel spinup (deploying spoilers automatically) or by manual deployment.

  According to the system logic, brake-On Initiation is not related to spoilers panels but the spoiler handle
  Requesting further analysis

- The rudder showed two considerable movements. The 1st max rudder travel was 28 degree at FN 497 (right). (According to Boeing data, this deflection exceeds the max rudder deflection).The 2nd max rudder travel was 8 degree at FN 533 (right). The rudder deflection looks consistent with the lateral acceleration. The rudder movement is not consistent with the Right Hydraulic System failure.
  Requesting further analysis

- To compute the landing roll distance, TAS must be derived first (using IAS and Density Ratio). Density ratio can be derived using press ratio and temp ratio. TAS should be converted to ground speed applying wind correction. Landing roll distance should be derived by integrating the Ground Speed w.r.t. time using one of the numerical integration methods. (results using this procedure disagree with the results from the accident report)
  Requesting further analysis to check the landing touch point

Time Local	Time (Frame No)	Time (Frame No)-97000	GMT HH	GMT MM	IAS (kt)	HEADING (deg)	WOW	RADIO ALTITUDE (feet)	BRAKE PRESS-L	BRAKE PRESS-R
13:34:36	97345	345	10	34	188	306.2	1	2427	34	16
13:34:37	97346	346	10	34	188	305.5	1	2410	34	18
13:34:38	97347	347	10	34	187	305.2	1	2390	34	16
13:34:39	97348	348	10	34	186	304.8	1	2378	34	20
13:34:40	97349	349	10	34	186	304.5	1	2363	34	16
13:34:41	97350	350	10	34	185	304.1	1	2353	34	20
13:34:42	97351	351	10	34	186	303.8	1	2320	34	16
13:34:43	97352	352	10	34	186	303.4	1	2303	39	18
13:34:44	97353	353	10	34	185	303	1	2283	34	15
13:34:45	97354	354	10	34	185	303	1	2276	39	17
13:34:46	97355	355	10	34	182	303	1	2260	39	16
13:34:47	97356	356	10	34	181	303	1	2235	39	18
13:34:48	97357	357	10	34	181	303	1	2212	39	16
13:34:49	97358	358	10	34	183	303.4	1	2199	39	17
13:34:50	97359	359	10	34	182	303.4	1	2171	39	15
13:34:51	97360	360	10	34	181	303.4	1	2119	39	17
13:34:52	97361	361	10	34	182	302.7	1	2102	39	15
13:34:53	97362	362	10	34	181	302.7	1	2070	39	18
13:34:54	97363	363	10	34	181	302.3	1	2047	39	17
13:34:55	97364	364	10	34	179	302.7	1	2028	39	18
13:34:56	97365	365	10	34	181	302.7	1	2004	39	16
13:34:57	97366	366	10	34	179	302.7	1	1974	39	20
13:34:58	97367	367	10	34	177	302.7	1	1951	39	17
13:34:59	97368	368	10	34	176	303	1	1926	39	20
13:35:00	97369	369	10	35	176	302.7	1	1907	39	17
13:35:01	97370	370	10	35	176	302.7	1	1884	39	20
13:35:02	97371	371	10	35	175	302.7	1	1865	39	16
13:35:03	97372	372	10	35	174	303	1	1852	39	20
13:35:04	97373	373	10	35	174	303.4	1	1838	39	16
13:35:05	97374	374	10	35	174	304.5	1	1830	39	20
13:35:06	97375	375	10	35	172	305.5	1	1815	39	16
13:35:07	97376	376	10	35	170	305.9	1	1794	39	20
13:35:08	97377	377	10	35	170	305.9	1	1760	39	16
13:35:09	97378	378	10	35	169	305.9	1	1756	39	18
13:35:10	97379	379	10	35	170	305.9	1	1735	39	16
13:35:11	97380	380	10	35	172	305.9	1	1705	39	20
13:35:12	97381	381	10	35	170	306.2	1	1702	39	17
13:35:13	97382	382	10	35	169	306.6	1	1678	39	20
13:35:14	97383	383	10	35	169	306.9	1	1658	39	17
13:35:15	97384	384	10	35	169	307.6	1	1650	39	18
13:35:16	97385	385	10	35	170	307.6	1	1622	39	17
13:35:17	97386	386	10	35	170	307.6	1	1602	39	18
13:35:18	97387	387	10	35	168	308	1	1593	39	15
13:35:19	97388	388	10	35	166	307.3	1	1553	39	18
13:35:20	97389	389	10	35	166	307.3	1	1547	39	16
13:35:21	97390	390	10	35	167	306.9	1	1521	39	18
13:35:22	97391	391	10	35	165	306.6	1	1510	39	16

13:35:23	97392	392	10	35	165	306.6	1	1479	39	18
13:35:24	97393	393	10	35	164	308.9	1	1464	39	16
13:35:25	97394	394	10	35	162	306.6	1	1468	39	18
13:35:26	97395	395	10	35	160	306.9	1	1426	39	16
13:35:27	97396	396	10	35	159	307.3	1	1404	39	18
13:35:28	97397	397	10	35	158	307.3	1	1375	39	17
13:35:29	97398	398	10	35	157	307.3	1	1343	39	18
13:35:30	97399	399	10	35	156	307.3	1	1315	39	16
13:35:31	97400	400	10	35	156	307.3	1	1298	39	20
13:35:32	97401	401	10	35	157	307.3	1	1266	39	16
13:35:33	97402	402	10	35	158	307.3	1	1253	39	18
13:35:34	97403	403	10	35	155	307.6	1	1220	39	17
13:35:35	97404	404	10	35	154	307.6	1	1200	39	20
13:35:36	97405	405	10	35	155	307.6	1	1184	39	16
13:35:37	97406	406	10	35	152	307.6	1	1171	39	18
13:35:38	97407	407	10	35	152	307.6	1	1149	39	17
13:35:39	97408	408	10	35	151	308	1	1123	39	20
13:35:40	97409	409	10	35	150	308	1	1103	39	17
13:35:41	97410	410	10	35	149	308	1	1075	39	18
13:35:42	97411	411	10	35	149	308	1	1044	39	17
13:35:43	97412	412	10	35	148	308	1	1040	39	20
13:35:44	97413	413	10	35	149	308	1	1005	39	17
13:35:45	97414	414	10	35	149	308.3	1	1004	39	20
13:35:46	97415	415	10	35	148	308.7	1	978	39	17
13:35:47	97416	416	10	35	148	309	1	976	39	18
13:35:48	97417	417	10	35	146	309.7	1	958	39	16
13:35:49	97418	418	10	35	148	310.4	1	952	39	20
13:35:50	97419	419	10	35	146	310.1	1	944	39	16
13:35:51	97420	420	10	35	151	310.1	1	926	39	20
13:35:52	97421	421	10	35	150	309.7	1	918	39	17
13:35:53	97422	422	10	35	152	309.4	1	915	39	20
13:35:54	97423	423	10	35	151	308.7	1	911	39	17
13:35:55	97424	424	10	35	149	309.4	1	897	39	20
13:35:56	97425	425	10	35	149	310.1	1	887	39	18
13:35:57	97426	426	10	35	148	311.1	1	881	39	20
13:35:58	97427	427	10	35	147	311.8	1	873	39	17
13:35:59	97428	428	10	35	146	312.9	1	858	39	20
13:36:00	97429	429	10	36	145	313.9	1	835	39	17
13:36:01	97430	430	10	36	144	315	1	821	39	20
13:36:02	97431	431	10	36	144	316.1	1	797	39	17
13:36:03	97432	432	10	36	144	316.8	1	780	39	20
13:36:04	97433	433	10	36	143	317.8	1	755	117	105
13:36:05	97434	434	10	36	142	318.9	1	731	127	98
13:36:06	97435	435	10	36	143	319.9	1	695	39	17
13:36:07	97436	436	10	36	142	321	1	678	39	21
13:36:08	97437	437	10	36	142	321.7	1	647	39	17
13:36:09	97438	438	10	36	140	322	1	620	39	20
13:36:10	97439	439	10	36	140	322.4	1	603	39	18
13:36:11	97440	440	10	36	139	322.7	1	580	39	20
13:36:12	97441	441	10	36	140	323.1	1	561	39	17
13:36:13	97442	442	10	36	141	323.1	1	540	39	20
13:36:14	97443	443	10	36	140	323.1	1	525	39	17
13:36:15	97444	444	10	36	139	323.1	1	508	39	21
13:36:16	97445	445	10	36	138	322	1	489	39	17

13:36:17	97446	446	10	36	140	321	1	440	39	20
13:36:18	97447	447	10	36	140	319.9	1	424	127	100
13:36:19	97448	448	10	36	140	318.9	1	437	132	99
13:36:20	97449	449	10	36	141	317.5	1	419	39	17
13:36:21	97450	450	10	36	141	315.7	1	393	39	21
13:36:22	97451	451	10	36	140	312.8	1	370	39	17
13:36:23	97452	452	10	36	140	310.8	1	358	39	20
13:36:24	97453	453	10	36	141	308.7	1	335	39	17
13:36:25	97454	454	10	36	142	306.9	1	370	39	20
13:36:26	97455	455	10	36	142	305.5	1	293	39	18
13:36:27	97456	456	10	36	140	304.5	1	272	39	20
13:36:28	97457	457	10	36	142	303.4	1	249	39	17
13:36:29	97458	458	10	36	143	302.7	1	243	39	21
13:36:30	97459	459	10	36	142	302.3	1	232	39	18
13:36:31	97460	460	10	36	143	302.3	1	224	39	20
13:36:32	97461	461	10	36	143	302.7	1	205	39	18
13:36:33	97462	462	10	36	144	303.4	1	203	39	21
13:36:34	97463	463	10	36	145	304.1	1	187	39	18
13:36:35	97464	464	10	36	146	305.2	1	176	39	21
13:36:36	97465	465	10	36	146	305.9	1	163	39	18
13:36:37	97466	466	10	36	146	306.2	1	147	39	21
13:36:38	97467	467	10	36	146	305.5	1	134	39	18
13:36:39	97468	468	10	36	144	305.2	1	116	39	20
13:36:40	97469	469	10	36	144	304.8	1	102	39	18
13:36:41	97470	470	10	36	145	304.5	1	87	39	21
13:36:42	97471	471	10	36	146	304.5	1	69	39	18
13:36:43	97472	472	10	36	146	305.5	1	58	39	21
13:36:44	97473	473	10	36	146	306.2	1	46	39	18
13:36:45	97474	474	10	36	144	306.2	1	32	39	20
13:36:46	97475	475	10	36	143	306.2	1	19	39	17
13:36:47	97476	476	10	36	140	305.2	1	12	39	21
13:36:48	97477	477	10	36	139	304.5	1	8	39	18
13:36:49	97478	478	10	36	135	304.1	1	6	39	21
13:36:50	97479	479	10	36	136	303.8	1	4	39	18
13:36:51	97480	480	10	36	134	304.1	1	3	39	21
13:36:52	97481	481	10	36	132	304.8	1	2	39	18
13:36:53	97482	482	10	36	131	305.2	1	1	24	0
13:36:54	97483	483	10	36	130	304.8	1	0	29	7
13:36:55	97484	484	10	36	128	304.5	1	-1	24	10
13:36:56	97485	485	10	36	127	304.1	1	-1	132	0
13:36:57	97486	486	10	36	126	303.4	1	-1	235	4
13:36:58	97487	487	10	36	124	303.4	0.5	-1	342	10
13:36:59	97488	488	10	36	121	304.1	0	-1	10	5
13:37:00	97489	489	10	37	116	305.2	0	-1	10	7
13:37:01	97490	490	10	37	112	306.6	0	-1	15	0
13:37:02	97491	491	10	37	110	306.2	0	-1	186	0
13:37:03	97492	492	10	37	105	305.2	0	-1	181	0
13:37:04	97493	493	10	37	102	304.1	0	-1	289	0
13:37:05	97494	494	10	37	100	302.7	0	-1	289	0
13:37:06	97495	495	10	37	96	302.3	0	-1	396	0
13:37:07	97496	496	10	37	94	303.8	0	-1	680	0
13:37:08	97497	497	10	37	90	305.2	0	1	689	0
13:37:09	97498	498	10	37	88	306.9	0	-2	694	0

13:37:10	97499	499	10	37	84	308.3	0	-2	688	0
13:37:11	97500	500	10	37	80	308.3	0	-1	660	0
13:37:12	97501	501	10	37	76	307.3	0	-2	670	0
13:37:13	97502	502	10	37	72	305.9	0	-1	631	0
13:37:14	97503	503	10	37	71	303.8	0	-1	636	1
13:37:15	97504	504	10	37	68	302.3	0	-2	601	0
13:37:16	97505	505	10	37	63	301.3	0	1	582	0
13:37:17	97506	506	10	37	61	301.3	0	-1	587	6
13:37:18	97507	507	10	37	58	302	0	-2	553	4
13:37:19	97508	508	10	37	55	303	0	-1	548	4
13:37:20	97509	509	10	37	53	305.5	0	-2	479	6
13:37:21	97510	510	10	37	52	306	0	-2	504	0
13:37:22	97511	511	10	37	51	309.7	0	-2	489	0
13:37:23	97512	512	10	37	49	311.1	0	-2	489	0
13:37:24	97513	513	10	37	48	311.5	0	-1	485	0
13:37:25	97514	514	10	37	50	311.8	0	-2	435	0
13:37:26	97515	515	10	37	50	311.5	0	-2	416	5
13:37:27	97516	516	10	37	51	310.1	0	-1	396	0
13:37:28	97517	517	10	37	50	309	0	-1	411	0
13:37:29	97518	518	10	37	52	308	0	-1	381	1
13:37:30	97519	519	10	37	52	307.3	0	-1	391	6
13:37:31	97520	520	10	37	54	306.9	0	-2	386	4
13:37:32	97521	521	10	37	54	306.9	0	-1	367	0
13:37:33	97522	522	10	37	53	305.9	0	2	377	0
13:37:34	97523	523	10	37	56	306	0	-1	372	0
13:37:35	97524	524	10	37	54	308.3	0	-2	386	0
13:37:36	97525	525	10	37	54	308.7	0	-1	381	4
13:37:37	97526	526	10	37	58	308.3	0	1	381	0
13:37:38	97527	527	10	37	58	308	0	1	347	0
13:37:39	97528	528	10	37	58	308.7	0	1	425	0
13:37:40	97529	529	10	37	60	310.1	0	2	589	9
13:37:41	97530	530	10	37	61	312.9	0	0	1032	6
13:37:42	97531	531	10	37	59	319.2	0.5	0	391	0
13:37:43	97532	532	10	37	68	324.5	1	-2	24	0
13:37:44	97533	533	10	39	71	331.2	1	2	34	10
13:37:45	97534	534	10		70	338.9	1	-2	34	6
13:37:46	97535	535	10		72	347	1	-2	34	9
13:37:47	97536	536	10		67	353	1	-2	39	5
13:37:48	97537	537	10	43	38	354	1	-2	29	9
13:37:49	97538	538	10		0	354	1	2	54	6
13:37:50	97539	539	10		0	354	1	-2	39	9
13:37:51	97540	540	10		0	354	1	-2	39	5
13:37:52	97541	541	10	47	0	354.4	1	-2	39	9
13:37:53	97542	542	10		0	354.4	1	-2	39	6
13:37:54	97543	543	10		0	354.4	1	-2	39	9
	97544	544								
	97545	545								