The Importance of High Load Event Reporting

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I'm responsible to investigate aircraft accidents and serious incidents in the territory of Republic of Kosovo. I have been involved in many Aircraft Investigations as a Investigator in Charge (IIC).

I have attended many professional trainings in Aircraft Investigations such as: Aircraft Accident Investigation Course – ***South California Safety Institute (SCSI),*** *General Familiarization and Investigation Training -* ***Rolls Royce UK,*** *Airbus Course for Investigation* ***- Airbus France,*** *Aircraft Accident Investigation Management Course –* ***Singapore Aviation Academy, Singapore.***

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History of the Flight

On December the 1st at 20:55 h [1] the aircraft Airbus A320-232 took off from Basel Mulhouse Airport (BSL) and landed on Pristina International Airport (PRN) at 23:49 h [1] local time. The flight was a night charter flight and there were 6 crew members and 178 passengers on board of the aircraft. The pilot in command (PIC) was pilot flying (PF) and was seated on the left side while the co-pilot was pilot monitoring (PM) and had occupied the right seat in the cabin. The approach was conducted on runway 35 via VOR/DME P (non-precision approach).

The weather on the day of the incident in the Pristina Airport at 22:30 UTC according to METAR information was: Light Rain Snow, Wind Direction 320 [0] (degree), Wind Speed 7 knots (kt).

The Operators had internal Procedures where states that all the landings at the Pristina Airport will be made by the Captain seated on the left side of the cockpit (the more experienced one of the flight crew).

During the flight the Pilot Flying (CM1) had an issue with the Left Sliding Window. The heating in this window was not working and the Captain had foggy window and almost no peripheral view. This issue was an MEL Item and the flight crew were informed about this issue through Aircraft Technical Logbook. According to Airbus Report and the data downloaded from FDR shows that the flight towards Pristina progressed normally and the Pilot Flying (CM1) prepared the aircraft for a flap FULL landing on Runway 35 adjusting the approach speed in the FMGS to ensure a five knot margin above VLS.

The flight crew disengaged the autopilot at 2000ft RA, and the aircraft was manually handled by PF and left the auto thrust (A/THR) engaged and active. The speed was managed by the crew and CAS was following the speed target

At 3 NM the flight crew had visual contact with the runway. At 1000 ft RA the PM called out the stable approach parameters with accordance to operator SOPs the final approach of the aircraft was consider as stabilized.

The pilot and co-pilot conducted a briefing during the landing approach and agreed to have a Positive Landing[2] because of the weather conditions (snowing).

The crew reported they did not feel any abnormality during the landing and everything seemed normal. The flight crew also did a post landing briefing and discussed the landing and both agreed that the landing was not “unusual landing” because of the Positive Landing. There were no fault messages from the ECAM (Electronic Centralized Aircraft Monitor) and the FMGS (Flight Management Guidance System), as per system intent. The automatic print out of the LOAD <15> report did not occur due to missing paper in the DMU (Data Management Unit), and the flight crew were in knowledge about this fact (MEL items 31-30-07 A).

There were no actions taken by the PF regarding the landing, there was a post landing discussion between the flight crew and the cabin crew about the landing and the PF stated that the landing was a little bit hard but within the limits. No recordings were taken into the aircraft technical log book by the PF.

The aircraft continued to fly 8 more sectors to the destination Basel Mulhouse and back to Pristina. Two days after the hard landing the co-pilot had a private talk with the Training Manager of the Operator regarding the night of the incident because he was doubtful about that landing and after the conversation, immediate actions were taken to load paper in the DMU. On date 05.12.2017 the DMU was filled with paper and generated LOAD <15> report and the parameters shown on the report were that VRTA (vertical acceleration) was 3.04 G. The data had exceeded the limit given by the Airbus AMM and the aircraft was declared AOG and grounded for further checks on 6th of December. On 15th of December the Airbus provided the special permission to fly to Craiova, Romania MRO, following detailed inspections. All inspections were completed before permanent release and all four Main Landing Gear wheels and the RH shock absorber assembly were replaced

The aircraft was released to service on 28th of December.

Meteorological Information

According to Pristina International Airport “Adem Jashari” (BKPR) weather observation at 22:30 UTC: visibility 8000 m, light rain snow, scattered clouds at 1400ft, broken clouds at 4000ft, direction of the wind 330°, speed of the wind 7kt, pressure 1011 hPa, temperature +2°C, dew point at 0°C.

BKPR, Pristina (Kosovo).
WMO index: 13481. Latitude 42-39N. Longitude 021-09E. Altitude 545 m.

METAR/SPECI from BKPR, Pristina (Kosovo).

SA	01/12/2017 23:30->	METAR BKPR 012330Z 34006KT 4000 -SHSN BR SCT010 OVC025 01/M01 Q1011 NOSIG RMK 17290095=
SA	01/12/2017 23:00->	METAR BKPR 012300Z 32006KT 5000 -SN BR SCT010 OVC025 01/M01 Q1011 NOSIG RMK 17290095=
SA	01/12/2017 22:30->	METAR BKPR 012230Z 33007KT 8000 -RASN SCT014 BKN040 02/M00 Q1011 NOSIG RMK 17290095=
SA	01/12/2017 22:00->	METAR BKPR 012200Z 32006KT 8000 -RASN SCT012 OVC030 02/M00 Q1011 NOSIG RMK 17290095=

Figure 1: METAR information 18 minutes before the event *Source: BKPR*

The next METAR information was published 12 minutes after the event with no significant change.

Aids to Navigation

At the night of the event, the Runway 35 was used for landing at Pristina Airport (BKPR). Runway 35 is a Non-Precision Approach, VOR/DME P and some of the runway characteristics are as follow:

- QFU 353°
- Length 2501 m
- Width 45 m
- Elevation 1786ft

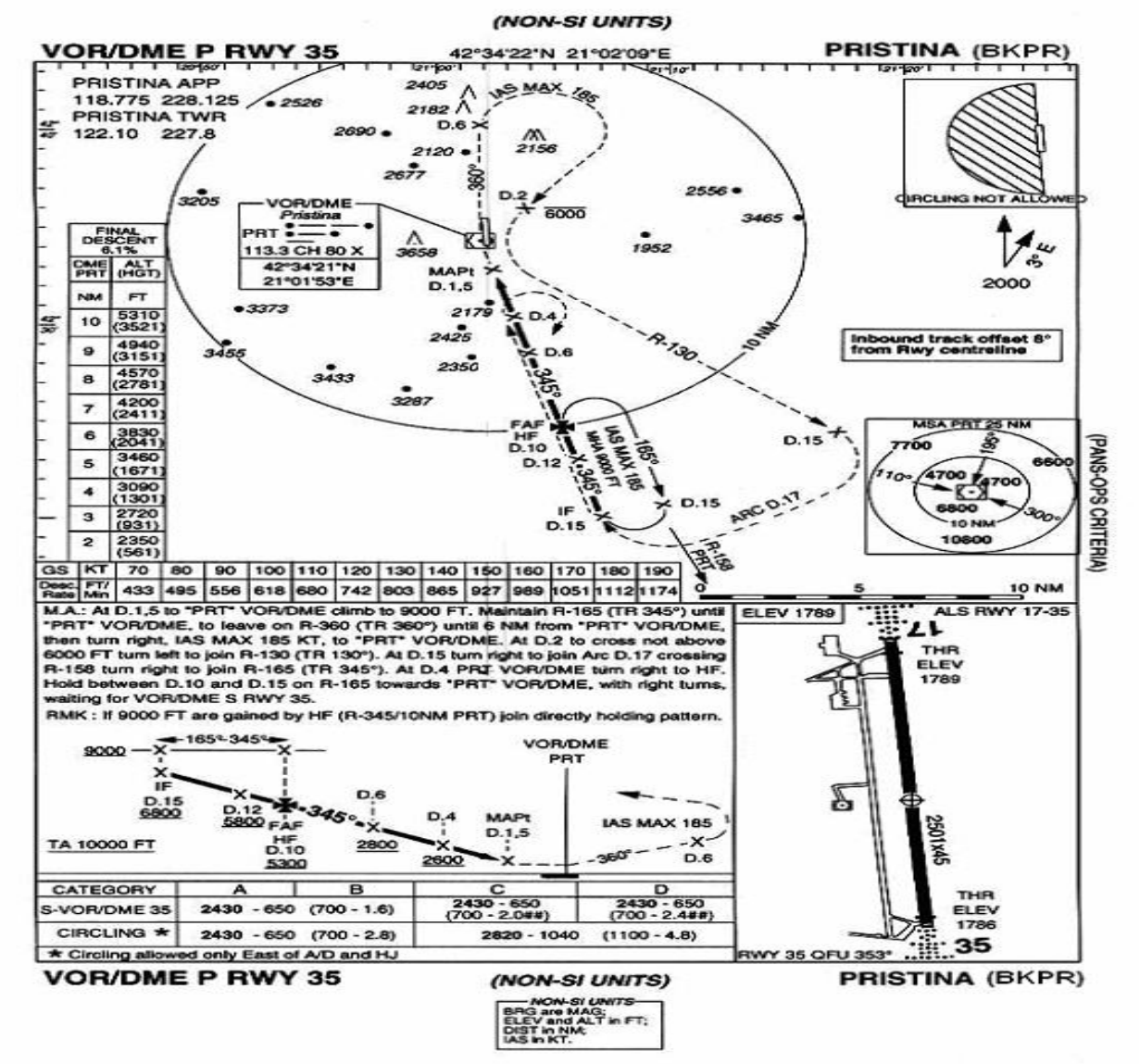


Figure 2: Runway 35 VOR/DME P approach chart *Source: AIP Kosovo*

During the final approach at Runway 35 VOR/DME P there is a need for a right turn. This right turn happens at approximately 500ft RA.

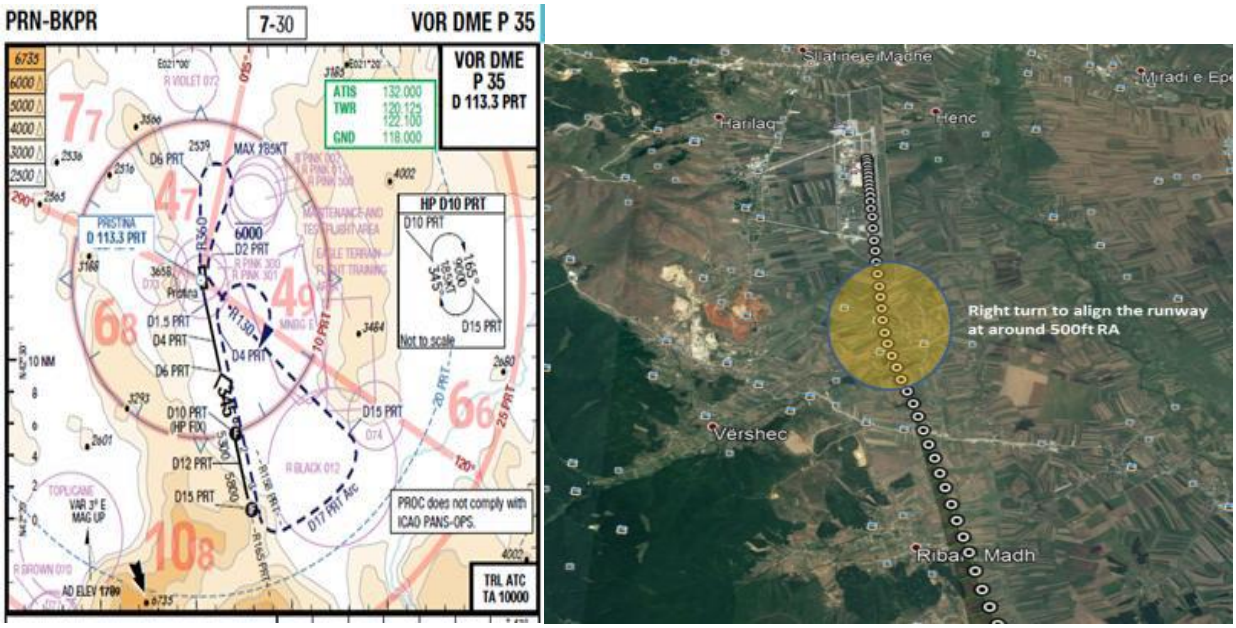


Figure 3: Pristina Approach Runway 35 *Source: Airbus*

1.4 Data from FDR

The Flight Data Recorder (FDR) for this event was a Digital Flight Data Recorder (DFDR) and was provided by the operator. Prior to the four consecutive flights after the incident the CVR was overwritten. Flight data was recovered and extracted from the Flight Data Recorder (FDR).

At 2000ft RA the Autopilot (AP1) was disengaged by the flight crew, the PF was manually flying the aircraft and the aircraft configuration was CONF FULL (Slats/Flaps 27°/40°), the landing gear was selected down, Auto brake was armed in MED mode and ground spoilers were not armed. The Flight Directors (FDs) were engaged in DES (vertical) and NAV (lateral) modes. The Auto thrust (A/THR) was engaged and active in "THRUST" mode, Lowest Selectable Airspeed VLS was 133kt, and speed target was managed at 138kt (VAPP=VLS+5kt) so the CAS was 138kt. Rate of descent was approximately 1400ft/min with Pitch angle 0° and heading 2° higher than final approach heading (final course approach 345°).

At the final approach during the alignment of the aircraft to the runway approximately 300ft the ground spoilers were armed, both FD's (Flight Directors) were disengaged.
On the longitudinal axis the PF side stick inputs varied between ~3/5 of full nose up and 3/4 of full nose down deflection. Pitch angle varied between -2.5° (nose down) and +4.5° (nose up).
Speed target varied between 138kt and 141kt. CAS varied between 133kt (VAPP-5kt) and 142kt (=VAPP+2kt). Rate of descent varied between ~2400ft/min (around 1900ft RA) and ~600ft/min. Vertical load factor varied between +0.9G and +1.1G.

On the lateral axis PF side stick inputs varied between ~1/2 of full right and ~3/5 of full left deflection. Roll angle varied between -3° (left wing down) and +10° (right wing down). Heading increased from 341° (final approach course) to 353° (QFU 353°). Drift angle varied between -3° (aircraft nose toward to the left of the track) and +2° (aircraft nose toward the right of the track). No significant lateral load factor was recorded.
Between 300ft RA to flare 20ft RA on the longitudinal axis, the PF side stick inputs varied between ~1/2 of full nose up and ~3/4 of full nose down deflection. Pitch angle varied between +2° (nose down) to +6° (nose up). Rate of descent varied between 880ft/min and 200ft/min. Vertical load factor varied between +0.8G and +1.1G. Speed target decreased from 141kt and 138kt. CAS varied between 134kt (=VAPP-6kt) to 139kt (=VAPP-2kt).
On the lateral axis the PF side stick varied between ~3/4 of full right and left deflection. Roll angle varied between +4° (right wing down) to -3° (left wing down). Rudder pedal input was applied up to ~1/4 of full left deflection. No significant lateral load factor was recorded.
Drift angle increased from 0° to +3° (aircraft nose toward the left of the track).
Heading decreased from 353° to 350° (QFU 353°).

From flare at 20ft RA to touchdown on the longitudinal axis a full back stick was applied by PF, pitch angle gradually increased from +2° to +3.5°. Vertical load factor varied between +0.96G and +1.05G. Rate of descent decreased from ~880ft/min to ~420ft/min. CAS decreased from 138kt (VAPP) to 135kt (VAPP-3kt). Auto thrust still engaged. On the lateral axis the PF side stick input varied between ~1/2 of full right and ~1/4 of full left. Roll angle increased from +0° to +2.5° (right wing down). Rudder pedal input was maintained to ~1/4 of full left deflection. Heading remained around 350° (QFU353°). Drift angle reached +3° (aircraft nose toward the left of the track).

The aircraft touched down with following data: on the longitudinal axis**:**
- +3.5° of pitch angle.
- -17ft/s (±2ft/s) of recalculated aircraft vertical speed.
- +3.0G of vertical load factor.
- +2.5° of roll angle (right wing down).
- +3° of drift angle (aircraft nose to the left of the track)
- Thrust levers were retarded to “IDLE” and A/THR disengaged.
- Ground spoilers started to extend.
- CAS was 135kt (=VLS+2kt).
- Ground Speed was 138kt.

And on the lateral axis**:**
- 350° of heading (QFU 353°).
- +3° of drift angle (aircraft nose toward the left of the track).
- Lateral load factor was at +0.3G (consistent with drift angle).

The above mentioned are graphically illustrated in the figure below.

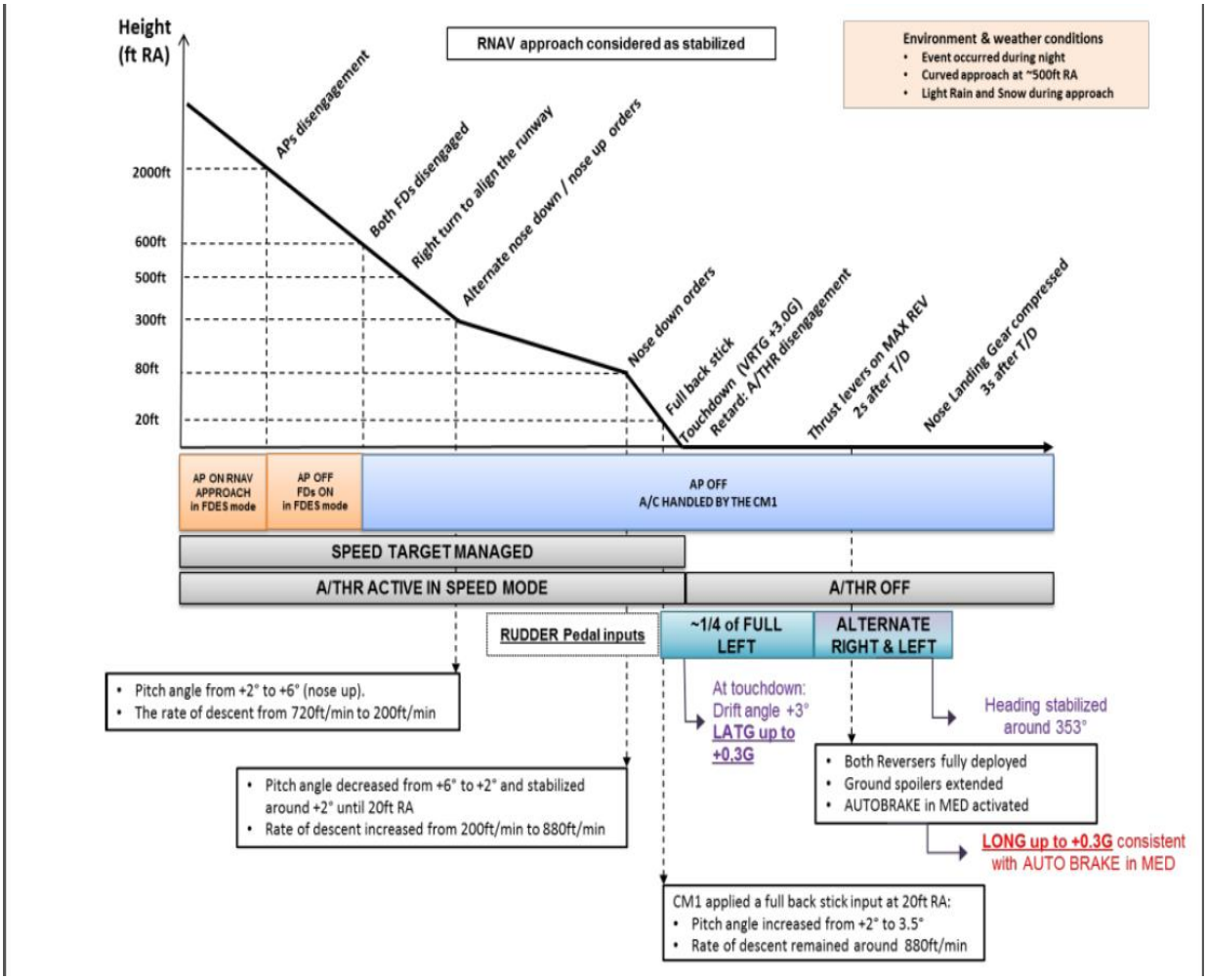


Figure 4: The approach sequence and touch down *Source: Airbus*

General Information on Hard Landings

The definition on hard landing is when the aircraft touches the ground with a greater vertical speed than a normal landing.

To trigger the hard landing the first information comes from the report of the flight crew, where after being suspicious about the landing they report the hard landing.

Also the aircraft today are equipped with software that shows and reports the landing parameters. The software is called AIDS and is centralized system which automatically collects and processes aircraft information. The AIDS generates reports and these reports are results of related AIDS monitored aircraft systems. Also these reports can be requested manually or started automatically.

Collected monitored aircraft data are automatically supplied to related systems during unusual aircraft operation. The automatic modes for printing and ACARS are fully customizable by each operator, for both triggering thresholds and logic. These may be changed at the Operators discretions.

The monitor functions have fixed trigger mechanisms, fixed data collection and output formatting. The output of data is done by the Data Management Unit (DMU).

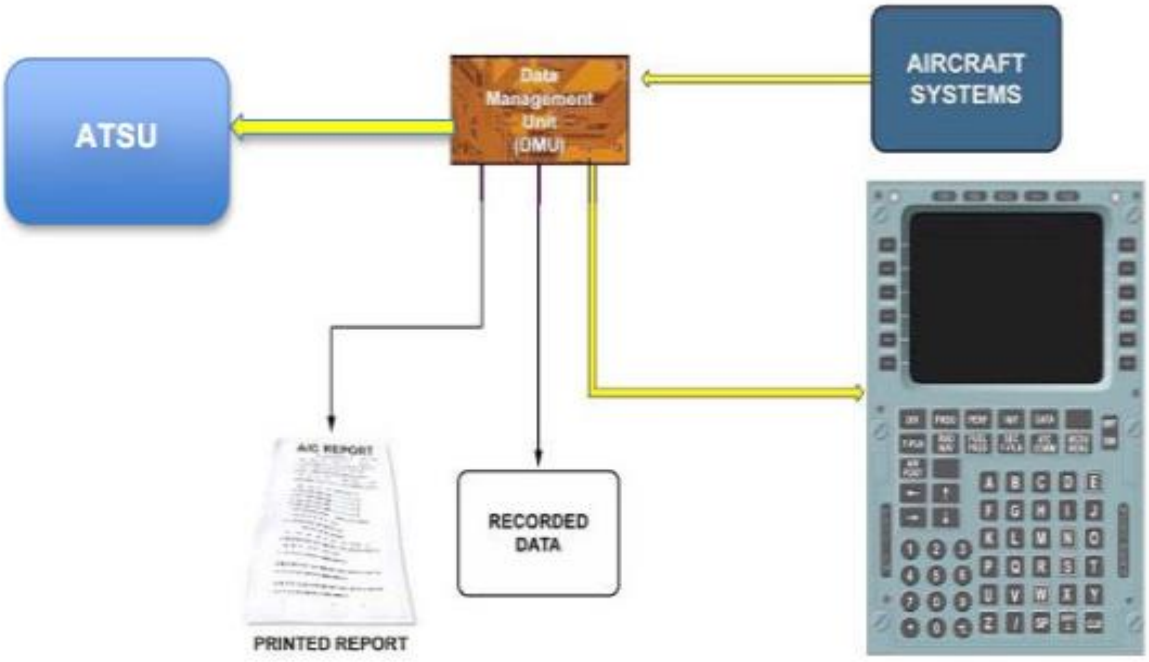


Figure 5: Function of the DMU *Source: BEA*

Load Report <15>

The aircraft A320 have an Integrated Data System that is called AIDS. This system receives information from many other systems through its DMU. The DMU then processes this data and produces reports based on various parameters. The report generated that identifies the hard landings is called Load <15> report. This report will be produced automatically if any of the following conditions are met:

- The vertical acceleration (VRTA) is higher than 2.6 g (at +/-5 seconds) during the landing and after.

- The radio altimeter descent rate (RALR) is greater than 9ft/sec during the landing (at +/- 5seconds)
- When the aircraft gross weight (GW) is higher than the maximum landing gross weight (GWL) and the radio altimeter descent rate is less 6ft/sec.
- When the aircraft gross weight (GW) is higher than the maximum landing gross weight (GWL) and vertical acceleration (VRTA) is higher than 1.7 g.
- For a bounced landing the vertical acceleration (VRTA) is higher than 2.6 g (at +/- 5 seconds) during the landing.

The Load <15> report is a structural exceedence report to identify if a hard landing has occurred, if so to ensure appropriate checks and inspections followed by AMM reference.

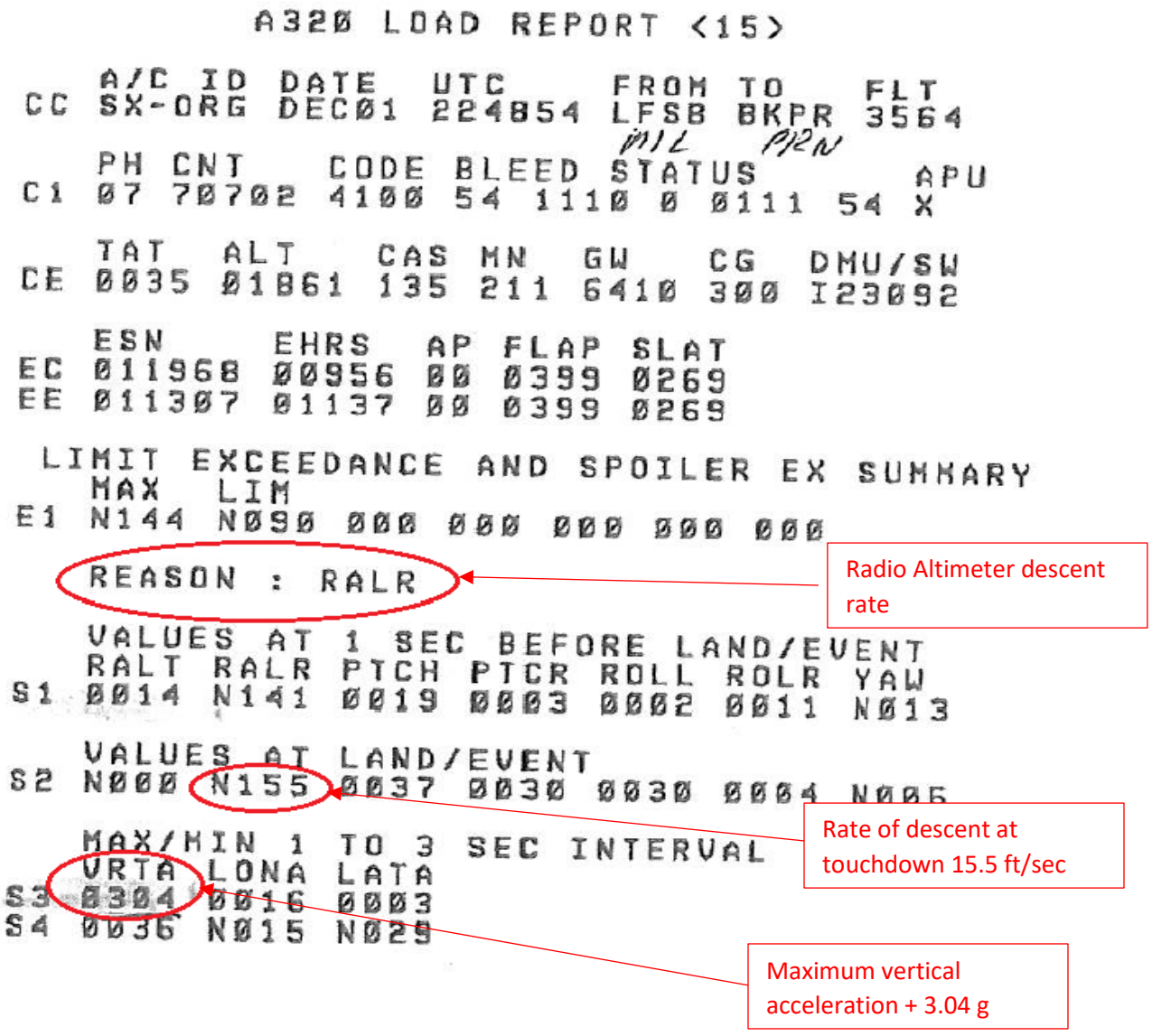


Figure 6: Load <15> report *Source: Operator*

Minimum Equipment List (MEL)

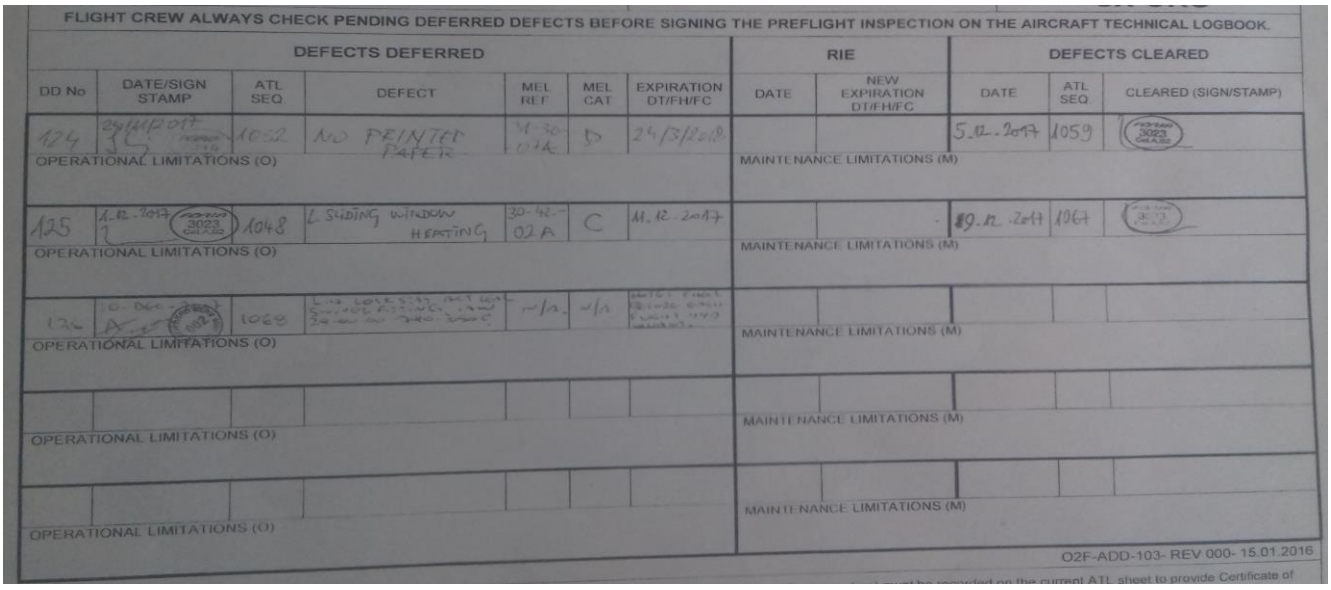
For the operation of the aircraft, specific conditions of the flight, or with particular equipment inoperative, the operator has to have a Minimum Equipment List. MEL is a list and has to be in conformity or more restrictive than the Master Minimum Equipment List (MMEL) established for the aircraft type (ICAO Annex 6: Operation of Aircraft).

Master Minimum Equipment List (MMEL) is a list established for a particular aircraft type by the organization responsible for the type design with the approval of the State of Design which identifies items which individually may be unserviceable at the commencement of a flight.

The operator shall include in the operations manual a minimum equipment list (MEL), approved by the State of the Operator which will enable the pilot-in-command to determine whether a flight may be commenced or continued from any intermediate stop should any instrument, equipment or systems become inoperative.

According to operator's MEL, the missing paper in the DMU was categorized as MEL item Cat D. Category D means the Repair interval shall be rectified within 120 consecutive calendar days, excluding the day of discovery.

The figure shows aircraft maintenance log book.


FLIGHT CREW ALWAYS CHECK PENDING DEFERRED DEFECTS BEFORE SIGNING THE PREFLIGHT INSPECTION ON THE AIRCRAFT TECHNICAL LOGBOOK.

DEFECTS DEFERRED							RIE		DEFECTS CLEARED		
DD No	DATE/SIGN STAMP	ATL SEQ	DEFECT	MEL REF	MEL CAT	EXPIRATION DT/FH/FC	DATE	NEW EXPIRATION DT/FH/FC	DATE	ATL SEQ	CLEARED (SIGN/STAMP)
124	29/HPOTT	1052	NO PRINTER PAPER	M 30-01A	D	24/3/2018			5.12.2017	1059	
OPERATIONAL LIMITATIONS (O)							MAINTENANCE LIMITATIONS (M)				
125	1.12.2017	1048	L SLIDING WINDOW HEATING	30-42-02A	C	11.12.2017			09.12.2017	1067	
OPERATIONAL LIMITATIONS (O)							MAINTENANCE LIMITATIONS (M)				
126	10 DEC	1068									
OPERATIONAL LIMITATIONS (O)							MAINTENANCE LIMITATIONS (M)				
OPERATIONAL LIMITATIONS (O)							MAINTENANCE LIMITATIONS (M)				
OPERATIONAL LIMITATIONS (O)							MAINTENANCE LIMITATIONS (M)				

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Figure 7 Maintenance Technical Log Book *Source: Operator*

Aircraft examination

After the event the aircraft was grounded at Pristina airport for further inspections. The maintenance engineers could not perform a complete AMM 05-51-11 inspection due to lack of aircraft jacking facilities on location. The items that need to be inspected via aircraft on jacks are: **Inspection of Nose landing gear and Inspection of the MLG.**

The operator requested a ferry flight to suitable maintenance facility to carry out further maintenance actions related to the event.

Before an approval by the manufacturer for the ferry flight, there are certain aircraft structure inspections that need to take in place in order the ferry flight be allowed. Inspections were performed on the aircraft with nil findings. The ferry flight was conducted with the following conditions/restrictions according to Airbus – Flight Conditions for a Permit to Fly with the approval number 80392630/089/2017-1

- The aircraft should be operated at the lowest possible weight
- Fuel load shall be limited to the quantity necessary to perform the intended leg
- Only the crew members in charge of the flight should be on board
- Zero payload as per weight and balance manual
- The aircraft is permitted to perform 2 (two) “zero payload” flight cycles with the Landing Gears down and locked

At the maintenance facilities, the AMM 05-51-11 jacked inspections of the nose landing gear and main landing gear were completed with NIL findings. Also detailed structure inspections programme issue 3 has been completed with NIL findings.

Following the inspections the operator requested initially to Airbus that all four wheels on the Main Landing Gear Wheels (MLG) and Rear Shock Absorber (RH) to be replaced. Airbus Ref: 80392630_133 issued, stated that there is no need to remove the wheels, but still the operator made the changes of all main wheels and as was initially requested the Rear Shock Absorber (RH) were replaced as well.

The maintenance company made the requested changes and on 28th of December 2017 released the aircraft back to service followed with aircraft certificate of release to service.

Contributing Factors

- The maneuvers of the PF on the stick seconds before touchdown. There were several nose up and nose down inputs at very low height.
- A late full back stick applied by the PF at 20ft/RA. This action was too late to change the vertical descent rate, so the hard landing was unavoidable at this point.
- The weather circumstances during that night were contributing factors to this occurrence, it was snowing and the runway was wet.
- Decision of the flight crew to have a Positive Landing resulted in an increased rate of descent
- Touchdown occurred with a high rate of descent (880 ft/min) as a result the Severe Hard Landing occurred.
- The left side window of the PF was foggy and was out of order because the heating was not working and the captain had reduced peripheral view. This malfunction was an MEL item, was inoperative and was out of order, the flight crew were in aware of it.

Findings as to Risk

- The flight crew failed to obtain the task written in the AMM 05-51-11-200-004 regarding that the flight crew are responsible to make a report if they think that there was a hard/overweight landing.
- Missing printer paper in the DMU was an MEL item, but also crucial for printing the Load <15> report and confirming the landing parameters.
- The aircraft continued to fly 8 more sectors without any inspection which might lead to compromising the safety of flight operations.

Safety Recommendation

Safety Recommendation AAIIC 2018-01

The Operator to implement an ACARS system or to ensure that there will be no paper shortage in the DMU.

Safety Recommendation AAIIC 2018-02

The operator to ensure a safety training to the flight crew regarding reporting a hard/overweight landing.

Source of Information and References

- Air Traffic Control of Republic of Kosovo
- Civil Aviation Authority of Republic of Kosovo
- Pristina International Airport – Adem Jashari
- Airbus
- Operator
- Airbus – Safety First nr.26, article on High Load Event Reporting