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FINAL INVESTIGATION REPORT ON SERIOUS INCIDENT TO AIR INDIA A320-231 AIRCRAFT VT-ESL AT JAMMU AIRPORT ON 09/06/2017

Foreword

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2012, the sole objective of the investigation of an accident shall be the prevention of accidents and incidents and not apportion blame or liability.

This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and laboratory examination of various components. Consequently, the use of this report for any purpose other than for the prevention of future accidents or incidents could lead to erroneous interpretations.

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GLOSSARY

AAIB	Aircraft Accident Investigation Bureau, India
AMSL	Above Mean Sea Level
ARC	Airworthiness Review Certificate
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
AUW	All Up Weight
C of A	Certificate of Airworthiness
CAR	Civil Aviation Requirements
COI	Committee of Inquiry
CPL	Commercial Pilot License
CVR	Cockpit Voice Recorder
DFDR	Digital Flight data Recorder
DGCA	Directorate General of Civil Aviation
DVOR	Doppler VOR
F/O	First Officer
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Training Manual
FRTOL	Flight Radio Telephone Operators License
GS	Ground Speed
hrs	Hours
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
LLZ	Localizer
MEL	Minimum Equipment List
MLG	Main Landing Gear
NDB	Non-Directional Beacon
NLG	Nose Landing Gear
Nm	Nautical Miles
PA	Passenger Address
PCN	Pavement Classification Number
PIC	Pilot in Command
QRH	Quick Reference Handbook
RESA	Runway End Safety Area
SB	Service Bulletin
SEP	Safety and Emergency Procedures Manual
VFR	Visual Flight Rules
VOR	VHF Omnidirectional Range
UTC	Coordinated Universal Time

FINAL INVESTIGATION REPORT ON SERIOUS INCIDENT TO M/s AIR INDIA AIRBUS A320-231 AIRCRAFT VT-ESL AT JAMMU ON 09/06/2017

1.	Aircraft Type	: Airbus A320-231
	Nationality	: Indian
	Registration	: VT –ESL
2.	Owner & Operator	: Air India Limited
3.	Pilot – in –Command	: ATPL holder on type
	Extent of injuries	: Nil
4.	First Officer	: CPL Holder on type
	Extent of injuries	: Nil
5.	Place of Incident	: Jammu Airport, Jammu
6.	Date & Time of Incident	: 9th June 2017, 0645 UTC
7.	Last point of Departure	: IGI Airport, Delhi
8.	Point of intended landing	: Jammu Airport, Jammu
9.	Type of operation	: Schedule Operation
10.	Crew on Board	: 02+04
	Extent of injuries	: Nil
11.	Passengers on Board	: 137
	Extent of injuries	: Nil
12.	Phase of operation	: Landing Roll
13.	Type of incident	: Tyre Burst &Runway over run
14.	Coordinates of Site	:32°41′15.24″N, 074°50′19.71″E
15.	Elevation	: 961 feet

(ALL TIMINGS IN THE REPORT ARE IN UTC)

SUMMARY

On 09.06.2017, Air India A320 aircraft while operating a schedule flight AI821 from Delhi to Jammu was involved in a serious incident of runway over run after landing on runway 36 at 0645 UTC at Jammu Airport. The aircraft was under the command of pilot an ATPL holder with co-pilot, CPL holder on type. There were 137 passengers and 04 cabin crew on board the aircraft. There was no injury reported to person on board.

The aircraft took off from Delhi at 0544 UTC for Jammu and during enroute flight was uneventful. During approach when the crew lowered landing gear down, "BRAKE AUTO BRAKE FAULT" warning came. However crew continued the approach as landing was planned to be carried out using manual breaking as per FCOM. The aircraft was high on approach and touched runway at approx. 2400 ft from runway threshold. After touchdown, full thrust reversals were deployed and manual brakes were applied but PIC experienced lack of braking and subsequently, parking brakes were applied twice for de-acceleration of the aircraft. Four (04) main landing gear tyres (No. 1, 2, 3 &4) burst during landing. Crew could not able to stop the aircraft on runway and aircraft overshoot the runway and went into the soft ground. Final rest position of the MLG was 24 feet and NLG at 74 feet from the edge of the runway 18. As there was no RESA for runway 36, the aircraft came close to 53 feet from the perimeter wall of the airport. The landing G load at the time of landing was 1.2 G.

Shortly after landing cabin crew in-charge informed the PIC that there is some smoke in the rear cabin. Subsequently, the emergency evacuation of the passengers was carried out using escape slides.

The occurrence was classified as Serious Incident by AAIB as per the Aircraft (Investigation of Accidents and Incidents) Rules, 2012. Committee of Inquiry was appointed by Ministry of Civil Aviation vide its notification Ref AV.15013/11/2017-DG dated July 2017appointing Mr. Amit Gupta, Deputy Director, AED as Chairman and Mr. Dinesh Kumar, Air Safety Officer, AAIB along with Capt. Pankaj Dua, AAIB Pool of Experts as member.

In accordance with the provisions of Annex 13, BEA France has appointed an investigator as accredited representative and Airbus representative as technical advisor for this serious incident.

The probable cause of incident is "Delayed touchdown of the aircraft and low deceleration rate due to improper brake application resulted in tyre burst and runway overrun".

1. FACTUAL INFORMATION

1.1 History of the flight:

On 09/06/2017, Air India A320-231classic aircraft while operating a schedule passenger flight AI821 from Delhi to Jammu was involved in an incident of runway overrun while carrying out landing roll on runway 36 at Jammu airport. There were 02 operating crew, 04 cabin crew and total 137 passengers on board the aircraft.

Before Delhi- Jammu flight, the aircraft had operated Delhi-Surat-Delhi flight on the same day. After Pre-flight inspection aircraft took off from Delhi at around 0544 UTC under the command of an ATPL holder acting PF and co-pilot, CPL holder as PM. The enroute flight was uneventful.

As per the statement of PIC, aircraft joined the hold to descend to carry out ILS NDB approach. During approach when the landing gear was selected down "Brake Auto Brake Fault" ECAM warning message was triggered at 0642 UTC with failure message of "BRK NORM SERVOVLV7 (80GG)".PIC continued to approach to Jammu airport and crew planned for manual braking as per operational procedure after reckoning manual brake performance.

The flight crew voluntarily disengaged both autopilots at 770ft RA (064357 UTC), then final approach was manually handled by the PIC with the autothrust engaged and active in "SPEED" mode. The speed target was managed. Then, below 500 feet RA, the aircraft began to fly below the glide slope. The glide slope deviation increased and exceeded its callout value (>1/2DOT) reaching 3/4 DOT below the glide path at ~180ft RA. Final approach was no more stabilized. Thereafter, from 160 feet RA, aircraft flied back towards the glide. After touchdown full thrust reversers were deployed and manual barking was applied up to full pedal deflection. However, both the crew experienced lack of braking and subsequently, Anti-skid was turned off after 19 sec from touchdown time at 064517 UTC. Finally aircraft came to halt on unpaved area at the end of runway 18 after overrun of runway. The final rest position

of the MLG was 24 feet and NLG at 74 feet from the edge of the runway 18.There was no RESA for runway 36, the aircraft came close to 53 feet from the perimeter wall of the airport.

After the aircraft came to a complete halt, Cabin Crew In-charge informed the PIC that there is some smoke in the rear cabin. Subsequently, the emergency evacuation of the passengers was carried out using escape chutes. There were no fire or injuries reported to any of its occupants and all the passengers were transported to the terminal building in passenger coaches.

As per Jammu ATC, the visibility at the time of incident was reported 6 Km with variable winds of 04 Knots and runway surface condition was dry.

During the passenger evacuation process, L1 door did not open and the evacuation was carried out through L2, R1 & R2 doors. After the evacuation, escape chutes L2& R1blown away automatically. Cabin crew assisted the passengers in evacuation and exit after evacuating all the passengers.

Air India engineering team pulled back the aircraft on runway with the help of metallic cables attached at both RH & LH MLG and changed the MLG wheel assembly #2 & #3 on runway at around 1345 UTC on 09.06.2017. Due to aircraft being stuck on end of runway 36/18, the runway was not available for operations and flight operations were affected at Jammu airport.

1.2 Injuries to persons

INJURIES	CREW	PASSENGERS	OTHERS
FATAL	Nil	Nil	Nil
SERIOUS	Nil	Nil	Nil
~~MINOR~~/NONE	Nil	Nil	Nil

1.3 Damage to Aircraft :

The aircraft exited the runway end and got stuck in the unpaved surface. Tyre No. 1, 2, 3 & 4 were blown out damaging associated wiring and Axle of four (04)

wheels. Apart from damage to Main Landing Gears tyre assembly, the aircraft did not receive any other damage.

1.4 Other damage: NIL

1.5 Personnel information

1.5.1 Pilot – in – Command

AGE	: 41 yrs& 11 months
Licence	: ATPL Holder
Date of Issue	: 13/01/2011
Valid up to	: 13/01/2022
Category	: Aeroplane
Class	: Multiengine
Date of Med. Exam.	: 08/11/16
Med. Exam valid upto	: 08/11/17
FRTO Licence No.	: 7672
Date of issue	: 03/12/2011
Valid up to	: 03/12/2021
Total flying experience	: 9421:43 hrs.
Experience on type	: 9171:43 hrs.
Experience as PIC on type	: 5616:40 hrs.

Flying details (in hrs.):

Total flying experience during last 180 days	: 403:37
Total flying experience during last 90 days	: 200:05
Total flying experience during last 30 days	: 67:46
Total flying experience during last 07 Days	: 17:59
Total flying experience during last 24 Hours	: 02:20

1.5.2 Co-Pilot

AGE	: 24 yrs& 09 months
Licence	: CPL Holder
Date of Issue	: 03/02/14
Valid up to	: 02/12/19

Category	: Aeroplane
Class	: Multiengine
Date of Med. Exam.	: 30/08/16
Med. Exam valid upto	: 25/08/17
FRTO Licence No.	: 18576
Date of issue	: 03/12/14
Valid up to	: 02/02/19
Total flying experience	: 1859:28 hrs.
Experience on type	: 1609:28 hrs.

Flying details (in hrs.):

Total flying experience during last 180 days	: 367:58
Total flying experience during last 90 days	: 170:10
Total flying experience during last 30 days	: 76:55
Total flying experience during last 07 Days	: 18:45
Total flying experience during last 24 Hours	: 04:50

Both the operating crew were not involved in any serious incident/ accident in past. Both the operating crew had adequate rest as per the Flight Duty Time Limitations (FDTL) requirement prior to operating the incident flight.

1.6 Aircraft Information:

The A320 Classic is a subsonic, medium-range, civil transport aircraft. The aircraft has two high bypass turbofan engines manufactured by M/s International Aero Engines. The aircraft is designed for operation with two pilots and has passenger seating capacity of 168.

The aircraft is certified in Normal (Passenger) category, for day and night operation under VFR & IFR. The maximum operating altitude is 39,100 feet and maximum take-off weight is 73500 Kgs. The Maximum Landing weight is 64500 kgs. The Aircraft length is 37.57 meters, wingspan is 34.15 meters and height of this aircraft is 12.08meters. The distance between main wheel centres is 7.59 meters. The distance between engines is 11.5 meters and Engine Ground Clearance is 26.4961 inch.

Airbus A320 aircraft VT-ESL (MSN 0499) had been manufactured in year 1994 and carried out first flight on 27/09/1994. The aircraft was delivered to INDIAN AIRLINES on 15/12/1994 and C of A was issued on 23/12/1994. The aircraft was

registered with DGCA under the ownership of AIR INDIA LIMITED on 04/03/2005. The aircraft is registered under category 'A' and the Certificate of Registration No. 2621/3.

The Certificate of Airworthiness Number 2109 under "NORMAL category" subdivision Passenger / Mail / Goods was issued by DGCA on 01/08/2014. The specified minimum operating crew is two and the maximum all up weight is 73,500 Kgs. At the time of incident the Certificate of Airworthiness /ARC was current and valid up to 28/04/2018.

The Landing Gear of aircraft is Double Bogey Type i.e. 04 wheels in each Main Landing Gears. The reasons for 04 main wheels instead of 02 is that the double Bogey aircraft could land on runways with a lower PCN than what the aircraft was initially certified for using the normal MLG. Additionally having 8 MLG and brakes also considerably improved its stopping distance over the standard A320 series. Even though the 4-wheel bogies have translated to a weight penalty but double Bogey is good for especially from the smaller airfields.

The aircraft was holding a valid Aero Mobile License No. A-014/051-RLO (NR) at the time of incident. This aircraft was operated under Scheduled Operator's Permit No.AOP S-9 which was valid up to 30.06.2017. As on 09.06.2017, the aircraft had logged 58233.50 airframe hours and 35596 cycles.

The Airbus A320 aircraft and its engines are being maintained as per the maintenance programme consisting of calendar period/ flying hours or cycles based maintenance as per maintenance programme approved by Regional Airworthiness office, Delhi vide letter Ref. No. F-APP/AIR INDIA/2894 dated 20.12.2016.

Accordingly, the last major inspection 2250FH/ 360 Days ‘4A’ check carried out at 57258.43 Hrs. / 34851 cycles on 17.01.2017. Subsequently all lower inspections (Pre-flight checks, Service Checks, Weekly Checks) were carried out as and when due before the incident.

The aircraft was last weighed on 28.04.15 at Delhi, and the weight schedule was prepared and duly approved by the O/o DDG (NR), DGCA, Delhi. As per the approved weight schedule the Empty weight of the aircraft is 39945.71 Kgs. Maximum Usable fuel Quantity is 18730 Kgs. Maximum payload with fuel tanks full is 10639.57Kgs. Empty weight CG is 18.74 meters aft of datum. As there has not

been any major modification affecting weight & balance since last weighing, hence the next weighing is due on 27.04.2020. Prior to the incident flight the weight and balance of the aircraft was well within the operating limits.

The left engine S/N V0299 had logged 46668.12 Hrs. and 30882cycles and the right Engine S/N V0303 had logged 44984.00 Hrs. and 29999 cycles. There was no defect report on the engine on the previous flight.

All the concerned Airworthiness Directive, Mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine has been complied with as on date of event.

1.7 Meteorological information

The incident occurred at 0645 UTC and the METAR of 0630 UTC was valid at the time of incident. As per the METAR, following meteorological conditions existed.

Time (UTC)	**0530**	**0630**	**0730**
Wind	050/03	120/04	VRB/02
Visibility	6000 M	6000 M	6000 M
Temp	32° C	34° C	36° C
Dew Point	15° C	14° C	13° C
QNH	1005 hPa	1004 hPa	1004 hPa
Clouds	FEW 030 SCT 090	FEW 030 SCT 090	FEW 030

No significant trend was reported by ATC. CVR tape transcript revealed that the weather information was also passed by the Jammu ATC to the aircraft while giving the landing clearance.

The METAR indicated good weather and visibility of more than 6 km from 0530 UTC to 0730 UTC. The winds were consistent, with bearing 120 and velocity 04 kts. There were scattered clouds at 9000 feet.

1.8 Aids to navigation

Jammu airport is equipped with following Radio Navigation and Landing Aids.

a	Air-to- ground communication VHF/Ground to Ground Communication- HF/DVTRS/Master clock System /ATIS/DIAL-UP (AFTN) /DSCN /VPN / AMSS/VCCS & LAN/WAN	ATC with IAF/TER-128.5 MHz DSCN,LAN/WAN (AAI)
b	NDB & DVOR /DME (High Power)	NDB –IAF JA 415 KZ, DVOR-JJU 113.3 MHZ, DME (HP)-1167-1104 MHZ
c	ILS/DME (Low Power)(LLZ/GP)	RWY 36- CAT I(LLZ-IJMU 110.1 MHZ, GP-334.4 MHZ)
d	Surveillance Radar	Not Available

1.9 Communications

At the time of incident the aircraft was in contact with Jammu ATC on frequency 128.5 MHz. From the CVR transcript it was apparent that there was no communication problem between the Flight Crew & ATC. Aircraft maintained positive communication with the ATC throughout the flight.

1.10 Aerodrome information

Jammu Airport is operated by the Indian Air Force and AAI maintains the Civil Enclave. The Airport Reference point is 32`41'34" N 74`50'25"E. The elevation of the airport is 961 feet (AMSL). The runway code is 4C. The IATA location Identifier code is IXJ and ICAO location Indicator code is VIJU. The flight traffic permitted is only IFR/VFR flights and no night operation is permitted. The Airport Rescue and Fire Fighting Services was Category '7' (Seven) and provided by IAF. Precision Approach ILS CAT-I is available. Approach Lighting System (ALS) CAT-I available at R/W 36. Rwy / Twy / Turn Pad / Apron Edge Lights are available &Precision Approach Path Indicator (PAPI) are available at both ends. R/W & Taxi Tracks markings are standard as per Annex- 14.The dimensions of Runway strip is 2100m x 45m. The orientation of the runway is 18/36. The runway shoulders are 7.50 m each side for full length of Rwy. Threshold was displaced by 60 m at original place

and threshold of Rwy 36 was not displaced. The detail of runway distances is as below;

Runway No.	TORA(M)	TODA (M)	ASDA (M)	LDA (M)	WIDTH (M)	RESA (M)
18	2042	2100	2100	1980	45	90 x 90
36	2042	2042	2042	2042	45	NIL

The Jammu runway 36 was not equipped with an ICAO complaint RESA. ICAO standards prescribed a RESA of 90m/295 feet and recommended 240m/780 feet. In locations where this is not possible, ICAO recommends that airports consider reducing some of the declared distances. Being defence airfield, the airport is not licensed by DGCA.

1.11 Flight recorders:

The aircraft was fitted with Solid State CVR & DFDR as per table given below. The recorders showed no signs of damage. Data from both CVR & DFDR were downloaded and analysed after the serious incident.

No	Unit	Manufacturer	Part Number	Serial Number	Total Duration of available Recording
1	CVR	L3 Communication, USA	2100-1020-02	000460586	02 Hrs 04 min 14 sec
2	DFDR		2100-4043-02	000623444	353Hrs17mins 43 sec

1.11.1 Cockpit Voice Recorder

04 Audio channels with duration of 02 hrs 04 min 14 sec were found in CVR. The channels are

- HQ 1.wav,containing P1 Microphone recordings
- HQ 2.wav,containing P2 Microphone recordings
- HQ 3.wav,containing Passenger Address Microphone recordings
- HQ CAM.wav containing the Cockpit Microphone recordings

Following are the salient observations

S. No.	GMT	From	Recording/*Noise*
1.	06: 45:52	----	End of Recording
2.	06:45:47	ATC	CFT 1 follow aircraft immediately
3.	06:45: 37	P1	*****
4.	06:45:27	ATC	Expected Tyre Burst
5.	06:45:27	Analysis	*Noise (Runway overrun)*
6.	06:45:23	ATC	CFT follow aircraft immediately
7.	06:45:18	P1	Oh Shit
8.	06:45:16	Analysis	*Continuous repetitive chime Noise (Master Warning)*
9.	06:45:16	Analysis	*Transient Noise (Tyre Blow out)*
10.	06:45:13	P1	Anti-Skid off Kar
11.	06:45:09	P1	Anti A A Anti-skid off, ek minute anti-skid off kar, acha rukja rukja rukja
12.	06:45:07	P2	Reverse Speed
13.	06:45:05	P2	Spoilers
14.	06:44:58	Analysis	*Noise (Main wheel touch down)*
15.	06:44:55	P1	Baith Jai Bhai
16.	06:44:50	Synthetic voice	Retard, Retard
17.	06:45:43	Synthetic voice	100
18.	06:44:35	P2	Checked
19.	06:44:34	Synthetic voice	200
20.	06:44:33	P1	Continue
21.	06:44:32	P2	Minimums

22.	06:44:28	Synthetic voice	300
23.	06:44:22	Synthetic voice	400
24.	06:44:19	P2	Checked
25.	06:44:16	P1	PAPI 2 by 2 RED
26.	06:44:11	P1	Todi se Tail wind hai

1.11.2 Digital Flight Data Recorder

The DFDR readout was analysed and following are the salient observations:-

At Radio Altitude 974 ft

Sl. No.	Parameters	Values
1	Time	06:43:40
2	Autopilot	Both AP ON
3	Throttle Angle 1	25.3
4	Throttle Angle 2	22.2
5	Norm Brake Press 1,2,3,4	0
6	Anti Skid Selection	On
7	CAS	137.2 kts
8	GS	147 kts
9	Pitch	2.5
10	Roll	0.7
11	Vert G	0.95
12	Standard Altitude	2112 ft
13	Flaps	Not recorded
14	Heading	353.7 deg
15	Flaps	40 deg
16	Slats	27 deg

At Radio Altitude 770 ft (APs disengaged)

Sl. No.	Parameters	Values
1	Time	06:43:57
2	Autopilot	NO AP ON
3	Throttle Angle 1	25.3
4	Throttle Angle 2	22.5
5	Norm Brake Press 1,2,3,4	128, 64, 128, 64

6	Anti Skid Selection	On
7	CAS	139.3 kts
8	GS	146 kts
9	Pitch	2.1
10	Roll	1.7
11	Vertical G	0.9 to 0.92
12	Standard Altitude	1916 ft
13	Heading	353.3
At Touchdown (Radio Alt -1 ft)		
Sl. No.	**Parameters**	**Values**
1	Time	06:44:58
2	Autopilot	NO AP ON
3	Throttle Angle 1	0
4	Throttle Angle 2	-2.8
5	Norm Brake Press 1,2,3,4	128, 64, 128, 64
6	Anti Skid Selection	ON
7	CAS	137.4 kts
8	GS	145 kts
9	Pitch	3.2
10	Roll	0.3
11	Vertical G	0.97
12	Standard Altitude	1172 ft
13	Heading	354.0 deg
14	AUTO_BRK_FLT	A/B FAULT
At CAS is 0, Radio Ht. 0 (Aircraft Stopped)		
Sl. No.	**Parameters**	**Values**
1	Time	06:45:33
2	Autopilot	NO AP ON
3	Throttle Angle 1	-19.7
4	Throttle Angle 2	-22.5
5	Norm Brake Press 1,2,3,4	Not recorded
6	Anti Skid Selection	--
7	CAS	Not recorded
9	Pitch	0
10	Roll	-1
11	Vertical G	0.97 to 1.09
12	Standard Altitude	1208
13	Heading	9.8
14	AUTO_BRK_FLT	A/B FAULT

1.12 Wreckage and impact information:

The aircraft carried out landing on Rwy 36 at Jammu airport and decelerated after the thrust reversers were applied. Subsequently, parking brakes were applied and aircraft overshot the end of runway 18 and came to halt on unpaved surface.

Apart from damage to wheel assembly of both main landing gears the aircraft was serviceable and was put back into service after tyre replacement and necessary inspections.

Following are the distance measured with help of DFDR & Ground marks.

1. Distance of aircraft touch down on Rwy36 from threshold :- 2400 feet
2. Distance of aircraft Main Landing from end of runway 18 in soft ground:- 24 feet
3. Distance of aircraft Nose Landing from end of runway 18 in soft ground:- 74 feet
4. Distance of aircraft Nose Landing & Perimeter wall in soft ground:- 53 feet
5. Tyre rub marks on Runway to stop point: -from 2000 ft to end of runway.
6. Maximum Deviation of LH Tyre Mark w.r.t Runway centre line :- 38 feet
7. Maximum Deviation of RH Tyre Mark w.r.t Runway centre line :- 65 feet

1.13 Medical and pathological Information:

Prior to operating the flight both the cockpit crew & cabin crew had undergone pre-flight medical / Breath Analyser test at Delhi and were found negative. Post flight BA test was carried out for crew members and none of the crew members were found under the influence of alcohol.

1.14 Fire:

There was no pre or post impact fire. But the pilot had operated the Engine 1, & 2 Fire bottles. Fire Extinguisher Bottle Eng#1 (Forward & Rear) and Fire Extinguisher Bottle Eng#2 (forward) were found discharged.

1.15 Survival aspects:

The incident was survivable. After landing the cabin crew seated at 1 R informed Cabin Crew In-charge seated on 1L regarding smoke in the rear cabin. Cabin Crew In-charge informed the PIC and made announcement for evacuation. Emergency evacuation using escape chutes were carried out from 1R, 2L and 2R doors. The 1L door couldn't opened and no evacuation was carried out from over wing windows. There was no injury to any person during evacuation. However, after evacuation, the escape slides R1 and L2 collapsed. The member of committee visited the Jammu Airport on 10-06-2017 and door L1 was opened in armed condition. However, the escape slide of L1 also collapsed after 3 minutes of deployment.

1.16 Tests and research

Twenty Eight (28) components were sent to lab for testing/investigation after the incident. The components and their status are

S.no.	Name of Component	Sl. No.	Position	Remarks
1.	Nose Wheel Assembly	AN 397	#1	No damage observed
2.	Nose Wheel Assembly	AN 109	#2	No damage observed
3.	Brake Assembly	D/AB 1092	#1	Damaged
4.	Brake Assembly	U 107	#2	Damaged
5.	Brake Assembly	U 169	#3	Damaged
6.	Brake Assembly	U 221	#4	Damaged
7.	Main Wheel Assembly	AM 615	#1	Tyre Bust & both hub sheared
8.	Main Wheel Assembly	AM 294	#2	Tyre Bust & both hub sheared
9.	Main Wheel Assembly	AM 580	#3	Tyre Bust & both hub sheared
10.	Main Wheel Assembly	AM 355	#4	Tyre Bust & both hub sheared
11.	Main Wheel Assembly	AM 684	#5	No Damage observed.
12.	Main Wheel Assembly	AM 534	#6	No Damage observed.
13.	Main Wheel Assembly	AM192	#7	No Damage observed.
14.	Main Wheel Assembly	AM 175	#8	Cuts observed on side wall of Tyre
15.	Cylinder Door Damper	1318	#1	Pressure indicator showing Zero. Unit received in shop in discharged condition.
16.	Cylinder Door Damper	1493	#2	Pressure indicator showing Zero. Unit received in shop in discharged condition.
17.	Cylinder Door Damper	709	#3	Pressure indicator showing Zero. Unit received in shop in discharged condition.
18.	Cylinder Door Damper	227	#4	Pressure indicator showing Zero. Unit received in shop in discharged condition.
19.	Escape chute & Reservoir	A7225 & 751-1055	#1	Reservoir found discharged condition & escape slide ruptured due life over

				17 years (Recommended life 15 yrs).
20.	Escape chute & Reservoir	A7580 & 751-1162	#2	Reservoir found discharged condition & escape slide ruptured due life over 16 years (Recommended life 15 yrs).
21.	Escape chute & Reservoir	A6853 & 751-3737	#3	Reservoir found discharged condition & escape slide ruptured due life over 18 years (Recommended life 15 yrs).
22.	Escape chute & Reservoir	A6737 & 751-3650	#4	Reservoir found discharged condition & escape slide ruptured due life over 18 years (Recommended life 15 yrs).
23.	Engine Fire Extinguisher	5612EL	#1 Forward	Cartridge blown off & pressure indicator shows zero
24.	Engine Fire Extinguisher	8086EL	#2 Rear	Cartridge blown off & pressure indicator shows zero
25.	Engine Fire Extinguisher	5685EL	#1 Forward	Cartridge blown off & pressure indicator shows zero
26.	Brake System Control Unit (BSCU)	20024		Observed antiskid INOP on STS Page
27.	Brake System Control Unit (BSCU)	20036		Brake Sticky but on bench check no Failure found (NFF).
28.	Normal Brake Servo V/V	3319	#7	Damaged.

1.17 Organisation and Management information:

Air India Limited is a Scheduled Airlines and operates a fleet of Airbus and Boeing aircraft. It is a public sector undertaking under Ministry of Civil Aviation. The airline has headquarter at New Delhi. Its primary hub is at Indira Gandhi International Airport, New Delhi, and secondary hub at Chhatrapati Shivaji International Airport, Mumbai. The airline is having DGCA Air Operator's Permit (AOP) No. S-9 in Category "Passenger and Cargo" valid up to 30.06.2018. The Airline IATA Code is "AI", ICAO code "AIC" and call sign "Air India". The airline operates a fleet of 113 aircraft includes 24 Airbus A319-100 aircraft, 28 Airbus A320-200 aircraft, 20 Airbus A321-200 aircraft , 05 Boeing 747-400 aircraft, 15 Boeing 777 aircraft and 21 Boeing 787. Air India is having 02 Subsidiaries as Air India Express & Air India Regional which have separate permit. The Company is headed by Chairman & Managing Director assisted by a team of professional of various departments. The Flight Safety Department is headed by Chief of Flight Safety approved by DGCA. The Chief of Safety is an Executive Director who reports directly to the Chairman. Air India has a full established Operations training facility for the pilots. The training facility for the Airbus pilots is set up at Hyderabad and for the Boeing pilots it is in Mumbai. Both the training facilities are headed by the Executive Director Training who reports to Chairman. The engineering training facility is established at Delhi and Mumbai.

1.18 Additional Information

1.18.1 Aircraft Brake System

Anti-skid and auto brake functions are controlled by a two-channel Brake and System Control Unit (BSCU), a computer which transmits brake commands either from the pilots' brake pedal positions or from the auto brake system. Auto brake is armed by the crew through a push-button panel on the flight deck and operated in MAX (maximum, for rejected takeoffs), MED and LOW (medium and low, for landings).

There is an 'anti-skid & nosewheel steering' switch (A/SKID & N/W STRNG) with simple 'ON' and 'OFF' selections. With this switch OFF there is no anti-skid protection to the brakes and pilots should refer to the triple pressure indicator (showing left, right and accumulator), keeping brake pressures at the wheels to below 1,000 psi to prevent the tyres from skidding and bursting.

The wheel braking system can operate in four modes:

1) Normal braking - with auto brake available and anti-skid operating (Green hydraulic system).

2) Alternate braking with anti-skid - pedal braking by crew with anti-skid operating (Yellow hydraulic system).

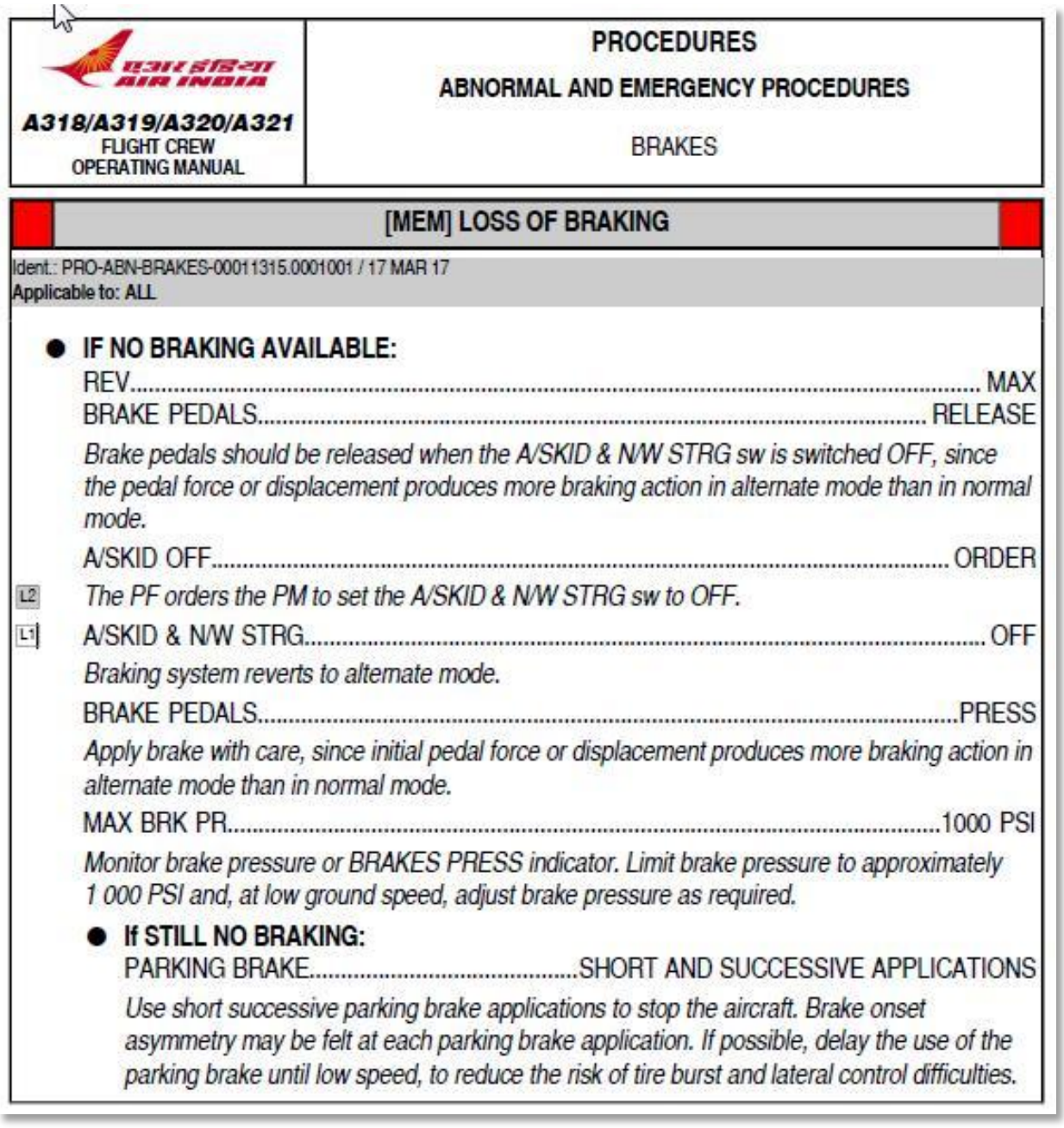
3) Alternate braking without anti-skid - pedal braking by crew with no anti-skid, either due to BSCU failure and/or A/SKID & N/W STRNG switch OFF. Crew maintain brake pressures below 1,000 psi to avoid locking a wheel.

4) Parking brake - primarily used for aircraft parking but this may be used as an emergency brake in short and successive applications.

Aircraft had eight number of Normal Brake Servo Valves & four number of Alternate Brake Servo Valves.

1.18.2 Pilot Actions on Auto brake fault:

For a loss of braking action, the following actions are detailed in the operator's FCOM (flight crew operating manual) as memory items:



AIR INDIA

A318/A319/A320/A321
FLIGHT CREW
OPERATING MANUAL

PROCEDURES

ABNORMAL AND EMERGENCY PROCEDURES

BRAKES

[MEM] LOSS OF BRAKING

Ident.: PRO-ABN-BRAKES-00011315.0001001 / 17 MAR 17
Applicable to: ALL

- **IF NO BRAKING AVAILABLE:**

REV..... MAX

BRAKE PEDALS..... RELEASE

Brake pedals should be released when the A/SKID & N/W STRG sw is switched OFF, since the pedal force or displacement produces more braking action in alternate mode than in normal mode.

A/SKID OFF..... ORDER

L2 *The PF orders the PM to set the A/SKID & N/W STRG sw to OFF.*

L1 A/SKID & N/W STRG..... OFF

Braking system reverts to alternate mode.

BRAKE PEDALS.....PRESS

Apply brake with care, since initial pedal force or displacement produces more braking action in alternate mode than in normal mode.

MAX BRK PR.....1000 PSI

Monitor brake pressure or BRAKES PRESS indicator. Limit brake pressure to approximately 1 000 PSI and, at low ground speed, adjust brake pressure as required.

- **If STILL NO BRAKING:**

PARKING BRAKE.....SHORT AND SUCCESSIVE APPLICATIONS

Use short successive parking brake applications to stop the aircraft. Brake onset asymmetry may be felt at each parking brake application. If possible, delay the use of the parking brake until low speed, to reduce the risk of tire burst and lateral control difficulties.

At 0642 UTC, the PIC reported the following warning message: "BRAKE AUTO BRK FAULT". This warning message was linked with the failure message "BRK SERVOVLV7 (80GG)" highlighting an issue on the servo valve 7 detected during the pre-land test. Consequently to the servo valve failure:

- Normal braking was lost
- Auto brake function was lost.
- Alternate braking with anti-skid was available.

At time of touchdown 064458 UTC, the following actions were recorded:

- MAX REV thrust was applied on both engines.
- Manual braking was progressively applied.
- ~4 sec after the touchdown
  - ground spoilers were fully deployed
  - nose landing gear touched the runway.

At 064506 UTC,

- Max brake pedals deflection was reached after 08 sec.
- The deceleration progressively increased and stabilized between +0.2g and +0.25g.
- The ground speed decreased from 145kt to 125kt.

As there was ECAM message of "Break Auto Break Fault" during landing, aircraft was on alternate braking, brake pedal order commanded alternate braking pressures. However the deceleration experienced by the aircraft remained low (between +0.2 and +0.25g) despite max brake pedal application.

From 064506 UTC after touchdown to 064517 UTC, the brake pedals were maintained to full deflection while aircraft deceleration remained constant. As a consequence, the ground speed continued to decrease regularly from 125kt to 76kt.

At 064517 UTC, the anti-skid was turned off as per Abnormal and Emergency procedures. Aircraft continued to decelerate.

At 064522 UTC with GS 45 kts, the PIC applied parking brake for 02 sec as per Abnormal and Emergency procedures. Aircraft continued to decelerate.

At 064525 UTC with GS 30kts, PIC again applied parking brake for 08 sec as per Abnormal and Emergency procedures.

At 064529 UTC, aircraft went off the asphalt at GS10kts.

At 064533 UTC, aircraft stop at distance of 6800 feet from the threshold.

The PIC carried out as per checklist, however the aircraft deceleration was low until the aircraft exited the runway.

1.18.3Escape chutes burst:

After the incident, Emergency evacuation using escape chutes were carried out from 1R, 2L and 2R doors except the door 1L as the door couldn't be opened. However, after evacuation, the escape slide no. 2L and 1R collapsed. The member of committee visited the site on 10-06-2017 and door 1L was opened in the armed condition. However, the escape slide of 1L also collapsed after 03 minutes.

The escape chutes were examined at shop and it was found that all escape chutes were more than 15 years and crossed manufacture recommended life. The age of escape chutes were 16, 17 & two with 18 years.

1.18.4 Aircraft Recovery

a) The aircraft has been recovered in accordance with ARM (Aircraft Recovery Manual) procedures.
b) The MLGs cleaned of all debris in accordance with AMM landing gear cleaning procedures.
c) The NLG wheels, tyre assemblies & NLG axle sleeves was removed and fully cleaned to remove all debris and then visually inspected for any signs of damage.
d) The MLG wheel, tyre assemblies & Brake assemblies at axle locations 1, 2, 3, & 4 was replaced. The brake attached axle flange inspected for damage and deformation.
e) The remaining MLG wheel and tyre assemblies (at location 5, 6, 7, 8) was also removed and cleaned to remove all debris and then visually inspected for any signs of damage.
f) Performed the AMM task 05-51-16-200-001-A #inspection required after brake emergency application or overheat.
g) The MLG axle sleeves removed and fully cleaned to remove all debris and then visually inspected for any signs of damage.
h) The remaining brake assemblies (at locations 5, 6, 7, 8) inspected according to AMM task 32-42-27-210-006-A Inspection /Check of the Brake with the wheel removed.
i) Brake cooling fans cleaned and inspected as per AMM Task 32-48-00-720-001-7 before return to service. Replaced the normal servo valve #7 (80GG) in accordance with AMM 32-42-48.

j) Preformed a visual inspection of the tachometers and their assembly (drive shafts bent or damaged, mechanical interface between debris guard and driveshaft, mechanical interface between drive shaft and tachometer).

k) Performed a wiring test of the normal servo valves #1 to4 (15GG, 16GG, 17GG, 18GG) and of the alternate servo valves (40GG, 41GG, 42GG, 43GG).

l) Checked the normal and alternate servo valves associated to wheels #1 and #2 and wheel #3 and #4 are not cross connected. Checked if the tachometers associated to wheel #1 and #2 and wheel #3 and #4 are not cross connected.

m) Inspected engines for Bird Strike, Foreign object or slush ingestion inspection.

n) As the landing gear retraction test couldn't be carried out at Jammu, ferry flight was carried out on 23-06-2017 from Jammu to Delhi where the full Inspections as per AMM 05-51-24 carried out.

1.18.5 Performance limited airport

Jammu Airport is considered as performance limited airport due shorter runway and non-availability of RESA. DGCA has issued Operations Circular 02 of 2012 Rev 1 dated 26th March 2015 "Route and Aerodrome Competence Qualification".

The guidelines contained in the aforesaid circular states that "All operators shall carry out an assessment of the area of operation and categorize the aerodromes depending upon the safety risk assessment and shall define the training and qualification requirements for those aerodromes.

The Operations Manual should specify a method of categorization of aerodromes and specify the requirements necessary for each of these categories. If the least demanding aerodromes are Category A, Category B and C would be applied to progressively more demanding aerodromes. The Operations Manual should specify the parameters which qualify an aerodrome to be considered Category A and then provide a list of those aerodromes categorized as B or C".

Air India has also incorporated in their Operations Manual regarding the classification of airports according to the type of navigational facilities, aerodrome lighting and terrain in take off and approach path.

As per the Operations Manual there are three categories of airports: A, B & C wherein Jammu airport is placed under Category 'C'.

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Classification by the operator as per the DGCA Operations Circular 02 of 2012:

Category A:

a) An approved instrument approach procedure;
b) At least one runway with no performance limited procedure for take-off and/or landing;
c) Published circling minima not higher than 1000 feet above aerodrome level; and
d) Night operations capability.

Category B: An aerodrome which does not satisfy the Category A requirements or which requires extra considerations such as:

(a) Non-standard approach aids and/or approach patterns; or
(b) Unusual local weather conditions; or
(c) Unusual characteristics or performance limitations; or
(d) Any other relevant considerations including obstructions, physical layout, lighting etc.

Category C: An aerodrome, which requires additional considerations to a Category B aerodrome.

Prior to operating to a Category C aerodrome, the crew should be briefed and undertake a flight to the aerodrome as an observer and/or undertake instruction in a flight simulator with visual database. This instruction should be certified by the operator.

1.18.6 Earlier incident of Tyre Burst VT-ESL

The aircraft VT-ESL was earlier involved in the incident of tyre bust at Mumbai on 15-03-2016 wherein No.5 & No.6 tyre burst. During investigation it was found that there could be transient malfunction of Normal/Alternate Brake Servo valve which could led to inadvertent loss of brake release signals leading to momentary wheel jamming resulting tyre bust.

After the incident, Air India introduced a special weekly inspection schedule. Also, the functional /Operational check of Techogen, NWS/Antiskid System, Normal/Alternate Brake System, wheel rotation and Tyre condition check has been changed from ‘C’ check to ‘A’ check.

1.18 Useful or effective investigation techniques: NIL

2.1 ANALYSIS

2.1 Serviceability of the aircraft.

The aircraft had a valid Certificate of Airworthiness and a valid Certificate of Registration on the day of incident. The scrutiny of the Airframe Log book revealed that as on 9th June 2017 the aircraft had completed 58233:50 Airframe hours and 35596 landings .The aircraft is powered by two CFM Engines. The Engine # 1 had logged 46668:12 hrs. & 30882 cycles and Engine # 2 had logged 44984:00 hrs. & 29999 cycles since new. Scrutiny of the snag register revealed that there was no snag reported on the aircraft prior to the incident flight. Prior to incident flight the aircraft weight & balance was well within the operating limits.

The aircraft and its engines were maintained as per the maintenance program consisting of calendar period/ flying Hours or Cycles based maintenance as per maintenance program approved by DGCA. The aircraft was last weighed on 28.04.15 at Delhi, and the weight schedule was prepared and duly approved by the O/o DDG (NR), DGCA, Delhi.

After the incident, Emergency evacuation using escape chutes were carried out from 1R, 2L and 2R doors .However, after evacuation, the escape slides L2 & R1 collapsed. The member of committee visited the site on 10-06-2017 and door 1L was opened. However, the escape slide of 1L also collapsed after 03 minutes. The escape chutes were examined at shop and it was found that escape chutes were 16, 17 & two with 18 years. However, manufacture recommended age for escape chutes is 15years.

Aircraft BSCU S/N 20036 was inspected at shop, but No fault found (NFF) during shop investigation.

2.2 Weather:

The Met report issued on the date of incident indicated good weather with visibility of more than 06 Km and wind of 04 knots.

2.3 Handling of Evacuation procedures:

Emergency evacuation was carried out as per the procedure defined in airline operations manual. As per the para 11.2 (b) of Operations Manual Part B;

"It must be stressed that for persists smoke or a fire that cannot be positively confirmed to be completely extinguished, a passenger evacuation must be accomplished;"

The crew carried out evacuation of passengers immediately after landing as per the defined procedures. Passengers evacuated from both port and starboard side after cabin crew assessed both sides for safety. There was no Injury reported to any of passengers.

2.4 CVR & DFDR Readout:

The CVR and DFDR Correlation carried out and following are the salient findings:-

a) Below 500 ft RA, aircraft began to fly below the glide path.
b) During flare initiation at 55 feet RA till the touchdown, pitch angle increased from +2° to +6° then decreased progressively to +3° when nose up inputs were released.
c) Aircraft floated above runway at 2 feet RA for 4 sec.
d) As per CVR, PIC was trying to bring the aircraft to touchdown the runway.
e) The Main Landing Gear touched Runway at 064458 UTC at a distance of 2400 feet from threshold at GS 145 kt.
f) The Nose Landing Gear touched runway at 064502 UTC at 3200 feet at GS 137 kts.
g) Ground Spoilers deployed and max Reverser thrust applied.
h) Full manual breaking was applied at 064506 UTC at 4160 feet at GS 125 kts.
i) Right wheels first and left wheels tyre burst between 4000 feet to 6000 feet.
j) Anti-skid off at 064517 UTC at 6000 feet at GS 76 kts.
k) Parking brake applied for 02 sec at 064522UTC at 6400 feet at GS 45 kts.
l) Parking brake applied for 08 sec at 064525UTC at 6600 feet at GS 30 kts.
m) At 064529 UTC, aircraft went off the asphalt at GS10kts.
n) At 064533 UTC, aircraft stop at distance of 6800 feet from the threshold.
o) Vertical G at the time of touchdown was 1.2 g.

2.5 Performance limited airports Operations:

As per the operator's Operations Manual, Jammu Airport falls under the Category 'C' Airport and considered as performance limited airport due shorter runway and non-availability of RESA. However, being defence airfield, the airport is not licensed by DGCA.

To operate at Jammu Airport both the crew needs to be trained to operate at performance limited airport and training requirements are laid down in Operations Manual Part 'D'.

Airfield	P1 Training Requirement	P2 Training Requirement
Jammu	• Minimum experience of 200 hrs • 02 R/C	AIRBUS: • 300 hrs - Min Exp • 1 SNY • First Flight with a Training Captain

Both the crew are meeting the requirements and are qualified to operate at Jammu airport.

2.6 Circumstances leading to the Incident:

After take-off from Delhi airport, the en route flight was uneventful and the aircraft joined the hold to descend to carry out ILS NDB approach at Jammu. While the landing gear was selected down by PIC, "Brake Auto Brake Fault" ECAM warning message was triggered along with the failure message of "BRK NORM SERVOVLV7 (80GG)" which indicated that the servo valve for wheel 7 has malfunction. Subsequently, crew disengaged the autobrake and decided for manual braking as that is also as per the operational procedure set by the airline to land at Jammu Airport.

The flight crew voluntarily disengaged both autopilot at 770ft RA and final approach was manually handled by the PIC with the autothrust engaged and active in "SPEED" mode. At this point of time, the speed target was managed within the specified limit. Then, below 500ft RA, the aircraft began to fly below the glide and exceeded its callout value (>1/2DOT) reaching 3/4 DOT below the glide path when aircraft was at approximately 180ft RA and based on AFM/FCOM, final approach was no more stabilized. Finally, from 160 feet RA, aircraft flied back towards the glide slope.

During flare initiation at 55 feet RA till the touchdown, pitch angle increased from +2° to +6° and then decreased progressively to +3° when nose up inputs were released. Moreover, the main landing gears touched down at 2400 feet from the runway threshold point with a significant ground speed of 145 kts. Aircraft floated above the runway at 2 feet RA for 4 seconds. After touchdown, full thrust reversers were deployed on both the engines and manual braking was applied. Max brake pedal deflection was reached after 8 seconds of touchdown and maintained to full deflection upto 19 sec after touchdown, and the aircraft ground speed dropped continuously from 125 kts to 76 kts. Now the aircraft was left with a remaining runway length of 750 feet. Finally when the aircraft ground speed was 76 kts, Anti-skid was turned off. While the aircraft was on the threshold markings at ground speed of 45 kts, parking brakes were applied twice. When the aircraft left the paved surface, aircraft deceleration increased sharply. As there was no RESA for runway 36, the aircraft came close to 53 feet from the perimeter wall of the airport.

High pitch angle at touchdown, prolonged flare and low response of braking action due to the failure of servo valve along with the improper application of emergency checklist resulted into increase in the landing distance and runway overrun at Jammu airport.

3. CONCLUSIONS

3.1 Findings:

1. The Certificate of Airworthiness, Certificate of Registration and certificate of flight release of the aircraft was current/valid on the date of incident.
2. Both the pilots were qualified on type to operate the flight and were meeting the competency requirements to operate at performance limited airport, Jammu.
3. The landing was carried out by PIC and Co-pilot was PM for the flight.
4. The aircraft was cleared for landing runway 36 by ATC.

5. While the landing gear was selected down by PIC, "Brake Auto Brake Fault" ECAM warning message came. PIC continued the approach and decided for manual braking.
6. The aircraft carried out ILS approach for runway 36 under VFR condition. However, the approach was not stabilized.
7. As per the MET report the weather at the time of incident was visibility 6000 meters with winds 120/04.
8. During flare initiation at 55 feet RA till the touchdown, pitch angle increased from +2° to +6° and then decreased progressively to +3° when nose up inputs were released.
9. The aircraft floated on the runway and the main landing gears touched down at 2400 feet from the runway threshold point with a ground speed of 145 kts and landing load 1.2 G.
10. After touchdown, full thrust reversers were deployed on both the engines and manual barking was applied.
11. Four (04) main landing gear tyres (No. 1, 2, 3 & 4) burst during landing roll.
12. PIC applied parking brake (02) times as per FCOM procedure, but could not able to stop the aircraft on runway and aircraft overshoot the runway, went into the soft ground.
13. Both the Main Landing Gear and Nose landing Gear exit the end of runway 18 and came to halt at 24 feet and 74 feet respectively. As there was no RESA for runway 36, the aircraft came close to 53 feet from the perimeter wall of the airport.
14. Aircraft damages are mainly confined to both the main landing gear.
15. Passengers were evacuated using emergency escape chutes.
16. During evacuation L1 door did not open and L2, R1 & R2 were used for the emergency evacuation. Escape chutes L2 & R1 collapsed automatically after passenger evacuation.
17. The L1 escape chute burst in front of investigation team when opened in armed configuration on 10-06-2017.
18. Shop investigation revealed that the Escape chute and pressure bottles were beyond the manufacturers recommended life.
19. BSCU S/N 20036 of aircraft was inspected at shop but found No fault found (NFF) during shop investigation.

3.2 Probable cause of the Incident:

The probable cause of incident is "Delayed touchdown of the aircraft and low deceleration rate due to improper brake application resulted in tyre burst and runway overrun".

4. Safety Recommendations:

1. DGCA may reiterate safety circular highlighting the incident advising crew to carryout go around when the approach is not stabilized specially at performance limited airfields.

2. DGCA shall issue necessary instructions to all the operators for timely inspection and replacement of escape shoots before the due date.

10.08.2018
(Dinesh Kumar)
Air Safety Officer, AAIB
Member COI , VT-ESL

10/08/18
(Amit Gupta)
Director (AED),DGCA
Chairman COI , VT-ESL

Date: 10-08-2018
Place: New Delhi

PHOTOGRAPHS