FINAL INVESTIGATION REPORT ON SERIOUS INCIDENT OF M/s G0-AIR , REGISTRATION VT-WGR AT BENGALORE AIRPORT, ON 11/11/2019

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INVESTIGATOR-IN-CHARGE

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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 2017, the sole objective of the investigation of an accident shall be the prevention of accidents and incidents and not to apportion blame or liability.

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

ABBREVIATIONS

AAIB	Aircraft Accident Investigation Bureau
ACC	Area Control
ADC	Aerodrome Control
APP	Approach Control
ATC	Air Traffic Controller
ASR	Approach Control Surveillance Approach Radar
ATPL	Airline Transport Pilot License
CPL	Commercial Pilot License
DFDR	Digital Flight Data Recorder
DME	Distance Measuring Equipment
FATA	Foreign Aircrew Temporary Authorization
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rule
NM	Nautical Miles
SMGCS	Surface Movement Guidance and Control System
UTC	Co-ordinated Universal Time
VHF	Very High Frequency
VOR	VHF Omnidirectional Range

TABLE OF CONTENT

1.	Aircraft Type	Airbus A320
2.	Nationality	INDIAN
3.	Registration	VT-WGR
4.	Owner	GO-AIR
5.	Operator	GO-AIR
6.	Pilot – in –Command	ATPL/FATA HOLDER
	Extent of Injuries	NIL
7.	Co-Pilot	CPL
	Extent of Injuries	NIL
8.	Place of Incident	BANGALORE
9.	Co-ordinates of Incident Site(Location)	13.1986° N, 77.7066° E
10.	Last point of Departure	NAGPUR
11.	Intended place of Landing	BANGALORE
12.	Date & Time of Incident	11/11/2019 AT 0152 UTC
13.	Extent of Injuries	NIL
14.	Phase of Operation	LANDING
15.	Type of Incident	SERIOUS INCIDENT
(ALL TIMINGS IN THE REPORT ARE IN UTC)		

SYNOPSIS

A Serious incident occurred at Bangalore airport on 11/11/2019 at 0152 UTC of M/s Go-Air (Type -A320, Registration- VT-WGR).

Aircraft drifted to left of the Runway 09 and touched unpaved surface. After touching the ground for few seconds, aircraft made a missed approach due to which main undercarriage touched the unpaved surface resulting in stall of Engine no 1.

The aircraft made an approach into Bangalore in deteriorating weather conditions and carried out missed approach due to loss of visual reference in low visibility conditions. Aircraft diverted and landed in Hyderabad.

The occurrence was classified as a “Serious Incident” in accordance with the Aircraft (Investigation of Accidents and Incidents) Rules, 2017. DG, AAIB ordered an investigation into this occurrence vide Order INV-12011/23/2019-AAIB dated11/11/2019. In accordance with the provisions of Annex 13, Initial notification of the occurrence was sent to ICAO on 18/11/2020.

1.0 FACTUAL INFORMATION

1.1 History of the flight

On 11th November 2019, an Airbus 320 aircraft VT-WGR was involved in a Serious Incident while operating flight from Nagpur to Bangalore (VOBL). The scheduled departure time of the flight from Nagpur was 00:35 UTC with a flying time of 01:21 hours. The flight departed Nagpur at 00:24 UTC.

The aircraft made an approach into VOBL in deteriorating weather conditions and carried out a missed approach due to loss of visual references in low visibility. During missed approach, main undercarriage of the aircraft contacted the unpaved surface (kutcha) by the side of runway (within the aerodrome), followed by engine 1 stall during the missed approach. After holding for some time over VOBL, the aircraft diverted to Hyderabad (VOHS) and carried out a safe landing at VOHS. The Serious Incident occurred at 01:52 UTC.

Prior to operation of flight, remote preflight briefing was held at Nagpur by the flight crew. The briefing included weather at destination airport and alternate. The visibility at the destination was forecast at 2000 meter and a TEMPO reduction of 800 meters in Fog.

PIC was pilot flying (PF) for takeoff and landing and for the remaining phase of flight, the Co-pilot was the pilot flying. As per DATIS, the weather at VOBL at the time of approach was light winds, visibility of 200 meters, RVR as 1500 meters in Fog and cloud base reported was broken at 200 feet. The flight till approach into VOBL was uneventful. When the flight was with Approach Radar Control and the aircraft was being vectored for Runway 09, visibility and RVR were decreasing.

At 01:44:34 UTC, Radar controller transmitted “All Station Visibility 200 meters and RVR 1200 meters”. After this, no weather update was passed on by ATC. At 01:46:41 UTC, the flight was cleared for ILS approach Runway 09 and after establishing on Localizer, it was changed to tower. Though there was a

progressive drop in the visibility, the tower controller also did not pass the current RVR and visibility, when the incident flight was on final.

The PIC took over as PF and commenced approach. The aircraft was stabilized on the instrument landing system above 1000 feet AFE. The PF disconnected the Autopilot at 220 feet Radio Altitude for a manual landing. During the flare manoeuvre, he consistently applied aft side stick commands and the aircraft floated above the ground for duration of about 8 seconds while the thrust levers were brought to idle. 02 seconds prior to contact, at 20 feet RA the First Officer announced “Go Around” and the PF initiated a Go Around. The Aircraft contacted the unpaved surface on the left side of the runway (within the aerodrome) during the Go Around manoeuvre.

Subsequently, the left engine stalled due to foreign object ingestion during the transient touchdown on the unpaved surface (Kutcha), causing thrust reduction from the affected engine. The aircraft took up a holding pattern over Bangalore and subsequently diverted to Hyderabad since there was no weather improvement at Bangalore. The aircraft landed safely at Hyderabad.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor/None	06	175	Nil

1.3 Damage to the Aircraft

During walk around inspection at Hyderabad, mud and grass was observed on both LH & RH MLG wheels and brakes, No other external damage or abnormality was noticed. Externally, there were no signs of any FOD on engines. There was no damage on landing gear. Extension/ Retraction and free fall checks were satisfactory.

A full Bore Scope Inspection (BSI) of both engines was carried out. On ENG#1 heavy rub marks were observed on HPC Rotor 7 and 8 Outer Air seal. There was spallation of HPC Stator 7 Inner Air seal.

There were no observations based on the BSI of Engine #2.

1.4 Other damages

Nil

1.5 Personnel Information

1.5.1 Pilot-in-command (PF at the time of occurrence)

Age	61 YEARS
License	ATPL/FATA
Date of Issue	21-May-18
Valid up to	11-Apr-20
Category	Multi Engine (Cat-1)
Date of Class I Med. Exam.	19-Aug-19
Class I Medical Valid up to	01-Mar-20
Date of issue FRTOL License	21-May-18
FRTO License Valid up to	11-Apr-20
Endorsements as PIC	A-320
Total flying experience	20427 hours
Total flying experience on type	8568 hours
PIC experience on type	6249 hours
Last Flown on type	09-Nov-19
Total flying experience during last 30 days	58:44 hours
Total flying experience during last 24 Hours	04:27 hours
Rest period before flight	26:23 hours

1.5.2 Co-Pilot (PM at the time of occurrence)

Age	25 years
License	CPL
Date of Issue	10-Sep-15
Valid up to	09-Sep-20

Category	Multi engine
Date of Class I Med. Exam.	23-Jul-19
Class I Medical Valid up to	20-Aug-20
Date of issue FRTOL License	10-Sep-15
FRTO License Valid up to	09-Sep-20
Total flying experience	325:45 hours
Total flying experience on type	109:20 hours
Last Flown on type	09-Nov-19
Total flying experience during last 30 days	72:27 hours
Total flying experience during last 24 Hours	04:27 hours
Rest period before flight	26:23 hours
Whether involved in Accident/Incident earlier	NO

1.6 Aircraft Information

1.6.1 General

Aircraft Model	A320-271N
Aircraft S. No.	MSN 08209
Year of Manufacturer	2018
C of R	Valid
C of A	Valid
Category	NORMAL
A R C issued on	27th July 2020
ARC valid up to	25th July 2021
Maximum Take-off weight	79000 KG
Last major inspection	08th FEB 2020 (A4 Check)

List of Repairs carried out after last major inspection till date of incidence	No Major repairs or inspection

1.6.2 Post Flight Report (Maintenance)

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+--------------------+
:    MAINTENANCE     :
: POST FLIGHT REPORT :
+--------------------+

A/C ID   DATE    GMT         FLTN      CITY PAIR
.VT-WGR  11NOV   0024/0326   GOW811    VANP VOHS

WARNING/MAINT.STATUS MESSAGES
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GMT  PH ATA
0152 04 77-11 ENG 1 STALL
0155 06 22-00 AUTO FLT AP OFF (2)
0225 06 77-11 ENG 1 STALL
0324 08 34-58 NAV FM/GPS POS DISAGREE

FAILURE MESSAGES
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GMT  PH ATA                                SOURCE    IDENT.
0152 05 71-00-00 ENG1D-0041-ENG SURGE       EIU1FADEC
0155 06 22-83-34 AFS:FMGC1                  AFS 1     EIS 2
                                                      IR 1
                                                      IR 2
                                                      IR 3
0155 06 22-83-34 AFS:FMGC2                  AFS 1     EIS 2
                                                      IR 1
                                                      IR 2
                                                      IR 3
0156 06 34-41-11 WXR ANTENNA(11SQ)          RADAR 1
0200 06 34-41-33 WXR1(1SQ1)/DU ND FO        EIS 2
                 (3WT2)/DMC2(1WT2)
0226 06 22-83-34 FMGC2(1CA2)/RMP2(1RG2)     RMP1,2OR3
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1.7 Meteorological Information

Bangalore airport experiences light fog during October-November and dense fog mostly during November-December-January. Sudden changes in visibility and RVR being recorded is a common phenomenon during this period. Fog onset usually occurs between 1800 and 0300 UTC and its formation is less likely thereafter.

At Bangalore airport, visibility & RVR are continuously recorded through a software (Drishti) which has a refresh rate of 10 seconds. Latest Weather Report of the airport, together with trend forecast valid for the next 2 hours is also

broadcast on ATIS. As per Bangalore Metrological Department records, METARs were issued at 0130 UTC and 0200 UTC. In between, a SPECI was also issued at 0153 UTC.

Time (UTC)	0130	0153 (Speci)	0200
Wind	040 Degree/ 03 Kts	070 Degree/ 05 Kts	070 Degree/ 04 Kts
Visibility	200 M	100 M	50 M
RVR (09)	1500 M	125 M	125 M
QNH	1016	1016	1016
WEATHER	Haze	Haze	Haze
TREND	No Significant Change	No Significant Change	No Significant Change

Following are the relevant real time recordings by the software system. The shaded row shows the time of the Incident

S. No.	Time IST (HH/MM/SEC)	Time UTC(HH/MM/SEC)	RVR (Meter)
1	07:06:33	01:36:33	1200
2	07:07:13	01:37:13	800
3	07:10:43	01:40:43	600
4	07:10:53	01:40:53	500
5	07:11:33	01:41:33	175
6	07:11:53	01:41:53	125
7	**07:23:00**	**01:53:00**	**125**

The Terminal Area Forecast at the time of departure was as follows (of 11.11.2019):

Between 0000 to 0900 UTC - VRB 02KT 2000 BR SCT004 SCT012 TEMPO

Between 0000 to 0300 UTC - FG 800 BKN 002 SCT012 BECMG

Between 0400 to 0500 UTC - 6000 SCT012

1.8 Aids to Navigation

Frequencies of navigational aids at Bangalore are as below: -

Navigation Aid	Frequency
LLZ 09 (IBAN)	109.3 MHz
GP 09	332.0 MHz
DVOR I (BIA)	116.8 MHz
DME I	1139/1202 MHz
DVOR (BIB)	114.5 MHz
DME	1179/1116 MHz
ILS DME 09 (Co-located with GP 09)	1054/991 MHz

As per the requirements, flight navigation systems must be regularly calibrated, inspected and maintained to ensure that all essential navigation aids for pilots are always working properly. Accordingly, ILS calibration was at Bangalore was done on 27-5-2019 which was valid till 27-11-2019.

1.9 Communication

Two way communications between the ATC units and the aircraft was always maintained. Relevant portion of tape transcript of Approach (127.75 MHz) is as below:-

TIME	CHANNEL	
013358	ASR	IGO 909, VISIBILITY 200 METERS AND RVR FOR RUNWAY 09 1500 METERS
013405	IGO909	RADAR COPIED 909
013423	ASR	SEJ1035 DESCEND TO FLIGHT LEVEL 120
013426	SEJ1035	DESCEND 120 SEJ1035
013428	ASR	AND VISIBILITY 200 METER
014048	ASR	GOW811 DESCEND TO FLIGHT LEVEL 80

014051	GOW811	MAM DESCEND TO 80 GOW811
014151	ASR	GOW811 DESCEND TO 7000 FEET QNH 1016 TRANSITION LEVEL FLIGHT LEVEL 80
014157	GOW811	DESCNED 7000 1016 QNH TRANSITION FLIGHT LEVEL 80 GOW811
014226	ASR	GOW811 REDUCE SPEED TO 210 KNOTS
014228	GOW811	SPEED 210 GOW811
014311	ASR	GOW811 DESCEND TO 5900 FEET
014314	GOW811	5900 FEET GOW811
014316	ASR	25 MILES FROM TOUCHDOWN REDUCE SPEED TO 180 KNOTS
014436	ASR	ALL STATIONS VISIBILITY 200 METERS, RVR 1200 METERS
014637	ASR	GOW811 LEFT HEADING 120 CLEARED FOR ILS APPROACH RUNWAY09
014641	GOW811	LEFT 180 CLEARED FOR ILS 09 GOW811
014757	ASR	GOW811 ON LOCALIZER
014802	**GOW811**	**GOW811 ON ILS MAM**
014804	ASR	ROGER 10 MILES FROM TOUCHDOWN CONTACT TOWER 124.35

Relevant portion of tape transcript of Tower on frequency 124.35 MHz

TIME	**CHANNEL**	
014623	SEJ1035	TOWER NAMASKAR SEJ1035 ON ILS 09 MILES
014637	SEJ1035	CLEARED TO LAND 09 CORRECTION CONTINUE APPROACH SEJ1035
014737	TWR	SEJ1035 RUNWAY09 CLEARED TO LAND WIND CALM
014741	SEJ1035	CLEARED TO LAND 09 SEJ1035

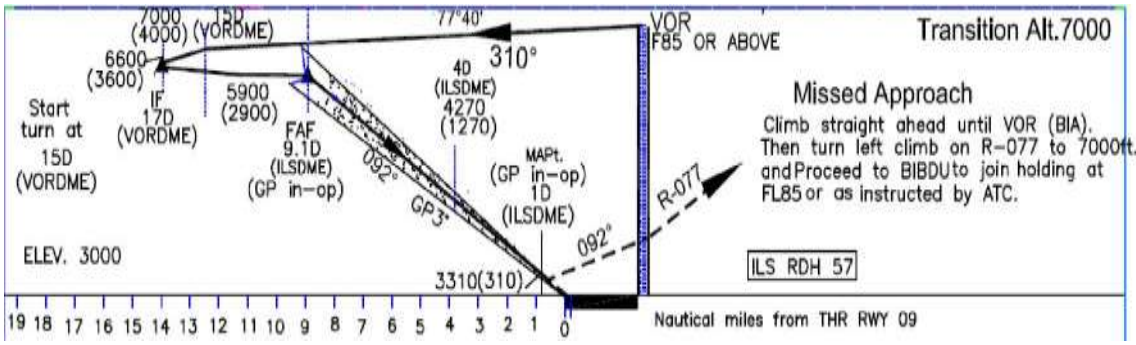
014832	GOW811	TOWER GOW811 NAMASKAR ON FINAL
014836	TWR	GOW811 BANGALORE TOWER NAMASKAR CONTINUE APPROACH RUNWAY09 WIND CALM
014840	GOW811	CONTINUE APPROACH GOW811
014921	SEJ1035	GOING AROUND
014931	TWR	SEJ1035 CONFIRM GOING AROUND
015001	TWR	GOW811 RUNWAY09 CLEARED TO LAND WIND CALM
015006	GOW811	CLEARED TO LAND RUNWAY09 GOW811
015217	TWR	GOW811 CONFIRM GOING AROUND
015220	GOW811	BANGALORE GOW811 GOING AROUND
015222	TWR	GOW811 ROGER CLIMB INITIALLY 7000 CONTACT AND APPROACH RADAR 127.75
015228	GOW811	12775 GOW811

1.10 Aerodrome Information

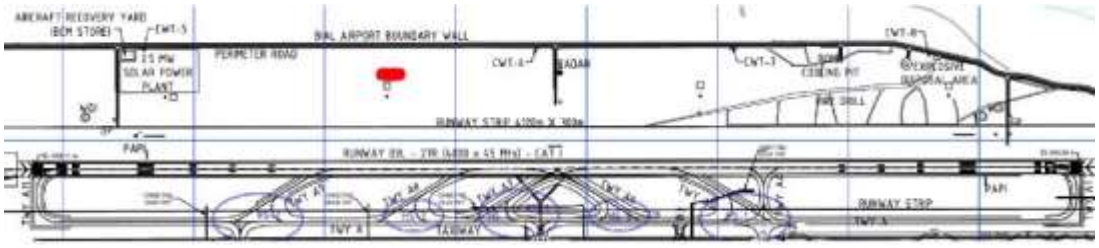
Bangalore Airport (Kempegowda International Airport (IATA: BLR, ICAO: VOBL)), is owned and operated by Bangalore International Airport Limited (BIAL). It has got a single Runway with orientation as 09/27. The dimensions of runway are 4000 m x 45 m. Runway 09 is installed with ILS and is a CAT I runway with only runway edge lights available. It does not have center line lights.

VOBL AD 2.14 APPROACH AND RUNWAY LIGHTING

Runway Designator	Type, length and intensity of approach lighting system	Runway threshold lights, colour and wing bars	Type of visual slope indicator system	Length of runway touchdown zone lights
1	2	3	4	5
09	CAT I 900 M	Green	PAPI LEFT/3.00 DEG MEHT (63.75FT)	
27	CAT I 900 M	Green	PAPI LEFT/3.00 DEG MEHT (64.30FT)	



Missed approach procedure at Bangalore airport



The Bird Chaser who was positioned near A-8 northern shoulder (shown by red dot) reported that at the time the aircraft touched down, the visibility was low with dense fog. He could not see the aircraft but heard the sound of engines which was very loud. The Bird chaser immediately reported to the shift in-charge that an aircraft has flown just above his location.

1.11 Flight Recorders

The CVR recording was available and has been used for investigation purposes. In addition to FDR analysis, the FDR readout was also shared with the OEM (Airbus) and a handling report was received from them. The following is the factual data information from the report. The aircraft carried out an ILS approach to runway 09 at Bangalore.

At 1000 ft RA (01:50:40 UTC),

- The aircraft configuration was
  - >Gross weight - 65.2t
  - >CG at 30.6%
  - >Aircraft in CONF FULL with Slats as 27° & Flaps as 40°
  - >Landing gear selected down

> Ground spoilers armed

> Auto-brake “LOW” mode was armed

Both autopilots (APs) and Flight Directors (FDs) were engaged in “G/S” (vertical) and “LOC” (lateral) modes.

- Speed

  > Auto-thrust (A/THR) was active in “SPEED” mode

  > Recorded VLS was 128kts

  > Speed target was managed at 136kts (VLS+8kts)

  > CAS was 136kts (speed target).

- Attitude and trajectory

  > Rate of descent was approximately 700ft/min

  > Pitch angle was +2.5° (nose up)

  > Heading was 091°

  > Drift angle was +1° (aircraft nose toward the left of the track)

  > The aircraft was on the glide slope and the localizer

From 1000ft RA (01:50:40 UTC) to APs disengagement at 220ft RA (01:51:46 UTC)

- On the longitudinal axis

  > Pitch angle varied between +2.5° and +3.5° (nose up)

  > Speed target was managed at 136kt

  > CAS varied between 135kt (speed target-1kt) and 137kt (speed target+1kt)

  > Rate of descent varied between 750ft/min and 650ft/min

  > No significant vertical load factor variation

  > Aircraft was on the glide slope

- On the lateral axis

  > No significant variations on aircraft lateral axis

  > Aircraft was stabilized on the localizer

From APs disengagement (01:51:46 UTC) to flare initiation at 45ft RA (01:51:59 UTC),

- On the longitudinal axis
  - CM1 nose-up side-stick input reached ~1/5 of full nose-up deflection
    - Pitch angle was around +3.0° (nose up)
  - Rate of descent varied between 700 ft/ min and 600 ft/ min
  - No significant vertical load factor variation
  - Speed target was still managed at 136kt
  - CAS varied between 135 kts (speed target-1kt) and 137 kts (speed target+1kt)
  - Aircraft was on the glide slope
- On the lateral axis
  - CM1 side stick input reached ~1/5 of full left deflection
    - Roll angle reached -3.5° (left wing down)
  - No significant rudder pedal input was applied
  - Heading varied between 089° and 092° (QFU 092°)
  - No significant drift angle
  - No significant lateral load factor variation
  - Aircraft was on the localizer

From flare initiation at 45ft RA (01:51:59 UTC) to touchdown (01:52:15 UTC)

- On the longitudinal axis
  - At ~45ft RA, flare was initiated by CM1 with a ~2/3 of full nose-up input followed by a continuous nose-up order up to ~4/5 of full deflection
    - Pitch angle increased step by step from +3° to +6°, then to +7.5° and finally to +8.5°.
  - Vertical load factor increased from +1.00G to +1.15G then decreased to +0.90G before increasing again up to +1.00G.
  - Rate of descent decreased from 600ft/min to 100ft/min, then increased up to 600ft/min before touchdown.

> At 01:52:03 UTC (~25ft RA), thrust levers were retarded to “IDLE” leading to A/THR disconnection.

> CAS decreased from 136kt (speed target) to 120kt (speed target-16kt).

> At 01:52:12 UTC (~20ft RA), a go-around was initiated as thrust levers were pushed to “TOGA”.

- On the lateral axis

> CM1 side-stick input varied between ~1/3 of full left and half of full right deflection.

  - Left roll angle increased from -2° to -11° before decreasing to -1° before touchdown.

> Leftward rudder pedal inputs were applied up to ~1/4 of full deflection then rightward rudder pedal orders were applied up to half of full deflection.

  - Heading decreased from 089° to 078° then increased to 087° (QFU 092°).
  - Drift angle increased from +1.0° to +4.5° (aircraft nose toward the left of the track) then reversed to -8.0° (aircraft nose toward the right of the track) reached at touchdown.

> Lateral load factor varied between +0.05G and -0.10G.

> Localizer deviation started to increase and reached ~3.5DOT to the left of the localizer at touchdown.

At 01:52:15 UTC (Touchdown)

- On the longitudinal axis

> +8° of pitch angle.

> -7ft/s (±2ft/s) of recalculated aircraft vertical speed.

> +1.80G of vertical load factor.

> CAS 120kt (VLS-8kt).

- On the lateral axis

> -1° of roll angle (left wing down).

> 087° of heading (QFU 092°).

> -8° of drift angle (nose toward the right of the track).

>-0.40G of lateral load factor.

From touchdown (01:52:15 UTC) to lift-off (01:52:19 UTC)

- On the longitudinal axis

>Main landing gears were recorded compressed for ~3.5s.

>PF continued to apply a nose-up order up to full back stick. CM2 applied a nose-up order up to ~1/3 of full deflection.

- Pitch angle reached +5.5° then started to increase.

>Vertical load factor varied between +0.65G and +1.30G.

>CAS was around 120kt (VLS-8kt).

>Master Warning triggered on ground.

- On the lateral axis

>PF applied a right roll order up to ~3/4 of full deflection. CM2 applied some slight left roll orders.

- Roll angle reached -2° (left wing down) then reversed and right roll angle increased.

>Rightward rudder pedal order continued to be applied up to half of full deflection.

- Drift angle stabilized around -8.0° (aircraft nose toward the right of the track).

>Lateral load factor varied between -0.55G and +0.40G.

>Localizer deviation continued to increase and up to ~4.5DOT to the left of the localizer.

1.12 Wreckage & Impact Information

The images below show clear marks of the main gear rolling on the unpaved surface (Kutcha).

There was also a pile of rubble and a tower which were in the offset trajectory of the aircraft while it was on the ground.

The aircraft was airborne well before the tower and had turned right immediately after getting airborne.

The tower would not have been visible to the crew given the prevailing visibility.

Tyre Marks

1.13 Medical & Pathological Information

The flight crew had undergone pre-flight medical examination at Nagpur prior to take off. The Pre Flight Medical Report was satisfactory and Breath analyser test was negative.

1.14 Fire

Nil

1.15 Survivable Aspect

The incident was survivable.

1.16 Test & Research

Nil

1.17 Organisational & Management Information

1.17.1 Meteorological Services at Bangalore

The Meteorological Services for civil aviation are provided by the India Meteorological Department (IMD). At Bangalore Airport weather is available for 24 Hrs. As per procedure, METAR is issued every 30 minutes in which Time, Wind, direction/ Speed, Visibility, RVR, Cloud, Trend etc is given. If some significant change is observed in weather condition like change in Visibility, RVR or warning etc a SPECI (Local special report) is issued in between METARs. Latest Weather Report of the airport, together with trend forecast valid for the next 2 hours is broadcasted on ATIS. Dristhi software is installed at the airport. It monitors real time change in Visibility and RVR.

As per Meteorological Department records, METAR were issued at 0130 UTC and 0200 UTC when visibility and RVR were 200m/1500m and 50m/125m respectively. In between the above METARs, a SPECI was also issued at 0153 UTC with visibility and RVR as 100m/125m.

SPECI - Special METAR

A SPECI is the same as a METAR but issued when the following criteria is met·

WIND :

1 Mean surface wind direction has changed by 60 degrees or more, the mean wind speed before and/or after the change being **10Kt** or more
2 Mean surface wind speed has change **by 10Kt** or more, in the latest METAR.
3 Wind Gusts have increased by **10Kt or** more, the mean wind speed before and/or after the change being **15Kt** or more.

VISIBILTY
4.Visibility changes to or pass:

a Visibility **800,1 500,3 000 or 5000 meters**

b. 550,1200,2000,2500,4000 meters Additional speci

5.Runway visual range (RVR) changes to or pass 150, 350, 600, 800m.

SIGNIFICANT WEATHER :
6 When any combination of **weather in the** significant begins, ends or changes intensity.(**Precipitation, thunderstorm, squall)**

BASE OF THE CLOUD :
7. Height of the base of the lowest cloud layer of BKN or OVC extent, changes to or passes.
a **100, 200, 500 or 1000 or 1500ft (30 or 60 or 150 or 300 or 450 meters)**
When the amount of cloud below 1500ft changes from:
a. **SKC, FEW, SCT to BKN or OVC**
b **BKN or OVC to SKC, FEW, SCT**

TEMPERATURE:
9. Increase in temperature of **2 degrees** Celsius or more.

RVR reporting

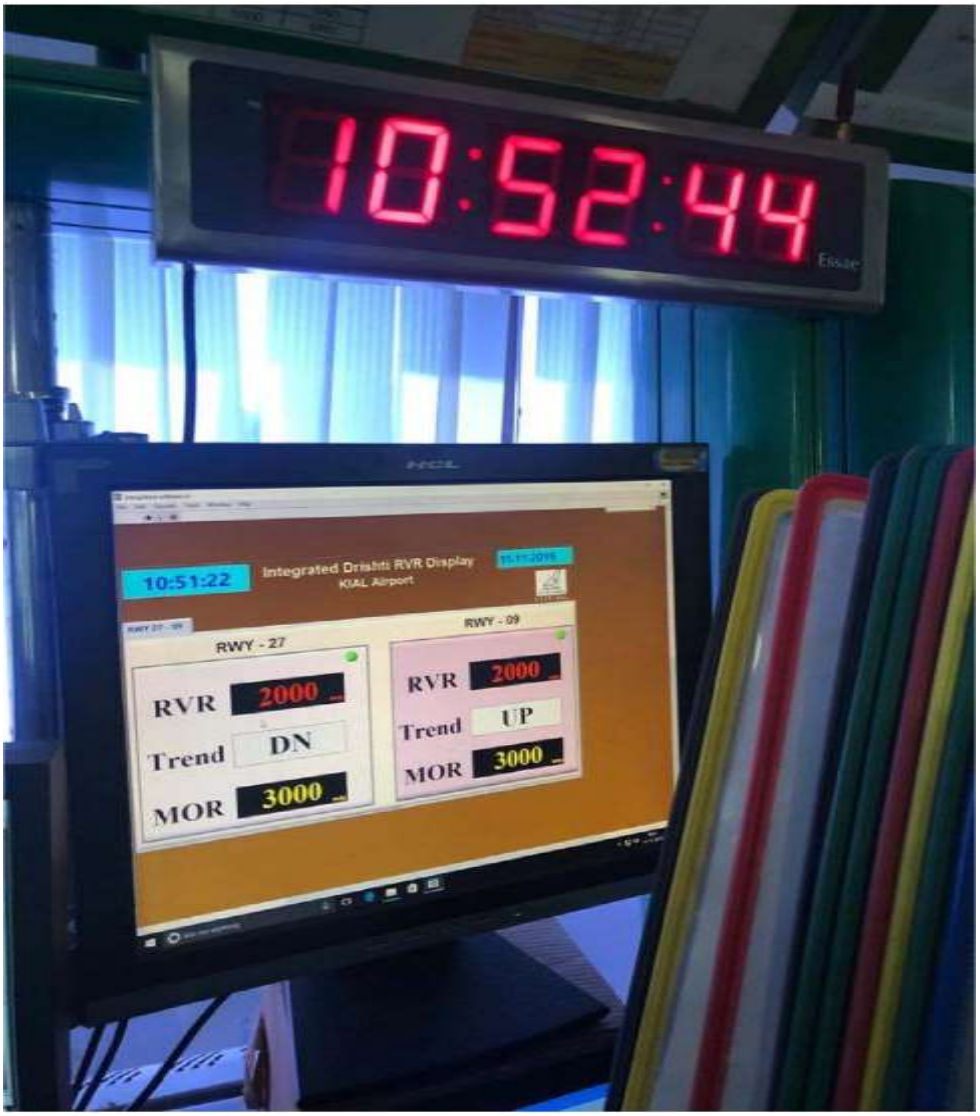
METAR : R09/0450 R27/0500 (4DIGITS)

MET REPORT RVR **RWRY09 450M RWRY27 500M (3 DIGITS)**

W1/W'	x:	ww Presentwx
0	**Half or less through**	**00 — cloud not observed/not visible**
1	**— more than half and less than half partly**	**01 becoming** less
2	--- **more than half through**	**02 no change**
		03 forming or developing

Drishti Display at Approach Controller:

A separate screen is kept at the approach controller station, where current weather is displayed. A time lag of 82 seconds in the Dristhi display and actual UTC time display was observed.



Time lag between actual UTC window and Dristhi display (Approach position)

The Drishti Weather Display is not in clear line of sight for the approach controller. The display is obstructed with shift folders placed between the approach controller and the display. The controller would need to turn in order to view the display for any weather change/ update.

Hindrance in Viewing Weather Screen

IMD has issued a circular for issuing a SPECI, which requires that whenever RVR changes to or crosses the limits i.e. 150 m, 350 m, 600 m and 800 m. But in this case, the SPECI was not issued at 0141 UTC when RVR decreased to 125 m. It was found from real time weather pick up that RVR decreased from 1200 m to 125 m in about 5 1/2 minutes. At that time, the subject aircraft was changed over from approach to tower.

Drishti Display at Tower Controller

A separate screen is kept in tower controller position, where current weather is displayed and there is also a person who mans the position. Tower met officer gives a hand written METAR /SPECI to the tower controller who in turn passes the current weather to the aircraft. When the weather is deteriorating, a senior MET officer is required to be present in the tower, but on investigation, it was found that due to the shortage of manpower, this is often not done.

1.17.2 Airline Operator

The Operator is a Scheduled Airline Service Operator and holds a valid Permit.

(A) Organisational Structure of the Flight Operations Department

As per the approved organisation structure for Flight Operations, the Director Flight Operations (DFO) has all relevant support departments and functions reporting to him. The position of a Vice President is placed above the DFO in reporting line to the Accountable Manager. The reporting line for the DFO is dotted to the Accountable Manager, while he remains a direct report to the Vice President Flight Operations.

Monitoring of Weather Minima Violations by Flight Safety Department

As per the requirements, the Operators Flight Safety Department is required to investigate all weather minima violation reports filed by operation department. All arrival and departure messages (relevant to the occurrence) shall be appended with the relevant METAR. These shall be assessed by the Chief of Flight Safety and if any violations are noticed, the same should be communicated to DFO for corrective action. Minima violation reports were not available with the Flight Safety Department.

(B) Regulatory Oversight of the Operator

Special Audit Findings

A Special Audit was conducted on the Airline by the DGCA from 1st July 2019 to 4th July 2019. The DGCA observed two Level 1 findings and ten Level 2 findings. A Corrective Action Report prepared by the Airline on 22 August 2019, was submitted to the DGCA. As on 25th August 2020, the Airline had yet not received confirmation on whether corrective actions taken by the airline via the report submitted were acceptable to the DGCA.

Main Base Inspection

A Main Base Inspection by the DGCA was carried out from 22 July to 26 July 2019. Vide their report dated 7th August 2019, serious concerns which included 12 Level 1 Findings and 54 Level 2 findings were raised. The target date for closure of the audits was stated as 14 Aug 2019 for Level 1 and 07 September 2019 for the Level 2 findings. The Airline submitted a response dated 13 August 2019 which was received at DGCA on 16 August 2019.

However, as on 25th August 2020, the Airline had yet not received confirmation on whether corrective actions taken by the airline submitted through the ATR were acceptable to the DGCA or not.

(C) Flight Planning at Dispatch

As per the Dispatch Manual, the duties and responsibilities of Flight Dispatcher shall conform to CAR Series "M", Section 7, Part II. He should have all information latest by two hour prior to aircraft departure time.

- He has to collect the latest meteorological data from the concerned agencies and thoroughly analyse the possible effects of the weather on the route to be flown in the light of meteorological reports and forecasts for the destination and alternate aerodromes; recent weather reports and forecasts for the route and areas adjacent to it; and current weather charts.
- Ensure that a flight is planned to depart only when current meteorological reports or a combination of reports and forecasts indicate that conditions at the airport of intended landing, or where a destination alternate is required, at least one destination alternate airport will, for a period of one hour before and after the estimated arrival time, be at or above operating minima.
- Ensure that before a flight is commenced, meteorological conditions and expected delays are taken into account.

Flight Planning during FOG

During winter which is likely to cause disruption in flight operations mainly due to FOG (Low Visibility), it is imperative that the Managers in the respective shifts maintain a fog watch for flights in our network and notify OCC/ Rostering via Email followed by telecom at least 24 hours in advance to enable them roster CAT-III crew which can possibly avoid an unnecessary diversion. The following points should be considered while sending a FOG watch message:-

a) Fog Watch is applicable for the next / approaching 12 hours.
b) Fog Watch is based primarily on the TAF and any other official Weather source.
c) If the TAF is expected to fall below CAT 1 minima, the respective station must alert crew scheduling, (local and Mumbai), in advance.
d) Nodal Officers nominated from time to time in Roster and Flight Dispatch is to be intimated.
e) Fog Watch Email is to be originated by Manager-Flight Dispatch on a daily basis for at time 1300 UTC for all the fog affected stations.

Adverse Weather Watch

An Adverse Weather Watch will continue to be maintained and emails generated only for the station where adverse weather is prevalent OR forecasted.

1.18 Additional Information

1.18.1 CAR section 8 Series C Part I

(i) For Category I (CAT I)

A decision height not lower than 60 m (200 ft) and with either a visibility not less than 800 m or a runway visual range not less than 550 m;

(ii) Para 4.5 Approach and Landing Conditions

Before commencing an approach to land, the PIC must satisfy himself/ herself that, according to the information available to him/her, the weather

at the aerodrome and the condition of the runway intended to be used should not prevent a safe approach, landing or missed approach, having regard to the performance information contained in the Operations Manual.

(iii) Para 4.6.1

The PIC shall not commence an instrument approach if the reported RVR/ Visibility is below the applicable minimum.

(iv) Para 4.6.2

If, after commencing an instrument approach, the reported RVR/ Visibility fall below the applicable minimum, the approach shall not be continued:

(a) Below 1 000 ft above the aerodrome; or

(b) Into the final approach segment.

(v) Para 11.3.6: VISUAL REFERENCE

A pilot may not continue an approach below MDA/MDH unless at least one of the following visual references for the intended runway is distinctly visible and identifiable to the pilot

(a) Elements of the approach light system;

(b) The threshold;

(c) The threshold markings;

(d) The threshold lights;

(e) The threshold identification lights;

(f) The visual glide slope indicator;

(g) The touchdown zone or touchdown zone markings;

(h) The touchdown zone lights;

(i) Runway edge lights

1.18.2 A-320 Auto-land Capability in CAT 1

As per the Airbus 320 Flight Crew Technique Manual, the crew are advised to plan the approach using the best approach capability available. This is normally the CAT 3 DUAL with Auto-land depending on the aircraft status. The crew then assess the weather and plan a possible downgrade capability if applicable. For

Bangalore Runway 09, the approach category would be CAT 1 ILS and the aircraft would have been flown down to CAT 1 ILS minimum Altitude to sight the runway and continue for either a manual or automatic landing (Auto-Land).

The FCTM extract below states the Auto-land capability for CAT 1 as possible with precautions.

APPROACH STRATEGY (FCTM)

Regardless of the actual weather conditions, the crew should plan the approach using the best approach capability. This would normally be CAT 3 DUAL with Autoland, depending upon aircraft status. The crew should then assess the weather with respect to possible downgrade capability.

Conditions	CAT I	CAT II	CAT III	
			WITH DH	NO DH
Flying technique	Manual flying or AP/FD, A/THR	AP/FD, A/THR down to DH	AP/FD/ATHR and Autoland	
Minima & weather	DA (DH) Baro ref Visibility	DH with RA RVR		
Autoland	Possible with precautions	Recommended	Mandatory	

The precautions in the table above are explained in FCOM Limitations chapter.

"Automatic landing system performance is demonstrated with CAT II or CAT III ILS/MLS airport installation. However, automatic landing in CAT I or better weather conditions is possible on CAT I ground installations or on CAT II/III ground installations when ILS/MLS sensitive areas are not protected, if the following precautions are taken:

- *The airline checked that the ILS/ MLS beam quality, and the effect of the terrain profile before the runway has no adverse effect on AP/FD guidance. Particularly, the effect of terrain profile within 300 m before the runway threshold must be evaluated*
- *The flight crew is aware that LOC or G/S beam fluctuations, independent of the aircraft system, may occur. The PF is prepared to immediately disconnect the autopilot, and to take the appropriate action, should not satisfactory guidance occur*

- *At least CAT2 capability is displayed on the FMA and the flight crew uses CAT II/III procedures*
- *Visual references are obtained at an altitude appropriate for the CAT I approach. If not, a go-around must be performed. "*

Airbus has provided adequate reference for the operator to adopt the feature of Auto-land in CAT 1 or better visibility and left it to the Operator to carry out the required assessment to include this capability to their operations. The Auto-land feature provides for enhanced monitoring of the Auto-land functions and continuing to keep visual reference throughout the landing. It proves to be an enhancement to situational awareness when operating in inclement weather conditions.

1.18.3 Flight Plan (first Page)

FLIGHT & FLIGHT PLAN DETAILS

FLT NO	ORIG	DEST	ETD	ETA	EST BLK	ATD	ATA	ACT BLK
GOW811	VANP	VOBL	00:35Z	02:12Z	01:37			
	LCL DATE	UTC DATE	STD	STA	SCH BLK	A/B	T/D	FLT TIME
	11-Nov-2019	11-Nov-2019	00:30Z	02:15Z	01:45			

AIRCRAFT DETAILS							
A/C REGN	EQUIP	TYPE	ENGINES	PERF FACTOR	DSR	BAY NO	FIC/ADC
VT-WGR	A320-271N	NEO	PW1127GA	1.05 %	2.049		

OTHER DETAILS								
PLAN ID	COMP AT	VALID TILL	GRIB	CRZ ISA DEV	AVG WCP	MAX SHEAR	COST INDEX	TANKERING
541641	102341Z	120600Z	101800Z	11	M011	3/VOMF/VA BF	09	YES

SIGNIFICANT AIRCRAFT MEL / CDL INVOKED		
MEL/CDL NO	DEFECT DETAILS	FLT PLAN LIMITS / CORRN
MEL : 33-40-07A	LOGO LIGHT INOP IN BOTH POS	

ALTERNATES			
DEST ALTN1	DEST ALTN 2	ENR ALTN	T/O ALTN
VOHS	VOMM		

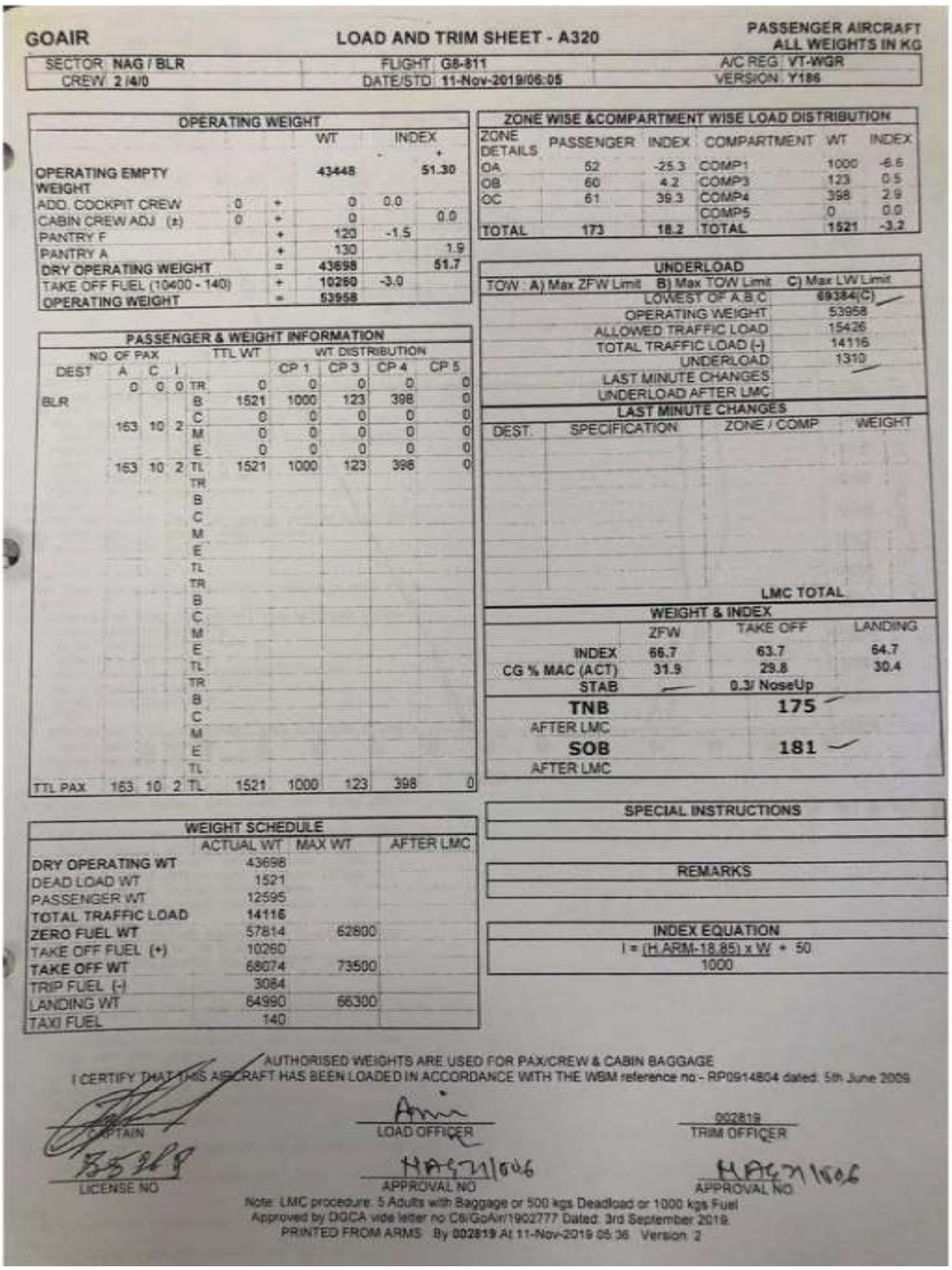
FUEL PLAN				PLANNED WEIGHTS - KGS			
	FUEL (KG)	TIME (HH:MM)	DIST (NM)		LIMIT	PLANNED	ACTUAL
TAXI OUT(A)	00140	00:11	--	OEW	43448		
TRIP	03084	01:21	0503	PAYLOAD	19352	14852	
ENR RES 5% (MIN 15Q)	00155	00:05	--	ZFW	62800	58300	
ALTN VOHS (B1)	01676	00:42	245	FUEL	18622	10400	
ALTN VOMM (B2)	01194	00:31	143	TKF WT	73500	68540	
FINAL RES (HOLD) (C)	00840	00:30	--	TRIP		03084	
APU BURN	00040	--	--	LDG WT	66300	65456	
MIN SEC FUEL (D1)	05935	02:33		MLW LIMITED TOW		69384	
MIN SEC FUEL (D2)	05453	02:22		EZFW		58300	
EDTO ADDL FUEL	N.A						
COMPANY EXTRA (X)	00300	00:10		MAX FUEL UPLIFT POSSIBLE		11084	
DISCRETIONARY FUEL (E)	--			EDTO CRITICAL FUEL		N.A	
TANKERING FUEL (F)	04100						
TOTAL FUEL(H1) (D1+X+E+F)	10400			PLANNED FL			
TOTAL FUEL(H2) (D2+X+E+F)	09900			FOB			
MDF (B1+C)	02516						

REMARKS:
OFP COMPUTED WITH TANKER FUEL OF 4100 KG

I CERTIFY THAT ALL MY LICENCES, RATING ETC., ARE VALID CURRENT AND I AM LEGALLY AND MEDICALLY _____ FOR THE OPERATION OF MY ROSTER DUTIES.

		V.D.Patw
NAME OF PIC :SERGEY T	NAME OF F/O :BURZIN DARUWALLA	VIVEK PATASKAR
DATE/TIME: BA TEST NO:	DATE/TIME: BA TEST NO:	NAME OF DISPATCHER

1.18.4 Load and Trim Sheet



GOAIR — **LOAD AND TRIM SHEET - A320** — PASSENGER AIRCRAFT, ALL WEIGHTS IN KG

SECTOR	NAG / BLR	FLIGHT	G8-811	A/C REG	VT-WGR
CREW	2 /4/0	DATE/STD	11-Nov-2019/06:05	VERSION	Y186

OPERATING WEIGHT

			WT	INDEX	+ / -
OPERATING EMPTY WEIGHT			43448		51.30
ADD. COCKPIT CREW	0	+	0	0.0	
CABIN CREW ADJ (±)	0	+	0		0.0
PANTRY F		+	120	-1.5	
PANTRY A		+	130		1.9
DRY OPERATING WEIGHT		=	43698		51.7
TAKE OFF FUEL (10400 - 140)		+	10260	-3.0	
OPERATING WEIGHT		=	53958		

ZONE WISE &COMPARTMENT WISE LOAD DISTRIBUTION

ZONE DETAILS	PASSENGER	INDEX	COMPARTMENT	WT	INDEX
OA	52	-25.3	COMP1	1000	-6.6
OB	60	4.2	COMP3	123	0.5
OC	61	39.3	COMP4	398	2.9
			COMP5	0	0.0
TOTAL	173	18.2	TOTAL	1521	-3.2

UNDERLOAD

TOW : A) Max ZFW Limit	B) Max TOW Limit	C) Max LW Limit
	LOWEST OF A,B,C	69384(C)
	OPERATING WEIGHT	53958
	ALLOWED TRAFFIC LOAD	15426
	TOTAL TRAFFIC LOAD (-)	14116
	UNDERLOAD	1310
	LAST MINUTE CHANGES	
	UNDERLOAD AFTER LMC	

PASSENGER & WEIGHT INFORMATION

DEST	NO. OF PAX A	C	I		TTL WT	WT DISTRIBUTION CP 1	CP 3	CP 4	CP 5
	0	0	0	TR	0	0	0	0	0
BLR				B	1521	1000	123	398	0
				C	0	0	0	0	0
	163	10	2	M	0	0	0	0	0
				E	0	0	0	0	0
	163	10	2	TL	1521	1000	123	398	0
				TR					
				B					
				C					
				M					
				E					
				TL					
				TR					
				B					
				C					
				M					
				E					
				TL					
				TR					
				B					
				C					
				M					
				E					
				TL					
TTL PAX	163	10	2	TL	1521	1000	123	398	0

LAST MINUTE CHANGES

DEST	SPECIFICATION	ZONE / COMP	WEIGHT
		LMC TOTAL	

WEIGHT & INDEX

	ZFW	TAKE OFF	LANDING
INDEX	66.7	63.7	64.7
CG % MAC (ACT)	31.9	29.8	30.4
STAB		0.3/ NoseUp	
TNB		175	
AFTER LMC			
SOB		181	
AFTER LMC			

WEIGHT SCHEDULE

	ACTUAL WT	MAX WT	AFTER LMC
DRY OPERATING WT	43698		
DEAD LOAD WT	1521		
PASSENGER WT	12595		
TOTAL TRAFFIC LOAD	14116		
ZERO FUEL WT	57814	62800	
TAKE OFF FUEL (+)	10260		
TAKE OFF WT	68074	73500	
TRIP FUEL (-)	3084		
LANDING WT	64990	66300	
TAXI FUEL	140		

SPECIAL INSTRUCTIONS

REMARKS

INDEX EQUATION

$$I = \frac{(H.ARM-18.85) \times W}{1000} + 50$$

AUTHORISED WEIGHTS ARE USED FOR PAX/CREW & CABIN BAGGAGE

I CERTIFY THAT THIS AIRCRAFT HAS BEEN LOADED IN ACCORDANCE WITH THE WBM reference no:- RP0914804 dated: 5th June 2009

CAPTAIN — LICENSE NO 35918

LOAD OFFICER — APPROVAL NO HAG/1/006

002819 TRIM OFFICER — APPROVAL NO HAG/1/006

Note: LMC procedure: 5 Adults with Baggage or 500 kgs Deadload or 1000 kgs Fuel
Approved by DGCA vide letter no: CS/GoAir/1902777 Dated: 3rd September 2019.
PRINTED FROM ARMS By 002819 At 11-Nov-2019 05:36 Version: 2

1.18.5 FCTM/ FCOM references

FCTM - OPERATIONAL RECOMMENDATIONS

In normal operations, the rudder should only be used during landing flare in case of crosswind for de-crab purposes.

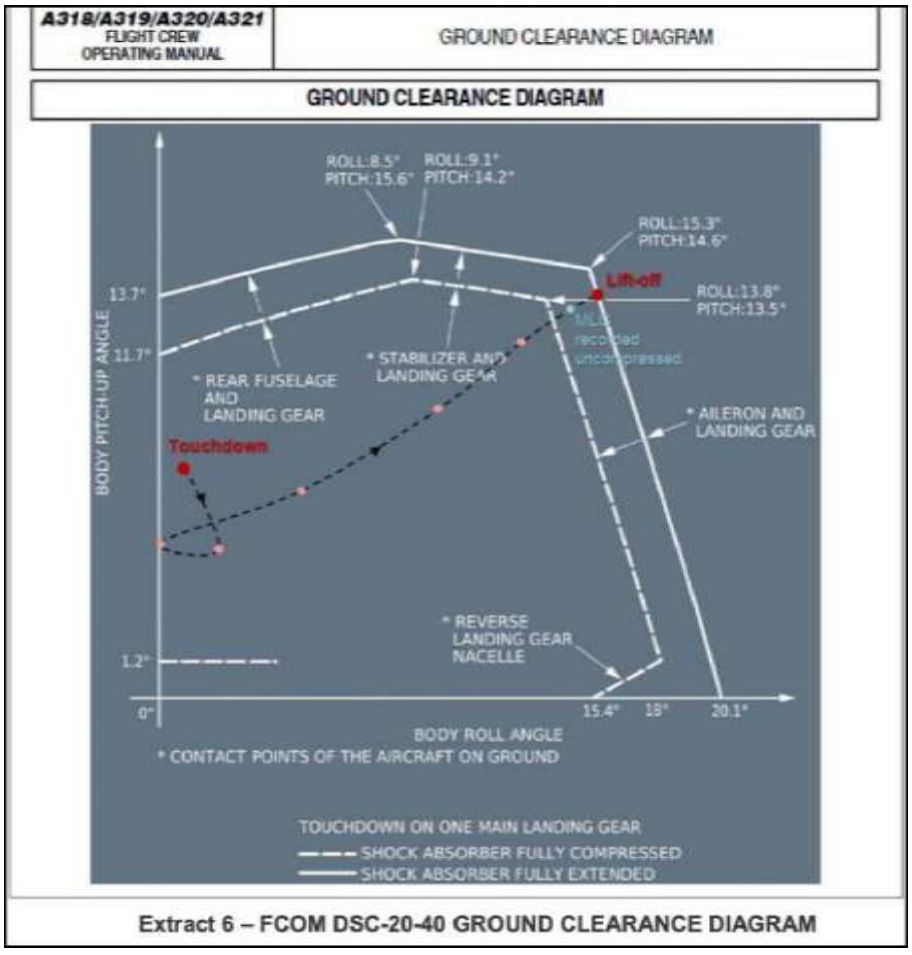
FCTM - CONSIDERATIONS ABOUT GO-AROUND

The flight crew must consider performing a go-around if the stability is not maintained until landing or if adequate visual references are not obtained at minima or lost below minima

FCOM - FLIGHT PARAMETERS

PM's role of "actively monitoring" is very important: PM shall announce "BANK BANK" when the roll angle increased above 7°.

FCOM - Ground Clearance



Extract 6 – FCOM DSC-20-40 GROUND CLEARANCE DIAGRAM

1.19 Useful or Effective Investigation Techniques

Nil

2. ANALYSIS

2.1 General

The aircraft had a valid Certificate of Registration and Certificate of Airworthiness. All maintenance schedules, mandatory modifications and checks were carried out as per the requirements. There were no defects / snags pending rectification, apart from the aircraft Logo Light (unserviceable), which had no bearing on the incident.

The crew were licensed and qualified to operate the aircraft. The First Officer was not cleared for supervised Take-off and landing for the sector. This was the crew's first flight for the day and they had received adequate rest and were within the operators' flight duty time limitations to operate the flight.

The flight Dispatch documents were prepared as per the regulatory requirements and the crew were satisfied with the pre-flight documentations and fuel uplift. The Load and Trim of the aircraft was as per the requirements for the flight sector.

2.2 Meteorological and Environmental Aspects

The TAF (Terminal Aerodrome Forecast) provided to the crew at the time of departure was as below. The time of approach for the aircraft was 01:50 UTC. This would mean the aircraft was to arrive with a forecast visibility of 800 metres in Fog and a cloud base broken at 200 feet.

1100/1109 VRB02KT 2000 BR SCT004 SCT012

TEMPO ***1100/1103 0800 FG BKN002*** SCT012 BECMG

1104/1105 6000 SCT012

The METARS show a rapid deterioration of the visibility right up to the point the aircraft commenced approach. Bangalore airport, at this time of the year usually experiences morning fog which intensifies at sunrises.

The Operations Manual Part C for Go Airlines does not cover Bangalore airport. The phenomenon of likely rapid reduction in visibility would not be known to a

pilot who has not flown in these geographic regions earlier. The PF relied on the Terminal forecast provided to him which reported marginal visibility and a low cloud base to make an approach into Bangalore ILS 09.

The actual RVR at the time of the approach reduced very rapidly to 125 meters. The time of the incident was just after Sunrise and the Sun was positioned at 14 degrees above the horizon and at a bearing of 112 degrees (20 degrees to the right of the runway alignment). This would have further impacted the already reduced visibility.

The image below illustrates the position of the sun relative to the horizon.

2.3 ATC Management in Deteriorating Weather

The Local Standby was declared at 2300 UTC of 10th November, when the visibility was 2000 meters. The aircraft was informed at 01:34:31 UTC that the visibility was 200 meters and the RVR was 1500 meters. Subsequently at 01:45:13 UTC, the visibility remained at 200 meters and RVR reduced to 1200 meters.

The Approach Controller broadcast the visibility of 200 meters and RVR of 1200 Meters at 01:45:13 UTC. The Drishti RVR recorded for this period was 125 meters with no improvement up to the time the incident occurred. There is no meteorological report issued by the MET department between 01:00 to 01:53 which reports the RVR as 1200 meters. At 01:36 UTC, the Drishti software records an RVR of 1200 meters and at 01:37 UTC the software records 800

meters. At 01:41 UTC, the RVR recorded was 125 meters and there was no improvement till 01:53 UTC which is the time the incidented flight carried out the missed approach. It appears the Approach Controller has not verified the latest RVR from the Drishti display while making the broadcast of RVR 1200 meters. The Approach Controller has not issued any further broadcast messages with regard to RVR deterioration for the duration this flight was on the approach frequency. The Display for the DRISHTI is not in clear line of sight for the Approach Controller. This could have played a role in the controller transmitting earlier RVR.

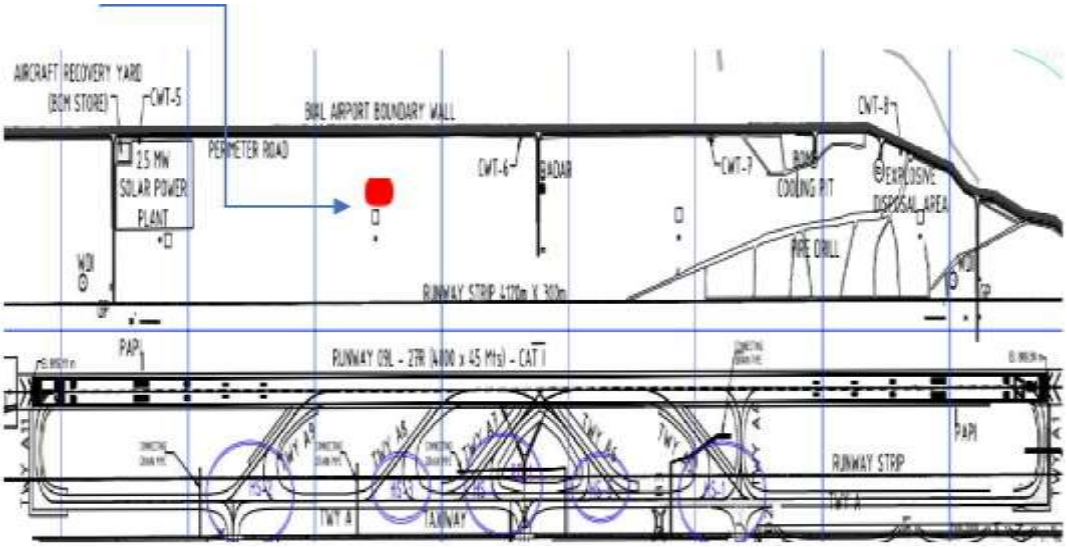
The aircraft ahead of the incident flight initiated a Go Around. The reason for Go Around was not intimated to the Tower Controller and the Tower Controller handed over the aircraft to Approach control. The incident aircraft continued its approach and the PIC reviewed the Go Around Manoeuvre with the First Officer and this aircraft was given landing clearance when it was 4NM on approach. By the time the incident aircraft was over the threshold, the tower controller would have the latest RVR which had reduced to 125 meters and nothing was visible from the tower. However, this reduction was not transmitted to the aircraft.

After the incident aircraft was on the missed approach the tower controller transferred the aircraft to approach control. Shortly after this, another aircraft was heard inquiring about the visibility improvement and the approach controller informs them that the RVR is 125 meters and not improving.

The tower controller was aware of the Local Standby procedure being applicable for that morning. The Tower has the RVR indication panel (DRISHTI) located in the Tower along with a MET Officer stationed there. The Indication Panel reports the RVR every 10 seconds and the sharp reduction in RVR would have been displayed on the screen. Once the preceding aircraft carried out a missed approach, the tower controller could have quickly viewed the DRISHTI application for the latest RVR (which was 125 meters at the time) and transmitted the same to the incident aircraft.

A Bird Chaser who was positioned near A-8 northern shoulder reported that the visibility was low with dense fog. The Bird Chaser heard the engines for the subject aircraft to be louder than usual. The Bird chaser immediately reported to the shift in-charge about the aircraft flying above him.

Location of the Bird Chaser



2.4 Flight Operations

2.4.1 Dispatch Criteria

The incident flight was a self-dispatch flight from Nagpur to Bangalore. The crew are to collect the flight documents and assess the fuel requirements and proceed to the aircraft. The operational flight plan was calculated with 4100 Kg of extra fuel due to fuel tankering. This would translate into an additional 2 hours of holding fuel at the destination, if required. The Flight plan catered for 2 Destination alternates. The Primary Alternate was the further alternate of Hyderabad and the secondary alternate was the closer airport Chennai. The minimum diversion fuel was provided for both alternates.

The visibility in the weather forecast for Chennai (the closer airport) was 1500 meters in Mist with a temporary reduction between 00:00 UTC to 03:00 UTC to 800 metres in Mild Fog. The secondary alternate which was closer by distance, would have been at the minimum visibility required for arrival. Hyderabad which

was the Primary Alternate although a little further away had adequate margin for weather and reported a visibility of 3000 meters with a temporary reduction to 1500 meters in mist between 00:00 to 03:00 UTC. Both the alternates met regulatory requirements for dispatch.

As per the operator's Operations Manuals, the PF is assigned the responsibility and authority with regards to the decisions needed to be made with regards to weather requirements and fuel for completing the flight. The Flight Dispatcher role is that for providing support to the PF and aid in decision making. However, for the incident flight the flight papers were received by the PF at Nagpur airport. There is no Dispatcher available at Nagpur for briefing. There was no verbal briefing provided to the crew for the flight and the crew did not contact the Dispatch office for any additional information.

The Airline also follows an Adverse Weather Watch and has listed procedures for Flight Planning during fog. The procedures stated in these sections require the aircraft and crew being scheduled to adverse weather stations to be upgraded to CAT III qualified in order to avoid diversions. These procedures do not include stations that may experience fog wherein the visibility could reduce below minima, but do not have CAT III certification, as is the case with Bangalore.

For the incident flight, although the forecast weather was above the regulatory requirements for dispatch, the visibility reduced very quickly below the minimum required for an approach. This was neither forecast in the Meteorological briefing nor intimated by the flight dispatcher as a potential threat. The phenomenon is not uncommon for the location given the time of day for the winter season. Guidance to the PIC about such phenomena may have provided insight and prepared him to expect a sharp decline in visibility.

2.4.2 Crew Perspective of the Flight

The PF stated that the layover stay was good. They carried out the Breath Analyser test and the flight was uneventful till the approach phase in Bangalore. The First Officer had assumed the role of PF from 1000' to 1000' for the sector.

During Approach, they were following a B737 aircraft which executed a missed approach. At this point, the PIC reviewed the Go Around procedure. Since the First officer had low (on type) experience, the PIC had to additionally monitor the First Officer actions causing additional workload. The crew sighted the approach lights, centre line and threshold lights at 600 feet on approach. At 50 feet, with the approach lights beneath the aircraft and the sun in their eyes, the visibility was blurred. With the Fog conditions and the sun rays in his eyes, the PIC misinterpreted the left runway edge lights to be the runway centreline lights. He then initiated a bank toward the left while arresting the descent rate and initiated the flare manoeuvre. The PIC then scanned the localiser indication on the PFD and realised the localiser pointer showed a deviation. The First Officer announced Go Around due to loss of visual reference to the runway environment. Being uncertain of his position and hearing the call from the First Officer, the PIC initiated a Go Around manoeuvre.

The crew heard some aural warnings after lift-off but were unable to clearly ascertain these. To the best of their recollection, it was a GPWS and a Stall warning. The First Officer observed the ECAM for Engine 1 Stall during the Go Around.

2.4.3 STOL Policy (1000'-1000')

The PIC gave the First Officer controls from 1000' after Take-off to 1000' prior to landing. The P2 was relatively new to the A320 and there was additional monitoring on part of the PIC. The P1 was not aware of the company policy with regards to Enroute flying for the P2. The Airline does not permit 1000' to 1000' flying. During routine CVR monitoring, the Safety Department had not raised any observations with regards to the 1000' to 1000' flying.

2.4.4 Airbus 320 Auto-land Capability in CAT 1

As per the Airbus 320 Flight Crew Technique Manual, the crew are advised to plan the approach using the best approach capability available. This is normally the CAT 3 DUAL with Auto-land depending on the aircraft status. The crew then

assess the weather and plan a possible downgrade capability if applicable. For Bangalore Runway 09, the approach category is CAT 1 ILS and the aircraft was flown down to CAT 1 ILS minimum Altitude to sight the runway and could continue for either a manual or automatic landing (Auto Land).

Airbus has provided adequate reference for the operator to adopt the feature of Auto-land in CAT 1 or better visibility and left it to the Operator to carry out the required risk assessment to include this capability to their operations. The Auto-land feature generally provides for enhanced monitoring of the Auto-land functions and continuing to keep visual reference throughout the landing. If used through adequate training and detailed procedures it proves to be an enhancement to situational awareness when operating in inclement weather conditions.

In this incident, if the provision for carrying out an Auto-land was made available, the crew would have 3 possible scenarios.

1. Runway in sight with the aircraft trajectory along the intended path: An Auto-land being made keeping the runway environment in sight would reduce pilot workload of manual flying and would increase the monitoring of flight path.
2. Runway in sight with the aircraft trajectory **not** along the intended path: The crew would carry out a missed approach as laid down by procedure.
3. Runway not in sight: The crew would carry out a missed approach.

Although the Auto-land for CAT I ILS provision is available for the A320 aircraft, each operator must carry out a safety risk assessment prior to carrying out the Auto-land feature and assess and mitigate the risks derived from such an exercise.

2.5 Aircraft Handling

2.5.1 Visual Perception

The crew of the aircraft were provided with weather conditions which were above the minimum required to commence approach and landing. While the actual

visibility began to reduce to 125 meters in a very short period of time, the crew were not informed of the same. The crew expected to have adequate visual reference approaching minimums to establish contact with the runway environment and continued to make a manual landing. The crew sighted the approach lights above the decision altitude. This sighting was due to the illuminated Approach Lights, however, as the aircraft approached 100' Radio altimeter, the approach lights would have passed under them and the remaining runway lighting were inadequate to maintain runway environment reference. The lack of centreline lights would have contributed toward the loss of visual reference. This situation would have been further aggravated with the position of the sun just 14° above the horizon and at 112° which is about 20° to the aircraft's right. The glare would have possibly reduced the visibility toward the right of the aircraft and the only remaining linear lighting visible to the PIC was the runway edge lights to the left. Given the fact that there was only one linear light visible, the PIC assumed that to be the runway centre line lights (which the aerodrome did not have installed). At 110' Radio Altitude, the PIC began an attempt to align the aircraft with the runway edge lights and while doing so, arrested the descent rate significantly.

The images below are replicated using visuals from a flight simulator. It is pertinent to note that the visuals in flight simulators would not be as accurate as the crew experienced from the flight deck due to the simulator limitations. The simulator would not be able to accurately factor the position of the sun with reference to the aircraft and also the degree of fog and its refractive index. However, the images have been used to aid the reader in understanding the general variation between what was expected vs. what the crew saw (on approximation)

200 feet Altitude and 1200 meters visibility

100 Feet altitude and 500 metres visibility

50 feet Altitude and 125 meters visibility

2.5.2 Aircraft Handling Till Touch Down

The aircraft was flown on Autopilot down to 220' RA. The aircraft was stabilized on approach as per the company's stabilized approach criteria at 1500'. The Autopilot and auto thrust maintained the ILS profile with no deviations and the Auto Thrust was in managed speed mode with a target speed at Vapp(Approach speed).

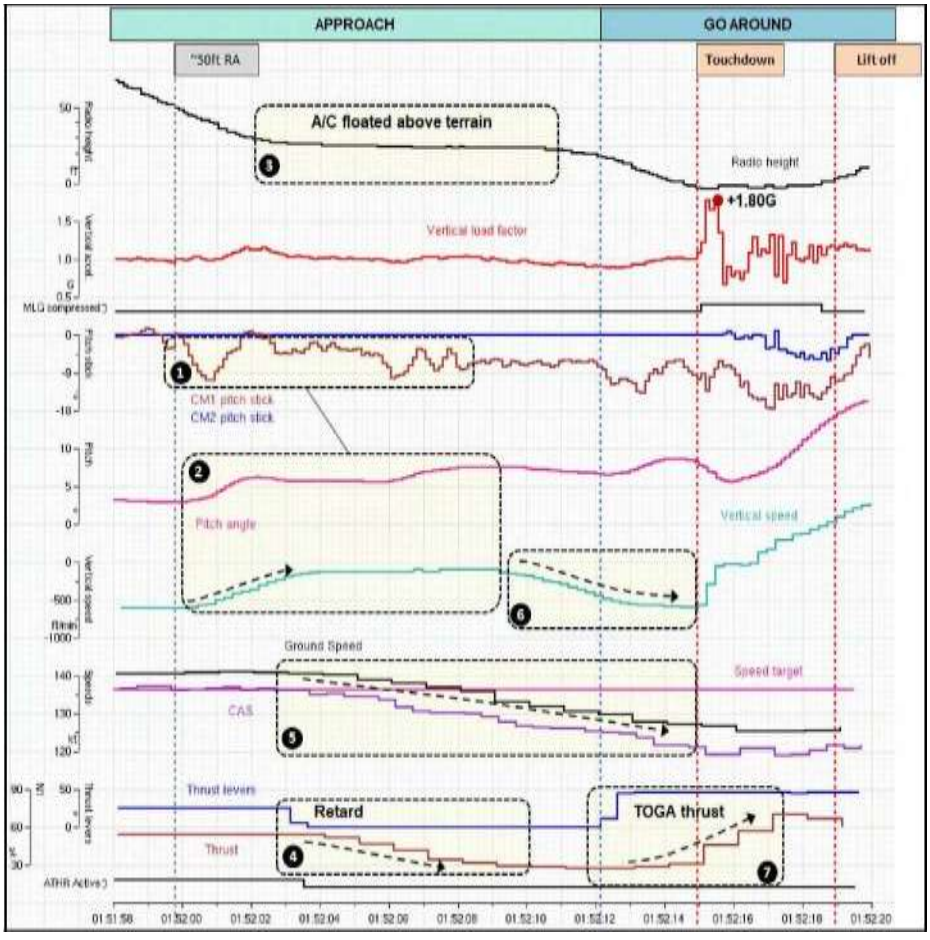
The call "Approach Lights" was called by the First Officer at 350' RA. The Autopilot was disconnected at 220' RA by the PIC and at 110' a slight bank was initiated toward the left. The bank angle gradually increased to10 degrees and the pitch was increased to arrest descent.

The Auto-thrust remained in speed mode and maintained the required thrust to maintain speed. At 25' RA, the aircraft was maintaining altitude and the Auto-thrust was retarded to idle. This caused the Auto-thrust to disconnect and maintained idle thrust. Following this, the PIC continued to maintain the altitude while attempting to align with the left runway edge light assuming these to be the centre line lights.

The PIC used alternating roll inputs along with rudder inputs that are indicative to an alignment attempt by the PIC. As the aircraft bank to the left was increased, the localizer deviation was also increasing and reached 3.5 units deviation prior to touch down. The First Officer did not make any call out for the lateral deviation.

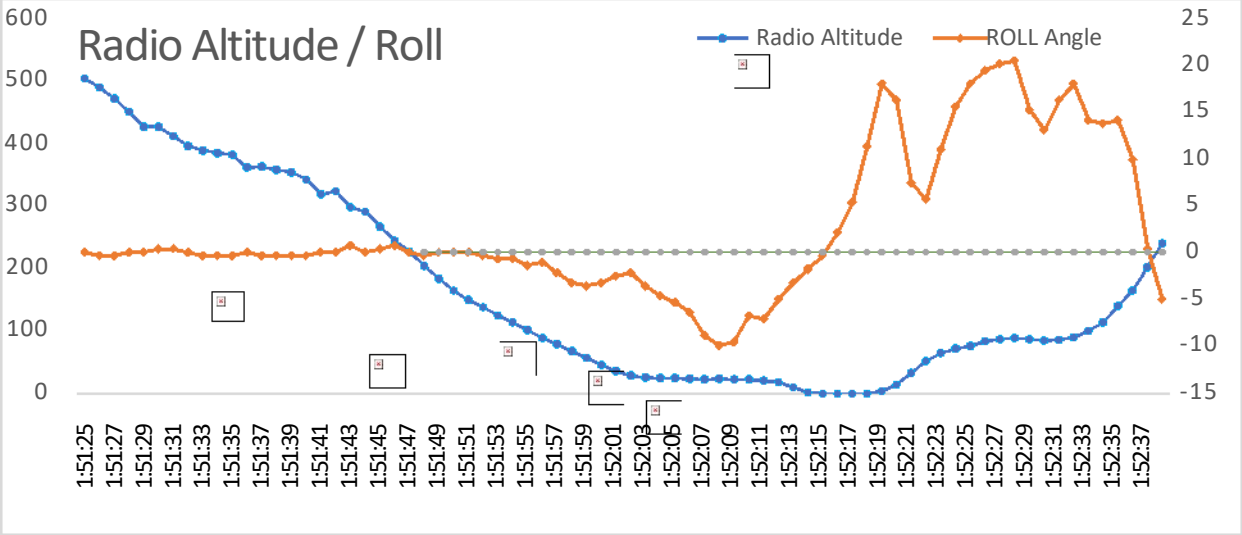
The First Officer announced Go Around 2 seconds prior to the aircraft contacting the unpaved surface. The Go Around thrust was initiated by the PIC immediately and a pitch up command was recorded by the left side stick. However, the aircraft was below final approach speed and the response to the pitch command did not result in a climb and the aircraft contacted the unpaved surface. After touch down on the main wheels, there is several pitch and roll commands registered on both side-sticks up to the point the aircraft lifted off the surface.

Flare and go-around / longitudinal axis



The plot above shows the crew side stick and rudder pedal inputs along the longitudinal axis.

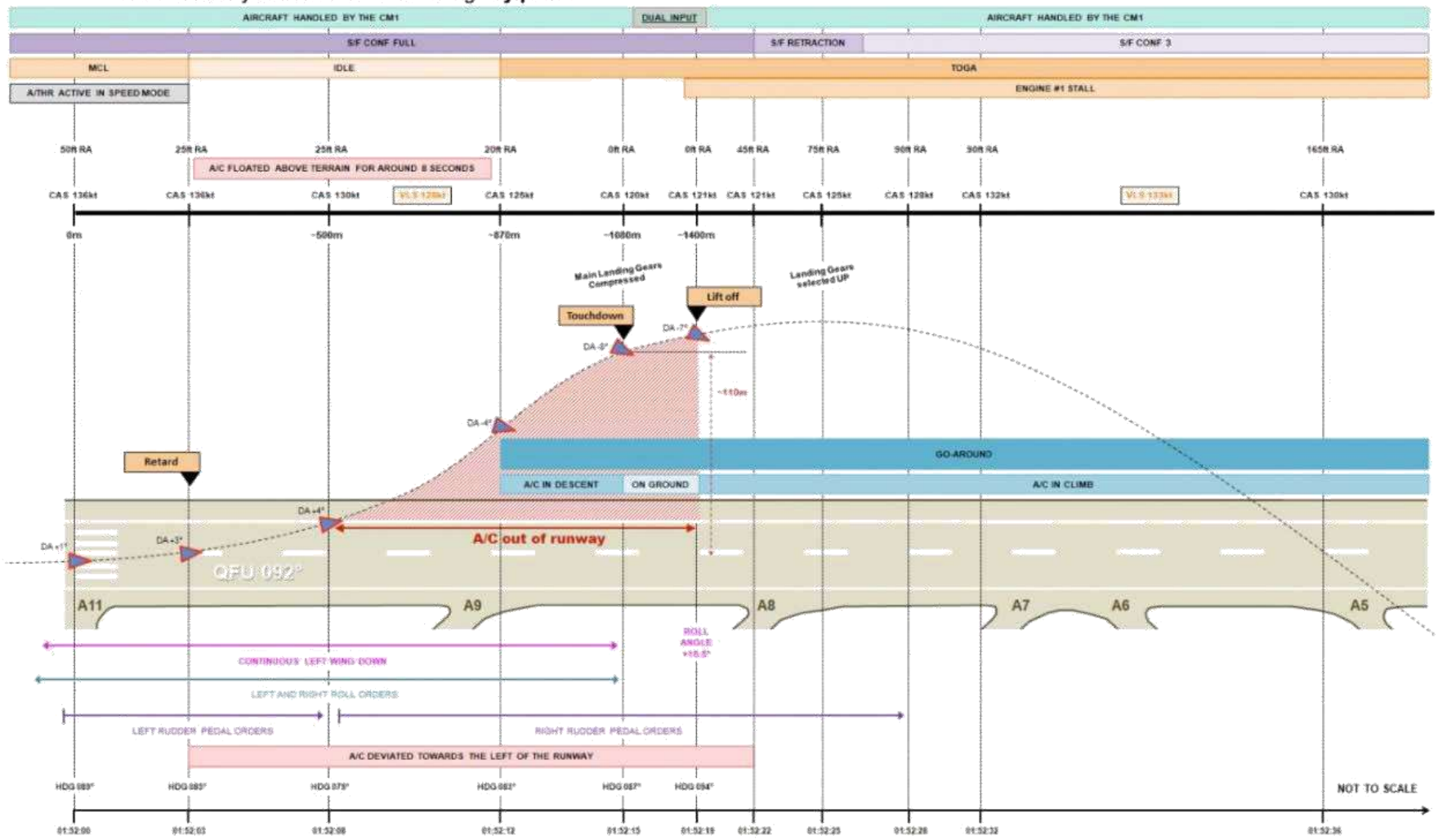
Bank Angle variations prior to and after touchdown



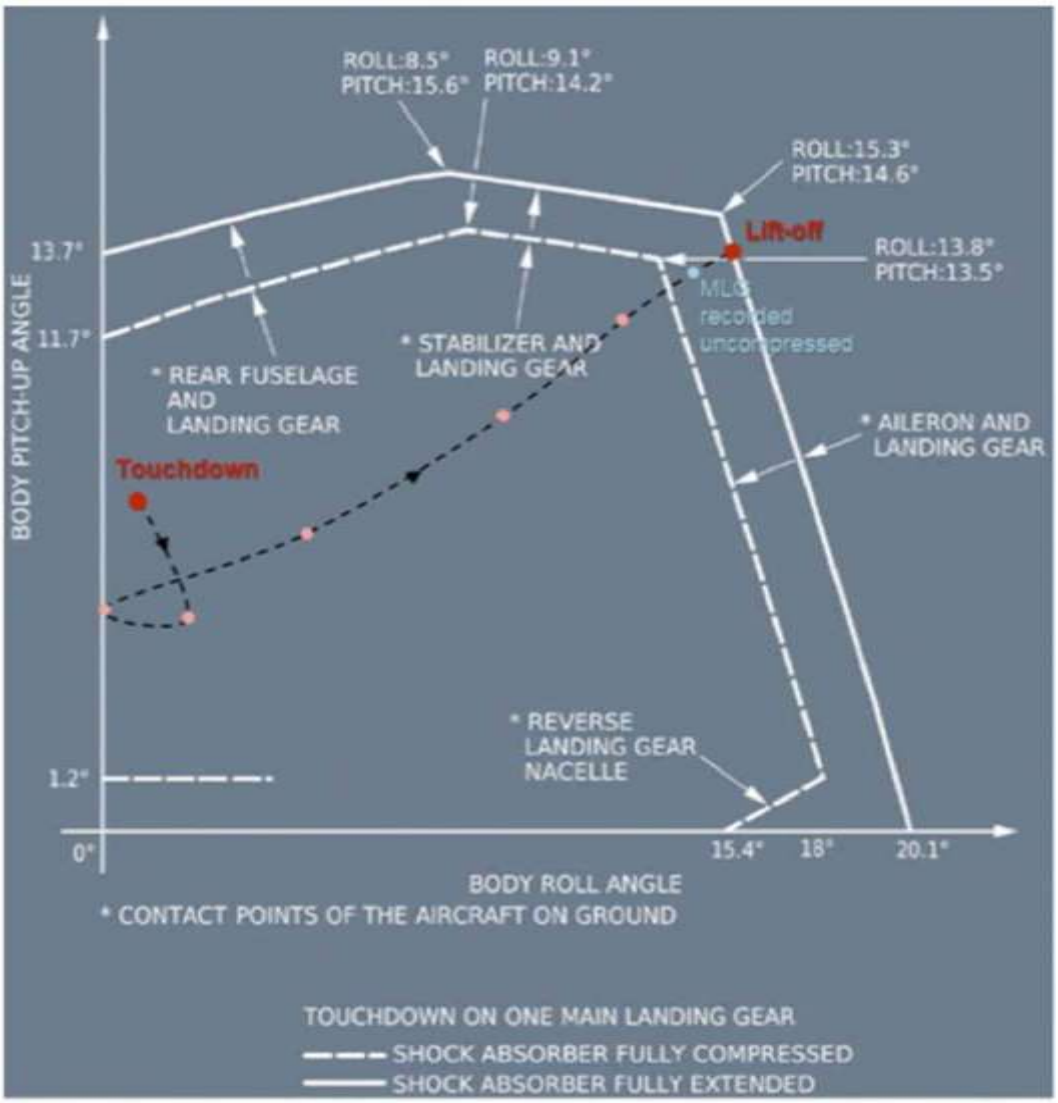
No.	Time	Roll	RA	Comment
1	01:51:55	L 1.5	102	A gradual bank of 1.5 degrees left is developed
2	01:52:02	L 2.1	29	Flare Law is active
3	01:52:08	L 9.8	24	Maximum Bank of 9.8 degrees prior to Touch down
4	01:52:12	L 5.0	18	Extended flare from 29’ – 18’ for 10 seconds. Bank angle reducing
5	01:52:15	L 0.3	0	Touchdown on main landing gear
6	01:52:19	R 17.0	4	Aircraft banks aggressively to the right and gets airborne again

The aircraft begins a gradual bank toward the left after autopilot is disconnected. The PIC then reduces the descent rate (flying almost level) while increasing left bank to align with the left runway edge lights (which he believes are the center line lights). At the point of touchdown, the wings are near level. During the 5 seconds the aircraft has touched down, the PIC initiates an aggressive right bank which reaches 12 degrees. It reaches 17 degrees just after lift-off. The key points of FDR analysis are shown on the figure below (from OEM report)

The FDR analysis indicates the following **key points**:



The above plot shows the aircraft flight path over the runway (Airbus handling report).



The figure above highlights the clearance margin from body contact

Airbus has given the clearance margins to avoid aircraft body contacting the ground (Body pitch up v/s body roll angle). As per this, with main landing gear fully extended and a pitch angle of +13.5°, the right aircraft aileron will contact the ground when the roll angle reaches +15.7°. In the present case, due to nose-up and right roll orders applied by the flight crew when the aircraft was on ground, pitch and right roll angles increased and reached high values close to the ground clearance diagram limits. The right aileron was close to the ground at lift off.

2.5.3 Aircraft Handling after Touch Down and Lift Off

The touchdown and subsequent landing roll was bumpy. The accelerometers recorded high values in the lateral and vertical plane. This confirms that the aircraft had contacted and rolled on an undulating surface. The Aircraft lifts off with a high bank angle to the right which increased to 18° one second after lift-off. After lift-off, the crew received three warnings within 15 seconds.

	Time delay*	Warning	Remarks
1	2 seconds	Terrain warning	The EGPWS sensed an obstacle
2	6 Seconds	Low Speed Warning	The aircraft detected the speed is low
3	4 Seconds	Engine 1 Stall (ECAM)	The EWD displayed and Engine stall

* time delay between events.

The stimulus for the crew was high following a perceived hard landing on the runway during a Go Around manoeuvre.

The First Officer identified the ECAM message and alerted the PIC. Once the PIC had established a climb, the ECAM actions were taken. The PIC retarded the Number 1 thrust lever to idle and the Stall conditions stopped and the ECAM actions were completed. The crew waited for 230 seconds after retarding the thrust levers and on observing normal parameters increased the thrust levers slowly in an attempt to restore the engine. The engine parameters were symmetrical and produced the commanded thrust of 64% N1. After 6 seconds, the Master Caution for ENG 1 Stall triggered and the crew reduced the thrust levers to idle. The thrust levers were kept at idle for the rest of the flight.

2.5.4. Decision Making and Diversion

Any decision making model requires the ascertaining of the facts of the current situation. Some pertinent facts were not considered by the crew as they were probably unaware of them at the time. The crew did not discuss the touchdown location after the Go Around was initiated assuming it to be a hard landing on the

runway. The crew did not inform the ATC about the engine stall and only advised the ATC of a technical problem.

The crew initially held for completion of abnormal procedures and attempted a restoration of engine while waiting for any improvement in visibility in Bangalore. The crew eventually diverted to Hyderabad VOHS airport after assessing the weather.

2.6 Factors Leading to the Incident

When the aircraft was radar vectored for an ILS 09 approach in VOBL, the ATC advised all aircraft that the visibility was 200 meters and the RVR was 1200 meters. There was no further update on meteorological conditions provided to the crew. The preceding aircraft to the incident flight also carried out a missed approach while on ILS 09. The Tower Controller has neither asked the reason for the Go Around of the preceding aircraft nor updated the current RVR. The First Officer sighted the Approach Lights for runway 09 at 100' above the Decision Altitude. The autopilot was disconnected passing decision altitude and the PIC took manual control (now PF) of the aircraft.

Once the aircraft crossed over the approach lights segment, due to the prevailing visibility which was much lower than expected, the PF lost visual reference to the runway environment. In addition, the orientation of aircraft was in line (opposite) to the reflection from the sun and as such the PF could only see the left runway edge lights (for approximately 150 meters ahead). Assuming the left runway edge lights to be the centreline lights, the PF manoeuvred the aircraft with a left bank to align with the left runway edge. The PM did not make any callout for Localiser deviation as a result of the manoeuvre.

The PF arrested the descent rate to allow for more time to align for landing. The thrust levers were retarded once the automated "retard" call was generated at 30' radio altitude. The rudder and side stick deflections (DFDR) were indicative of the attempt to align the aircraft with the left runway edge lights.

Actual scenario at this point of time was that the crew expected the visibility to be higher than what they experienced at decision height. Sighting of the approach lights provided confirmation to the crew that they had established the required visual reference to continue for a manual landing. However, as the aircraft flew over the approach lights the remaining runway lighting was inadequate to keep visual reference. The PF then sighted the runway edge lights and assumed these to be the centreline lights not realising that the airport does not have centre line lights. The PF then manoeuvred to align with the left runway edge lights. The low visibility and the relative position of the sun might have contributed to the PF perceiving the left runway edge lights as centre line lights. The aircraft contacted the unpaved surface after having initiated a Go Around.

2 seconds prior to the main gears contacting the surface, the PM announced “Go Around” and the Go Around actions were immediately carried out by the PF.

Both aircraft main landing gears contacted the unpaved surface with the Left Main Gear contact occurring 01 second prior to the Right Main Gear. The pitch attitude at touchdown and subsequent side stick input prevented the nose wheel from contacting the surface. High accelerations were recorded in the vertical axis of upto 1.8g and in the lateral axis of -0.55g. The aircraft became airborne after 5 seconds of rolling on the undulating surface with a bank angle of 18 degrees to the right just after getting airborne. The Flight Data records a terrain warning followed by a low speed warning a few seconds after lift-off. Once the aircraft is established in climb with the wings level, an ECAM alert for Engine 1 Stall is recorded and the crew follow the required actions for the ECAM. The visibility at VOBL is now reported at 125 meters with no improving trend. The crew attempts to restore the number 1 engine by advancing the thrust levers however, an engine stall alert occurs and the thrust lever for engine 1 is retarded to idle and left at idle for the remainder of the flight.

The crew discussed a diversion to Chennai and Hyderabad. The decision is made to divert to Hyderabad airport since the visibility was higher than that at Chennai with no reducing trend. The aircraft landed safely in Hyderabad.

3 CONCLUSION

3.1 Findings

3.1.1 The aircraft had a valid Certificate of Registration and Certificate of Airworthiness.

3.1.2 All maintenance schedules, mandatory modifications and checks were carried out as per the requirements. There were no defects / snags pending rectification.

3.1.3 Flight crew were appropriately licensed to undertake the flight. Their medical was valid and both had undergone pre-flight medical checks including BA test which was negative.

3.1.4 The Airline has laid down procedures for Flight Planning during Fog. The documented procedure refers to monitoring the TAF and planning the crew with the CAT III qualifications. The airline does not cater for FOG for stations that do not have CAT III ILS approach facilities.

3.1.5 The Flight was self-dispatched by the crew. There was no contact with the dispatch office for any additional information. The Pre-flight documents met the company and regulatory standards.

3.1.6 The First Officer was the Pilot Flying from 1000’ after Take Off to 1000’ prior to landing. The landing checklist was carried out by the PIC as PM. The operator does not have a documented procedure for this practice. Task switching at a late stage of flight with the prevailing visibility, reduced the situational awareness of both pilots.

3.1.7 The ATC for Approach and Tower have the DRISHTI RVR indication available at the controller stations. Neither controller informed the aircraft of the rapidly reducing RVR.

The Approach Controller made a broadcast for RVR which was 8 minutes old as recorded by the DRISHTI software. The DRISHTI Display is not in clear line of sight from the approach controller station.

The Tower Controller did not inform the reducing trend of the RVR to the incidented aircraft even after the preceding aircraft had carried out a missed approach.

The DRISHTI indicating panel does not have aural or visual alerts for sudden RVR deterioration below threshold values.

3.1.8 After the preceding aircraft carried out a missed approach, the go around procedure and actions required on the part of PF and PM were discussed from a crew coordination perspective. The crew could have obtained the latest RVR observation from ATC at this point for better situational awareness.

3.1.9 The Aircraft was stabilised on approach as per the operator's requirements and both autopilots were selected for the ILS.

3.1.10 At 220 feet Radio Altitude, the autopilot was disconnected and the PIC continued on the ILS profile to 110 feet Radio Altitude. The PIC then manoeuvred the aircraft by initiating a left bank and reducing the rate of descend to be on the runway perceiving the left runway edge lights as the centre line lights.

3.1.11 At 27 feet Radio Altitude, the thrust was retarded to Idle after the automatic call out for "Retard". This disconnected the Auto Thrust system and the aircraft speed began to reduce as the rate of descent was being maintained near level by the PIC side stick pitch command.

3.1.12 2 seconds prior to touchdown the First Officer announced "Go Around" and the PIC initiated the Go Around manoeuvre.

3.1.13 The aircraft contacted the unpaved (kutcha) surface by the side of the runway with the left main landing gear making contact 1 second prior to the right main landing gear.

3.1.14 Due to the undulating terrain, there were excessive vertical and lateral loads. Due to these loads experienced and a combination of side stick inputs, the aircraft was airborne with a bank angle of 18°.

3.1.15 There was ingestion into the engines during the ground roll and a subsequent engine stall condition developed for the number 1 engine.

3.1.16 The crew informed the ATC that they had a technical problem after Go Around. The crew carried out a hold for a few minutes and after observing no improvement in visibility, the crew elected to divert to Hyderabad.

3.1.17 The Airline has oversight procedures for routine CVR monitoring and landing below minima events. The 1000' to 1000' flying was not picked up during routine CVR monitoring and there were no records of below minima landings.

3.1.18 At the time of occurrence, the organization was not having an active flight watch/ monitoring programme. Once the aircraft departed, no advice or update was provided to the flight crew. The investigation has observed the above aspects in other organizations also.

3.2 Probable Cause

- The incident occurred due to loss of visual reference after crossing the approach lights resulting in aircraft getting offset from the runway and landing gear touching the kutcha during late Go Around.
- The PIC who was the pilot flying, in an attempt to regain the visual reference sighted the left runway edge lights and assuming these to be centre line runway lights maneuvered the aircraft to the left in an attempt to make an alignment late in the landing phase.

- The far lower visibility than anticipated by the crew, along with the sighting of approach lights and relative position of the sun in the early morning hours misled the visual perception of the Pilot Flying.
- The update of rapidly reducing RVR not made available to the flight crew.
- Loss of visual reference after crossing the Approach Lights.
- Flight crew not initiating a timely Go Around
- PIC giving flying to the First Officer at the beginning of the climb (i.e. 1000 ft RA) and not taking over controls at an early stage prior to the landing.
- The OEM has a provision for Auto-land capability in visibility conditions higher than CAT I ILS. The Airline has not carried out a safety assessment for implementing this capability in their procedures. Having the procedures laid out for Auto-land, the crew would have benefitted with a higher degree of situational awareness while optimising the use of automation.

4.0 SAFETY RECOMMENDATIONS

4.1 All airline operators must emphasize during simulator training that the crew correctly assesses any reduction in visibility having occurred below minimum requirements while on approach and the corrective actions thereon. This training should include adequacy of remaining visual reference and must focus on crew assessment and response to the same.

4.2 All airline operators may assess the inclusion of the OEM provision for carrying out an Auto-land in CAT I or higher visibility. This must be done after carrying out a Safety Risk Assessment.

4.3 All airline operators may expand the Fog Watch to include stations which are likely to have marginal visibility during winter (fog months) irrespective of the Aerodrome with CAT II or lower facilities.

4.4 The Flight Safety Department of Go Air should enhance oversight in order to capture deviations from Standard Operating Procedures such as but not limited to the 1000' to 1000' flying by the First Officer as Pilot Flying.

4.5 AAI and IMD must ensure that the software display providing real time visibility / RVR are located in clear sight of the Air Traffic Controller for all stations.

4.6 IMD may carry out an evaluation for inclusion of Audio / Visual Alerts from the software being used for updating of RVR/ Visibility, whenever Visibility / RVR reduces below threshold values.

4.7 DGCA should extend, the Adverse weather watch system/ procedure for other seasonal variations wherein operating conditions deteriorates significantly like monsoon operations.

4.8 DGCA should positively provide closure report as per the time limits on the audit findings after receiving the Action Taken Reports from the Operator.

-S/d-

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