FINAL INVESTIGATION REPORT ON SERIOUS INCIDENT TO M/s INTERGLOBE AVIATION LTD. AIRBUS A 321 (NEO) AIRCRAFT VT-IUD AT DELHI AIRPORT ON 06TH AUGUST 2020.

Ms. Kunj Lata
Investigator -In- charge

Amit Kumar
Investigator

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/serious incident shall be the prevention of accidents and incidents and not to apportion blame or liability. The investigation conducted in accordance with the provisions of the above said rules shall be separate from any judicial or administrative proceedings to 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.

INDEX

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
C of R	Certificate of Registration
CAR	Civil Aviation Requirements
CPL	Commercial Pilot License
CVR	Cockpit Voice Recorder
DFDR	Digital Flight data Recorder
DGCA	Directorate General of Civil Aviation
F/O	First Officer
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Training Manual
FRTOL	Flight Radio Telephone Operators License
Hrs	Hours
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
LLZ	Localizer
MEL	Minimum Equipment List
MLG	Main Landing Gear
MTOW	Maximum Take Off Weight

NDB	Non-Directional Beacon
NLG	Nose Landing Gear
NM	Nautical Miles
PF	Pilot Flying
PIC	Pilot in Command
PM	Pilot Monitoring
QRH	Quick Reference Handbook
RA	Radio Altitude
RESA VFR	Runway End Safety Area Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional Range
UTC	Coordinated Universal Time

FINAL INVESTIGATION REPORT ON SERIOUS INCIDENT OF M/S INTERGLOBE AVIATION LIMITED, AIRBUS A 321 AIRCRAFT VT-IUD AT DELHI ON 06th AUGUST 2020.			
1.	Aircraft	Type	A 321-271NX (Neo)
		Nationality	Indian
		Call Sign	IGO2752
		Registration	VT-IUD
2.	Owner & Operator		TFDAC Ireland II Limited & Inter Globe Aviation Limited
3.	Pilot		ATPL Holder
	Extent of Injuries		Nil
4.	Co- Pilot		CPL Holder
	Extent of Injuries		Nil
5.	No. of Passengers on board		129
6.	Date & Time of Serious Incident		06th August 2020 at 1408 UTC
7.	Place of Serious Incident		Delhi Airport
8.	Co-ordinates of Serious Incident Site		Lat: 28° 34’ 07” N Long: 77° 06’ 44” E
9.	Last point of Departure		Chennai Airport
10.	Intended landing place		Delhi Airport
11.	Type of Operation		Scheduled Operation
12.	Phase of operation		Landing
13.	Type of Serious Incident		Severe Hard Landing

SYNOPSIS

On 6th August 2020, M/s Indigo, Airbus A 321 aircraft VT- IUD while operating a Scheduled flight from Chennai to Delhi was involved in a Serious Incident of hard landing while landing at Delhi airport.

The aircraft was under the command of an ATPL holder who was Pilot Monitoring (PM) with a co-pilot a CPL holder as Pilot Flying (PF).Supervisory takeoff and landing was in progress. There were 129 passengers on board the aircraft with 04 cabin crew members.

The aircraft departed from Chennai airport at 1144 UTC, the flight was uneventful till final approach. The aircraft was cleared for landing on Runway 10 by ATC, Delhi. The aircraft made a hard landing while landing. Wherein the aircraft's main wheels first touches the runway with 3.137 G, bounced back in air for about 4 sec and then finally landed on main wheels with less G value.

Director General, AAIB appointed Ms. Kunj Lata, Assistant Director, AAIB as Investigator – In – Charge & Sh. Amit Kumar, Safety Investigator Officer, AAIB as Investigator to investigate into the probable cause(s) of the serious incident, vide Order No. INV.12011/9/2020-AAIB dated 13th August 2020 under Rule 11 (1) of Aircraft (Investigation of Accidents and Incidents), Rules 2017.

1. FACTUAL INFORMATION

1.1 HISTORY OF THE FLIGHT

On 6th August 2020, M/s Indigo Airbus A321 aircraft was involved in a Serious Incident of hard landing at Delhi. There was no reported abnormality in the last sector operated by the same aircraft. Thereafter, the aircraft was scheduled to operate Chennai – Delhi sector. The Pilot in Command (PIC) was Pilot Monitoring (PM) and Co-Pilot was Pilot Flying (PF) during landing at Delhi. Supervisory takeoff and landing was going on. Both Crew underwent B.A test at Chennai, prior to flight which was satisfactory.

The aircraft took-off from Chennai at 1144 UTC. Aircraft came in contact with Delhi Approach Controller at 1345 UTC at FL 208. Autopilots were disengaged at 1300ft (RA). At 500 ft (RA) aircraft was stabilized.

At 14:01UTC, Delhi Approach Controller cleared it for ILS Approach Runway 10. At 14:06 UTC, Tower Controller cleared the aircraft for landing and gave wind 100 Degree and 17 kt. The flight was uneventful till the landing phase.

During landing, aircraft initially touched down on its both Main Landing Gears (MLG) with a high Vertical Acceleration (VRTA) of 3.13 G and bounded back in the air. In the meantime, Pilot - In - Command took the control of the aircraft from the Co-Pilot and on second attempt aircraft landed on MLG with RH MLG had touched first and then the LH MLG followed by the NLG. This time VRTA was 2.41G. The landing weight was 67.58 Tons. After landing, aircraft taxied to the parking bay on its own.

After landing Load Report 15 was generated. As per Load report the Maximum VRTA value was 3.13G. However, in PDR the Crew reported "Suspected hard landing at Delhi with VRTA 2.41 and landing weight 67.58 tons. Aircraft landing on M/W, bounced once and landed on M/W again". Later Post Flight Report was generated, which showed 'NIL' failure messages pertaining to the Hard Landing.

The passengers were disembarked normally. The aircraft sustained undercarriage damages during the incident and there was no injury to any of the occupant on board.

1.2 INJURIES TO PERSONS

Injuries	Crew	Passengers	Others
Fatal	NIL	NIL	NIL
Serious	NIL	NIL	NIL
~~**Minor**~~**/ None**	02+04	129	**NIL**

1.3 DAMAGE TO AIRCRAFT

Post incident, visual inspection was carried out to determine the damages to the aircraft but no abnormalities was found.

As per Auto generated Load Report A15, the maximum recorded VRTA value during the incident was 3.13 G, which indicates severe Hard Landing. As per Aircraft Maintenance Manual (AMM), M/s Indigo reported the severe Hard Landing to Airbus (Manufacturer) for further Maintenance Instructions. As per Airbus instruction, initially the following maintenance tasks were performed: -

a) Inspection for Severe Hard Landing.

b) Inspection of the Engine after Heavy or Overweight Landings (Phase 1 and 2), which also includes Borescope Inspection (BSI) of both

Engines. Phase inspection also includes, examination of the blades tips, a General Visual Inspection of the Turbine Exhaust System, and Fan Cowl Doors, Engine fan and core areas and Fuel Distribution System.

(c) In the meantime, Airbus came up with some Abnormal Event Technical Dispositions. Operator performed the task as per Airbus disposition satisfactorily. In final disposition Airbus suggested removal of certain components from both MLG and transported to Shop for checks.

Engine manufacture also suggested removal of RH engine based on BSI report, as rubbing mark were observed on the RH engine.

1.4 OTHER DAMAGE

Nil

1.5 PERSONNEL INFORMATION

1.5.1 Pilot – In – Command

Nationality	INDIAN
Date of Birth	15/06/1987
DOJ	23/12/2014
License Type	ATPL
Date of issue	15/11/2015
Valid Up to	14/11/2020
Category	CAPTAIN
Endorsements as PIC	23/12/2014
Date of Medical Exam	08/01/2020
Medical Validity	Valid
FRTOL Date of Issue/Validity	02/02/2020/ Valid
RTR Date of Issue/Validity	18/02/2014/ Valid
Total Flying Experience	7269.53 HOURS
Hours Flown on Type	A321-10.28
Previous Flight (Date of Last Flight)	06.08.2020

Experience as PIC on Type	A321-10.28
Hours flown in last 365 days	584.00 HOURS
Hours flown in last 180 days	161.52 HOURS
Hours flown in last 30 days	28.29 HOURS
Hours flown in last 7 days	13.55 HOURS
Hours flown in last 90 days	52.06 HOURS
Hours flown in last 24Hrs.	5.27 HOURS
Rest period before the flight	14.45 HOURS
Previous incident history	Nil
Last IR/PPC	25/06/2020
Last Annual Line Check (ALC)	12/12/2019
Last Ground Refresher	30/05/2020

1.15.2 Co-Pilot

Nationality	INDIAN
Date of Birth	22/06/1991
DOJ	28/03/2019
License Type	CPL
Date of issue	18/07/2018
Valid Up to	17/07/2023
Category	FO
Endorsements as PIC	NA
Date of Medical Exam	11/12/2019
Medical Validity	Valid
FRTOL Date of Issue/Validity	01/06/2018/ Valid
RTR Date of Issue/Validity	18/05/2018/ Valid
Total Flying Experience	625.57 HOURS
Hours Flown on Type	A321-10.45
Previous Flight(Date of Last Flight)	06.08.2020
Experience as PIC on Type	NA

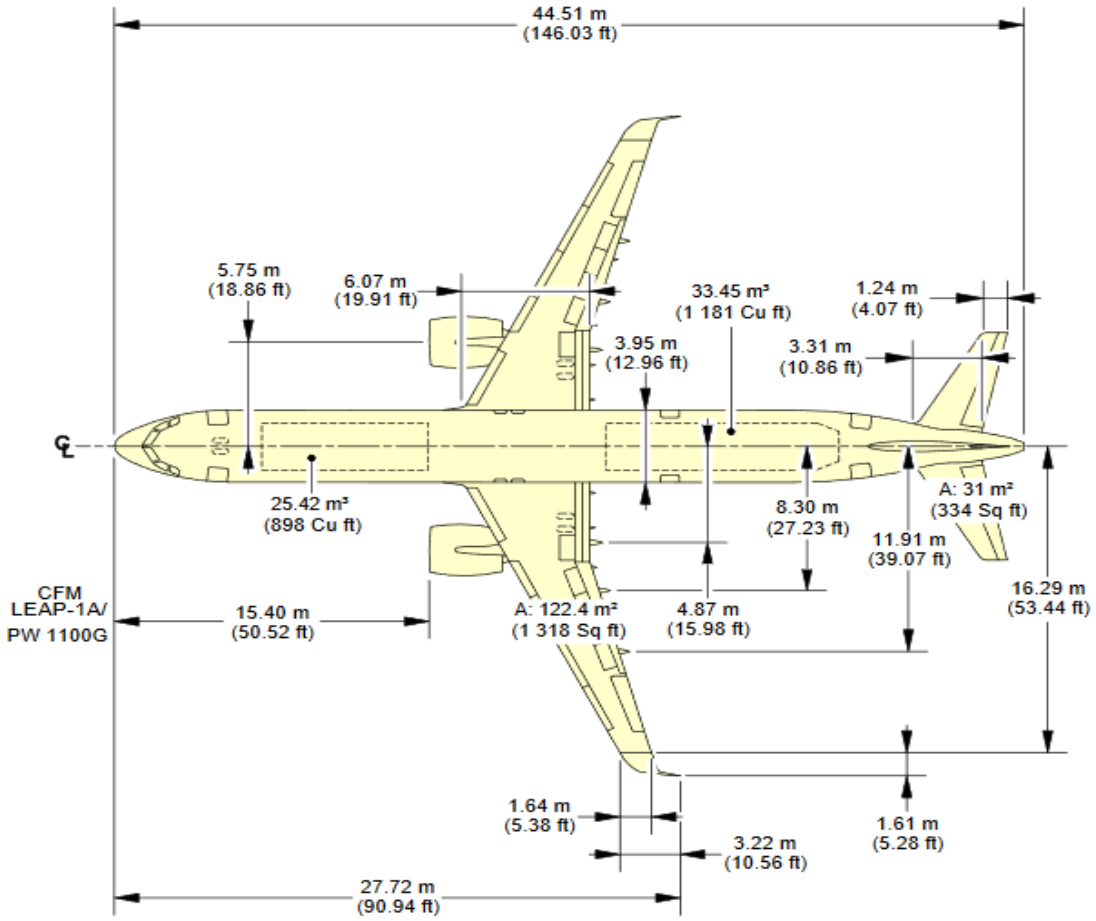
Hours flown in last 365 days	394.15 HOURS
Hours flown in last 180 days	79.41 HOURS
Hours flown in last 30 days	19.56 HOURS
Hours flown in last 7 days	3.22 HOURS
Hours flown in last 90 days	22.21 HOURS
Hours flown in last 24Hrs.	3.22 HOURS
Rest period before the flight	18.29 HOURS
Previous incident history	Nil
Last IR/PPC	IR-30.11.2019 AND PPC-31.07.2020
Last Annual Line Check (ALC)	17/10/2019
Last Ground Refresher	16/07/2020

1.6 AIRCRAFT INFORMATION

1.6.1 Airbus A321 Aircraft Description

Airbus A321 is modified version of A320 aircraft. The A321 is a subsonic, medium-range, civil transport aircraft. The aircraft is fitted with two Pratt & Whitney 1127G-JM engines. It is categories in Passenger and freight category.

A321 is a longer by 7 mtrs from A320 with less fuel consumption. A320 has a seating capacity of 165 and A321 has 206 passengers.


44.51 m
(146.03 ft)
5.75 m
(18.86 ft)
6.07 m
(19.91 ft)
33.45 m³
(1 181 Cu ft)
1.24 m
(4.07 ft)
3.95 m
(12.96 ft)
3.31 m
(10.86 ft)
25.42 m³
(898 Cu ft)
A: 31 m²
(334 Sq ft)
8.30 m
(27.23 ft)
11.91 m
(39.07 ft)
CFM
LEAP-1A/
PW 1100G
15.40 m
(50.52 ft)
A: 122.4 m²
(1 318 Sq ft)
4.87 m
(15.98 ft)
16.29 m
(53.44 ft)
1.64 m
(5.38 ft)
1.61 m
(5.28 ft)
3.22 m
(10.56 ft)
27.72 m
(90.94 ft)

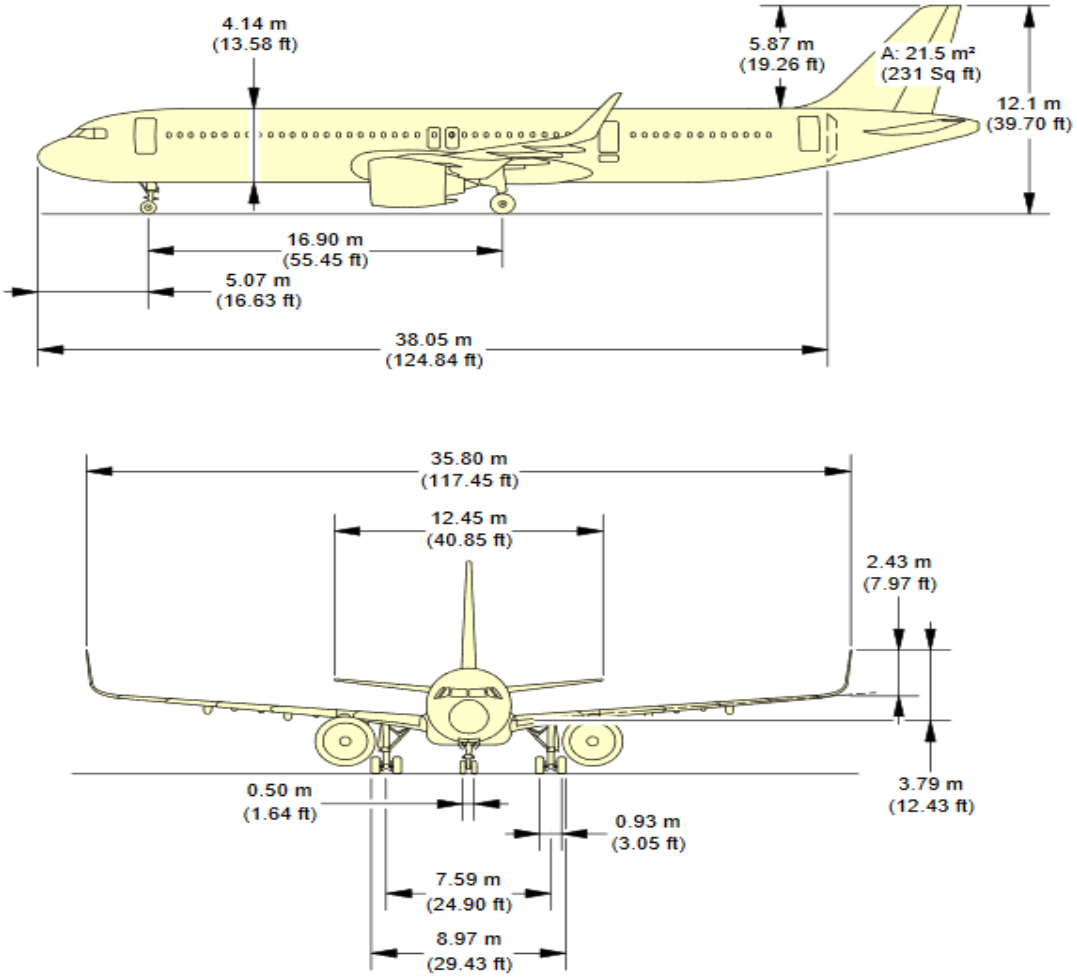


Figure: 3D View of A321

1.6.2 Aircraft VT-IUD General Information

Aircraft Model	A321-271NX
MSN	8710
Year of Manufacturer	2019
Name of Owner	TFDAC Ireland II Limited
C of R	5092
C of A	7195
Category	Normal
C of A Validity	N/A
A R C issued	18-05-2020
ARC valid up to	21-05-2021
Aircraft Empty Weight	48230.325 Kg
Maximum Take-off weight	97000.000 Kg
Date of Aircraft weighment	07-02-2019

Operating Empty Weight	49315.756 Kg
Max Usable Fuel	20960.000 Kg
Max Payload with full fuel	26724.244 Kg
Operating Empty Weight C.G	21.462 % MAC
Next Weighing due	06-02-2024
Total Aircraft Hours	3495:58
Last major inspection	750 FH/ 90 Days Inspection on 19-06-2020
List of Repairs carried out after last major inspection till date of incidence:	NIL
Engine Type	PW1133G-JM
Date of Manufacture LH	04-10-2019
Engine Sl. No. LH	P771088
Last major inspection (LH)	750 FH/ 90 Days Inspection on 19-06-2020
List of Repairs carried out after last major inspection till date of incidence:	NIL
Total Engine Hours/Cycles LH	1908:27 EH/ 862
Date of Manufacture RH	19-08-2019
Engine Sl. No. RH	P771454
Last major inspection (RH)	750 FH/ 90 Days Inspection on 19-06-2020
List of Repairs carried out after last major inspection till date of incidence:	NIL
Total Engine Hours/Cycles RH:	2021:18 EH/ 802
Aero mobile License	30-06-2024
AD, SB, Modification complied (LH ENGINE):	ALL AD/SB Complied
AD, SB, Modification complied (RH ENGINE):	ALL AD/SB Complied

The Aircraft is registered in “Normal” category & Sub Division - “Passenger Aircraft”. The C of A remains valid subject to validity of Airworthiness Review Certificate. The Aircraft was holding a valid Aero Mobile at the time of incident with a validity till 30 June 2024.

The aircraft was last weighed on 7th Feb 2019 and the weight schedule was duly approved by the office of Director of Airworthiness, DGCA, New Delhi. As per the approved weight schedule the Empty Weight of the aircraft is 49315.756 Kg and Maximum Take-Off Weight (MTOW) and Maximum landing Weight (MLW) of the aircraft are 97000.00 Kg and 79200 Kg respectively. Maximum usable fuel quantity is 20960.000 Kg. Operating Empty weight CG is 21.462 % MAC. "Load And Trim" sheet of the incident flight was prepared and centre of gravity was found within limit.

All concerned Airworthiness Directives, mandatory Service Bulletins and DGCA Mandatory Modifications on this aircraft and its engines were complied with as on date of event.

1.7 METEOROLOGICAL INFORMATION

Relevant MET Report of IGI Delhi Airport on the day of incident:

Time UTC	**Wind (Deg/KT)**	**Vis (Mtrs)**	**Clouds**	**Temp (°C)**	**QNH (hPa)**	**TREND**
1331	090/12	4500	SCT 3000 ft FEW CB 3500 ft BKN 10000 ft	32	0997	TEMP 15020G 30kt, Visibility 1000m Thunderstorm rain
1401	100/13	4000	SCT 3000 ft FEW CB 3500 ft BKN 10000 ft	32	0997	TEMP 15020G 30kt Visibility 1000m Thunderstorm rain

As per DFDR, weather information when the aircraft was between 900ft and 200ft (i.e., between 14:07:02 UTC and 14:08:02 UTC) was as Wind 095° at 20kt with gusts between 30kt and 13kt.

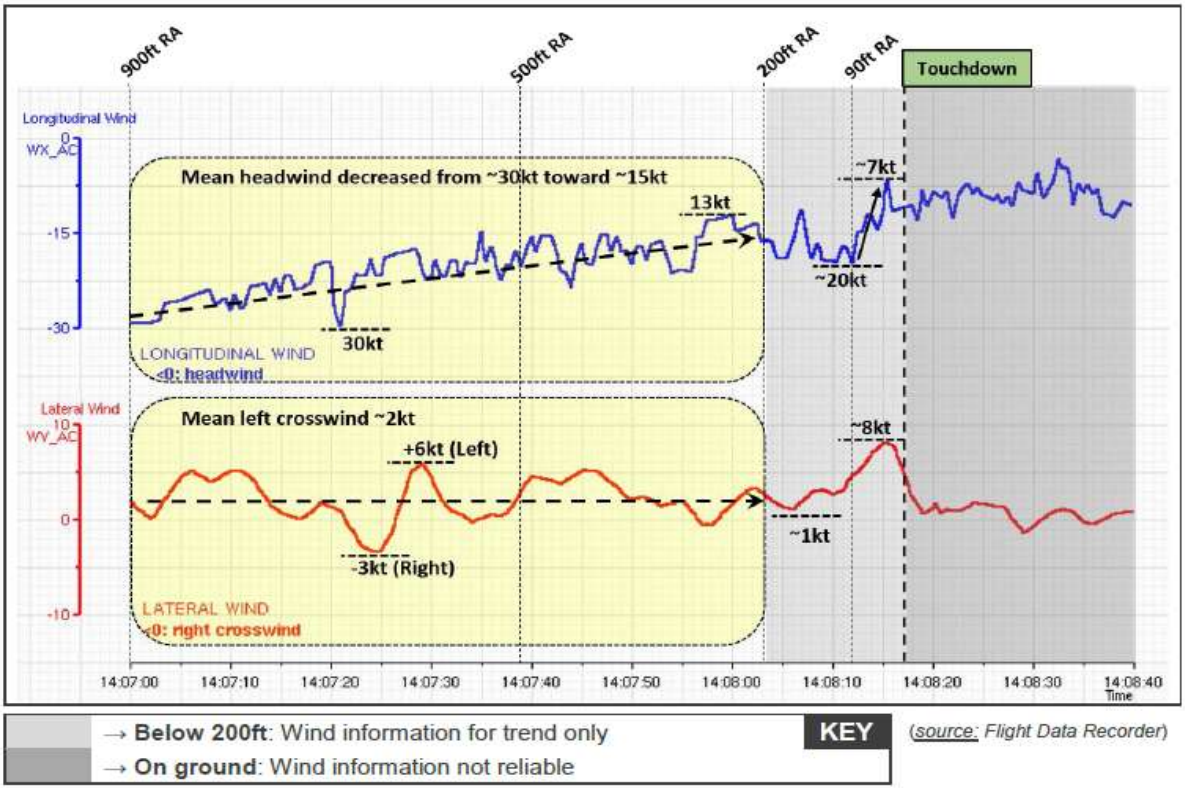


Figure: MET Information obtained from DFDR analysis (Manufacturer).

The headwind decreased to around 13kt in the last 90 ft, it contributed to a loss of CAS and thus to a loss of lift at low height. This led to increased rate of descent and to initiate a pitch down dynamics.

The ground effect encountered at low height contributed to maintain the pitch down dynamics and thus the rate of descent.

The flare action performed at 30ft RA with a high rate of descent (880ft/min) and a negative pitch angle (-1.5°) did not enable to sufficiently change the aircraft trajectory before the touchdown to avoid the severe hard landing

1.8 AIDS TO NAVIGATION

Navigational Aids available at Delhi Airport is as given below:

Type of Aid	Frequency	WGS-84 Coordinates	Elevation of DME Antenna
VOR (DPN)	116.1MHz	283400N 0770542E	
DME (DPN)	1132 MHz 1195MHz	Collocated with VOR	786FT
LLZ-RWY10 (IDEL)	109.5MHz	283328.2N 0770516.4E	

GP-RWY10	332.6MHz	283402.6 N 0770516.4 E	
DME-RWY10 (IDLH)	993 MHz 1056MHz	Collocated with GP10	737FT

1.9 COMMUNICATIONS

At the time of serious incident, the aircraft was in contact with Delhi Tower on frequency 118.1 MHz. There was always two-way communication between the aircraft & ATC.

Relevant communication between Aircraft and ATC at Approach (Arrival) (124.2 MHz) and Tower (118.1 MHz) of tape transcript are given bellow:-

Approach Arrival Unit (124.2 MHz)		
TIME (UTC)	**UNIT**	**TRANSMISSIONS**
135739-135741	IGO2752	DELHI ARRIVAL IFLY TWO SEVEN FIVE TWO GOOD EVENING
135742-135747	RADAR	IFLY TWO SEVEN FIVE TWO DESCEND TO TWO THOUSAND SIX HUNDRED FEET QNH NINER NINER SEVEN
135747-135751	IGO 2752	DESCENDING TWO THOUSAND SIX HUNDRED FEET QNH NINER NINER SEVEN IFLY TWO SEVEN FIVE TWO
140106-140110	RADAR	IFLY TWO SEVEN FIVE TWO TURN RIGHT HEADING ZERO SEVEN FIVE CLEARED FOR ILS APPROACH RWY ONE ZERO
140110-104112	IGI 2752	HEADING ZERO SEVEN FIVE CLEARED FOR ILS ONE ZERO IFLY TWO SEVEN FIVE TWO
140318-1403222	RADAR	IFLY TWO SEVEN FIVE TWO CLEARED FOR ILS APPROACH RWY ONE ZERO ONE ONE MILE FOR TOUCH DOWN CONTACT TOWER ONE ONE EIGHT DECIMAL ONE
140325-140330	RADAR	IFLY TWO SEVEN FIVE TWO CONTACT TOWER ONE ONE EIGHT DECIMAL ONE CLEARED FOR ILS APPROACH RWY ONE ZERO
140329-140332	IGO 2752	CLEARED FOR ILS ONE ZERO CONTACT ONE ONE EIGHT ONE IFLY TWO SEVEN FIVE TWO GOODAY
Tower Unit (118.1 MHz)		
140335-140338	IGO2752	DELHI TOWER IFLY TWO SEVEN FIVE TWO GOOD EVENING ON LOCALISER RWY ONE ZERO
140338-104343	TOWER	IFLY TWO SEVEN FIVE TWO CONTINUE APPROACH RWY ONE ZERO, ONE ZERO ZERO DEGREES ONE ONE KNOTS
140343-140347	IGO2752	CONTINUE APPROACH RWY ONE ZERO WIND COPIED IFLY ONE.. TWO SEVEN FIVE TWO
140610-140615	TOWER	IFLY TWO SEVEN FIVE TWO RWY ONE ZERO CLEARED TO LAND WIND ONE ZERO ZERO DEGREES ONE SEVEN KNOTS

140615-140618	IGO2752	CLEARED TO LAND RWY ONE ZERO IFLY TWO SEVEN FIVE TWO
AT 1408 UTC, IGO2752 LANDED WITH VRTA VALUE OF 2.41G (FINAL REST)		
140942-140945	IGO2752	DELHI IFLY TWO SEVEN FIVE TWO VACATING VIA UNIFORM

1.10 AERODROME INFORMATION

Indira Gandhi International Airport (IATA:DEL,ICAO:VIDP) is a Joint venture airport being managed by Delhi International Airport Limited (DIAL) and Airports Authority of India. The air traffic services at IGI airport are provided by AAI which includes Aerodrome Control service (ADC/SMC), Approach Control service (APP), Area Control Service (ACC), Terminal Approach Radar (TAR) and Route Surveillance Radar Service (RSR). Aerodrome has ARP at 283407N 0770644E. The Aerodrome is operational round the clock.

IGI airport houses three near converging runways in the westerly direction namely Runway 27, Runway 28 and Runway 29. On the other hand, it has three diverging runways in the easterly direction i.e. Runway 09, Runway10 and Runway 11.

At the time of incident easterly flow was operational and aircraft landed on Runway 10.

Runway Orientation and Dimension at IGI Airport:

Runway 09 / 27 = 2813 x 45 m

Runway 10 / 28 = 3810 x 46 m

Runway 11 / 29 = 4430 x 60 m

1.11 FLIGHT RECORDERS

Both Solid State Cockpit Voice Recorder (SSCVR) and Solid-State Flight Data Recorder (SSFDR) were downloaded and readout was carried out.

1.11.1 Cockpit Voice Recorder:

The Cockpit Voice Recorder (CVR) had been downloaded and analyzed. The Salient points of CVR are given below:

a) At 13:45 UTC, Aircraft was at FL 280 and came in contact with Delhi Radar. Radar Controller had given descend to FL 100, FL 70 and to 2600ft and advised the Flight Crew to contact Approach at 124.2 MHz

b) At 14:01UTC, Approach Controller, cleared the aircraft for ILS approach to runway 10 and advised the Flight Crew to contact Tower at 118.1MHz.

c) At 14:03 UTC, Tower Controller gave wind 100 Degree and 11 kt.

d) At 14:06 UTC, Tower Controller cleared the aircraft for landing and gave wind 100 Degree and 17 kt.

e) Flight crew were found using local language during Critical Phase of Flight (which is a violation as mentioned in company's Ops Manual).

f) Extract from Ops Manual-

0.11 OFFICIAL LANGUAGE AND MODES OF COMMUNICATION

English shall be the official language for communication. The Company Operations manual and all other company documents will be published in English and in such a way that entire documentation contains legible and accurate information.

The English language shall be used as a common language for use by all flight crew members for communication:

i) On the flight deck during line operations;

ii) Between the flight crew and Cabin crew during line operations;

iii) During flight crew training and evaluation activities.

iv) English shall also be used as the universal language in radiotelephony. It is expected that Crew use English language of an operationally acceptable standard.

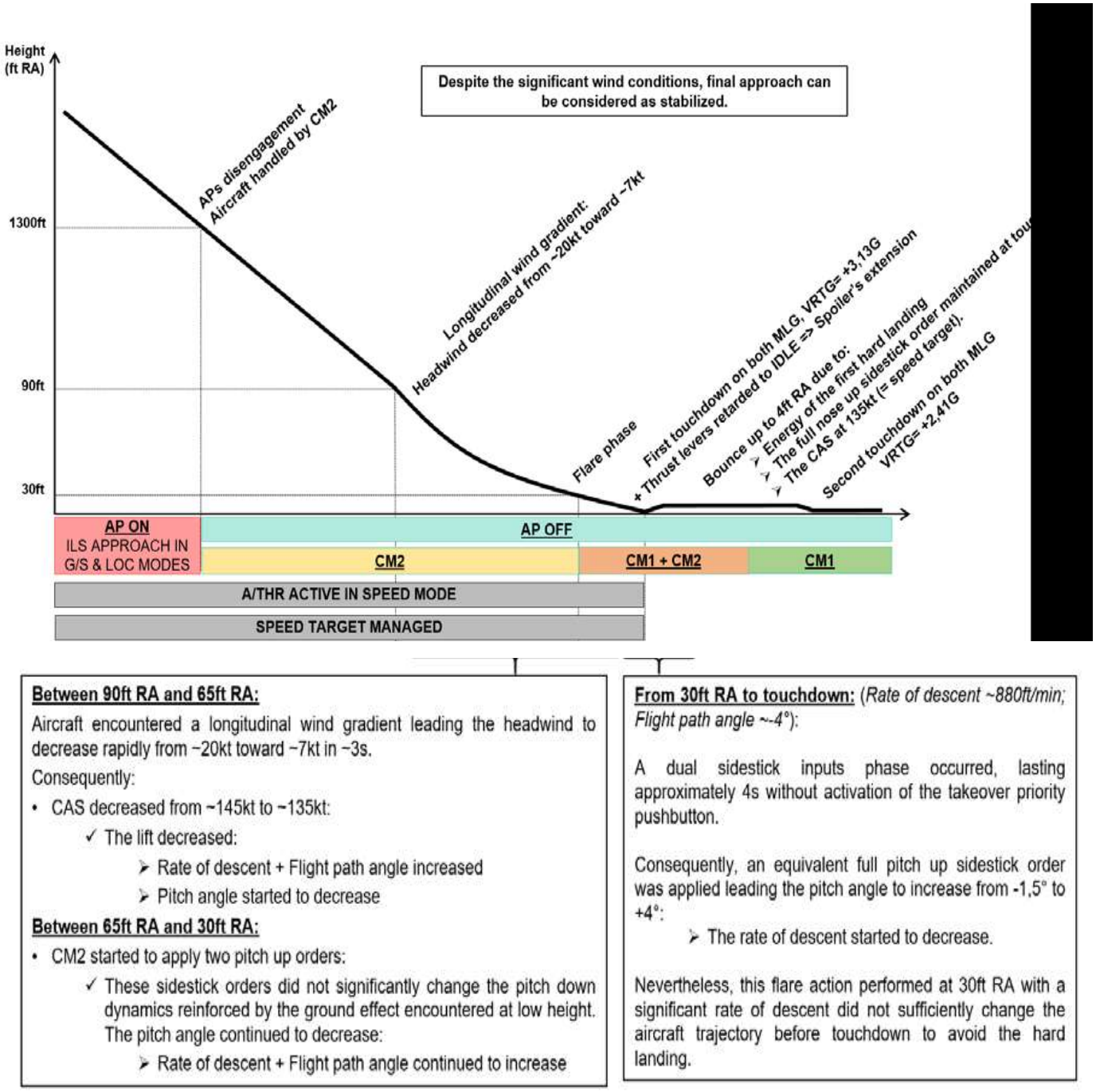
g) Extract from Ops Manual- Critical Phases of flight.

17.11 CRITICAL PHASES OF FLIGHT (STERILE COCKPIT)

Critical phases of flight are defined as all ground operations from 'start up to shut down' and all other flight operations conducted below 10,000 ft AAL except cruise flight.

1.11.2 Digital Flight Data Recorder

Digital Flight Data Recorder (DFDR) had been downloaded and sent to Manufacturer for analysis. Pictorial view of the findings.



The Salient points of DFDR analysis are as follows:

a) At 14:06 UTC, the aircraft was at 1300 ft RA. Auto Pilot (AP) was disengaged and the aircraft was controlled and flown by the Co-Pilot. Rate of descent (ROD) at that time was 700 ft/min approx. with Calibrated Air Speed (CAS) 140 Kt approx.

b) At 14:07:02 UTC, the aircraft was at 900 ft RA. Slats/Flaps were at 27/34 and landing gear was selected down. The Calibrated Air Speed (CAS) was 140Kt and the Auto Thrust (A/THR) was active in Speed mode. Rate of descent (ROD) at that time was700 ft/min approx. The aircraft was on ILS i.e., on the glide slope and the localizer. Pitch angle was +1° (Nose up). Speed target was managed at 141kt.

c) Between 14:07:02 UTC to 14:07:58 UTC, aircraft descent from 900 ft RA to 240 ft RA, during this period the CAS varied between 141kt and 137 knots and the Rate of descent (ROD) varied between 340ft/min and 960 ft/min. Pitch angle also varied between -2° (nose down) and + 1.5° (nose up).

d) At 500ft RA (stabilization height recommended in VMC):

- The aircraft was on the correct lateral and vertical flight path
- The aircraft was in the landing configuration
- No excessive flight parameter deviation was recorded

e) At 500 ft RA, Rate of Descent (ROD) 924 ft/min approx., CAS 141 Kt approx. The aircraft was in the landing configuration and the aircraft was on the correct lateral and vertical flight path.

f) At 14:07:58 UTC aircraft was at 230 ft RA and at 14:08: 17 UTC, aircraft made its first touchdown, during this period the CAS varied between 135kt and 145kt and the Rate of Descent (ROD) varied between 510ft/min and 880ft/min. Pitch angle also varied between -1.5° (nose down) and + 4° (nose up).

g) Between 90ft RA and 65ft RA, headwind decreases rapidly from 20kt to 7 kt in 3sec. CAS decreases from 145kt to 135kt, the Rate of Descent (ROD) increases and Pitch angle decreased.

h) Between 65ft RA and 30ft RA, PF started to apply two pitch up command. CAS decreases from 145kt to 135kt, However, the Rate of Descent (ROD) further increases and Pitch angle continued to decreased.

i) From 30ft RA to touchdown, a dual sidestick inputs observed for 4 sec without activation of the takeover priority pushbutton. Consequently, the Rate of Descent (ROD) started decreasing from 880ft/min and Pitch angle increased from -1.5° (nose down) and + 4° (nose up). At this height flare action performed.

1.12 WRECKAGE AND IMPACT INFORMATION

NIL

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

The crew had undergone pre-flight medical (Breath Analyzer Test) at Chennai before departure as per requirement of CAR Section 5, Series F, Part III. The test result was negative i.e. both cockpit crew were not under the influence of alcohol.

The involved controllers were having valid medical certificate.

1.14 FIRE

There was no fire.

1.15 SURVIVAL ASPECTS

The Incident was survivable.

1.16 TESTS AND RESEARCH

NIL

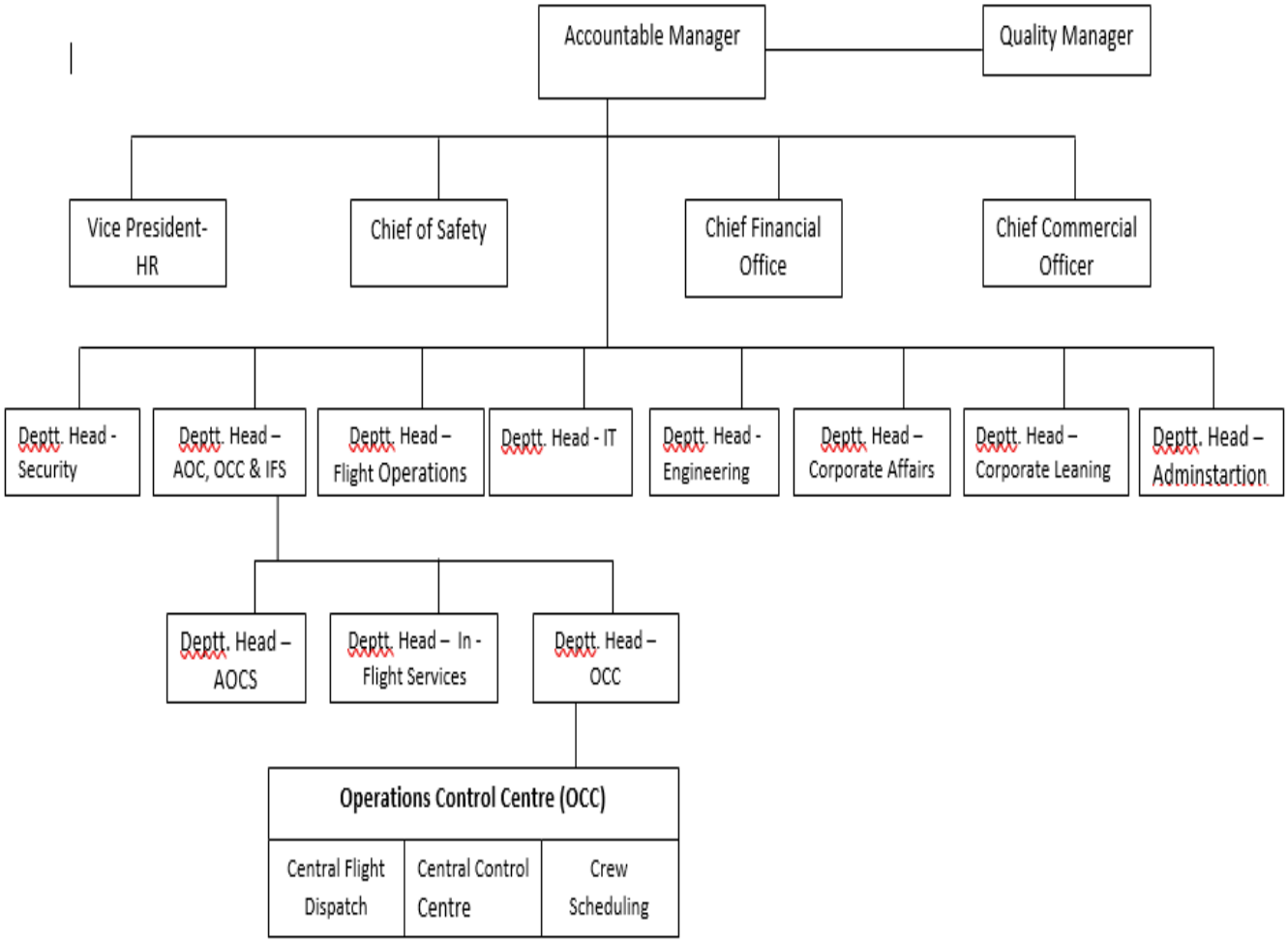
1.17 ORGANISATIONAL AND MANAGEMENT INFORMATION

1.17.1 Indigo

The aircraft was operated by M/s Indigo which is a scheduled operator holding Air Operator Permit (AOP) No. S-19 in Passenger and Cargo Category which is valid till 02.08.2022. M/s Indigo currently has a fleet of 276 aircraft, comprising of 231 Airbus A320, twenty-four ATR- 72, and twenty-one A321 aircraft.

The Organization holds a CAR 145 maintenance approval to carry out maintenance of the aircraft. It also has an approved training facility for the pilots and Engineering.

The Organizational chart is given below:



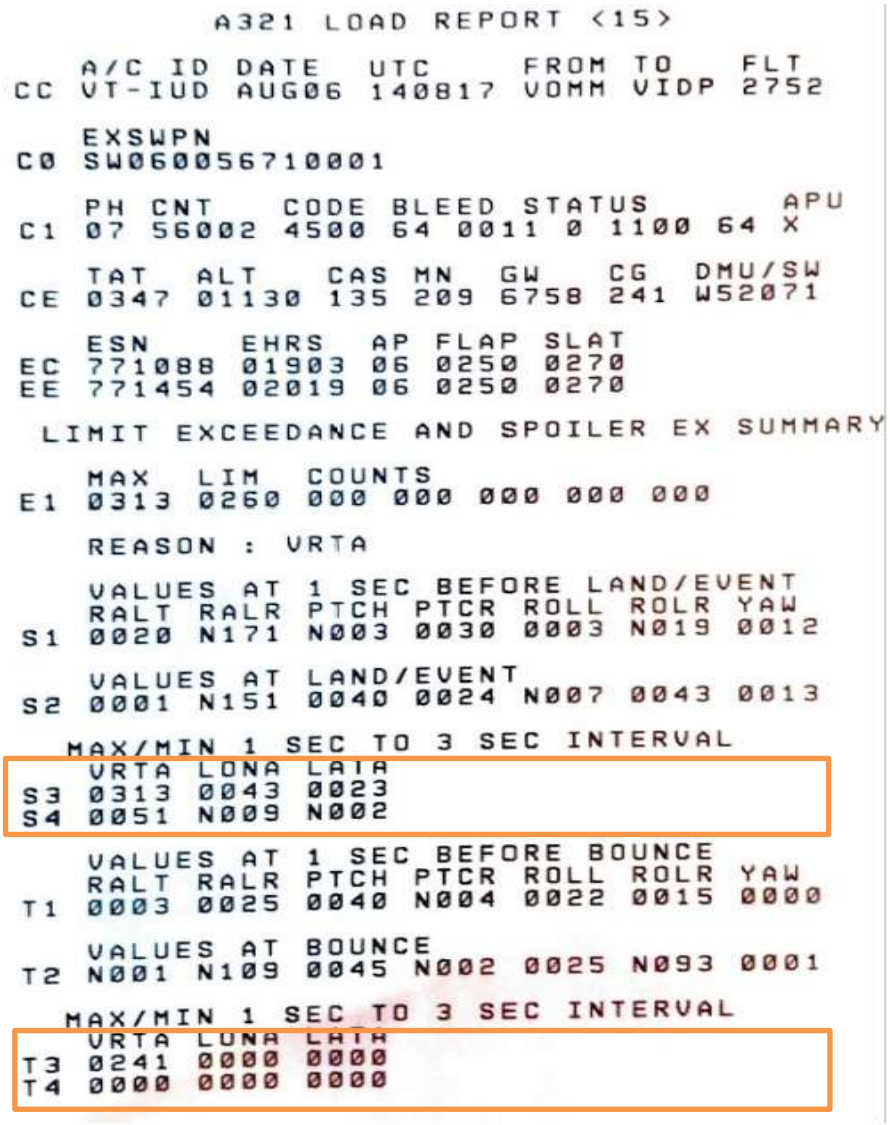
1.17.2 Airports Authority of India

Airports Authority of India (AAI) is a statutory body working under the Ministry of Civil Aviation, Government of India. It provides Communication Navigation Surveillance / Air Traffic Management (CNS/ATM) services over Indian airspace and adjoining oceanic areas.

Training of Air Traffic Controllers are done in Allahabad, Hyderabad and Gondia.

1.18 ADDITIONAL INFORMATION

1.18.1 Load Report:



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                A321 LOAD REPORT <15>

     A/C ID DATE  UTC    FROM TO   FLT
CC   VT-IUD AUG06 140817 VOMM VIDP 2752

     EXSWPN
C0   SW060056710001

     PH CNT   CODE BLEED STATUS       APU
C1   07 56002 4500 64 0011 0 1100 64 X

     TAT  ALT   CAS MN  GW   CG  DMU/SW
CE   0347 01130 135 209 6758 241 W52071

     ESN    EHRS  AP FLAP SLAT
EC   771088 01903 06 0250 0270
EE   771454 02019 06 0250 0270

 LIMIT EXCEEDANCE AND SPOILER EX SUMMARY

     MAX  LIM  COUNTS
E1   0313 0260 000 000 000 000 000

     REASON : VRTA

     VALUES AT 1 SEC BEFORE LAND/EVENT
     RALT RALR PTCH PTCR ROLL ROLR YAW
S1   0020 N171 N003 0030 0003 N019 0012

     VALUES AT LAND/EVENT
S2   0001 N151 0040 0024 N007 0043 0013

   MAX/MIN 1 SEC TO 3 SEC INTERVAL
     VRTA LONA LATA
S3   0313 0043 0023
S4   0051 N009 N002

     VALUES AT 1 SEC BEFORE BOUNCE
     RALT RALR PTCH PTCR ROLL ROLR YAW
T1   0003 0025 0040 N004 0022 0015 0000

     VALUES AT BOUNCE
T2   N001 N109 0045 N002 0025 N093 0001

   MAX/MIN 1 SEC TO 3 SEC INTERVAL
     VRTA LONA LATA
T3   0241 0000 0000
T4   0000 0000 0000
```

Note: After touchdown load report 15 was generated which indicates that Max VRTA was 3.13 G and aircraft was bounced back and finally landed on 2.41 G. As per Airbus 3.13 G is categorized as severe hard landing.

1.18.2 FCTM extract: Flare and Touchdown.

FLARE AND TOUCHDOWN

Ident.: PR-NP-SOP-250-00020012.0001001 / 14 DEC 18
Applicable to: ALL

PITCH CONTROL

When approaching the ground, auto-trim ceases and the flare law activates. During flare, PF will have to apply a progressive and gentle back stick order until touchdown. The flare law technique is thus very conventional.

Prior to flare, avoid destabilization of the approach and steepening the slope at low heights in attempts to target a shorter touchdown. If a normal touchdown point cannot be achieved or if destabilization occurs just prior to flare, a go-around (or rejected landing) should be performed.
The PM monitors the rate of descent and should call "*SINK RATE*" if the vertical speed is excessive prior to the flare.
From stabilized conditions, the flare height is about 30 ft.
This height varies due to the range of typical operational conditions that can directly influence the rate of descent.

Compared to typical sea level flare heights for flat and adequate runway lengths, pilot need to be aware of factors that will require an earlier flare, in particular:

- High airport elevation.
  Increased altitude will result in higher ground speeds during approach with associated increase in descent rates to maintain the approach slope.
- Steeper approach slope (compared to nominal 3 °).
- Tailwind.
  Increased tailwind will result in higher ground speed during approach with associated increase in descent rates to maintain the approach slope.
- Increasing runway slope.
  Increasing runway slope and/or rising terrain in front of the runway will affect the radio height callouts down to over flying the threshold used by the flight crew to assess the height for the start of flare possibly causing flare inputs to be late. The visual misperception of being high is also likely.

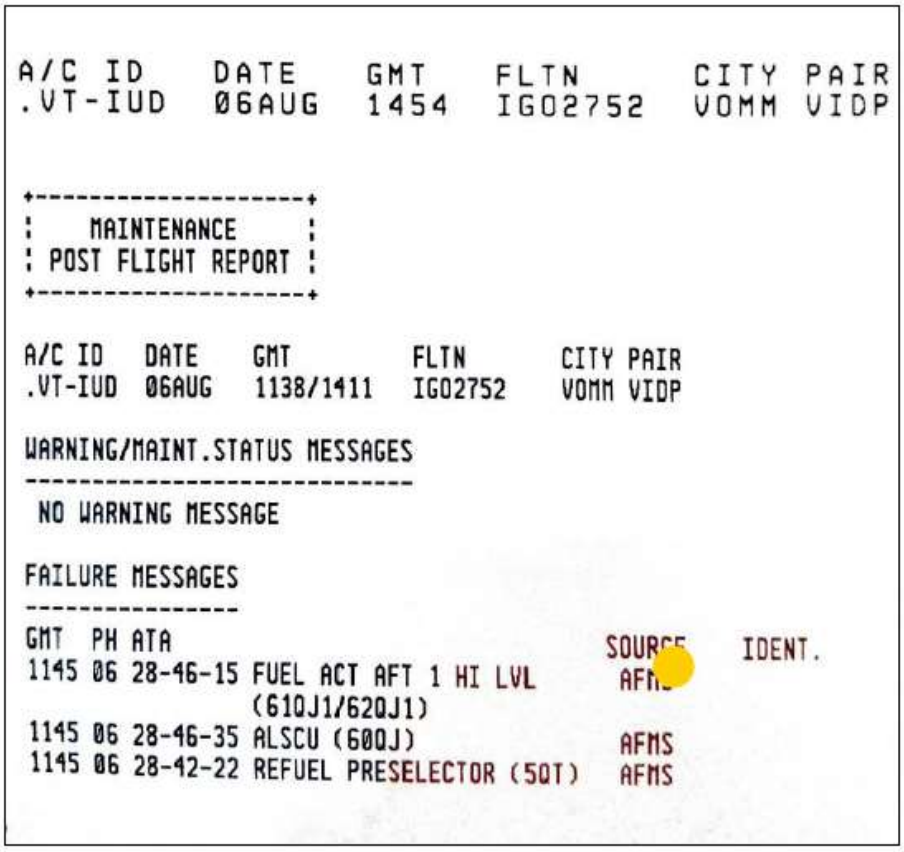
Note that the cumulative effect of any of the above factors combined for one approach will require even more anticipation to perform an earlier flare.
If the flare is initiated too late then the pitch changes will not have sufficient time to allow the necessary change to aircraft trajectory. Late, weak or released flare inputs increase the risk of a hard landing.

Avoid under flaring.

- The rate of descent must be controlled prior to the initiation of the flare (rate not increasing)
- Start the flare with positive (or "prompt") backpressure on the sidestick and holding as necessary
- Avoid forward stick movement once Flare initiated (releasing back-pressure is acceptable)

Note: Normally for stabilized approach flare height is about 30 ft. This height may vary due to operational conditions which can vary rate of descent. Thus, is these cases pilot has to access the situation and apply flare accordingly. Like, in this case the rate of descent was more thus, the flare should be applied much earlier.

1.18.3 Post Flight Report.



```
A/C ID    DATE    GMT    FLTN      CITY PAIR
.VT-IUD   06AUG   1454   IG02752   VOMM VIDP


+--------------------+
!    MAINTENANCE     !
! POST FLIGHT REPORT !
+--------------------+

A/C ID   DATE    GMT         FLTN      CITY PAIR
.VT-IUD  06AUG   1138/1411   IG02752   VOMM VIDP

WARNING/MAINT.STATUS MESSAGES
-----------------------------
 NO WARNING MESSAGE

FAILURE MESSAGES
----------------
GMT  PH ATA                                SOURCE   IDENT.
1145 06 28-46-15 FUEL ACT AFT 1 HI LVL      AFMS
                (61QJ1/62QJ1)
1145 06 28-46-35 ALSCU (60QJ)              AFMS
1145 06 28-42-22 REFUEL PRESELECTOR (5QT)   AFMS
```

Note: Post flight report did not generated any warning or failure report.

1.18.4 FCTM extract: Use of sidestick.

IndiGo **A318/A319/A320/A321** FLIGHT CREW TECHNIQUES MANUAL	**AIRBUS OPERATIONAL PHILOSOPHY** **DESIGN PHILOSOPHY** FLY-BY-WIRE - UTILIZATION PRINCIPLES

USE OF SIDESTICK

Ident.: AOP-10-30-20-00016249.0001001 / 20 MAR 17
Applicable to: ALL

Only one pilot flies at a time.

If the PM wants to act on the sidestick, he/she must:
- Clearly announce "I have control"
- Press and maintain his/her sidestick pushbutton, in order to get full control of the Fly-By-Wire system.

The flight crew should keep in mind that sidestick inputs are algebraically added. Therefore dual inputs must be avoided, and will trigger aural and visual alerts.
Either pilot can make an input on their sidestick at any time.
Either pilot can deactivate the other pilot's sidestick by pressing on their sidestick pb.

Note: As per FCTM Only one flight crewmember should fly the aircraft but during landing, a dual sidestick inputs phase occurred from 30ft RA, lasting approximately 4 seconds without activation of the takeover priority push button.

- **Extract from Ops Manual – Stabilized Approach.**

25.1.4 Stabilized approaches – conditions/ requirements

The following Stabilisation thresholds need to be met:

a)	NPA/PAR	-	FAF
b)	ILS	-	1000 ft AAL
c)	Visual	-	500 ft AAL
d)	Circling	-	Not approved by DGCA

By this threshold, the airplane should be:

- In desired landing configuration.
- On the published approach profile (vertical and lateral) until conditions have been met to descend below MDA/DA.
- At Speed TARGET as computed by the FMS.
- Rate of descent not in excess of 1000 ft/ min.
- Engines spooled up. Thrust stabilized usually above idle, compatible to approach configuration in order to maintain V tgt.
- No excessive flight parameter deviation
- The landing check list 'to the line' must be completed

PM will check above parameters and callout 'Stabilised'. If the aircraft is not stabilized, he shall callout 1000'/ 500' un-stabilised the flight crew must initiate a go-around, unless they think that only small corrections are necessary to rectify minor deviations from stabilised conditions due, amongst others, to external perturbations.

Note: If ATC requests a speed constraint that is not compatible with speed and thrust stabilization at 1 000 ft AAL, a later speed and thrust stabilization is acceptable, provided that:

Note: The aircraft was stabilized on approach and co-pilot was pilot flying.

- **Extract from Ops Manual – Significant Deviation.**

25.1.5 Significant Deviation in approach

The PM will make callouts for the following conditions during final approach:

o Approach speed	Decreases below Speed Target 0 Kt or increase above Speed Target +10 Kt
o Rate of descent	V/S more than 1000 ft/ min
o Bank Angle	greater than 7°
o Pitch Attitude	Lower than -2.5° or higher than +10°
	Lower than -2.5° or higher than +7.5° (A321)
o Localiser	½ dot deviation
o Glide slope	½ dot deviation
o Cross track	XTK greater than 0.1 nm
o VDEV	when vertical deviation is greater than ½ dot
o Course	Greater than ½ dot or 2.5° (VOR) or 5°(ADF)
o At Alt check points	..... Ft High/ Low
o Thrust	Any significant deviation from average thrust setting

Notes:

I. It is responsibility of the PM to call out any significant deviation.

II. 360º turns on the Final Approach is prohibited and a missed approach must be executed whenever the airplane is not stabilized during this phase.

III. The PM to remain 'heads down' at DA (H) and below.

Note : While first touchdown pilot monitoring was Pilot-in-Command and supervisory takeoff or landing was going on. Pilot flying (i.e. Co-Pilot) has total flying hours of approximately 10 hrs thus, PF may have faced difficulty in accessing the situation as the wind was gusty and rate of descent was more.

1.18.5 Supervised Take-off and Landing (STL)

STL provides the Co-Pilots opportunity to acquire vital experience in handling the aircraft during critical phases of flight; Take-off & landing. The Pilots who are authorized to permit and undertake flying under supervision are notified in this NOTAC (Notice to Aerodrome Certificate), However Pilots can exercise the privileges of STL from the time DGCA, HQ receives the STL notification letter send by the company**.**

a) Experience criteria:

The PIC who permits a Co-Pilot to effect take-off and landing shall have:

- Minimum flying experience –3000 hours.
- Minimum command experience –1000 hours.

- Minimum PIC experience on type –300 hours.
- Blameworthy free accident/incident record for preceding 3/1yearsrespectively.
- Recent flying experience of 10 hours in preceding 90 days.
- Been suitably trained and assessed for supervised take-off and landing in a level C/CG/D/DG simulator.

The Co-Pilot who effects take-off and landing shall have:

- Been suitably trained and assessed for supervised take-off and landing in a level C/CG/D/DG simulator.
- Completed type rating syllabus including base training/ZFTT simulator.

Note *(i) M/s Indigo permits STL from initial phase of flying (in simulator).*
(ii)There is no flying experience required by the Co-Pilot to carry out STL.
(iii)In this case both flight crew were having flying experience of around 10 hrs only on A321.
(iv) After first touchdown PIC took over control.

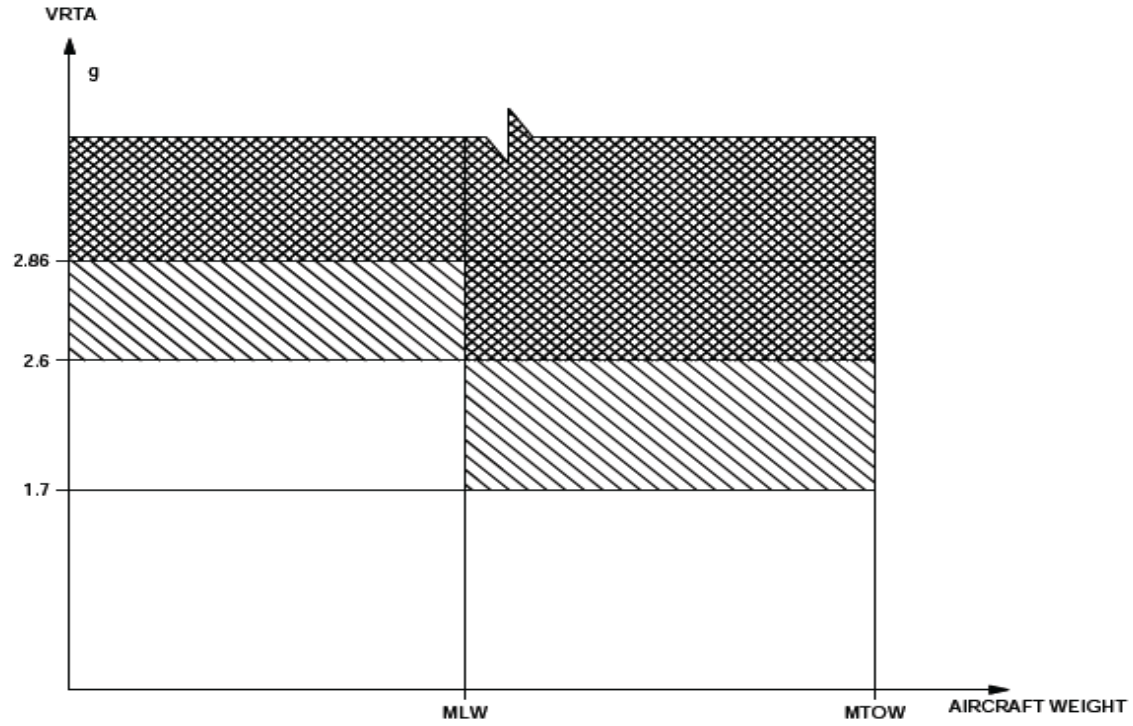
1.18.6 Classification of Hard Landing

Airbus has lead down certain task which is to be carried out when pilot reports hard landing. All the steps where carried out and the data was shared with Airbus.

When VRTA ≥ 2.6 G, Operator has to inspect the raw data generated by an aircraft and send to Airbus.

In this case, the aircraft was not more than minimum landing weight (MLW). The weight of the aircraft while landing was 67.58 Tons.

Airbus classifies the landings as below:



From the above diagram it is understood that:

- if VRTA is more than or equal to 2.6 G, It is considered to be hard landing or hard overweight landing.
- If VRTA ≥ 2.86 G, it is considered to have severe hard landing or severe hard overweight landing.

Thus, with VRTA 3.13 G, aircraft suffered severe hard landing.

1.19 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES

Nil.

2 ANALYSIS

2.0 GENERAL

On the day of incident M/s Indigo aircraft, VT-IUD (Call Sign- IGO2752) was scheduled to operate its flight from Chennai to Delhi. Aircraft was airworthy and the flight was uneventful till Final Approach. While touching down aircraft hit the ground with higher than permissible limit and suspected hard landing was reported. Which was further categorized as severe hard landing as per OEM guidelines.

ATC issued a Notam at 1401 UTC, in which winds were 100 degree 13 kts and Visibility 4000 mtr. The trend weather was also issued as wind gusting to

30kts, visibility 1000 mtr and with thunderstorm and rain. This information was monitored by flight crew.

While aircraft was descending from 900 ft to 200 ft RA, the DFDR recorded head wind gusting between 30kts to 15 kts with mean left crosswind of 2kts. At 900ft RA, the aircraft was in landing configuration. Final approach was manually handled by CM2 (P2) with the A/THR active in "SPEED" mode. Due to wind variation the targeted speed of aircraft was also varying from 141kts to 137kts.

Below 200ft RA, the headwind trend was to vary rapidly between 20kt and 7kt and the left crosswind trend was to vary between 1kt and 8kt. In this phase no side stick was applied and rate of descent was increasing. Control of the aircraft was with CM2 (P2).

Below 90ft RA, the aircraft encountered a longitudinal wind gradient leading the headwind to decrease rapidly from 20kt toward 7kt. This decrease in wind (13kt in 3s) led the CAS to decrease from 145kt toward 135kt and consequently decreased the lift. As a result, there was a loss of lift. This explains why the rate of descent and the flight path angle started to increase while no sidestick order was applied.

The ground effect encountered at low height contributed to maintain the pitch down dynamics and thus the rate of descent.

The flare action performed at 30ft RA with a high rate of descent (880ft/min) and a negative pitch angle (-1.5°) did not enable to sufficiently change the aircraft trajectory before the touchdown to avoid the severe hard landing. Both CM1 (P1) and CM2 (P2) sidestick inputs were applied without pushing priority button for about 4 sec which in turn algebraically added. Aircraft touched ground at a VRTA value of 3.13 G which is a case of severe hard landing.

The flare action applied was not sufficient to change the trajectory to aircraft and to avoid hard landing. As per FCTM, for stabilized approach flare height is 30 ft but, it may vary due to operational conditions. Control of the aircraft was with co-pilot as STL was in progress. PIC failed to access the situation and took over the control late.

The aircraft after touching down bounced back upto 4 ft and landed at VRTA value of 2.41 G.

Post flight report did not showed any warning. Flight crew reported suspected hard landing. Load report 15 was generated and it showed the aircraft touched ground two times with VRTA at 3.13 and 2.41 G.

2.1 SERVICEABILITY OF AIRCRAFT

2.1.1 The aircraft was manufactured in the year 2019 and was holding a valid Certificate of Registration (C of R) and Certificate of Airworthiness (C of A). Last Airworthiness Review Certificate (ARC) was issued on 18th May 2020 and was valid at the time of incident.

Aircraft, Engines and its components were maintained in accordance with the DGCA approved Aircraft Maintenance Program (AMP).Last major inspection (750 FH/ 90 Days Inspection)on aircraft & engine was carried out on 19th June 2020.

As per aircraft records, all modifications on the aircraft were found to be complied with at the time of incident. On scrutiny of the snag register it was observed that no snag were pending on the aircraft prior to the incident flight.

Load & Trim sheet was prepared for this flight and C.G was within the prescribed limits. Therefore, based on the above facts, it is inferred that serviceability of the aircraft was not a contributory factor to the incident.

2.2 WEATHER

As per METAR provided by the Delhi ATC was trending to be gusting upto 30 kts with Thunderstorm and Rain. Wind information obtained from the DFDR data analysis by the manufacturer, indicates that during the descent from 900ft RA to 200ft RA, the aircraft encountered a rapidly wind changes i.e., the mean headwind decreases from 30kt to 15kt with gust. In last 90ft, the

headwind further decreased from 20kt to 7kt. Due to this rapid change in headwind during the final approach and landing affected the CAS i.e., CAS decreased from 145kt to135kt. Consequently, Rate of Descent (ROD) increased and Pitch angle also decreased. Hence, it affected the aircraft landing.

From above we may conclude that weather was one of the contributory factors.

2.3 DFDR & CVR ANALYSIS.

2.3.1 DFDR

a) At approximately 1300ft RA, Autopilot was disengaged, Vapp was 140kt and Vertical speed was 650kt.

b) At around 1000ft RA, Vapp was 142kt, Vertical speed was 680kt,

c) At 900ft RA, Flight Directors were engaged in vertical and lateral modes. Auto thrust was active in Speed mode, speed target was managed at 141 kt, which was 13 kt more than QRH and the Rate of descent was approximately 700ft/min. The aircraft was in landing configuration and the speed target was managed.

d) Between 900ft RA and 500ft RA, PF applied sidestick input to change Pitch angle from -2° to + 1.5°i.e., the nose down pitch changes to nose up.PF controlled the exceeded parameters such Glide. The speed target was managed.

e) Between 230ft RA and 90 ft RA, both Pitch up and Pitch down orders were applied. The net change in Pitch angle was from -1° to -0.5° and consequently, the rate of descent changes from 750ft/min to 700ft/min.

f) Between 90ft RA and 30ft RA, due to the rapid decrease in headwind, the calibrated air speed decreases from 145kt to 135kt and consequently the lift decreased and hence **rate of descent increases from 700ft/min to 880ft/min** although twice pitch up orders were applied by the PF. These two Pitch up orders given by the PF, didn't change the pitch angle

at such a low height (< 65ft) under the influence of ground effect and **the pitch angle decrease further to -1.5°.**

g) At 30ft RA, flare action was performed with a negative pitch angle of -1.5° and with increasing rate of descent and consequently the aircraft made a hard landing. Although, the PIC (PM)also applied Pitch up orders along with PF, hence a dual sidestick phase occurred. Due this dual input aircraft Pitch angle changes to +4°. Aircraft bounced in air for approx. 4ft due to combination of full nose up order applied, energy(reaction) of first touchdown and aircraft speed. After bounce aircraft again landed on main wheels with less VRTG =2.41 G.

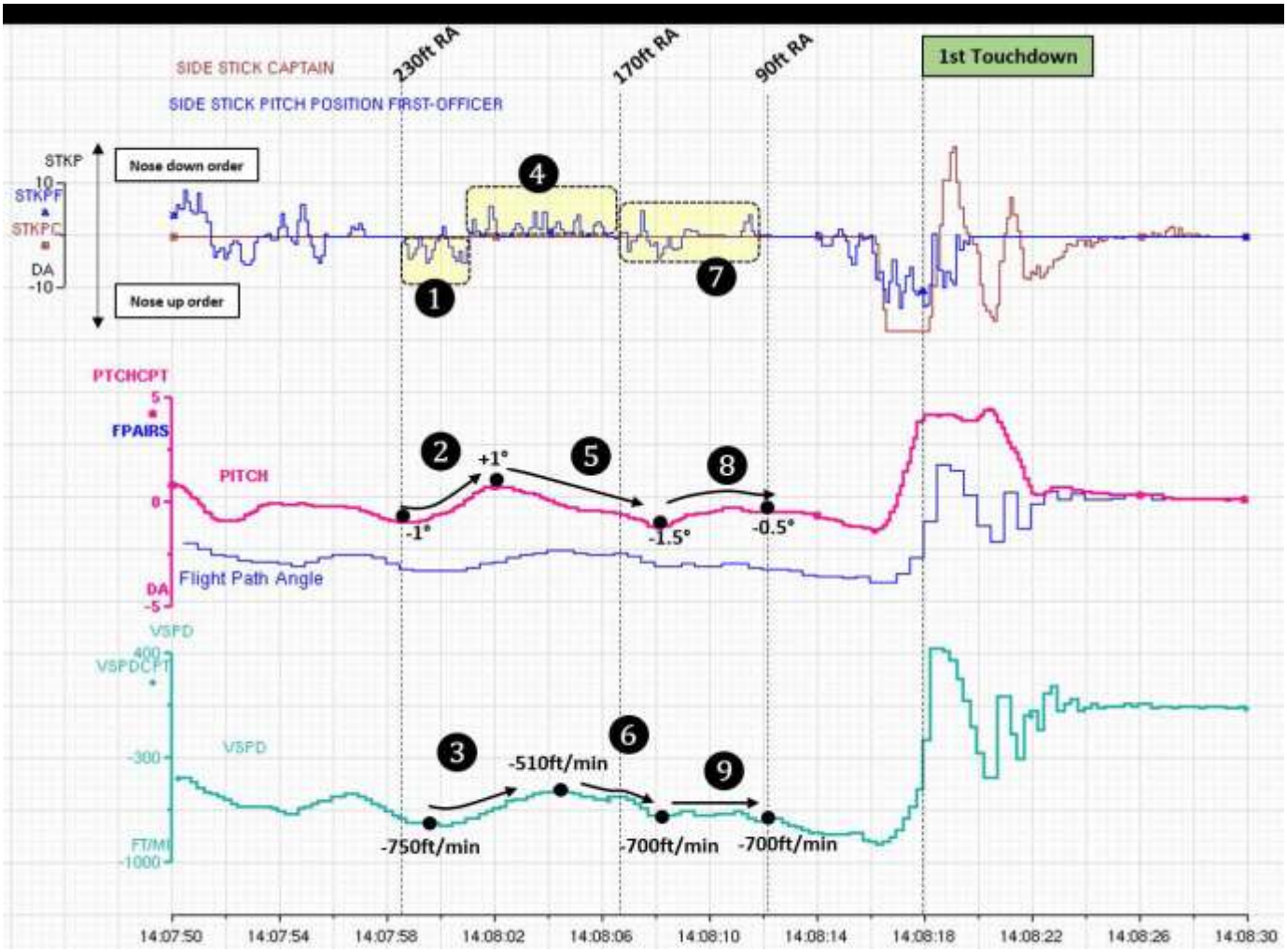


Figure: Behavior of aircraft from 230 ft to 90 ft

The above analysis shows the behaviour of aircraft from 230ft to 90ft RA:

a) A first phase of several pitch up orders were applied as in (Point 1) which lead the pitch angle to increase from -1° toward +1° as shown in (Point 2) and consequently reduced the rate of descent from 750ft/min to 510ft/min as shown in (Point 3).
b) Then a second phase of several pitch down orders were applied (Point 4) lasting approximately 6seconds. These action stopped the pitch increasing and led the pitch angle to decrease from +1° toward -1.5 as soon (Point 5). As a result, the rate of descent increased from 510ft/min toward 700ft/min as shown in (Point 6).
c) Then a third phase of pitch up and pitch down orders were applied as shown in (Point 7) leading the pitch angle to decrease and stabilize from -1.5° toward -0.5° as shown in (Point 8) and the rate of descent to gradually stabilize at about 700ft/min as shown in (Point 9).

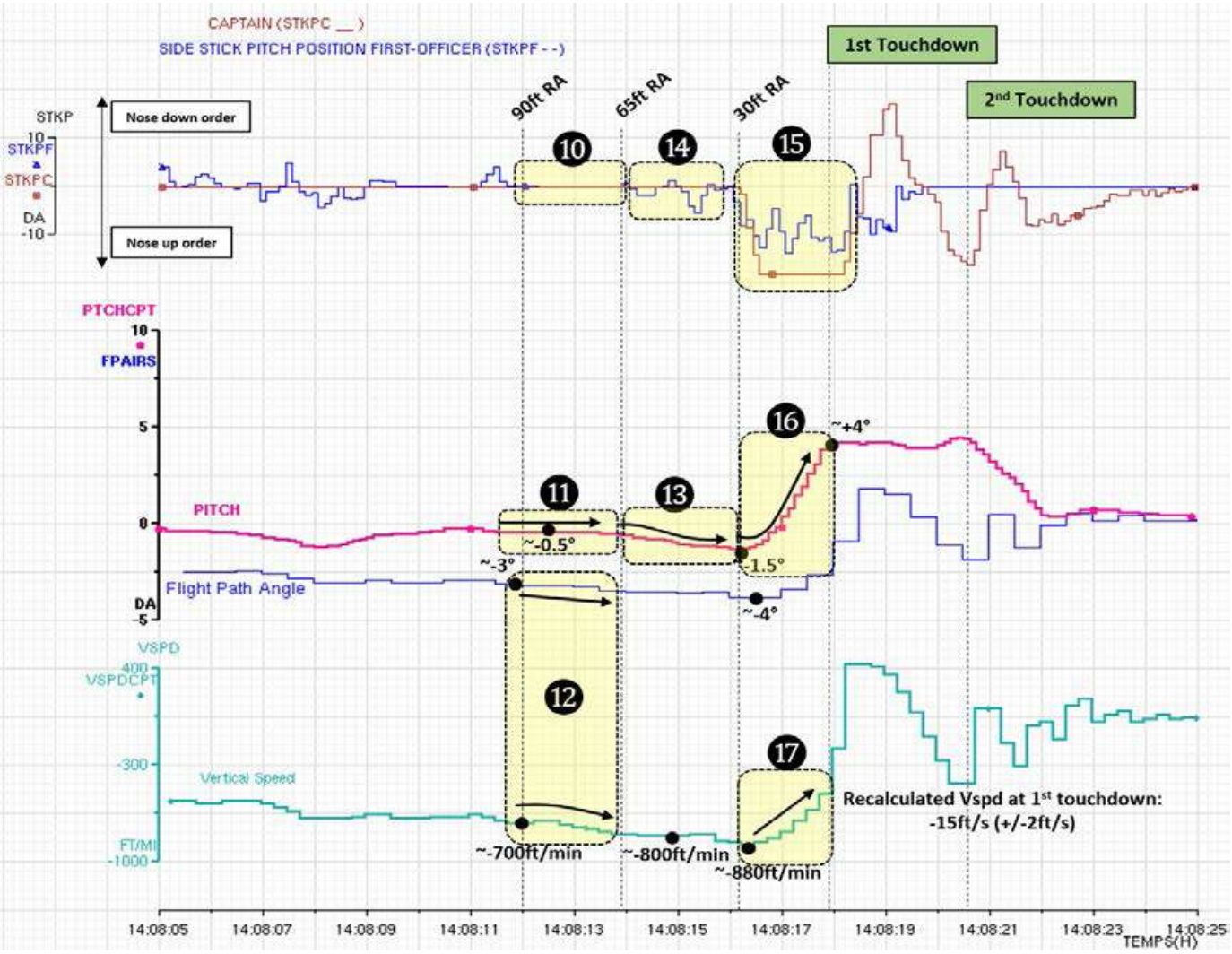


Figure: Behavior of aircraft from 90 ft to 65 ft

The above analysis shows the behaviour of aircraft from 90ft to 65 ft RA:

a) It was observed that no sidestick order was applied as shown in (Point 10) leading the pitch angle to remain at -0.5° as shown in (Point 11) However, during this period of time, the rate of descent and the flight path angle started to increase as shown in (Point 12).
b) Due to Wind condition during Final Approach, below 90ft RA, the aircraft encountered a longitudinal wind gradient leading the headwind to decrease rapidly from 20kt toward 7kt. This decrease in wind (13kt in 3sec) led the CAS to decrease from 145kt toward 135kt and consequently decreased the lift. As a result, this loss of lift explains why the rate of descent and the flight path angle started to increase while no sidestick order was applied.
c) From 65 ft RA, the pitch angle started to decrease as shown in (Point 13). This decrease in pitch is the second consequence of this loss of lift due to the headwind variation.
d) In parallel, CM2 (RHS pilot) started to apply two short pitch up orders by impulsion between 65ft RA and 30ft RA as shown in (Point 14). However, these sidestick orders did not significantly change the pitch down dynamics reinforced by the ground effect encountered at low height (50ft). The pitch angle continued to decrease toward -1.5°.
e) Then at 30ft RA, while the rate of descent reached 880ft/min, a dual sidestick inputs phase occurred as shown in (Point 15).
f) Sidestick inputs were simultaneously recorded on both CM1 (LHS pilot) and CM2 (RHS pilot) sides without activation of the takeover priority pushbutton: the sidestick orders were thus algebraically added. However, as per design, the resulting input was limited to a full back stick order.
g) This equivalent full pitch up sidestick order led the pitch angle to increase as shown in (Point 16) and the rate of descent to decrease prior to touchdown as shown in (Point 17).
h) This flare action performed at 30ft RA with a significant rate of descent (880ft/min) and a negative pitch angle (-1.5°) did not sufficiently change the aircraft trajectory before touchdown to avoid the hard landing.

As per the analysis, the flare action was performed at 30ft RA with a significant rate of descent (-880ft/min). As recommended in the Company FCTM extract, from stabilized conditions, the flare height is about 30ft and this height varies due to the range of typical operational conditions that can directly influence

the rate of descent. In other words, an increasing rate of descent close to the ground require to perform an earlier flare.

Thus, increase in rate of descent and late flare was the factor for leading hard landing.

2.3.2 Cockpit Voice Recorder (CVR)

It was observed that the crew was using plain language in the critical phase of flight. Which is not in compliance of Company Operational Manual Part A.

2.4 OPERATIONAL FACTOR (CREW HANDLING OF THE AIRCRAFT AND DECISION MAKING)

2.4.1 Pilot – In - Command

Between 90ft RA and 30ft RA, when the aircraft encountered rapid decrease in headwind and the rate of descent was increasing with negative Pitch angle, PIC could have taken call out for an early flare, to avoid under flare in such a typical operational condition.

2.4.2 Co-pilot

Between 90ft RA and 30ft RA, when the aircraft encountered rapid decrease in headwind and the rate of descent was increasing with negative Pitch angle, PF could have initiated an early flare, to avoid under flare in such a typical operational condition.

Thus, PIC decision of taking call out of flare and taking over the control was a factor for occurrence of incident .Further, Co-Pilot was not able to access the situation in gusty wind was also a contributing factor.

2.5 CIRCUMSTANCES LEADING TO THE INCIDENT

Aircraft approach was stabilized approach and uneventful till 230ft RA. From 230ft RA PF had tried to control the rate of descent by applying Pitch up orders. At 90ft RA Pitch angle was -0.5°and rate of descent was 700ft/min. Below 90ft the aircraft encountered a rapid decrease in longitudinal headwind and consequently CAS and lift decreased. Although PF had applied two pitch up orders but due to ground effect, aircraft did not respond and consequently

Pitch angle and rate of descend further decreased to -1.5 and 880ft/min respectively.

Crew had initiated flare action at 30ft RA, but due to prevailing typical operational condition, aircraft did respond sufficiently and hit the ground with high G value (3.13G) on its main wheels. Immediately after touching the ground the aircraft bounced in the air for approx. 4ft due to combination of full applied nose up order, energy(reaction) of first touchdown and aircraft speed. After bounce aircraft landed on main wheels with less VRTG 2.41 G with RH MLG had touching first and then the LH MLG followed by the NLG.

3. CONCLUSION

3.1 FINDINGS

3.1.1 General

1. The Certificate of Airworthiness, Certificate of Registration and Airworthiness Review Certificate of the aircraft were valid on the date of incident.
2. Both pilot were qualified to operate the flight.
3. The Enroute flight from Chennai was uneventful till approach phase.
4. Aircraft was cleared for ILS approach Runway 10.
5. Aircraft approach was a stabilized on localiser.
6. At 140618 UTC, aircraft was cleared to land on Runway 10 by the Delhi ATC.
7. Wind were gusting till 30 kts with a trend of thunderstorm with rain.
8. Below 90ft RA, aircraft encountered a rapid decrease in longitudinal headwind component and aircraft enter into a typical operation condition. Where in spite of PF Pitch up order, Aircraft Pitch angle continued to decrease and lift also decreases. Consequently, the rate of descent increased.

9. At 30ft RA, flare action was performed with 880ft/min rate of descent and Pitch angle was -1.5°. This could not affect much to aircraft trajectory and the aircraft hit the ground with high VRTA of 3.13G.
10. Co-Pilot was operating the flight. Supervisory takeoff and landing was going on.
11. Operator trains for STL in simulator itself. Scenario and mindset at simulator and actual flying is different. Thus, Co-pilot was not able to access the situation. The Co-pilot had only 10.45 hrs of total flying on A321 at the time of incident.
12. At 30ft RA, dual command was also recorded. When the PIC(PM) had applied nose up orders in addition to the PF orders. Due to this aircraft Pitch angle changes from -1.5° to +4°.
13. As per FCTM of company, dual control is not advisable. Only one flight shall fly at all time. While taking the control the other flight shall make a call out.
14. Aircraft landed on its MLG with a VRTA value of 3.13 G which is categorized as severe hard landing.
15. After first touch down PIC took over the control of aircraft.
16. After first touchdown aircraft bounced in air up to 4ft RA, due to energy of first touchdown and full pitch up orders along with aircraft target speed.
17. After bounce, aircraft landed on MLG then on NLG and touched the ground with comparatively less VRTA of 2.41G.
18. From CVR analysis it was observed that the Crew were using plan language for communication during critical phase of flight as given in the operator's Ops manual.
19. After landing there was no warning generated on flight report.
20. Load report 15 was generated, which indicated that the aircraft first landed with a VRTA of 3.13 G and bounced back upto 4 ft later landed with VRTA value of 2.41 G.

21. The report and data of recorders were sent to Airbus for analysis.
22. Airbus advised Abnormal Event Technical Dispositions since there was no warning generation. Operator performed the task as per Airbus disposition satisfactorily.
23. Airbus suggested removal of certain components from both MLG for shop examination.
24. Engine manufacture also suggested removal of RH engine based on BSI report, as rubbing mark were observed on the RH engine.

3.2 PROBABLE CAUSE OF THE INCIDENT

i. Aircraft flared at a height of 30ft RA with high rate of descent ROD (880ft/min) and negative Pitch angle (-1.5°) i.e., under typical operational conditions.
ii. Lack of situational awareness by the PIC and Co-Pilot.

3.3 CONTRIBUTORY FACTOR

Weather was a contributory factor which lead to the incident.

4. SAFETY RECOMMENDATIONS

4.1 It is recommended that both crew may be imparted suitable training. The training syllabus must stress upon the details about Standard Operating Procedures - landing and understanding of flare height variation.

4.2 Operator may devise some means to ensure that during the Pilots training, the trainer shall put stress on Standard Operating Procedures - landing and understanding of flare height variation.

4.3 Operator may stress upon adverse conditions (like weather, aircraft malfunctioning etc) during critical phases of flights in training when STL permission is to be given.

4.4 Operator may sensitize its crew for not using local language during Critical Phases of Flight.

KUNJ LATA
INVESTIGATION-IN-CHARGE

AMIT KUMAR
INVESTIGATOR