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FINAL INVESTIGATION REPORT ON ACCIDENT TO M/S INDIGO AIRBUS A320 AIRCRAFT VT-IJT AT COCHIN ON 14th JUNE 2020

AIRCRAFT ACCIDENT INVESTIGATION BUREAU
MINISTRY OF CIVIL AVIATION
GOVERNMENT OF INDIA

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 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.

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GLOSSARY

AAIB	:	Aircraft Accident Investigation Bureau, India
AMSL	:	Above Mean Sea Level
ARC	:	Airworthiness Review Certificate
ASR	:	Airport Surveillance Radar
ATPL	:	Air Transport Pilot Licence
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
ECS	:	Environmental Control System
FO	:	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
IFR	:	Instrument Flight Rules
ILS	:	Instrument Landing System
LLZ	:	Localizer
MEL	:	Minimum Equipment List
MLG	:	Main Landing Gear
NDB	:	Non-Directional Beacon
NLG	:	Nose Landing Gear
NM	:	Nautical Miles
PA	:	Passenger Address
PF	:	Pilot Flying
PIC	:	Pilot in Command
PM	:	Pilot Monitoring
QRH	:	Quick Reference Handbook
RA	:	Radio Altitude
RESA	:	Runway End Safety Area
SB	:	Service Bulletin
SEP	:	Safety and Emergency Procedures Manual
VFR	:	Visual Flight Rules
VMC	:	Visual Meteorological Conditions
VOR	:	VHF Omnidirectional Range
UTC	:	Coordinated Universal Time

FINAL INVESTIGATION REPORT ON ACCIDENT TO M/S INDIGO, AIRBUS A320 (NEO) AIRCRAFT VT-IJT ENROUTE TO COCHIN INTERNATION AIRPORT ON 14th JUNE 2020

1.	**Aircraft Type**	**:**	Airbus A320-271N
	Nationality	**:**	Indian
	Registration	**:**	VT - IJT
2.	**Owner**	**:**	Cavic 17 Designated Activity Company, Ireland
3.	**Operator**	**:**	M/s Interglobe Aviation Limited (INDIGO)
3.	**Pilot – in –Command**	**:**	ATPL holder
	Extent of injuries	**:**	Nil
4.	**First Officer**	**:**	CPL Holder
	Extent of injuries	**:**	Nil
5.	**Place of Incident**	**:**	Enroute
6.	**Date & Time of Incident**	**:**	14th Jun 2020 & Between 14:20 to 14:25 UTC
7.	**Last point of Departure**	**:**	Dammam International Airport, Saudi Arabia (OEDF)
8.	**Point of intended landing**	**:**	Cochin International Airport, India (VOCI)
9.	**Latitude/Longitude**	**:**	N/A
10.	**Type of operation**	**:**	Scheduled Operation (Chartered Flight)
11.	**Crew on Board**	**:**	09
	Extent of injuries	**:**	01
12.	**Passengers on Board**	**:**	170
	Extent of injuries	**:**	Nil
13.	**Phase of operation**	**:**	Descent Phase
14.	**Type of Occurrence**	**:**	Accident

(All the timings in this report are in UTC unless otherwise specified)

EXECUTIVE SUMMARY

On 14 Jun 2020, a Airbus 320-271N, registered VT-IJT, operated by M/s InterGlobe Aviation Ltd (IndiGo) as a scheduled flight 6E-9371 took off from Dammam International Airport, Saudi Arabia with a total of 179 persons on board, consisting of the Pilot in Command (PIC), eight other crew members and 170 passengers.

As per statement of PIC, the aircraft encountered turbulence during the descent to Cochin International Airport, which caused a cabin crew to fall down resulting in serious injuries.

Owing to the nature of injury and duration of hospitalization of the injured cabin crew; the occurrence was classified as Accident in accordance with the Aircraft (Investigation of Accidents and Incidents) Rules, 2017. Director General, Aircraft Accident Investigation Bureau vide order No. 11011/4/2020 – AAIB dated 23 Jun 2020 and corrigendum dated 11 Jan 2021 designated Sh Anil Tewari, Director, AAIB as investigator-in-charge and Sh Dinesh Kumar, AD, AAIB as investigator to investigate this accident. The occurrence was notified to the ICAO and the State of Design and Manufacture of the aircraft. The State had designated its accredited representative to assist in the investigation.

1. FACTUAL INFORMATION

1.1 History of the Flight

On 14 Jun 2020, an Airbus A320-271N registration VT-IJT, operated by M/s InterGlobe Aviation Ltd (IndiGo) took off from Dammam International Airport, as a Passenger Charter flight No. 6E 9371 (During Peak Covid-19 Period) for Cochin International Airport, with 179 persons on board, consisting of the PIC, eight other crew members and 170 passengers. The Flight was operated by the same crewmembers as the previous flight (from Cochin International Airport to Dammam International Airport as ferry flight).

Aircraft took off at 10:09:00 UTC from Dammam airport. After takeoff, aircraft continued to climb to cruising altitude of FL350, and no abnormality was recorded in the cockpit during the climb phase. Aircraft continued to the destination, however, as per the crew statement, they encountered some weather after crossing Muscat airspace which resulted into minor route deviation.

Well before top of descent, PIC obtained weather from Cochin. PIC carried out descent briefing and advised cabin crew to prepare for arrival. The PIC had confirmed that the en-route weather conditions of the flight-planned route on the day of the accident were mild. Further, during pre-departure briefing with the cabin crew, PIC had informed them that there would be no concern about such turbulence that could influence the in-flight concern since the weather conditions were generally good on the day.

Initially aircraft was cleared for FL260 by Cochin ATC during descent. PIC selected "Managed Descend Mode" to attain the selected flight level while the aircraft autopilot was in engaged mode. As per PIC statement, initially aircraft started descending at about 3000-4000 fpm. While passing FL300, aircraft descent rate increased to 4000-5000 feet per minute approximately.

While was passing FL240, crew observed ROD momentarily increased to 5500-6000 fpm approximately and simultaneously speed also touched 350 knots without any speed warning. The pitch went down to about 7 degree. As per crew statement, winds changed considerably from approx. 20 knots headwind to about 12-15 knots tailwind. To arrest the high rate of descend and to bring the aircraft back into a safe envelope, crew had disengaged the autopilot and pitched up the aircraft.

Autopilot was re-engaged by the crew after normal parameters were achieved in the cockpit.

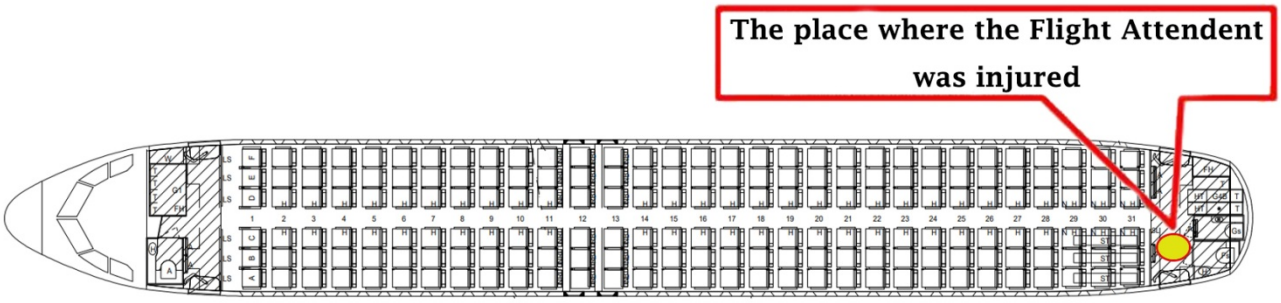


Figure - 1: The place where the Flight Attendant was injured

After a while, as per PIC, when aircraft was passing FL125, cockpit crew received a call from CCIC that L2 cabin crew had fallen down near the lavatory. Further, as per the L2 Cabin Crew statement, lavatory 'F' door was not properly latched / closed during the descend. L2 cabin crew got up from the jump seat to close the door as the seat belt signs were OFF. At that very moment, turbulence was felt and the cabin crew fell down on the floor near R2 door. The cabin crew could not get up immediately, however with the help of crew member positioned at R2, the injured cabin crew managed to sit on the jump seat. As the aircraft was already in descent mode, the injured crew was secured on the jump seat (L2) for landing with the help of CCIC and cabin crew R2. Aircraft landed safely at Cochin airport at 14:40:19 UTC. Upon PIC instructions, all the doors were disarmed initially by respective cabin crew before they were opened. L2 door was opened by the injured cabin crew.

After de-boarding the aircraft, injured cabin crew after administering initial medical assistance at Airport, was later shifted to a medical facility where X-Ray report confirmed that left leg has fractured in the accident.

1.2 Injuries to Persons

INJURIES	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	01	Nil	Nil
~~Minor~~/ None	02+06	170	Nil

1.3 Damage to Aircraft

There was no damage to the aircraft.

1.4 Other Damage

Nil

1.5 Personnel Information

1.5.1 Pilot - In – Command (PIC)

Age	:	**56 Yrs**
License & Validity	:	**ATPL & Valid**
Class	:	**Multi Engine**
Endorsements as PIC	:	**A320 *wef* 24-06-2016** **A321 *wef* 07-01-2019**
Date of Med. Exam & validity	:	**11/06/2019 and Valid**
Date of last Refresher/Simulator	:	**09/10/2019**
Familiarity with Route/ Airport flown for last 12 months and since joining the company.	:	**(a) Number of flights operated to/from COK - 18 flights as Captain & 8 flights as FO.** **(b) Number of flights operated to/from DMM - 1 flight as Captain & 1 flight as FO.**
Total flying experience	:	**8118:24 Hrs**
Total Experience on type	:	**7918:24 Hrs**
Total Experience as PIC on type	:	**3178:07 Hrs**
Last flown on type	:	**03/06/2020**
Rest period before the flight	:	**12:31 Hrs**

1.5.2 Co-Pilot

Age	:	**35 years**
License & Validity	:	**ATPL & Valid**
Class	:	**Multi Engine**
Endorsement as PIC	:	**NA**
Date of Joining Company	:	**13/02/2017**
Date of Endorsement as PIC on type	:	**N/A**
Date of Med. Exam & validity	:	**13/12/2019 and Valid**
Date of last Refresher/Simulator	:	**08/02/2020**

Total flying experience	:	**2038:00 Hrs**
Total Experience on type	:	**1816:31 Hrs**
Total Experience as PIC on type	:	**N/A**
Last flown on type	:	**09/06/2020**
Rest period before the flight	:	**17:38 Hrs**

1.6 Aircraft Information

Aircraft Model	:	AIRBUS A320-271N
Aircraft S. No.	:	9283
Year of Manufacturer	:	2019
Name of Owner	:	CAVIC 17 DESIGNATED ACTIVITY COMPANY
C of R	:	5166
C of A (ARC)	:	7269 (ARC)
Category	:	NORMAL
C of A Validity	:	VALID
ARC issued on	:	02.11.2020 (1ST EXTENSION)
ARC valid up to	:	04.11.2021
Aircraft Empty Weight	:	42371.975 KG
Maximum Take-off weight	:	79000 KG
Date of Aircraft weighment	:	10.10.2019
Empty Weight	:	42371.975 KG
Max Usable Fuel	:	18622.000 KG
Max Pay load with full fuel	:	17023.648 KG
Empty Weight CG	:	26.648% MAC
Next Weighing due	:	09.10.2024
Total Aircraft Hours	:	1477:11
Last major inspection	:	1500FH/180 DAYS ON 09.03.2020
List of Repairs carried out after last major inspection till date of incidence	:	NIL

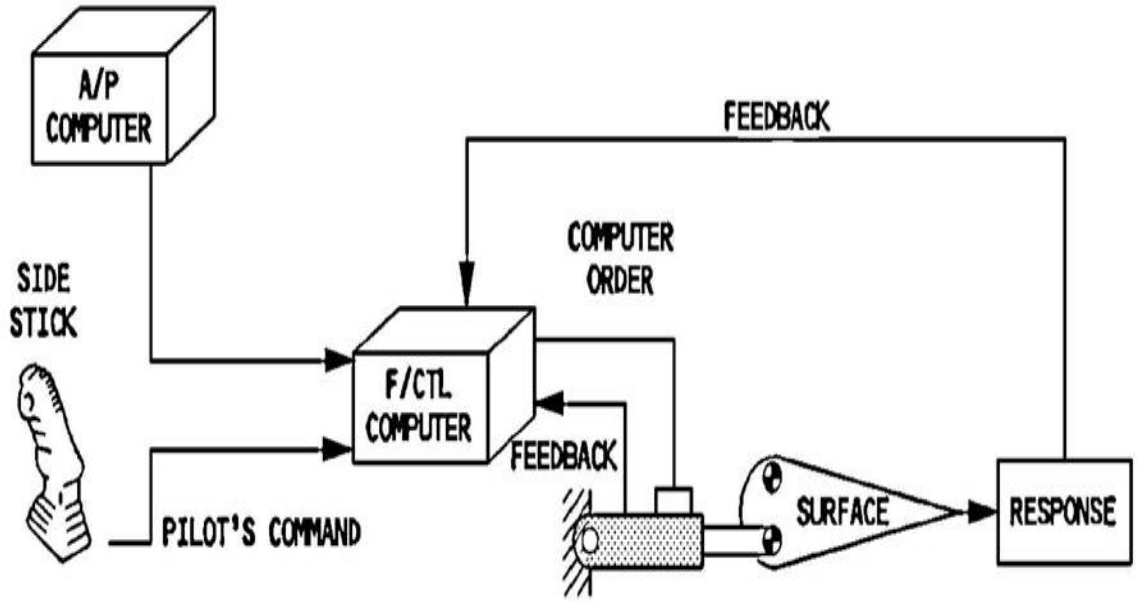
Engine Type	:	PW1100G-JM
Date of Manufacture LH	:	20.02.2019
Engine Sl. No. LH	:	P771219
Last major inspection (LH)	:	ENGINE INSTALLED ON 29.05.2020. NO MAJOR INSP POST REPLACEMENT.
List of Repairs carried out after last major inspection till date of incidence	:	NIL
Total Engine Hours/Cycles LH	:	2417:06/1685
Date of Manufacture RH	:	22.06.2019
Engine Sl. No. RH	:	P771459
Last major inspection (RH)	:	1500FH/180 DAYS ON 09.03.2020
List of Repairs carried out after last major inspection till date of incidence	:	NIL
Total Engine Hours/Cycles RH	:	1477:11/966
Aeromobile License	:	A-002/279/RLO(NR)
AD, SB, Modification complied	:	ALL APPLICABLE AD, SB, MODIFICATION COMPLIED
Aircraft flying under any MEL invoked	:	NO

When the accident occurred, the Aircraft's weight and position of center of gravity (CG) are estimated to have been within the allowable range.

1.6.1 Flight Control System

The flight control surfaces are all electrically-controlled and hydraulically-activated. The stabilizer and rudder can also be mechanically-controlled. Pilots use side sticks to fly the aircraft in pitch and roll (and in yaw, indirectly, through turn coordination).

The computers interpret pilot input and move the flight control surfaces, as necessary, to follow their orders. When in normal law, regardless of the pilot's input, the computers will prevent excessive maneuvers and exceedance of the safe envelope in pitch and roll axis. However, as on conventional aircraft, the rudder has no such protection.



Note: A/P computer = Flight Management and Guidance computers (FMGC1 & FMGC2)
F/CTL computer = Flight Control computers (ELAC1&2 and SEC 1&2&3)

***Figure -2: General Flight control system principle (*Copyright © Airbus SAS, 2020)**

1.6.2 Flight Management and Guidance System (FMGS)

Flight crew interface with FMGS

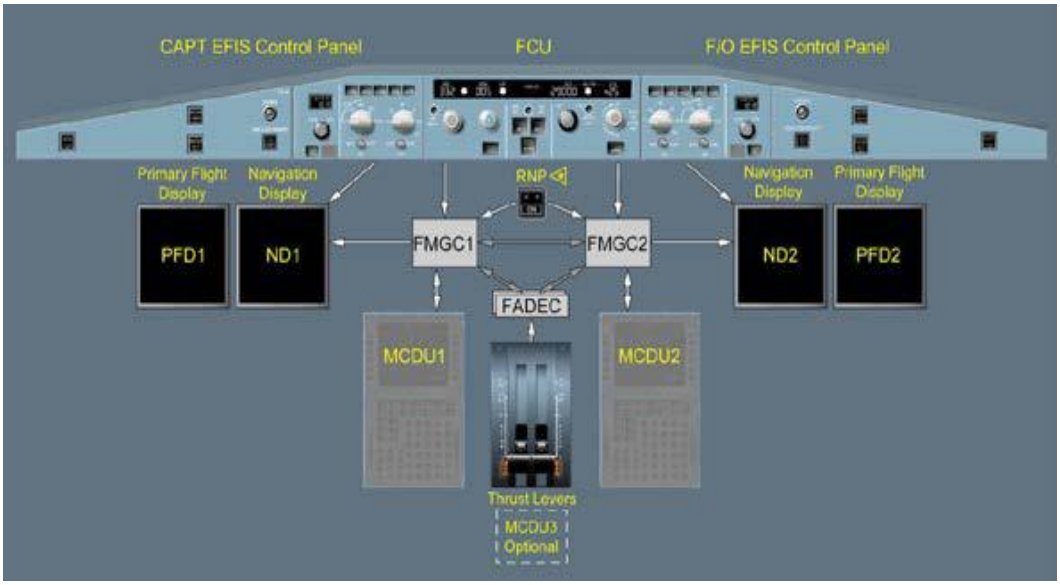


Figure-3:- General View of FMGS Cockpit Interface (Copyright © Airbus SAS, 2020)

Auto Pilot (AP) Disengagement

The standard manner for the flight crew to disengage the AP is to press the takeover push button (PB) on the side stick (AP Instinctive disconnection PB). When the AP is OFF, the associated pushbutton on the FCU goes off, and AP1 (or AP2) disappears from the FMA. (Refer figure-4 below illustrating cockpit effect when AP disengaged using side stick instinctive PB).

Figure -4: Autopilot disconnect by instinctive PB (Copyright © Airbus SAS, 2020)

As per FCOM (DSC-22-30-30), AP1 or 2 disengages when:

- The flight crew presses the takeover push button (PB) on the side stick, or
- The flight crew presses the corresponding AP pb on the FCU, or
- The flight crew pushes on the side stick harder than a defined threshold, or moves on the rudder pedals beyond a defined threshold, or
- The flight crew moves the pitch trim wheel beyond a defined threshold, or
- The other AP is engaged, except when localizer/glide slope modes are armed or engaged, or when the rollout or go-around mode is engaged, or
- Both thrust levers are set above the MCT detent and the aircraft is on ground, or
- One of the engagement conditions is lost.

In addition, in normal law with all protections available, the AP will disengage when:

- ❖ High speed protection activates, or
- ❖ Angle-of-attack protection activates:
  - ➢ From the liftoff to 100 ft RA during the landing, when α_{prot} +1 ° is reached, or
  - ➢ Below 100 ft RA during the landing, when α MAX is reached, or
- Pitch attitude exceeds 25 ° up, or 13 ° down, or bank angle exceeds 45 °, or
- A rudder pedal deflection is more than 10 ° out of trim.

AP Warnings

As per FCOM (DSC-22-30-30), when the AP is disengaged, the system warns the flight crew:

- If the flight crew disengages it with the takeover PB on the side stick, the warnings are temporary.
- If the disengagement results from a failure, from the flight crew pushing the pushbutton on the FCU, or from a force on the side stick, the visual and audio warnings are continual.

AP disengagement cockpit effects using AP instinctive P/B Chart

		AP DISENGAGEMENT	
		TAKEOVER PB on SIDESTICK	BY OTHER MEANS
CONSEQUENCE	**Master Warning Light**	Flashing red during 3 s maximum	Flashing red
	ECAM	AP OFF red message 9 s Maximum	AUTO FLT AP OFF red warning
	AUDIO	Cavalry charge 0.5 s Minimum 1.5 s Maximum	Continuous cavalry charge 1.5 s Minimum
	CLR PB on ECAM CONTROL PANEL	Extinguished	Illuminated

Vertical Flight Plan and Guidance Provided by Flight Management and Guidance System (FMGS)

- *General concept (extract from FCOM DSC 22-XX-XX subchapters):*

The FMGS computes the aircraft position continually, using stored aircraft performance data and navigation data. Therefore it can steer the aircraft along a preplanned route and vertical and speed profiles. This type of guidance is said to be "managed".

If the flight crew wants to modify any flight parameter (SPD, V/S, HDG, etc.) temporarily, they may do so by using the various Flight Control Unit (FCU) selectors. The FMGS then guides the aircraft to the target value of this parameter that they have selected. This type of guidance is said to be "selected".

The two available- types of guidance are:

- ***Managed guidance*** guides the aircraft along the preplanned route and the vertical and speed/Mach profile. (The FMGS computes the target values of the -various flight parameters).
- ***Selected guidance*** guides the aircraft to the target values of the various flight parameters the flight crew selects by using the FCU selectors.

Selected guidance always has priority over managed guidance.

FMS vertical flight plan:

The vertical flight plan is divided into the following flight phases:

Preflight - Takeoff - Climb - Cruise - Descent - Approach - Go-Around - Done.

All but "Preflight" and "Done" phases are associated with speed and altitude profiles.

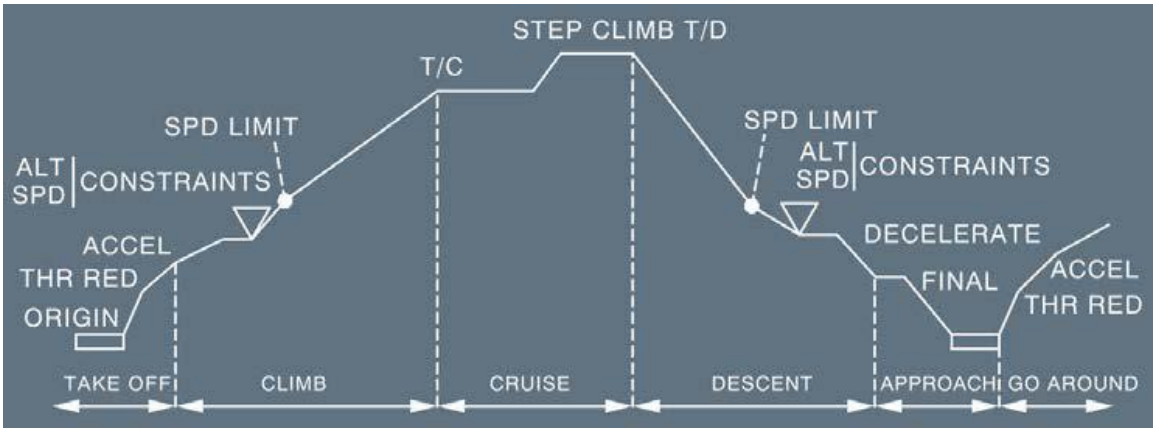


Figure-5: Typical FMS vertical profile characteristics

The vertical flight plan includes vertical constraints (altitude, speed, time) that may be stored in the data base or entered manually by the flight crew through vertical revision pages.

The flight crew may also define step climbs or descents for cruise purposes. If the flight crew plans to climb to a higher flight level or descend to a lower level, they can use a vertical revision at any waypoint to insert the new level.

When all the vertical data has been defined, the FMGC computes the vertical profile and the managed speed/Mach profile from takeoff to landing.

Guidance on FMS Descent Vertical Profile

The **DES** mode guides the aircraft along the descent path computed by the FMGS. The system computes this flight path backwards from the deceleration point up to the top of descent , with respect to the speed and altitude constraints at the deceleration point, the guidance begins the deceleration to V_{APP}, to be reached at 1000 ft above touchdown on the final descent path.

Internally, the computer divides the descent path into various segments, depending on the relative positions of the constraints. It starts at top of descent by setting up an "idle" segment that takes the aircraft down to the first constraint, and follows this with "geometric" segments between constraints.

The descent profile takes into account wind data and data from the lateral and vertical flight plans, and it is based upon the managed descent speed profile. It does not take holding patterns into consideration.

The descent- profile has several segments:

- A repressurization segment - When necessary, this produces a repressurization rate for the cabin during descent. It is a function of the destination airport altitude and the selected cabin rate (defaulted to -350 ft/min but this can be modified)
- Idle path segment - The AP/FD controls the speed and the autothrust stays at idle thrust. The guidance computes this profile from the top of descent or the end of the repressurization segment to the first vertical constraint that cannot be flown at idle -thrust
- Geometric path segments- The AP/FD control the vertical path, and autothrust controls the speed. These segments take the aircraft from the first constraint to the deceleration point.

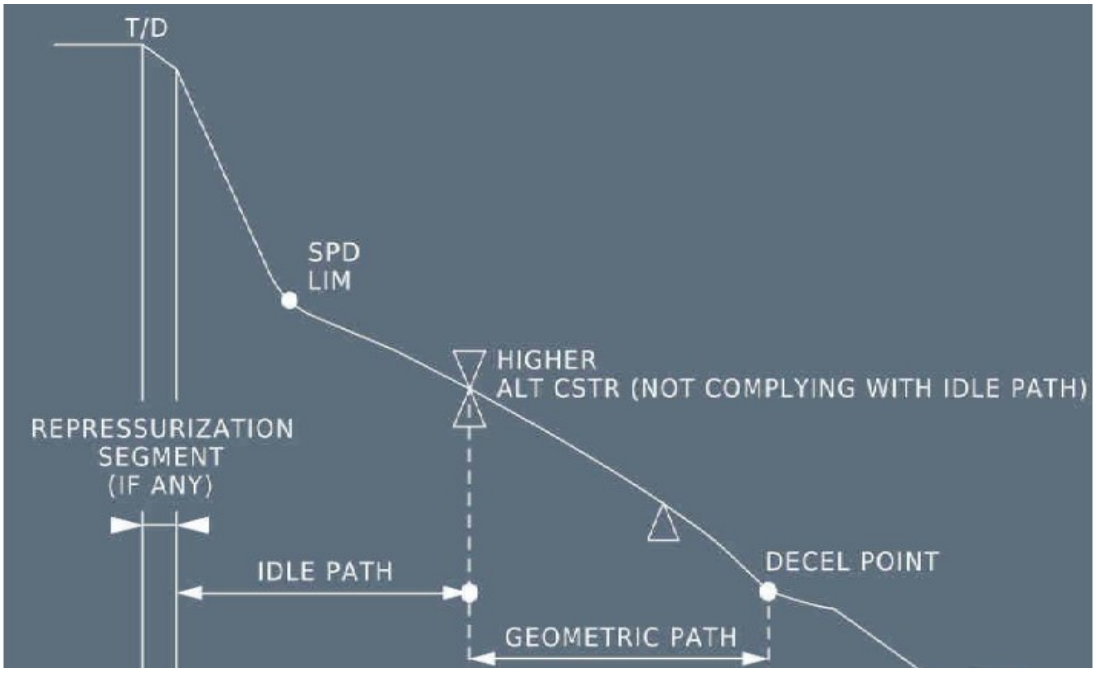
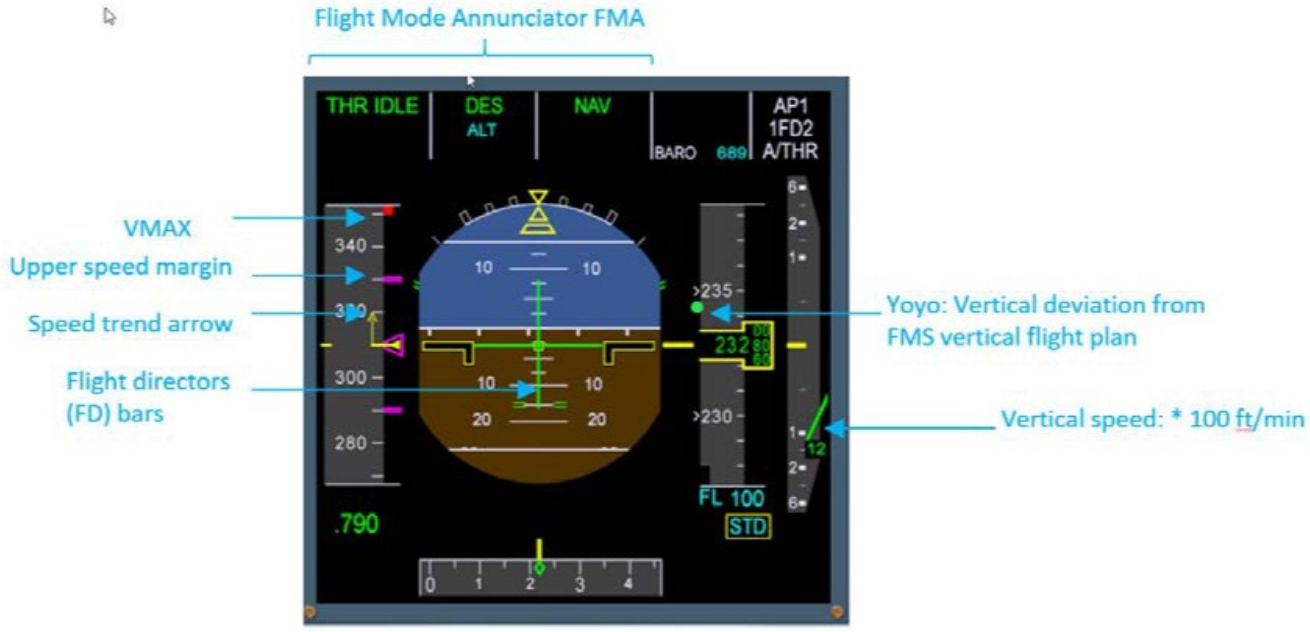


Figure-6: Typical FMS descent vertical flight plan profile

The descent mode is a managed mode that may be engaged during cruise. It can be armed or engaged in descent and approach phases (except if the FCU selected altitude is higher than the present aircraft altitude).

Main Cockpit Crew Interface During the Descent in Managed DES mode along FMS Computed Vertical Profile



Note: V_{MAX} = minimum CAS value between VMO=350kt or CAS equivalent to MMO=0.82

Figure -7: Typical PFD During Managed Descent

Figure-8: Typical ND during managed descent

Figure-9:- Typical MCDU vertical deviation display

Overspeed Warning and Manual High Speed Protection

The ECAM displays an "O/SPEED" warning message at VMO + 4kt and MMO + 0.006 together with an aural warning (continuous repetitive chime) and master warning lights.

Figure-10: ECAM Over speed warning message and Master warning light P/B

The aircraft automatically recovers, following a high speed upset. Depending on the flight conditions (high acceleration, low pitch attitude), the High speed Protection is activated at/or above VMO/MMO (also called VMAX).

The autopilot disconnects at VMO + 15kt / MMO + 0.04.

(FCOM DSC 27-20-10-20 sub-chapter on high speed protection activation conditions refers).

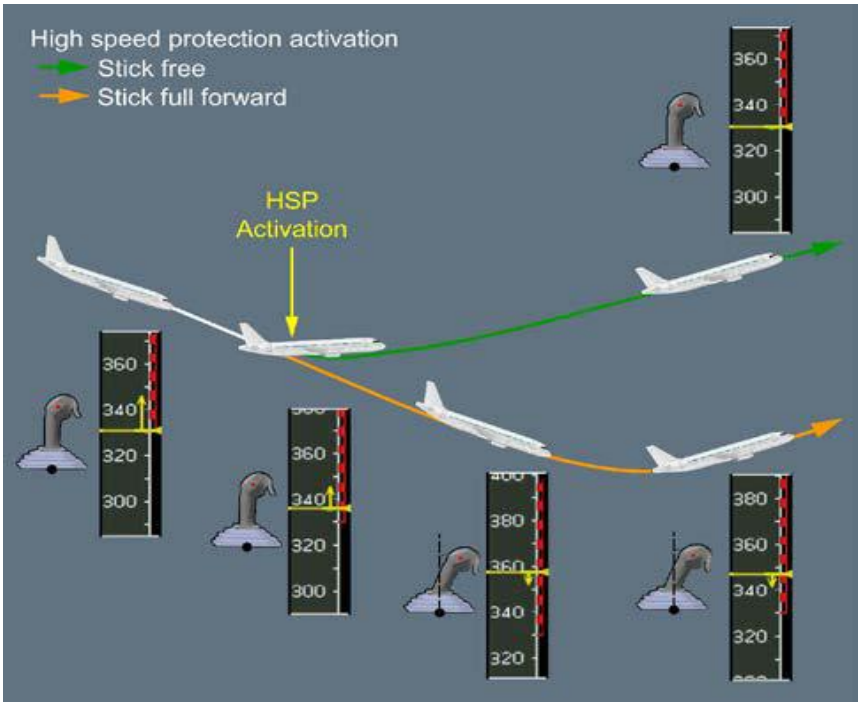


Figure -11: Manual high speed protection general principle

1.7 Meteorological Information

Enroute weather information on the day of accident : -

• **VOCI** 140500Z 1406/1512 09005KT 3500 RA BR SCT008 SCT012 FEW025CB OVC080 TEMPO 1406/1415 30010KT 2500 SHRA BECMG 1416/1418 VRB03KT 3000 BR SCT012 FEW025CB BKN080 TEMPO 1421/1502 31010KT 2500 **TSRA** RA SCT012 FEW025CB OVC080 BECMG 1506/1508 4000 RA BR=

• **VOTV** 140500Z 1406/1512 34010KT 4000 HZ FEW010 SCT012 FEW025CB BKN080 TEMPO 1406/1415 34010G25KT 2500 **TSRA** RA BECMG 1416/1418 VRB03KT 4000 BR SCT012 FEW025CB BKN080 TEMPO 1422/1502 32010KT 2500 RA BR SCT008 SCT012 FEW025CB BKN080 BECMG 1503/1505 4000 RA BR =

• **OEDF** 132007Z 1400/1506 33013KT CAVOK BECMG 1403/1405 35015G28KT PROB30 TEMPO 1406/1412 5000 BLDU NSC=

1.8 Aids to Navigation

All Navigational Aids fitted on the aircraft were working satisfactorily.

1.9 Communications

There was always a two way positive communications between the ATC and the aircraft.

1.10 Aerodrome Information

Not Relevant.

1.11 Flight Recorders

The aircraft was fitted with Solid State Cockpit Voice Recorder (SSCVR) and Digital Flight Data Recorder (DFDFR).

1.11.1 *Relevant DFDR data*

The DFDR data were downloaded to have an overview of the whole flight. However, undermentioned data are relevant to understand the occurrence.

Descent Phase before Manual Flying Phase

- At 14:15:39 UTC, the descent towards VOCI airport from FL350 was initiated by the crew with altitude target selected to 26000ft and AP1/FD1+2 & auto thrust ATHR engaged using DES with ALT mode armed, NAV and SPEED modes displayed on FMA. The managed Mach target was 0.79. The rate of descent (ROD) increased and stabilized at 1000ft/min.

- At 14:17:06 UTC, crossing 33700ft, the VPATHSPD boolean switched from 0 to 1. The rate of descent increased and the thrust & pitch decreased towards IDLE & -3° respectively.

- At 14:17:56 UTC, crossing 31850ft, the VPATHTRUST boolean switched from 0 to 1 and the ATHR mode changed from SPEED mode to THR IDLE mode displayed on FMA. The pitch was stabilized at around -3.5° and thrust continued to decrease towards IDLE.

- At 14:18:52 UTC, crossing 28000ft, guidance mode was changed to ALT capture mode (ALT* on FMA) and ATHR SPEED modes were engaged. Thereby increasing Pitch and thrust. Around 13 sec later, the vertical speed mode was transiently selected by the crew for one second and the vertical speed target was adjusted to -1540 ft/min.
- From 14:19:24 UTC to 14:19:58 UTC, crossing 26300 ft, altitude target was selected to 18000 ft and DES mode was engaged by the crew. ATHR mode changed from SPEED to THR IDLE mode. Pitch was decreasing towards -7.4° and thrust was decreasing towards IDLE. The rate of descent increased towards -6640 ft/min.
- At 14:19:37 UTC, the pitch was transiently stabilized at - 5°, at this time CAS increased above target speed (Speed reached 4kt below the upper speed margin and 9kt below VMAX).
- At 14:19:58 UTC, around 11 sec after CAS reached a maximum (9 knot below VMAX) and the rate of descent continue to increase beyond 6000 ft/min, the V/S mode was engaged by the crew with a vertical speed target selected to 0 ft/min.

Few Seconds before Manual Flying Phase

- Just before 14:19:58 UTC, aircraft was crossing 24030ft with wing level, autopilot AP1, flight director FD1+2 and auto thrust ATHR engaged with the guidance modes DES, NAV and THR IDLE displayed on FMA. The vertical speed mode (V/S) was engaged by the flight crew with a vertical speed target selected to 0 ft/min. It led to:
  - The vertical load factor to increase from +0.86g to +1g.
  - The pitch & vertical speed at -7.5° & - 6500ft/min to stop decrease and increase.
  - The thrust continued to decrease towards IDLE.

- At 14:20:01 UTC, CAS started increasing towards the target speed (339kt), the speed increased to VMAX -5kt (VMAX=350kt below the cross over altitude). The vertical load factor, pitch & vertical speed (ROD) continued to increase towards +1.15g, -6° & -6000ft/min respectively.

Manual Flying Phase

➢ At 14:20:04 UTC, AP1 was voluntarily disengaged using the AP instinctive disconnect side stick pushbutton. A nose up side stick input was immediately applied up to - 12° max. (75% maximum side stick deflection on pitch axis) during 800ms on CAPT side, followed by a nose down side stick input down to +9° max. (56% maximum side stick deflection on pitch axis). It led to

- the vertical load factor increased from +1.15g to +1.86g then reduced to +0.83g.
- the pitch increased from -6° to -4° then decreased to -5°.
- the vertical speed increased from -6000ft/min to -4500ft/min.

➢ Between 14:20:05 UTC and 14:20:11+ UTC, CAS was stable at around 347kt, 3kt below VMAX and 8kt above the speed target. Two nose up side stick inputs were applied (-8°max) during this period.

➢ On lateral axis, small side stick inputs were applied on roll axis (5° max) and roll varied between 0.5° RH side to 2° LH side. Lateral load factor varied between +0.05g / -0.004 g.

➢ At 14:20:11+ UTC, around 7sec later after the first nose up side stick input, CAS started to increase and go transiently 2kt beyond the VMAX. A second nose up side stick input, up to 13.5° (84% maximum side stick deflection on pitch axis) during 800ms was applied on CAPT side. It led to:

- Vertical load factor increased from +0.9g to +1.88g then decreased to 0.78g.
- Pitch increased from -4° to -0.5°.
- Vertical speed increased from -3500ft/min to -2000ft/min

It was immediately followed by a nose down side stick input of 69% (max) side stick deflection then another nose up side stick input of 65% (max) side stick deflection.

At 14:20:17, another nose up side stick input was applied of 63% (max) side stick deflection that led load factor to increase up to 1.46g.

At 14:20:23 UTC, aircraft crossing 22380ft STD, AP1 was reengaged with the OPEN DES, NAV and THR IDLE guidance modes displayed on FMA with 13000 ft altitude selected on

FCU. Aircraft continued the descent and landed to the runway 27 of VOCI airport at 14:40:19 UTC uneventfully.

1.11.2 ***Cockpit Voice Recorder Analysis***

SSCVR was not available to Investigation team for analysis.

1.12 Wreckage and Impact Information

N/A

1.13 Medical and Pathological Information

Cockpit & Cabin Crew had submitted self-declaration stating that they have neither consumed alcohol nor any psychoactive substance in the last 12 hours from the time of reporting for duty, as per the applicable DGCA circular during Covid-19 pandemic in vogue.

Post Occurrence Medical Examination of L2 Cabin Crew

After the accident, detailed medical examination confirmed that Cabin Crew positioned at L2 has suffered fracture on the left leg (Distal 1/3) after falling in the aircraft during the said flight.

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

M/s Interglobe Aviation Limited (Indigo) is an Indian registered Scheduled airline with it's headquarter in Gurugram, Haryana, India. The operator has more than 250 aircraft in its fleet mainly comprising of A320 neo aircraft. It operates scheduled flights to both domestic and international sectors. The Flight Safety Department is headed by Chief of Flight Safety approved by DGCA. M/s Interglobe Aviation Ltd has a fully established Operations training facility for the pilots.

1.18 Additional Information

Weather Analysis

As per the statement of PIC, aircraft had encountered significant amount of headwind as well as tailwind when the aircraft was in descend phase and which lead to inflight turbulence.

To verify inputs provided by PIC, raw data was analysed by the OEM and wind reconstruction was projected on the graph.

Wind Reconstruction

The wind reconstruction is an estimation of the wind around the aircraft based on the difference of the aircraft ground speed and the true air speed vectors:

- The ground speed was computed by integration of load factors. Load factor bias was corrected when necessary.
- The true air speed comes from anemoinertial system ADIRUs (Air data inertial reference unit).
- The sideslip was estimated with anemometric correction.

The wind components at aircraft CG have been reconstructed based on QAR data of the aircraft and projected on the aircraft axis (Fig 12 & 13).

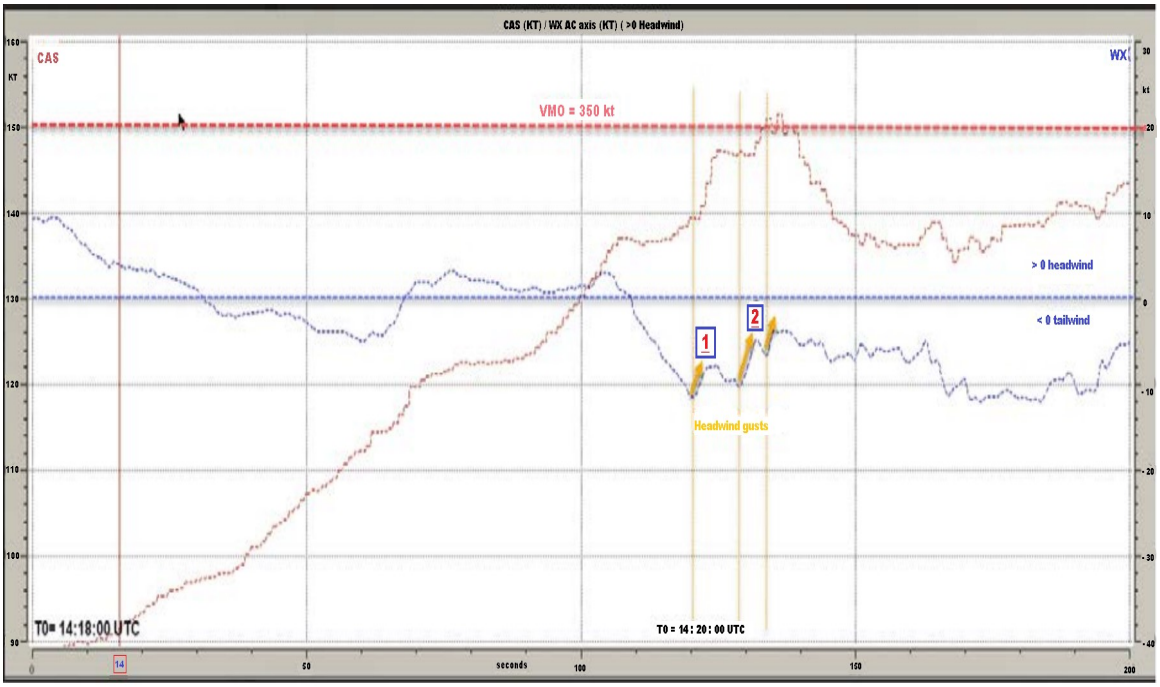


Fig-12: Longitudinal Wind Computation

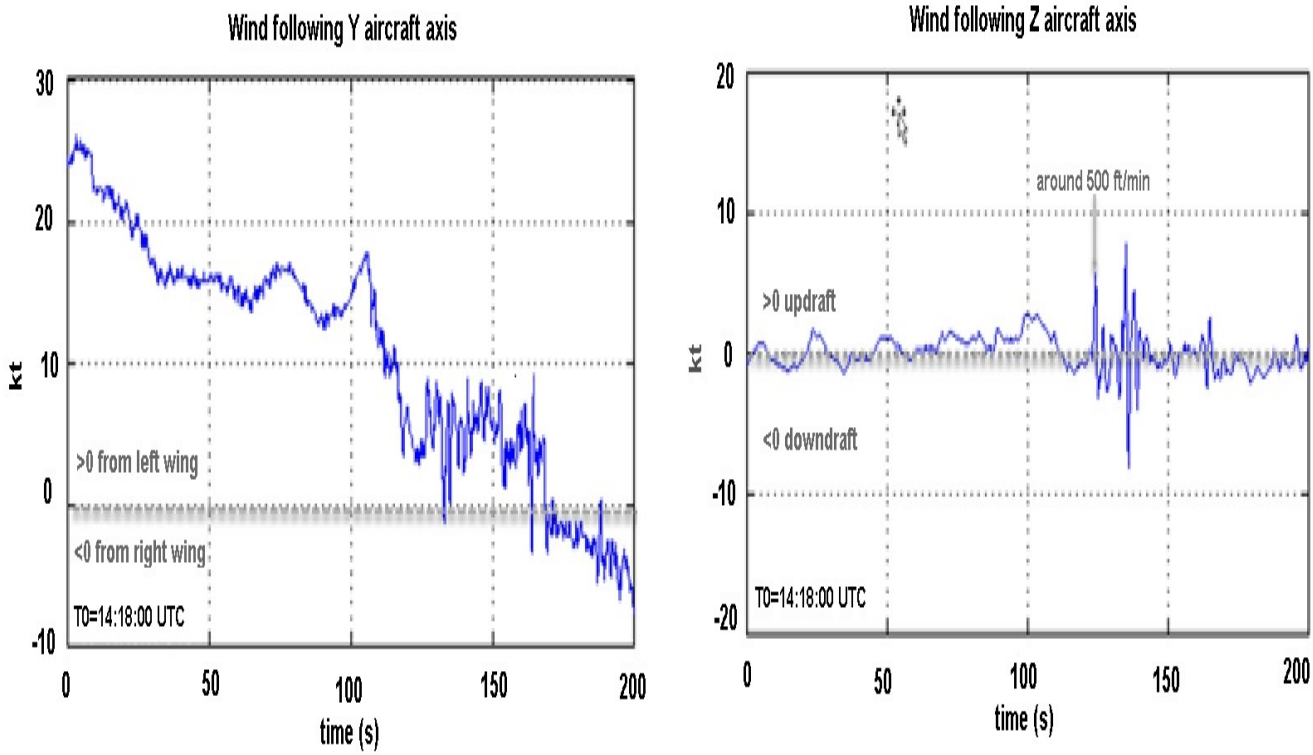


Fig-13: Lateral and vertical Wind Computation

Analysis of Wind Reconstruction

(a) On the aircraft longitudinal axis, a 4 knot headwind gust was observed at 14:20:00 UTC while aircraft was pitching up and thrust was decreasing towards to IDLE. These headwind gust was the cause of transient CAS excursion towards V_{MAX} speed around one second later.

(b) Other 6 knot and 3 knot headwind gusts were observed at 14:20:09 UTC while aircraft was pitching up (or neutral) and thrust was still decreasing towards IDLE. These headwind gusts was the cause of CAS excursions beyond VMAX speed (VMAX+2 knot) for one second.

(c) No large downdraft/updraft wind gusts observed on the vertical axis.

1.19 Useful or Effective Investigation Techniques

Nil

2. ANALYSIS

2.1 Serviceability of the Aircraft

The serviceability of the aircraft is not a contributory factor to the accident.

2.2 Weather

As per the cabin crew statements, aircraft encountered 20 knots of headwind approximately while descending and subsequently it changed to tailwind of around 10-15 knots.

However, as per DFDR data analysis, initially headwind gust of 4 knots was observed and later two consecutive headwinds gust of 6 knot & 3 knot were observed while aircraft was pitching up. These headwind gusts were the cause of CAS excursions beyond VMAX speed (VMAX+2 knot) for one second duration. However, no large downdraft / updraft wind gusts were observed on the vertical axis.

From above, it is inferred that weather was not a contributory factor to the accident.

2.3 Analysis of Digital Flight Data Recorder

The salient points of DFDR data analysis is as follows:

(a) ***Wind Reconstruction:*** Analysis of QAR data, no large downdraft/updraft wind gusts were observed on the vertical axis.

(b) ***Descent Phase before Manual Flying Phase***

(i) At 14:15:39 UTC, the descent towards VOCI airport from FL350 was initiated by the crew with altitude target selected to 26000ft and AP1/FD1+2 and auto thrust ATHR engaged using DES with ALT mode armed, NAV and SPEED guidance modes, as displayed on FMA. The managed Mach target was set to 0.79. Since, ATHR was in SPEED mode, the rate of descent was stabilized at around 1000ft/min and indicated that the descent was initiated before the top of descent as computed in the FMS vertical flight plan. Further, DES mode was using sub-mode, guiding the aircraft to recover the FMS vertical profile from below by tracking a rate of descent of 1000ft/min and using the ATHR to track the Mach target. The flight crew inputs entered in the FMS to compute the FMS vertical profile such as wind or temperature were not found / recorded DFDR.

(ii) At 14:18:52 UTC, passing FL 28000ft, guidance mode was changed to ALT capture mode (ALT* on FMA) and ATHR SPEED modes. Hence, pitch and thrust increased. Around 13 sec later, the vertical speed mode was transiently selected by the crew for one second and the vertical speed target got adjusted to -1540 ft/min while aircraft was getting close to the selected altitude target FL 26000ft on FCU and with ALT mode armed. (In this mode, ALT is automatically engaged to selected altitude target and ATHR mode automatically changes to SPEED mode to maintain the Mach/speed target).

(iii) From 14:19:24 UTC to 14:19:58 UTC, passing 26300 ft, altitude target was selected to 18000 ft and **DES** mode was engaged by the crew. **ATHR** mode was changed from **SPEED** to **THR IDLE** mode. Pitch was decreasing towards -7.4° and thrust was decreasing towards IDLE. The rate of descent increased towards -6640 ft/min. At 14:19:37 UTC, for 13 sec, the pitch stabilized at - 5°, when CAS increased above speed target and reached a maximum at 4kt below the upper speed margin and 9kt below V_{MAX}. Considering that VPATHSPD or VPATHTHRUST sub-mode did not engage and that ATHR mode change to THR IDLE mode, it can be deduced that SPD sub-mode of DES mode was engaged to perform the recovery of the FMS vertical profile with ATHR mode reducing thrust to IDLE. The altitude captured just before, led the aircraft to leave and deviate above the FMS descent vertical profile. The SPD mode commands a pitch nose down order and adapt the pitch to get the optimum rate of descent to capture the FMS vertical plan from above, to enable the CAS to not over-shoot the upper speed margin with a constant thrust reduced to IDLE. CAS transiently increased towards the upper speed margin was caused by a headwind gust.

(iv) At 14:19:58 UTC, approximately 11 sec after CAS reached a maximum at 9 knot below VMAX and the rate of descent continue to increase beyond 6000 ft/min, the V/S mode was engaged by the crew with a vertical speed target selected to 0 ft/min.

(c) Just before manual flying phase, at 14:19:58 UTC, while aircraft passing level 24030 ft, V/S mode was selected with vertical target set to 0 ft/min on FCU led to reduce the rate of descent. This resulted in increase of load factor and pitch (This action found to be consistent with the flight crew statement that they were concerned by the increase of rate of descent).

(d) At 14:20:01 UTC, the headwind gust combined with the actual rate of descent / flight path angle of -6500ft/min / -7.5° led to the transient increase of CAS (can be seen/ observed from wind reconstruction).

(e) At 14:20:04 UTC, AP1 was voluntarily disengaged using the AP instinctive disconnect side stick pushbutton. The manual take over on CAPT side was performed when:

- CAS increased and was 4kt below the VMAX
- The speed trend arrow reached momentarily VMAX+20 inside the V_{MAX} red strip.

(It is consistent with the flight crew report that indicates that they were concerned by the increase of speed).

(f) Between 14:20:05 UTC and 14:20:11 UTC, CAS was stable at around 347 knots (3 knot below VMAX and 8 knots above target speed). Two nose up side stick inputs of -8° (max) were applied. Further, at 14:20:17, another nose up side stick input (63% side stick deflection) was applied up to that led load factor to increase up to 1.46g. The second nose up side stick input was performed when CAS increased momentarily by 2 knot (max) beyond VMAX. No overspeed warning was triggered since the threshold of the ECAM overspeed warning had not been reached. The manual high speed protection had no or a very limited impact on the pitch axis command considering the limited short CAS excursion beyond VMAX. The speed trend arrow reached transiently VMAX+12 knot, inside the VMAX red strip.

(g) During the whole sequence of manual flying which lasted 18 sec, the aircraft response was consistent with the side stick inputs on pitch and lateral axis applied on CAPT (LHS) side. The 2 largest variations of vertical load factor +1.78g/+0.83g and +1.88g/+0.78g were mainly the result of the application of nose up/nose down side stick inputs (Two side stick deflection on pitch axis to 75% (up) / 56% (down) and 84% (up) / 69% (down) maximum). With thrust already close to IDLE, the 2 nose up side stick inputs on pitch axis were applied to contain 2 transient speed excursions towards or beyond VMO (VMO+2 kt) with the speed trend arrow reaching values beyond VMO, inside the VMAX red strip.

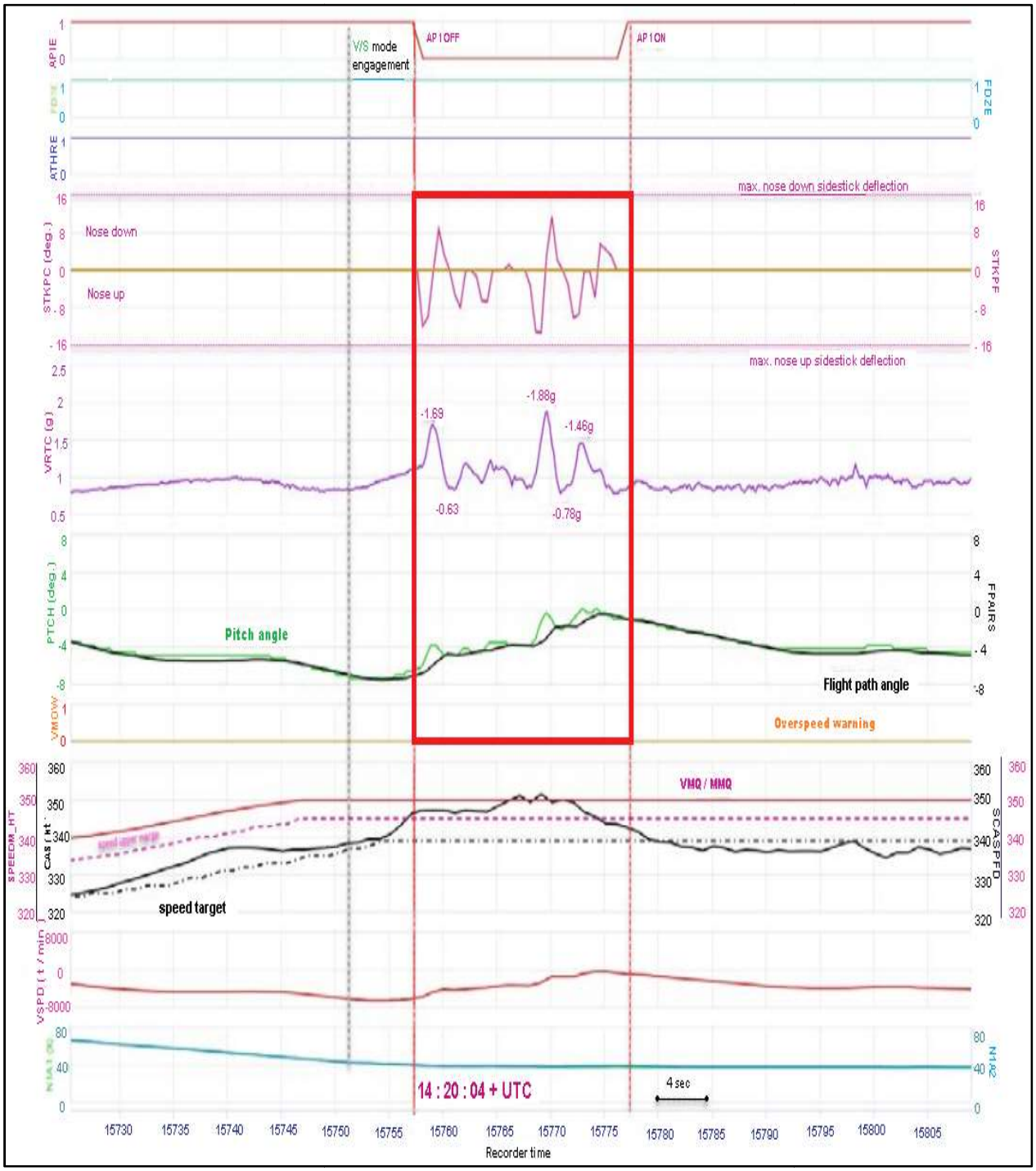


Fig - 14: *Longitudinal & Vertical Axis Plot - Summary*

(h) The ECAM over speed warning did not triggered since speed excursion stayed below the activation threshold. The 2 transient speed excursions were caused by head wind gust combined with a -7.5° and - 4° descent flight path angle. The speed brakes have not been used.

2.4 Crew Handling of the Aircraft

At 14:15:39 UTC, the descent towards VOCI airport from FL350 was initiated by the crew with altitude target selected to 26000ft and AP1/FD1+2 & auto thrust (ATHR) engaged. The managed Mach target was equal to 0.79.

While aircraft was crossing 24030ft, at 14:19:58 UTC, guidance mode was engaged and thrust moved towards IDLE.

As evident from DFDR data analysis, at 14:20:01 UTC, aircraft CAS started to increase towards the upper margin speed and reached equal to VMAX -5kt. During this time, the vertical load factor, aircraft pitch and ROD continued to increase towards +1.15g, -6° and 6000ft/min respectively.

Crews were continuously monitoring parameters and observed that aircraft ROD and flight path angle reached upto -6500ft/min and -7.5° respectively. The aircraft had also encountered headwind gust which led to the transient increase of CAS.

At 14:20:04 UTC, Crew (PIC) voluntarily disengaged the AP1 using AP instinctive disconnect side stick pushbutton and switched over to manual flying mode. To arrest the high rate of descent, PIC immediately applied a nose up side stick input of 12° (max) for around 800 milliseconds followed by a nose down side stick input down to 9° (max).

This action of PIC led to the vertical load factor to increase from +1.15g to +1.86g then +0.83g, pitch to increase from -6° to -4° then decrease to -5° and vertical speed to increase from -6000ft/min to - 4500ft/min.

At 14:20:11 UTC, around 7sec later after the first nose up side stick input, CAS started to increase and went transiently 2kt beyond the VMAX. A second nose up side stick input of 13.5° (84% maximum side stick deflection on pitch axis) for 800 milliseconds was applied by PIC. During this CAS excursion, the speed trend arrow reached inside the VMAX red strip. However, no overspeed warning was triggered in the cockpit as the threshold of the ECAM overspeed warning had not reached.

When Aircraft was flying close to thrust IDLE, then PIC had applied two nose up side stick inputs to contain two transient speed excursions towards or beyond VMO (VMO+2 knot), however, the aircraft speed was inside the VMAX red strip. It was observed that two transient speed excursions were caused when head wind gust combined with a -7.5° and - 4° descent flight path angle.

DFDR data has revealed that whole sequence of manual flying lasted for around 18 seconds; however, no speed brakes were applied by the PIC during that time to arrest the

VMO exceedance. However, the change to V/S selected mode with a FCU vertical target set to 0 ft/min led to reduce the rate of descent resulting from the guidance in DES managed mode by increasing the load factor and pitch. This action indicates that flight crew was concerned by the increase of rate of descent.

The two large side stick deflections in the cockpit by PIC led to a sudden and abrupt behaviour of the aircraft which was presumed as turbulence in the aircraft cabin.

At 14:20:23 UTC, while aircraft was passing 22380 ft, PIC re-engaged the AP1 with altitude selected as FL130. Thereafter, the flight was uneventful and aircraft continued descent to destination. Aircraft landed at Cochin airport at 14:40:19 UTC.

2.5 Circumstances Leading to the Accident

After obtaining clearance from Cochin ATC, Aircraft started descend from FL350. Aircraft commenced descend in Managed Descend mode with selected altitude as FL 260. Further, passing FL 260, altitude selection was changed to FL130. As the aircraft continued descend, wind speed was varying and wind direction was gradually changing to tail wind. The speed (managed) of aircraft was gradually increasing towards 350 knots and Pitch of aircraft reached to -7.4 deg with ROD increasing towards approx 6600 fpm. At this very time, Vertical Speed was selected to Zero by PIC.

At 14:20:03 UTC, AP was disengaged and controls were taken over by PIC (LHS). The analysis of DFDR data indicated that two vertical load variations between +0.78g and +1.88g have been recorded during the descent phase, crossing FL 23400ft, between 14:20:04 UTC and 14:20:22 UTC by the aircraft. Seat belt sign was OFF during this period. The vertical load variations were encountered mainly due to application of nose up / nose down side stick orders on captain side, immediately after the No. 1 autopilot was disengage. The recomputed wind based on DFDR data did not indicate a significant level of turbulence during said time frame. With the thrust already close to IDLE, the nose up side stick order was applied by PIC to contain two transient conventional airspeed (CAS) excursions, caused by transient head wind gust combined with descent flight path angle of -7.5^0 deg & -4^0. Both CAS excursions are explained below:

- ***1st CAS excursion***: Transient increase from VMO - 4 knot and stabilized to VMO – 2 or 3 kt. Nose up sidestick order applied by PIC (75% maximum sidestick deflection) on pitch axis for 800 milliseconds, immediately followed by a nose down order of 56% (max) sidestick deflection.

- ***2nd CAS excursion, 7 second later***: transient increase from VMO towards VMO +2 kt. Nose up sidestick order applied up to 84% maximum sidestick deflection within 800 milliseconds, immediately followed by a nose down order up to 69% max. sidestick deflection.

In all probability, the speed trend arrow displayed on PFD speed scale gave an impression to the flight crew that aircraft acceleration has increased momentarily beyond VMO inside the VMAX red strip (displayed on PFD speed scale) however, no overspeed warning was triggered.

No unexpected aircraft behavior could be observed from the analysis of the DFDR data made available to Airbus.

Subsequently, rate of descent was arrested and AP was reengaged at 14:20:23 UTC. Later speed selection was changed to 300 knots and further flight was uneventful.

Presumably during 18 Sec of manual flying in the descent phase, aircraft was shaken viciously. During this time, cabin crew fell down & got seriously injured.

3. CONCLUSION

3.1 Findings

(a) The Certificate of Airworthiness, Certificate of Registration and Certificate of Release to Flight were valid on the day of Incident.

(b) All concerned airworthiness directives, mandatory service bulletins, mandatory modifications on the aircraft and its engines on date of incident had been complied with.

(c) Both operating crew were duly qualified on type to operate the flight.

(d) As per Flight Duty Time Limitations (FDTL), both crew had adequate rest prior to undertaking the flight.

(e) Before aircraft performed top of descend, as per Cochin ATC, winds were calm and visibility was around 4000m. Further, no significant trend was reported by the ATC.

(f) During descent, aircraft ROD reached upto 6600 fpm. Autopilot DES mode was recovering the FMS vertical flight profile. Aircraft deviated from the FMS vertical profile due to the capture of altitude selected by the crew.

(g) Aircraft encountered headwind gust of around 6 knots & 3 knots and aircraft CAS exceeded VMAX for around 01 second, however, no overspeed warning was triggered.

(h) During corrective action initiated by PIC to arrest exceedance, AP was disengaged and nose up inputs upto 84% of maximum sidestick deflection were applied to arrest the high ROD and indicated airspeed excursion.

(j) Cabin crew positioned at L2 noticed that lavatory door was open and seat belts sign in 'OFF' position. Thereafter, crew stood up from the jump seat to close the door.

(k) Cabin crew fell down in aircraft near galley area due to which left leg was fractured.

(l) After landing at Cochin airport, no tech log entry was made on exceedance.

(m) Operator had not preserved the CVR of the flight after the accident.

(n) No unexpected aircraft behaviour was found to be recorded during DFDR data analysis.

3.2 Probable Cause of the Incident

It is highly probable that the Aircraft moved viciously during the descent phase due to improper handling of controls by cockpit crew while arresting high rate of descent, which caused cabin crew to lose balance (while closing the door of lavatory) and fell down awkwardly, which resulted in left leg fracture.

4. SAFETY RECOMMENDATIONS

4.1 Operator may emphasise all Cockpit Crew to adhere to the laid down procedures to arrest high rate of descent and VMO exceedance.

(Dinesh Kumar)
Investigator

(Anil Tewari)
Investigator – In - Charge

Date: 26 Apr 2021
Place: New Delhi