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# FINAL INVESTIGATION REPORT
# OF
# AIRPROX INCIDENT BETWEEN FLIGHT VT-WGE and VT-IGK IN VARANASI ACC ON 23/04/2018

## AIRCRAFT ACCIDENT INVESTIGATION BUREAU
## MINISTRY OF CIVIL AVIATION
## GOVERNMENT OF INDIA

## FOREWORD

This document has been prepared based upon the evidences collected during the investigation and opinion obtained from the experts. The investigation has been carried out in accordance with Annex 13 to the convention on International Civil Aviation and under Rule 11 of Aircraft (Investigation of Accidents and Incidents), Rules 2017 of India. The investigation is conducted not to apportion blame or to assess individual or collective responsibility. The sole objective is to draw lessons from this incident which may help in preventing such incidents in future.

## INDEX

# FINAL INVESTIGATION REPORT OF AIRPROX INCIDENT BETWEEN FLIGHT VT-WGE and VT-IG IN VARANASI ACC ON 23/04/2018

## 1.0 FACTUAL INFORMATION

### 1.1 History of Flight

On 23/4/2018 an airprox incident occurred between VT-WGE operating flight GOW585 (Mumbai to Patna) and VT-IGK operating fight IGO6488 (Kolkata to New Delhi).

GOW585 reported getting TCAS RA (with IGO6488) in Varanasi area (on W44) about 90 NM short of PPT, heading 035° while descending from FL370 to FL330. No Traffic information was provided by ATC to GOW585.The closest horizontal distance was reported to be approximately 4 to 5 NM & the closest vertical distance was reported to be approximately 500 feet.

IGO6488 was cruising at FL360 on radial 120 at 153 DME LKN. The reported relative bearing, range and altitude, with other aircraft was 9 to 10'O Clock, approaching at 20NM (Horizontal) and & 600 feet (Vertical). IGO6466 followed RA (Descend). No Traffic information was provided by ATC to IGO6488. As GOW585 also descended again there was breach of separation.

The closest distance was reported to be 5NM when with horizontal separation was 400 feet.

Both the aircraft reported RA to ATC and after reporting "Clear of Conflict" proceeded to their respective destinations.

### 1.2 Injuries to persons

| Injuries | Crew | Passengers | Others |
|---|---|---|---|
| Fatal | Nil | Nil | Nil |
| Serious | Nil | Nil | Nil |
| Minor | Nil | Nil | Nil |
| None | 06 (Go Air) &<br>06 (Indigo) | 154 (Go Air) &<br>165 (Indigo) | Nil |

## 1.3 Personnel Information

### 1.3.1 Pilot Flying – GOW585

| | |
|---|---|
| AGE | 60.5 years |
| License | ATPL 2413 |
| Total flying experience | 10865 |
| Total Experience on type | A320: 3060+A330: 3389 = 6449 |
| Total Experience as PIC on type | 3010 |
| Last flown on type | 02/05/2018 (after incident) |
| Total flying experience during last 01 Year | 602 |
| Total flying experience during last 180 days | 459 |
| Total flying experience during last 90 days | 237 |
| Total flying experience during last 30 days | 89 |
| Total flying experience during last 07 Days | 29 |
| Total flying experience during last 24 Hours | 7:21 |
| Rest period before the flight | 20h |

### 1.3.2 Pilot Monitoring- GOW585

| | |
|---|---|
| AGE | 34 years |
| License | ATPL 7440 |
| Total flying experience | 2418 |
| Total Experience on type | 892 |
| Total Experience as PIC on type | Nil |
| Last flown on type | 01/05/2018 |
| Total flying experience during last 01 Year | 752:31 |
| Total flying experience during last 180 days | 408 |
| Total flying experience during last 90 days | 212:06 |
| Total flying experience during last 30 days | 79:32 |
| Total flying experience during last 07 Days | 27:12 |
| Total flying experience during last 24 Hours | 5:06 |
| Rest period before the flight | 16:30 |

1.4 Damage to aircraft

Nil

1.5 Other damage

Nil

1.6 Aircraft information

Both the aircraft involved were Airbus A-320 aircraft. Details related to aircraft systems associated in this occurrence are given in the analysis. Relevant General Information is as below:

| A318/A319/A320/A321 FLIGHT CREW OPERATING MANUAL | GENERAL INFORMATION | |
|---|---|---|
| Ident.: GEN-IFIT-00015931.0002001 / 21 MAR 16<br>**Applicable to: MSN 03063**<br>L13 | | |
| AFT Cargo Ventilation<br>Cargo Ventilation<br>AFT ISOL VALVE<br>AFT CRG VENT<br>AFT CRG VENT FAULT<br>AFT Cargo isol valves<br>FWD(AFT) CARGO DUCT OVHT<br>FWD(AFT) CRG HEAT<br>FWD(AFT) CRG HEAT FAULT<br>FWD(AFT) CRG ISOL VALVE<br>FWD(AFT) CRG VENT FAULT<br>FWD(AFT) CRG VENT<br>Forward (aft) cargo isolation valves<br>isolation valves | VENT | Yes |
| Ident.: GEN-IFIT-00016522.0001001 / 23 JUN 15<br>**Applicable to: ALL** | | |
| Aileron Anti Droop | F/CTL | No |
| Ident.: GEN-IFIT-00015919.0002001 / 21 MAR 16<br>**Applicable to: ALL**<br>L13 | | |
| Air Conditioning System Controller (ACSC)<br>ACSC<br>ACSC 1<br>ACSC 2<br>Air Conditioning System Controllers | COND | Yes |
| Ident.: GEN-IFIT-00016523.0001001 / 23 JUN 15<br>**Applicable to: MSN 03063-06072** | | |
| AP/FD TCAS | AUTO FLT | No |
| Ident.: GEN-IFIT-00016523.0002001 / 23 JUN 15<br>**Applicable to: MSN 07047-08850** | | |
| AP/FD TCAS | AUTO FLT | Yes |
| Ident.: GEN-IFIT-00016840.0001001 / 21 MAR 16<br>**Applicable to: ALL**<br>L18 | | |
| ATSAW<br>ADS-B IN | SURV | No |
| Ident.: GEN-IFIT-00016524.0002001 / 23 JUN 15<br>**Applicable to: ALL** | | |
| Automatic FD Bar Engagement | AUTO FLT | Yes |

1.7 Meteorological information

The relevant meteorological information is as below:

| | |
|---|---|
| Airport | VOBN |
| Time | 230730 Z |
| Winds | 300/12KT |
| Visibility | 5000 Hz |
| Temp/DP | 38/07 |
| QNH | 1006 hPa |

No turbulence or weather deviation was reported.

1.8 Aids to Navigation

All the Navigational Aids on both the aircraft and installed at Varanasi Airport were working satisfactorily.

1.9 Communication

Two way communication between the aircraft (both) and ATC was loud and clear.

1.10 Aerodrome information

At the time of occurrence, sector Plan with the following jurisdiction was operational:

- ACC Sector North Jurisdiction: Airspace of Varanasi TMA including part of airspace from FL255 to FL460.

- ACC Sector South Jurisdiction: Airspace of Varanasi TMA including part of same airspace from FL50 to FL255 except the part of airspace under the Jurisdiction of the Aerodrome Control Tower.

Radar (RSR) Controller (South) was required to handover the aircraft at around BHITI to Radar Controller (North).

The communication frequency, automation, Radar Display [SDD] and Automatic Terminal Information system were working normal.

1.11 Flight recorders

Both the aircraft were fitted with CVR and FDR. Readouts were made available for investigation.

1.12 Wreckage and Impact Information

There was no damage to any of the aircraft and were serviceable after incident.

1.13 Medical and Pathological Information

The flight crew of both the aircraft had undergone pre flight medical and the reports were satisfactory.

1.14 Fire

There was no fire

1.15 Survival Aspects

The incident was survivable.

1.16 Tests and Research

Nil

1.17 Organizational and Management Information

Both the aircraft were operated by two different scheduled airlines and Air Traffic Control was provided by Airports Authority of India.

**1.18 Additional information**

**1.18.1 RSR (South) Controller**

At time 07:39:26 UTC, RSR South Controller, gave descend to GOW585 from FL370 to FL330 though the aircraft was in the jurisdiction of RSR North. He also gave the aircraft instructions for left heading 035°. He had later given instruction for climb to this descending aircraft i.e. GOW585.STCA (Yellow) followed by STCA (Red) appeared on the Radar Screen (SDD) of RSR (South) Controller.

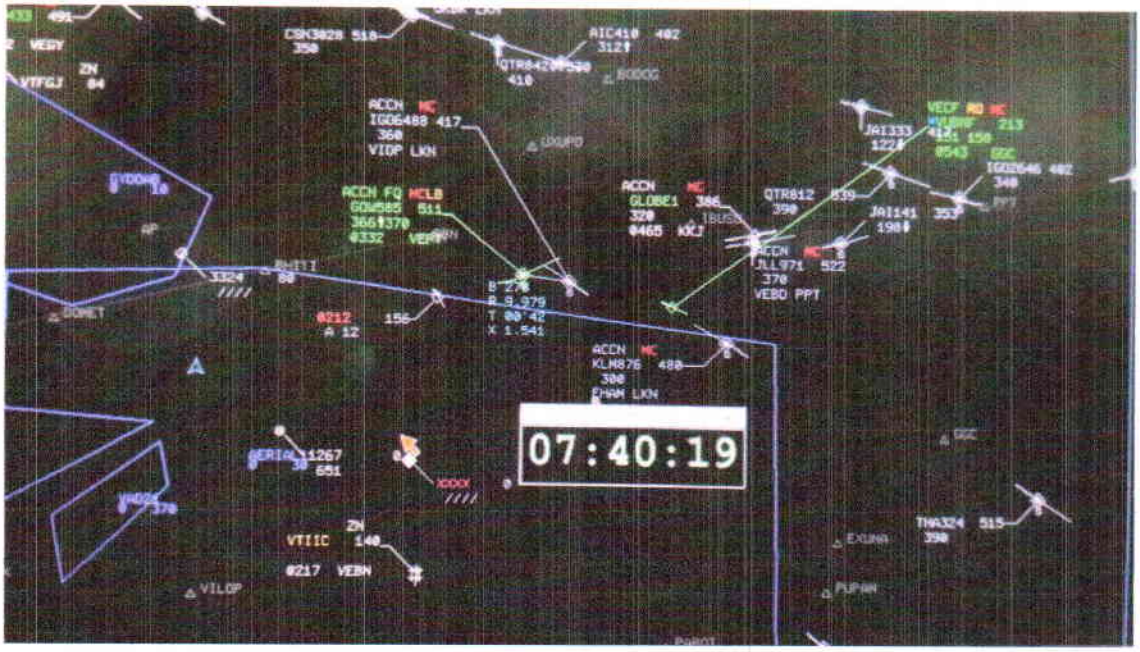
### 1.18.2 RSR (North) Controller

RSR (North) Controller was having positive control of the aircraft under his jurisdiction, i.e. IGO6488, A320 from Kolkata to Delhi at cruising level FL360. At time 07:37:44, GOW585, crossed the path of IGO6488 though GOW585 was under the jurisdiction of RSR (South Controller).


**GOW585 with Jurisdiction mismatch crossing the path of IGO6488**


At time 07:38: 06 RSR (North) Controller gave direct routing to IGO6488 for LKN but had not identified his aircraft/traffic i.e. GOW585. Short term conflict alert – Yellow (STCA-Y) was generated on the Radar screen of RSR (North) Controller

at time 07:39:44. At that time, GOW585 had left FL370 and was passing FL369 whereas IGO6488 was observed to be still maintaining FL360. The lateral separation was 18.35 NM.

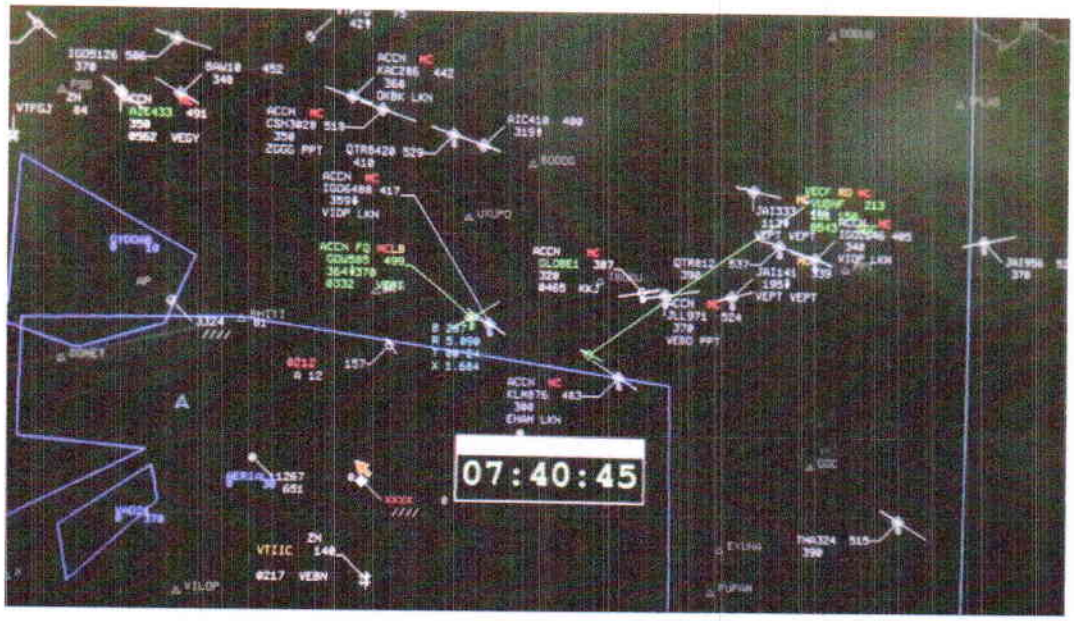



Short term conflict alert-red (STCA-R) was generated at time 07:40:19 on the Radar Screen of RSR (North) Controller. The Radar Controller (South) had asked the descending GOW585 to climb to FL370. GOW585 was observed to be climbing passing FL364 for FL370 and IGO6488 still maintaining FL360. The lateral separation was observed to be 10.93 NM

At time 07:40:39, the Radar (North) Controller was busy in terminating the Radar service of another flight SEJ8476 "Radar service terminated, Contact Delhi Control". At that time lateral and horizontal separations were 500 ft. and 5.5 NM.

At time 07:40:45, IGO6488 reported getting TCAS RA and Radar Controller replying "Roger". At that time, GOW585 was observed to be descending passing FL364 on its own whereas Crew of GOW585 were confirming to Radar (South) Controller on frequency 118.95 MHz that " Roger, Climbing Sir." IGO6488 was

observed to be following RA, descending passing FL359. The lateral separation was observed to be 5.0 NM and the horizontal separation was 500 feet.




### 1.18.3 The Aircraft (GOW585)

GOW585 descended on the instruction of Radar (South) Controller from FL370 to FL330. At time 07:39:36, GOW585 when descending passing FL367 was asked by Radar (South) Controller to Climb to FL370 to which GOW585 responded and after reaching FL364 it started climbing again till FL367. After reaching FL367 i.e. after confirming the Radar Controller that it is climbing and initially showing the Climb attitude till reaching FL367, the aircraft started descending on its own. Again in the descend mode, when it was passing FL364, RA was triggered and both GOW585 and IGO6488 were observed to be continuously descending. For IGO6488, the RA profile of descend was correct. Action of GOW585 was in contradiction to the RA. The flight crew of GOW585 stated that the engine response for climb was sluggish. Analysis of DFDR data (GOW585) was carried out and engine performance was found to be normal. The details of analysis are given below:

### 1.18.4 DFDR Data (GOW585)

At 07:39:15 UTC, aircraft was in cruise at FL370, flying towards VOR PPT (active waypoint) with heading of 082°.

- AP1 was engaged in ALT/NAV modes (SALTFCU=37000 ft) and A/THR was active in MACH mode
- TCAS crew selection was AUTO
- ARC mode was selected on both PF and PM NDs
- A range of 80 NM was selected on both PF and PM NDs
- Flap/ Slat configuration was CLEAN and spoilers were retracted

At 07:39:27 UTC, aircraft started to descend towards FL330

- Selected altitude was changed from 37000ft to 33000ft
- AP1 longitudinal mode switched from ALT to VS and VS target was set to -2000ft/min
- N1 target started to decrease and both engines thrust decreased accordingly

At 07:39:31 UTC, aircraft initiated a left turn

- AP1 lateral mode switched from NAV to HDG
- FCU selected heading was set to 035°

At 07:39:56 UTC, aircraft was crossing 36500 ft, AP1 longitudinal mode switched from V/s to Open DES.

- A/THR switched from MACH to THR IDLE accordingly
- N1 target continued to decrease
- Both N1A were around 55% decreasing

At 07:39:59 UTC VHF1 was recorded emitting for 1 second and 1s later AP1 was disengaged (APOFFV=1):

- AP OFF warning (APOFFW) triggered (for 10s) and 3s later Master Warning triggered accordingly for 3s
- A prompt -9° nose UP input (-2/3 full back stick deflection) was applied on CPT side combined with a right sidestick input
  - A/C pitch angle increased from 0° to ±5.8° within 6s and VRTG increased from + 1.0G to +1.41G
  - A/C descent rate was around -2000ft/min and started to increase towards +1500ft/min
  - A/C reached 36250ft and started to climb
  - A/C left roll angle decreased from -15° to -4°
- FD pitch order started to decrease as both FDs were engaged in OPDES/HDG modes
- Both TLs were still CLB notch and A/THR was still active in THR IDLE mode
- Both N1A were around 53%, decreasing towards IDLE thrust
- 5s later, MACH started to decrease

At 07:40:17 UTC, while A/C was crossing 36500ft STD in climb. TCAS Traffic Advisory (TA) triggered for 15s:

- TCAS FDs mode armed and ND range on F/O side changed from 80NM to 10NM
- A/C pitch angle was +4.9° and A/C climb rate was around +2000ft/min
- Both N1A were steady of around 43% (A/THR was still active in THR IDLE mode)
- MACH was 0.72M decreasing

At 07:40:24 UTC, MACH was 0.70M when MACH target became selected at 0.93M,

- A/THR was still active THR IDLE as both FDs longitudinal mode was still OPDES

- Both engines were still delivering IDLE thrust (both N1A were still steady at 43%)
- CAS was 226kt decreasing towards VLS (recorded at 223kt)

Then, several nose down input (around +2.6°) were applied on PF side.
A/C reached an altitude of 36700ft STD before starting to descend again.
At 07:40:33 UTC, while Aircraft was crossing 36600 ft in descent, TCAS Corrective Resolution Advisory (RA) "CLIMB" triggered.

- Both FDs longitudinal mode switched from OPDES to TCAS
- A/THR mode switched from THR IDLE to SPEED and selected Mach target changed from 0.93M to 0.69M (current MACH)
- CAS was 223kt (VLS)
- N1 target jumped from 20% to 90% and both N1A increased accordingly from 43% to 90% within 20s (~3%s)

4s later, while both N1A were increasing, both TLs were pushed to TO/GA. A/THR deactivated accordingly.

At 07:40:40 UTC, nose down input was maintained around +2° on PF side to increase Aircraft descent rate:

- Aircraft descent rate increased from -1000ft/min to -3900ft/min
- CAS started to re-increase above VLS

Aircraft continued to descend.
At 07:41:07 UTC, while aircraft was crossing 35500ft in descent:

- TCAS Traffic Advisory (TA) triggered for 7s
- TCAS FDs mode armed again for 7s

At 07:41:24 UTC, A/C reached 35250 ft STD before starting to climb back towards FL370.
At 07:42:00 UTC, FCU selected altitude was changed to 37000ft.
At 07:42:12 UTC, crossing 36500ft STD in climb, AP1 was re-engaged in VS / HDG modes.

At 07:42:15 UTC, AP1 longitudinal mode switched from VS to ALT, then to ALT 19s later.

At 07:42:18 UTC, both TLs were pulled back from TO/GA to CLB notch and A/THR reactivated in SPEED mode.

Aircraft leveled-off at FL370 and continued its flight uneventfully.

### 1.18.5 Flight Crew Training Programme

Relevant extract from Go Air Operations Manual Part D highlighting that there is no reference of training about TCAS AP/ FD Modes during initial, recurrent ground & simulator training is given below:

| | | |
|---|---|---|
| FLY SMART GO | **GO AIRLINES (INDIA) LTD** | **OM-D** |
| | **OPERATIONS MANUAL** | **ISSUE V REV. 00** |
| | | **EFFECTIVE 01 JUN 19** |
| | **FLIGHT CREW TRAINING PROGRAMME** | **CHAPTER 01** |

8. Dangerous Goods in passenger baggage.
9. Excepted quantities.
10. Emergency procedures concerning Dangerous Goods.

**1.7.3 TCAS Training**

**a) Ground Training for initial endorsement, upgrade training and Recurrent**

**DURATION -01 HOUR**

Subjects to be covered during ground class:-

i) Purpose and Objectives of using TCAS –II

ii) Definition and Description of TCAS-II system and brief knowledge on working on working principle

iii) TCAS-II System Capabilities

iv) Collision Areas, Caution Areas and Warning Areas

v) Transponders (mode A, mode C and mode S) in conjunction with TCAS-II Transponders/ TCAS-II control panel on airplane and how to use it TCAS-II information display

vi) Display symbology of TCAS-II related parameters

vii) Proximate Traffic and other traffic with symbols and data tags linked to them

viii) Traffic Advisory (TA) with symbols and data tags linked to them

ix) Resolution Advisory (RA) with symbols and data tags linked to it.

x) Aural messages for TAs all types of RAs and clear of conflict.

xi) Types of RAs –Corrective, Preventive, Strengthened or Enhanced RAs

xii) Flight Crew Response to TA

Flight Crew Response to RA (all types)

TCAS-II Protection from other airplanes having:

TCAS-II,

TCAS-I,

Mode C transponder

Mode A transponder

TCAS-II - Operational limits and Inhibits. TCAS-II - Failures and Annunciations.

TCAS-II - Follow up RT procedures with ATC.

TCAS-II - Guidelines and rules to be followed for correct use.

### 1.7.4 Upset Prevention and Recovery Training (UPRT)

This Upset Prevention and Recovery Training (UPRT) will be followed as laid down in DGCA Operations Circular no 06 of 2018 dated 15th October 2018 as amended from time to time.

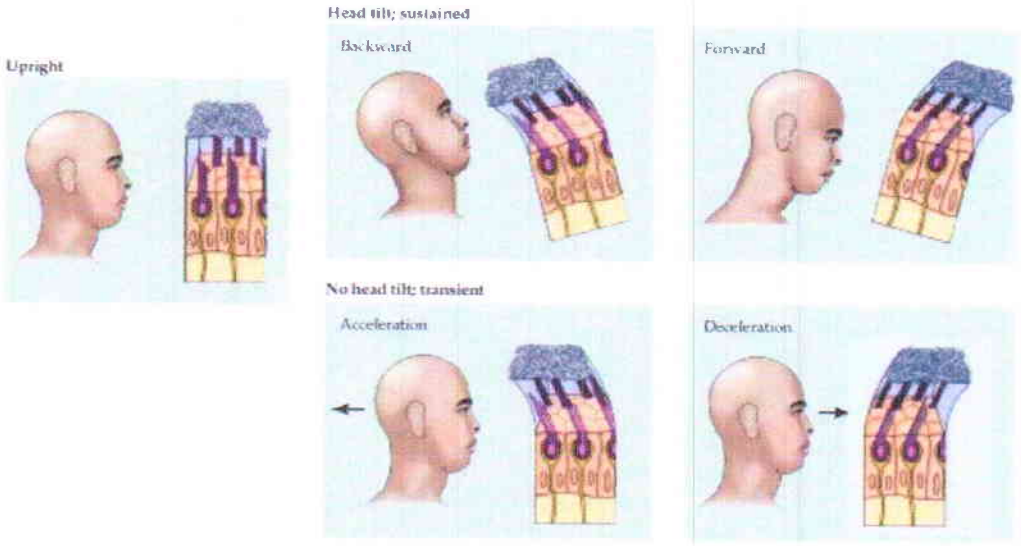
#### 1.7.4.1 Objectives

Training programme objective is to provide acceptable proficiency in following aspects:

### 1.18.6 Somatogravic Illusion (Human Factors)

Our vestibular system uses the Otolith Organs to detect accelerations i.e. help us sense tilt (i.e. if our head is upright). If we tilt our head backwards, the hairs in our utricle bend backwards (due to the acceleration force of gravity) and so sense this as a tilt (vice versa for a forward head tilt).. Our sacculus detects accelerations in the vertical plane and our utricle detects accelerations in the horizontal place.

Somatogravic is a strong pitching sensation (either up or down) when the body is exposed to either high acceleration or decelerations, and the somatogravic illusion is a vestibular illusion which is prevalent during high accelerations/ decelerations when a pilot has no clear visual reference. This illusion is due to the interaction of unnatural accelerations on our Otolith Organs, specifically our utricle

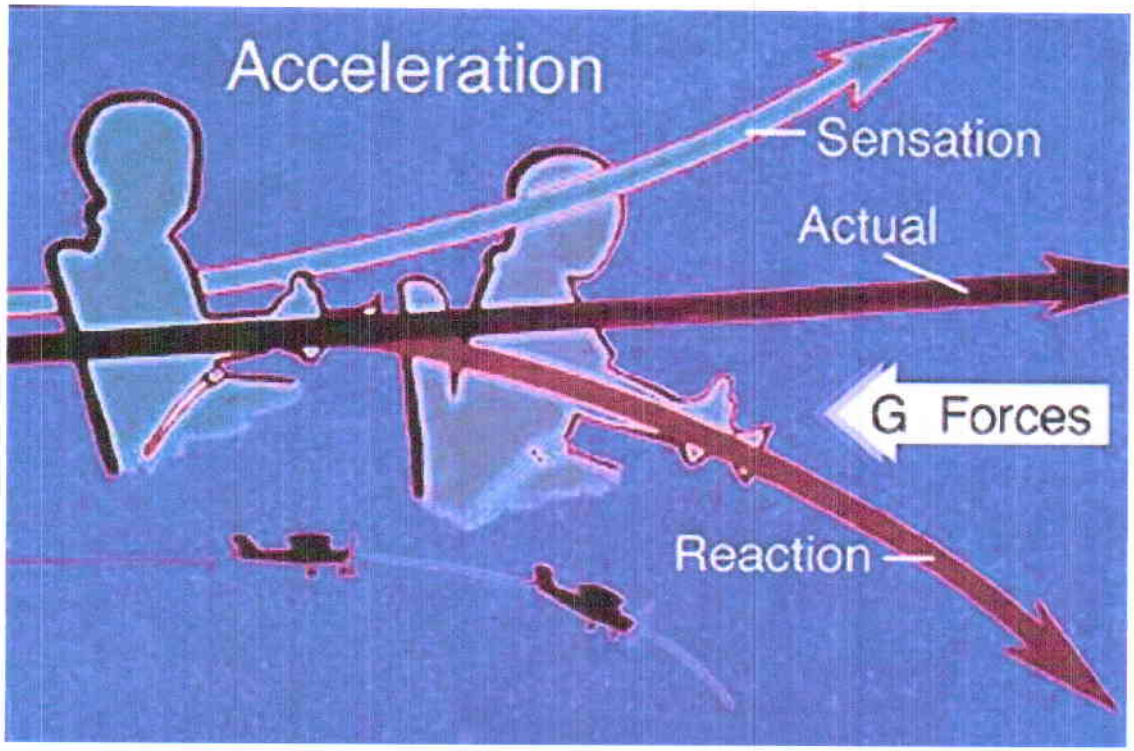



Forces acting on head (image from Neuroscience (2nd Ed.)

If we accelerate rapidly in the horizontal plane the hairs in the utricle bend backwards. As far as our brain is concerned this is the same sensation as the movement of a head tilt. This concept is shown in the figure below. Note how the hair (or macula) movement for head tilt backward and acceleration forward are exactly the same.

Typically this occurs during the missed approach or go-around segment of a flight where, power is rapidly applied and the aircraft accelerates rapidly. As no

visual cues exist, this generates a strong 'tilt back' sensation which the pilot interprets (incorrectly) as a rapid pitching up sensation. Despite this perception the aircraft may still actually be in a level attitude or only a slight climb (somatogravic illusion). The pilot will then push forward on the control column to control this (imaginary) climb thinking they are lowering the aircraft nose back to level flight, when in actual fact they are lowering the nose into a dive. As the aircraft nose lowers, the aircraft continues to accelerate, generating additional pitch up sensations, causing the pilot to lower the nose even further.




**Emergencies – Impact on ATCOs**

An emergency is usually associated with workload (there are more things to be done in less time) and stress (due to the increased workload and the unfamiliarity of the environment). Because of this one is prone to reacting differently and unexpectedly in such situations. Although controllers do not have the sense of

personal danger the flight crew is exposed to, they are also subject to stress when an emergency situation happens. The most common issues are:

- Controllers feel the urge to "do something". This sometimes makes them perform unnecessary actions.
- Higher workload – the emergency usually happens without warning and the controller needs to come up with a new (and sound) plan almost immediately.
- "***Tunnel vision***" (i.e. too much focus on certain details while overall perception is degraded) can easily occur when under stress.
- Time distortion – controllers' perception is that too much time has elapsed between communications.
- Memory is degraded under stress. Critical details can easily be forgotten leading to an even higher workload or the transmission of wrong information.

In case of an emergency, the procedures to be followed are usually standardised in terms of requirement compliance and ease of use during the higher workload that usually arises. Both the aircraft crew and the controllers undertake regular training to handle emergencies and practise the actions that may have to be taken in such an event. These recurring exercises enable personnel to build confidence and knowledge of the basic and predictable steps necessary to handle the emergency events to be carried out consistently. It triggers the appropriate reaction and skills for coping with the unanticipated or unique aspects of the situation.

Simulator training for emergencies can help one (ATCOs) familiarize oneself with the concept of non-standard situation as a whole. One should be aware of the psychological issues arising from emergency situations (e.g. tunnel vision, time distortion, memory degradation, the urge to "do something", etc.) and be ready with techniques to cope with them.

1.19 Useful or effective investigation Technique

Nil

## TIMELINE indicating the progress of GOW585 covering actions by pilot, system advisories and ATC callouts

| TIME | ATC Transmission | Auto Thrust (ATHR) MODE | Flight Director (FD) | Managed Navigation or Heading(HDG) | Auto-Pilot status (AP 1) | FCU Altitude (Target) | Aircraft Climbing or Descending | Actual Aircraft Altitude (Ft) | Aircraft Vertical speed | TCAS Advisory | Eng N1 | A/s Speed | Manual Pitch input |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07:39:26 | YES | Mach | ALT | Managed NAV | ON | 370 | Level Flight | 370 | Zero | NONE | Cruise values | Cruise Value | AP1 |
| 07:39:27 | NO | SPEED (2) | Vertical Speed | Managed NAV | ON | 330 | Descending | Leaving FL370 | Selected V/s -2000ft/min | NONE | Started reducing | Cruise Value | AP1 |
| 07:39:31 | NO | SPEED | Vertical Speed | HDG 035 | ON | 330 | Descending | FL368 | Selected V/s -2000 feet/min | NONE | Started reducing | Cruise Value& started to increase | AP1 |
| 07:39:36 | YES | SPEED | Vertical Speed | HDG 035 | ON | 330 | Descending | 36700 | Selected V/s 2000 feet/min | NONE | Reducing | Increasing | AP1 |
| 07:39:56 | NO | IDLE | OPEN DES | HDG 035 | ON | 330 | Descending | 36500 | -2000 feet/min | NONE | 55% Decreasing | Approaching VMax | AP1 |
| 07:39:59 | No | IDLE | OPEN DES | HDG 035 | OFF | 330 | Reversing descend | 36250 | From -2000ft/min to +1500 FT/min | NONE | Reducing | Over Speed | AP1 disconnected Input from Left & Right side stick |
| 07:40:17 | No | IDLE | OPEN DES | HDG 035 | OFF | 330 | Climbing | 36500 | +1500 Ft/min | TA | 43% | Reducing at a very fast rate | Left side stick |
| 07:40:24 | No | IDLE | OPEN DES | HDG 035 | OFF | 330 | Climbing | 36700 | +2000Ft/min | TA | 43% | 226Kts | Left side |
| 07:40:33 | NO | SPEED | TCAS | HDG 035 | OFF | 330 | Climbing | 36600 | As per TCAS Mode | RA-CLMB | Increasing from 40 to 90%. TL's pushed to TOGA | Selected M0.93 | Left Side stick |
| 07:40:40 | No | TOGA | TCAS | HDG 035 | OFF | 330 | Descending | 36204 | ROD increased from -1000 Ft/min to -3900 Ft/min | RA CLMB | TOGA | Speed re-increased above VLs | Left side stick |
| 07:41:07 | No | TOGA | TCAS | HDG 035 | OFF | 330 | Descending | 35352 | -3900 Ft/min | TA & TCAS FD Mode armed for 7 secs | TOGA | Increasing | Left side stick |
| 07:41:24 | No | TOGA | TCAS | HDG 035 | OFF | 330 | Started to climb back towards FL 370 | 35200 | -3900 Ft/min | NONE | TOGA | Increasing | Left side stick input |
| 07:42:00 | No | TOGA | TCAS | HDG 035 | OFF | 370 | Climbing | Climbing | Positive Rate of Climb | NONE | TOGA | Increasing | Left side input |
| 07:42:12 | No | TOGA | V/s | HDG 035 | AP1 | 370 | Climbing | 36500 | Positive Rate of climb | NONE | TOGA | Increasing | AP1 |
| 07:40:15 | No | TOGA | V/s | HDG 035 | ON | 370 | Climbing | V/s to ALT*. | Positive Rate of Climb | NONE | TOGA | Increasing | AP1 |
| 07:42:18 | No | CLB | ALT | HDG | ON | 370 | Level flight | ALT | Level flight | NONE | Cruise thrust | Managed speed | AP1 |

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## 2.0 ANALYSIS

There are two aspects in this occurrence namely ATC & Flight crew related aspect. Both have been discussed separately below for the purpose of analysis; ATC aspect was followed by Flight crew related aspect.

### 2.1 ATC aspects

The communication frequency, automation, Radar Display [SDD] and Automatic Terminal Information system were working normal.

Sector Plan with the following jurisdiction was operational:

- ACC Sector North Jurisdiction: Airspace of Varanasi TMA including part of airspace from FL255 to FL460.
- ACC Sector South Jurisdiction: Airspace of Varanasi TMA including part of same airspace from FL50 to FL255 except the part of airspace under the Jurisdiction of the Aerodrome Control Tower.

Radar (RSR) Controller (South) was required to handover the aircraft at around BHITI to Radar Controller (North). Radar (RSR) Controller (South) however transgressed into jurisdiction of Radar Controller (North), and at 07:39:26 UTC, gave descend to GOW585 from FL370 to FL330 without coordinating with RSR (North) Controller. Neither STCA (Yellow)[ STCA warning] nor STCA (Red) [STCA alert] appeared on the Radar Screen of RSR (South) Controller which RSR (South) Controller thought to be as a "System Fault". On realizing that IGO6488 was immediate traffic, RSR (South) controller instructed GOW585 to climb to FL370 at 07:39:36 UTC while it was passing FL367.

Similarly RSR (North) Controller could not identify the jurisdiction mismatch. He did not seek jurisdiction of his aircraft (GOW585) from RSR (South Controller).

At time 07:38: 06 RSR (North) Controller had given direct routing to IGO6488 for LKN, but could not identify his aircraft/traffic (GOW585) which he could have

done from Radar data block. Short term conflict alert –Yellow (STCA-Y) was generated on the Radar screen of RSR (North) Controller at time 07:39:44. At this time, GOW585 had left FL370 and was passing FL369 whereas IGO6488 was maintaining FL360.

Short term conflict alert-red (STCA-R) was generated at time 07:40:18 on the Radar Screen of RSR (North) Controller. The Radar Controller [RSR (South)] had asked the descending GOW585 to climb to FL370. GOW585 was observed to be climbing passing FL364 for FL370 and IGO6488 was still maintaining FL360.

## 2.2 Flight Crew aspects

The three recommended methods to commence descent on Airbus A-320 aircraft during normal operations are

- Managed Descent (MGD DES)
- Open Descent (Op DES)
- Vertical speed (V/s)

Airbus further recommends that "Managed Modes" be used as much as possible. However in case the descent is delayed flight crew uses "Vertical Speed" (selected value) mode for the initial part of the descent and then change over to either "Managed Descent or Open Descent" once the aircraft is on profile.

In the present case, when the ATC clearance was given to descend, the aircraft was in cruise at FL370, flying towards PPT VOR (next waypoint) with a HDG of 082 degrees. GOW585 was given clearance to descend to FL330 and heading 035 by RSR (South) at time 07:39:26 UTC. At that time, AP1 was engaged in ALT/NAV mode and ATHR was active in MACH. TCAS crew selection was Auto. Other selections were as follows:

- ARC mode was selected on CPT and F/o ND's
- A range of 80 NM was selected on both CPT and F/o ND's
- Slat/Flap configuration was clean and spoilers were retracted

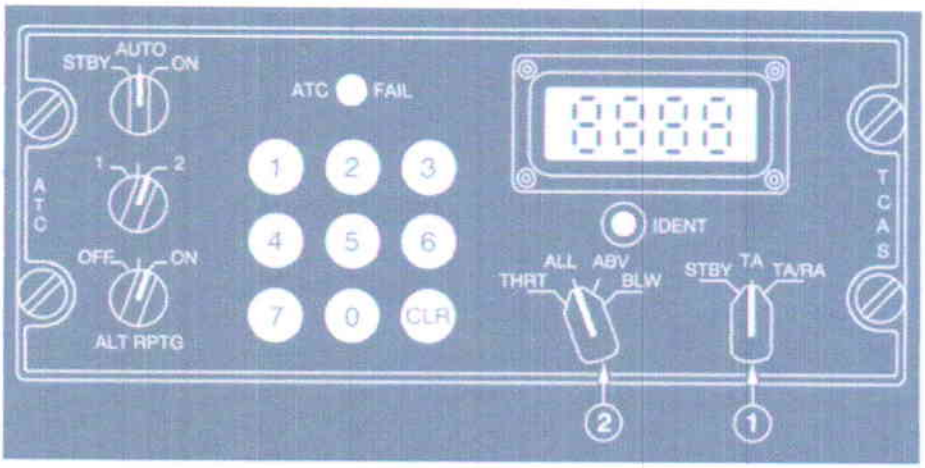
Generally once the cruise altitude is reached, flight crew selects "BLW" (Below) on the TCAS panel to display on the ND proximity traffic +2700 feet above and -

9900 below the aircraft flight level. This is to give an idea to the flight crew about the traffic around the aircraft. With the ND range selector at 80 NM, other traffic would have been visible. Relevant extracts from Airbus A-320 FCOM/ FCTM/ Operations Manual are reproduced below:



**ATC/TCAS PANEL**

Ident.: DSC-34-SURV-60-20-00001429.0004001 / 01 OCT 12
Applicable to: MSN 03306-08850




(1) Mode sel

TA/RA : Normal position.
The RAs, TAs and proximate intruders are displayed if the ALT RPTG switch is ON and the transponder is not on STBY.

TA : The TCAS does not generate any vertical orders. This mode should be used, in case of degraded aircraft performance (engine failure, landing gear extended, or approach on parallel runways).
All RAs are converted into TAs. TAs, proximate and intruders are displayed if the ALT RPTG switch is ON and the transponder is not on STBY
The "TA ONLY" white memo is displayed on the NDs.

STBY : The TCAS is on standby.

(2) TRAFFIC sel

THRT : Proximate and other intruders are displayed only if a TA or RA is present, and they are within 2 700 ft above and 2 700 ft below the aircraft.

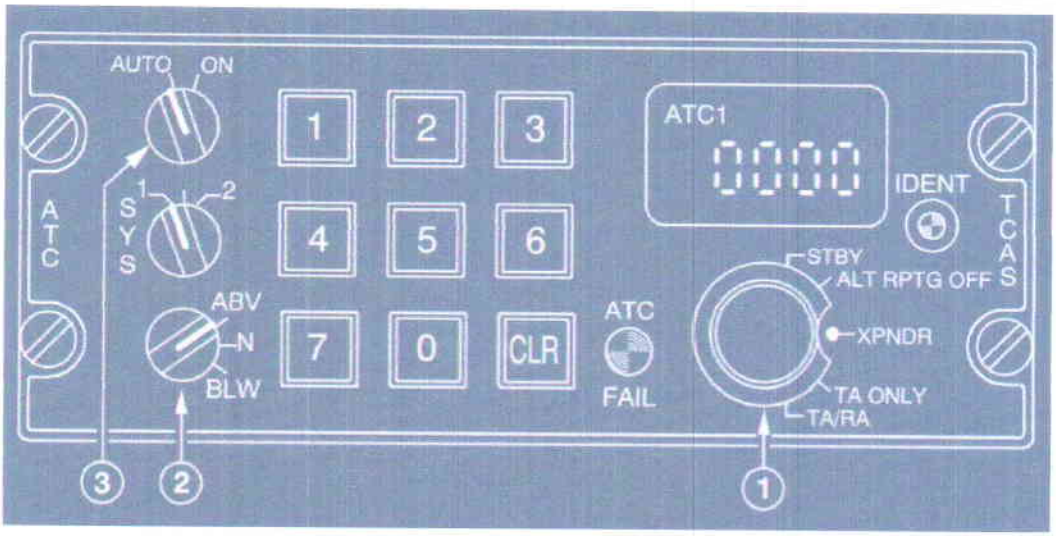
ALL : Proximate and other intruders are displayed even if no TA or RA is present (full time function). The altitude range is –2700 ft to +2 700 ft.

ABV : The same as ALL, except that the other intruders are displayed if within 9 900 ft above the aircraft and 2 700 ft below.

BLW : The same as ALL, except that the other intruders are displayed if within 9 900 ft below the aircraft and 2 700 ft above.

## ATC/TCAS PANEL

Ident.: DSC-34-SURV-60-20-00001429.0064001 / 01 OCT 12
**Applicable to: MSN 03063**




(1) Mode selector

TA/RA : Normal position.
TAs, RAs, proximate and other intruders are displayed.

TA ONLY : This mode should be used, in case of degraded aircraft performance (engine failure, landing gear extended, or approach on parallel runways).
All RAs are converted into TAs. TAs, proximate and other intruders are displayed.

STBY : The TCAS and ATC are on standby.

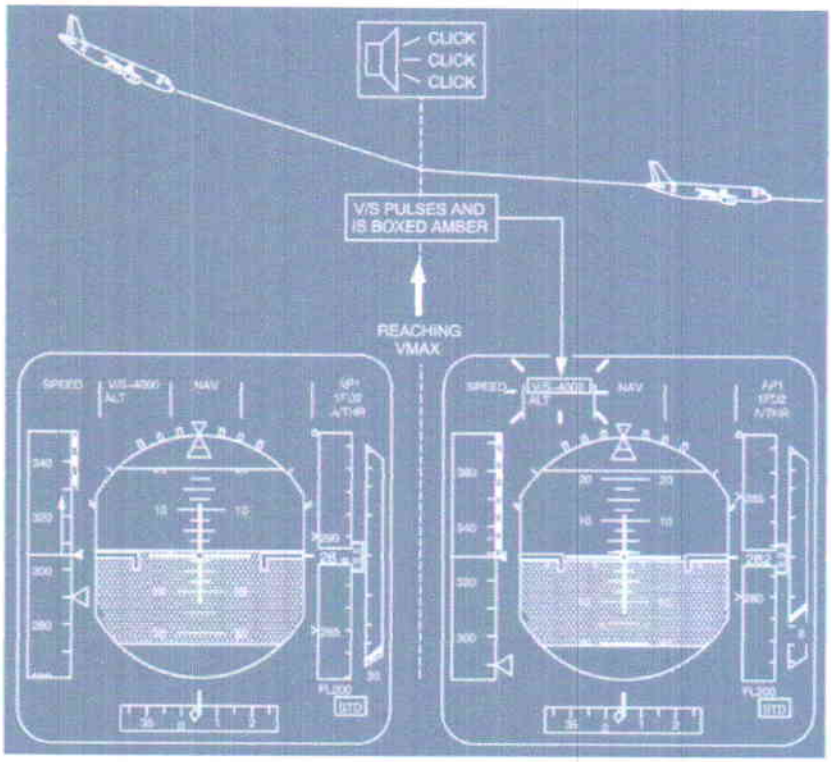
XPNDR :
- The TCAS is on standby
- On ground : The selected ATC Transponder only operates in the selective aircraft interrogation mode of Mode S
- In flight : The selected ATC Transponder operates.

(2) TRAFFIC selector

ABV : The altitude range is set to +7 000 ft above the aircraft, and -2 700 ft below the aircraft.

At 07:39:27, selected altitude was changed from 37000 feet to 33000 feet and the aircraft started to descend towards FL330. AP1 longitudinal mode was switched from ALT to VS and VS target was set to -2000 ft/min. N1 target started to decrease and both engines thrust decreased accordingly.

In general, selection of V/S of -2000 feet/min is a very high rate of descent selection at FL370 which would cause the speed to increase as the automation system of the aircraft would cause V/S to be the primary target till the speed reaches V Max. Once the speed reaches VMax a "Mode Reversion" will take place. In such a case of "Mode Reversion" the selected V/S is disregarded and aircraft reduces rate of descent to maintain V Max. Relevant Go Air Airbus A320 FCOM extract given below:




V/S mode remains engaged.
On the FMA, the V/S target is boxed with a flashing amber rectangle, and the V/S values pulses.
Besides, an aural triple click is generated.

Note: *When flying with FD bars only (AP OFF), the FMGS adjusts the pitch bar so that VMAX is maintained. However, no triple click is generated and the V/S target display on the FMA remains unchanged.*

Had the GOW585 flight crew selected ATC/ TCAS mode selector to BLW, they would have been able to see IGO6488 before initiating descent from FL370.

**Operations Manual of operator** clearly mentions that with the "Auto-Pilot" (AP) engaged within the last 1000 feet to the assigned level in case of any proximity traffic, rate of climb or descent must be kept to feet/min or less.



## 31.2 Instruction & Procedure for the Avoidance of Collision

### 31.2.1 Situational Awareness

The TCAS traffic display feature gives only limited information. To provide as much information as possible, the other aircraft must be equipped with a Mode C or a Mode S transponder. Only if both aircraft are equipped with Mode S transponders, TCAS will co-ordinate the resolution advisories between the aircraft involved. However, aircraft are only shown in a small airspace and no altitude information is available from aircraft equipped with Mode A transponders. Because of these limitations the TCAS display shall not be used to interfere with the ATC task to provide continuous positive separation.

GoAir aeroplane climbing or descending to an assigned altitude or flight level, especially with an autopilot engaged, will do so at a rate less than 1 500 ft/min throughout the last 300 m (1 000ft) of climb or descent to the assigned level when the pilot is made aware of another aircraft at or approaching an adjacent

At 07:39:31, the aircraft initiated a left turn by switching AP1 lateral mode from NAV to HDG & setting the heading to 035 degree. Short term conflict alert – Yellow (STCA-Y) was generated on the Radar screen of RSR (North) Controller at time 07:39:44.

At 07:39:56, when the aircraft was crossing 36500 feet, AP1 longitudinal mode was switched from VS to OP DES. At that time, ATHR switched from MACH to THR IDLE and N1 (target) continued to decrease.

At 07:39:59, the flight crew observed speed trend increasing and going close to VMax (VMO/MMO).Flight crew disconnected AP1 so as to recover from the situation manually, however the speed increased beyond VMO/MMO leading to "Over Speed Warning" and "Master Warning". Both flight crew applied "Nose Up" pitch input on the side stick while the aircraft was still descending in IDLE/OPDES.

Flight crew action was not in line with DGCA Operations Circular on MODE AWARENESS AND ENERGY STATE MANAGEMENT ASPECTS OF FLIGHT DECK AUTOMATION wherein a prototype automation policy for air carriers was developed after several major accident analysis.

The objective of the sample policy was to help minimize the frequency with which pilots experience mode confusion and undesirable energy states, which, in turn, required that crew understand the functions of the various modes of automation. The sample policy was based on a set of common industry practices that are known to be effective.

FCTM of the operator clearly defines how a flight crew should prevent & manage an "Overspeed" occurrence in flight. The flight crew should have used appropriate speed brakes with AP On.

# OVERSPEED

Applicable to: ALL

Ident.: PRO-ABN-OVERSPEED-AX-00018108.0001001 / 20 APR 17

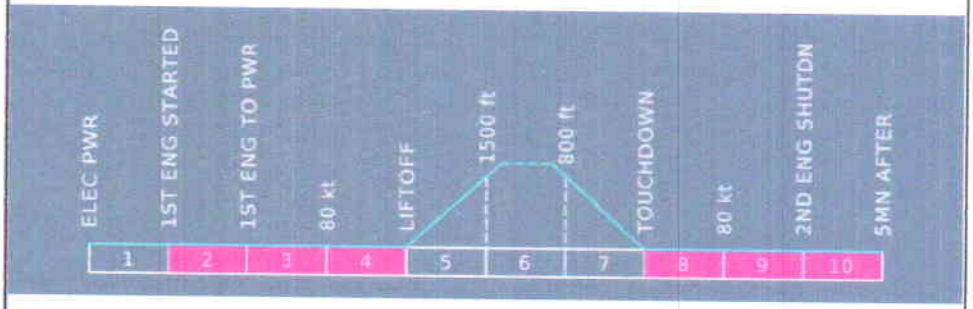
## ANNUNCIATIONS

Triggering Conditions:

L2 This alert triggers when:

- The aircraft speed/mach is greater than VMO + 4 kt/MMO + 0.006, or
- The aircraft speed is greater than VLE + 4 kt, with L/G not uplocked or L/G doors not closed, or
- The aircraft speed is greater than VFE + 4 kt, with slats and/or flaps extended.

Flight Phase Inhibition:




Ident.: PRO-ABN-OVERSPEED-AX-00016848.0001001 / 21 MAR 16

VMO/MMO..... 350/.82

L2 *(235/0.60 in case of dispatch with landing gear down).*

L1 VLE..... 280/.67

VFE..... SEE BELOW

| CONF | VFE |
|---|---|
| FULL | 177 |
| 3 | 185 |
| 2 | 200 |
| 1+F | 215 |
| 1 | 230 |

## LOW ENERGY RECOVERY

Increase the thrust and/or adjust the pitch depending on the circumstances, until the aural alert stops.

# OVERSPEED

**Applicable to: ALL**

Ident.: PR-AEP-MISC-B-00016353.0001001 / 20 MAR 17

## GENERAL

The flight crew must not intentionally exceed VMO/MMO (350 kt/M 0.82) during the flight. However, during normal operations, the aircraft may temporarily exceed VMO/MMO due to wind gradients.

The aircraft is designed to fly up to the maximum structural speed at which the aircraft structure will not be damaged. However, in the case of overspeed, the aircraft may encounter vertical load factors that may exceed the aircraft limits. In this case, exceeding VMO/MMO requires maintenance inspection.

Ident.: PR-AEP-MISC-B-00016354.0001001 / 20 MAR 17

## OVERSPEED PREVENTION

The flight crew should apply the overspeed prevention technique if the aircraft encounters significant speed variations close to VMO/MMO during the flight.

In this case, the flight crew should keep the autopilot (AP) and the autothrust (A/THR) engaged. The use of AP and A/THR enables the aircraft to remain on the intended flight path while thrust reduces to idle (if necessary).

The flight crew should decrease the speed target in order to increase the margin to VMO/MMO (at high altitudes the flight crew should not reduce the speed below green dot speed). After selection of the lower speed target, the flight crew should monitor the speed trend arrow on the Primary Flight Display (PFD). If the aircraft continues to accelerate, and if the speed trend arrow approaches or exceeds VMO/MMO, the flight crew should use the appropriate position of the

approaches or exceeds VMO/MMO, the flight crew should use the appropriate position of the speed brakes, depending on the rate of acceleration. The length of the speed trend is a good indication of the rate of acceleration.

Note: *The use of speed brakes is an efficient way to decelerate that is certified for the entire flight envelope. However, the use of speed brakes increases VLS and reduces the buffet margin at high altitudes. The use of speed brakes results in pitch up for which the AP and the normal law compensate.*

For descents in descent (DES) and managed speed modes, the flight crew should enter descent wind data that is as accurate as possible in the Flight Management and Guidance System (FMGS). The FMGS then computes an optimized vertical profile that offers a better capability to remain in the speed target range.
If the aircraft exceeds VMO/MMO, the flight crew applies the overspeed recovery technique.

Ident.: PR-AEP-MISC-B-00019238.0001001 / 26 MAR 17

## OVERSPEED RECOVERY

The flight crew must apply the overspeed recovery technique if the aircraft exceeds VMO/MMO. The OVERSPEED warning is triggered when the speed exceeds VMO +4 kt/MMO +M 0.006, and lasts until the speed is below VMO/MMO.
The flight crew should keep the AP engaged in order to minimize the vertical load factors. In order to minimize overspeed, the flight crew should extend the speed brakes to the most appropriate lever position, depending on the overspeed situation. In addition, the flight crew should keep the A/THR engaged and should check that the thrust reduces to idle.
To keep the A/THR engaged or to set the manual thrust to idle has the same effect on the overspeed recovery. Both techniques result in the same engine response in terms of thrust reduction.
If the A/THR is OFF, the flight crew must set the thrust levers to idle.
In the case of severe overspeed, the AP automatically disengages and then, the High Speed Protection activates in normal law. As a result, the aircraft encounters an automatic pitch up. *Refer to FCOM/DSC-27-20-10-20 Protections - High Speed Protection.*

Note: *The AP does not automatically disengage as soon as the speed reaches the green bars (that represent the threshold when the High Speed Protection activates) on the PFD. The AP disengagement depends on the speed variations and the High Speed Protection logic.*

The High Speed Protection is designed to request the appropriate demand of vertical load factor. Therefore, the flight crew should smoothly adjust the pitch attitude to avoid excessive load factors.

Note: *The flight crew must disregard the Flight Director (FD) orders while the high speed protection is active. The FD orders do not take into account the High Speed Protection.*

The flight crew should keep the speed brakes because the use of the speed brakes is compatible with the High Speed Protection.

Ident.: PR-AEP-MISC-B-00019239.0001001 / 20 MAR 17

**WHEN THE SPEED IS BELOW VMO/MMO**

When the aircraft speed is below VMO/MMO with a sufficient speed margin, the flight crew should retract the speed brakes and should select a new speed target. If the flight crew retracts the speed brakes when the speed is close to VMO/MMO, the speed may exceed VMO/MMO again at speed brake retraction. If the A/THR is OFF, the flight crew should manually adjust the thrust levers. After severe overspeed, the flight crew should recover the flight path smoothly, and then should engage the AP in accordance with the recommended procedure for AP engagement. *Refer to AS-FG-10-1 Recommended Practice for Autopilot (AP) Engagement.*

Ident.: PR-AEP-MISC-B-00016355.0001001 / 20 MAR 17

**REPORTING**

The flight crew must report any type of overspeed event (i.e. if the speed exceeds VMO/MMO) to the maintenance. This report results in appropriate maintenance actions.

Ident.: PR-AEP-MISC-B-00016356.0001001 / 20 MAR 17

**LINK BETWEEN VMO/MMO AND TURBULENCE**

The significant speed variations near VMO/MMO and above VMO/MMO may be one of the first indications of possible severe turbulence.
For more information, *Refer to PR-NP-SP-10-10-3 Introduction.*

Lowest level descended by GOW585 was FL363. At time 07:40:10 UTC, GOW585 initiated climb to FL370 and reached up to FL367 (max.).

This resulted in TCAS TA at 07:40:17 UTC when the aircraft was crossing 36500 feet in climb. At that time,

- TCAS FD's mode Reed and ND range on PM side changed from 80 NM to 10 NM
- A/c pitch angle was +4.9 and A/c climb rate was around +2000 feet/min
- Both N1 (actual) were steady at around 43% (ATHR was still active in THR IDLE mode)
- MACH was ).72M decreasing

## [MEM] TCAS WARNINGS

Ident.: PRO-ABN-SURV-00012455.0031001 / 17 MAR 17
Applicable to: MSN 07047-08850

■ **Traffic Advisory (TA) alert:**

TCAS mode.....CHECK ARMED

*Check that the TCAS flight guidance mode arms (TCAS blue). If not, the flight crew must be prepared to manually follow the Resolution Advisory orders.*

● **If the A/THR is off:**

A/THR.....ON

*The flight crew should set the A/THR to ON to avoid the triggering of the AUTO FLT A/THR LIMITED alert at the A/THR activation, in the case of a RA.*

Do not perform a maneuver based on a TA alone.

■ **Resolution Advisory (RA) alert:**

■ **If TCAS flight guidance mode is available:**

The flight crew applies this procedure, when a RA is triggered, and the TCAS mode engages. The TCAS mode follows the RA orders.

● **If AP OFF:**

FD ORDERs..... FOLLOW

*The AP can be engaged.*

VERTICAL SPEED.....MONITOR

*If a preventive RA was triggered: Check that the vertical speed remains out of the red area of the vertical speed scale.*
*If a corrective RA was triggered: Check that the vertical speed gets out of the red area, and remains in the green area of the vertical speed scale.*

| CAUTION | If for any reason during a RA, the aircraft vertical speed does not reach the green area of the vertical speed scale, the Pilot Flying (PF) should disconnect the AP, and override the FD orders, in order to lead the aircraft vertical speed out of the red area of the vertical speed scale. If necessary, the PF must use the full speed range between Vαmax and Vmax. |
|---|---|

● **If any "CLIMB" aural alert sounds during the final approach:**

TCAS MODE ORDERs.....MONITOR/FOLLOW
GO-AROUND..... CONSIDER

*If the flight crew performs a go-around, the TCAS mode disengages and the SRS mode engages. The AP/FD does no longer follow the RA orders. In any case, check*

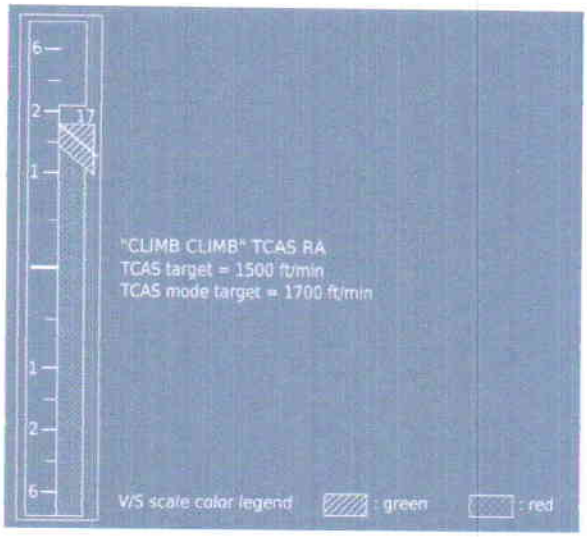
*Continued on the following page*



The situation continued as mentioned above and at 07:40:24 UTC, MACH was .70M when MACH target selected at 0.93M. At that time,

- ATHR was still active in THR IDLE as both FD's longitudinal mode was still OP DES
- Both engines were still delivering IDLE thrust (both N1 {actual} were still steady at 43%)
- CAS was 226 kt decreasing towards VLs (recorded at 223 kt)
- Several nose down input (+2.6 degrees) were applied on PF side
- A/c reached an altitude of 36700 feet before starting to descend again

After 15 seconds of triggering of TA, at 07:40:33 UTC, while aircraft was crossing 36600 feet in descent, TCAS Corrective RA "CLIMB" triggered. At that time, N1 target jumped from 20% to 90% and both N1 (actual) increased accordingly from 43% to 90% within 20 secs (~3%/sec). 4 secs later, while both N1 actual were increasing, both TL's were pushed to TOGA. As TCAS MODE was active at that time, there was no activation of "Alpha Floor" as per the aircraft design. Refer the Go Air Airbus A320 extract given below:




*Note: When the TCAS mode is engaged, the vertical speed target is not adjustable by the flight crew consequently the V/S FCU window is dashed.*

The TCAS mode ensures that the aircraft speed remains between VLS - 5 kt (VLS - 2 kt in landing configuration), and VMAX.

Alpha floor is temporarily inhibited when TCAS mode is engaged:
- If all thrust levers are in CLB when the Resolution Advisory is triggered, Alpha floor is inhibited while the TCAS mode is engaged.
- If at least one thrust lever is below CLB when the Resolution Advisory is triggered, Alpha floor is inhibited during 5 s, then:
  - If all thrust levers are set to CLB (LVR CLB flashes on the FMA), Alpha floor inhibition is maintained while TCAS mode is engaged
  - If at least one thrust lever remains below CLB, Alpha floor is reactivated.

When TCAS-RA was generated, (aircraft is equipped with TCAS-AP/FD mode)aircraft was being maneuvered manually, though the FD's had changed over to TCAS mode (ATHR went to SPEED mode). The flight crew did not follow FD commands and moved the TL's to TOGA.

In spite of disconnecting the AP, had the flight crew followed the FD orders with TCAS Mode activated, this would have been in line with the Airbus procedure for TCAS Warning as given below.



*Continued from the previous page*

| MODE | TYPE | GUIDANCE | REMARK |
|---|---|---|---|
| V/S-FPA | SELECTED | Mode used to guide the aircraft along a vertical speed or a selected flight path angle. | Altitude target is blue on PFD. V/S-FPA is a basic mode. (*Refer to DSC-22_30-10 Lateral Modes*). |
| G/S*<br>G/S<br>FINAL | MANAGED | Mode used to guide the aircraft along the final approach path (G/S or non ILS) | Selected by depressing the APPR pb on the FCU. The mode engaged depends upon the selected approach in the F-PLN. Linked to APPR common mode (APPR pb). |
| FLARE | MANAGED | Common mode which provides the alignment to the runway center line on the yaw axis and the flare on the pitch axis. | Engages below 50 ft RA as a function of the current vertical speed. |
| TCAS | MANAGED | Mode used to guide the A/C in the case of a TCAS RA. | Automatically engages when a RA is triggered. |

As the PF selected TOGA, the sudden pitch up could have caused sometogravic illusion, which explains why after initial pitch up and TOGA selection the PF pitched the aircraft nose down in spite of TCAS RA climb causing the aircraft to descent at -3900 ft per minute.

## GENERAL

Ident.: DSC-22_30-70-85-00013718.0001001 / 18 MAR 11
**Applicable to: MSN 07047-08850**

The TCAS mode is an Auto Flight System (AFS) guidance mode that provides vertical guidance in the case of a Traffic Alert and Collision Avoidance System (TCAS) Resolution Advisory (RA).
When a Traffic Advisory (TA) is triggered, the TCAS mode arms.
When a RA is triggered, the TCAS mode engages. The TCAS mode provides vertical guidance in accordance with the TCAS RA order.
When clear of conflict (the "CLEAR OF CONFLICT" aural alert sounds), the TCAS mode disengages.
The AFS provides guidance toward the latest target altitude set on the FCU.

## TCAS MODE INHIBITION CONDITIONS

Ident.: DSC-22_30-70-85-00013719.0001001 / 13 JAN 14
**Applicable to: MSN 07047-08850**

The TCAS mode is not available, when:
- The TCAS system is failed (NAV TCAS FAULT)
- The TCAS mode is failed (AUTO FLT TCAS MODE FAULT)
- The TCAS system is in TA mode
- FDs are inoperative.

The TCAS mode arming and engagement are inhibited when:
- The TA mode is manually selected (on the TCAS control panel)
- The aircraft is below 900 ft radio height
- The EGPWS, WINDSHEAR or STALL warning is triggered.

## ARMING CONDITIONS (WHEN A TRAFFIC ADVISORY IS TRIGGERED)

Ident.: DSC-22_30-70-85-00013720.0001001 / 18 MAR 11
**Applicable to: MSN 07047-08850**

The TCAS mode arms, when a TCAS TA is triggered.
The TCAS mode arms, even if both APs, and both FDs are disengaged. In this case, the APs and FDs remain disengaged.
When the TCAS mode arms, the FMA displays TCAS (in blue) on the third line of the second column (vertical modes)

| AP/FD pitch modes | A/THR modes |
|---|---|
| V/S - FPA<br>DES (geometric path)<br>ALT*, ALT<br>ALT CRZ*, ALT CRZ<br>ALT CST*, ALT CST<br>G/S*, G/S<br>FINAL, FINAL APP | SPEED/MACH MODE |
| AP/FD OFF | |
| CLB/DES (idle path)<br>OP CLB/OP DES<br>EXP CLB/EXP DES<br>SRS | THR (CLB, IDLE) MODE |
| FLARE | RETARD (IDLE) |

## INTERACTION BETWEEN AP/FD AND A/THR MODES

Ident.: DSC-22_30-10-00011037.0004001 / 23 JUN 15
**Applicable to: MSN 07047-08850**

The AP and FD pitch modes can control a target SPD/MACH or a vertical trajectory, and the A/THR mode can control a fixed thrust or a target SPD/MACH. However, the AP/FD and the A/THR cannot both control a target SPD/MACH simultaneously.

Therefore the AP/FD pitch modes and A/THR mode are coordinated as follows:

- If an AP/FD pitch mode controls a vertical trajectory, the A/THR mode controls the target SPD/MACH.
- If an AP/FD pitch mode controls a target SPD or MACH, the A/THR mode controls the thrust.
- If no AP/FD pitch mode is engaged, the A/THR mode reverts to controlling the SPD/MACH mode.

In other words, the selection of an AP/FD pitch mode determines which mode the A/THR controls.

| AP/FD pitch modes | A/THR modes |
|---|---|
| V/S - FPA<br>DES (geometric path)<br>ALT*, ALT<br>ALT CRZ*, ALT CRZ<br>ALT CST*, ALT CST<br>G/S*, G/S<br>FINAL, FINAL APP<br>TCAS | → SPEED/MACH MODE |
| AP/FD OFF | |

## MANAGED SPEED/MACH TARGET

Ident.: DSC-22_30-40-00011694.0002001 / 01 DEC 14
**Applicable to: MSN 07047-08850**

When the speed target is managed, the SPD/MACH window of the FCU shows dashes, and the corresponding dot is lighted. The PFD speed scale shows the speed target in magenta.

### ENGAGEMENT CONDITIONS

The SPD target is managed, whenever AP or FD is engaged, and one of the following occurs:

- The flight crew pushes in the SPD/MACH knob
- EXPEDITE mode is engaged
- V2 is inserted in the MCDU
- The speed reference system (SRS) is engaged (takeoff or go-around mode)
- The TCAS mode is engaged.

*Note: At takeoff, SRS will not engage if V2 is not available.*

### DISENGAGEMENT CONDITIONS

Managed speed disengages any time the flight crew selects a speed target on the FCU, or if the speed was preselected.

**A318/A319/A320/A321**
FLIGHT CREW OPERATING MANUAL

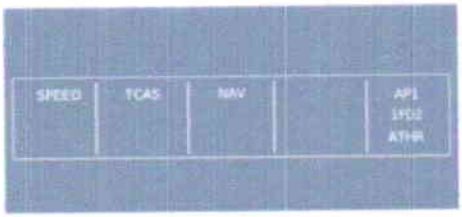
**AIRCRAFT SYSTEMS**
**AUTO FLIGHT - FLIGHT GUIDANCE**
AP/FD VERTICAL MODES - TCAS MODE

If the TCAS mode engages when both APs and both FDs are disengaged, HDG automatically engages. The heading target is the aircraft heading at HDG engagement.
If the TCAS mode engages when in TRK, HDG automatically engages. When the TCAS mode disengages, the FMA displays the TRK FPA DESELECTED message to inform the flight crew that the flying reference has changed.

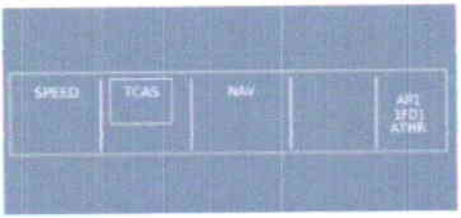
Ident.: DSC-22_30-70-00-0-0001[illegible]

**VERTICAL MODE**

If the TCAS mode engages, when a vertical mode is engaged, this vertical mode disengages.




If the TCAS mode engages, when a vertical mode is armed (different than ALT or ALT CRZ), the vertical mode disarms. In this case the FMA displays a white box for 10 s around the first and second FMA lines (to call flight crew attention on disarming of the vertical mode at TCAS mode engagement).




If the TCAS mode engages, when ALT (ALT CRZ) is armed:

- ALT (ALT CRZ) remains armed, if the TCAS vertical speed order is similar to the vertical speed mode that was previously engaged.
- ALT (ALT CRZ) disarms, if the TCAS vertical speed order is not similar to the vertical speed mode that was previously engaged.

*Note: If ALT capture conditions occur during the TCAS RA maneuver, and ALT (ALT CRZ) is armed, the TCAS mode captures the FCU selected altitude (without ALT* indicated on the FMA).*

## [MEM] TCAS WARNINGS

Ident.: PRO-ABN-SURV-00012455.0031001 / 17 MAR 17
Applicable to: MSN 07047-08850

■ **Traffic Advisory (TA) alert:**

TCAS mode.....CHECK ARMED

*Check that the TCAS flight guidance mode arms (TCAS blue). If not, the flight crew must be prepared to manually follow the Resolution Advisory orders.*

● **If the A/THR is off:**

A/THR.....ON

*The flight crew should set the A/THR to ON to avoid the triggering of the AUTO FLT A/THR LIMITED alert at the A/THR activation, in the case of a RA.*

Do not perform a maneuver based on a TA alone.

■ **Resolution Advisory (RA) alert:**

■ **If TCAS flight guidance mode is available:**

The flight crew applies this procedure, when a RA is triggered, and the TCAS mode engages. The TCAS mode follows the RA orders.

● **If AP OFF:**

FD ORDERs.....FOLLOW

*The AP can be engaged.*

VERTICAL SPEED.....MONITOR

*If a preventive RA was triggered: Check that the vertical speed remains out of the red area of the vertical speed scale.*
*If a corrective RA was triggered: Check that the vertical speed gets out of the red area, and remains in the green area of the vertical speed scale.*

| CAUTION | If for any reason during a RA, the aircraft vertical speed does not reach the green area of the vertical speed scale, the Pilot Flying (PF) should disconnect the AP, and override the FD orders, in order to lead the aircraft vertical speed out of the red area of the vertical speed scale. If necessary, the PF must use the full speed range between Vαmax and Vmax. |
|---|---|

● **If any "CLIMB" aural alert sounds during the final approach:**

TCAS MODE ORDERs.....MONITOR/FOLLOW
GO-AROUND.....CONSIDER

*If the flight crew performs a go-around, the TCAS mode disengages and the SRS mode engages. The AP/FD does no longer follow the RA orders. In any case, check*

*Continued on the following page*



As nose down input continued to be maintained around +2 degrees on PF side the aircraft descent rate increased from -1000 ft/min to -3900 feet/min. Due to this continued descent, IGO6488 received RA at 07:40:45 UTC and carried out RA maneuver as directed by descending to FL337. GOW585 while crossing

35500 feet in descent received TCAS TA which triggered for 7 seconds. Thereafter the flights continued uneventfully.

## 3.0 CONCLUSIONS

## 3.1 FINDINGS

3.1.1 Radar (South) controller

- Controlled the aircraft GOW585 which was in jurisdiction of another controller (Radar-North) and failed to hand over the aircraft at designated transfer of Control point.
- gave descend to aircraft (GOW585) without coordinating with Radar (North) Controller.

3.1.2 Radar (North) Controller could not

- identify the mismatch of Jurisdiction of GOW585
- acknowledge the Predicted Conflict Warning or Current Conflict Warning and take actions subsequent thereto.
- maintain proper surveillance over the aircraft under his jurisdiction.
- accord priority of transmission.

3.1.3 The Flight Crew of GOW585

- Did not follow the general procedure of selecting "BLW" once cruse altitude was reached which reduced the flight crew situational awareness of other traffic in the vicinity.
- Followed wrong procedure while correcting the "Over Speed Warning"
- Applied wrong procedure while handling TCAS-RA warning and maneuvered the aircraft opposite to TCAS RA.

3.1.4 How this occurrence could have been avoided

- Following clear cut SOP's by the Area Controller regarding handing over the aircraft to the adjacent controller and not to give climb or descent to an aircraft when the aircraft is out of his controlling area.

- PF could have used "Push to Level Off" function to stop descent of the aircraft.
- After the RA activated PF should have followed the "Flight Director" commands with AP "Off".
- When the AP was disconnected, the PF could have "Switched off the "FD's" and maneuvered the aircraft as per the "Conventional TCAS-RA" procedure.

## 3.2 PROBABLE CAUSE

- ATCO did not follow the prescribed procedure of handing over the aircraft to the adjacent sector controller and advised GOW585 to commence descent beyond his jurisdiction. This lead to a breach in aircraft separation between GOW585 & 6E-6648.

- Adding to the stress of breach of separation which was not expected by the flight crew of GOW585 and simultaneously encountering an aircraft "Over Speed" due to poorly managed descent (high vertical speed) and thereafter not following the FCTM procedure to correct the "Over Speed" condition.

- Both flight crew members of GOW585 giving input together on the side stick against the Airbus procedure of handling aircraft "Over Speed" condition lead to further aggravating the situation while in "IDLE OPEN DES". Aircraft speed dropped to 226 kts.

- Applying wrong TCAS AP/FD Mode procedure by not following FD bars with TCAS Mode active and pitching the aircraft nose down contrary to the TCAS RA "CLIMB".

## 4.0 RECOMMENDATIONS

4.1 AAI, during refresher training of ATCOs should regularly emphasise on the importance of coordination procedures, STCA procedures, Surveillance techniques and handing over aircraft at designated TCPs.

4.2 DGCA while approving simulator training facility being used by airlines for type rating or recurrent training or PIC upgrade training must ensure that TCAS

AP/FD Mode is available in the simulator and same be cross checked during surveillance/ approval of simulator.

4.3 All Airlines having TCAS AP/FD modification on their A320 aircraft must include the same in their ground/ simulator training as part of the syllabus during the flight crew initial type rating, annual recurrent training & PIC rating.

4.4 DGCA should include and ensure implementation of human factors aspects training integrated with flight deck automation for licenses issued to flight crew.

4.5 DGCA should ensure that all licensed ATCOs have undergone human factors training and the same must be included in the refresher trainings.

(Shilpy Satiya)
Investigator

(R.S. Passi)
Investigator-In-Charge

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Place: Delhi