Final Report

on

Serious Incident of Airprox

between M/s TATA SIA Airlines Ltd (Vistara) flight VTI946 (Reg. VT-TQL, Type of aircraft A320-251N) and M/s Ethiopian Airlines flight ETH689, (Reg. ET-ATL, Type of aircraft B787-800)

near IGI Airport, New Delhi on 10 Nov 2023

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 or incident is to prevent accidents and incidents and not to apportion blame or liability.

Therefore, this report is not for the purpose to determine blame or clarify questions of liability. If this report is used for purposes other than incident and accident prevention, this may give rise to erroneous interpretations.

The report has been prepared based upon the evidence collected during the investigation and opinion obtained from the experts.

Unless otherwise indicated, all times in this report are stated in Co-ordinated Universal Time (UTC). The relationship between IST and UTC is: IST = UTC + 5½ hours.

For reasons of data protection and simplification of the text, this report uses exclusively the generic masculine.

Note:

Figures used in this report are taken from different sources and are adjusted from the original for the sole purpose to improve the clarity of the Report. Modifications to images used in this report are limited to cropping, magnification or addition of bold text in red colour, arrows or lines; and repositioning of position of displayed time on snapshots of controller's situation display.

Glossary

AAIB	Aircraft Accident Investigation Bureau, India
AAI	Airports Authority of India
ACAS	Airborne Collision Avoidance System
ACC	Area Control Centre
ADS-B	Automatic Dependent Surveillance–Broadcast
ADC-M	Aerodrome Controller (Middle) having jurisdiction over Runway 28
ADC-N	Aerodrome Controller (North) having jurisdiction over Runway 27
ADC-S1	Aerodrome Controller having jurisdiction over South Runway 29L
ADC-S2	Aerodrome Controller having jurisdiction over South Runway 29R
ADC SUP	Aerodrome (Tower) Supervisor
AGL	Aeronautical Ground Light
AI	Air India
AIP	Aeronautical Information Publication
ANSP	Air Navigation Service Provider
ARP	Aerodrome Reference Point
A-SMGCS	Advanced Surface Movement Guidance and Control System
APAA	Approach Arrival
APAD	Approach Departure
APFD	Approach Final Director
Approx	Approximately
ATA	Actual Time of Arrival
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATD	Actual Time of Departure
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot Licence
ATS	Air Traffic Services
DIAL	Delhi International Airport Limited
CAR	Civil Aviation Requirements
CB	Cumulonimbus
CCW	Current Conflict Warning
CFL	Cleared Flight Level

CPL	Commercial Pilot License
CSOP	Company Standard Operating Procedures
CVR	Cockpit Voice Recorder
DIAL	Delhi International Airport Limited
DGCA	Director General of Civil Aviation
DFDR	Digital Flight Data Recorder
EEP	Estimate Entry Position
EFS	Electronic Flight Strip
ETA	Expected Time of Arrival
ETD	Expected Time of Departure
EQP	Error Queue Position
FL	Flight Level
FO	First Officer
FPL	Flight Plan
GP	Glide Path
GNSS	Global Navigation Satellite System
ICAO	International Civil Aviation Organization
IATA	International Air Transport Association
IFR	Instrument Flight Rules
IGIA	Indira Gandhi International Airport New Delhi
IIC	Investigation-in-Charge
ILS	Instrument Landing System
IST	Indian Standard Time
L	Left
LVOP	Low Visibility Operative Procedures
MATS	Manual of Air Traffic Services
MET	Meteorology
MHz	Mega Hertz
min	Minute(s)
MLAT	Multilateration
MoCA	Ministry of Civil Aviation
MSSR	Monopulse Secondary Surveillance Radar
NM	Nautical Mile

NOTAM	Notice to Airmen
OLBS	On-line Briefing System
OSS	Operational Support Specialist
PIC	Pilot In Command
PF	Pilot Flying
PSR	Primary Surveillance Radar
RNAV	Area Navigation
PM	Pilot Monitoring
PIC	Pilot In Command
R	Right
RA	Resolution Advisory
Ref	Refer / Reference
R/T	Radio Telephony
Runway	Runway
RVR	Runway Visual Range
SDD	Situation Data Display (having same meaning as Situation Display)
SID	Standard Instrument Departure
SMC	Surface Movement Control
SOIR	Simultaneous Operations on Parallel or Near-Parallel Instrument Runways
SOP	Standard Operating Procedures
SSR	Secondary Surveillance Radar
STCA	Short-Term Conflict Alert
SUP	Supervisor
TCAS	Traffic Alert and Collision Avoidance System
TDZ	Touchdown Zone
TEFS	Tower Electronics Flight Strip
TRA	TCAS Resolution Advisory
TRM	Team Resource Management
TTT	Time-To-Threshold
TWR	Tower
VHF	Very High Frequency
UTC	Co-ordinated Universal Time
WSO	Watch Supervisory Officer

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Final Report on Serious Incident of Airprox between M/s TATA SIA Airlines Ltd (Vistara) flight VTI946 (Reg. VT-TQL, Type of aircraft A320-251N) and M/s Ethiopian Airlines flight ETH689, (Reg. ET-ATL, Type of Aircraft B787-800) near IGI Airport, New Delhi on 10th Nov 2023

Date & Time of Incident	10 November 2023 & 044548 UTC	
Place of Incident	Approximately 3 NM WSW from ARP of Delhi Airport	
ATS Units	Aerodrome Control and Approach Control Surveillance Unit (APAD)	
Type of Occurrence	Airprox	
Classification of airspace	Class D	
Recorded Minimum separation	Approx 0.2 NM horizontal (lateral) and 400 feet vertical	
Light conditions	Daylight	
	Aircraft 1 (VTI946)	**Aircraft 2 (ETH689)**
Type of aircraft	A320- 251N ICAO Type Designator A20N	B787-800 ICAO Type Designator B788
Nationality	Indian	Ethiopian
Registration	VT-TQL	ET-ATL
Last point of departure and ATD	Ahmedabad (VAAH) 0337 UTC	Delhi (VIDP) 0445 UTC
Point of intended Landing and ETA	Delhi (VIDP) 0445 UTC	Addis Ababa (HAAB)
Call-sign of the aircraft	VTI946	ETH689
Flight Plan Route	VAAH-UUD-Q3-BUBNU-Q1-UKASO-VIDP RADAR VECTOR ILS RUNWAY 29L	DPN-A474-BBB-G450- ORLID-UT382-HARGA UW885-ARSHI ARSHI1A -HAAB SID DUDUM6C RUNWAY 29R
RNAV Specification	RNAV specification included "RNAV 1 all permitted sensors"	RNAV specification included "RNAV 1 all permitted sensors"
Operator	TATA SIA Airlines Ltd (Vistara)	Ethiopian Airlines
ACAS capability	TCAS II Version 7.1	TCAS II Version 7.1
Type of flight	Scheduled air services	Scheduled air services
Flight Rule	IFR	IFR
Crew on Board	Flight Crew 2 + Cabin Crew 5	Flight Crew 2 + Cabin Crew 4
POB	171	56
Injury	None	None
Level of damage to aircraft	No damage	No damage

Synopsis

On 10 November 2023, an Ethiopian Airlines Boeing 787-800 aircraft registered as ET-ATL, operating as flight ETH689, departed from Runway 29R of Indira Gandhi International Airport, New Delhi to Addis Ababa Bole International Airport. At about the same time, a Tata Singapore Airlines Airbus A320-251N registration VT-TQL, operating as flight VTI946, was expected to land on Runway 29L of Indira Gandhi International Airport, New Delhi.

On the day of incident, Segregated Dependent Westerly Mode of operations were in progress at IGI Airport New Delhi in which parallel runways 29L and Runway 29R were being used exclusively for arrivals and departures respectively.

The incident occurred when ETH689 was allowed for take-off from Runway 29R while VTI946 was approaching Runway 29L with a Time-To-Threshold (TTT) below the SOP minimum of 90 seconds. VTI946 initiated a missed approach due to wind shear and came into conflict with departing aircraft ETH689. Since the missed approach track of VTI946 and SID track followed by ETH689 intersected, this led to a breach of separation between ETH689 and VTI946 at 044548 UTC. TCAS RA generated for both aircraft which were followed by respective flight crews.

Upon contacting the Approach Departure Controller, ETH689 received instructions intended to de-conflict the traffic, but these were not suitable for the prevailing traffic scenario. Lateral spacing between ETH689 and VTI946 again started reducing and second TCAS RA event occurred. At 044753 UTC, the minimum separation between the two aircraft was reduced to approximately 0.2 NM horizontally (laterally) and 400 feet vertically.

However, the required separation was re-established and ETH689 continued to its destination without any further event. VTI946 was re-vectored for an ILS approach to runway 29L and landed at Delhi Airport at 0504.

The Director General of the Aircraft Accident Investigation Bureau appointed the Investigator-in-Charge vide order number INV 12012/1/2023-AAIB, dated 16.11.2023, to investigate the said serious incident and determine the probable cause(s) under Rule 11(1) of the Aircraft (Investigation of Accidents and Incidents) Rules, 2017.

The investigation is based on the recordings of the radio communications from the ATS system recorder, ATS surveillance (radar) recordings, CVR and DFDR recordings of VTI946, information provided by the aircraft operators, airport operator, and air navigation service provider, as well as statements and interviews with the air traffic controllers and the flight crew members of VTI946.

1. Factual Information:

1.1 History of the flight

1.1.1 Background:

Introduction to relevant Air Traffic Control Units providing ATC services to ETH689 and VTI946 at IGI Airport on 10th November 2023:

a. Indira Gandhi International Airport Delhi had two runway systems i.e. Northern System and Southern System as mentioned below (Ref Fig 1):

Runway System	Runways
Northern Runway System	Runway 09/27 and Runway 10/28
Southern Runway System	Runway 11L/29R and Runway 11R/29L

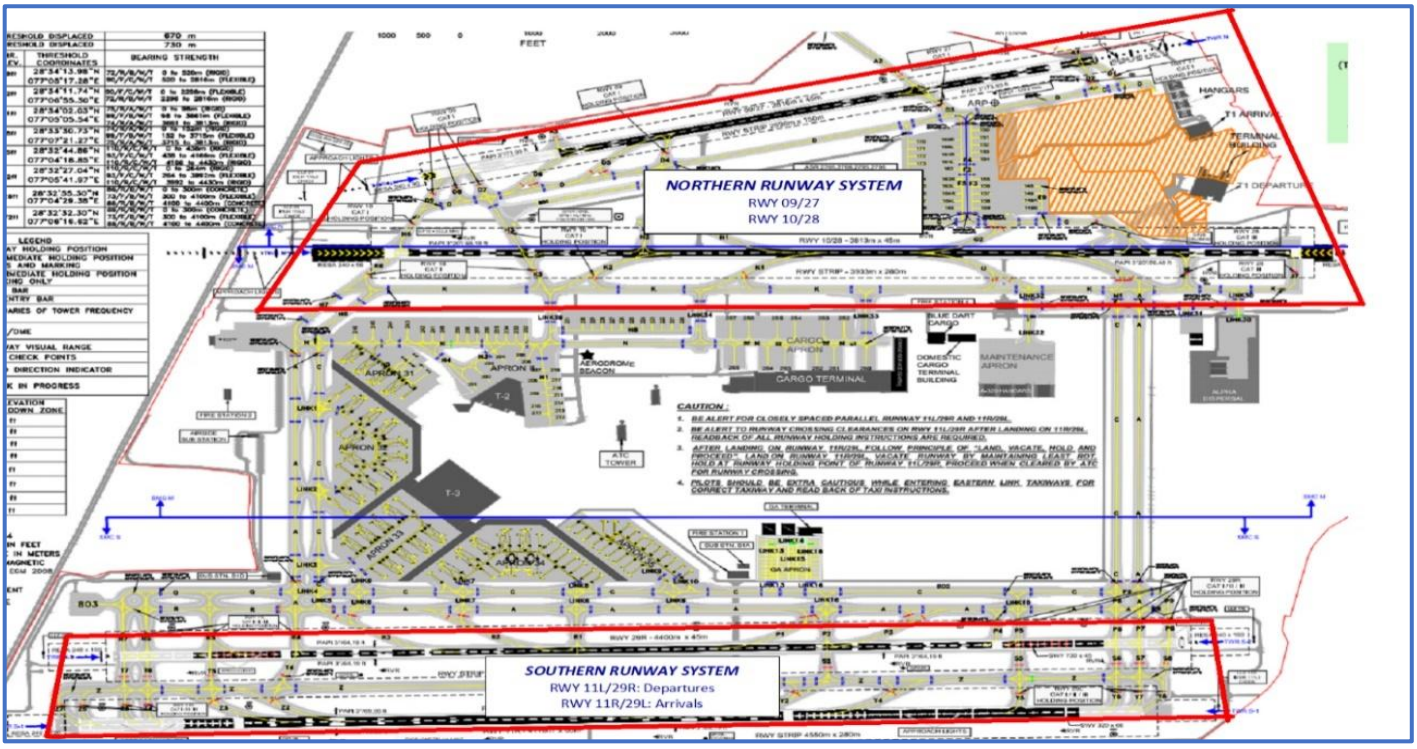


Fig 1: Northern System and Southern System

b. Runway 10/28 at IGI Airport was temporarily closed for resurfacing work between the period 11th September 2023 to 15th December 2023 (approximately 3 months) and prior notification was issued through AIP Supplement 124 of 2023 dated 27 Jul 2023. Along with the resurfacing works at Runway 10/28, rehabilitation of existing taxiways and construction of additional taxiways connecting Runway 10/28 had to be undertaken.

c. Both Runway Systems are either operated in Easterly Mode or Westerly Mode based on the winds profile. On the day of the incident, since Runway 10/28 was closed, three runways westerly mode of operation was in progress at IGI Airport and, during which Runway 29L and Runway 29R were being used exclusively for arrivals and departures respectively, whereas Runway 27 was being used in mixed mode i.e. for both arrivals and departures. Further, the arriving aircraft on Runway 29L, after landing, was required to cross runway 29R to proceed to its respective Passenger Terminal. Moreover, in respect to departures from runway 29R, the departing aircraft was dependent on the position of two aircraft, one on arriving aircraft on Runway 29L and other on the departing aircraft from Runway 27 due to weather. Following major modes of operations in westerly flow were published (Table 1):

Mode of operation		Remarks
Three Runway operations	27- ARR and DEP 29L- ARR 29R- DEP	a. Departures from Runway 27 are independent of position of arrival/departure on Runway 29L/ Runway 29R b. Departures from Runway 29L/ Runway 29R are independent of position of arrival/departure on Runway 27 c. Departures from Runway 29R are dependent upon position of arrival on Runway 29L.

Table 1: Modes of Operations

d. Following aerodrome controllers having relevance to the incident were providing ATC services when the incident took place:

- Aerodrome Controller South-1 (ADC-S1) was primarily responsible for operations on the Runway 29L.
- Aerodrome Controller South-2 (ADC-S2) was primarily responsible for operations on the Runway 29R.
- Aerodrome Controller North (ADC-N) was primarily responsible for operations on the Runway 27

Note: Aerodrome Control Middle (ADC-M) having responsibility for operations on the Runway 28, was closed due to rehabilitation work.

e. The jurisdiction of various ADC (Tower) controllers is depicted below (Ref Fig: 2).

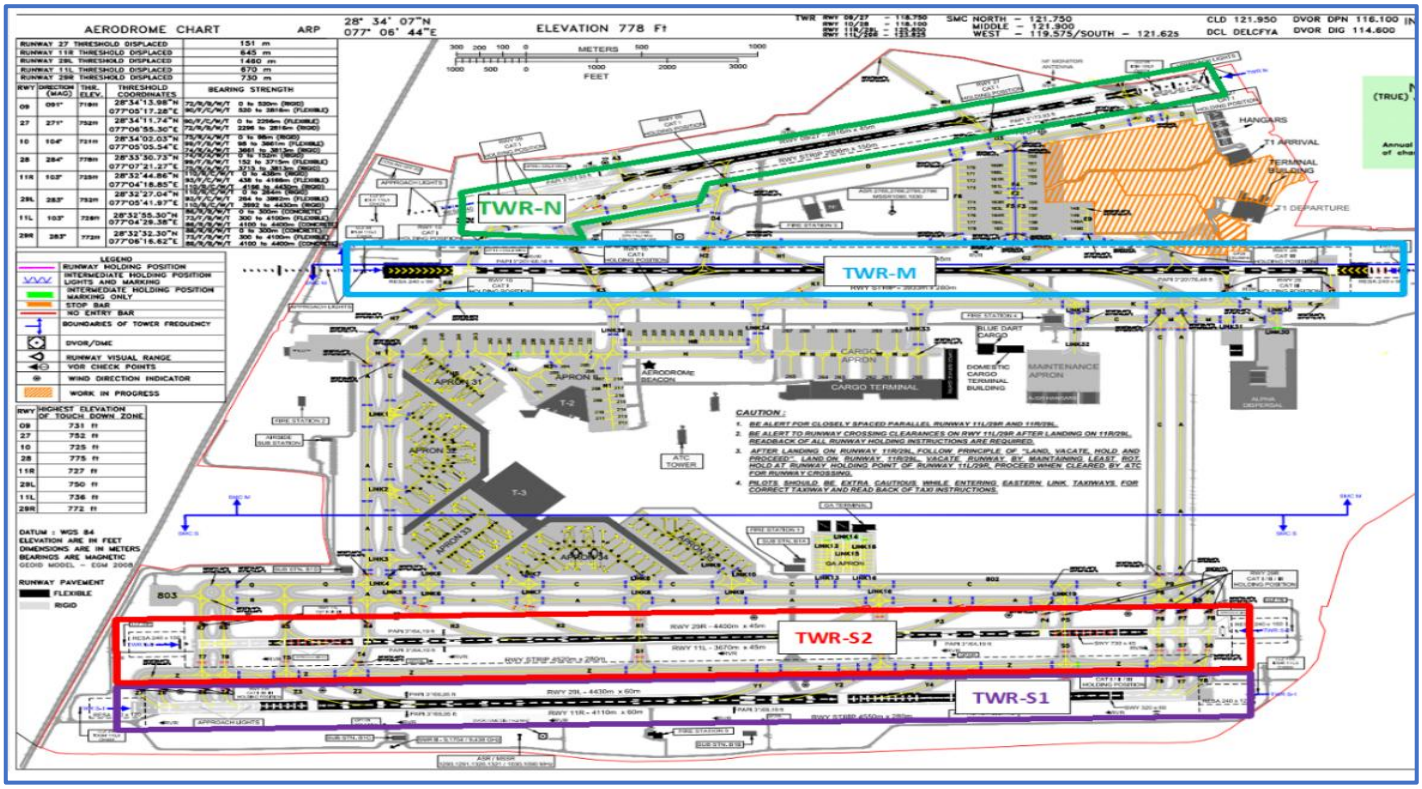


Fig 2: Runway jurisdictions

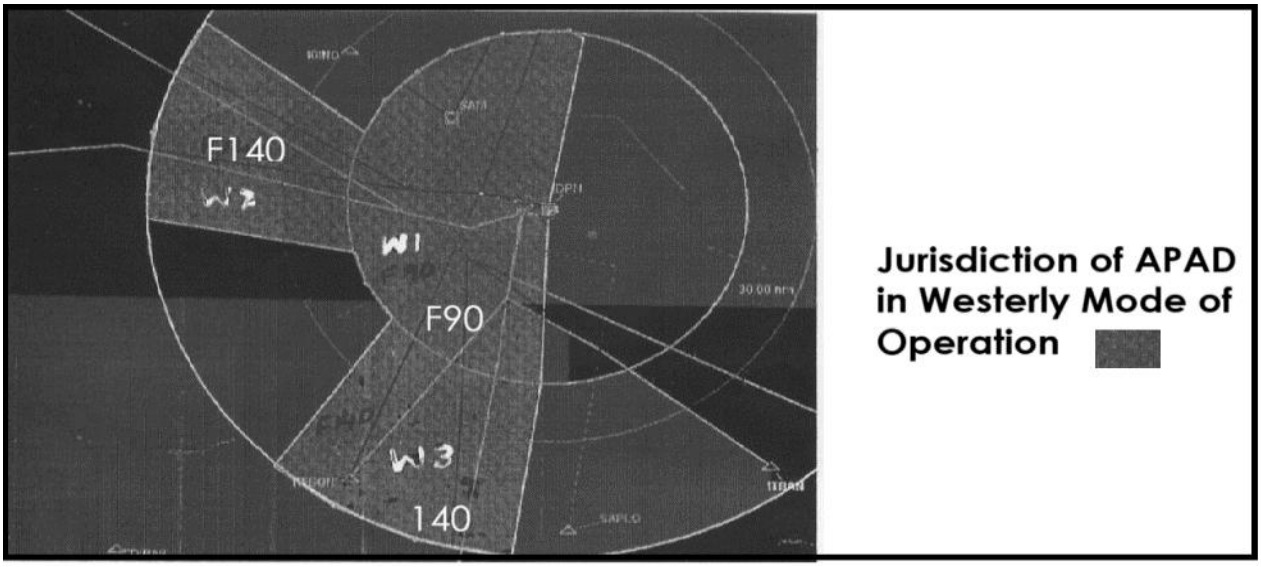


Fig 3: Jurisdiction of APAD Controller

The Approach Control Unit was divided into three sectors, namely Approach Departure (APAD), Approach Arrival (APAA), and Approach Final Director (APFD), which were responsible for providing air traffic services within their respective areas of jurisdiction.

1.1.2 Sequence of Events:

Unless otherwise indicated, all times in this report are stated in Co-ordinated Universal Time (UTC). The relationship between IST and UTC is: IST = UTC + 5½ hours.

1. Departure Route Assigned to ETH689:

At 034836, a B787-800 aircraft registration ET-ATL belonging to Ethiopian Airlines operating as a scheduled passenger flight under IFR regulations from IGI Airport Delhi was assigned SID DUDUM6C by Delhi ATC via Data Link. The aircraft was initially cleared to climb to an altitude of 4,000 feet en-route to its destination, Addis Ababa Bole International Airport (HAAB). For details on the DUDUM6C SID, refer to Annexure 'A' (Climb on heading 283, turn left at or above 1,700 feet, and proceed direct to DUDUM).

2. Non-Association of Flight Plan:

2.1 A Learjet aircraft VT-VRR belonging to a Non-Scheduled operator scheduled to operate from Delhi to Jabalpur, filed a flight plan (FPL) with an estimated off-block time (EOBT) of 0400 UTC. At 042719, after start up, the electronic flight strip (EFS) was moved to 'Taxi' by the SMC-S2 controller. However, at 042759, the FPL for VT-VRR got cancelled after receiving cancelation message (CNL) from ATS Reporting Office and subsequent manual intervention from FDD-3 (EEP/OSS) position. OSS/EEP was supposed to be managed by the EEP/OSS controller. However, no controller had taken over watch at the EEP/OSS position from 0200 to 0730.

2.2 The aircraft was cleared for take-off by the ADC-S2 controller, and it departed from Runway 29R at 0432. However, the FPL was not correlated with VT-VRR on the controller's situation display. Thereafter, the ADC-S2 controller attempted several times to correlate the FPL with VT-VRR but it was unsuccessful.

2.3 The APAD controller meanwhile advised the ADC-S2 controller to prioritize the FPL association of VT-VRR and to hold further departures. The ADC-S2 controller acknowledged the instruction and reported that he is attempting to associate the FPL.

2.4 Between 043712 and 043722, the ADC-S2 controller informed the APAD controller that the FPL was in a terminated state.

2.5 Between 043544 and 043608, the APAA controller at CWP-14 created the FPL for VT-VRR, executed various flight plan (FP) commands, and successfully associated the FPL with VT-VRR.

3. Between 043803 and 043818, the ADC-S2 controller confirmed from ETH689 whether aircraft is ready for departure, the flight crew reported that they would wait at least 5 minutes to assess the condition prior departure.

4. Wind shear reported by AIC806:

At 043859, an arriving aircraft, AIC806 (an A320), which was established on the ILS for Runway 29L, reported going around due to wind shear encountered at 1,000 feet.

5. Landing of THA323:

The next arriving aircraft, THA323, landed on the same Runway 29L at 0441. ATC neither sought any information regarding wind shear from THA323, nor did the aircraft report encountering any wind shear. Later on, THA323 landed at 04:41 and was waiting on Taxiway T6 to cross Runway 29R to proceed to passenger arrival terminal.

6. Line up and Taxi clearance to ETH689:

At 044252, the ADC-S2 controller issued an instruction to ETH689 to line up on Runway 29R via Taxiway P6, which was read back by ETH689. At 044343, the ADC-S2 controller issued take-off instructions to ETH689, which were also read back by the aircraft. At the time ETH689 was on Taxiway P6 for departure, the arriving aircraft VTI946, approaching Runway 29L, had a time-to-touchdown (TTT) value of 1 minute and 48 seconds (Fig. 4).

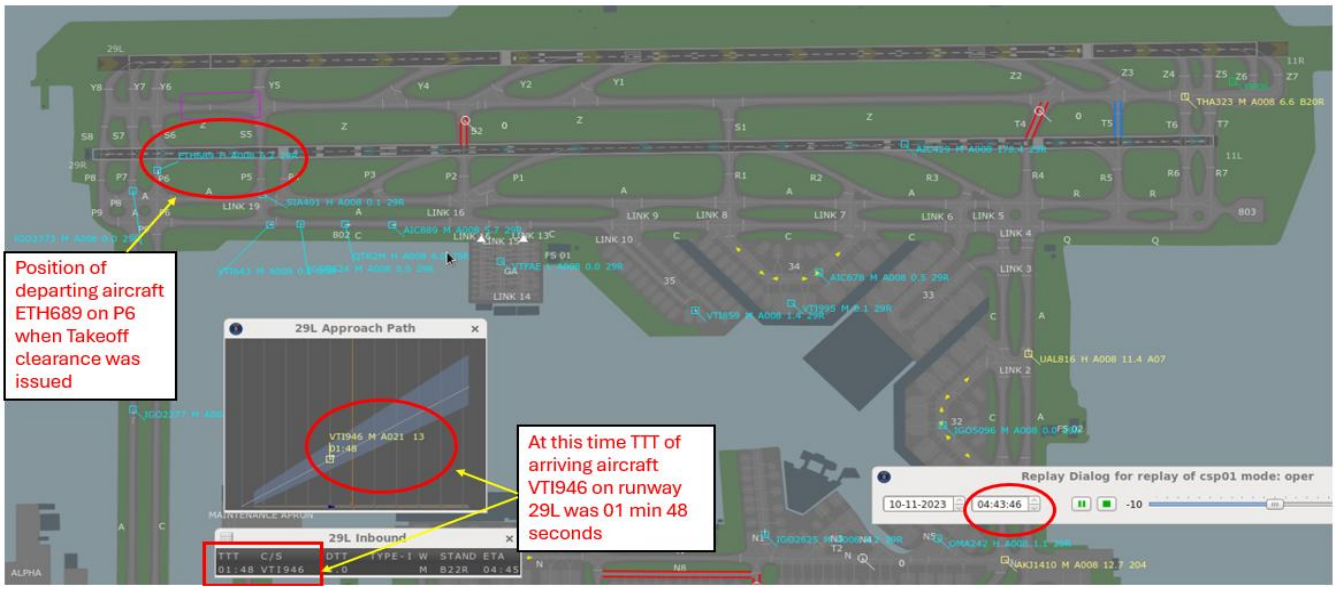


Fig 4: TTT and position of aircraft

7. Aircraft Holding for Departure

Meanwhile, seven departing aircraft (SIA401, VTI643, IGO5624, QTR2M, AIC889, IGO2373, and IGO2277) were waiting for departure at or near the holding point of Runway 29R.

8. Approach of VTI946 to Runway 29L

An A320 aircraft registration VT-TQL belonging to M/s Tata Singapore Airlines Ltd. operating as a scheduled passenger flight VTI964 under IFR regulations departed from Sardar Vallabhbhai Patel International Airport, Ahmedabad, at 0337 (ATD). Once the aircraft came in contact with the Approach Final Director (APFD) controller, VTI964 was radar-vectored for an ILS approach to Runway 29L at IGIA. Further, the aircraft was informed about wind shear encountered by a preceding landing aircraft. Thereafter, flight crew anticipated possible wind shear on final approach to Runway 29L. At 044400, when Ethiopian flight ETH689 was about to enter Runway 29R, the time-to-touchdown (TTT) for VTI946 was 1 minute and 30 seconds (see Fig. 5 below).

Fig 5: VTI946's TTT when ETH689 was entering on runway

10. Lining up of ETH689 on Runway 29R for departure

ETH689 lined up for take-off on Runway 29R at 04:44:09, and the time-to-touchdown (TTT) left for VTI946, approaching Runway 29L, was 1 minute and 18 seconds (see Fig. 6 below).

Fig 6: ETH689 position in respect of VTI946's TTT

11.Following instructions from APAD controller, VTI946 contacted ADC-S1 controller. At 044422, the controller had issued the landing clearance to the aircraft and reiterated the wind shear information.

12. ETH689 departed from Runway 29R at 0445. Before the departure of ETH689, approximately between 04:35 and 0445 UTC, two other aircraft's VIR300 and UAL816 had also crossed the Runway 29R at 0437 and 0441 respectively.

13. Go-around by VTI946

Within a few seconds of ETH689 becoming airborne, at 044526, VTI946 informed the ADC-S1 controller that due to unstabilised approach they have decided to go around.

Fig 7: Go around carried by VTI946 while ETH689 tookoff from parallel runway 29R

14. At 044530, the **ADC-S2** controller (Runway 29R) instructed ETH689 to contact the Approach Departure (APAD) controller, which was acknowledged by the aircraft.

15. At 044533, the **ADC-S1** controller (Runway 29L) provided traffic information to VTI946, stating, "Traffic Ethiopian Boeing 788 now climbing to one thousand eight hundred feet on adjacent runway".

16. At 044542, ETH689 contacted the APAD controller and reported passing 2,200 feet and climbing to 4,000 feet. The radar controller identified the aircraft and instructed it to climb unrestricted (further transmission message not clear).

17. **Breach of Standard Separation:**

At 044548, breach of separation occurred between Ethiopian aircraft ETH689 and Vistara aircraft VTI946 resulting into generation of Current Conflict Alert on the APAD controller's situation display (Ref Fig. 8). The breach of separation incident occurred approximately 3 NM WSW of IGIA (ARP).

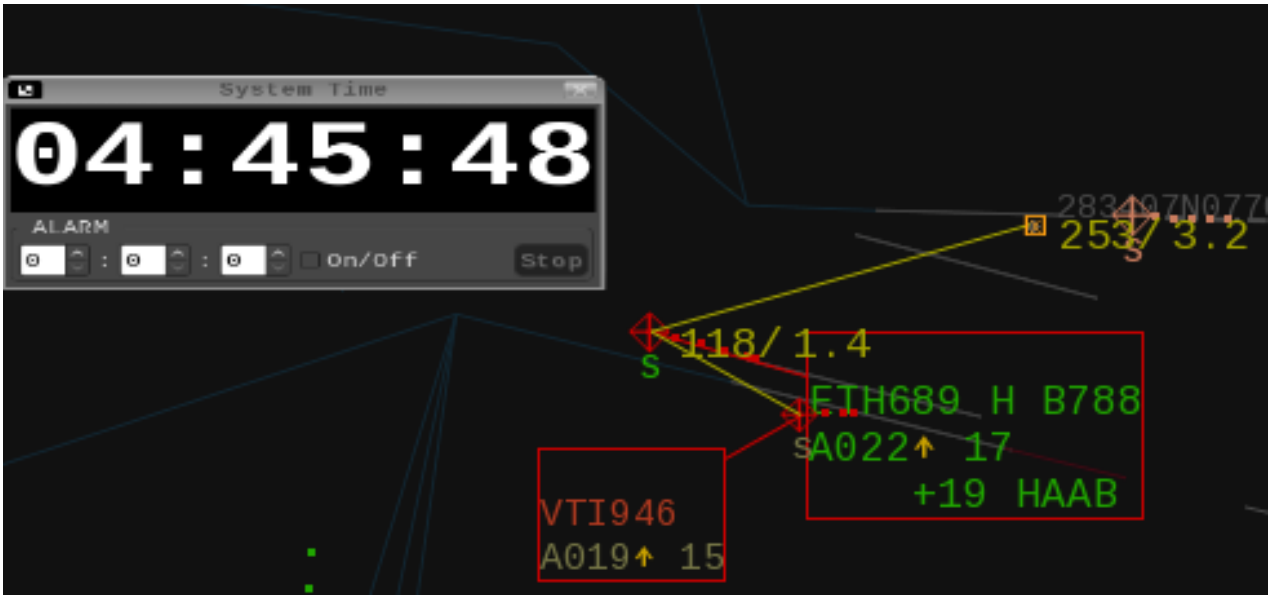


Fig 8: Breach of separation recorded by display

18. At 044555, the ADC-S1 controller called the APAD controller via intercom and informed that aircraft VTI946 had executed a go around. Thereafter, APAD controller inquired further about the aircraft. The ADC-S1 controller informed that the aircraft's altitude is 2,400 feet.

19. The APAD controller meanwhile instructed ETH689 to stop climbing at 2,600 feet. Since the crew did not fully understand the instruction, crew requested to repeat the transmission. Subsequently, the controller instructed the ETH689 to make a right turn and simultaneously provided traffic information about ETH689 to VTI946, although VTI946 was not in contact at the time.

20. At 044611, both Ethiopian aircraft ETH689 and Vistara aircraft VTI946 reached to same altitude i.e 2,600 feet and the horizontal separation between them reduced to 1.4 NM, as depicted in Fig. 9 below:

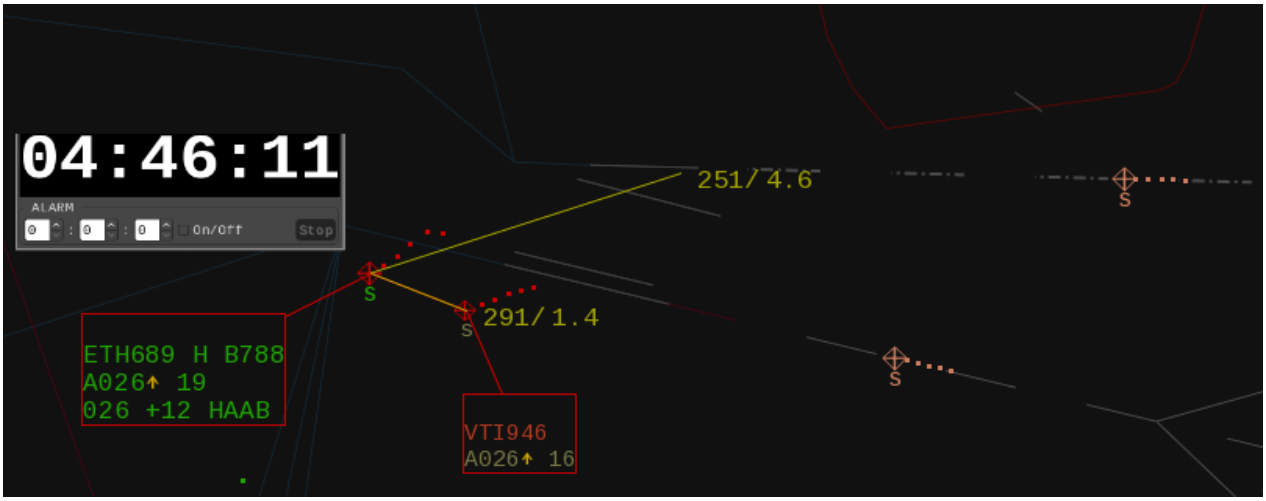


Fig 9: Both aircraft were at same altitude

21. First TA/RA Alert in the cockpit:

At 044613, the aircraft VTI946 received a Traffic Advisory (TA) when it was at an altitude of 2,553 feet, which later converted to TCAS Resolution Advisory (RA) at 044620. The crew followed the first TCAS RA ("Descend, Descend") in accordance with their company SOPs and initiated a descent. Thereafter, at 044631, while the aircraft was passing 2,253 feet, the crew received a TCAS RA ("Don't Climb").

22. TRA appeared in the data block:

At 044628, TCAS RA alert (TRA) also appeared in the data blocks of both ETH689 and VTI946 (see Fig. 10). Subsequently, ADC-S1 controller contacted VTI946. The crew informed, they are responding to TCAS RA instructions and requested ATC to remain on standby.

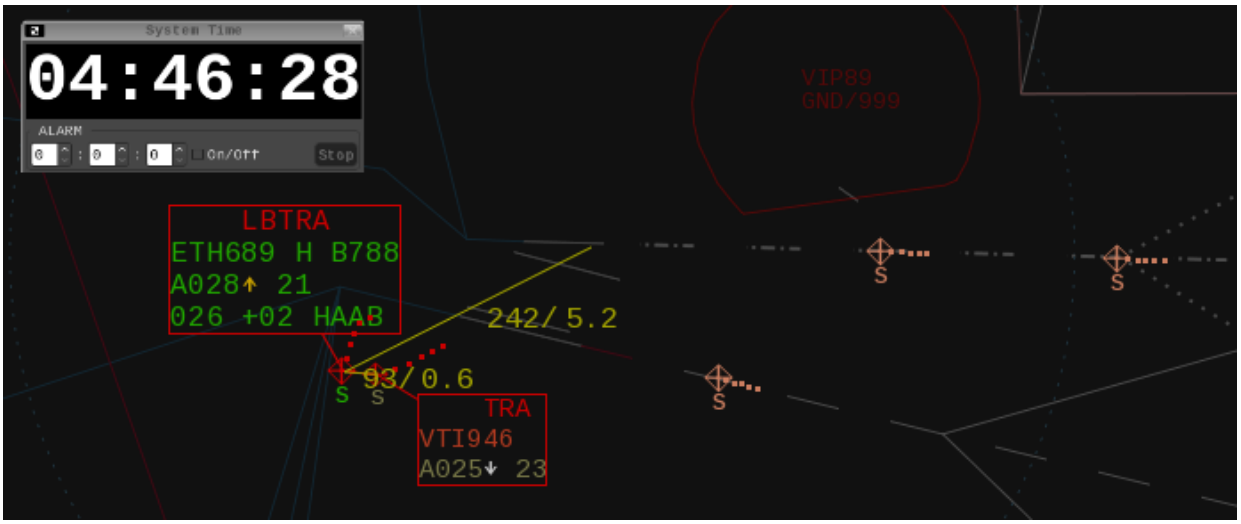


Fig 10: Both aircraft data block turned to red

23. After clear of conflict, ADC-S1 instructed VTI946 to contact Approach Radar (APAD) and simultaneously provided traffic information, stating that the Ethiopian aircraft was passing 2,800 feet. VTI946 acknowledged the frequency change.

24. ETH689 was instructed by the controller to stop climb.

25. At 044635 UTC, the APAD controller, in a panicked voice, instructed ETH689 to turn right to heading 270 and also transmitted traffic going around at 2,200 feet. Since the crew did not fully comprehend the message and they requested to repeat the transmission.

26. At 044645, VTI946 contacted APAD controller, who instructed it to maintain 2,000 feet. VTI946 reported passing 2,300 feet and being clear of the conflict.

27. At 044659, ETH689 informed the APAD controller that it was turning left to heading 270 and maintaining 3,000 feet, to which the controller acknowledged. However, according to the replay of the ATC surveillance system, ETH689 was actually turning right, as instructed by the APAD controller.

28. Second time TRA message triggered in Data Block:

At 04:47:02, ETH689 had reached 3,100 feet, while VTI946 was passing 2,400 feet. A TCAS RA alert (TRA) appeared in data block of VTI946, showing the aircraft was climbing to 2,600 feet, while ETH689 continued its right turn. The lateral spacing between the two aircraft began to reduce again (see Fig. 11). At 044721, the APAD controller instructed ETH689 to climb to FL70, and subsequently it was acknowledged by ETH689.

Fig 11: Second time TA/RA displayed on the data block

29. According to the DFDR of VTI946, at 044726, a second alert was generated by the TCAS system when the aircraft was at altitude of 2,600 feet, which later converted to RA ("Preventive - DON'T CLIMB") at 044739. At 044754, VTI946 was clear of traffic. Thereafter, crew reported about the TCAS RA event to ATC.

30. At 044753, TCAS Alert (TRA) triggered for both the aircraft on the radar display and the minimum separation recorded between the two aircraft was 0.2 NM horizontal and 400 feet vertical. (Ref Fig. 12).

Fig 12: Minimum separation recorded between the aircraft

31. At 044800, the APAD controller acknowledged and instructed VTI946 to report clear of traffic. VTI946 then confirmed being clear of the conflict and maintaining 2,600 feet (see Fig. 13).

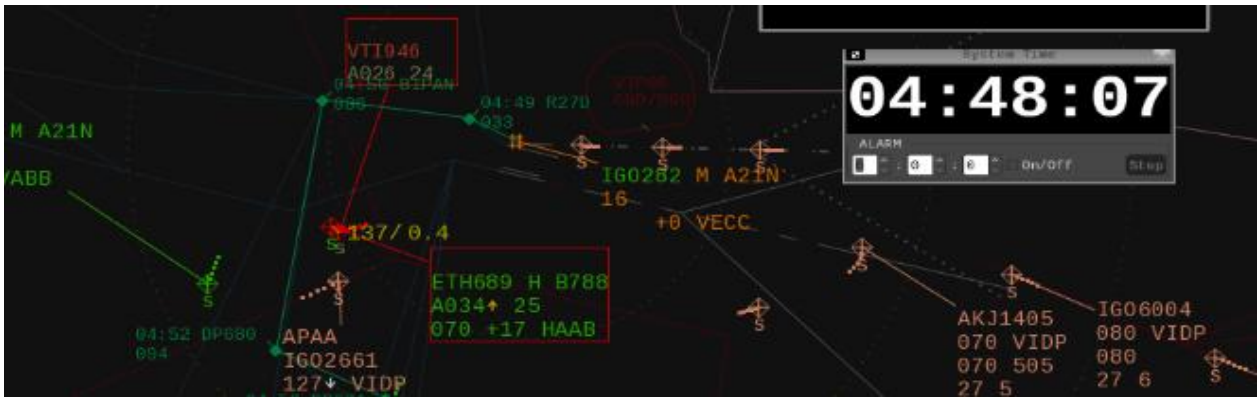


Fig 13: VTI946 reported clear of traffic

32. At 044814, the applicable minimum separation of 1,000 feet was restored, and the Current Conflict Alert disappeared. Thereafter, ETH689 left the Delhi FIR at 05:24 and continued to its planned destination without any further incident. VTI946 was again vectored for an ILS approach to Runway 29L and at 0504, it landed at IGIA Airport without further event.

1.2 Injuries to persons

NIL

1.3 Damage to aircraft

NIL

1.4 Other Damage

NIL

1.5 Personnel information

1.5.1 Flight Crew information

1.5.1.1 Ethiopian Flight ETH689

	Pilot-in-command	First Officer
Age	59 years	29 years
Licence Category	ATPL	MPL
Date of initial Issue	29/09/2020	08/10/2018
Valid up	31/12/2050	31/12/2050
Class of Licence	NA	NA
Aircraft Ratings	B777/B787	B777/B787
Date of Endorsement as PIC	NA*	NA
Date of Medical Exam	12/06/2023	22/09/2023
Validity of Medical	NA	18/08/2024
ICAO Language Proficiency Level	LEVEL 6	LEVEL 4
FRTO License Validity upto	NA	NA
Date of last IR Check	NA	NA

Date of last proficiency check	10/07/2023	06/03/2024
Total Flying Experience	21,000 hrs	4500 hrs
Total Flying Experience on type	800 hrs	3200 hrs
Experience as PIC on type	800 hrs	NA
Total Flying Experience during last 180 days	328:40 hrs	526:56 hrs
Total Flying Experience during last 30 days	58:59 hrs	68:31 hrs
Total Flying Experience during last 07 days	18:50 hrs	22:21 hrs
Total Flying Experience during last 24 hours	05:04 hrs	00:00 hrs
Rest period prior to reporting for duty	24:31 hrs	24:31 hrs
Any violation of Operator's flight crew FDTL scheme of concerned airlines	NA	NA
Whether flight crew member was subjected to Breath Analyser (BA) Test before undertaking the flight. If not, then reason thereof.	NA	NA

NA*- Not Available

1.5.1.2 Vistara Flight VTI946

	Pilot-in-command	**First Officer**
Age	34 years	35 years
Licence Category	ATPL	CPL
Valid up	10/01/2028	08/02/2027
Date of initial Issue	11/01/2018	09/02/2012
Aircraft Ratings	A320	A320
Date of Endorsement as PIC	11/01/2018 (P1)	14/07/2016 (P2)
Date of Medical Exam	15/09/2023	10/10/2023
Validity of Medical	14/09/2024	18/10/2024
ICAO Language Proficiency Level	LEVEL-06 as per ATPL	LEVEL-05 as per CPL
FRTO License Validity upto	09/06/2024	06/02/2027
Date of last IR Check	20/03/2024	30/12/2023
Date of last proficiency check	20/03/2024	30/12/2023
Total Flying Experience	7397:36 hrs	1929:30 hrs
Total Flying Experience on type	4655:39 hrs	1702:06 hrs
Experience as PIC on type	887:33 hrs	NA
Total Flying Experience during last 180 days	506:42 hrs	174:13 hrs
Total Flying Experience during last 30 days	83:38 hrs	54:21 hrs
Total Flying Experience during last 07 days	19:32 hrs	16:46 hrs

Total Flying Experience during last 24 hours	03:25 hrs	03:25 hrs
Rest period prior to reporting for duty on 10th Nov 2024	16:55 hrs	58:38 hrs
Any violation of Operator's Flight Crew FDTL Scheme of concerned Airlines	No	No
Roles of Pilots (PF or PM?)	PIC was PF and First Officer (Co-Pilot) was PM during go around and TCAS event.	

The flight crew members of VTI946 were in compliance with the FDTL regulations as per information provided by M/s TATA SIA Airlines Ltd.

1.5.2 **Air Traffic Controller information**

a) On 10 Nov 2023, the air traffic controllers at IGIA reported for morning shift which started at 0200 UTC (07:30 IST) and the incident took place at 044548 UTC. Scrutiny of their records revealed that the air traffic controllers involved in the occurrence were licenced and qualified for the operations. Ratings and other relevant information pertaining to different controllers is appended below in tabular form:

Controller	Age of Controller	Controller Ratings at IGI	ICAO Language Proficiency	Medical Fitness on the day of incident	Whether controller was involved in any other incident during last three years
ADC-S1	33 years	Aerodrome Control Rating (IGIA) on 24/10/2019	Level 4	Held valid medical fitness certificate	No
ADC-S2	36 years	Aerodrome Control Rating (IGIA) on 21/06/2023	Level 5	Held valid medical fitness certificate	No
APAD	42 years	Approach Control Surveillance Rating (IGIA) on 22/04/2021	Level 4	Held valid medical fitness certificate	No
APFD	39 years	Approach Control Surveillance Rating (IGIA) on 16/09/2019	Level 6	Held valid medical fitness certificate	No

Table 2: Controllers details

b) ADC-S2 was trained in basic automation course from 03.08.2022 to 12.08.2022. The training course included FDD and SDD operations.

c) The investigation, which included a review of concerned controller's shift schedule, determined that fatigue was likely not a factor in this occurrence. In this regard, a table containing shift schedule and previous duty day is provided below:

Controller Position	Shifts Scheduled on the day of incident	Previous Duty
ADC-S1	0200-0300 UTC 0400-0500 UTC	The last duty performed by the controller at same position was on 09 Nov 2023
ADC-S2	0200-0300 UTC	The last duty performed by the controller at same position was on 07 Nov 2023

	0400-0500 UTC	
Approach Final Director (APFD)	0200-0320 UTC 0440-0600 UTC	The last duty performed by the controller at same position was on 06 Nov 2023
Approach Departure (APAD)	0200-0320 UTC 0410-0520 UTC	The last duty performed by the controller at same position was on 06 Nov 2023

Table 3: Controllers position on the day of incident

d) The controller at EEP/OSS, who was responsible for FPL management, error queue, and estimate entry, had not taken over the watch on the incident day.

1.6 Aircraft information

1.6.1 VTI946:

VTI946, aircraft type A320-251N, manufactured by M/s Airbus had valid certificates of airworthiness in accordance with subject to ARC validity. The aircraft was equipped with TCAS II Version 7.1

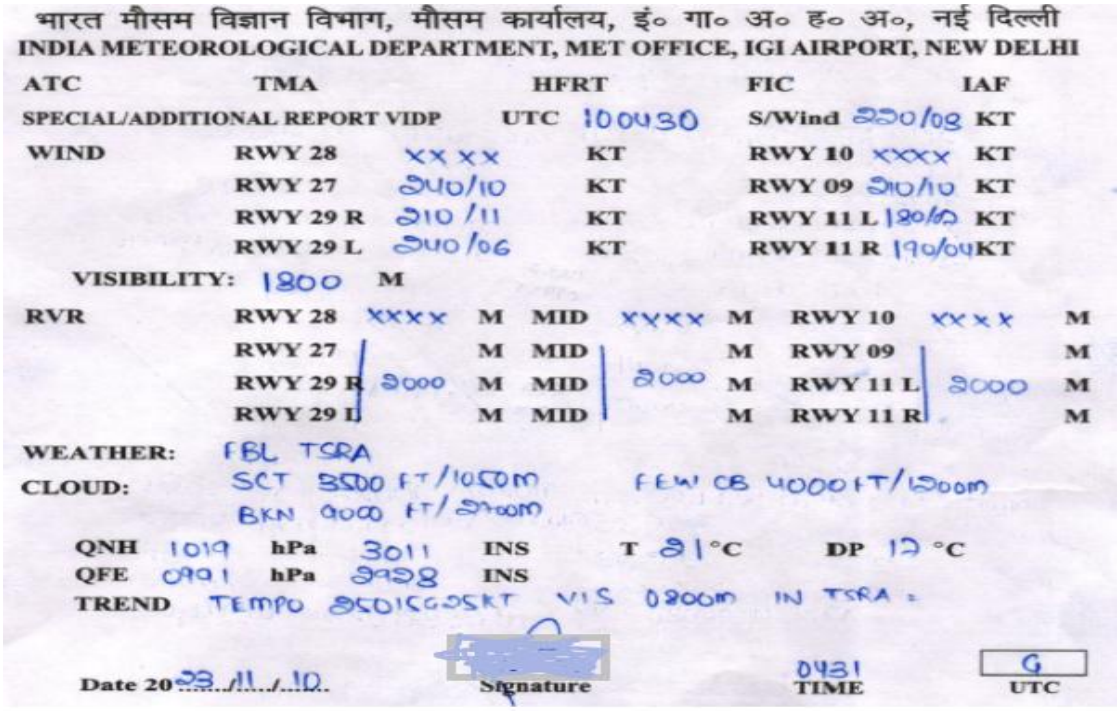
1.6.2 ETH689:

ETH689, aircraft type B787-800, manufactured by M/s Boeing had valid certificates of airworthiness. The aircraft was equipped with TCAS II Version 7.1

1.7 Meteorological Information

1.7.1 METAR REPORT

The weather conditions at the time of the incident at IGI airport is provided below. This information is from the records of the METAR issued by MWO, Palam on 10 Nov 2023 at 0431 UTC.



भारत मौसम विज्ञान विभाग, मौसम कार्यालय, इं० गा० अ० ह० अ०, नई दिल्ली
INDIA METEOROLOGICAL DEPARTMENT, MET OFFICE, IGI AIRPORT, NEW DELHI

ATC TMA HFRT FIC IAF
SPECIAL/ADDITIONAL REPORT VIDP UTC 100430 S/Wind 230/08 KT
WIND RWY 28 XXXX KT RWY 10 XXXX KT
RWY 27 240/10 KT RWY 09 210/10 KT
RWY 29 R 210/11 KT RWY 11 L 180/05 KT
RWY 29 L 240/06 KT RWY 11 R 190/04 KT
VISIBILITY: 1800 M
RVR RWY 28 XXXX M MID XXXX M RWY 10 XXXX M
RWY 27 M MID M RWY 09 M
RWY 29 R 2000 M MID 2000 M RWY 11 L 2000 M
RWY 29 L M MID M RWY 11 R M
WEATHER: FBL TSRA
CLOUD: SCT 3500 FT/1050M FEW CB 40001FT/12000M
BKN 9000 FT/2700M
QNH 1019 hPa 3011 INS T 21 °C DP 17 °C
QFE 0991 hPa 2938 INS
TREND TEMPO 25015G25KT VIS 0200M IN TSRA
Date 2023/11/10 Signature 0431 TIME G UTC

Fig 13: METAR recorded by IMD at the time of incident

METAR applicable for IGI airport at 0500 UTC:

202311100500 VIDP 100500Z 12007KT 1800 R27/2000 R29L/2000 R29R/2000 TS SCT035 FEW040CB BKN090 21/71 Q1018 TEMPO 25015G25KT 0800 TSRA

One Aerodrome warning, applicable on the day of incident, was also issued by MWO, Palam which is reproduced below:

VIDP AD WRNG 3 VALID 100430/100630 MOD TS SFC WSPD 15KT MAX 25KT FROM 250 DEG FCST

The warning expected moderate thunderstorm between 0430 UTC to 0630 UTC with maximum gust speed upto 25 Knots.

According to MWO, although this aerodrome warning was included in the OLBS, it was still displayed on the screens at MET briefing room and the ATC office. In addition, the information was also communicated to the ATC Tower, WSO, AOCC and LIAISON. However, the MWO confirmed that no wind shear report was received at the MET office on 10th Nov 2023 and therefore, no warning was issued in this regard.

1.7.2 Meteorological Briefing:

Scrutiny of Met Register maintained by the Met department located on the first floor of the ATC building revealed that only 20 controllers took meteorological briefings before undertaking their respective positions. However, on the day of incident, a total of 48 controllers in the concerned shift.

Further, it was noticed that except ADC-S1 controller, all the other controllers involved in providing ATC services at the time of incident took Met briefing before handling active channels. There was no automated system for ATCOs for obtaining meteorological briefing.

1.8 Aids to navigation

Both aircraft, VTI946 and ETH689 were equipped with standard NAV & approach aid equipment and also possessed RNAV-1 capability, and no technical failure of their navigation equipment was reported.

Runway 29L was equipped with ILS CAT I, II and III. At the time of incident, Cat I conditions were prevailing and all the navigational and surveillance aids were reported serviceable.

1.9 Communications

Both aircraft were in positive contact with ATC Delhi and no communication failure was recorded during the incident. The frequency usage plan for IGI airport was as follows:

S. No.	Unit	Frequency (MHz)		Hours of operation	Position	Service Designator
		Main	Standby			
1	Approach Control Unit	126.350 and 125.675	121.350	H-24	Approach/TAR	Delhi Approach
		124.200	124.250	H-24	Approach/TAR	Delhi Arrival
		118.825	124.600	H-24	Approach/TAR	Delhi Departure
2	Aerodrome Control Tower	118.750	118.250	H-24	Tower-North	Delhi Tower
		118.100	124.375	H-24	Tower-Middle	Delhi Tower
		125.85	124.375	H-24	Tower-South	Delhi Tower
		121.750	119.575	H-24	SMC-North	Delhi Ground
		121.900	119.575	H-24	SMC-Middle	Delhi Ground
		121.625	119.575	H-24	SMC-South	Delhi Ground
		119.575	-	-	SMC-West	Delhi Ground

Fig 14: Frequencies allocated to different units

VTI946 was initially communicating with ADC S-1 on 125.85 and subsequently APAD on frequency 118.825 MHz. Similarly, ETH698 was initially communicating with ADC S-2 on 123.825 MHz and subsequently APAD on frequency 118.825 MHz. No unserviceability was reported about any of the VHF.

All concerned ATC units were equipped with intercom for the purpose of coordination at IGIA. During the interview with the investigation team, ADC S1, ADC-S2 and ADC-N controllers revealed that due to close proximity with each other, they had coordinated verbally during the event as it was more expeditious. Hence, the communication held between them, without intercom, was not available for the investigation purpose. In addition to this, GM (ATM) IGIA stated that ATIS recording (126.4 MHz) was not preserved after the incident by the ATS department, as it was not mandatory.

During the investigation, it was noted that the recording of SIP intercom was also unavailable due to the unserviceability of the Harmony recorder from 5 Aug 2023 to 18 Nov 2023. As a result, information relayed from the Tower Supervisor to the Meteorological Office if any, could not be retrieved.

The TEFS data was not stored by the AAI and therefore, movement of EFS information was not available with the ATC service provider. Further, Air Traffic Control Units were also not equipped with any device to record background communication of air traffic controllers work stations.

The relevant portion of the tape transcripts between ADC-S2 & APAD Controller and APAD Controller & ADC-S1 controllers is appended as Annexure 'B' to this report.

1.10 Aerodrome information

Indira Gandhi International Airport Delhi (IATA Code: DEL, ICAO: VIDP) is an international airport serving New Delhi, the capital of India, and the National Capital Region (NCR). The Co-ordinates of the Aerodrome Reference Point are 283407N 0770644E. Earlier, IGI Airport had only three runways 29/11, 28/10 and 27/09 till 13 July 2023.

A new runway, 29R/11L, was operationalized at 0431 UTC on July 14, 2023, and the existing runway 29/11 was renamed 29L/11R. Runways 29L/11R and 29R/11L are parallel, separated by only 360 meters. These runways did not meet the criteria for parallel instrument runways for simultaneous use, as specified in para 3.1.12 of DGCA CAR Section 4, Series B, Part 1, Issue II. Therefore, both runways were operated in Segregated Dependent Mode, with Runway 29L designated exclusively for arrivals and Runway 29R for departures.

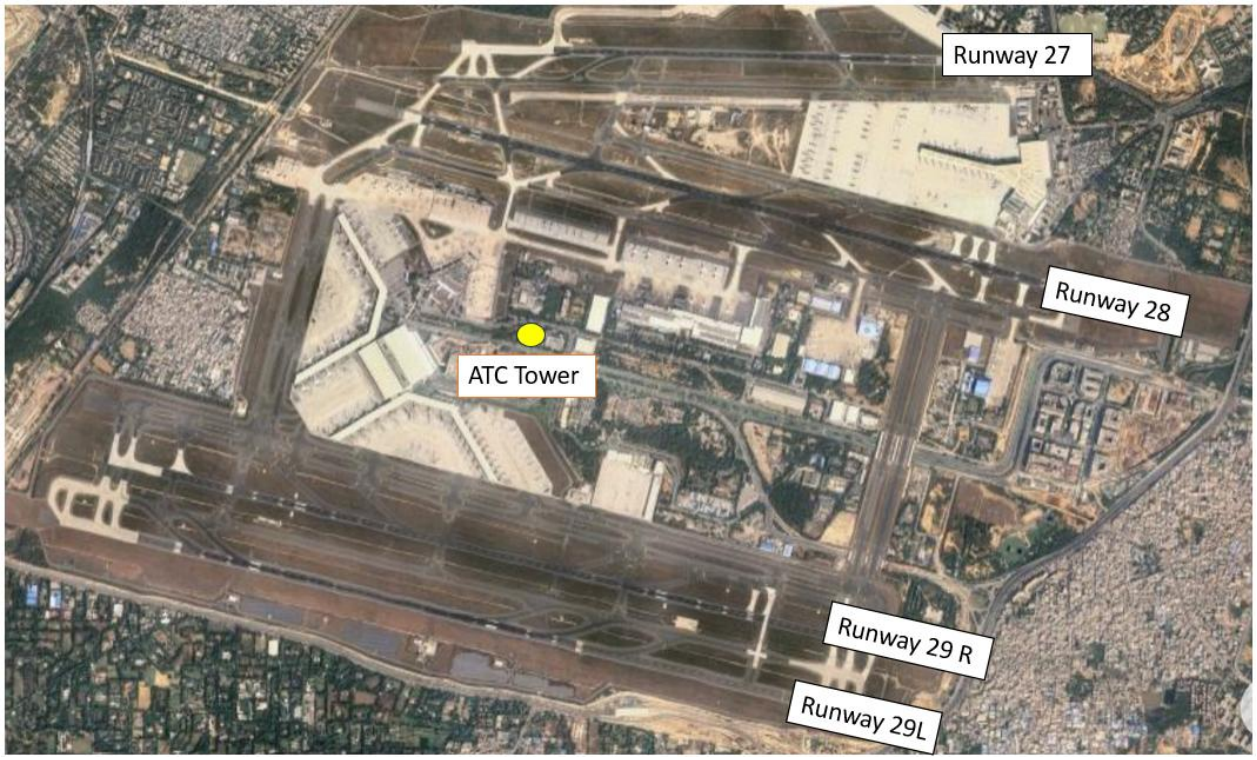


Fig 15: Runway positions at IGI Airport

Runway dimensions along with other relevant information of all the four operational runways at IGI airport is provided below in tabular form:

RWY Designator	TORA (M)	TODA (M)	ASDA (M)	LDA (M)	Threshold displaced	RESA
09	2816	2816	2816	2816	-	240 X 90M
27	2816	2816	2816	2665	151 M	240 X 90M
10	3813	3813	3813	3813	-	240 X 90M
28	3813	3813	3813	3813	-	240 X 90M
11L	3670	3670	4400	3000	670 M	240 X 150
29R	4400	4400	4400	3670	730 M	240 X 150
11R	4110	4110	4430	3465	645 M	240 X 120M
29L	4430	4430	4430	2970	1460 M	240 X 120M

Table 4: Runway specifications

MATS-2 issued after the incident has encompassed details pertaining to the convergence between all the four runways once newly inducted runway 29R being operationalised. The details of convergence of runways is presented below:

Between RWYs	Angle	Point of convergence	Distance between centre lines
RWY 09/27 and 10/28	13 degrees	1.08 NM from end of RWY 27	Largest Distance: 1077.91 m Shortest Distance: 436.79 m
RWY 09/27 and 11R/29L	12 degrees	7.6 NM west of DPN	Largest Distance: 3635.06 m Shortest Distance: 3040.61 m
RWY 09/27 and 11L/29R	12 degrees	6.27 NM from RWY 11L Threshold. 6.80 NM from RWY 09 Threshold.	Largest Distance: 3255.04 m Shortest Distance: 2660.60 m
RWY 10/28 and 11R/29L	1 degree	116 NM east of DPN	2554.68 m, from RWY 28 Threshold to RWY 29L beginning
RWY 10/28 and 11L/29R	1 degree	69.45 NM from RWY 29R Threshold.	2172.15 m (from RWY 28 threshold to RWY 29R beginning)
RWY 11R/29L and 11L/29R	0.40 degree	Almost Parallel	380 m (from RWY 29L beginning to RWY 29R beginning)

Fig 16: Runway convergence information

The minimum sector altitude and circuit altitude defined at IGI airport was 2600 feet.

The wind shear warning/alert system was not installed at IGI Airport, which could generate alerts for pilots and air traffic controllers. As a result, the Meteorological office and ATC at IGIA were solely dependent on pilot reports. These warning were then subsequently passed to next arriving or departing aircraft.

1.11 The Flight Recorders

The data from the Digital Flight Data Recorder (DFDR) of aircraft VIT946 and its CVR recording was provided by the M/s TATA SIA Airlines and the relevant parameters were analysed. However, Cockpit Voice Recorder and DFDR of ETH689 was not analysed during the investigation due to non-availability of data to investigation team. The relevant portion of the CVR tape transcript received from Vistara is appended as Annexure 'C' to this report.

1.12 Wreckage and impact information

Not relevant to this investigation.

1.13 Medical and pathological Information

No adverse medical conditions were reported about any of the controllers and flight crews of VIT949 and ETH689. Flight crews of VTI946 were subjected to Breath analyser test at Ahmedabad whereas information about BA test to flight Crews of ETH689 was not made available.

DGCA CAR Section 5 Series F Part IV Issue I, dated 16th September 2019, on "Procedure for Breath-Analyzer Examination of Personnel Engaged in Aircraft Maintenance, Air Traffic Control Services, Aerodrome Operations, and Ground Handling Services for Detecting Alcohol Consumption," applicable on the date of the incident, required that the organization, i.e., AAI, ensure that at least 10% of individuals employed were randomly subjected to breath-analyser examination on a daily basis when reporting for duty. According to the requirement of CAR, the ADC S2 Controller, who appeared on the randomized list of ATCOs for the BA test, was subjected to the BA test. The remaining Aerodrome Controllers in the Tower and APAD Controller were not on the randomized list and, therefore, were not subjected to the BA test.

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

1.17.1 AIRPORTS AUTHORITY OF INDIA (AAI)

The Air Traffic Services including Aerodrome Control services and Approach Control Surveillance services at IGIA, were being provided by Airports Authority of India (AAI). AAI was constituted by an Act of Parliament and came into being on 1st April 1995, where it was entrusted with the responsibility of creating, upgrading, maintaining and managing civil aviation infrastructure both on the ground and air space in the country.

1.17.1.1 MATS- PART 1 & MATS- PART 2

The Manual of Air Traffic Services – Part 1 (MATS-Part1) issued by the AAI provides processes, procedures and instructions that are essential for the provision of safe and efficient air traffic services within the airspaces under the jurisdiction of AAI and at airports where air traffic services are provided by AAI. As per the provisions outlined in MATS-1, ATS-in-charges of various airports are required to developed airport specific Manuals of Air traffic Services (MATS)-Part 2. It contains information, guidance, procedures and instructions applicable to the ATS units of those particular airports and are maintained by the ATS-in-charge of the concerned airport. Notwithstanding, MATS-2 publication, if any additional instructions, procedures or guidance are to be issued, those are issued separately by ATS-in-charges through ATC circulars.

The purpose of MATS- Part 2 document is to establish procedures, provide information and instructions, which are essential for the provision of safe and efficient air traffic services at Indira Gandhi International Airport, New Delhi. It is published for the use and guidance of Air Traffic Controllers working at the I.G.I. Airport, New Delhi.

MATS-2 Edition 7 dated 28 June 2022, applicable on the date of incident, contained the instructions and guidelines for ATS personnel. The relevant portion from Chapter 4 'Duties and responsibilities of ATS personnel" is appended below:

Para 4.18. DELHI APPROACH CONTROL UNIT (APP)

Para 4.18.1. *The Delhi Approach Control Unit is responsible for Air Traffic Control Service, Flight information service and Alerting service to all flights operating under its jurisdiction i.e. within 60NM around DPN in Delhi TMA and below FL140, except manoeuvring area.*

Para *4.18.2. Approach Control Team Composition*

a) ***Approach Supervisor***

b) Approach Arrival Controller

c) Approach Final Controller

d) Approach Departure Controller

e) ***Approach Alpha***

Para 4.18.3. *Duties and Responsibilities of* ***Approach Supervisor*** *(SUP)*

h) Arrange proper relief for the officials.

p) Take over watch to give relief to Approach controllers.

Para 4.18.9*. Duties and Responsibilities of* ***Approach Alpha***

a) Approach flight Data Assistant shall Operate Intercom/ Telephones.

b) Enter flight data into the FDD.

c) Ensure FDD is operational. In case of any abnormality, he/ she shall report to Operational and Technical supervisor.

d) Receive FPLs of flights and manually prepare flight progress strips when Automation System fails.

e) Assist Approach Radar/ Procedural Approach Controller for coordinating traffic with Safdarjung/ VIDX.

f) Assist Approach Radar/ Procedural Approach Controller in meeting situation objectives.

g) Inspection, correction, and submission of incoming messages on the Error Queue promptly.

h) Deletion of irrelevant messages and/or duplicate messages from the Error Queue.

i) Taking proper action on messages in the system message queue of the screen header and acknowledge them.

4.24. AERODROME CONTROL TOWER (ADC)

ADC Team Composition:

a) Tower Supervisor

b) Tower Coordinator

c) Departure Sequence Planner

d) Aerodrome Controller

e) Surface Movement Controller

f) Clearance Delivery Controller

g) DA-CDM Controller (ADC)

h) ATIS Alpha Controller

i) Tower Alpha Controller

j) SMC Alpha Controller

Para 4.24.1. *Duties and Responsibilities of* ***Tower Supervisor***

m) He/she shall ensure that DATIS is transmitted regularly. It shall be updated as and when required (Particularly whenever there is Change in Runway-in-use / Mode of Operation and/or weather). The recording of DATIS should be replayed and monitored to ensure the correct and successful transmission.

j) He/ She shall be responsible for the duties of Tower Coordinator and departure sequence planner in addition to his normal duties, till such time, a regular Tower Coordinator, and departure sequence planner is deployed.

Para 4.24.2. *Duties and Responsibilities of* ***Tower Coordinator***

a) To facilitate coordination between individual controller viz ADC, SMC, CLD and departure planning controller and to improve overall situational awareness.
b) To coordinate with arrival/ final radar controller and DEP radar controller for spacing planning and expediting departures and arrivals on the principle of least average delay.
c) Focus on the "bigger picture" i.e. on the overall traffic situation- both Departures and Arrivals taking active role in the planning process and strategic and tactical decision making to ensure maximum efficiency.
d) Monitoring and helping individual controllers to find solutions to any built up of traffic with ADC/SMC/CLD.
e) Perform duties of Departure Sequence Planner till the time a regular Departure Sequence Planner is deployed.
f) Until the time, regular Tower Coordinator is deployed; Tower Supervisor will be responsible for discharging the duties of Tower Coordinator in addition to his normal duties.

Para 4.24.4. *Duties and Responsibilities of* ***Aerodrome Controller***

a) Aerodrome Controller shall be responsible for issuing information and clearance to Aircraft under his/her control to achieve a safe, orderly and expeditious flow of air traffic on and in the vicinity of the Aerodrome with the object of preventing collision(s) between:

i. Aircraft flying in the Aerodrome traffic circuits around the Aerodrome.

ii. Aircraft operating on the runway(s) being used for landing and takeoff.

iii. Aircraft landing and taking off.

iv. Aircraft and vehicles operating on the runway(s) being used for landing and takeoff.

v. Aircraft and obstructions on the runway(s) being used for landing and takeoff.

b) The Aerodrome controller shall provide ATC service to arriving Aircraft when it is transferred by approach radar to his/her control till the Aircraft vacates the runway-in-use and handed over to SMC.
c) The Aerodrome controller shall do the movement of TEFS in FDD as specified in relevant SOP as per status of flight.
d) The Aerodrome controller is responsible for notifying pilot-in-command of aircraft under his/her control and also approach/Radar of non-availability of runway, taxiway, parking area or any failure or irregularity of any apparatus, lights or other aids for guidance of aerodrome traffic.
e) The Aerodrome controller is responsible for switching on crash alarm for at least 10 seconds to alert the safety services in case of emergency / accidents on/in the vicinity of the airfield. Relevant information about the emergency / accident shall be passed to SMC for further action.
f) When meteorological report indicates that VFR operations are not possible in the Delhi CTR, the Aerodrome controller shall inform approach and in coordination with approach suspend VFR operations. He/she shall hold all VFR departures and in case of request for startup for special VFR or cancellation of VFR coordinate clearance with Approach Control.

w) Aerodrome Controller shall release an aircraft to Approach Controller:

As per Transfer of Communication procedure defined in relevant SOP. After the aircraft is airborne and it's PPS, as observed on SDD, gets associated with the flight plan available FDPS system. In case of non-association of the FPL, he should inform approach radar controller about the flight ID and allocated SID and release the aircraft to approach control, or immediately after departure.

Para 4.24.9. *Duties and Responsibilities of* ***Tower Alpha Controller***

a) Attend all telephone/ hotline calls.
b) Printing and Managing Flight Progress Strips of all concerned flights as and when required by Aerodrome controller/SMC/CLD.
c) In case of any unserviceability of automation system, manually prepare FPS in duplicate one each for Aerodrome Controller and for SMC.
d) Pass the Departure Time of Departing Aircraft from Delhi to the Briefing Alpha for originating departure message when Automation System is unserviceable.
e) Check serviceability of all telephone lines/ Sitti Communication System, Strip Printer etc. and take necessary action to intimate concerned maintenance official for rectification and inform the Tower supervisor.
f) Assisting the Tower Controller and the Tower Supervisor in meeting situation objectives.

In addition to this, other guidelines contained in MATS-2 relevant to this investigation are quoted below:

Para 12.65 GUIDELINES TO ALL CONTROLLERS

Para 12.65.3. *All coordination with between different ATC units shall be done via SITTI system.*

Para 12.65.4. *English should be the language used for coordination and use of regional language on intercom should be avoided.*

Para 13.7.7. Coordination

a) Tower shall coordinate all missed approach instruction with Approach Departure (APAD).
c) Tower shall release all departure and aircraft carrying out missed approach to Approach Departure (APAD).

Para 17.1.19*. Aerodrome controller issues the landing clearance to the Aircraft depending upon his/her local traffic. In case Aircraft carries missed approach, the Approach / Radar controller shall be immediately informed.*

35.7 INTRA UNIT COORDINATION ON SITTI INTERCOM

Para 35.7.1 *It has been observed multiple times that the controllers avoid using the intercom to coordinate with another unit/controller. Although this practice may save a few seconds, but this is a latent feature which affects safety in the long term.*

Para 35.7.2*. It is re-emphasized that:*

a) All coordination with different ATC Units shall be done on SITTI system

b) English should be the language used for coordination and use of regional language on intercom to be avoided.

MATS-Part 1 (6.1 Edition) dated 26 Dec 2022, applicable on the date of the incident, illustrated the guidelines or instructions to be followed by ATC personnel regarding relay of weather information. The relevant paragraphs of MATS- 1 pertaining to MET information are appended below:

Para 3.12.3 *All ATC officers before taking over watch must familiarize themselves with:*

a) The current weather report and forecast

Para 6.6. *At the commencement of final approach, the following information shall be transmitted to aircraft:*

a) significant changes in the mean surface wind direction and speed;

(b) the latest information, if any, on wind shear and/or turbulence in the final approach area, shall be transmitted to arriving aircraft by a unit providing approach control service.

Para 7.15.*1 Whenever a pilot reports wind shear conditions to ATC, the information shall be passed to subsequent arriving and departing aircraft until either confirmation is received that the condition no longer exists or wind shear information has been included in ATIS and flight crew of the concerned aircraft reports the receipt of the appropriate ATIS designator.*

Para 7.15.2 *Reports on wind shear from aircraft should be passed to meteorological office.*

Para 9.1.5.7.2.2 *The ATIS broadcast messages contain information for arriving and departing aircraft consisting of the following elements of information:*

p) Any available information on significant meteorological phenomena in the approach and climb-out areas including wind shear, and information on recent weather of operational significance contained in MET report.

Based on the instructions and guidelines laid down in MATS-Part 1 , the MATS-2 which was specifically for IGI Airport has also incorporated guidelines for MET related information. The content of the MATS-2 dealing with weather information is reproduced below:

Para 11.2.9 *There is no provision of providing information regarding wind shear which could adversely affect aircraft on approach or take-off paths or during circling approach to unit providing approach control service/ control tower by met office. Any report of wind shear received by approach controllers shall be coordinated with Tower controller and vice-versa.*

Para 11.2.10. *Information regarding wind shear is being incorporated in the current weather reports as per information received from approaching aircraft.*

Para 11.2.11. *Provision of reporting of wind shear to Met office:*

Importance of wind shear in flight safety especially during approach and landing phase is well known. There is no instrument installed at IGI airport to forecast wind shear. Such warnings are issued based on the reports of pilot- in -flight. Whenever such information is received by ATC from pilot the same is passed to Met office in tower/Met briefing office for issue of wind shear alert warning. The information includes:

a) Altitude/Flight level at which Wind Shear is experienced.

b) Time of experiencing wind shear

c) Flight number of the aircraft

Para 11.3. *MET BRIEFING FOR ATCOS*

ATCOs shall Met briefing at the time of reporting for duty. Copies of latest India Weather Bulletin (IWB) and Delhi inference (morning and evening) are taken by computer/Transmission seat in evening and night duty and handed over to batch in-charge. The batch in-charge enters the brief of IWB in the relevant register for briefing to ATCOs. IWB and Delhi inference are tagged in relevant folder. ATCOs take Met briefing and put their signature in register kept for this purpose.

12.63. PROVISION OF REPORTING OF WIND SHEAR TO AIRCRAFT BY ATC

Para 12.63.1. *The provision contained in MATS Part - 1 is to be followed for reporting of wind shear to aircraft.*

QUOTE

Note*: Wind shear is a sustained change in the wind velocity along the aircraft flight path, which occurs significantly faster than the aircraft can accelerate or decelerate. It can occur at any level, but it is 'low level wind shear', occurring from the surface to a height of approximately 1500 ft, which can cause problems of sufficient magnitude to affect the control of aircraft in departure or final approach phases of flight.*

Whenever a pilot reports wind shear conditions to ATC, the information shall be passed to subsequent arriving and departing aircraft until either confirmation is received that the condition no longer exists or wind shear information has been included in ATIS and flight crew of the concerned aircraft reports the receipt of the appropriate ATIS designator.

***Phraseology**: WIND SHEAR WARNING ARRIVING (or DEPARTING) (type of aircraft) REPORTED LIGHT (or MEDIUM or HEAVY) WIND SHEAR.*

Reports on wind shear from aircraft should be passed to meteorological office.

UN QUOTE

***Para 12.63.2**. Any report of wind shear received by approach controllers shall be coordinated with tower controller and vice-versa.*

***Para 27.9.2.** Action by Tower Controllers for reporting adverse weather conditions*

c) Whenever a pilot reports wind shear conditions to ATC, the information shall be passed to subsequent arriving and departing aircraft.

f) iii. During bad weather and when departing aircraft are not able to follow the standard instrument departure instructions and also the arrivals, if carrying out a missed approach are unable to follow the standard missed approach procedure, the dependent mode of arrival and departures on the other runway and accordingly separation standards as applicable to dependent mode of operation, shall apply.

1.17.1.2 ATC CIRCULARS

On 13th Jun 2023, GM (ATM) IGIA issued ATC Circular 40 of 2023 on "Standard Operating Procedure (SOP) for Four Runway Operations at IGI Airport, Delhi (Trial operations from 13-07-2023 to 12-10-2023)" which was later regularised through ATC Circular 96 of 2023 dated 12th Oct 2023. Circulars are attached as Annexure 'D' to this report.

Para 4 ***Westerly mode: Four Runway westerly operation***

Para 4.1 ***Runway usage plan***

<table>
<tr><th colspan="2">Westerly Flow</th><th>Remarks</th></tr>
<tr><td rowspan="2">Northern Runway System</td><td>Runway 27 - Arrival</td><td rowspan="2">• Runway 27 and Runway 28 in segregated dependent mode.
• Departures from Runway 28 are dependent on the position of arrivals on Runway 27.
• Departures from Runway 28 are independent of aircraft movement on southern Runway system.</td></tr>
<tr><td>Runway 28 - Departure</td></tr>
<tr><td rowspan="2">Southern Runway System</td><td>Runway 29R - Departure</td><td rowspan="2">• Runway 29R and Runway 29L in segregated dependent mode.
• Departures from Runway 29R are dependent on the position of arrivals on Runway 29L.
• Departures from Runway 29R are independent of aircraft movement on northern Runway system.</td></tr>
<tr><td>Runway 29L - Arrival</td></tr>
</table>

As per the ATC Circular 96 of 2023, the two Runways within the Runway system (Northern and Southern) are dependent on each other.

Para 7.4. *Time-Based Spacing (TBS)*

vii. For Releasing departures from Runway 29R, the take-off clearance may be cancelled if the departure has not commenced its take-off roll and the succeeding arrival on the dependent Runway has a Time to Threshold (TTT) value of 01:30 (90 seconds).

Note 2: While issuing the take-off clearance, the controller should keep in mind various factors like the position of aircraft, its state of readiness, time taken in issuing the clearance, the read-back time, and the pilot reaction time etc.

Para 8*. Dependency between Departures and Departures*

Para 8.1 *Simultaneous departures are permitted from any runway of Northern Runway System and another runway of Southern Runway System, when the departures are following the published RNAV SIDs or Non RNAV instructions, except when: i. There is bad weather in the Approach and/or take-off path.*

At the time of the incident, Runway 28 was not available due to rehabilitation work and Runway 27 was being used for mixed mode operations.

The safety assessment for the "Operationalization of Fourth Runway 11L/29R, associated taxiways, Eastern link taxiways, Four Runway Operations and associated operating procedures" conducted by GM(ATM) IGIA on 6 June 2023. The hazards identified during the safety assessment were not related to IAL and SID Procedures Runway 29L and 29R respectively.

1.17.2 DELHI INTERNATIONAL AIRPORT LIMITED (DIAL)

Delhi International Airport Limited (DIAL) is the airport operator responsible for managing Indira Gandhi International (IGI) Airport. The IGI airport was previously managed by the Airports Authority of India (AAI). In 2006, as part of a public-private partnership, the Airports Authority of India ("AAI") and Delhi International Airport Limited ("DIAL") entered into Operation, Management and Development Agreement ("OMDA"), pursuant to which DIAL was entrusted to develop, finance, design, construct, modernise, operate, maintain, use and regulate the Indira Gandhi International Airport.

During introduction of runway 29R/11L, the Safety Assessments for Design, Execution and Commissioning Level was done by DIAL. DGCA approved commissioning of fourth Runway 11L/29R in Departure mode only along with associated taxiways at IGI Airport, New Delhi vide DGCA letter AV.20025/0l/2006-AL dated 12.06.2023. AIP Supplement 73 of 2023 dated 31 May 2023 was issued for commissioning of new Runway 29R/11L w.e.f 13 Jul 2023. A new runway 29R/11L was operationalized w.e.f. 0431 UTC of 14 July 2023 and the existing runway 29/11 was renamed as 29L/11R. Runway 29L/11R and 29R/11L were separated by 360 m.

On 13th Jun 2023, AAI issued ATC Circular 40 of 2023 on "Standard Operating Procedure (SOP) for Four Runway Operations at IGI Airport, Delhi (**Trial** operations from 13-07-2023 to 12-10-2023). Before the completion of this trial operations, DIAL had decided to temporarily close the Runway 10/28 for resurfacing work for approximately 3 months from 11th September 2023 to 15th December 2023 and a prior notification was issued through AIP Supplement 124 of 2023 dated 27 Jul 2023.

Following the review of feedback on the SOP received from the stakeholders, the ATM office at IGIA concluded that there was no need to introduce any amendments or modifications to the existing SOP. Accordingly, the existing SOP for four-runway operations at IGIA, New Delhi, was regularized effective from 13/10/2023 through ATC Circular 96 of 2023.

1.17.3 TATA SIA AIRLINES LTD. (VISTARA AIRLINES)

Vistara is a Schedule Airline Operator which was a joint venture of Tata Sons Private Limited and Singapore Airlines Limited (SIA). It had corporate headquarters in Gurugram, Haryana. Its fleet included A320neo, Airbus A321neo and Boeing 787-9.

1.17.4 INDIA METEOROLOGICAL DEPARTMENT (IMD)

India Meteorological Department (under the Ministry of Earth Science, Government of India) is the national agency in India, which is responsible in all the matters pertaining to meteorology in civil aviation. The technical coordination and overseeing of the functions of the aviation meteorological offices is done by Central Aviation Meteorological Division (CAMD), at DGM New Delhi. Aviation services are provided for National and International flights for safe and efficient operations in terms of take-off, landing and en-route forecasts. These services are provided through a network of Meteorological Watch Offices (MWOs) functioning at four international airports at Chennai, Kolkata, Mumbai and New Delhi and other Aerodrome Meteorological Offices (AMOs). Aerodrome Meteorological Offices functioning at Mumbai, Kolkata, Delhi and Chennai airports also serve as Meteorological Watch Offices (MWOs). The Aerodrome Meteorological Offices provide the airports specific current weather reports, forecasts and warnings for safety, economy and efficiency of aircraft operations.

The web-based information dissemination system known as On-line Briefing System (OLBS) of IMD is being maintained by the meteorological offices functioning at MWOs Chennai and New Delhi, through which the registered users can directly download the forecast products as desired. Apart from the primary communication channels of AAI, the department has all advanced communication modes for the dissemination of aviation information.

The IMD published its first consolidated SOP (in March 2021) on aviation meteorological services for the use by aviation meteorological offices. As per the SOP, AMO has the responsibility to supply low level wind shear information to aeronautical users. The various provisions of the SOPs which pertains to the detection of wind shear are appended below:

Para 6.4.3 Detection of Wind Shear

Evidence of the existence of wind shear shall be derived from:

1. *Ground-based wind shear remote-sensing equipment, for example, Doppler Radar;*
2. *Ground-based, wind shear detection equipment, for example, a system of surface wind and/or pressure sensors located in an array monitoring a specific runway or runways and associated approach and departure paths;*
3. *Aircraft observations during the climb-out or approach phases of flight to be made in accordance with the provisions of*
4. *Aircraft Observations and Reports*

6.4.10 Cancellation of Wind Shear:

Wind shear warning for arriving aircraft and/or departing aircraft shall be cancelled when aircraft reports indicate that wind shear no longer exists, or alternatively after an elapsed time of two hours.

Wind shear reports received by ATC through arriving or departing aircraft were transmitted to the Meteorological office IGIA because wind shear warning radar/instrument was not yet installed at the IGI Airport.

1.17.5 ETHIOPIAN AIRLINE

Ethiopian Airlines is the flag carrier of Ethiopia. It was founded on 21 December 1945 and commenced operations on 8 April 1946. Ethiopian Airlines has its head office at Bole International Airport, Addis Ababa. Airline serves on both domestic as well as international destinations with their mixed fleet of Airbus and Boeing aircraft.

1.18 Additional Information

1.18.1 SMS Manual, Air Traffic Services

The AAI provided its Safety Management System, IGIA Manual to the investigation team. It was observed that the SMS Manual (Issue 4) pertaining to Air Traffic Services applicable for IGI airport was approved by GM, CNS, IGI airport and made effective from 19.04.2024. Relevant portion of the SMS manual is appended below: -

Chapter 7 'Safety reporting and remedial actions', Para 7.2.6 of the SMS manual provides procedures for Safety occurrence/incident reporting. Some of the relevant paras are appended below:

……..

Incident/Accident should be immediately informed on telephone to Member (Ops), ED (Ops) giving all available details;

- DGCA should be informed within 24 hours of an accident occurrence and within 48 hours of an incident;
- No vehicles or equipment shall be removed from the accident site as far as possible, till the time investigation is over. In case the accident/incident involves the aircraft, no evidence shall be tampered till the time clearance is given by the DGCA or appropriate authority.

……..

1.18.2 Surveillance and ATM Automation

The ATM Automation System installed at DATS Complex, IGIA New Delhi is designed to enhance the safety and efficiency of air traffic management. This advanced system integrates a variety of surveillance sensors, including radars, ADS-B, and Multilateration systems (WAM/MLAT*), along with weather data and flight planning information to provide air traffic controllers with comprehensive situational awareness. The system has been in use at IGIA since August 2, 2019.

The ATM Automation System is integrated with nine MSSR and nine ADS-B, providing surveillance coverage over the majority of Delhi FIR's airspace. Data received from the aircraft via ADS-B and Mode-S is also being processed by the System. The system generates many alerts based on information obtained from the integrated sensors as well as information received from the aircraft. The generated alerts relevant to the subject incident are as appended below:

The Short-Term Conflict Alert's (STCA) which is indicated by red colour box around the data block of the aircraft on controllers' situation display. The goal of STCA is to prevent conflict situations between two aircraft early enough to carry out the required controller actions. The STCA takes both lateral and vertical motion, as well as speed and level, into account. STCA functionality operates by continuously monitoring the positions and trajectories of aircraft within controlled airspace. The system uses sophisticated algorithms to predict future positions based on the current speed, heading, and altitude of each aircraft. When the system identifies a potential conflict, where the predicted paths of two or more aircraft would violate established separation standards, it generates a warning/alert, as applicable.

TCAS Alert which is indicated red coloured text TRA in track label when the track receives the related item, from ASTERIX cat 48 or cat 20 messages.

Differential Time Based Spacing using Time-To-Threshold (TTT) was available on A-SMGCS display to ADC controllers for managing aircraft spacing during ILS approaches. Display provided TTT for arriving aircraft which were carrying out ILS approaches, provided A-SMGCS, concerned surveillance sensors, and Situation Data Display (SDD) were serviceable. On the day of the incident, all the prerequisite for TTT information were meeting, therefore, TTT information for arriving aircraft on Runway 29L was available to ADC S-2 controller on A-SMGCS Display which was an essential requirement to release the departure from Runway 29R.

Multilateration (MLAT) system: A group of equipment configured to provide position derived from the secondary surveillance radar (SSR) transponder signals (replies or squitter's) primarily using time difference of arrival (TDOA) techniques. Additional information, including identification, can be extracted from the received signals.

1.18.3 Air Traffic Control Work Stations

The workstation was set up with a number of displays to help both ADC-S1 and ADC-S2 controllers to monitor and direct the movement of aircraft, manage communications and gather information to assist pilots.

Fig 17: Layout of ADC-S1 workstation

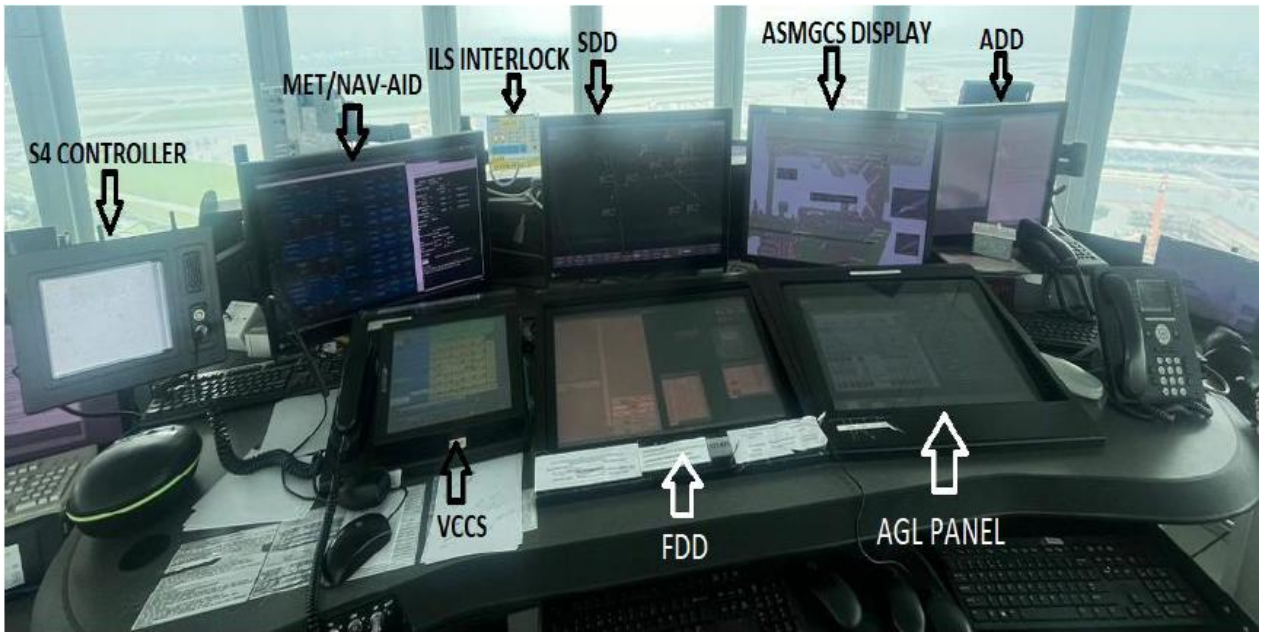


Fig 18: Layout of ADC-S2 workstation

Screens and Panels installed at workstations to assist ADC controllers:
VCCS

The voice communication control system (VCCS) is a voice switching and control system for networking the communication system. It provides the operating personnel on the ground with communication access to each other and to the air to ground radios that communicate with the airplanes.

FDD

It displays information concerning flight plans not supplying display of data on air situation. It allows controllers to perform adjustments on flight plans and other significant data. The primary data managed by the subsystem is flight plan data. Flight plan data is displayed in EFS and Lists.

SDD

SDD provides a digital of the images as seen by the surveillance sensors to derived from the Flight Plans of the aircraft for which the controllers are responsible. Flights are shown with all the relevant flight data.

ADD

ADD is an extension of FDD (where available). On pressing INFO and NOTAM buttons in FDD, the corresponding windows open in ADD screen. The relevant aeronautical data is made available in ADD.

A-SMGCS

A-SMGCS system is used to augment visual observations of traffic on the manoeuvring area and to provide surveillance of traffic in area of its coverage.

ILS INTERLOCK

The switch is used for effecting selection of ILS for a particular Runway. Interlock Switching Mechanism performs switching between Reciprocal ILS.

MET/NAV-AID

MET display is available to display current METAR, RVR information, Wind information as received from IMD. NAV Aid display is available to display operational status (serviceable/unserviceable) of ILS. VOR and DME.

S4 CONTROLLER

Standalone VHF equipment in ATC units is provided as a backup for the analog and VoIP based VHF communication integrated in VCCS system.

AGL PANEL

ADC and SMC position in ATC Tower is provided with an AGL control system panel to control ground lights in the respective jurisdiction of the controller.

1.18.4 Past Recommendation by AAIB on ATC Workstations Recording

VHF and HF communication held between aircraft and ATC units are being recorded and preserved by the respective ATC stations subsequently an event occurs. However, it has been noted that currently AAI has not implemented any provision regarding recording and preservation of background communication and aural environment at different ATC units. Further, Chapter 3 of ICAO Annex 11 and DGCA CAR Section 9 Series E Part 1 has already underscore the requirement for such recordings.

To comply the said recommendation of ICAO and DGCA, AAIB recommended AAI to create infrastructure for recording with necessary storage and retrieval facility in earlier Investigation Report.

The recommendation from the previous serious incident is quoted below:

Serious Incident of Airprox between two A320 aircraft VT-ITD (IGO455) and VT-ISV (IGO246) operated by M/s IndiGo near Kempegowda International Airport, Bengaluru on 7 January 2022

Safety Recommendation 4.2: 10) It is recommended that AAI should implement the recommendation as given in para 3.3.3 of Chapter 3 of ICAO Annex 11 (Air Traffic Services) and para 3.3.4 of DGCA CAR Section 9 Series E Part 1 on equipage of Air Traffic control units with devices that record background communication and the aural environment at air traffic controller workstations.

1.18.5 Interview /Statements/Air Safety Reports

During the course of investigation, statements of Vistara's Crew and IMD-IGI airport & AAI officials were recorded for the investigation purpose. Statements of different personnel relevant to this investigation have been summarized below:

Brief of Statements of Flight Crew of VTI 946:

The flight crew of VTI946 reported adverse weather during the final approach, which caused their speed to increase by more than 15 knots above the approach speed, resulting in an unstable approach. While they initially suspected wind shear, no system warnings appeared. They initiated a missed approach using a wind shear manoeuvre but quickly transitioned to a standard missed approach.

During the missed approach, they noticed ETH689 (B788) taking-off from Runway 29R. ATC provided no traffic information or instructions. Following the published missed approach procedure, they climbed to 2,600 feet, but ATC issued a call to stop at 2,000 feet. By then, they had already surpassed 2,400 feet and received a TCAS Resolution Advisory (RA) to descend, as ETH689 turned left towards them. After resolving the conflict, they climbed back to 2,600 feet.

Shortly after, ETH689 turned towards them again, triggering a second TCAS RA to level off. ATC gave no further instructions except to report when clear of the conflict. The aircraft was then vectored for an ILS approach to land on Runway 29L.

The TCAS RA report indicated that during the first RA, the intruder aircraft was at their 2 o'clock position, and during the second RA, it was at their 10 o'clock position, with a separation of less than 1 NM.

Air Safety Report filed by the Captain of ETH 689

Quote

"Departing DEL 29R on SID Dudum6C, shortly after departure and turning left following the SID to waypoint DP666 while climbing to 4,000 feet, ATC instructed us to maintain 2,600 feet. The controller then shouted at us to turn right to heading 270. A conflict aircraft was spotted visually at our 1 o'clock position on an obvious converging flight path. It became clear that an aircraft landing on 29L was performing a go-around. The captain took control, disconnected the autopilot, and made an immediate right turn away from the conflict. This was followed shortly by a climbing TCAS RA, with the traffic 200 feet below the aircraft. TCAS cleared us of the conflict at approximately 3,000 feet. Shortly thereafter, another TCAS RA advised 'monitor vertical speed' as the conflict aircraft passed 400 feet below, from right to left, while the controller instructed us to climb to FL70. It was obvious that the controller had lost situational awareness and panicked. His instructions exacerbated the situation."

Unquote

No statements were provided by the flight crew of ETH689. However, an Air Safety Report was filed as mentioned above.

Statements by the controllers:

ADC-S1 Controller:

When VTI 946 informed him (ADC-S1 controller) that it was going around, this information was passed to the APAD controller and subsequently informed VTI946 that ETH689 departure traffic from the adjacent runaway 29R got airborne. The controller called again VIT946 and instructed to change to APAD Frequency. It was admitted by ADC-S1 controller that he missed meteorological briefing before taking over ATC watch.

ADC-S2 controller

The controller stated that due to weather conditions, there was a dependency between departures from Runways 27 and 29R and congestion was present at the holding point for Runway 29R. ETH689 had reported readiness for departure after holding for over 5 minutes due to wind shear.

The controller stated that ETH689 lined up on Runway 29R and shortly after this take-off clearance was issued. The Time-To-Touchdown (TTT) information for VTl946, which was arriving on Runway 29L, was 1 minute 45 seconds. After ETH689 became airborne, it was handed off to the Approach Departure Controller.

He was later informed by the ADC-S1 controller that VTI946 had initiated a go-around (balked landing). However, since ETH689 had already been transferred to the Approach Departure Controller, he could not provide essential traffic information regarding VTl946 to ETH689.

In his subsequent statement, the controller clarified that he became occupied with planning the departure sequence for multiple aircraft at the holding points of Runway 29R while considering the dependency of departures from Runway 27. He also clarified that he was required to take care of the traffic which were required to cross runway 29R for proceeding to their passenger terminals.

APAD Controller:

The APAD controller stated that ETH689 via DUDUM 6C departure came in contact while climbing to 4000 feet. At the same time, the ADC-S1 controller informed that VTI946 was conducting a missed approach from Runway 29L. He observed on rada

r that VTI946 was passing 2400 feet and climbing, so he advised the Tower (ADC) to issue a higher climb clearance to VTI946.

During the investigation of the incident, the controller clarified that reason for confirming level through ADC-S1 in place of using own situation display was due to present position symbols (PPS) of both aircraft had merged and overlapped on the radar display, preventing proper identification and made it difficult to confirm the levels.

Controller observed that ETH689 was appearing to turn left and conflicting with VTI946. He (APAD) instructed ETH689 to stop climbing at 2600 feet and to turn right to heading 270. VTI946 came into contact and reported performing a TCAS RA manoeuvre. He asked VTI946 to report clear of the RA. Upon observing VTI946 descending to 2200 feet and reporting clear of the RA, he instructed ETH689 to climb to FL070.

The controller further stated that he reported the incident to the Watch Supervisor Officer (WSO) and requested to get relieved. However, he was only relieved after completing the assigned slot time.

During ATC tape replay it was observed by the investigation team that APAD controller was irritated with the ADC-S2 Controller and multiple times instructed ADC-S2 controller on intercom to corelate the flight plan of VT-VRR. In response to this, APAD controller had clarified that the flight plan of the aircraft handed over to him was not correlated and therefore, he was unable to input the cleared flight level (CFL), and moreover the aircraft was likely to enter another sector and this situation made him uncomfortable.

WSO:

The APAD controller was relieved as soon as a reliever was arranged from the available Approach Radar controllers after receiving the information in the office.

1.18.6 Human Factors:

1.18.6.1 Situational awareness and working memory

Situational awareness is defined as “the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future”.

Air traffic controllers must create and maintain a transient, dynamic pictorial representation (mental image) of the airspace under their control. The controller's environment is characterised by a continuous sequence of ever- changing, transient information." They must continuously process transient information to ensure that aircraft remain separated by the appropriate minima, and then discard the information.

Controllers must first perceive air traffic information using different displays in front of them. They must then establish the relevance of this information to identify conflicts between aircraft and, finally, use this information to project future states and events to ensure the required separation is maintained between aircraft.

Shortcomings may occur at all 3 levels of information processing, particularly when processing resources are limited, workload is high, or distractions break the flow pattern of ongoing activities and result in incomplete or inadequate situations assessments.

1.18.6.2 Attention and workload

Accurate situational awareness is highly dependent on attention to different aspects of the work environment. A person's ability to divide their attention is limited, and increased workload can adversely affect their ability to perceive and evaluate information from the environment.

Workload is a function of the number of tasks that must be completed within a given amount of time. If the number of tasks that must be completed increases, or if the time available to complete them decreases, the workload increases. Task saturation occurs when the number of tasks to be completed in a given time exceeds someone's capacity to perform them, and some tasks must be shed or deferred as a result.

Increased workload can lead to attention narrowing or tunnelling. This means that a person lacks in on certain cues or features of the environment they are trying to process, and may thus inadvertently stop scanning the whole environment. In some cases, people may unintentionally focus on the information they believe is most important. In other cases, people may fixate on certain information and forget to reinstate their information scan. Either situation can result in their situational awareness being inaccurate.

Interruptions or distractions can compete with other tasks, increases workload, and divert attention from higher priority tasks. This lapse of attention may result in omitting to do something, such as detecting possible conflicts, or not correcting the resulting abnormal condition or configuration.

1.18.6.3 Automation and working memory

If attention is not sustained, information is forgotten from working memory in approximately 15 seconds. Working memory is particularly impacted when distracting or concurrent events demand attention. Although air traffic controllers have the status of relevant aircraft flight information available on their displays, there are occasions when their attention is directed to tasks that are not related to controlling aircraft, such as providing the weather to a pilot or solving technical issues with air traffic service equipment.

Information loss from working memory is also impacted as workload increases. As workload increases in volume and complexity, recalling one's current plan, such as resolving a possible conflict identified earlier, becomes more challenging.

Cues available for working memory, such as SDD and FDD, assist a controller in processing information by reducing workload and supporting their memory for immediate and future traffic situations.

1.19 Useful or effective investigation techniques

None

2. ANALYSIS

2.1 The Incident Aspects

At the time of incident, three runway westerly mode of operation was in progress in which Runway 29L and Runway 29R were being used exclusively for arrivals and departures respectively whereas Runway 27 was being used in mixed mode i.e. both for arrival and departure. Departure from runway 29R were dependent on the position of arriving aircraft on Runway 29L, as well as on departures from Runway 27 due to weather constraints. To ensure safe operations, the departing aircraft from Runway 29R was required to begin take-off roll before the following arrival on Runway 29L reached a Time-To-Touchdown (TTT) of 1:30 (90 seconds).

Both the APFD and ADC-S1 controllers passed wind shear information, reported by one of the preceding arriving aircraft, to VTI946. As a result, the flight crew of VTI946 anticipated a possible wind shear on final approach to Runway 29L. When VTI946 contacted the ADC-S1 controller, he issued landing clearance and also passed information about the wind shear report from the preceding aircraft.

Meanwhile, ETH689, positioned on Taxiway P6, was instructed to line up on Runway 29R. When ETH689 was cleared for take-off by the ADC-S2 controller, VTI946 had a Time-To-Touchdown (TTT) of 1:48. As ETH689 approached Runway 29R, the TTT for VTI946 had already reduced to 1:30, but the controller did not respond to the situation, despite the commencement of the take-off roll after this point was the violation of the SOP-specified for minimum TTT value. At this stage, the ADC-S2 controller had an opportunity to cancel the take-off clearance. Had the take-off clearance been cancelled, the incident could have been avoided. However, the controller did not cancel the clearance, and ETH689 departed at 0445.

VTI946 encountered adverse weather on final approach, causing the aircraft to accelerate more than 15 knots above the approach speed, resulting in an unstable approach and a subsequent go-around, while ETH689 had already departed from Runway 29R. VTI946 followed the missed approach procedure, turning left to intercept R-250 from DIG VOR and climbing to 2600 feet, while ETH689 followed the DUDUM 6C SID, climbing to 4000 feet. This created a conflict situation, triggering a Short-Term Conflict Warning (STCW) on the APAD controller's situation display.

The ADC-S1 controller (Runway 29L) detected the emerging conflict and provided traffic information to VTI946, which was already responding to a TCAS Resolution Advisory (RA). VTI946 visually identified ETH689 at their 2 o'clock position. The first TCAS RA was triggered when horizontal separation reduced to 0.6 NM and vertical separation to 300 feet, as displayed on the APAD controller's situation display.

The ADC-S1 controller informed the APAD controller about the go-around. The APAD controller, panicking upon realizing the conflict, attempted to confirm VTI946's altitude through ADC-S1 instead of resolving the conflict directly with ETH689, which was in contact with him. The controller instructed ETH689 to stop climbing at 2600 feet and turn right to a heading of 270, but the flight crew incorrectly read back the instructions. However, they executed the right turn as intended by the APAD controller.

These instructions worsened the situation. If ETH689 had continued its climb to 4000 feet as per the original clearance, the proximity between those aircraft might have not been reduced significantly. Furthermore, avoiding the right turn could have prevented the second TCAS RA, as ETH689 had already crossed VTI946's path and was on a diverging track. The separation between the aircraft decreased to 0.2 NM horizontally and 400 feet vertically, with both aircraft executing second TCAS RA advisories.

2.2 Situational Awareness Aspect

2.2.1 ADC-S2 Controller

The ADC-S2 controller's workload was heavy and complex. The ADC-S2 controller experienced cognitive overload due to the simultaneous management of multiple tasks, including pressure from the APAD controller to correlate the flight plan with VT-VRR and hold departures until the correlation was completed. This was further compounded by managing seven departing aircraft in the queue, monitoring the positions of arriving aircraft on Runway 29L and

departing aircraft from Runway 27 due to adverse weather conditions, managing the crossing of Runway 29R by aircraft that had landed on Runway 29L and were taxiing to the passenger terminal, and simultaneously ensuring the separation between departing aircraft. As a result of this high cognitive overload, the ADC-S2 controller fixated on the clearing the departures which were on hold and this impacted his information scan. At this juncture, the controller had likely lost his situational awareness and therefore did not cancel the take-off clearance for ETH689, even though the TTT value for the following arrival, VTI946, was not meeting the prescribed minimum requirement.

2.2.2 ADC-S1 Controller

The ADC-S1 controller, while maintaining situational awareness of the traffic, delayed transferring communication of VTI946 to the APAD controller due to being engaged on the intercom with the APAD controller and addressing the TCAS RA issued to VTI946.

2.2.3 APAD Controller

Meanwhile, the APAD controller, already in a slightly agitated state, panicked upon seeing the PPS of both aircraft merging on radar display after receiving the go-around message from the ADC-S1 controller. The high-pressure situation likely contributed to cognitive overload and a loss of situational awareness for the APAD controller.

Since the ADC-S2 controller was managing multiple tasks and was also coordinating with the APAD and ADC-N controllers before granting departure clearance, he did not check the TTT of arriving aircraft at the last moment before ETH689 was cleared for take-off from Runway 29R. According to research by George A. Miller, human short-term memory can process only 7 (±2) chunks of information at a time. Given the high workload, the ADC-S2 controller likely could not process all this information effectively, which contributed to the take-off clearance for ETH689 not being cancelled.

Investigation also revealed that since VTI946 and ETH689 were operating at two different tower frequencies, therefore, once the VTI946 conducted a go around, flight crew unaware of each other's positions realised the threat once both aircraft received a TCAS alert.

2.3 SIDs and Instrument Approach Procedures Aspects

Ethiopian aircraft ETH689 departed from Runway 29R and followed the DUDUM6C SID, which is a standard route for west bound flights and requires a left turn to join the route. After getting airborne the aircraft faced a conflict with Vistara aircraft VTI946 conducting a missed approach from the closely spaced parallel Runway 29L. The predefined left turn in the SID brought the departing aircraft into potential conflict with the missed approach path, as the projected path of both aircraft converged at similar altitudes. This left little time for the controller to detect and resolve the conflict. The situation posed an inherent safety risk, which could have been identified and addressed during the safety assessment for the "Operationalization of Fourth Runway 11L/29R, associated taxiways, Eastern link taxiways, Four Runway Operations, and associated operating procedures," conducted on 6 June 2024. And during safety assessment, the overall safety magnitude of the change was assessed 'MINOR'.

Although the Safety Case Assessment and Reporting System (SCARS) of AAI conducted at the design, concept and execution level identified the hazard 'loss of separation' in case of "Departures from RWY 11L/29R will be crossing the Missed approach path of the arrival going around from RWY 11R/29L". But this hazard was rated 3 on the scale and mitigation proposed was to 'compliance of Standard Operating Procedures and passing of essential traffic information'.

It has been observed that during assessment, although the missed approach scenario was identified as a hazard for closely located runways but other factors such as errors by crew during missed approach and delay of relevant information or instructions by the controllers were not taken into consideration, which can further aggravate the situation.

2.4 Standard Operating Procedure (SOP) Aspects

The Standard Operating Procedure (SOP) for Four Runway Operations at IGI Airport, Delhi (Westerly mode) required the ADC-S2 controller to manage departures from runway 29R based on the position of arriving aircraft on runway 29L. It allowed simultaneous departures from runways 29R and 27, provided aircraft followed RNAV SIDs or non-RNAV instructions. However, during the incident, the APAD controller instructed the release of departures from

runway 29R based on departures from runway 27, despite no documented SOP for this condition. Runway 27 was located behind the ADC-S2 controller's position, making situational awareness dependent on coordination with the ADC-N controller and monitoring the A-SMGCS. While this worked under normal conditions, the overload presented a potential for increased risk of failure, as there were no safeguards in place for such scenarios. However, designing a SID for runway 29R and missed approach runway 29L to ensure initial positive separation would have allowed the controller more time to intervene and resolve the conflict.

2.5 Duties, Responsibilities and Teamwork aspects

The intercom conversation between the ADC-S2 and APAD controllers reveals a lack of teamwork, as the ADC-S2 controller due to his gradient difference hesitated to communicate the situation clearly to the senior APAD controller. The fear of reprimand in a high-stress environment can result in incorrect decisions or delays in responding to critical situations, potentially compromising safety. This contributed to the ADC-S2 controller's inability to notice an evolving unsafe situation, wherein ETH689 was allowed to commence its take-off roll even though the succeeding arrival on the dependent Runway 29L had a TTT value of less than 01:30 (90 seconds).

In addition, meanwhile the ADC-S2 controller was trying to correlate the Flight Plan, his workload was continually increased as the traffic was building up at departure and their holding time was also increasing. One Thai Airways aircraft was also waiting for clearance for taxing out to the passenger terminal.

According to MATS-2, one Alpha controller who was supposed to assist the ADC controller. He was also not available at the workstation when the controller was struggling with the Flight plan issue. The duties entrusted to Tower alpha controller are assisting the Tower Controller and the Tower Supervisor in meeting situation objectives.

Further, according to MATS-2, the duties and responsibilities defined for Tower Co-ordinator has clearly stated that the Tower Coordinator has to facilitate coordination between individual controller viz ADC, SMC, CLD and departure planning controller to improve overall situational awareness. In addition to this, Tower Coordinator was also entrusted with the responsibilities of coordination with arrival/final radar controller and DEP radar controller for spacing planning and expediting departures and arrivals on the principle of least average delay. Focus on the bigger picture i.e on the overall traffic situation- both Departures and Arrivals taking active role in the planning process and strategic and tactical decision making to ensure maximum efficiency. It further emphasised on monitoring and helping individual controllers to find solutions to any build up of traffic with ADC.

Lack of coordination and non-assistance by Tower Supervisor/Tower Coordinator and Alpha Controller when the ADC-S2 was struggling with the Flight Plan and subsequently traffic built up at departure shows there was a lack of teamwork between different units. Assistance by a second controller to alleviate the ADC-S2 controller's workload could have avoided the situation where he lost his situational awareness.

The tower supervisor/coordinator did not adequately monitor the developing situation and did not observe that the level and complexity of current and anticipated traffic at dependent departure had increased. As a result, no steps were taken to alleviate ADC-S2 controller's workload.

If tower supervisor does not adequately monitor controller workload in complex situations with high traffic levels, workload may exceed controller limits, increasing the risk of adverse consequences, such as a loss of separation.

The serious airprox/TCAS RA incident occurred between 04:46 and 04:48, yet the controller was not relieved until 05:20. During such critical events, controllers can experience high stress and overload, impairing decision-making and potentially impacting aircraft safety. Prompt relief is essential to help the controller regain composure. The WSO should have arranged for a relief as soon as possible rather than waiting for the assigned duty slot. Better team resource management could have ensured an earlier relief and maintained operational effectiveness.

2.6 Communication and its Recording Aspects

When two individuals are seated side by side in close proximity, it is a natural tendency to communicate directly rather than using any other medium. The ADC-S1 and ADC-S2 controllers, seated side by side, coordinated verbally without using the intercom. The ADS-N was seated behind the ADC-S1 and ADC-S2 controllers, still in close proximity. Although ATC instructions existed for the use of the intercom for ATC messages, however, non-adherence to these instructions is common due to the human tendency to opt for more expedient coordination without extra effort when people are in close proximity. Similarly, coordination with the Tower Supervisor was done verbally, which resulted in

a loss of an evidence regarding coordination between the ADC controllers, and between the ADC controllers and the TWR Supervisor, who played a crucial role in the safe and efficient functioning of Aerodrome Control. Had ATC units been equipped with devices that recorded background communication and the aural environment at air traffic controller workstations, it could have captured overall communication held in the ATC tower. This facility could have assisted in the investigation of the incident and, in turn, helped prevent similar incidents caused by intra-unit communication errors.

During one of the investigations, a similar finding was made in the "Investigation Report of the Serious Incident of Airprox between two A320 aircraft, VT-ITD (IGO455) and VT-ISV (IGO246), operated by M/s IndiGo, near Kempegowda International Airport, Bengaluru on 7 January 2022." It was recommended that AAI implement the recommendations outlined in para 3.3.3 of Chapter 3 of ICAO Annex 11 (Air Traffic Services) and para 3.3.4 of DGCA CAR Section 9 Series E Part 1, which pertains to the equipage of Air Traffic Control units with devices that record background communication and the aural environment at air traffic controller workstations. However, the same Recommendation is still pending and not complied by AAI.

Further to this, it was observed that the APAD, ADC-S1 and ADC-S2 controllers were using local language and thus not coordinating in aeronautical English which lacked clarity and took more time in effective communication. Using any language instead of aeronautical English in ATC communication can compromise aircraft safety by reducing precision, increasing the time taken to convey instructions, and potentially causing misunderstandings. It also limits situational awareness for other team members and non-compliance with requirement given at para 35.7.2 of MATS-2.

ATIS recording was also not preserved by AAI at IGIA due to interdepartmental communication issues. Further communication between ATC and Meteorological Office was not recorded due to unserviceability of Harmony recorder from the period 05.08.2023 to 18.11.2023 and therefore, recording of passing any information from Tower Supervisor to Meteorological office could not be confirmed. The prolonged non restoration of recording services revealed that AAI lacks SOPs for handling situations where the recorder becomes unserviceable.

TEFS recording were not available at the time. Therefore, many of the safety critical information about the movement of EFSs were not provided.

Investigation into this serious incident revealed that, at multiple levels, either due to unserviceable devices or non-compliance with regulations, a device was either not recording or not installed to capture the communication, and therefore, the data was neither available nor could it be preserved for investigation purpose.

2.7 Adverse Weather Condition Aspects

Wind shear was reported by the arriving aircraft AI 806 on Runway 29L, but this information was not passed to the subsequent arriving aircraft, THA323, by either the ADC-S1 or APAD controller, which did not comply with para 7.15.1 of MATS 1. This provision requires that wind shear information be communicated to all relevant aircraft until the condition confirms no longer wind shear exist or else included in the ATIS. The ATIS recording was not preserved, and the wind shear information was not included in the ATIS, as confirmed by the Tower Supervisor. Additionally, the wind shear report was not transmitted to the Meteorological Office, as required by para 11.2.11 of MATS 2. The Meteorological Office, lacking wind shear detection equipment, relied on pilot reports relayed through ATC.

Controllers were required to undertake meteorological briefings as per para 11.3 of MATS 2; however, not all controllers completed the briefing. The ADC-S1 controller, who received the wind shear report, had not taken this briefing before joining his workstation. Even among the controllers who completed the briefing, it is unclear what specific information was covered during their MET briefing. The absence of an automated self-briefing system for meteorological conditions further compounded the issue. Such a system could have facilitated more effective briefings and improved oversight by logging controller activities and generating summary reports for management.

2.8 ATM Automation Aspects

The information provided by the SDD and FDD contributes to a controller's situational awareness and is designed to assist controllers in early prediction of potential conflicts.

When the VTI946 was following the ILS, its flight data was being posted on the controller's display. The position of the arriving aircraft in respect to threshold was continuously depicted as TTT (Time-to-Threshold) for the awareness of the controller and to plan the departures accordingly.

According to the instructions laid down in ATC Circular applicable on the day of incident, the ADC controller was required to monitor the TTT of arriving aircraft on runway 29L before releasing the departure from Runway 29R. However, due to workload and traffic built up at departure, the ADC-S2 controller without realising that TTT had already crossed the set threshold value (01 minute 30 seconds), released the departure for take-off from Runway 29R. Once the aircraft was cleared for takeoff from runway 29R, the arriving aircraft VTI946 reported go around. At this stage, the controller realised that he should have waited for the landing of aircraft on runway 29L and held the departure under his control, as the TTT had already breached the minimum set value. Since the controller cleared the aircraft for take-off due to a loss of situational awareness, an automated system that alerts the controller when the Time-to-Threshold (TTT) reaches 01:30 seconds could have helped in cancelling the take-off clearance.

Due to the ATM system's inability to generate alerts on SDD for TTT breaches, the controller could not recognize the error during a period of high workload and operational complexity.

3 CONCLUSIONS

3.1 Findings

3.1.1 Licensing, Certification and Airworthiness

1. The air traffic controllers providing aerodrome, surface movement, and approach control surveillance services held valid licenses with appropriate ratings and were medically fit at the time of the incident.

2. The flight crew of both aircraft, VTI946 and ETH689, held valid licenses and medical certificates.

3. Both aircraft had valid certificates of airworthiness and were equipped with ACAS II (TCAS Version 7.1).

3.1.2. Aerodrome Infrastructure and Airspace Configuration

4. AIP Supplement 73/2023 was issued for the commissioning of new Runway 29R/11L effective from 13 July 2023. The new Runway 29R/11L was made operational from 0431 UTC on 14 July 2023. The existing Runway 29/11 was renamed Runway 29L/11R, and a distance of 360 meters existed between both runways.

5. ATC Circular 40/2023 detailing the "Standard Operating Procedure (SOP) for Four Runway Operations at IGI Airport, Delhi" was issued by AAI on 13 June 2023 for trial operations starting from 13 July 2023 to 12 October 2023.

6. ATC Circular 40/2023 and AIP Supplement 73/2023 established SOPs for four-runway operations beginning 13 July 2023.

7. The review of feedback from stakeholders on the SOP for four-runway operations at IGIA identified no need for amendments or modifications, and the existing SOP was regularized effective from 13 October 2023 via ATC Circular 96 of 2023.

8. Runway 10/28 was closed for resurfacing work from 11 September 2023 to 15 December 2023, as notified through AIP Supplement 124/2023.

9. The airport was operating in a three-runway westerly mode: Runway 29L for arrivals, Runway 29R for departures, and Runway 27 in mixed mode. Departures from Runway 29R were dependent on traffic on both runways; arrivals on Runway 29L and departures from Runway 27 due to weather conditions.

10. According to the SOP outlined in MATS-2, departing aircraft from Runway 29R were required to commence their take-off roll before the following arrival on parallel Runway 29L reached a Time-to-Touchdown (TTT) of 1:30 (90 seconds).

11. There were no documented SOPs for handling situations where Runway 29R departures were dependent on simultaneous operations both on Runway 29L and 27 under adverse weather.

3.1.3 Meteorological Context and Briefing Gaps

12. The meteorological report (METAR) issued at 0431 UTC by the India Meteorological Department indicated visibility of 1000 meters, forecasted to improve to 2000 meters, providing Category 1 conditions for safe operations.

13. Some air traffic controllers did not obtain meteorological briefings before assuming their watch, and AAI lacked effective mechanism to ensure that controllers had received meteorological briefings prior to commencing duty.

14. AIC806 reported wind shear at 1000 feet on ILS Runway 29L to the ADC-S1 controller and subsequently conducted a go-around. This information was passed to the APAD controller and Tower Supervisor, but it was neither communicated to the following aircraft THA323 nor it was included in the ATIS broadcast.

15. Wind shear report communicated by AIC806 was also not forwarded to the MWO at IGIA, which lacked a wind shear warning system. However, ADC-S1 relayed the same information to VTI946, allowing its crew to prepare in advance to handle any adverse weather phenomena during approach.

3.1.4. Flight Plan Management and Coordination among Controllers

4. The ATS Reporting Office issued a flight plan cancellation message (CNL) for VT-VRR, which was subsequently deleted from the EEP/OSS position. This deletion resulted in a loss of correlation between the flight plan of VT-VRR and its PPS. Consequently, the ADC-S2 controller was unable to correlate the flight plan, as it had been deleted and was in a terminated state. No controller had recorded taking over the watch at the EEP/OSS position during the shift period from 0200 to 0730 UTC.

5. The APAD controller exerted undue pressure on the ADC-S2 controller to correlate the VT-VRR Flight Plan, reflecting poor team coordination.

6. The junior ADC-S2 controller hesitated to communicate the situation clearly to the senior APAD controller.

7. The instructions and procedures underscored in MATS-1 and MATS-2 were not adhered and intercom facility was not utilized during communication leading to non-availability of recordings pertaining to co-ordination among different controllers. Similarly, coordination between ADC controllers and the Tower Supervisor/Tower coordinator was also not recorded due to the non-usage of intercom.

3.1.5. Controller Workload and Situational Awareness

8. The ADC-S2 controller experienced cognitive overload due to the simultaneous management of multiple tasks; including pressure from the APAD controller to correlate the flight plan with VT-VRR aircraft and hold all departures until completion of flight plan correlation; managing seven departing aircraft in the queue; monitoring the positions of arriving aircraft on Runway 29L and departing aircraft from Runway 27 in adverse weather conditions; managing the aircraft while crossing Runway 29R that had already landed on Runway 29L and were taxiing to the passenger terminal; and ensuring separation between departing aircraft.

9. The ADC-S1 controller delayed transferring of VTI946 to the APAD controller due to being engaged in handling the TCAS RA and ongoing intercom coordination.

10. The APAD controller, despite being informed of the go-around, attempted a conflict resolution by restricting VTI946's altitude, but this action of the controller was too late since both aircraft were already responding to TCAS alerts.

11. When VTI946 established communication, the APAD controller issued an inappropriate conflict resolution instruction, worsening the situation and triggering a second TCAS RA with minimum separation recorded was 0.2 NM horizontally and 400 feet vertically.

3.1.6. The Incident Sequence

12. VTI946 encountered adverse weather on final approach, resulting in an unstable approach and a subsequent go-around. The aircraft followed the missed approach procedure, climbing to 2600 feet, and at the same time, ETH689 began following the DUDUM6C SID, climbing to 4000 feet. The design of the missed approach procedure for Runway 29L and the DUDUM 6C SID did not ensure initial positive separation, leaving insufficient time for ATC to resolve the conflict. ETH689's turn after departing from Runway 29R created a conflict situation, triggering a Short-Term Conflict Warning (STCW) on the APAD controller's situation display.
13. Both VTI946 and ETH689 followed their respective TCAS RA advisories, resulted due to breach of separation (0.6 NM horizontally and 300 feet vertically). While flight crew of VTI946 was following RA, they had visual contact with ETH689.
14. After first TCAS RA conflict was resolved, a second TCAS RA occurred, with separation reducing to 0.2 NM horizontally and 400 ft vertically, due to the APAD controller's late and inappropriate instruction.
15. The flight crews of both VTI946 and ETH689 followed their TCAS RA respectively and had successfully avoided any probable collision.

3.1.7. Post-Incident Relief and Stress Management

16. The ADC-S1 and ADC-S2 controllers were relieved on time after the incident, but the APAD controller was not relieved promptly despite experiencing same mental stress during the incident.
17. AAI does not have a Critical Incident Stress Management (CISM) program in place for controllers, which could provide immediate and effective support to its controllers post traumatic or stressful events.

3.1.8. Deficiencies in Recording and Compliance

18. Controller workstations lacked devices to record background communications and the aural environment, violating ICAO Annex 11 and DGCA CAR Section 9 Series E Part 1.
19. ATIS recording was not preserved by ATS IGIA as there was no explicit requirement in MATS-1.
20. Tower Electronic Flight Strips (TEFS) were also not recorded.

3.1.9. Procedures on accident reporting and shifting of wreckage mentioned in Organization's SMS Manual are not according to prevailing regulations.

3.2 Probable Cause(s)

The serious incident of airprox occurred due to a loss of situational awareness of the Aerodrome Controller (ADC-S2), wherein an aircraft was allowed to take off from Runway 29R even though the arriving aircraft's Time-to-Threshold (TTT) had already breached the minimum set value of 90 seconds while approaching dependent parallel Runway 29L. Subsequently, the arriving aircraft, due to an unstabilised approach on finals, initiated a Go-around from Runway 29L and simultaneously the other aircraft got airborne from the parallel Runway 29R which consequently led to intersection of their projected flight paths.

3.3 Contributory Factors

The following are identified as contributory factors to the serious incident:

a) **Operational Interdependency and Complexity:**

The ADC-S2 controller's dependency, while issuing take-off clearance to aircraft under their jurisdiction, on the position of arriving aircraft on Runway 29L and concurrent operations on Runway 27 under adverse weather conditions created a complex and high-stress environment, increasing susceptibility to human error and compromising decision-making.

b) **Cognitive Overload on the ADC-S2 Controller:**

The ADC-S2 controller was required to manage multiple simultaneous safety-critical tasks at a very busy airport resulted in cognitive overload. This impaired the controller's ability to effectively prioritize actions and respond to critical situations in a timely manner.

c) **Delayed Transfer of Communication During Missed Approach:**

The ADC-S1 controller's delayed transfer of communication to the Approach Departure Controller regarding execution of missed approach, impeded efficient conflict resolution and limited the controller's ability to manage the situation effectively.

d) **Ineffective Conflict Resolution Instructions:**

The Departure Controller issued inappropriate resolution instructions to the aircraft involved in the conflict potentially resulted into less separation between both aircraft and escalated the risk of airprox.

e) **Inadequate Separation Assurance in SID Design:**

The design of the Standard Instrument Departure (Dudum6C) did not adequately ensure positive separation between departing aircraft from Runway 29R and aircraft executing a missed approach from Runway 29L, increasing the risk of loss of separation.

4 SAFETY RECOMMENDATIONS

4.1 Airports Authority of India (AAI)

1) It is recommended that AAI take appropriate action to review and redesign Standard Instrument Departures (SIDs) and missed approach procedures at IGIA to have initial positive separation assurance. The design should provide controllers with adequate time to intervene and resolve any potential conflicts between aircraft conducting missed approaches and departing aircraft from closely spaced runways.

2) It is recommended that AAI consider and implement procedures enabling automatic transfer of communication from Aerodrome Controllers to Approach/Departure Controllers at IGIA. This would allow departing aircraft, under normal conditions, to directly contact the Approach/Departure Controller without requiring explicit manual instructions from the Aerodrome Controller. A safety assessment should be conducted prior to implementation to ensure the procedure is safe and effective, with contingency measures in place for special circumstances.

3) It is recommended that AAI develop and implement training programs on Team Resource Management (TRM), emphasizing the benefits of TRM in reducing teamwork-related incidents and enhancing communication and coordination among ATC personnel.

4) It is recommended that AAI ensure air traffic controllers coordinate via intercom and communicate exclusively in aviation English. Using the intercom enhances communication efficiency by providing a clear, direct, and reliable means of coordination between controllers. This minimizes background noise and potential distractions, ensuring that critical information is accurately conveyed. Communicating in aviation English, the global standard, further reduces the risk of miscommunication, especially in high-pressure situations, promoting safer and more consistent operations.

5) It is recommended that the recommendation from the previous investigation report to ensure that ATC units are equipped with devices to record background communications and the aural environment at controller workstations be implemented by AAI on priority.

6) It is recommended that AAI implement an automated self-briefing system for meteorological conditions to ensure that all air traffic controllers receive and complete their required briefings. This system would allow controllers to access up-to-date weather information independently, log their briefing completion, and generate summary reports for management oversight. Implementing this system will standardize the briefing process, reduce the risk of missed or incomplete briefings, and enhance operational safety, particularly in managing weather-related events like wind shear.

7) It is recommended that AAI review the "Standard Operating Procedures for Four Runways" and incorporate explicit contingency plans for scenarios where one or more runways are unavailable. These procedures should ensure that operations remain safe and efficient during any adverse weather conditions or disruptions.

8) It is recommended that AAI ensure strict adherence to SOPs by controllers and implement periodic and effective monitoring of compliance with established procedures to maintain operational consistency and safety.

9) It is recommended that AAI ensure air traffic controllers undergo periodic refresher training on automation functions that are infrequently used. This will help controllers maintain proficiency in all aspects of their role and reduce the likelihood of errors due to forgetting less frequently used functions over time. Regular training updates and simulated exercises should be implemented to reinforce their knowledge and skills in effectively using these automation tools.

10) It is recommended that AAI develop effective implementation of windshear reporting procedures to ensure timely and accurate dissemination of information, enhancing the safety of flight operations during adverse weather conditions.

11) It is recommended that AAI review and enhance the simulator training of surveillance controllers, focusing on conflict resolution techniques for handling unusual situations. Regular training will ensure that controllers are well-prepared to manage unexpected events safely and efficiently.

12) It recommended that AAI ensure inclusion of provision of preservation of ATIS recording, particularly if any safety occurrence happens in terminal airspace or at an aerodrome.

13) It is recommended that AAI ensure that Tower Electronics Flight Strips (TEFS) movements are consistently recorded whenever such systems are introduced in any ATM Automation System. This will facilitate thorough safety investigations in the event of incidents or accidents by providing a comprehensive record of flight data and controller actions.

14) It is recommended that AAI should have a comprehensive SOPs for a situation when any of communication channel recorder becomes unserviceable.

15) It is recommended that AAI should effectively implement procedures to promptly relieve air traffic controllers from duty after a critical incident to mitigate stress effects. Timely relief will help prevent impaired decision-making and reduced performance due to heightened stress levels.

16) It is recommended that AAI implement a Critical Incident Stress Management (CISM) program for controllers to provide immediate and effective psychological support following traumatic or stressful incidents. The program should include timely debriefings, peer support, and access to professional counselling services. By addressing stress in a structured and supportive manner, AAI can help controllers recover quickly, maintain performance, and reduce the risk of stress-related errors, ultimately enhancing operational safety.

17) It is recommended that AAI ensure all safety-critical positions are consistently manned including Alpha Controller position, and controllers take over watch in accordance with established procedures. This will contribute to the safe and efficient management of Air Traffic Services and support effective safety investigations in the event of incidents or accidents.

18) AAI may verify the SMS manual issued by ANS, IGI Airport to ensure that regulations, guidelines and procedures outline in the manual are in line with the existing regulations.

19) It is recommended that AAI ensure that ATM Automation System should be developed for alerting the controllers when TTT reaches the pre-defined value to attract their attentions and no departure is released after TTT breaches the limit.

4.2 India Meteorological Office

20) It is recommended that the India Meteorological Department (IMD) implement wind shear warning systems at all busy airports. These systems will provide real-time wind shear alerts to both aircraft and air traffic control (ATC), significantly enhancing safety during take-off and landing phases. By enabling timely and accurate warnings, this system will allow pilots and controllers to take proactive measures, reducing the risk of incidents caused by sudden wind shear conditions.

Place: New Delhi

Date: 09 Sep 2025

Annexure ‘A’

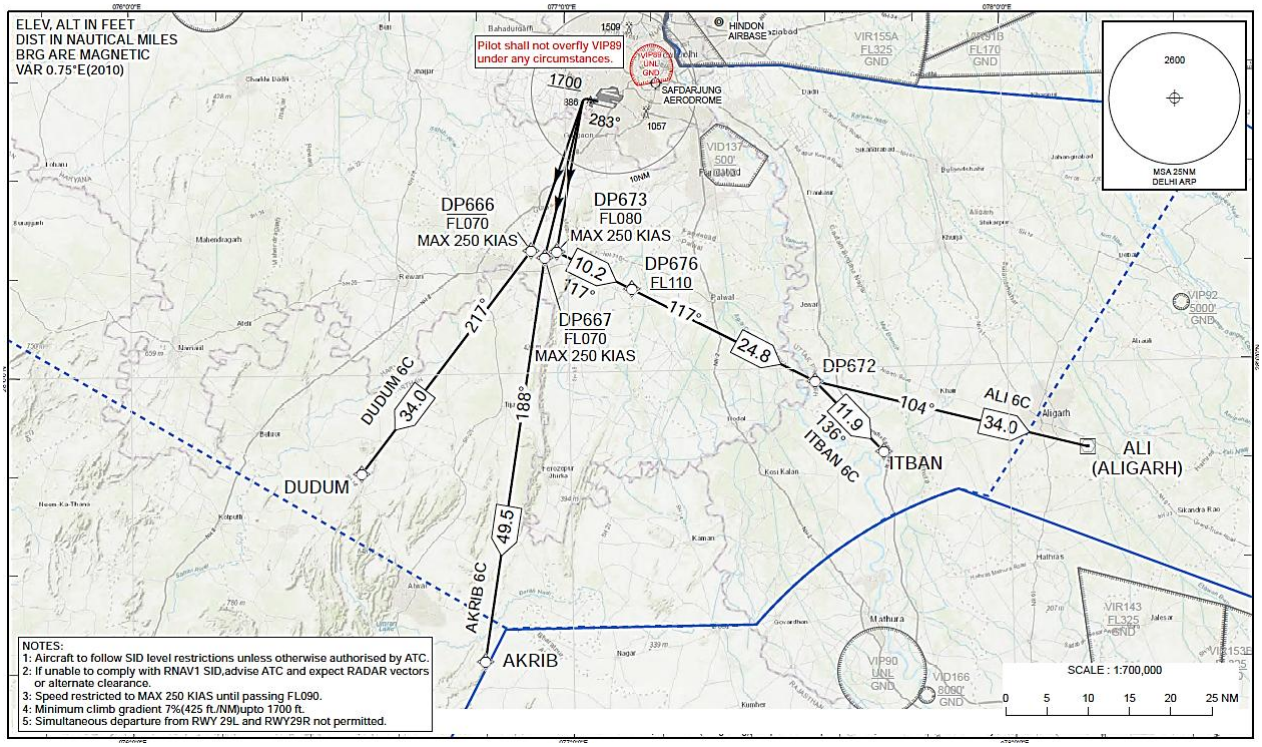
SID (DUDUM)

STANDARD DEPARTURE CHART
INSTRUMENT (SID)
RNAV1(GNSS)
SURVEILLANCE REQUIRED

TRANSITION ALT
5000

CLD	121.950	APP(FD)	124.200
TWR(RWY27)	118.750	APP(DEP)	118.825
TWR(RWY28)	118.100	ACC(E)	120.900
TWR(RWY29R)	123.825	ACC(S)	125.700
TWR(RWY29L)	125.850	ACC(SW)	132.150
APP(ARR 1)	126.350	ACC(W)	124.550
APP(ARR 2)	125.675		

DELHI (VIDP)
INDIA
AKRIB 6C,ALI 6C,DUDUM 6C,
ITBAN 6C - RWY29R



Annexure ‘B’

ATC TAPE TRANSCRIPT

VHF TAPE TRANSCRIPT

DATE: 10.11.2023
CALL SIGN: VTI946
FREQUENCY: 125.85 MHz
UNIT: ADC-S1
TIME: 0443-0448 UTC

TIME (HHMMSS)	UNIT	TRANSMISSIONS
044320-044321	TOWER	VISTARA NINER FOUR SIX TOWER
044327-044328		VISTARA NINER FOUR SIX TOWER
044353-044354		VISTARA NINER FOUR SIX TOWER
044359-044400		VISTARA NINER FOUR SIX TOWER
044407-044422	VTI946	TOWER VISTARA NINER FOUR SIX NAMASKAR
	TOWER	VISTARA NINER FOUR SIX TOWER NAMASKAR RUNWAY TWO NINER LEFT CLEARED TO LAND SURFACE WIND ONE TWO ZERO DEGREES ZERO FOUR KNOTS
	VTI946	RUNWAY TWO NINER LEFT CLEARED TO LAND VISTARA NINER FOUR SIX
	TOWER	EXERCISE CAUTION PREVIOUS AIRCRAFT REPORTED WIND SHEAR NINE HUNDRED THOUSAND..NINE HUNDRED FIVE HUNDRED METRE
	VTI946	ROGER
044524-044531	VTI946	VISTARA NINER FOUR SIX GOING AROUND
	TOWER	VISTARA NINER FOUR SIX TOWER
044533-044540	TOWER	VISTARA NINER FOUR ....VISTARA NINER FOUR SIX TOWER TRAFFIC ETHIOPIAN BOEING SEVEN EIGHT EIGHT NOW CLIMBING TO ONE THOUSAND EIGHT HUNDRED FEET ON ADJACENT RUNWAY
044550-044556	TOWER	VISTARA NINER FOUR SIX TOWER
	VTI946	GO AHEAD VISTARA NINER FOUR SIX
	TOWER	CONFIRM TRAFFIC MONITORED
	VTI946	AFFIRM
044558-044600	VTI946	FOLLOWING MISSED APPROACH PROCEDURE VISTARA NINER FOUR SIX
044618-044620	TOWER	VISTARA NINER FOUR SIX TOWER

044623-044635	VTI946	TCAS RA STAND BY
	TOWER	VISTARA NINER FOUR SIX CONTACT APPROACH RADAR ONE ONE EIGHT DECIMAL EIGHT TWO FIVE TRAFFIC INFORMATION ETHIOPIAN PASSING TWO THOUSAND EIGHT HUNDRED FEET
	VTI946	CHANGE OVER TO ONE ONE EIGHT EIGHT TWO FIVE VISTARA NINER FOUR SIX
044732-044734	TOWER	VISTARA NINER FOUR SIX CONFIRM MONITORED ONE ONE EIGHT DECIMAL EIGHT TWO FIVE

THE ABOVE TAPE TRANSCRIPT IS SPECIFIC TO TRANSMISSIONS ON VHF FREQUENCY 125.85 MHz OF ADC S-1 FROM 0443-0448 UTC ON 10/11/2023 BASED ON TRANSMISSION/ RECEPTION AT CONTROLLER POSITION.

VHF AND INTER UNIT COMMUNICATION TAPE TRANSCRIPT

DATE: 10.11.2023
FREQUENCY: 123.825 MHz
UNIT: ADC SOUTH-2
TIME: 0434-0445 UTC

TIME (HHMMSS)	UNIT	TRANSMISSIONS
043334-043336	AIC429	TOWER AIR INDIA FOUR FOUR ZERO
043339-043349	TOWER	AIR INDIA FOUR FOUR ZERO TOWER
	AIC429	CORRECTION SIR AIR INDIA FOUR TWO NINE SIR WE WOULD LIKE TO MAINTAIN AFTER TAKEOFF RUNWAY HEADING
	TOWER	AIR INDIA FOUR TWO NINER ROGER STANDBY WE WILL ADVISE
	AIC429	THANKYOU
043350-043359	TOWER	AIR INDIA ONE ONE FOUR TOWER CONTACT GROUND ONE ONE NINE DECIMAL FIVE SEVEN FIVE
	AIC114	ONE ONE NINER FIVE SEVEN FIVE AIR INDIA ONE ONE FOUR GOOD DAY
043405-043414	AIC506	AND TOWER AIR INDIA FIVE ZERO SIX WOULD LIKE TO MAINTAIN RUNWAY HEADING FOR EIGHT TO TEN MILES THEN ABLE LEFT TURN ADVISE APPROACH
	TOWER	AIR INDIA FIVE ZERO SIX ROGER STANDBY
043417-043429	APAD	YES
	TOWER	SIR AIRINDIA FIVE ZERO SIX REQUESTING RUNWAY HEADING FOR EIGHT...
	APAD	ISKO AIRBORNE KARAO VICTOR TANGO VICTOR ROMEO ROMEO ROMEO KO
	TOWER	SIR YE HO NI RAHA HAI MANUAL CORRELATE KAR RAHA HUN MAIN
043453-043514	APAD	YES
	TOWER	SIR AIR INDIA FIVE ZERO SIX REQUESTING RUNWAY HEADING FOR EIGHT TO TEN MILES
	APAD	RUNWAY HEADING?
	TOWER	HAAN SIR
	APAD	RUNWAY HEADING DE DO PEHLE ISKO AIRBORNE TO KARAO PEHLE DUSRA KAAM KARNE LAGE HO PEHLE ISKE EK KAAM KARWAO VICTOR TANGO...
	TOWER	KAR RAHA HOON SIR KAR RAHA HOON... WO BHI KAR HI RAHA HOON... HO NAHI RAHA HAI
	APAD	NAHI HO RAHA HAI TO FIR DEPARTURE KO ROK KE RAKHO FIR
	TOWER	THEEK HAI FIR ROKE HUE HOON
043539-043542	VIR300	VIRGIN THREE HUNDRED HOLDING SHORT OF TANGO SIX

043545-043602	TOWER	VIRGIN THREE ZERO ZERO TOWER CROSS RUNWAY TWO NINER... TWO NINER RIGHT FROM TANGO SIX TO ROMEO SIX ROMEO HOLD SHORT OF ALFA
	VIR300	OKAY... CROSS TWO NINER RIGHT... ROMEO SIX TO... ROMEO HOLD SHORT OF ALFA VIRGIN THREE HUNDRED
043659-043705	TOWER	VIRGIN THREE ZERO ZERO TOWER REVISED... AA... CORRECTION CONTACT GROUND ONE ONE NINE DECIMAL FIVE SEVEN FIVE
043707-043711	VIR300	CONTACT GROUND ONE ONE NINE FIVE SEVEN FIVE VIRGIN THREE HUNDRED
043712-043722	TOWER	SIR
	APAD	ISKA JO HAI FLIGHT TERMINATE... PLAN JO HAI TERMINATE HO GAYA THA
	TOWER	SIR WAHI KAR RAHA HOON MAIN USKA
	APAD	NAHI HO GAYA HO GAYA AB KYA KAR RAHE HO AB
	TOWER	KOSHISH TO KARI SIR NAHI HO RAHA THA
043741-043748	APAD	YES
	TOWER	SIR AIR INDIA FIVE ZERO SIX KA RUNWAY HEADING SIR
	APAD	HAAN RUNWAY HEADING DIJIYE DEPENDENT CHORIYEGA TWO SEVEN PE
	TOWER	THEEK HAI
043749-043800	TOWER	AIR INDIA FIVE ZERO SIX TOWER RUNWAY TWO NINER RIGHT CLEARED FOR TAKE OFF WIND ONE SIX ZERO DEGREES ONE FIVE KNOTS AND RUNWAY HEADING APPROVED
	AIC506	RUNWAY HEADING APPROVED WIND COPIED CLEARED FOR TAKE OFF AIR INDIA FIVE ZERO SIX
043803-043818	TOWER	ETHIOPIAN SIX EIGHT NINER TOWER ARE YOU READY NOW
	ETH689	ETHIOPIAN SIX EIGHT NINE NEGATIVE WE'RE GONNA WAIT AT LEAST FIVE MORE MINUTES AND... AND CHECK THE CONDITIONS BUT RIGHT NOW NEGATIVE
	TOWER	ETHIOPIAN SIX EIGHT NINER ROGER REPORT READY
	ETH689	WILCO ETHIOPIAN SIX EIGHT NINE
043818-043825	TOWER	AIR INDIA FOUR TWO NINER TOWER LINEUP RUNWAY TWO NINER RIGHT VIA PAPA FIVE
	AIC429	LINEUP RUNWAY TWO NINER RIGHT VIA PAPA FIVE AIR INDIA FOUR TWO NINER
043853-043856	AIC429	WE WOULD BE MAINTAINING RUNWAY HEADING AFTER DEPARTURE SIR AIR INDIA FOUR TWO NINER
043854-043902	APAD	YES
	TOWER	SIR AIR INDIA FOUR TWO NINER ALSO REQUESTING RUNWAY HEADING
	APAD	RUNWAY HEADING DIJIYE AUR TWO SEVEN SE DEPENDENT CHORIYEGA

	TOWER	OKAY
043924-043930	TOWER	AIR INDIA FIVE ZERO SIX TOWER CONTACT APPROACH RADAR ONE ONE EIGHT DECIMAL EIGHT TWO FIVE
	AIC506	ONE ONE EIGHT DECIMAL EIGHT TWO FIVE AIR INDIA FIVE ZERO SIX GOOD DAY SIR
043934-043957	TOWER	UNITED EIGHT ONE SIX TOWER... CROSS RUNWAY TWO NINER RIGHT FROM TANGO SIX TO ROMEO SIX... QUEBEC HOLD SHORT OF ALFA
	UAL816	OKAY CROSS RUNWAY TWO NINER RIGHT TANGO SIX QUEBEC SIX AND HOLD SHORT OF ROMEO AHEAD ON ALFA YOU SAID?
	TOWER	UNITED EIGHT ONE SIX AFTER ROMEO SIX QUEBEC HOLD SHORT OF ALFA
	UAL816	RIGHT AFTER ROMEO SIX QUEBEC AND SHORT OF ALFA UNITED EIGHT ONE SIX
044029-044032	ETH689	ETHIOPIAN SIX EIGHT NINE WE ARE HAPPY TO ACCEPT DEPARTURE NOW
044046-044103	TOWER	UNITED EIGHT ONE SIX TOWER... HOLD SHORT OF ALFA ON QUEBEC CONTACT GROUND ONE ONE NINE DECIMAL FIVE SEVEN FIVE
	UAL816	ONE ONE NINE SEVEN FIVE AA... UNITED EIGHT ONE SIX
	TOWER	UNITED EIGHT ONE SIX ONE ONE NINE DECIMAL FIVE SEVEN FIVE
	UAL816	AA... ONE ONE NINE FIVE SEVEN FIVE UNITED EIGHT ONE SIX
044105-044115	ETH689	DELHI ETHIOPIAN SIX EIGHT NINE
	TOWER	ETHIOPIAN SIX EIGHT NINER TOWER
	ETH689	WE ARE HAPPY TO ACCEPT DEPARTURE NOW ETHIOPIAN SIX EIGHT NINER
	TOWER	ETHIOPIAN SIX EIGHT NINER TOWER ROGER
044138-044141	APAD	YES
	TOWER	SIR DEPARTURE RELEASE KAR SAKTE HAIN?
	APAD	DEPARTURE RELEASE KARIYE
	TOWER	THEEK HAI
044237-044249	TOWER	AIR INDIA FOUR TWO NINER TOWER RUNWAY TWO NINER RIGHT CLEARED FOR TAKE OFF WIND ONE SIX ZERO DEGREES ZERO FIVE
	AIC429	CLEARED FOR TAKE OFF TWO NINER RIGHT AIR INDIA FOUR TWO NINER AND WE WOULD BE MAINTAINING RUNWAY HEADING TILL F... FIVE MILES SIR
	TOWER	ROGER RUNWAY HEADING APPROVED
044251-044301	TOWER	ETHIOPIAN SIX EIGHT NINER TOWER LINEUP RUNWAY TWO NINER RIGHT VIA PAPA SIX
	ETH689	LINEUP AND WAIT RUNWAY TWO NINE RIGHT VIA PAPA SIX ETHIOPIAN SIX EIGHT NINER
044324-044336	THA323	TOWER THAI THREE TWO THREE
	TOWER	THAI THREE TWO THREE TOWER TAXI VIA TANGO SIX HOLDING

		POINT RUNWAY TWO NINER RIGHT
	THA323	TAXI TANGO SIX HOLDING POINT RUNWAY TWO NINER RIGHT THAI THREE TWO THREE
044343-044354	TOWER	ETHIOPIAN SIX EIGHT NINER TOWER RUNWAY TWO NINER RIGHT CLEARED FOR TAKE OFF WIND ONE EIGHT ZERO DEGREES ZERO SIX KNOTS
	ETH689	CLEARED FOR TAKE OFF RUNWAY TWO NINER RIGHT ETHIOPIAN SIX EIGHT NINER
044354-044403	VTI946	TOWER VISTARA NINER FOUR SIX NAMASKAR
	TOWER	VISTARA NINER FOUR SIX TOWER NAMASKAR CONTACT TOWER ONE TWO FIVE DECIMAL EIGHT FIVE
044415-044417	AIC429	FOLLOWING THE SID SIR AIR INDIA FOUR TWO NINE
044420-044421	TOWER	AIR INDIA
044421-044428	AIC429	THE SID
	TOWER	AIR INDIA FOUR TWO NINER CONTACT APPROACH RADAR ONE ONE EIGHT DECIMAL EIGHT TWO FIVE
	AIC429	ONE ONE EIGHT DECIMAL EIGHT TWO FIVE BBYE
044447-044456	TOWER	SINGAPORE FOUR ZERO ONE TOWER LINEUP RUNWAY TWO NINER RIGHT VIA PAPA FIVE
	SIA401	LINEUP TWO NINER RIGHT VIA PAPA FIVE SINGAPORE FOUR ZERO ONE GOOD MORNING
	TOWER	GOOD MORNING
044532-044538	TOWER	ETHIOPIAN SIX EIGHT NINER TOWER CONTACT APPROACH RADAR ONE ONE EIGHT DECIMAL EIGHT TWO FIVE
	ETH689	ONE ONE EIGHT EIGHT TWO FIVE ETHIOPIAN SIX EIGHT NINE THANKS BYE

THE ABOVE TAPE TRANSCRIPT IS SPECIFIC TO TRANSMISSIONS ON VHF FREQUENCY 123.825 MHZ AND INTER UNIT COMMUNICATION AT ADC SOUTH-2 POSITION FROM 0434-0445UTC ON 10.11.2023 BASED ON TRANSMISSION/ RECEPTION AT CONTROLLER POSITION.

VHF TAPE TRANSCRIPT

DATE: 10.11.2023
CALL SIGN: VTI946 & ETH689
FREQUENCY: 118.825 MHz
UNIT: APPROACH DEPARTURE (APAD)
TIME: 0446-0453 UTC

TIME (HHMMSS)	UNIT	TRANSMISSIONS
044542-044554	ETH689	DEPARTURE GOOD MORNING ETHIOPIAN SIX EIGHT NINE WITH YOU PASSING TWO THOUSAND TWO HUNDRED CLIMBING FOUR THOUSAND
	RADAR	ETHIOPIAN SIX EIGHT NINER RADAR IDENTIFIED CLIMB UNRESTRICTED TO...
INTERCOM COMMUNICATION BETWEEN APAD AND ADC S1		
044555-044602	TWR S1	*SIR YE BHI HO GAYA GO AROUND VISTARA NINE FOUR SIX*
	RADAR	*KYA... KYA LEVEL PASS KAR RAHA HAI*
	TWR S1	*AA... THREE... EK SECOND... CHOUBEES SAU PE HAI*
TIME (HHMMSS)	**UNIT**	**TRANSMISSIONS**
044602-044604	RADAR	ETHIOPIAN SIX EIGHT... *USKO CLIMB DIJIYE*
044606-044623	RADAR	ETHIOPIAN SIX EIGHT SIX STOP CLIMB TWO THOUSAND SIX HUNDRED FEET
	ETH689	OKAY ETHIOPIAN SIX EIGHT NINE SAY AGAIN STOP PART
	RADAR	ETHIOPIAN SIX EIGHT SIX... TURN... RIGHT TURN RIGHT HEADING...
	RADAR	VISTARA NINE FOUR SIX TRAFFIC CLIMBING TWO THOUSAND SIX HUNDRED FEET
044627-044641	RADAR	ETHIOPIAN SIX EIGHT NINER
	ETH689	GO AHEAD ETHIOPIAN SIX EIGHT NINE
	RADAR	TURN RIGHT HEADING TWO SEVEN ZERO
	ETH689	RIGHT HEADING TWO SEVEN ZERO ETHIOPIAN SIX EIGHT NINER
	RADAR	ETHIOPIAN SIX EIGHT NINER TRAFFIC... GO AROUND... MAINTAINING TWO THOUSAND TWO HUNDRED
044641-044642	VTI946	SIR VISTARA NINER FOUR SIX
044645-044656	VTI946	RADAR VISTARA NINER FOUR SIX
	RADAR	VISTARA NINE FOUR SIX MAINTAIN TWO THOUSAND
	VTI946	CLIMBING TO... PASSING TWO THOUSAND THREE HUNDRED VISTARA NINER FOUR SIX

	VTI946	CLEAR OF CONFLICT NOW
044659-044708	ETH689	ETHIOPIAN SIX EIGHT NINER WE ARE NOW TURNING LEFT HEADING TWO SEVEN ZERO MAINTAINING THREE THOUSAND FEET
	RADAR	ETHIOPIAN SIX EIGHT NINER... ROGER
044710-044711	VTI946	RADAR VISTARA NINER FOUR SIX
044713-044715	VTI946	RADAR VISTARA NINER FOUR SIX
044718-044721	RADAR	ETHIOPIAN SIX EIGHT NINER... CLIMB *UNCLEAR*
044721-044725	RADAR	ETHIOPIAN SIX EIGHT NINER CLIMB TO FOUR THOUSAND... CLIMB TO FLIGHT LEVEL SEVEN ZERO
044727-044739	ETH689	ETHIOPIAN SIX EIGHT NINE SAY AGAIN
	RADAR	ETHIOPIAN SIX NINE... SIX EIGHT NINER CLIMB TO FLIGHT LEVEL... SEVEN ZERO
	ETH689	CLIMB FLIGHT LEVEL SEVEN ZERO ETHIOPIAN SIX EIGHT NINE
044749-044754	RADAR	VISTARA NINER FOUR SIX
	VTI946	GO AHEAD VISTARA NINER FOUR SIX... TCAS RA STANDBY
044759-044807	VTI946	RADAR VISTARA NINER FOUR SIX
	RADAR	VISTARA NINE FOUR SIX REPORT CLEAR OF RA
	VTI946	CLEAR OF CONFLICT NOW VISTARA NINER FOUR SIX
	VTI946	MAINTAINING TWO THOUSAND SIX HUNDRED
044823-044834	VTI946	RADAR VISTARA NINER FOUR SIX CONFIRM PRESENT HEADING
	RADAR	VISTARA NINE FOUR SIX... TURN LEFT HEADING ONE EIGHT ZERO
	VTI946	ONE EIGHT ZERO VISTARA NINER FOUR SIX
	RADAR	VISTARA NINE FOUR SIX CONFIRM CLEAR OF RA
044835-044836	*UNCLEAR*	ROGER
044914-044922	RADAR	VISTARA NINE FOUR SIX
	VTI946	GO AHEAD VISTARA NINER FOUR SIX
	RADAR	VISTARA NINE FOUR SIX... TURN LEFT HEADING ONE... ZERO FIVE
	VTI946	LEFT HEADING ONE ZERO FIVE VISTARA NINER FOUR SIX
044943-044956	RADAR	ETHIOPIAN SIX EIGHT NINER TURN LEFT HEADING ONE EIGHT ZERO
	ETH689	LEFT HEADING ONE EIGHT ZERO ETHIOPIAN SIX EIGHT NINER
	RADAR	ETHIOPIAN SIX EIGHT NINER CLIMB TO FLIGHT LEVEL NINER ZERO UNRESTRICTED
	ETH689	CLIMB FLIGHT LEVEL NINE ZERO UNRESTRICTED ETHIOPIAN SIX EIGHT NINE
045001-045012	ETH689	DEPARTURE ETHIOPIAN SIX EIGHT NINE REQUEST REGISTRATION OF THE CONFLICTING TRAFFIC

	RADAR	ETHIOPIAN SIX EIGHT NINER SAY AGAIN
	ETH689	REQUEST FLIGHT NUMBER OF THE CONFLICTING TRAFFIC
045014-045018	RADAR	VISTARA NINE FOUR SIX
	ETH689	VISTARA NINE FOUR SIX COPIED
045020-045033	VTI946	RADAR VISTARA NINER FOUR SIX
	RADAR	VISTARA NINE FOUR SIX GO AHEAD
	VTI946	REQUESTING TRAFFIC INFORMATION ETHIOPIAN AIRCRAFT
	RADAR	TRAFFIC WAS ETHIOPIAN SIX EIGHT NINER BOEING SEVEN EIGHT EIGHT IT GOT... WAS DEPARTED RUNWAY TWO NINER RIGHT
045230-045233	ETH689	ETHIOPIAN SIX EIGHT NINE MAINTAINING FLIGHT LEVEL NINER ZERO
045252-045258	RADAR	VISTARA NINE FOUR SIX CONTACT ARRIVAL ONE TWO FOUR DECIMAL TWO
	VTI946	ONE TWO FOUR TWO VISTARA NINER FOUR SIX

THE ABOVE TAPE TRANSCRIPT IS SPECIFIC TO TRANSMISSIONS ON VHF FREQUENCY 118.825 MHZ OF APAD FROM 0446-0453UTC ON 10.11.2023 BASED ON TRANSMISSION/RECEPTION AT CONTROLLER POSITION.

Annexure 'C'

CVR Tape Transcript VTI946

51:52:20	Tower S	946 namaskar, RW 29L clear to land ….. wind 120 deg 04 kts
51:52:25	P2	RW 29L clear to land Vistara 946
51:52:27	**Tower S**	**Exercise caution previous aircraft reported windshear 900 / 500 mtr**
51:52:33	P2	Roger
51:52:36	P1	Check captain
51:52:40	P1	ONE THOUSAND ft stabilized landing clearance is obtained
51:52:42	P2	Check
51:52:50	P1	Maintaining autopilot
51:52:52	P2	Check
51:52:56		FIVE HUNDRED
51:52:58	P1	Check
51:53:04		FOUR HUNDRED
51:53:08	P1	LAND
51:53:09	P2	Check
51:53:13		THREE HINDRED
51:53:16		HUNDRED ABOVE
51:53:20		TWO HUNDRED
51:53:21	P1	**Check, Windshear TOGA, MAN TOGA SRS, NAV, positive climb gear up, Flaps one notch up**
51:53:36	P2	Vistara 946 going around
51:53:46	Tower S	**Vistara 946, tower traffic Ethiopian Boeing 788 climbing to 1800 ft, adjacent runway**
51:53:51	P2	Roger
51:53:52	Tower S	…… Runway
51:53:54	P1	ALT STAR, Flaps to 1
51:54:00	P1	Speed ALT STAR
51:54:01	P2	Check
51:54:03	Tower S	Vistara 946 Tower
51:54:04	P2	Go ahead Vistara 946
51:54:06	Tower S	Confirm traffic monitored
51:54:07	P2	Affirm
51:54:08	P1	Following missed approach procedure
51:54:09	P2	**Following missed approach procedure Vistara 946**
51:54:15	P2	OK left murrha hai
51:54:21	P1	Oh Oh, OK Flaps Zero
51:54:24		**TRAFFIC TRAFFIC**
51:54:26	P2	TCAS
51:54:29	P1	BLUE
51:54:30	Tower S	Vistara 946 Tower
51:54:31		DESCEND DESCEND
51:54:35	P1	TCAS RA stand by
51:54:37	Tower S	Vistara 946 contact approach radar 118.825, traffic information Ethiopian passing 2800 ft

51:54:43		…….
51:54:45	P1	Change over to 118.825 Vistara 946
51:54:47	Tower S	……Traffic go around maintaining 2200
51:54:53	P1	Radar Vistara 946
51:54:57	P1	Radar Vistara 946
51:54:58	Radar	Vistara 946 maintain 2000
51:55:03	P1	We are passing 2300 Vistara 946, clear of conflict now
51:55:09	P2	ALT STAR
51:55:10	P1	Check
51:55:10	E 689	Ethiopian 689 we are now turning left HDG 270 Maintaining 3000 ft
51:55:16	Radar	Ethiopian 689 roger
51:55:18	P1	Ye kya karraha, why he is coming close to us
51:55:25	P1	Radar Vistara 946
51:55:28	P1	Aap Descend karlo 2000
51:55:29	Radar	Ethiopian 689 climb to FL 70
51:55:36		**TRAFFIC TRAFFIC**

51:55:38	P1	TCAS BLUE
51:55:40	E 689	Ethiopian 689 say again
51:55:41	Tower	Ethiopian 689 climb FL 70
51:55:48	E 689	Climb FL 70 Ethiopian 689
51:56:01	Radar	Vistara 946
51:56:02	P2	Go ahead Vistara 946 TCAS RA stand by
51:56:05		**CLEAR OF CONFLICT**
51:56:08	P1	VS ZERO
51:56:11	P2	Radar Vistara 946
51:56:13	Radar	Vistara 946 report clear of RA
51:56:16	P2	Clear of conflict now Vistara 946, maintaining 2600
51:56:34	P2	Radar Vistara 946 confirm present HDG
51:56:38	Radar	Vistara 946 turn left HDG 180
51:56:40	P2	Left HDG 180 Vistara 946
51:56:44	Radar	Vistara 946 confirm clear of RA
51:56:45	P2	Affirm
51:56:47	Radar	Roger
51:57:26	Radar	Vistara 946
51:57:27	P2	Go Ahead Vistara 946
51:57:29	Radar	Turn left heading 105
51:57:32	P2	Left heading 105, Vistara 946
51:57:35	P1	Heading 105 Checked
51:57:10	P1	Just ask him for the traffic information and note it down, so we can file the report

51:58:22	E 689	Request flight number of the conflicting traffic
51:58:25	Radar	Vistara 946
51:58:28	E 689	Vistara 946 copied
51:58:32	P1	Radar Vistara 946
51:58:33	Radar	Vistara 946 go ahead
51:58:34	P1	Requesting traffic information type of aircraft
51:58:39	Radar	Traffic was Ethiopian 689 Boeing 788 was departed RW 29 R
51:58:46	P1	Roger
51:59:24	P1	Briefing remains same, Ill make an announcement in some time when he starts vectoring properly. I think the Approach path is also clear this time. I initiated go around because speed was almost 15 kts beyond the approach speed …a bit too much. He should have kept separation, I don't know why there was no separation. Any way we will talk after landing. Any idea any questions anything you would like to add captain
52:00:16		PA

Annexure 'D'

ATC Circular No: 96 of 2023

Subject: Standard Operating Procedure (SOP) for Four Runway Operations at IGI Airport, Delhi

ATC circular 40 of 2023 regarding SOP for Four Runway Operations at IGI Airport, Delhi was promulgated to all controllers on 13th June 2023. The SOP was on a trial period for three months from 13-07-2023 till 12-10-2023.

Feedback regarding the SOP was sought from all stakeholders. After the review of the SOP and feedback received, no need is felt to introduce any amendment/ modification in the existing SOP. **Accordingly, the existing SOP for four Runway operations at IGIA, New Delhi is now being regularized w.e.f 13/10/2023.**

AAI/DP/ATM-07/2316 DATE: - 13-06-2023

ATC Circular No. 40 of 2023

Subject: Standard Operating Procedure (SOP) for Four Runway Operations at IGI Airport, Delhi (Trial operations from 13-07-2023 to 12-10-2023)

1. Introduction

1.1. Consequent upon commissioning of the new 4th Runway 11L/29R, north and parallel to existing runway 11R/29L, at IGI Airport Delhi from 13-07-2023 (Refer AIP SUP 73/2023), it is decided to use the 4th runway 11L/29R for operations from 13-07-2023 in departure only mode up to CAT-I visibility conditions. Runway 11L/29R is not available for Arrivals.

1.2. Based on the available associated resources, it is envisaged to use all four runways i.e. 09/27, 10/28, 11L/29R and 11R/29L for simultaneous operations.

1.3. Since, the distance between the centerlines of RWY 11L/29R and RWY 11R/29L is 380m, Runway 11L/29R and Runway 11R/29L will be used in segregated dependent mode, wherein Runway 11L/29R will be used for departures and Runway 11R/29L will be used for arrivals.

1.4. The shortest distance between the centerlines of RWY 09/27 and RWY 10/28 is also less than 760m and because of the geometry, this pair will also be used in segregated dependent mode.

1.5. At IGIA, there will be two runway systems, i.e. Northern System and Southern System as mentioned below.

RUNWAY SYSTEM	*RUNWAYS*
Northern Runway System	RWY 09/27 and RWY 10/28
Southern Runway System	RWY 11L/29R and RWY 11R/29L

1.6. The two Runways within the Runway system (Northern and Southern) are dependent on each other.

2. General conditions

At IGI Airport, various modes of operation are permitted. Runways available at IGI airport are used in various modes for optimal use of available ground and air resources. Particular mode of operation to be implemented is decided by ATC considering various factors including the prevalent weather conditions, visibility/RVR, serviceability of navigation and landing aids, ground infrastructure, traffic density and its composition, noise abatement requirements etc. One/Two/Three/Four runway modes of operations shall be tactically utilized during low/high density traffic situations so as to attain the optimal capacity at all times.

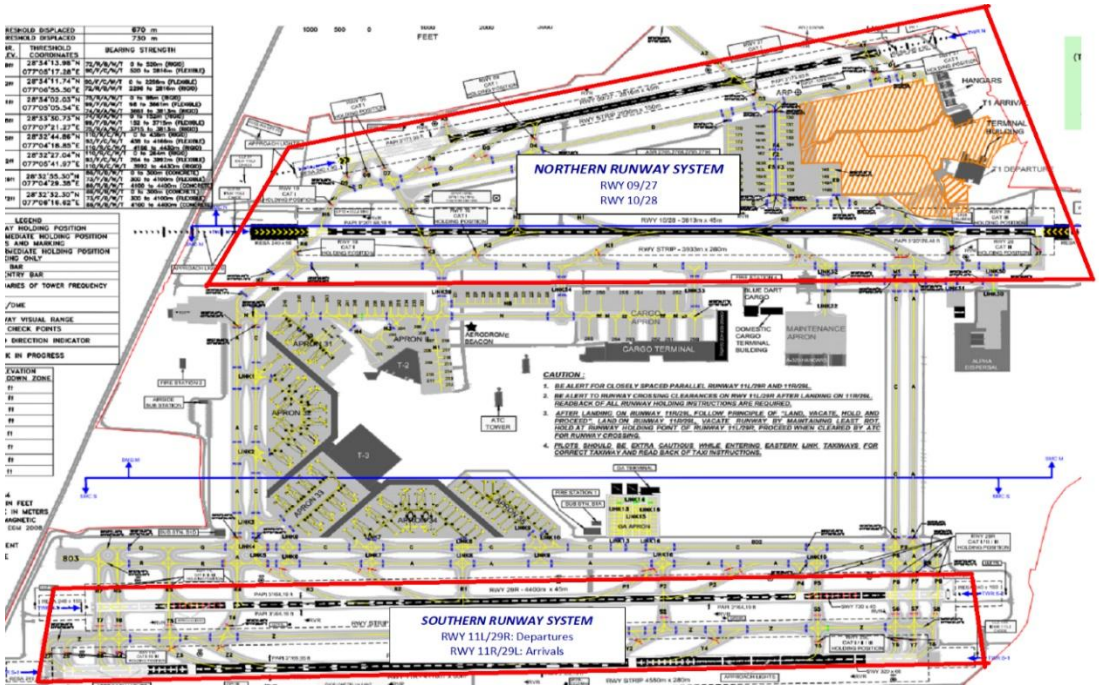
The pair of Runways in the Northern Runway System can be used in segregated dependent mode up to the minima of Runway 09/27 and Runway 10/28. Similarly, the pair of Runways in the Southern Runway System shall be used in segregated dependent mode up to the CAT-I conditions only. During the Four Runway Operations:

2.1. All four tower positions shall be manned.

2.2. Approach departure position should be manned.

2.3. Independent simultaneous approaches on any two runways are not permitted.

2.4. The two runways within the runway system (Northern or Southern) are dependent on each other.



2.5. In view of closely spaced southern runways (380 meters), near similar runway designation (Runway 11L and 11R or Runway 29R and 29L) and high intensity multi runway operations, all the controllers and supervisors should exercise due precaution in usage of such runway designations. All such runway designation in the clearances as stipulated shall be clearly stated and read back of it, shall be taken as per procedure. All the read back and hear back in communication should be closely monitored. The compliance of such instructions should be correlated with the active surveillance of the concerned aircraft visually and/or with all

available surveillance tools as applicable. Wherever needed, appropriate phraseology such as 'I say again' etc. should be used for reinforcement and clarity.

2.6. As far as practicable, the Tower Supervisor should prepare the roster in a manner where the controller taking-over watch on Runway 11L/29R is not required to take-over watch on the Runway 11R/29L on the same day of duty.

2.7. In case of change in mode of operation from westerly to easterly mode or vice versa, due care should be exercised as Runway 29L (Left) in westerly mode will become Runway 11R (Right). Similarly, Runway 29R (Right) in westerly mode will become Runway 11L (Left).

3. Jurisdiction (During Four Runway Mode of Operations)

3.1. Tower (North): The jurisdiction of Tower (North) shall extend over RWY 09/27 and area north of Runway 10/28 east of TWYs H6-D9 (including TWYS H6-D9) and west of TWY D4 (excluding TWY D4).

3.2. Tower (Middle): The jurisdiction of Tower (Middle) shall extend over RWY 10/28.

3.3. Tower (South-1): The jurisdiction of Tower (South-1) shall extend over RWY 11R/29L.

3.4. Tower (South-2): The jurisdiction of Tower (South-2) shall extend over RWY 11L/29R, including all taxiways south of Runway 11L/29R.

3.5. SMC North: North of RWY 10/28 excluding the jurisdiction of Tower (North).

3.6. SMC Middle: South of RWY 10/28, up to North of Link-1 on C (excluding Link-1), North of junction of TWY A and TWY N (including TWY N), Apron 31, Terminal-2, Remote stand 232-246, Cargo Apron, stand 220-231, A320 Hanger, ARC hanger, AIC maintenance, BSF hangar, up to North of TWY P9 on Eastern Link TWY A (excluding TWY P9), North of junction of Eastern Link TWY C and TWY M (including TWY M) .

3.7. SMC West: South of TWY N on TWY A (excluding TWY N), South of Link-1 on TWY C (including Link-1), West of Link-7 on TWY C (excluding Link-7) and West of Link-6 on TWY A (including Link-6), North of RWY 11L/29R, Apron 32 and 33.

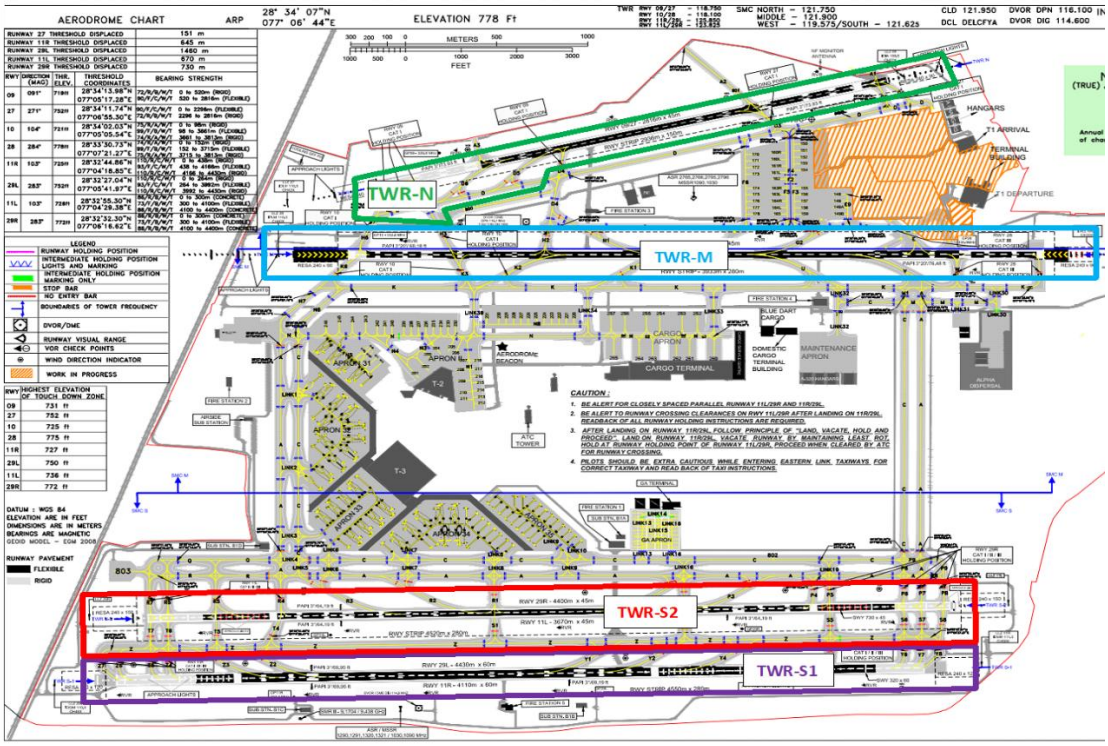
Note: Tower Supervisor may open/close SMC-West as per requirement and with the approval of WSO. Accordingly, jurisdiction of it will be handed over as published.

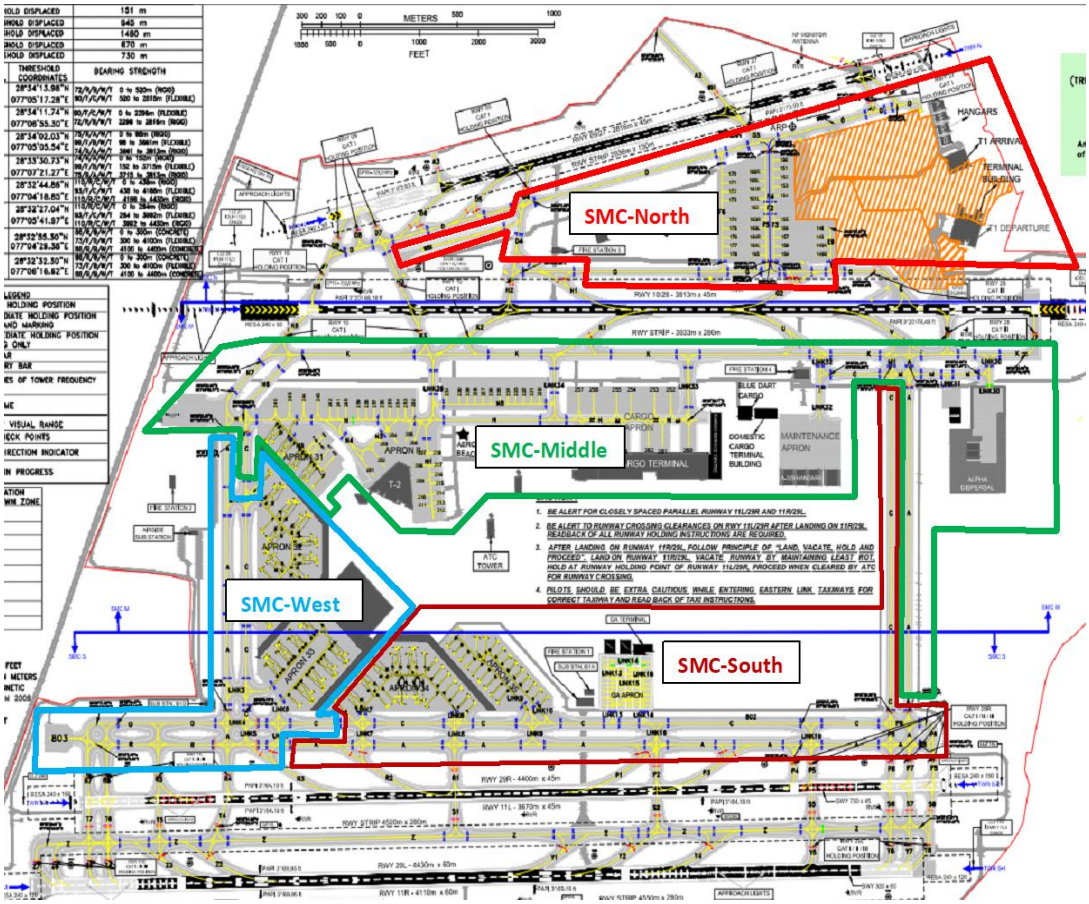
3.8. SMC South: East of Link-7 on TWY C (including Link-7) upto South of TWY M on Eastern Link TWY C (excluding TWY M) and East of Link-6 on TWY A (excluding Link-6) upto south of junction of Eastern Link TWY A and TWY P9 (including P9), North of RWY 11L/29R, Apron 34, 35 and General Aviation Apron.

3.9. Approach Final Director (APFD): The jurisdiction of the Approach Final Director (APFD) controller shall extend over an area of the trapezoid symmetrically placed on either side of DPN VOR aligned along the approach side depending upon the direction of the flow of width at DPN end, other end and length of 30 NM, 40 NM, and 40 NM respectively excluding the area under jurisdiction of approach departure.

3.10. Approach Arrival (APAA): The jurisdiction of Approach Arrival shall extend over an area of 60 NM around DPN within Delhi TMA at and below FL140, excluding the airspace of defined dimension over which jurisdiction is exercised by Delhi Approach Final Director.

3.11. Approach Departure (APAD): The jurisdiction of Approach Departure shall extend from ground to FL090 vertically for departures from all the RWYs, as defined in the MATS Part-2.





4. Westerly mode: Four Runway westerly operation

4.1. Runway usage plan

Westerly Flow		*Remarks*
Northern RWY System	RWY 27 - Arrival	• RWY 27 and RWY 28 in segregated dependent mode. • Departures from RWY 28 are dependent on the position of arrivals on RWY 27. • Departures from RWY 28 are independent of aircraft movement on southern RWY system.
	RWY 28 - Departure	
Southern RWY System	RWY 29R - Departure	• RWY 29R and RWY 29L in segregated dependent mode. • Departures from RWY 29R are dependent on the position of arrivals on RWY 29L. • Departures from RWY 29R are independent of aircraft movement on northern RWY system.
	RWY 29L - Arrival	

4.2. Runway Assignment

i. Arrivals should be assigned RWY as per the Runway allocation plan.

ii. Any arrival, requesting RWY 28 due aircraft performance/or otherwise may be accommodated on RWY 28. Approach controller shall coordinate with Tower (Middle) in such cases and the spacing as desired by Tower (Middle) to release departure lined up on RWY 28, if any, may be provided between arrivals on RWY 27 and RWY 28.

iii. No departure shall be permitted from RWY 27 and RWY 29L during this mode of operation.

iv. Departures should be assigned RWY as per following plan:

Military, ARC hangar, Terminal-1, Terminal-2, Cargo Apron, Apron 31	*RWY 28*
GA Apron, Apron 34, Apron 35	RWY 29R
Apron 32, Apron 33	Available for Balancing

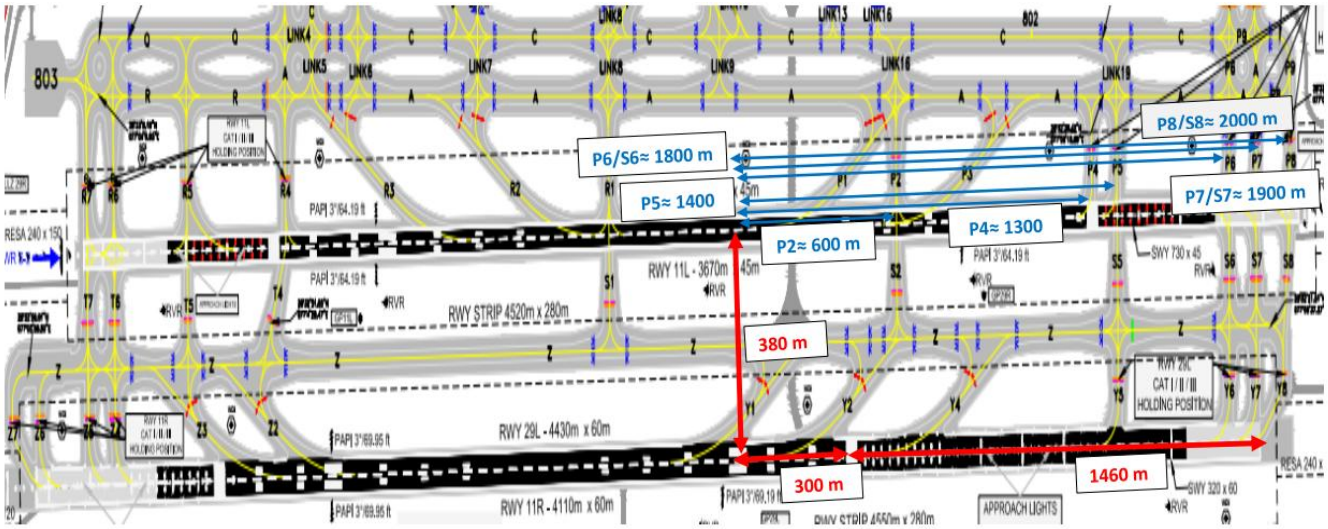
4.3. Wake Turbulence Separation

The distance between the centerlines of RWY 29L and RWY 29R is 380 meters and due to the displaced threshold of Runway 29L, the departures from Runway 29R need to be provided the wake turbulence separation w.r.t the arrival landing on Runway 29L as per the provisions of MATS-Part 1.

Runway 29L has a threshold displaced by 1460 meters. Normally, the arrival is expected to touch down in approximately another 300 meters. The wake vortices of the arrival cease to be generated when the nose landing gear touches the ground during landing. In the case of RWY 29L, this distance to touchdown is approximately 1800 meters from the physical beginning of Runway 29L.

If the departure from RWY 29R leaves the ground and gets airborne after the point abeam to the touchdown point of the heavier arrival on RWY 29L, then wake turbulence separation between such arrivals and departures will not be applicable. The distances from the various entry points on RWY 29R to the point abeam to the touchdown point of the arrival on RWY 29L are mentioned below in the table and shown in the diagram.

RWY 29R							
Entry TWY	**R1**	**P2**	**P4**	**P5**	**P6/S6**	**P7/S7**	**P8/S8**
TORA (m)	1914	2955	3662	3753	4159	4257	4382
Distance between Line-Up points and Abeam Point (m)	NA	≈600	≈1300	≈1400	≈1800	≈1900	≈2000



Example: while releasing departure from RWY 29R, if P2 holding point is utilized for releasing departures with wake turbulence category 'Light', normally, there would be no need for providing wake separation to the departure from Runway 29R with respect to a heavier arrival on Runway 29L considering the departure will require a take off run more than 600 meters and will lift beyond the point abeam to the touchdown point of the heavier arrival on RWY 29L. However, if such departure requires take-off run less than 600 meters, then the wake turbulence separation will be applicable.

Similarly, if P4 or P5 holding points is utilized for releasing departures with wake turbulence category 'Medium' or "Heavy", normally, there would be no need for providing wake separation to the departure from Runway 29R with respect to the heavier arrival on Runway 29L considering the departure will require a takeoff run more than 1400/1500 meters respectively and will lift beyond the point abeam to the touchdown point of the heavier arrival on RWY 29L. However, if such departure requires take-off run less than 1400/1500 meters, then the wake turbulence separation will be applicable.

Note: A NOTAM stipulating the requirement of crew to notify the ATCO about the above requirements at the time of pushback will be published separately. ATCOs should use this information for planning the Holding Point and application of wake turbulence separation.

4.4. Preferred Entry Taxiways

As shown in Annexure 1, Taxiways P2, P4 and P5 should be used as preferred entry taxiways for departures lining up Runway 29R. Taxiway P2 may be used as preferred entry point for

departures with wake turbulence category 'Light' and/or slow-moving departures. Similarly, Taxiways P4/ P5 may be used as preferred entry point for departures with wake turbulence category 'Medium' or 'Heavy'. However, Taxiway P2 may be also used as a preferred entry taxiway for departures with wake turbulence category 'Medium' but expected to lift-off in less than 1400/1500 meters (eg: ATR, GL5T, F2TH, other general aviation aircraft etc.) for effective utilization of inter-arrival spacing and thus maximization of capacity.

4.5. Preferred Ground Traffic flow

For an indicative ground traffic flow showing the preferred entry points, vacation points and crossing points during Four Runway Westerly mode of operations, Refer Annexure 1.

5. Easterly mode: Four Runway easterly operations

5.1. Runway usage plan

Easterly Flow		***Remarks***
Northern RWY System	**RWY 09 - Departure**	• RWY 09 and RWY 10 in segregated dependent mode. • Departures from RWY 09 are dependent on position of arrivals on RWY 10. • Departures from RWY 09 are independent of aircraft movement on southern RWY system.
	RWY 10 - Arrival	
Southern RWY System	**RWY 11L - Departure**	• RWY 11L and RWY 11R in segregated dependent mode. • Departures from RWY 11L are dependent on the position of arrivals on RWY 11R. • Departures from RWY 11L are independent of aircraft movement on northern RWY system.
	RWY 11R - Arrival	

5.2. Runway Assignment

i. Arrivals should be assigned RWY as per the Runway allocation plan.
ii. Whenever required for load balancing, arrivals may be shifted from RWY 10 to RWY 11R and vice-versa, giving due consideration to aircraft requirements, performance, parking position and overall operational efficiency.
iii. Any departing aircraft from Terminal-1 or Cargo apron requesting RWY 10 due aircraft performance may be accommodated on RWY 10. Tower (North) and Tower (Middle) shall coordinate with each other and Approach Departure (APAD), in such cases and release one departure at a time, as simultaneous departures are not permitted from RWY 09 and RWY 10.
iv. Departures should be assigned RWY as per following plan:

Military, Terminal-1	*RWY 09*
GA Apron, Apron 35, Apron 34, ARC Hangar	RWY 11L
Terminal-2, Apron 31, Apron 32, Apron 33, Cargo Apron	Available for Balancing

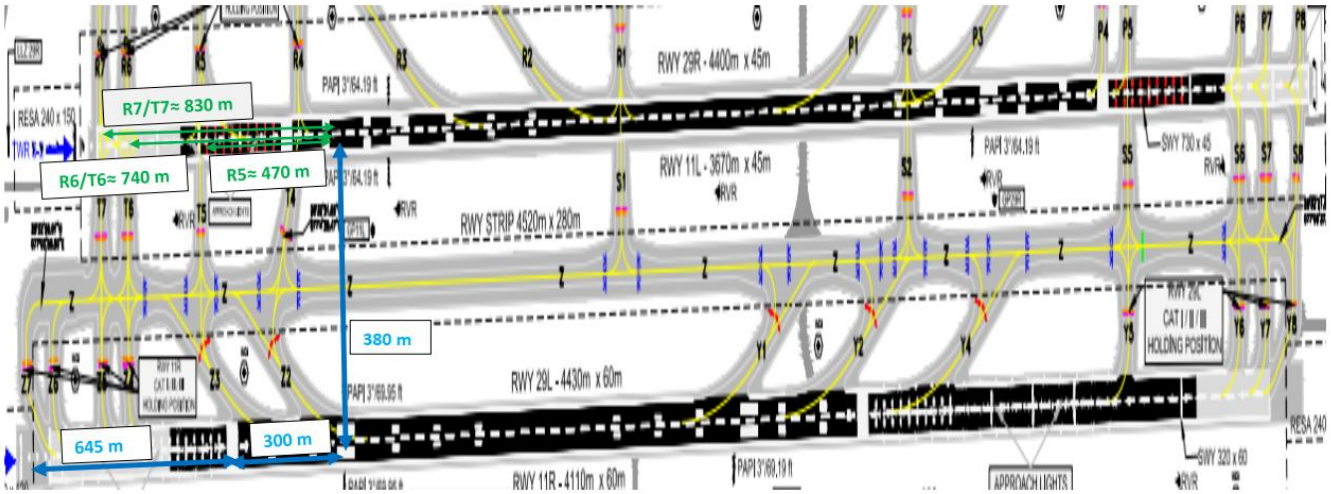
5.3. Wake Turbulence Separation

The distance between the centerlines of RWY 11L and RWY 11R is 380 meters and due to the displaced threshold of Runway 11R, the departures from Runway 11L need to be provided the wake turbulence separation w.r.t the arrival landing on RWY 11R as per the provisions of MATS-Part 1.

Runway 11R has a threshold displaced by 645 meters. Normally, the arrival is expected to touch down in approximately another 300 meters. The wake vortices of the arrival cease to be generated when the nose landing gear touches the ground during landing. In the case of RWY 11R, this distance to touchdown is approximately 1000 meters from the physical beginning of Runway 11R.

If the departure from RWY 11L leaves the ground and gets airborne after the point abeam to the touchdown point of the heavier arrival on RWY 11R, then wake turbulence separation between such arrivals and departures will not be applicable. The distances from the various entry points on RWY 11L to the point abeam to the touchdown point of the arrival on RWY 11R are mentioned below in the table and shown in the diagram.

RWY 11L					
Entry TWY	**R1**	**R4**	**R5**	**R6/T6**	**R7/T7**
TORA (m)	1779	2950	3307	3572	3670
Distance between Line-Up points and Abeam Point (m)	NA	NA	≈470	≈740	≈830



Example: while releasing departure from RWY 11L, if R5 or R6/T6 holding point is utilized for releasing departures with wake turbulence category 'Light', normally, there would be no need for providing wake separation to the departure from Runway 11L with respect to a heavier arrival on Runway 11R considering the departure will require a takeoff run more than 470 meters or 740 meters respectively and will lift beyond the point abeam to the touchdown point of the heavier arrival on RWY 11R. However, if such departure requires take-off run less

than 470 meters or 740 meters as the case may be, then the wake turbulence separation will be applicable.

Similarly, if R7/T7 or R6/T6 holding points are utilized for releasing departures with wake turbulence category 'Medium' or "Heavy", normally, there would be no need for providing wake separation to the departure from Runway 11L with respect to the heavier arrival on Runway 11R considering the departure will require a takeoff run more than 830 meters and will lift beyond the point abeam to the touchdown point of the heavier arrival on RWY 11R. However, if such departure requires take-off run less than 830 meters, then the wake turbulence separation will be applicable.

Note: A NOTAM stipulating the requirement of crew to notify the ATCO about the above requirements at the time of pushback will be published separately. ATCOs should use this information for planning the Holding Point and application of wake turbulence separation.

5.4. Preferred Entry Taxiways

As shown in Annexure 2, Taxiways R5, R6 and R7 should be used as preferred entry taxiways for departures lining up Runway 11L. Taxiway R5/R6 may be used as preferred entry point for departures with wake turbulence category 'Light' or 'Medium'. Similarly, Taxiways R7 may be used as preferred entry point for departures with wake turbulence category 'Heavy' or 'Medium'.

5.5. Preferred Ground Traffic flow

For an indicative ground traffic flow showing the preferred entry points, vacation points and crossing points during Four Runway Easterly mode of operations, Refer Annexure 2.

6. Ground Movement and taxiing restrictions

6.1. Aircraft taxiing on taxiway 'Z', 'A' or 'R' are not permitted to taxi behind another aircraft holding at holding point RWY 11L/29R.

6.2. Arrivals on Runway 29L should use taxiway 'T7' or 'T6' as preferred crossing points of Runway 29R/11L, and arrivals on Runway 11R should use taxiway 'S5' or 'S6' as preferred crossing point of Runway 11L/29R to route to the arrival stand. The use of above-mentioned crossing points provide the following inherent advantages:

i. It reduces ground conflicts and gives adequate time to the SMC controller for better traffic planning on the Taxiways and within the apron.

ii. To mitigate/reduce the severity of potential conflict in case of runway incursion by reducing the risk of high energy collision.

6.3. In westerly mode of operations, due to the limited space on taxiway 'Z' to hold aircraft, normally not more than 2 aircraft should be permitted to hold south of runway 29R for crossing after landing on Runway 29L. Hence, Tower-South 2 controller should endeavor to give unimpeded taxi to crossing aircraft. While giving the Runway crossings, traffic information should be passed to any aircraft which is lined up on Runway 11L/29R. The Tower-South 1 (Runway 29L) controller should instruct the arrival vacating via TWY Z2 or Z3 to turn left on TWY Z and hold short of TWY T6.

Depending on the number of arrivals required to be held at the holding point Runway 29R for crossing, the Tower-South 2 (Runway 29R) controller will give further taxi instructions to the arrival for Holding Point T7 or T6. As an example, the first arrival landing on Runway 29L may be cleared to T7 holding point Runway 29R and the second arrival landing on Runway 29L may be cleared to T6 holding point Runway 29R. This will allow the Runway 29R controller to accommodate 2 Runway crossings at once. Aircraft holding on Runway Holding Point on T7 and T6 can be given crossing simultaneously via R7 and R6 respectively. Aircraft should be cleared for further taxi via 'R7-Q hold short of A' and 'R6-R-Hold short of A' by the Tower South-2 controller and then changed to the SMC controller. In case, after crossing, it is not possible to give unimpeded taxi to the arrival via TWY R or TWY Q, the runway vacation report may be taken by the pilot or verified on the ASMGCS before issuing the take-off clearance to the departure.

Note: The Tower-South 2 (Runway 29R) controller should instruct the arrival aircraft to taxi to holding point 'T7' or 'T6' at the earliest, so that the Runway 29L vacation via TWY 'Z3' or 'Z2' is not blocked for the subsequent arrivals. However, the Runway crossing may be given when there is sufficient spacing. Any constraints foreseen in non- availability of exit taxiway of Runway 29L due to any reason should be mutually coordinated between arrival-29L and departure-29R controllers.

6.4. In easterly mode of operations, depending on the number of departures holding at Holding Point Runway 11L, their type, the inter-arrival spacing on Runway 11R, up to 4 arrivals landing on Runway 11R may be held at the holding point Runway 11L to release departures in each 4 NM inter-arrival spacing. The Tower-South 1 (Runway 11R) controller should instruct the arrival vacating via TWY Y1, Y2 or Y4 to turn right on TWY Z and hold short of TWY S5.

Depending on the number of arrivals required to be held at the holding point Runway 11L for crossing, the Tower-South 2 (Runway 11L) controller will give further taxi instructions to the arrival for Holding Point S6 or S5. As an example, the first 2 arrivals may be cleared to S6 holding point Runway 11L and the subsequent 2 arrivals may be cleared to S5 holding point Runway 11L. All the 4 aircraft may be accommodated for simultaneous crossing and given further unimpeded taxi on TWY A or C to expeditiously clear the Runway 11L. Phraseologies like 'Give Way', 'Follow', 'Behind' etc. may be used while simultaneously giving crossing to multiple aircraft via different crossing points. In case, after crossing, it is not possible to give unimpeded taxi to the arrival via TWY A or TWY C, the runway vacation report may be taken by the pilot or verified on the ASMGCS before issuing the take-off clearance to the departure.

Note: The Tower-South 2 (Runway 11L) controller should instruct the arrival aircraft to taxi to holding point 'S6' or 'S5' at the earliest, so that the Runway 11R vacation via TWY 'Y4', 'Y2' or 'Y1' is not blocked for the subsequent arrivals. However, the Runway crossing may be given when there is sufficient spacing. Any constraints foreseen in non- availability of exit taxiway of Runway 11R due to any reason should be mutually coordinated between arrival-11R and departure-11L controllers.

The SMC-South controller should keep in mind such crossing aircraft traffic while giving taxi instructions to incoming traffic via Eastern Link TWY 'A'.

6.5. To mitigate the risk of runway incursion by the arrivals landing on Runway 11R/29L and crossing Runway 11L/29R:

i. All the read back of Runway crossing instructions and Runway Holding position instructions is required by the pilots and should be carefully monitored. The compliance of such instructions should be correlated by increased surveillance visually or via ASMGCS in low visibility conditions or night.

ii. The stipulated strip management procedures shall be strictly adhered to i.e. the arrival crossing the departure runway shall be brought to the relevant Runway zone. The traffic information about arrival crossing the Runway should be passed to the lined-up/ lining-up departure to enhance the situational awareness of all the stakeholders.

Note: Due to the limitation in Indra automation system, wherein two (or more) TEFS of the same RWY cannot be brought in the Runway zone, the Tower-South 2 (Runway 11L/29R) controller should place the TEFS of the aircraft in the Runway zone of the arrival aircraft which is expected to cross and vacate the Runway at the last.

iii. The stopbars of Runway 11L/29R shall be operated at all times. The crossing lights of Runway 11L/29R shall be operated during night and LVP operations. In case of unserviceability of stopbars or crossing lights, such caution should be included in the ATIS.

6.6. To mitigate the risk of inadvertent entry of an aircraft on the Eastern Links (A and C), the SMC controller shall monitor the read back very carefully containing taxi instructions on Eastern Links. Progressive taxi instructions specifying the first or second left/right turn while joining Eastern Links may be used. The ATCO should scan the target on ASMGCS or visually monitor the aircraft while it is joining the Eastern Links. The assistance of Follow Me vehicles may be taken whenever required.

7. Releasing Departures with respect to Arrival on Dependent Runway

7.1. General Conditions

i. The tower controllers working in the Northern Runway System should keep the ILS window of both the Runways (Runway 09 & Runway 10 in easterly mode and Runway 27 & Runway 28 in westerly mode) open in the SDD and ASMGCS.

ii. The tower controllers working in the Southern Runway System should keep the ILS window of both the Runways (Runway 11L & Runway 11R in easterly mode and Runway 29L & Runway 29R in westerly mode) open in the SDD and ASMGCS. This would help in early detection of an arrival aircraft wrongly aligning on the closely spaced parallel departure Runway (Runway 29R in westerly mode and Runway 11L in easterly mode) at the last moment and the corrective actions can be taken in time. The tower controller handling arrivals shall correlate the position of arrival and its profile with respect to intended arrival runway on ILS window and visually while issuing the landing clearance, so that any last-minute wrong alignment to departure runway can be identified for appropriate action.

iii. The tower controller handling arrivals shall specify Runway while issuing continue approach or landing instructions. Similarly, the tower controller handling departures shall specify the

Runway while issuing the Line-Up/ Take-off or crossing instructions. The read-back of such instruction should be carefully monitored due to closely spaced geometry, near similar runway designation and high intensity Multi runway operations. The compliance of such instructions should be correlated by increased surveillance visually or via ASMGCS in low visibility conditions.

iv. In the northern Runway system, in case any arrival aircraft on ILS (Runway 27 or Runway 10) is not maintaining a normal approach profile, the Approach controller should coordinate with both the Aerodrome controllers (North and Middle). Similarly, in the southern Runway system, in case any arrival aircraft on ILS (Runway 29L or Runway 11R) is not maintaining a normal approach profile, the Approach controller should coordinate with both the Aerodrome controllers (South-1 and South-2). When any of the Tower controllers observe the abnormal profile of the arrivals, the same shall be immediately coordinated with the other Tower controllers and Approach controllers for appropriate actions.

    Note: The approach controller should first coordinate with the departure runway controller in case there is a need to hold the departure.

v. In case any aircraft (on Runway 27 or Runway 10 in the Northern Runway System/ Runway 29L or Runway 11R in the southern runway system) initiates a missed approach, the Aerodrome controller (Runway 27 or Runway 10 in the Northern Runway System/ Runway 29L or Runway 11R in the southern runway system) shall:
    a) Pass the essential traffic information to the aircraft carrying out missed approach, if there is a departure from the segregated dependent Runway (Runway 28 or Runway 09 in the northern runway system/ Runway 29R or Runway 11L in the Southern Runway system).
    b) Inform the Aerodrome controller of the Departure Runway.
    c) Inform the Approach Controllers (Approach Departure and Final Approach).

vi. In case of a missed approach by an aircraft on Runway 27 or Runway 10 in the Northern Runway System/ Runway 29L or Runway 11R in the Southern runway system, Aerodrome Controller (Runway 28 or Runway 09 in the northern runway system/ Runway 29R or Runway 11L in the Southern Runway system) shall pass traffic information to the departure from the dependent Runway (Runway 28 or Runway 09 in the northern runway system/ Runway 29R or Runway 11L in the Southern Runway system), if any and coordinate the same with the Approach controller.

    Note: Passing of essential traffic information to both aircraft (arrival going around and the departure taking-off) in segregated dependent mode is required for the situational awareness of both the pilots are maintaining different frequencies and following a near similar profile.

vii. In case of situations other than detailed in the SOP, the controller should use his best judgment to handle it.

7.2. Nominal Inter-Arrival Spacing

Arrival Runway	Inter-Arrival Spacing without Departure	Inter-arrival Spacing to release Departure (Category C or higher) from Segregated Dependent Runway	Remarks
10	4 NM	4NM	Departure From Runway 09
27	4 NM	4NM	Departure From Runway 28
11R	3.5 NM	4 NM	Departure From Runway 11L
29L	3.5 NM	5 NM	Departure From Runway 29R

7.3. Distance-Based Spacing (DBS)

The departure on the segregated dependent Runway should not be permitted to commence take-off until the preceding arriving aircraft on segregated dependent Runway has landed.

Departure Runway	Arrival Runway	Category of Aircraft	Position of Arrival when the take-off clearance should be cancelled if Departure has not commenced Take-off Roll
09	10	A, B	4 NM
		C or Higher	3 NM
28	27	A, B	4 NM
		C or Higher	3 NM
11L	11R	A, B	4 NM
		C or Higher	3 NM
29R	29L	A, B	5 NM
			4 NM (Departure from P2/ R1 intersection)
		C or Higher	4 NM

Note1: The type and actual ground speed of the arriving aircraft shall be considered while issuing take-off clearance.

Note2: The Aerodrome Controller shall coordinate with the Approach Controller if there is any requirement for spacing in addition to the nominal spacing.

7.4. Time-Based Spacing (TBS)

i. **This procedure is not applicable for Code 'A', Code 'B' and Code 'F' departures.** In such cases, distance based inter-arrival spacing shall be used for releasing a departure from the dependent Runway.
ii. ASMGCS, ASR (ELDIS1 and ELDIS2) and Situation Data Display (SDD) at Tower position must be serviceable and TTT information should be continuously displayed on the ASMGCS screen.
iii. This procedure shall not be used during LVP.
iv. This procedure shall not be used for VVIP and Emergency/ priority flights.

v. The departure should not be permitted to commence take-off until the preceding arriving aircraft on dependent Runway has landed.

vi. For Releasing departures from **Runway 09, Runway 28 and Runway 11L,** the take-off clearance may be cancelled if the departure has not commenced its takeoff roll and the succeeding arrival on the dependent Runway has a **Time to Threshold (TTT) value of 01:15 (75 seconds).**

vii. For Releasing departures from **Runway 29R,** the take-off clearance may be cancelled if the departure has not commenced its takeoff roll and the succeeding arrival on the dependent Runway has a **Time to Threshold (TTT) value of 01:30 (90 seconds).**

Note 1: The Aerodrome Controller shall coordinate with the Approach Controller if there is any requirement or spacing in addition to the nominal spacing.

Note 2: While issuing the take-off clearance, the controller should keep in mind various factors like the position of aircraft, its state of readiness, time taken in issuing the clearance, the read-back time, and the pilot reaction time etc.

8. Dependency between Departures and Departures

8.1. Simultaneous departures are permitted from any runway of Northern Runway System and another runway of Southern Runway System, when the departures are following the published RNAV SIDs or Non RNAV instructions, except when:

i.ASR (ELDIS1 and ELDIS2) is not available.

ii. CAT-II/CAT-III/LVTO operations are in progress.

iii. There is a VVIP movement.

iv. There is bad weather in the Approach and/or take-off path.

v. Cross wind component exceeds 10kts.

8.2. Simultaneous departures from RWY 27 and RWY 28, RWY 29L and RWY 29R, RWY 09 and RWY 10, RWY 11L and RWY 11R are not permitted.

8.3. Whenever approach departure position is not manned, simultaneous departures from RWY 28 and RWY 29R, RWY 09 and RWY 11L may be released in coordination with approach (APAA).

9. Dependency between Arrivals and Arrivals

9.1. Simultaneous independent approaches are not permitted on any two RWYs.

9.2. Dependent parallel ILS approaches on any two RWYs are permitted subject to Separation minima of 1000 ft. vertical or 3 NM horizontal separation, applicable between two arrivals during turn-on to parallel ILS localizer courses and between successive arrivals on adjacent ILS localizer courses.

9.3. In case, ILS of one runway becomes unserviceable or is not available, the aircraft can be cleared for any alternate non-precision approach subject to maintaining separation minima of 1000 ft. vertical or 5 NM horizontal separation with respect to aircraft established on the final approach track of an adjacent runway.

9.4. The arriving aircraft may be vectored and sequenced for approach to the pair of RWY by a single final controller.

9.5. The sequence of arrivals on two runways shall be considered as one stream for the purpose of sequencing.

9.6. In case of likely reduction in separation minima between aircraft on adjacent localizers, the succeeding aircraft will be asked to Go-Around by the radar controller himself or through Tower controller. Tower controllers will inform Approach Departure (APAD) and will release departure from the same/ dependent runway after coordination with Approach Departure (APAD).

10. ASR (ELDIS1 and ELDIS2) Requirement

10.1. When ASR (ELDIS1 and ELDIS2) is unserviceable, the minimum spacing between arrivals shall be kept as 5NM or the spacing provided in a particular mode whichever is more, as the Radar separation is 5 NM within 60 NM of Radar head when ASR is unserviceable.

10.2. AS the ILS window will not be available, descent of all aircraft shall be continuously monitored when the aircraft is established on Glide Path.

10.3. Due to the slow rate of update, controllers must be careful in providing minimum separation.

10.4. Due consideration must be given for ground speed and rate of descent of aircraft.

10.5. Simultaneous departures from any two runways are not permitted.

10.6. Dependent parallel approaches on Two RWYs may be continued with minimum radar separation of 5 NM between two arrivals during turn-on to parallel ILS Localizer courses and between successive arrivals on adjacent ILS localizer courses.

11. Limitations, Suspension and Termination

11.1. Due to the limited availability of Logical sectors in Tower, the fourth Runway will be assigned the logical sector of VIP tower. During the VVIP movement, the Four Runway mode of operations shall be suspended to make available the logical sector for VIP position. The assignment of the logical sectors should be initiated by the tower supervisor with WSO/ CMD well in advance and the WSO shall assign the logical sector to VIP Tower position well in advance so that VVIP movement is not affected in any way. When the VVIP movement is completed, the Four Runway Operations may be resumed by changing the assignment of logical sector.

11.2. Four Runway mode of operations shall be suspended and segregated independent modes of operations or single RWY operations may be conducted whenever:

i.Surveillance services are not available in approach,

ii. Visibility falls below aerodrome operating minima for any of the Runways.

iii. ASMGCS is not available, and visibility falls below 2000 meters,

iv. Any of the SDD at working Tower position is unserviceable.

11.3. The tower supervisor in consultation with and approval of WSO may suspend, terminate or implement any mode of operation in the interest of Flight safety and efficiency of operations considering various factors including weather /VVIP movement/special conditions/equipment degradation/emergency handling / aircraft accident/closure of any part of manoeuvring area/manpower etc.

This is issued for the information, guidance and compliance by all the ATCOs.

Jt.GM (ATM-SQMS)
For GM (ATM), IGIA