Final Report

on

Serious Incident

between

M/s British airways Ltd., B787-9

&

M/s Thai Airways Ltd., B777-300

at

Delhi

on

07.10.2017.

K Ramachandran
Assistant Director
Investigator

Dr. Jitender Loura
Deputy Director
Investigator - in - Charge

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 incident shall be the prevention of incidents and not apportion blame or liability.

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

Glossary

AAIB	Aircraft Accident Investigation Bureau, India
AGL	Above Ground Level
AIP	Aeronautical Information Publication
AOP	Air Operator Permit
APAC	Approach Arrival Radar Controller
APST	Approach Final Radar Controller
ATCO	Air Traffic Control Officer
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot Licence
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CPL	Commercial Pilot License
DFDR	Digital Flight Data Recorder
ICAO	International Civil Aviation Organization
IATA	International Air Transport Association
IFR	Instrument Flight Rule
MHz	Mega Hertz
MSN	Manufacturer Serial number
MTOW	Maximum Take Off Weight
NOTAM	Notice to Airmen
PIC	Pilot In Command
Pax.	Passenger
QFE	Query: Field Elevation
QNH	Query: Nautical Height
RESA	Runway End Safety Area
R/T	Radio Telephony
VHF	Very High Frequency
UTC	Co-ordinated Universal Time

INDEX		
CONTENTS		**PAGE No.**
	SYNOPSIS	02
1	**FACTUAL INFORMATION**	04
1.1	HISTORY OF THE FLIGHT	04
1.2	INJURIES TO PERSONS	07
1.3	DAMAGE TO AIRCRAFT	07
1.4	OTHER DAMAGE	07
1.5	PERSONNEL INFORMATION	07
1.6	AIRCRAFT INFORMATION	07
1.7	METEOROLOGICAL INFORMATION	09
1.8	AIDS TO NAVIGATION	09
1.9	COMMUNICATIONS	09
1.10	AERODROME INFORMATION	10
1.11	FLIGHT RECORDERS	11
1.12	WRECKAGE AND IMPACT INFORMATION	11
1.13	MEDICAL AND PATHOLOGICAL INFORMATION	11
1.14	FIRE	11
1.15	SURVIVAL ASPECTS	11
1.16	TESTS AND RESEARCH	11
1.17	ORGANISATIONAL & MANAGEMENT INFORMATION	11
1.18	ADDITIONAL INFORMATION	12

Final Report on Serious Incident between M/s British Airways Ltd. B787-9 & M/s Thai Airways Ltd. B777-300 at Delhi on 07.10.2017.

1. Aircraft

Type : B787-9 (British Airways)/ B777-300 (Thai Airways)

Nationality : British/Thailand

Registration : G-ZBKF (British Airways)/ HSTKC (Thai Airways)

2. Owner/ Operator : M/s British Airways Ltd. / M/s Thai Airways

3. Pilot – in –Command : ATPL Holder for both British Airways and Thai airways

Extent of injuries : Nil

4. First Officer : CPL Holder for both British Airways and Thai Airways

Extent of injuries : Nil

5. Place of Incident : Within 02 NM of IGI Airport's climb out area.

6. Date & Time of Incident : 07th October 2017, 18:24 UTC

7. Last point of Departure : London for British Airways and New Delhi for Thai Airways

8. Point of intended landing : New Delhi for British Airways and Bangkok for Thai Airways

9. Type of operation : Scheduled Operation for British Airways & Thai Airways

10. Crew on Board : 03+11 (British Airways) and 04+20 (Thai airways)

Extent of injuries : Nil

11. Passengers on Board : 216 (British Airways) and 234 (Thai Airways)

Extent of injuries : Nil

12. Phase of operation : Missed Approach for British Airways & Departure for Thai Airways

13. Type of Occurrence : Air Proximity

(ALL TIMINGS IN THE REPORT ARE IN UTC)

SYNOPSIS

On 07.10.2017, British Airways flight BAW143, aircraft B787-9, from London to New Delhi was given interception by Approach Radar Controller [APST] and the flight BAW143 established on ILS Rwy 29. The aircraft was changed over to Tower South Controller at frequency 125.85 MHz at approximately 10 NM from touchdown. As per ATC, since interception, BAW143 continued to maintain speed of 200[1] kts whereas BAW143 was observed to be reducing speed[2] from 205 Kts at 20 Nm from touch down, 194 kts at 12 Nm from touch down, 185 kts at 10 Nm from touch down,183 Kts 7.5 Nm from touch down and 176 kts at 5 Nm from touch down. The inter arrival spacing between BAW143 and the preceding arrival, Airbus 321 aircraft flight AIC014 was observed to 6.5 NM[3] with the speed of preceding aircraft (AIC014) as 140 kts and succeeding aircraft (BAW 143) as 200 kts (with a speed differential of 60 kts)

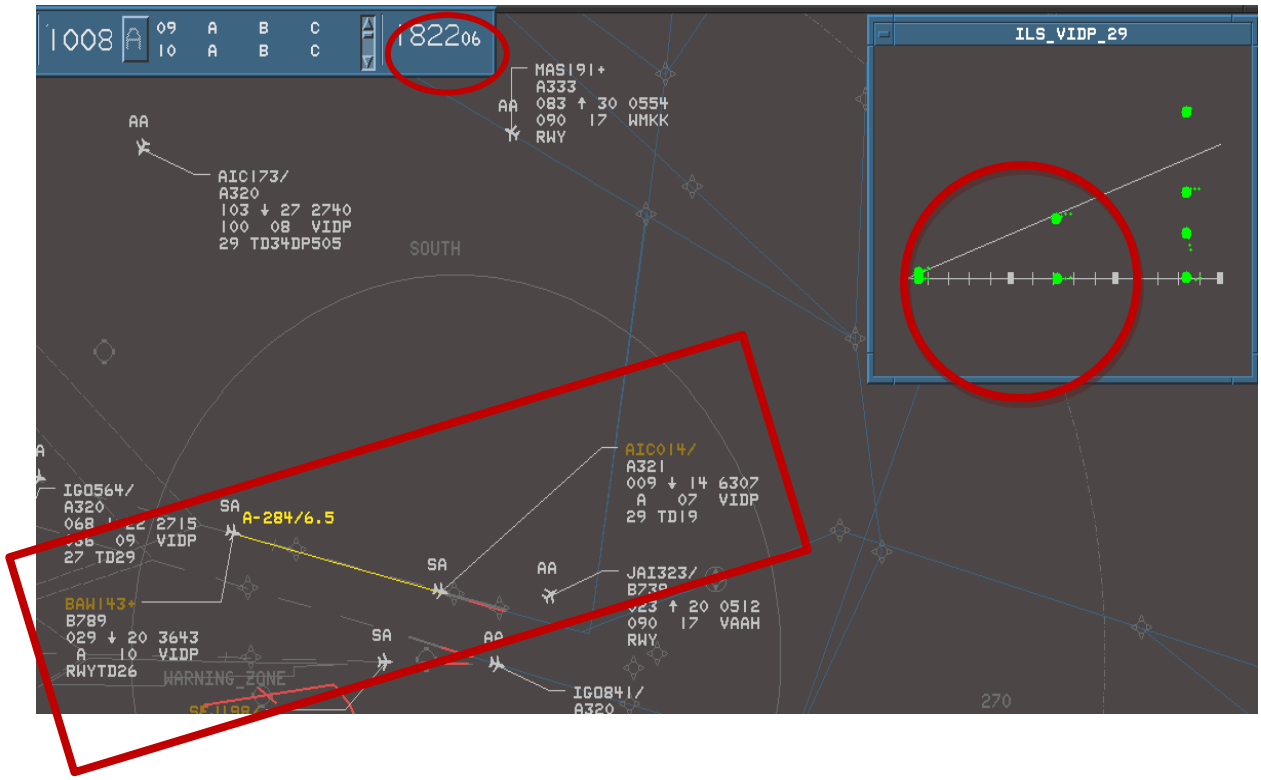

Figure 1: Showing inter-arrival spacing of BAW143 with speed of 200kts as 6.5 NM with speed differential of 60 Kts

[1] ATC Radar replay and Tabular chart provided by ATC, Delhi
[2] FDM data of G-ZBKF (BAW 143)
[3] Approach – Arrival Radar Snap Shot at time 18:22:06 UTC

The inter arrival spacing between arriving flight BAW143 and departing Thai flight THA316 was 6NM, when THA316 was lining up. This inter arrival spacing was actually further reduced and was approximately **5.27 NM,** taking into consideration the high speed of BAW143, the displaced threshold of RWY29 by 1460 M and CE2 intersection departure [110 M from beginning of Rwy 29] by THA316.

The Aerodrome Controller without taking into consideration the speed of arriving BAW 143, the reduced inter arrival spacing and displaced threshold of RWY29 lined up and cleared the departing THA316 for CE2 intersection takeoff. The departing THA316 also took some time on the runway before commencing takeoff roll.

In the meantime, the arriving BAW143, which was approaching threshold of RWY29, initiated missed approach at less than 01 NM from touchdown [approximately from the beginning of Rwy 29].

This simultaneous going around of the BAW143 and the departure of THA316 from Rwy 29 resulted in the breach of standard separation. The lateral and vertical separation was reduced to less than 01 NM and 200 feet respectively. The departing THA316 was restricted in climb to 2600 feet and changed over to approach arrival (APAC) controller at 126.35 MHz. The going around aircraft, BAW143 was asked to expedite climb to 3600 feet and in coordination with approach arrival radar controller, given a left heading of 180. BAW143 was changed over to approach arrival radar (APAC) at 126.35MHz.

Thereafter the flights were uneventful with no injuries to persons on board either aircraft.

Director General, Aircraft Accident Investigation Bureau appointed Investigator –in-charge vide order number AV-15020/13/2017-AAIB dated 11.10.2017, to investigate the cause of the Serious Incident under Rule 11 (1) of Aircraft (Investigation of Accidents and Incidents), Rules 2017 comprising of Dr. Jitender Loura, Assistant Director, AAIB as Investigator-in-Charge and Shri K Ramachandran, Air Safety Officer, AAIB as Investigator.

1. FACTUAL INFORMATION

1.1 History of the flight

On 07.10.2017, British Airways flight BAW143 from London to New Delhi came in contact with approach [APST] radar controller at frequency 124.2 MHz at 18:10:24 UTC and was vectored for ILS approach Rwy 29. The flight BAW143 was changed over to Aerodrome Controller-South at 10 NM from touchdown. The APST radar Controller didn't ask the British Airways flight BAW143 to reduce speed[4] to the published approach speed to maintain inter arrival spacing of 7 NM. The Captain of BAW143 recalls that the approach was subject to radar vectors and speed control from ATC, but due to the time elapsed since the event, cannot recall the exact speeds requested or flown[5].

The Tower South Controller gave line up to Thai Airways flight THA316 for CE2 intersection[6] departure at time 18:21:57 when the arriving BAW143 was approximately at 7 NM from touchdown with speed of 200[7] kts/183[8] Kts.

Tower South Controller cleared THA316 for CE2 intersection takeoff at time 18:23:02 when the arriving BAW143 at 4 NM from touchdown with speed of 160 kts. Crew of THA316 stated that after receiving clearance to line up on runway 29, Pilots carried out standard operation procedure (SOP) as normal. After received take off clearance from ATC and checklist had been completed, pilot took off as normal without delay.[9] The departing THA316 appears to take some time on the runway before starting takeoff roll. At time 18:24:28, BAW143 reported going around[10].

The minimum lateral and vertical separation reduced to less than 01 NM and 200 feet respectively. The tower Controller passed traffic information[11] to BAW143 about departing THA316. The Tower Controller restricted the climb of THA316[12] to 2600 feet and asked

[4] ATC Tape transcript of APST Radar frequency 124.2MHz
[5] Statement of Crew of BAW143
[6] ATC tape transcript of Tower frequency 125.85 MHz
[7] Radar Snap Shots and tabular data of ATC, Delhi
[8] FDM data of G-ZBKF (BAW 143)
[9] Statement of Crew of THA316.
[10] ATC tape transcript of Tower frequency 125.85 MHz
[11] ATC tape transcript of Tower frequency 125.85 MHz
[12] *ibid*

BAW143[13] to expeditiously climb to 3600 feet and gave left heading 180 in coordination with Approach Radar Controller at 126.35 MHz. Thereafter the flights were uneventful.

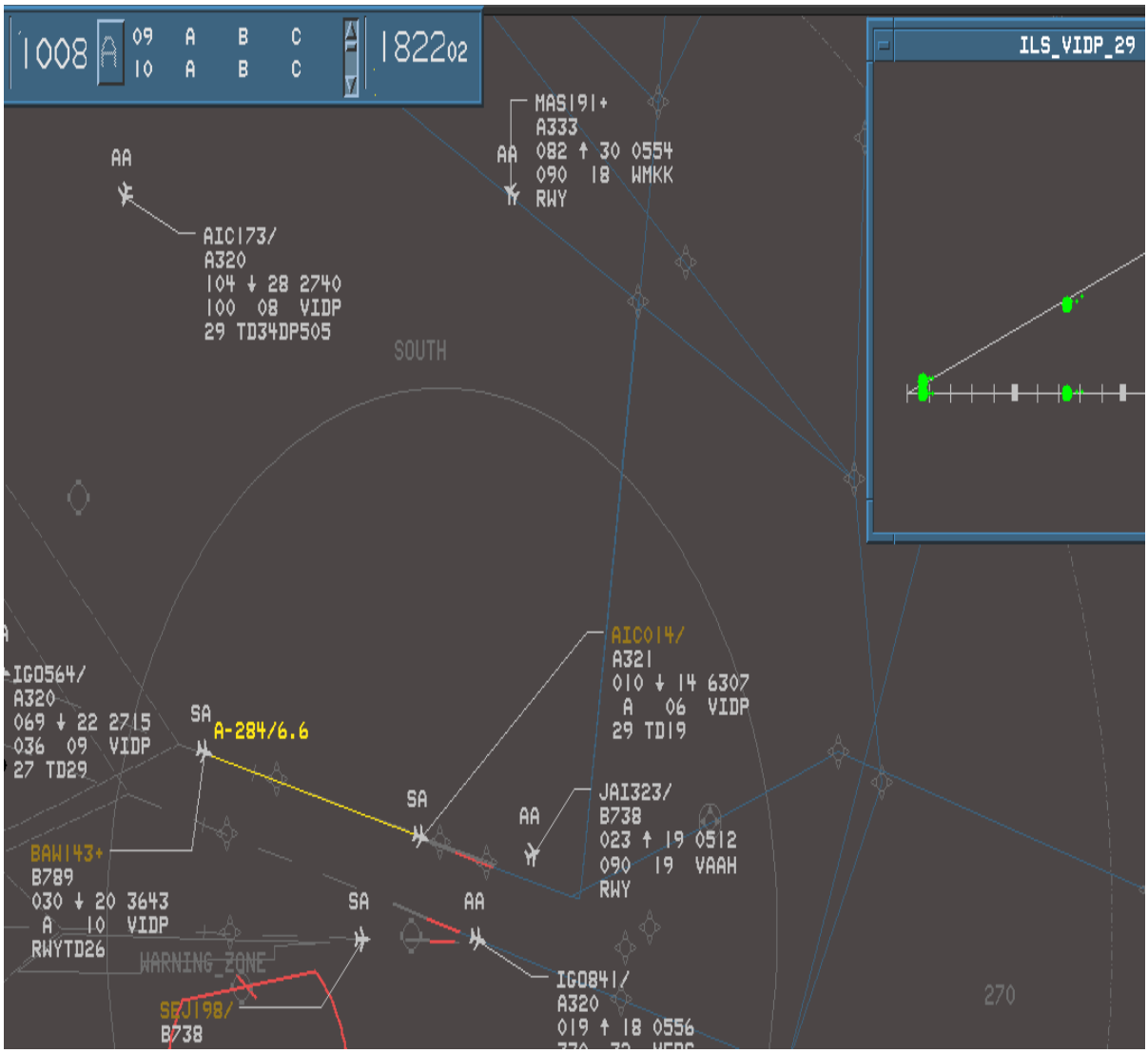

Figure 2: Tower Controller giving lineup to THA316 when BAW143 at 7NM from touchdown

[13] *ibid*

Figure 3: Simultaneous Go Around of BAW143 and departure of THA 316 from Rwy29

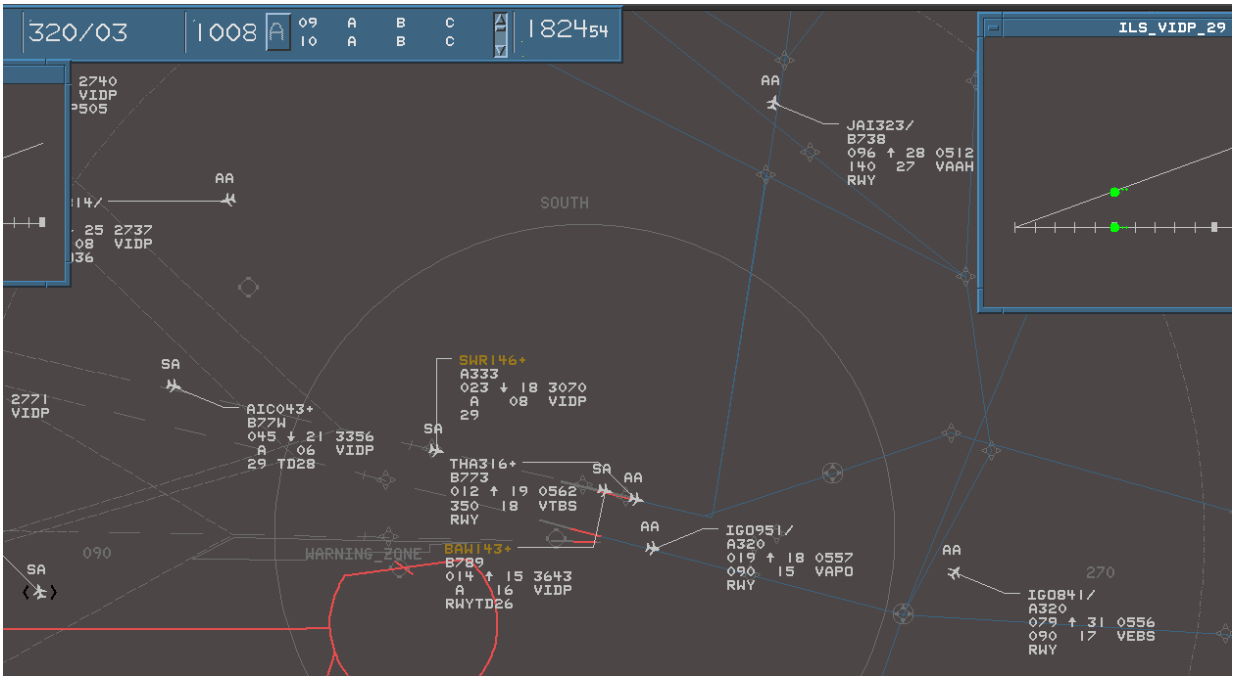

Figure 4: BAW143 going around and THA 316 departing Rwy29 simultaneously.

1.2 Injuries to persons

INJURIES	CREW	PASSENGERS	OTHERS
FATAL	Nil	Nil	Nil
SERIOUS	Nil	Nil	Nil
~~MINOR~~/**NONE**	(03+11) British Airways (04 +20) Thai Airways	216 British Airways 234 Thai Airways	Nil

1.3 Damage to aircraft Nil

1.4 Other damage Nil

1.5 Personnel information

Both the flights i.e. BAW143 and THA316 were operated by scheduled airlines and all the flight crew were appropriately licensed. The crew of both the airlines fulfilled all the requirements of concerned State for operating the flight.

Both the Air Traffic Controllers i.e. the Aerodrome Controller and the Approach Radar Controller (APST) were authorized to handle R/T in the procedural and Radar environment respectively. Both the Aerodrome Controller and Approach Radar Controller had undergone the proficiency checks in the respective ATC units and were found proficient[14] to perform ATC duties.

1.6 Aircraft information

M/s British Airways Ltd. B787-9 and M/s Thai Airways Ltd. B777-300

The Boeing 787 Dreamliner is a long-haul, mid-size wide body, twin-engine manufactured by Boeing Commercial Airplanes. Its variants seat 242 to 335 passengers in typical three-class seating configurations. It is the first airliner with an airframe constructed

[14] Proficiency Check reports as obtained from GM ATC,AAI,IGI Airport.

primarily of composite materials. Boeing 787 was designed to be 20% more fuel-efficient than the Boeing 767. Boeing 787 Dreamliner's distinguishing features include mostly electrical flight systems, raked wingtips and noise-reducing chevrons on its engine nacelles. It shares a common type rating with the larger Boeing 777 to allow qualified pilots to operate both models.

The Boeing 787-9 Dreamliner which features light-weight construction. Boeing 787-9 flight systems has a key change from traditional airliners in the form of electrical architecture. The architecture is bleed less and replaces bleed air and hydraulic power sources with electrically powered compressors and pumps, while completely eliminating pneumatics and hydraulics from some subsystems.

Boeing 787-9 has a "fly-by-wire" control system similar in architecture to that of the Boeing 777. The flight deck features multi-function LCDs, which use an industry-standard graphical user interface widget toolkit (Cockpit Display System Interfaces to User Systems / ARINC 661).

Boeing 787-9 is the first major commercial airplane to have a composite fuselage, composite wings, and use composites in most other airframe components.

Boeing 787-9 is powered by two engines; these engines use all-electrical bleed less systems, eliminating the superheated air conduits normally used for aircraft power, de-icing, and other functions. The aircraft's left engine's serial Number is 10573 and was fitted on 03/11/2017. The right engine's serial Number is 10376 and never changed since new.

The aircraft B787-9 is certified in Normal (Passenger) category, for day and night operation under VFR & IFR. The maximum operating altitude is 43100 feet and the maximum Laden weight (MTOW) is 173000 Kgs. The Aircraft length is 62.8 meters. The distance between main wheels is 9.8 meters. The distance between engines is 19 meters.

Boeing 787-9 aircraft G-ZBKF (MSN 38622) had been manufactured in year 2016. The aircraft's Certificate of registration No. is G-ZBKF/R1. The Certificate of Airworthiness Number 068040/001 under "Large Aero plane category" was issued by UK, Civil Aviation Authority At the time of incident the Certificate of Airworthiness was current.

Boeing 777 is a family of long-range wide-body twin-engine jet airliners developed and manufactured by Boeing Commercial Airplanes. It is the world's largest twinjet and has a typical seating capacity of 314 to 396 passengers, with a range of 5,240 to 8,555 nautical miles (9,704 to 15,844 km). Commonly referred to as the "Triple Seven", its distinguishing features include the largest-diameter turbofan engines of any aircraft, long raked wings, six wheels on each main landing gear, fully circular fuselage cross-section and a blade-shaped tail cone. As Boeing's first fly-by-wire airliner, it has computer-mediated controls.

The Boeing 777-300 of M/s Thai Airways, HSTKC (MSN 29211) had been manufactured in year 1999. At the time of incident, the Certificate of Airworthiness and Certificate of Registration was current.

1.7 Meteorological information:

Date: 07th October 2017 and Time of Observation: 18:00 UTC

Wind	Visibility	Weather	Cloud	Temperature	Dew Point	QNH
320° 03Kts	3000 meters	HZ (Haze)	NSC	23 ° C	13 ° C	1008 hPa

1.8 Aids to navigation

All aids to navigation along with Tower South frequency 125.85 MHz, Approach (APST) frequency 124.2 MHz and approach arrival (APAC) frequency 126.35 MHz were reported working normal.

1.9 Communications

During the period of occurrence both the aircraft, B787-9 and B777-300 were in contact with ATC on approach (APST), Tower –South and Approach arrival frequency at 124.2 MHz, 125.85 MHz and 126.35 MHz respectively. There was always two -way communications between concerned ATC units and both the aircraft.

1.10 Aerodrome information

Indira Gandhi International Airport (IATA: DEL, ICAO: VIDP) is a Joint venture airport being managed by Delhi International Airport Limited (DIAL) and Airports Authority of India. The air traffic services at IGI airport are provided by AAI which includes Aerodrome Control service (ADC/SMC), Approach Control service (APP), Area Control Service (ACC), Terminal Approach Radar (TAR) and Route Surveillance Radar Service (RSR). IGI airport houses three near converging runways in the westerly direction namely Rwy 27, Rwy28 and Rwy29. On the other hand, it has three diverging runways in the easterly direction i.e. Runway 09, Rwy10 and Rwy 11. At the time of serious incident, the mode of operation at IGI airport was westerly, with all the three runways being used as:

I. Runway 29 (runway-in-use) was used for both arrival and departures.
II. Runway 28 was used for departures only.
III. Runway 27 was used for arrivals only.

Two sector plan approach sector (AA+ SA) was operational.

1.10.1 Declared Distances[15]

The declared distances concerning Rwy-in-use at the time of serious incident are

Rwy Designator	TORA (M)	TODA(M)	ASDA(M)	LDA(M)	Threshold Displaced	Remarks
29	4430	4430	4430	2970	1460	RESA = 240*120M

1.10.2 Intersection Departures Specific to Delhi[16]

The intersection departures concerning the runway-in-use are as:

Runway	Taxiway	TORA (M)
29	CE1	4417
29	CE2	4320

[15] Manual of Air Traffic Services –Part 2 table 6.4 pg 6-5
[16] Manual of Air Traffic Services –Part 2 table 6.7 pg 6-6

1.11 Flight recorders

The ATC tape recording of frequency 128.85 MHz (Tower – South), 124.2 (Approach Final controller) (APST), Direct Speech Circuit, SMGCS recordings and FDM data of G-ZBKF (BAW 143) were available for analysis.

1.12 Wreckage and impact information

There was no damage to either of the aircraft.

1.13 Medical and pathological Information

There was no reported adverse medical condition of the cockpit crew of both M/s British Airways and M/s Thai Airways.

1.14 Fire

There was no fire.

1.15 Survival aspects

The incident was survivable.

1.16 Tests and research: Nil

1.17 Organizational and management information

Both the aircraft were operated by the Scheduled International airlines viz. British Airways and Thai Airways.

Both the procedural and Radar Controllers were under the administrative control of Airports Authority of India which is responsible for Air Traffic Services at IGI airport including Route Radar Surveillance, Terminal Approach Radar, Area control Service, Approach Control Service and Aerodrome Control Service.

1.18 Additional information

1.18.1 The standard provisions vide Para 1.5 and 1.6 of ARRIVAL, DEPARTURE PROCEDURE AND RUNWAY CAPACITY ENHANCEMENT MEASURES at Section 5.2 (III) (1) of VIDP AD 2.22 of AIP India at page AD 2 VIDP-34 and 35 are applicable.

Para 1.5 inter alia states that *"Pilot **shall** complete all mandatory pre-departure checks before entering the active runway for departure so that the aircraft is in a position to take off immediately upon receipt of take-off clearance."*

Para 1.6 inter alia states that *"When the aircraft is issued with a line-up and take-off clearance at the taxi holding position it **shall** be in a position to line up and affect an immediate take- off in one continuous movement."*

1.18.2 The provisions of Para 1.8 of ARRIVAL, DEPARTURE PROCEDURE AND RUNWAY CAPACITY ENHANCEMENT MEASURES at Section 5.2 (III) (1) of VIDP AD 2.22 of AIP India at page AD 2 VIDP-35 are applicable.

Para 18 *inter-alia* states that *"If the Controller observes a delay in respect of the departing aircraft commencing its take off run after issuance of take- off clearance, the take- off clearance will be cancelled and the aircraft be advised to vacate the runway immediately at the nearest taxiway to make way for the subsequent arrival or departure. Necessary entries in this regard shall be recorded in the Log Book."*

1.18.3 The provisions of Para 29.1.3.6.2 and Para 29.1.8.3 of MATS-part 2 Page 29-3 and Page 29-7 are relevant. Para 29.1.3.6.2 *inter-alia* states that *"Approach Arrival controller shall be responsible for providing desired landing interval between arrivals."*

1.18.4 Para 29.1.8 of MATS-Part2 IGI Airport "Nominal spacing between arrivals" vide table 29-6 states that for Rwy 29, the nominal spacing between arrivals when there is a departure in between arrivals, is **7NM.** This nominal spacing comes with many riders. One relevant to this case is vide Para 29.1.8.3.

Para 29.1.8.3 inter-alia states that "the spacing between two arrivals may be increased when the speed differential between the preceding and succeeding arrivals is high."

1.18.5 The required separation standard applicable is Para 7.10.1.1 of MATS-part1 Page 7-15.

Para 7.10.1.1 inter-alia states that "a landing aircraft will not normally be permitted to cross the runway threshold on its final approach until the preceding departing aircraft has crossed the end of the runway-in-use, or has started a turn, or until all preceding landing aircraft are clear of the runway - in-use." (Figure 4A)

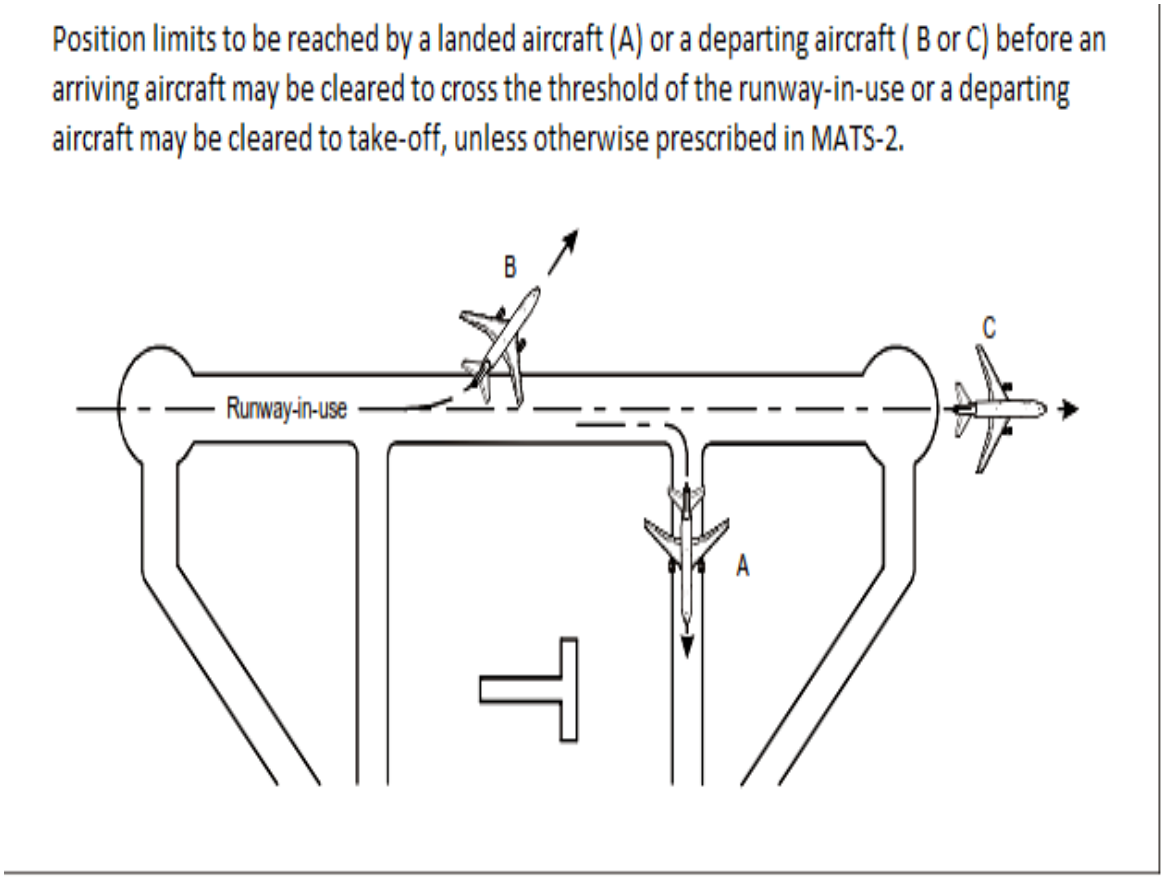

Figure 4 A: Separation between departing and arriving aircraft

1.19 **Useful and Effective Techniques** Nil

2. ANALYSIS

The analysis of ATC tape recording of frequency 128.85 MHz (Tower – South), 124.2 MHz (Approach Arrival-SA), Direct Speech Circuit and SMGCS recordings, Log books of Tower and Approach Arrival and Proficiency Check report of AAI and FDM data of G-ZBKF (BAW 143) reveal that:

1. On 07.10.2017, British Airways flight BAW143, B787, from London to New Delhi came in contact with approach final [APST] radar controller at frequency 124.2 MHz and was vectored for ILS approach Rwy 29. The aircraft was changed over to Aerodrome Controller-South at 10 NM from touchdown. At this point of time, BAW143 was number two in the arrival sequence maintaining speed of 185[17] kts. The number one aircraft Airbus 321 flight AIC014 was 3 miles from touchdown with speed of 140 kts. The inter arrival spacing, with a speed differential of 45 kts between the same type of aircrafts (Heavy/wide body), was less than 8 NM. This inter arrival spacing was continuously reducing and was 6.5 NM when the preceding aircraft was 0.5 NM from touchdown and the succeeding BAW143 was 7NM from touchdown, flying with the speed of 183 kts.

2. Approach Radar Controller[18] [APST] didn't apply the speed control restrictions.

3. The crew of BAW143 was observed to be reducing speed[19] from 205 Kts at 20 Nm from touch down, 194 kts at 12 Nm from touch down, 185 kts at 10 Nm from touch down ,183 Kts 7.5 Nm from touch down and 176 kts at 5 Nm from touch down but this speed was 20 to 25 kts higher as compared to the speed as laid down in SOP[20].

4. Tower South Controller gave line up to THA316 for CE2 intersection departure without confirming for immediate departure at time 18:21:57 when the arriving BAW143 was approximately at 7 NM from touchdown with speed of 183[21] Kts.

5. Tower South Controller cleared THA316 for CE2 intersection takeoff at time 18:23:02 when the arriving BAW143 at 4 NM from touchdown with speed of 160 kts.

[17] FDM data of G-ZBKF (BAW 143)
[18] Para 29.1.3.6.2 and Para 29.1.8.3 of MATS-part2 pg. 29-3 and pg. 29-7
[19] FDM data of G-ZBKF (BAW 143)
[20] Table 8-3: Speed Control under Radar Environment for Arriving Aircraft, MATS-Part1 pg. 8-26.
[21] FDM data of G-ZBKF (BAW 143)

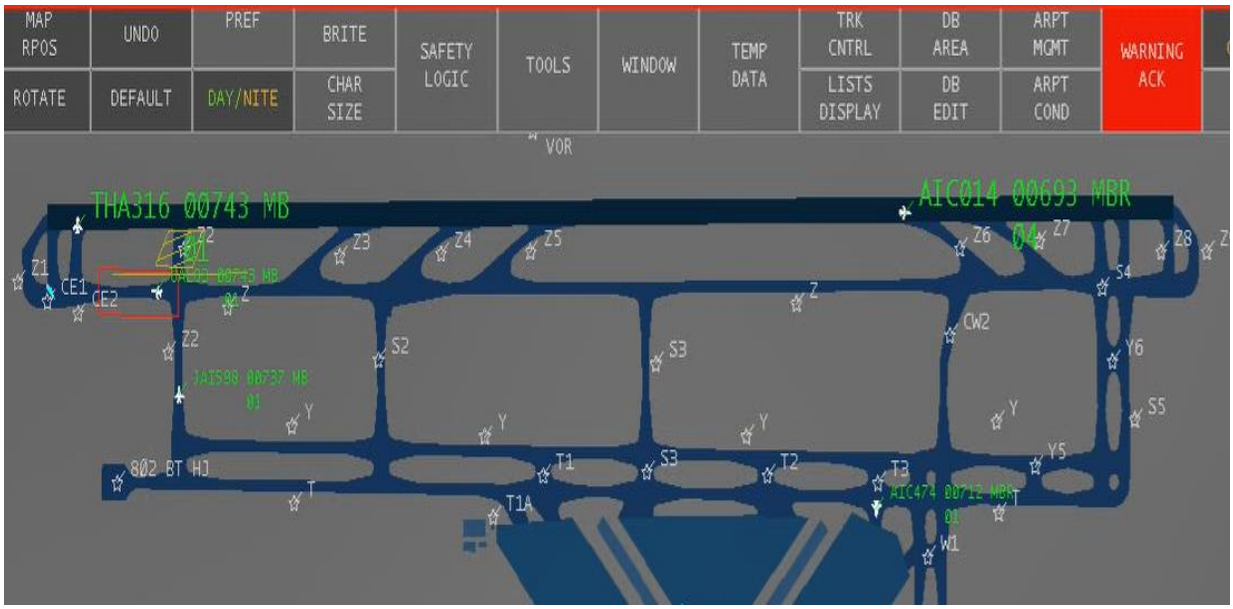

Figure 5: THA316 Lining up RWY29 via TWY CE2 & AIC014 on Runway 29 at 18:22:59

Figure 6: THA316 Lined up RWY29 via TWY CE2 & AIC014 Vacated Runway 29 Via TWY Z6 (time 18:23:24). Takeoff Clearance given at time 18:23:02-18:23:09

Figure 7: THA316 rolling RWY29 position abeam Twy Z2 at time 18:24:02

6. The departing THA316 was observed to be taking some time on the runway before starting takeoff roll. Though the Crew of THA316 have stated *"After received clearance to line up on runway 29, pilots carried out the standard operation procedure (SOP) as normal. After received takeoff clearance from ATC and Checklist had been completed, pilot took off as normal without delay"*, yet the crew of THA316 appears to not followed the standard provisions vide Para 1.5 and 1.6 of ARRIVAL, DEPARTURE PROCEDURE AND RUNWAY CAPACITY ENHANCEMENT MEASURES at Section 5.2 (III) (1) of VIDP AD 2.22 of AIP India at Page AD 2 VIDP-34 and 35.

7. The Tower Controller did not take into consideration the developing dynamic situation and didn't cancel takeoff clearance Thai Airways.. The Tower Controller did not follow the provisions of Para 1.8 of ARRIVAL, DEPARTURE PROCEDURE AND RUNWAY

CAPACITY ENHANCEMENT MEASURES at Section 5.2 (III) (1) of VIDP AD 2.22 of AIP India at Page AD 2 VIDP-35.

8. The Approach Radar Controller did not follow the provisions of Para 29.1.3.6.2 and Para 29.1.8.3 of MATS-part 2 Page 29-3 and Page 29-7.

9. *The speed differential between the preceding and succeeding arrival was high* and it was continuously above 30 kts and sometimes more than 50 kts.

10. The required standard separation as enunciated by Para 7.10.1.1 of MATS-part1 page 7-15 and depicted vide Figure 4 A: Separation between departing and arriving aircraft was not followed by Tower Controller and crew of BAW 143. In the instant case, the arriving BAW143 had crossed the threshold of RWY29 when the departing THA316 was still rolling on RWY29 abeam Twy Z4. (Figure 8).

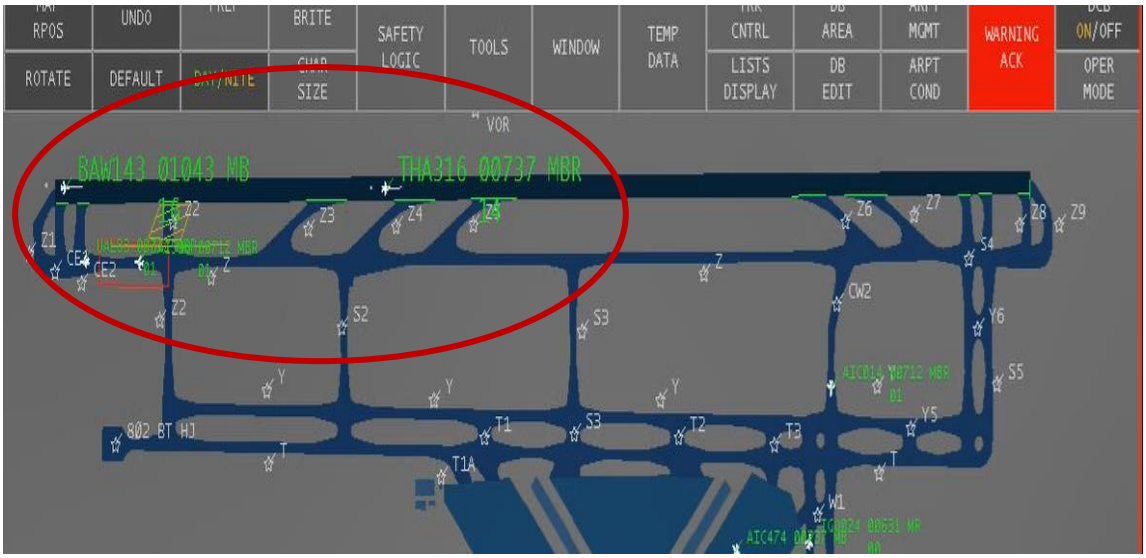

Figure 8: BAW143 at the beginning of RWY29 (Abeam CE1) (0.7 NM from touchdown) speed 160kts and THA316 rolling (abeam Twy Z4) speed 140 kts at time 18:24:21

11. At time 18:24:28, BAW143 reported going around. At this time, BAW143 had crossed threshold of RWY29 (abeam Twy CE2) and the departing/rolling THA316 was still on Rwy29 (abeam Twy Z4)

12. The minimum lateral and vertical separation reduced to less than 1 NM and 200 feet respectively.

13. The Tower Controller passed the traffic information to BAW143 about departing THA316.

14. The Tower Controller restricted the climb of flight THA316 to 2600 feet and asked the flight BAW143 to expeditiously climb to 3600 feet and gave left heading 180 in coordination with Approach Radar Controller. Thereafter the flights were uneventful.

15. The Coordination between Tower South Controller and the Approach Radar Controller was affected in non-standard Language.

16. Weather was not a contributory factor.

3. CONCLUSION

3.1 Findings

1. Both the scheduled flights were under the command of an appropriately licensed ATPL holder and FO being CPL holders.
2. The medical of all cockpit crew members was valid.
3. Traffic density with Approach Arrival Radar and Aerodrome Control South was moderate.
4. All communication facilities including approach (APST) frequency, Tower –South frequency and Approach arrival (APAC) frequency at 124.2 MHz, 125.85 MHz and 126.35 MHz respectively were reported to be working normal.

5. The crew of BAW143 was observed to be reducing speed[22] from 205 Kts at 20 Nm from touch down, 194 kts at 12 Nm from touch down, 185 kts at 10 Nm from touch down ,183 Kts 7.5 Nm from touch down and 176 kts at 5 Nm from touch down but this speed was at all the times 20 to 25 kts higher than the speed laid down in SOP.

6. No efforts were made by the approach radar controller[23] (APST) to reduce speed of the arriving aircraft.

7. The approach arrival radar Controller [APST] failed to provide *"desired landing interval between arrivals."* The nominal interval is 7NM and the spacing can be increased in cases like this where the speed differential was over 30 NM [from the interception of Localizer by BAW143 till around 5 NM from touchdown.]

8. The inter arrival spacing between arriving flight BAW143 and departing Thai flight THA316 was 6NM, when THA316 was lining up. This inter arrival spacing was actually further reduced and was approximately **5.27 NM,** taking into consideration the high speed of BAW143, the displaced threshold of RWY29 by 1460 M and CE2 intersection departure [110 M from beginning of Rwy 29] by THA316.

9. Tower South controller failed to take into consideration the high speed of the arriving aircraft BAW143 and the continuously reducing inter arrival spacing which **reduced to 5.27 NM,** before giving intersection line up to the departing THA316.

10. Tower South controller also failed to reassess the dynamic situation and didn't cancel the take-off clearance given to the departing THA316 flight.

11. Departing THA316 flight appears to have taken some time before rolling which is not in accordance to the laid down SOPs of the Airport.

12. The Coordination between Tower South Controller and the Approach Radar Controller was also affected in non-standard Language.

13. Weather was not a contributory factor.

[22] FDM data of G-ZBKF (BAW 143)
[23] Para 29.1.3.6.2 and Para 29.1.8.3 of MATS-part2 pg. 29-3 and pg. 29-7

3.2 Probable Cause

Non-adherence to the Standard Operating Procedures by the Aerodrome Controller.

3.3 Contributory Factors

1. Failure of Approach Radar Controller to provide adequate inter arrival spacing and to apply speed control methods on the arriving aircraft.
2. Failure of the Crew of flight THA 316 to adhere to the published departure procedures.
3. Failure of Crew of flight BAW143 to adhere to the published speed control norms.

4 SAFETY RECOMMENDATIONS

AAI

1. The Tower Controller be reemphasized on situational awareness and to handle such situations. The Tower Controllers should not use Non-Standard language during Coordination.
2. The Approach Arrival Controller may be made aware of inter-arrival spacing, speed control techniques and use of standard language during inter-unit coordination.

K. Ramachandran

(K. Ramachandran)
Assistant Director
Investigator

(Dr. Jitender Loura)
Deputy Director
Investigator-in-Charge

Place: New Delhi

Date: 20.11.2018

ANNEXURE-I

Phase of flight	IAS		Status	Remarks
	Turboprop	Turbojet		
Enroute and initial descent upto FL 290	N/A	250 kt or actual whichever is higher	Optional/ As per requirement of ATC	Speed less than 250 kt will be subject to concurrence of pilot
Below FL 290 and upto FL 150	250 kt or actual speed whichever is lower	250 kt or actual whichever is higher	Optional/ As per requirement of ATC	Speed less than 250 kt will be subject to concurrence of pilot. Below FL 210 speed may be reduced to 240 kt by ATC with the concurrence of pilot
Below FL 150 & within 25D to 20NM (30D to 20 NM in case of straight-in) or on Downwind	220 kt or actual speed whichever is lower	220 kt or minimum clean speed whichever is higher	Mandatory	Below 10000 ft AMSL speed may be reduced to 210 kt by ATC subject to concurrence of pilot
Within 20NM from touch down	180 kt	180 kt	Mandatory	Speed may be further reduced to 170Kt by ATC
Intercept leg or 12NM from touch-down in case of straight-in	180-160 kt	180 -160 kt	Mandatory	Speed to be reduced to 160 kt during the intercept leg
10 - 5 NM from Touchdown **	160-150 kt	160 kt	Mandatory	Turboprop aircraft unable to maintain the specified speed must inform ATC as early as possible preferably during intercept leg or when 12 NM from touchdown. ** At the time approach clearance is issued, speed restrictions shall remain applicable unless withdrawn by ATC
Within 5NM from touch down	N/A	N/A	N/A	

Table 8-3: Speed Control under Radar Environment for Arriving Aircraft

(All DME (D) Distances are from VOR and all distances in NM are from touchdown)

If below FL 70, climb and reach FL 70 before crossing 25 NM outbound from 'DPN VOR'. If higher, descend to FL 70 in 'SKA' hold

4.3.1.Leave 'SKA' VOR at FL70 to carry out published ILS/VOR DME ARC approach procedure for assigned runway.

5.PROCEDURE FOR DEPARTURES:

5.1.DEPARTURE INTENDING TO CONTINUE TO DESTINATION

Any departing aircraft experiencing RCF and intending to continue to its filed plan destination shall:

5.1.1.Continue on assigned SID or heading climbing to or maintaining cleared level or FL70, whichever is higher.

5.1.2.Three minutes after setting Mode A/C code 7600 or reaching FL 70 or cleared Flight level (if higher than FL70) whichever is later:

i.If following 'SID', continue on SID to join ATS route and climb to filed Flight level and continue as per the filed flight plan.

ii.If following Radar heading, turn (avoiding VIP 89) to join ATS route by shortest route maintaining cleared flight level/FL 70 as per para 5.1.1. After joining ATS route, climb to filed Flight level and Continue as per the filed flight plan

5.2DEPARTURE INTENDING TO LAND BACK AT DELHI:

Any departing aircraft experiencing RCF after departure and intending to land back at IGI Airport shall

5.2.1Continue on assigned SID or heading climbing to or maintaining cleared level or FL70, whichever is higher.

5.2.2Three minutes after setting Mode A/C code 7600 or reaching FL70 or cleared Flight level (if higher than FL70) whichever is later, take a turn (avoiding VIP 89) to proceed direct to 'SKA' VOR.

5.2.3If higher, descend to FL70 in 'SKA' hold.

5.2.4If required, Jettison fuel while in 'SKA' hold, taking all necessary precautions.

5.2.5Leave 'SKA' VOR at FL70 to carry out published ILS/VOR DME ARC approach procedure for assigned runway.

III.ARRIVAL, DEPARTURE PROCEDURE AND RUNWAY CAPACITY ENHANCEMENT MEASURES

The traffic has been growing at Delhi Airport at a faster rate which necessitates the optimum use of resources to meet our requirement of safe, efficient and expeditious handling of air traffic. Runway Occupancy Time has been one of the important factors affecting such requirement. The following procedures and important Aerodrome data are published (TORA/LDA from different entry/exit TWYs) which will facilitate the Airlines/Pilots in achieving minimum Runway Occupancy Time for common goal of enhancing runway capacity utilizing the existing available resources.

1.DEPARTURE PROCEDURE

1.1.The aircraft should be in a position to commence its taxi not more than five minutes after the issue of start-up clearance failing which the start-up clearance will be cancelled and the aircraft will lose its priority and be considered for start-up depending upon the traffic situation and subject to delay.

1.2.Taxiing aircraft should maintain a minimum taxiing speed of not less than 15 Knots on the straight portion of taxiways and between 8-12Kts during turning manoeuvres

1.3.Any aircraft if observed, by the Controller, to be too slow taxiing and thereby adversely affecting the efficient aircraft movement shall be taken out of the sequence and will be considered for departure as a last priority depending upon the traffic situation subject to delay.

1.4.Based on the aircraft type and its performance characteristics, ATC will issue taxiing instructions so as to depart from the nearest runway intersection from where adequate take off run is available for departure. Pilots unable to accept departure from intersection may request ATC for alternate take off position. Pilots requiring departure from the beginning of runway should make such request at the time of Push back/Start-up. However, such requests will be considered by ATC subject to delay.

1.5.Pilot shall complete all mandatory pre-departure checks before entering the active runway for departure so that the aircraft is in a position to take off immediately upon receipt of take-off clearance.

(ii)

1.6.When the aircraft is issued with a line-up and take-off clearance at the taxi holding position it shall be in a position to line up and affect an immediate take- off in one continuous movement.
1.7.When the aircraft is issued with a take- off clearance after lining up on the runway it shall commence take-off roll immediately upon receipt of take- off clearance.
1.8.If the Controller observes a delay in respect of the departing aircraft commencing its take off run after issuance of take- off clearance, the take- off clearance will be cancelled and the aircraft be advised to vacate the runway immediately at the nearest taxiway to make way for the subsequent arrival or departure. Necessary entries in this regard shall be recorded in the Log Book.
1.9.Refer AD 2.24 for charts related to Take-off Run Available from different intersections.
NOTE: With the objective of expediting the flow of traffic, ATC may authorize Departure from intersections also.

2.ARRIVALS

2.1 Pilots are reminded that rapid exit from the runway enables ATC to apply minimum spacing on final approach that will achieve maximum runway utilisation and will minimise the occurrences of 'go around'.
2.2 Pilots of small and medium aircraft are requested to consider which Rapid Exit Taxiway offers the best opportunity for a safe and expeditious exit from the runway in order to reduce delays and maximise utilisation.
2.3Aircraft are expected to vacate the runway via first available RET depending on aircraft performance.
2.4Refer AD 2.24 for charts related to the locations of exit taxiways with respect to threshold for all the runways.

IV.DELHI AIRPORT COLLABORATIVE DECISION MAKING (DA-CDM)

I BACKGROUND

1.1The Delhi Airport - Collaborative Decision Making (DA-CDM) undertaken at IGI Airport is a joint programme among all airport partners –
•Air Navigation Service Provider (ATC)
•Airline Operators (AO)
•Air Traffic Flow Management Unit (ATFMU)*
•Delhi International Airport Pvt. Limited (DIAL)
•Ground Handlers (GH)
•Support services (Police, Customs and Immigration, Air Force Movement Liaison Unit, etc.)
All the partners are required to work in close collaboration to ensure the successful operation of DA-CDM.
1.2The efficiency of the Air Transport System is highly dependent on traffic predictability. DA-CDM effectively enhances predictability (this reduces buffer times for resource planning and flight times), overall efficiency and punctuality by linking and sharing of accurate and timely information amongst Airlines, Airport Operator, ATC, etc.
1.3The primary objective of DA-CDM is to facilitate the sharing of operational data for a better informed, well planned and transparent decision making to ensure more precise overall operational processes. It leads to an optimized utilization of resources, an efficient turn round process and everyone has a common awareness of the situation.
1.4Through implementation of DA-CDM, long-lasting benefits can be reaped.
Benefits of DA-CDM are:
•Improved overall efficiency of the operation
•Reduced delays and increased punctuality
•Reduced ATFM slot wastage*
•Optimized en-route capacity
•Optimized use of the airport infrastructure
•Reduced apron and taxiway congestion
•Cost savings
•Reduction of carbon emission and noise pollution
•Enhanced predictability
•Optimized use of ground handling resources
•Optimized use of stands, gates and terminals
•Enables flexible pre-departure planning

2 TERMS AND ABBREVIATIONS

All Acronyms are time parameters which have a standard length of four characters and have been arranged as per aircraft movement sequence.
[While developing the DA-CDM procedures, the guidance material published by Euro control, ICAO and other Organizations has been used].

S. NO.	ACRONYMS	DEFINITION	EXPLANATION
2.1	ELDT	Estimated Landing Time	The estimated time that an aircraft will touchdown on the runway. (Equivalent to ATC ETA = Estimated Time of Arrival = landing).

ANNEXURE - III

VHF Tape Transcript

DATE : 07-10-2017
FREQUENCY : 125.85 MHz & On Direct Speech Circuit (DSC)
CALL SIGN : BAW143, THA316
UNIT : Tower (South), Delhi Approach Radar (AA)

TIME (HHMMSS)	UNIT	TRANSMISSIONS
181657-181706	THA316	Delhi Tower THA316
	Tower	THA316 Tower hold short of Z
	THA316	Hold short of Z, THA316
181926-181937	Tower	THA316 tower taxi via Z - CE2 - Holding point RWY29
	THA316	Taxi via Z - CE2 hold short of RWY29, THA316
182133-182144	BAW143	Tower Hello BAW143 established ILS RWy29
	Tower	BAW143 Tower continue approach RWY29 surface wind Calm
	BAW143	Continue, BAW143
182157-182206	Tower	THA316 Tower lineup RWY29 via CE2
	THA316	Lineup RWY29 via CE2, THA316
182302-182309	Tower	THA316 Tower RWY29 cleared for takeoff surface wind calm
	THA316	Cleared for takeoff RWY29 THA316
182334-182339	Tower	BAW143 continue approach departure rolling
	BAW143	Continue, 143
182428-182450	BAW143	BAW143 going around
	Tower	BAW143 Roger traffic THA B773 taking-off form RWY29
	BAW143	<Unclear> Traffic <Unclear> Heading <Unclear> missed approach
	Tower	BAW143 continue climb to 3600 feet, Expedite
	BAW143	*[Chuckling]* Expedite <Unclear> BAW143
182453-182507	***RADAR (On DSC)***	***Hanji***
	Tower	THA316, ah... stop climb 2600 feet, contact radar 126.35
	RADAR (On DSC)	***Kya ho gaya?***
	Tower (On DSC)	***Sir Go-around hai***
	RADAR (On DSC)	***Kon sa? Piche wala?***
	THA316	126.35 and stop climb 2600 feet, THA316
182507-182511	***RADAR (On DSC)***	***Ok***
	Tower (On DSC)	***Sir left heading de raha hu 180***
	RADAR (On DSC)	***Kisko... BAW ko?***
	Tower (On DSC)	***Haan Sir***
	RADAR (On DSC)	***Theek hai... de do***
182511-182523	Tower	BAW143 turn left heading 180
	BAW143	Left turn heading 180 BAW143
	Tower	BAW143 contact radar 126.35
	BAW143	12635 BAW143
182523-182529	***RADAR (On DSC)***	***Speedbir... THA ko kitna diya hai?***
	Tower (On DSC)	***Sir***

29-11-2017
Tushar Anand
Manager (ATM-SRMS)

(iv)

	RADAR (On DSC)	*THA ko kitna diya hai?*
	Tower (On DSC)	*Sir THA 2600 feet and BAW 3600 feet*
	RADAR (On DSC)	*Ok*
182531-182546	BAW143	Radar BAW143 is with you, left turn heading 180 leveling 3600 feet
	Tower	BAW143 climb to 3600 feet and Radar 126.35
	BAW143	26.35 Thank you
182547-182551	*Tower (On DSC)*	*Hanji Sir*
	RADAR (On DSC)	*VHF de do BAW ka*
	Tower (On DSC)	*haan haan Sir change kar diya*

The above transcript is specific to VHF communication between Tower (South), THA316, BAW143 on 125.85 MHz and intra-unit coordination between Tower (South) and Delhi Approach (AA) on DSC from time 1816 to 1826 UTC.

Tape Transcript prepared by:

29/11/2017

Tushar Anand,
Manager (ATM)

VHF Tape Transcript

DATE : 07-10-2017
FREQUENCY : 124.2 MHz
CALL SIGN : BAW143, THA316
UNIT : Approach Arrival (SA) / Radar

TIME (HHMMSS)	UNIT	TRANSMISSIONS
181023-181033	BAW143	Radar, Hello BAW143, descend flight level 100, heading 100
	Radar	BAW143 Radar, descend to flight level 90
	BAW143	Level 90 BAW143
181113-181118	Radar	BAW143 Radar, descend to flight level 70
	BAW143	Descend Level 70 BAW143
181307-181312	Radar	BAW143 turn left heading 015
	BAW143	Left 015 BAW143
181352-181400	Radar	BAW143 turn left heading 315 to intercept localizer RWY29
	BAW143	Left 315 intercept localizer RWY29, BAW143
181502-181510	Radar	BAW143 Radar, descend to 4000 feet QNH 1008
	BAW143	Cleared 4000 feet 1008, BAW143
181549-181600	Radar	BAW143 descend to 2600 feet QNH 1008 cleared for ILS approach RWY29
	BAW143	Descend 2600 feet cleared ILS approach RWY29, BAW143
182111-182120	Radar	BAW143 Radar 10 miles from touchdown 118.. 125.85
	BAW143	12585 BAW183, Goodbye

The above transcript is specific to VHF communication between Approach Arrival (SA) and BAW143 only on 124.2 MHz from time 1810 to 1822 UTC.

Tape Transcript prepared by:

Tushar Anand,
Manager (ATM)

The tabular presentation of ground speeds of AIC014 and BAW143 and approximate spacing between these two arrivals.

Sno.	Position of AIC014 (approx. Distance to touchdown in NM)	Ground speed of AIC014 (Kts)	Ground speed of BAW143 (Kts)	Approx. Spacing between AIC014 & BAW143 (NM)
1	5 *[REF Snapshot -BAW143_2]*	170	200	9
2	4 *[REF Snapshot -BAW143_4]*	160	200	8.1
3	3	140	200	8
4	2 *[REF Snapshot -BAW143_5]*	140	200	7.4
5	1.5 *[REF Snapshot -BAW143_6]*	140	200	7
6	1 *[REF Snapshot -BAW143_7]*	140	200	6.6
7	0.5 *[REF Snapshot -BAW143_8]*	140	200	6.5

28/12/17

Aircraft	FAA Reference Code	Approach Speed (knots)	MTW (lb.)	MTW (kg)	MLW (lb.)	MLW (kg)	Wingspan (ft.)	Wingspan (m)	Length (ft.)	Length (m)	Max Tail Height (ft.)	Max Tail Height (m)
707-320/-420	C-IV	125	316,000	143,500	207,000	94,000	142.42	43.40	152.92	46.61	42.17	12.85
707-320B	C-IV	128	333,600	152,500	215,000	97,500	145.75	44.42	152.92	46.61	42.08	12.83
707-320C	C-IV	137	336,000	152,500	247,000	112,100	145.75	44.42	152.92	46.61	42.00	12.80
717-200	C-III	133	119,000	55,338	102,000	46,269	93.33	28.40	124.00	37.80	29.67	9.00
717-200HGW	C-III	139	122,000	54,884	110,000	49,898	93.33	28.40	124.00	37.80	29.67	9.00
727-100	C-III	126	170,000	77,200	142,500	64,700	108.00	32.92	133.17	40.59	34.25	10.44
727-200	C-III	136	210,000	95,300	161,000	73,100	108.00	23.92	153.17	46.68	34.92	10.65
737 BBJ	C-III	135	171,500	77,791	134,000	60,781	117.42	35.79	110.33	33.63	41.58	12.67
737 BBJ 2	D-III	142	174,700	79,245	146,300	66,360	117.42	35.79	129.50	39.47	41.42	12.62
737 BBJ 3	D-III	144	187,700	85,139	157,300	71,350	117.83	35.90	138.17	42.10	40.75	12.42
737-100	C-III	128	111,000	50,349	99,000	44,906	93.00	28.35	94.00	28.65	37.17	11.33
737-200	C-III	130	116,000	52,617	103,000	46,720	93.00	28.35	100.17	30.53	37.25	11.35
737-200ADV/C/QC	C-III	133	128,600	58,332	107,000	48,534	93.00	28.35	100.17	30.53	37.25	11.35
737-300	C-III	135	140,000	63,503	116,600	52,889	94.75	28.88	109.58	33.40	36.58	11.15
737-300W	C-III	135	140,000	63,503	116,600	52,889	102.42	31.22	109.58	33.40	36.58	11.15
737-400	C-III	139	150,500	68,266	124,000	56,245	94.75	28.88	119.58	36.40	36.58	11.15
737-500	C-III	127	136,500	61,915	110,000	49,895	94.75	28.88	101.75	31.01	36.58	11.15
737-600	C-III	126	145,000	65,771	121,500	55,111	112.58	34.32	102.50	31.24	41.67	12.70
737-600W	C-III	126	145,000	65,771	121,500	55,111	117.42	35.79	102.50	31.24	41.67	12.70
737-700/C	C-III	132	155,000	70,307	129,200	58,604	112.58	34.32	110.33	33.63	41.58	12.67
737-700W	C-III	132	155,000	70,307	129,200	58,604	117.42	35.79	110.33	33.63	41.58	12.67
737-8	n/a-III	n/a	181,700	82,417	152,800	69,308	117.83	35.90	129.50	39.47	40.75	12.42
737-800	D-III	142	174,900	79,333	146,300	66,361	112.58	34.32	129.50	39.47	41.42	12.62
737-800W	D-III	142	174,900	79,333	146,300	66,361	117.42	35.79	129.50	39.47	41.42	12.62
737-900	D-III	141	174,700	79,243	147,300	66,814	112.58	34.32	138.17	42.11	41.42	12.62

Aircraft	FAA Reference Code	Approach Speed (knots)	MTW (lb.)	MTW (kg)	MLW (lb.)	MLW (kg)	Wingspan (ft.)	Wingspan (m)	Length (ft.)	Length (m)	Max Tail Height (ft.)	Max Tail Height (m)
737-900ER	D-III	144	188,200	85,366	157,300	71,350	112.58	34.32	138.17	42.11	41.42	12.62
737-900ERW	D-III	144	188,200	85,366	157,300	71,350	117.42	35.79	138.17	42.11	41.42	12.62
737-900W	D-III	141	174,700	79,243	147,300	66,814	117.42	35.79	138.17	42.11	41.42	12.62
747-100B	D-V	145	753,000	341,500	585,000	265,300	195.67	59.64	231.83	70.40	64.25	19.58
747-200B	D-V	152	836,000	379,100	630,000	285,700	195.67	59.64	231.83	70.40	64.25	19.58
747-200F	D-V	152	836,000	379,100	630,000	285,700	195.67	59.64	231.83	70.40	64.67	19.71
747-300	D-V	142	753,000	341,500	564,000	255,800	195.67	59.64	231.83	70.40	64.25	19.58
747-400	D-V	153	877,000	397,801	630,000	285,764	213.00	64.92	231.85	70.67	64.00	19.51
747-400 Domestic	D-V	146	613,500	278,279	574,000	260,362	195.67	59.63	231.85	70.67	64.25	19.59
747-400ER	D-V	157	913,000	414,130	652,000	295,743	213.00	64.92	231.85	70.67	64.25	19.59
747-400ERF	D-V	158	913,000	414,130	666,000	302,093	213.00	64.92	231.85	70.67	64.08	19.54
747-400F	D-V	158	877,000	397,801	666,000	302,093	213.00	64.92	231.85	70.67	64.08	19.54
747-8	D-VI	153	990,000	449,056	688,000	312,072	224.42	68.40	250.17	76.25	64.00	19.51
747-8F	D-VI	161	990,000	449,056	763,000	346,091	224.42	68.40	250.17	76.25	64.17	19.56
747SP	C-V	126	703,000	318,800	450,000	204,100	195.67	59.64	184.75	56.31	65.83	20.06
757-200/PF	C-IV	137	256,000	116,100	210,000	95,250	124.83	38.05	155.25	47.32	45.08	13.74
757-300	D-IV	142	271,000	122,930	224,000	101,610	124.83	38.05	178.58	54.43	44.75	13.64
767-200	C-IV	133	317,000	143,789	272,000	123,377	156.08	47.57	159.17	48.51	52.92	16.13
767-200ER	C-IV	140	396,000	179,623	300,000	136,078	156.08	47.57	159.17	48.51	52.92	16.13
767-300	C-IV	140	352,000	159,665	300,000	136,078	156.08	47.57	180.25	54.94	52.58	16.03
767-300ER	D-IV	145	413,000	187,334	320,000	145,150	156.08	47.57	180.25	54.94	52.58	16.03
767-300F	D-IV	147	413,000	187,334	326,000	147,871	156.08	47.57	180.25	54.94	52.92	16.13
767-400ER	D-IV	150	451,000	204,570	350,000	158,757	170.33	51.92	201.33	61.37	55.83	17.01
777-200	C-V	139	634,500	287,800	460,000	208,700	199.92	60.93	209.08	63.73	61.50	18.75
777-200LR	C-V	138	768,000	348,358	492,000	223,168	212.58	64.80	209.08	63.73	61.50	18.75

Aircraft	FAA Reference Code	Approach Speed (knots)	MTW (lb.)	MTW (kg)	MLW (lb.)	MLW (kg)	Wingspan (ft.)	Wingspan (m)	Length (ft.)	Length (m)	Max Tail Height (ft.)	Max Tail Height (m)
777-300	D-V	150	662,000	300,280	524,000	237,680	199.92	60.93	242.33	73.86	61.50	18.75
777-300ER	D-V	150	777,000	352,442	554,000	251,290	212.58	64.80	242.33	73.86	61.83	18.85
777F	D-V	149	768,800	348,722	575,000	260,816	212.58	64.80	209.08	63.73	62.33	18.99
787-8	D-V	145	503,500	228,384	380,000	172,365	197.25	60.12	186.08	56.72	56.08	17.09
787-9	D-V	153	561,500	254,692	425,000	192,777	197.25	60.12	206.08	62.81	56.08	17.09
DC-10-10	D-IV	138	433,000	196,406	363,500	164,881	155.33	47.35	182.26	55.55	58.42	17.81
DC-10-10CF	D-IV	138	443,000	200,942	363,500	164,881	155.33	47.35	182.26	55.55	58.42	17.81
DC-10-30	D-IV	149	558,000	253,105	403,000	182,798	165.33	50.39	181.60	55.35	58.58	17.86
DC-10-30CF	D-IV	149	558,000	253,105	411,000	186,427	165.33	50.39	181.60	55.35	58.58	17.86
DC-10-40	D-IV	149	558,000	253,105	403,000	182,798	165.33	50.39	182.22	55.54	58.58	17.86
DC-10-40CF	D-IV	149	558,000	253,105	411,000	186,427	165.33	50.39	182.22	55.54	58.58	17.86
DC-3	A-III	74	25,200	11,431	24,400	11,068	95.00	28.96	64.50	19.66	23.50	7.16
DC-4	B-III	94	73,000	33,112	58,200	26,399	117.50	35.81	93.90	28.62	27.60	8.41
DC-6A/B	B-III	108	107,000	48,534	88,200	40,007	117.50	35.81	105.60	32.19	28.70	8.75
DC-7C	B-IV	110	143,000	64,864	111,000	50,349	127.50	38.86	112.30	34.23	30.80	9.39
DC-8-43	C-IV	133	318,000	144,245	207,000	93,895	142.40	43.40	150.70	45.93	43.43	13.24
DC-8-55	C-IV	137	328,000	148,781	217,000	98,431	142.40	43.40	150.70	45.93	43.56	13.28
DC-8-55F	D-IV	144	328,000	148,781	240,000	108,864	142.40	43.40	150.70	45.93	43.74	13.33
DC-8-61	D-IV	144	328,000	148,781	240,000	108,864	142.40	43.40	187.40	57.12	43.23	13.17
DC-8-61F	D-IV	144	331,000	150,142	258,000	117,029	142.40	43.40	187.40	57.12	43.19	13.16
DC-8-62	C-IV	138	353,000	160,121	240,000	108,864	148.40	45.23	157.50	48.01	43.25	13.18
DC-8-62F	C-IV	138	353,000	160,121	250,000	113,400	148.40	45.23	157.50	48.01	43.32	13.20
DC-8-63	D-IV	143	358,000	162,389	258,000	117,029	148.40	45.23	187.40	57.12	43.00	13.11
DC-8-63F	D-IV	143	358,000	162,389	275,000	124,740	148.40	45.23	187.40	57.12	43.13	13.14
DC-9-15/F	C-III	132	91,500	41,504	81,700	37,059	89.40	27.25	104.40	31.82	27.58	8.40

Aircraft	FAA Reference Code	Approach Speed (knots)	MTW (lb.)	MTW (kg)	MLW (lb.)	MLW (kg)	Wingspan (ft.)	Wingspan (m)	Length (ft.)	Length (m)	Max Tail Height (ft.)	Max Tail Height (m)
DC-9-21	C-III	126	101,000	45,813	95,300	43,227	93.30	28.44	104.40	31.82	27.42	8.40
DC-9-32/-33F	C-III	133	109,000	49,442	99,000	44,906	93.30	28.44	119.30	36.36	27.75	8.50
DC-9-41	C-III	131	115,000	52,163	102,000	46,266	93.30	28.44	125.60	38.28	28.42	8.70
DC-9-51	C-III	135	122,000	55,338	110,000	49,895	93.35	28.45	133.58	40.72	28.75	8.80
MD-11	D-IV	152	605,500	274,655	430,000	195,048	170.50	51.97	202.17	61.20	58.83	17.93
MD-11 Combi	D-IV	153	605,500	274,655	458,000	273,294	170.50	51.97	202.17	61.20	58.83	17.93
MD-11ER	D-IV	152	633,000	287,122	430,000	195,048	170.50	51.97	202.17	61.20	58.83	17.93
MD-11F	D-IV	155	605,500	274,655	471,500	213,872	170.50	51.97	202.17	61.20	58.83	17.93
MD-81	C-III	131	141,000	63,958	128,000	58,061	107.85	32.85	147.83	45.02	30.17	9.20
MD-82/-88	C-III	132	150,500	68,266	130,000	58,967	107.85	32.85	147.83	45.02	30.17	9.20
MD-83	C-III	137	161,000	73,028	139,500	63,276	107.85	32.85	147.83	45.02	30.17	9.20
MD-87	C-III	131	150,500	68,266	130,000	58,967	107.85	32.85	130.42	39.75	31.17	9.50
MD-90-30	C-III	138	157,000	71,214	142,000	64,410	107.83	32.87	152.58	46.50	31.17	9.50
MD-90-30ER	C-III	138	168,500	76,430	142,000	64,410	107.83	32.87	152.58	46.50	31.17	9.50

For more information, please contact us at:

Airport Compatibility Engineering
2201 Seal Beach Blvd. M/C: 110-SB02
Seal Beach, CA 90740-1515

Phone: 562-797-1172
Fax: 206-766-5520
e-mail: AirportCompatibility@boeing.com