FINAL REPORT
OF SERIOUS INCIDENT OF AIR PROXIMITY BETWEEN
M/s SPICEJET FLIGHT SEJ234 (VT-SPJ) AND M/s INDIGO FLIGHT IGO286 (VT-IEB)
AT DELHI ON 2ND SEPTEMBER, 2013

1. Aircraft		
Type	:	B737-800 (Spicejet) and A320 (Indigo)
Nationality	:	INDIAN
Registration	:	VT-SPJ (Spicejet) and VT-IEB (Indigo)
2. Owner/ Operator	:	Spicejet and Indigo
3. Pilot – in –Command	:	ATPL holders qualified on type
Extent of injuries	:	Nil
4. First Officer	:	CPL Holders qualified on type
Extent of injuries	:	Nil
5. Place of Incident	:	IGI Airport Delhi
6. Date & Time of Incident	:	2nd September 2013 08:52:50 UTC(Approx.)
7. Last point of Departure	:	Shamshabad (Hyderabad) for VT-SPJ and Delhi for VT-IEB
8. Point of intended landing	:	Delhi for VT-SP and Coimbatore for VT-IEB
9. Type of operation	:	Schedule Operation
10. Crew on Board	:	2 pilots + 4 cabin crew on VT-IEB, 2 pilots + 4 cabin crew on VT-SPJ
Extent of injuries	:	Nil
11. Passengers on Board	:	93 on VT-IEB, 184+02 (Infants) on VT SPJ
Extent of injuries	:	Nil
12. Phase of operation	:	Landing for Spicejet VT-SPJ (eventually Go-Around) and Takeoff for Indigo VT-IEB
13. Type of incident	:	Air Proximity

(ALL TIMINGS IN THE REPORT ARE IN UTC)

Summary :

VT- SPJ (B737-800) aircraft of Spice Jet operating schedule flight SEJ234 from Shamshabad to Delhi on 2nd Sept., 2013 was in approach to land for Delhi Runway 28 and at this instance VT-IEB of Indigo operating schedule flight IGO286 from Delhi to Coimbatore was lined up for take off on the same runway. IGO 286 was sequenced to take off behind flight AIC 312 (operated by heavy aircraft B 787) and SEJ 234 to land following IGO 286 departure.

In presence of a rated Controllers at ATC tower (freq 118.1), an ATC Instructor was also conducting the training to a Trainee Controller and therefore there were three ATCOs at the channel. The instructor controller is expected to have taken over the channel formerly from the duty controller and following this the trainee controller is expected to handle the channel under the supervision of the instructor. This procedure is not followed and duty controller signs out on the log book which is not yet taken over by the Instructor and the trainee controller is handling the channel while the Instructor is not wearing the head set and is hence off line.

The take off for the Indigo VT-IEB flight was delayed on account of expected wake turbulence as a heavy aircraft (B787) had taken off from this runway prior to this Indigo departure. The intention to delay Takeoff was expressed by the crew and acknowledged by the ATC.VT IEB was advised to enter and Line up on the active runway Runway 28 instead of being on the Taxi Holding point. In this process while Indigo VT-IEB waited on the runway, the Spice Jet VT-SPJ continued its approach as advised by the ATC. VT- SPJ eventually executed a go-around at about the threshold point of RUNWAY 28 at height just below 50ft as by this time Indigo aircraft was still on its takeoff roll and hence the runway was not available for landing.

Consequent upon the go-around executed by VT-SPJ, the Indigo aircraft VT-IEB rotated for takeoff from the same runway after few seconds and hence both aircraft converged in the takeoff path of Runway 28 departure. The lateral and vertical separations between these two aircraft reduced below the safe limits and hence was the air-proximity incident.

The TCAS Resolution Advisories were annunciated in both aircrafts as the separation between the two converging aircrafts reduced below the system alert thresholds. The complimenting TCAS advisories in both aircraft were incorrectly interpreted and were only partially complied.

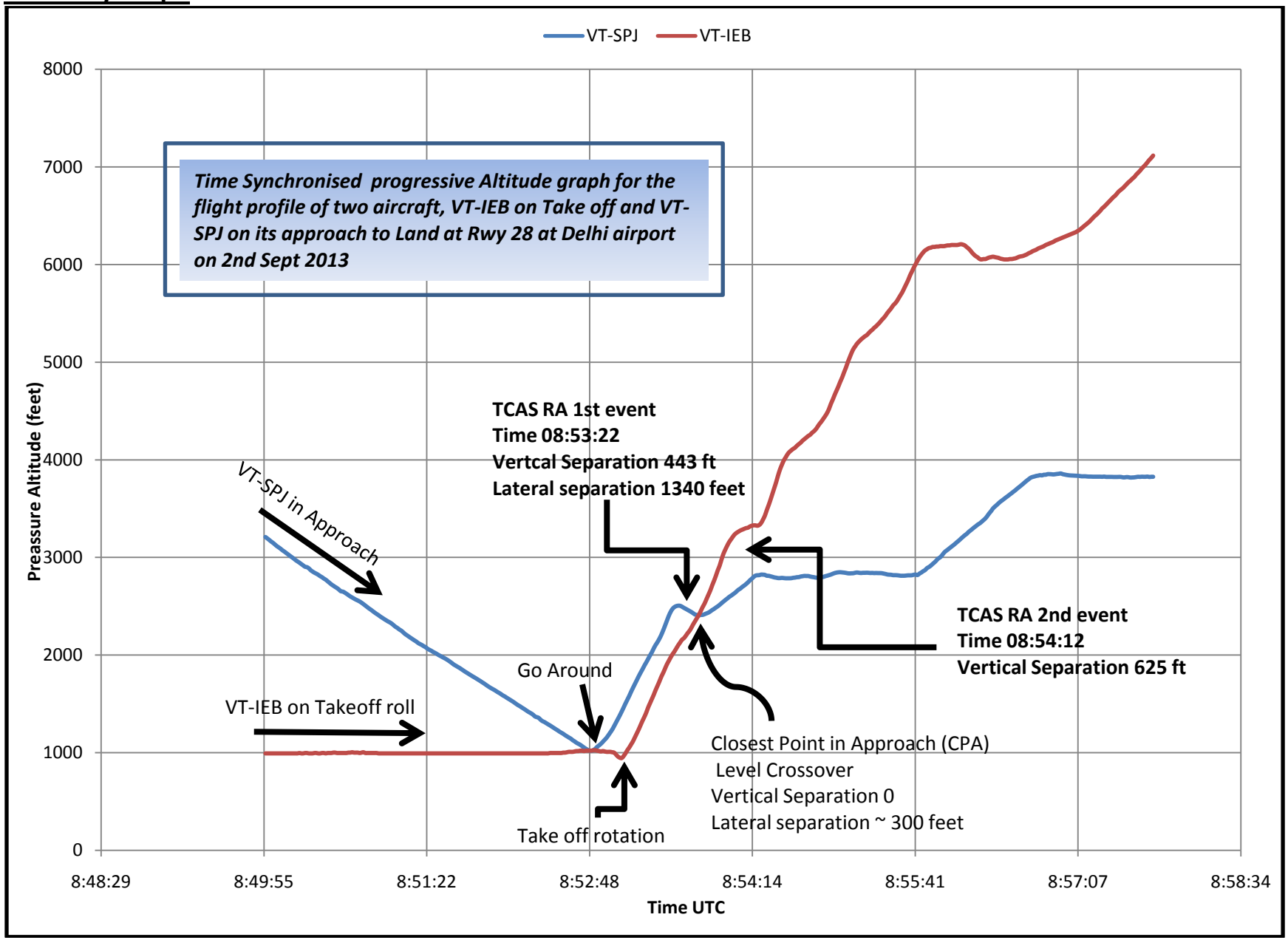
The Indigo aircraft VT-IEB climbing from below crossed the level flown by the Spice jet aircraft VT-SPJ and at this closest point the two aircrafts were with zero vertical separation and estimated lateral separation of mere 300 feet.

The conflict was resolved by the last second avoidance roll maneuver executed by VT-SPJ seeing VT-IEB in the visual contact.

Following this resolve VT-IEB leveled off and VT-SPJ resumed climb and again entered into another conflict generating another Resolution Advisory by the TCAS which was flown to “Clear of Conflict”.

Following altitude graph of the flight profile followed by two conflicting aircraft on the synchronized time scale depicts the incident.

Summary Graph



1. Factual Information :

1.1 History of the flight

SEJ 234 is a scheduled flight operated by Spicejet on 2nd September, 2013 by aircraft VT-SPJ (B737-800) from Shamshabad to Delhi and at about 08:52:00 UTC the aircraft was on its final approach segment to land on Runway 28 at the IGI Airport Delhi. Prior to this flight the aircraft had flown from Coimbatore to Shamshabad with the same crew members which was an uneventful safe flight. There were no deficiencies or deferred snag on the aircraft prior to the incident Flight. On sector shamshabad – Delhi Snag of Weather radar brightness being very low is reported.

IGO286 is a scheduled flight operated by Indigo on 2nd September 2013 by aircraft VT-IEB from Delhi to Coimbatore and was operated by the crew members as their first sector for the day. There were no snags reported which had any deferred maintenance.

1.2 Injuries to persons.

INJURIES	CREW	PASSENGERS	OTHERS
FATAL	Nil	Nil	Nil
SERIOUS	Nil	Nil	Nil
MINOR	Nil	Nil	Nil

1.3 Damage to aircraft :

Nil

1.4 Other damage :

Nil

1.5 Personnel information :

1.5.1 Crew VT – IEB (Indigo) :

	Pilot in Command	Co Pilot
License Number	ATPL Holder	ATPL Holder
Date of Issue	17-11-2004	08-10-10
Validity	16-11-2014	07-10-14
Category	Aero Plane	Aeroplane
Class	Single/Multi-Engine Land/Sea	Multi Engine land
Endorsements as PIC	C152, King Air C-90A, ATR 42-500/320, ATR 72-500, A320	Cessna 152 & A-320

Age	55 Years	33Yrs 07Months
Date of Medical Exam	25-10-2013	05-02-2013
Medical Exam Valid Upto	24-04-2014	04-02-2014
FRTO License Number	FRTOL 8870	9748/2
Date of Issue	26-09-2003	02-11-2011
Validity	25-09-2018	01-11-2016
Total Flying Experience	10533:57	3645:27
Total Flying Experience on Type	5967:42	1427:57
Total Flying Experience as PIC on Type	5779:59	81:27
Total Flying Experience during 180 days	323:09	363:40
Total Flying Experience during 90 days	136:21	128:33
Total Flying Experience during 30 days	73:32	33:50
Total Flying Experience during 07 days	18:10	00:00
Total Flying Experience during 24 hours	04:09	00:00
Last Rest Day(Weekly Off)	31-08-2013	01-09-13

1.5.2 Crew VT-SPJ (Spice Jet) :

	Pilot in Command	**Co Pilot**
License Number	ATPL Holder	CPL Holder
Date of Issue	17TH Nov. 2011	3rd Sep., 2008
Validity	16th Nov. 2015	2nd Sep. 2018
Category	Aeroplane	Aeroplane
Class	Multi Engine land	Multi Engine land

Endorsements as PIC	1st Feb., 2012	NA
Age	29 years	26 years
Date of Medical Exam	24th Oct., 2013	30, Apr. , 2013
Medical Exam Valid Upto	23rd Oct., 2014	29th Apr., 2014
FRTO License Number	9299	11945
Experience as PIC on Type	1620 hrs.	NA
Total Flying Experience during last 180 days	560:29	398:06
Total Flying Experience during last 90 days	280:17	191:48
Total Flying Experience during last 30 days	90:05	72:22
Total Flying Experience during last 07 days	18:55	20:01
Total Flying Experience during last 24 hours	07:05	07:05

1.5.3 ATC Controllers : ATCO, named X, Jr. Executive ATC was the Incharge handling on freq 118.1 Mhz. ATCO (Instructor), named Y, Sr. Manager ATC, an Instructor was conducting the training to ATCO, named Z, , Asst. Manager, ATC at the time of the incident.

Controller Z was undergoing double banking training and has not obtained the ATC tower rating for Delhi on date of incident. He however processes the ADC / SMC / FDPS / APP rating for Cochin. He was therefore in the ATC tower in the capacity of a trainee who is undergoing double banking training with instructor controller Y.

Following are the qualifications and training details :

1. **Controller X**
   a) Double Banking start : 13th August, 2012
   b) Date or Rating : 20th March, 2013

2. Controller Z

a) Double Banking Start : 13th August, 2012
b) Previous Rating cochin : ADC / SMC / FDPS / APP

3. Controller Y

i. Double Banking Start :

a)	TWR	:	25TH October, 2007
b)	ACC / FIC	:	20th February, 2008
c)	ADS/CPDLC	:	18th June, 2008
d)	ARSR	:	18th August, 2009

ii. Date of Rating :

a)	TWR	:	15th January, 2008
b)	ACC / FIC	:	4th July, 2008
c)	ADS / CPDLC	:	17th October, 2008
d)	ARSR	:	21st November, 2010 (Fail) 14th February, 2011

iii. OJTI : 23rd May, 2011

iv. Previous Rating Kolkata : TWR,ACC / FIC

1.6 Aircraft information:

B737-800 and A320 are both twin engine transport Category C aircrafts certified for day and night operations under VFR and IFR.

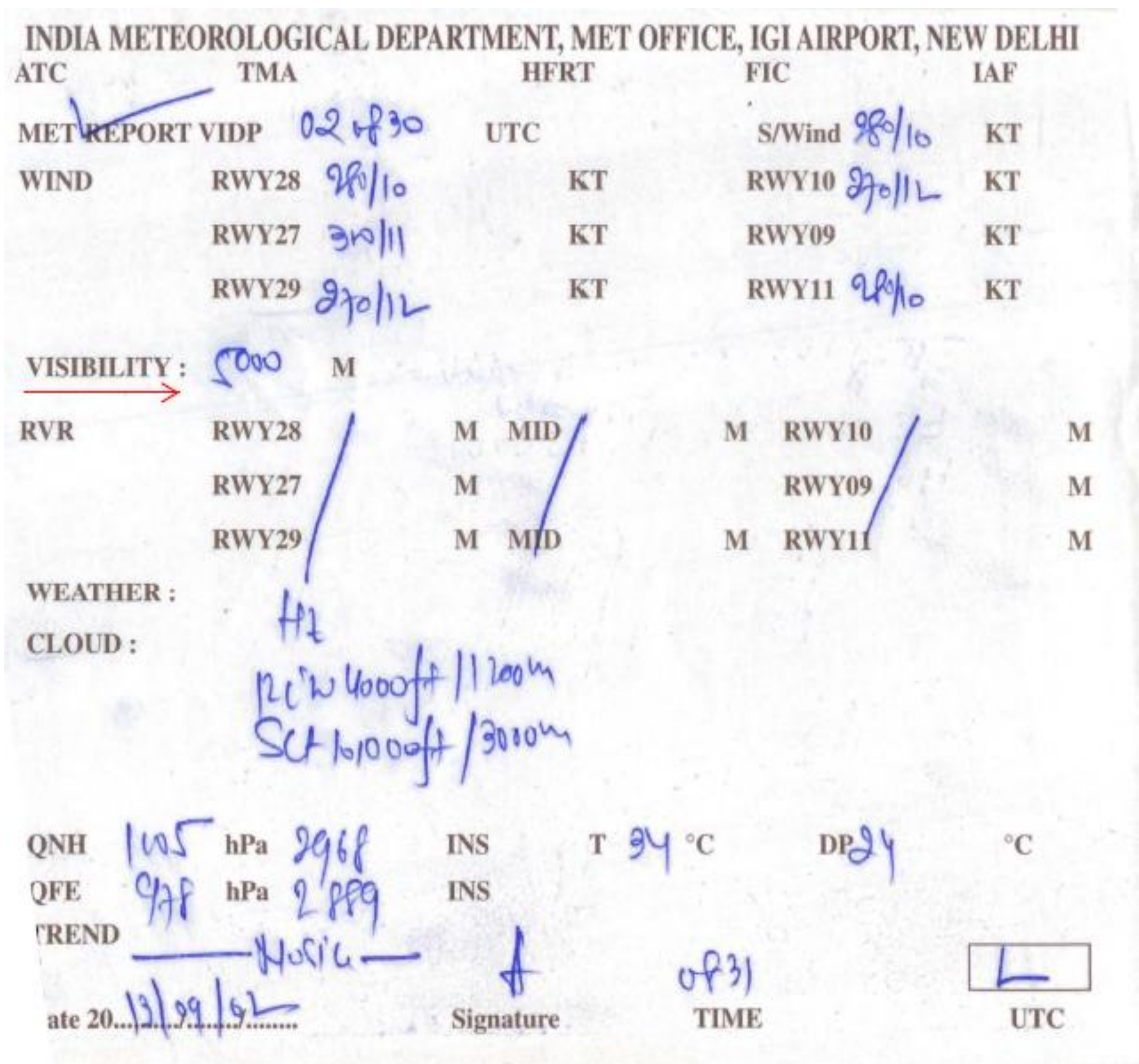
Traffic Alert and Collision avoidance System (TCAS) **:**

Both aircraft are installed with TCAS II that is used for detecting and tracking aircraft in the vicinity of your own aircraft by interrogating their Mode-S transponders. It analyses the replies to determine Range, Bearing and the relative altitude of the intruder. Should the TCAS processor determine that the possible collision hazard exists it issues visual and audio advisories to the crew for appropriate vertical avoidance maneuvers. TCAS II predicts the time to and the separation at the intruders closest point in approach (CPA) and if the alert safe boundaries are expected to be violated it will issue the traffic advisory to alert the crew that closing traffic is in the vicinity. If the intruder continues to close, TCAS II will issue resolution advisory to obtain or maintain safe vertical separation between your aircraft and the intruder.

VT-IEB has Production installed TCAS P/N: 9000000-11111 & S/N: 22001780. On-Wing Modification c/out on 18th Feb 2013 and Part Number upgraded to -11313 & S/N remains the same.

VT-SPJ has TCAS model TTR / 921, PN 822 / 1293 / 003, SN 154400 from Rockwell Collins.

1.7 Meteorological information :



INDIA METEOROLOGICAL DEPARTMENT, MET OFFICE, IGI AIRPORT, NEW DELHI

ATC TMA HFRT FIC IAF

MET REPORT VIDP 02 0830 UTC S/Wind 280/10 KT

WIND	RWY28 280/10	KT	RWY10 270/12	KT
	RWY27 310/11	KT	RWY09	KT
	RWY29 270/12	KT	RWY11 280/10	KT

VISIBILITY : 5000 M

RVR	RWY28 /	M	MID /	M	RWY10 /	M
	RWY27 /	M			RWY09 /	M
	RWY29 /	M	MID	M	RWY11	M

WEATHER : HZ

CLOUD : FEW 4000ft/1200m
SCT 10000ft/3000m

QNH 1005 hPa 2968 INS T 34 °C DP 24 °C

QFE 978 hPa 2889 INS

TREND — NOSIG —

Date 20..13/09/12......... Signature TIME 0831 UTC

1.8 Aids to navigation :

Runway 28 at Delhi is equipped with Cat III B ILS. Other navigation aids installed include DME,DVOR and NDB with Precision and Non Precision approach procedures.

1.9 Communications :

During the period of occurrence both aircraft were tuned in with ATC on Tower Frequency 118.1 MHz. There was always two way communication between the ATC and both aircraft.

1.10 Aerodrome information :

Indira Gandhi International Airport (IATA: DEL, ICAO: VIDP) is the primary international airport of the National Capital Region of Delhi operated by Delhi International Airport Private Limited (DIAL) with a current capacity of handling more than 46 million passengers.

The elevation of the airport is 777 ft, and it has three near-parallel runways: runway 11/29, 4,430 m × 60 m (14,534 ft × 197 ft) with CAT IIIB instrument landing system (ILS) on both sides, runway 10/28, 3,810 m × 45 m (12,500 ft × 148 ft), and an auxiliary runway 09/27, 2,813 m × 45 m (9,229 ft × 148 ft). Runway 28 and runway 11/29 are the only two in South Asia to have been equipped with the CAT III-B ILS.

The other Navigation aids installed include Cat I ILS DME, DVOR and NDB with precision and non-precision approach procedures for Runways 11/29, 10/28 and 09/27.

IGI Airport has Category 10 rescue and firefighting capabilities with all ARFF personnel trained in rescue and fire-fighting as well as medical first-aid.

1.11 Flight recorders :

The flight data recorder (FDR) of both aircraft involved in the incident were downloaded and the relevant parameters analyzed. The cockpit voice recorder (CVR) of VT-SPJ was available for investigation. VT-IEB having continued the flight to its scheduled destination after the airprox incident, the CVR recordings are not available for review (last two hours of cockpit voice recording are retained on these recorders). The ATC voice recordings (tower freq 118.1 Mhz.), Approach Radar recording and SMGC recordings are also analyzed in conjunction to the other available recorders.

The FDR of VT-IEB and VT-SPJ are two different entities recording flight parameters at two separate platforms with individual references. They are to be initially synchronized to understand the relative occurrences between the two conflicting aircraft which led to such an incident of air proximity. Further synchronization is required between ATC recordings and the conflicting aircraft for complete event reconstruction.

It is considered that the fairly accurate synchronization is achieved by coinciding the 'event' "Clear of Conflict" of the TCAS recordings on the individual flight recorder of two aircraft. The TCAS of each conflicting aircraft communicate on the data link established between their respective mode S transponders and following the resolution of conflict a "Clear of Conflict" (audio and data recording) or TCAS warning status is simultaneously recorded in real time on both recorders. This event is therefore chosen to be best suited for the purpose of time synchronization. The conflict RA recording too are recorded in complementary advisories in the respective recorders real time but this event being inhibited in certain aircraft for specific phases of flight does not always provide a accurate tool for the purpose of synchronization between FDR of two separate entities.

VT-SPJ and VT-IEB had a TCAS(RA) annunciation recorded on their respective recorders and following this first RA the "Clear of Conflict" is recorded on VT-SPJ at time reference UTC 08:53:59. The same event on VT-IEB is seen recorded with their time reference as 14:23:56 IST (UTC 08:53:56). The Flight data recorders of both aircraft on this synchronized time scale are seen matching to all subsequent events. The clock time recorded on two FDRs are therefore concluded to show a difference of three seconds between them which is understandable and is considered fairly accurate. All data analysis of events are taken with time references as on VT-IEB .

The CVR of VT-SPJ was transcript in relative time reference and observation of a TCAS advisory "Increase Descend " audio annunciation is matched to this TCAS advisory recording on the VT-SPJ FDR as parameter "Advisory rate to maintain" registers change from -1500 to -2500 (fpm) and hence the time synchronization achieved. All further events are thereafter traced on such synchronized time lines.

The tape transcript of communication with ATC frequency 118.1 Mhz. is further synchronized with the CVR of VT-SPJ matching up the call made by Tower at time reference 08:51:21 (ATC transcript time 08:51:26) which are recorded on both i.e. aircraft CVR and ATC tape recorder. The CVR having been synchronized with the two FDRs of both conflicting aircraft extends the ATC tapes synchronization further with the data recorders.

The FDR (VT-SPJ), FDR (VT-IEB), CVR (VT-SPJ) and ATC tape recordings (118.1 Mhz.) are therefore synchronized between them and the recording are then analyzed on the common time line and hence relative flight occurrences inferred.

On the common synchronized time line between two FDRs and utilizing the 'ground speed' as parameter the estimation of lateral distance travel is made progressively for each second of the FDR data. Further as VT-IEB initiated take off roll from 'C' intersection of Runway 28 and VT-SPJ executed go around at about the runway threshold point, the relative lateral separations between Threshold and "C" intersection is factored while estimating the relative lateral separation between the two aircraft as the time progresses. The lateral separation is therefore only the estimated separation with restricted accuracy.

All estimation drawn with the procedures as above are then compared to the radar recordings and SMGC recordings in the ATC for confirmations.

The following are the observation by which the occurrence is reconstructed as an event :

VT-IEB entered the Runway 28 from 'C' intersection at 08:50:43 and at this time VT-SPJ was continuing approach for the same runway while at altitude 2578 ft and 1737radio height maintaining speed 156 kts and descending at approx 630 fpm (position coordinates N 28 32 22 and E 077 12 93). VT-IEB was aligned to the Runway direction holding at the line up point at time 08:51:03 with VT-SPJ at altitude

2321 ft. (1482 ft. radio height) and continuing approach with speed 152 kts. At this time the ATC was conveyed by VT-IEB on RT that they still have about one minute and twenty two seconds more to wait before they roll out for take off.

VT-IEB started rolling for take off at 08:52:25 and at this instance the VT-SPJ was at pressure altitude of 1301 ft. and radio height of 275 ft.

At 08:52:47 with radio height of 29 ft. VT-SPJ initiated the go around and also made a RT communication for the same. At this instance VT-IEB was still on its take off roll at IAS of 82 knots. By this time the VT-IEB was 22 seconds from the beginning of its take off roll and has travelled approx 1100 feet of lateral distance on the runway. The separation of 'C' intersection from Runway threshold is about 1700 feet and so the estimated lateral separation between two aircraft at this point is about 2800 feet (with VT-SPJ behind VT-IEB). The progressive lateral separation is calculated with this as reference.

VT-IEB did the take off rotation at 08:53:02 at speed 138 knots IAS and was unstuck to the runway at 08:53:05. At the time when VT-IEB was unstuck to the runway surface, VT-SPJ was at altitude of 1420 ft(455 ft radio height) and climbing at rate approx 2300 fpm. The lateral separation at this point is estimated at 1794ft between the two aircraft with VT-SPJ flying behind the VT-IEB

The first TCAS (RA) annunciated on VT-SPJ at time 08:53:22 at altitude 2067 ft(radio height 1160ft)and climbing at speed 175 knots and rate of climb of 2070 fpm. At this time VT-IEB was at altitude 1592 and radio height 717 and climbing with speed 161 knots and rate of climb 2784 fpm. The vertical separation at this stage is 443 feet and the estimated lateral separation is about 1340 ft. Further the speed diff between two aircraft is 14 knots and VT SPJ which is behind the VT-IEB travelling faster and hence converging. The rate of climb difference between them is about 700 fpm with VT-IEB which is below climbing faster and hence converging. TCAS RA annunciations are inhibited by system below 1100 feet, descend advisories below 1200 ft. and increased descend below 1450 ft. it is therefore VT-SPJ at this stage having crossed the threshold received its first RA. VT-SPJ initially received the UP Corrective advisory (Climb) just for a second which are reversed to Descend immediately with audio "Descend Descend NOW". This is attributable to the aspect that the conflicting traffic on its takeoff was seen climbing (by TCAS)and hence the Climb advisory to VT-SPJ (complimenting Descent to conflicting traffic) was not sustained. The guided descend advisory for VT-SPJ was with -1500 fpm. VT-IEB being below 1200 feet radio height in this position the TCAS RA are inhibited to them. Such generated RA in such inhibited phase are however converted to display as TA for the reference of Pilots to monitor and resolve conflict.

At 08:53:34 VT-IEB first received TCAS RA (the RA inhibition zone of 1200 radio height is now crossed). At this instance the aircraft parameters are altitude 2068 feet, radio height 1252 feet speed 155 knots and rate of climb 1745 fpm. Correspondingly VT-SPJ at this time is at altitude 2501, radio height 1657speed 181 knots and climbing at 465 fpm. The lateral separation between the two is estimated at 882 ft. This is another turn of events as beginning this time VT-SPJ has started to convert their climb into descend loosing height and therefore increasing the convergence rate. VT-IEB from below was still

climbing at about 1700 fpm. VT-SPJ had excess speed in comparison to VT-IEB by about 20 knots and this being behind and flying faster was converging the traffic laterally also.

At 08:53:41 VT-IEB (altitude 2248 altitude, 1490 AGL 156 knots and roc of 1727 fpm) and VT-SPJ (altitude 2451 1666AGL, 186 knots and rod of - 690 fpm) were converging into each other very fast. The vertical separation is 176 feet and estimated lateral separation 521 ft. The TCAS RA annunciation was increased to record "increased descend" to -2500 fpm for VT-SPJ and complimenting to VT-IEB..The synchronized CVR recording of VT-SPJ also records "Increase descend, increase descend". Both aircraft being above the 1450 feet radio height at this instance the increased rate commands were admissible as being out of its inhibition range.

08:53:45 is considered the " Closest Point in Approach" (CPA). The Flight parameters of two aircraft at this stage are

	Altitude(ft)	**Radio Height(ft)**	**Speed-IAS (kts)**	**Vertical Speed (fpm)**	**Heading**
VT - SPJ	2410	1606	184	-255	291
VT - IEB	2380	1600	155	1958	289

The lateral separation at this point is estimated at 300 feet.

As is also confirmed from the synchronized voice recordings VT-SPJ spotted the conflict aircraft visually at this stage and executed the roll maneuver to right by 30 deg roll attitude and corrected back by time 08:53:56. A mid air collision is hence narrowly avoided.

08:53:56 VT-IEB (altitude 2868, 2132 AGL, 159 knots) and VT-SPJ (altitude 2499 ft, 1712 AGL, 178 knots) stands clear of Conflict and their respective FDRs and CVR records the same. The vertical separation is increasing with VT-IEB having flown through the VT-SPJ altitude higher in height and climbing fast. Lateral separation on account of VT-SPJ flying off from the extended centre line is also in safe limit.

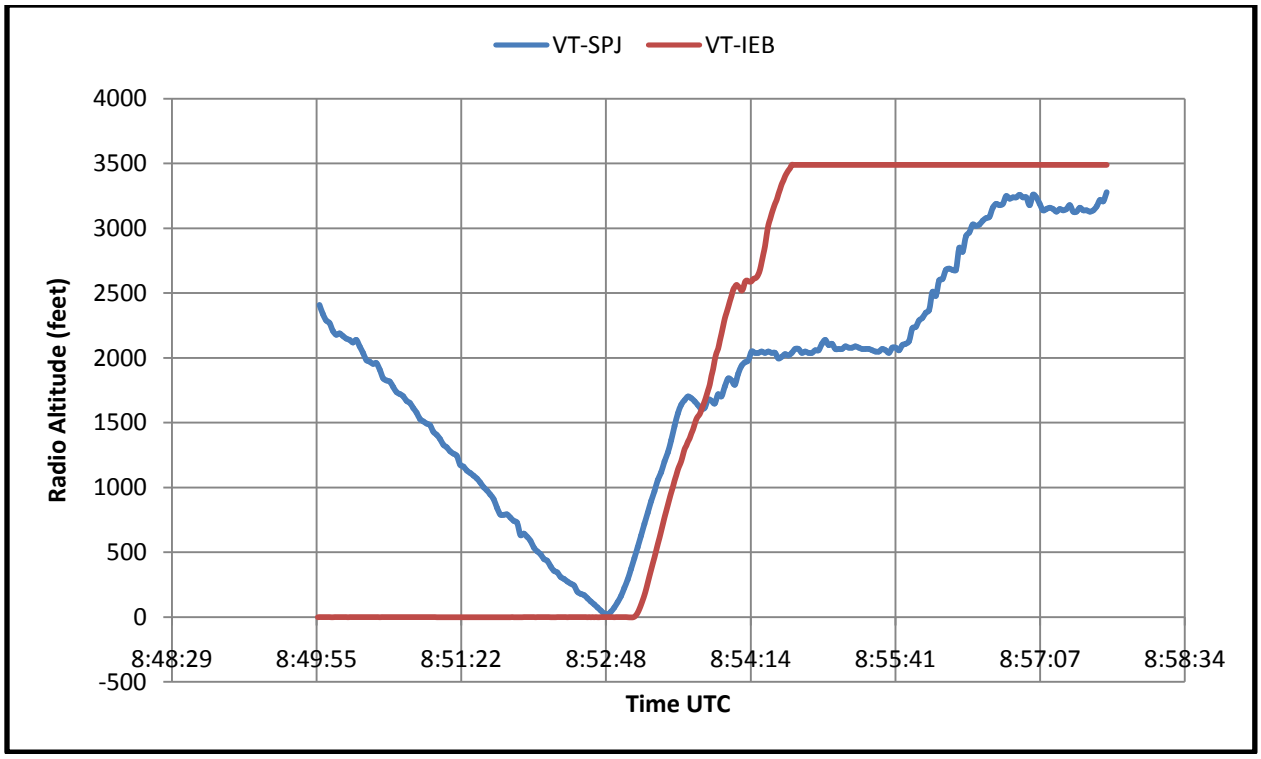
Subsequent thereof to the 'Clear of Conflict' VT-SPJ is climbing at approx 800 – 900 fpm rate and VT IEB which was till this climbing at increased rates of about 3300 – 3400 fpm began to reduce climb to almost fly level by 08:54:07 at altitude of 3264 (2551 AGL). By this time VT-SPJ is at altitude 2669 ft (1879 AGL) and climbing at 945 fpm at 175 knots. This generated another conflict situation.

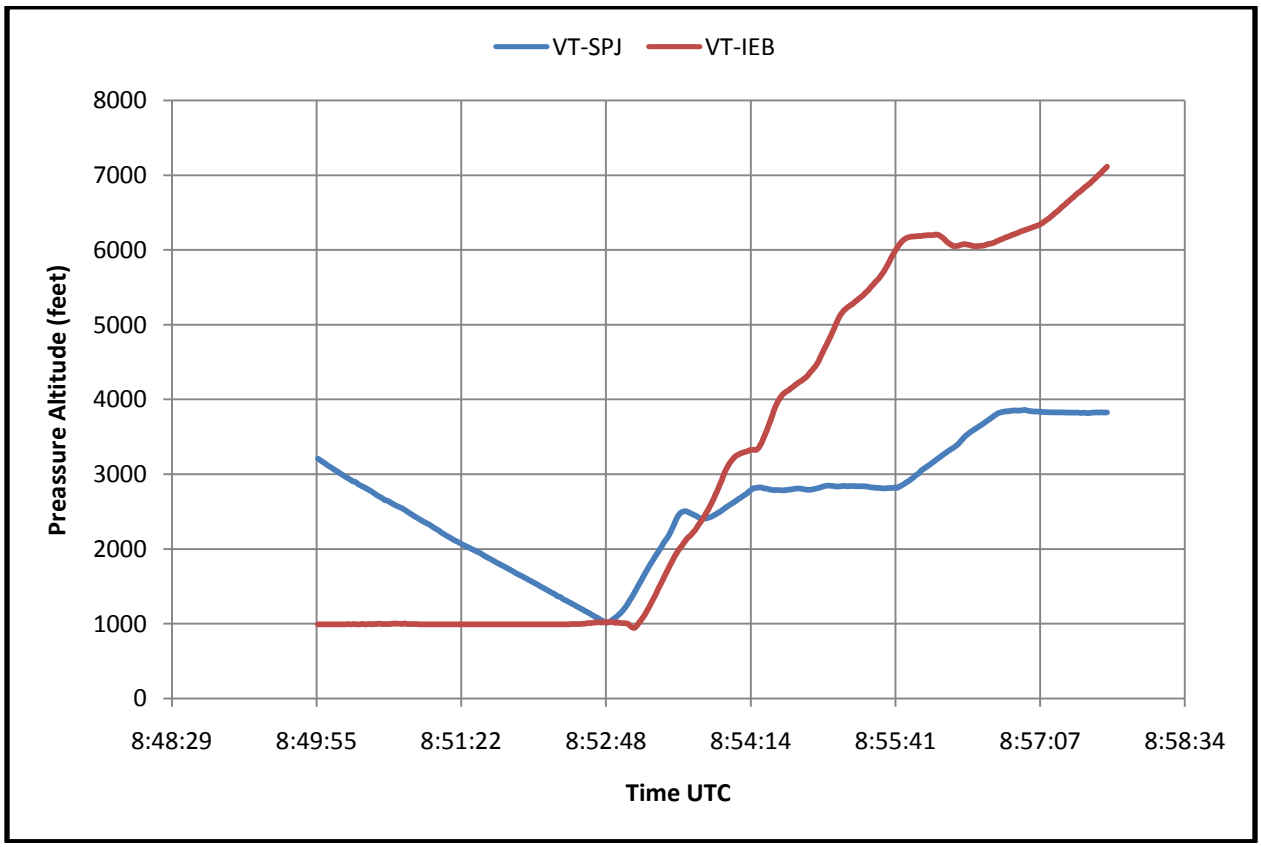
Another TCAS RA is generated at 08:54:12 with VT-SPJ at altitude 2744 ft. (1974 ft. AGL) speed 178 knots and climbing at 1050 fpm. VT-IEB at this time is 3304 ft. altitude (2599 ft AGL) speed 176 knots and flying almost level at roc of 243 fpm. Two aircraft are again seen converging with VT-IEB at this time flying level and VT-SPJ climbing from below. The RA generated to VT-SPJ is Preventive as "Don't Climb" and expectedly the Climb" for VT-IEB. Both aircraft this time followed the RA Commands with VT-SPJ flying level at prevailing height (No Climb) and VT-IEB climbing at about 3000 fpm initially.

08:54:47 the TCAS off ("Clear of Conflict") is recorded on the FDRs and also the CVR. At this instance VT-IEB is at altitude 4392ft 3491ftAGLand VT-SPJ at altitude 2797 ft and 2050 AGL.

The aircraft vertical and lateral separations increased thereafter.

Graphical representation of all recorded relevant data for the applicable time are as under :


VT-SPJ
VT-IEB
4000
3500
3000
2500
2000
1500
1000
500
0
-500
Radio Altitude (feet)
8:48:29
8:49:55
8:51:22
8:52:48
8:54:14
8:55:41
8:57:07
8:58:34
Time UTC


VT-SPJ
VT-IEB
8000
7000
6000
5000
4000
3000
2000
1000
0
Preassure Altitude (feet)
8:48:29
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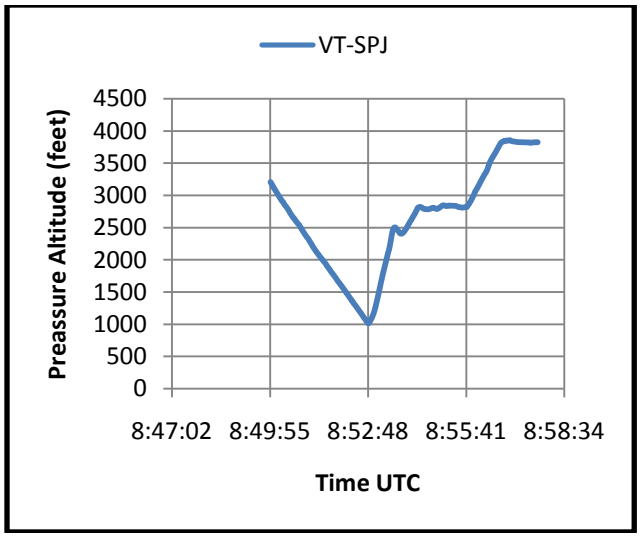
8:54:14
8:55:41
8:57:07
8:58:34
Time UTC


VT-SPJ
Preassure Altitude (feet)
4500
4000
3500
3000
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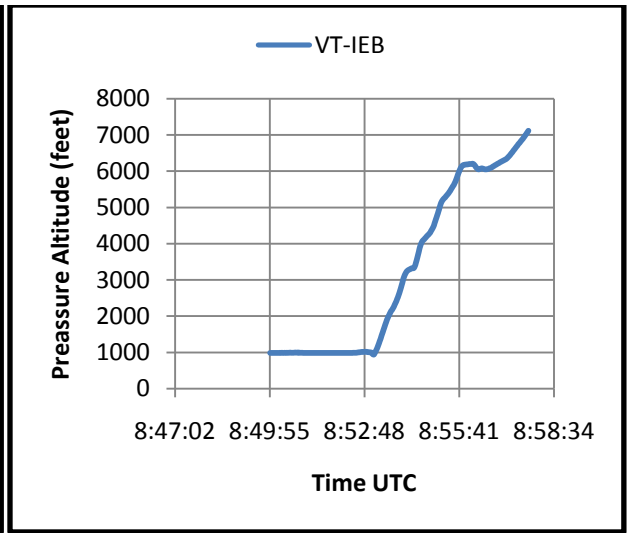
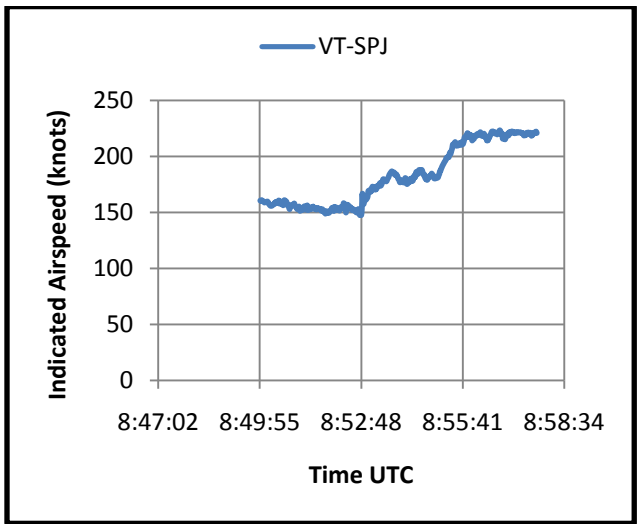
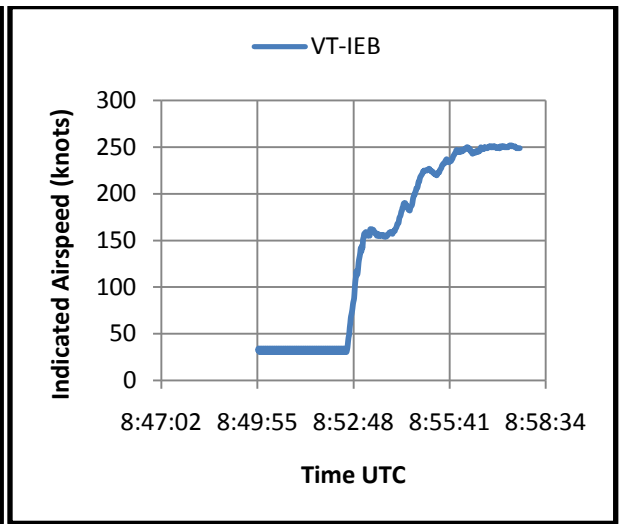
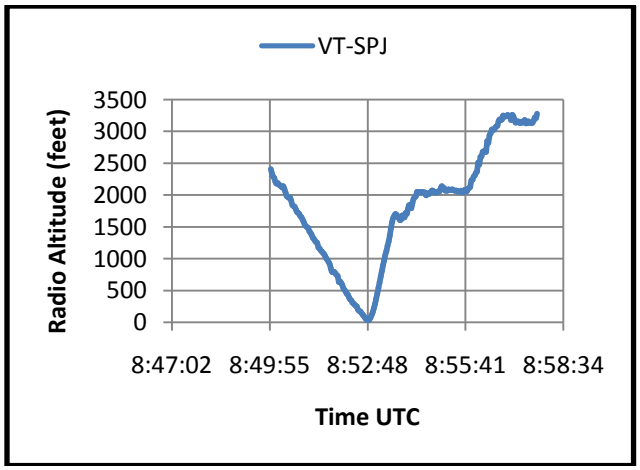
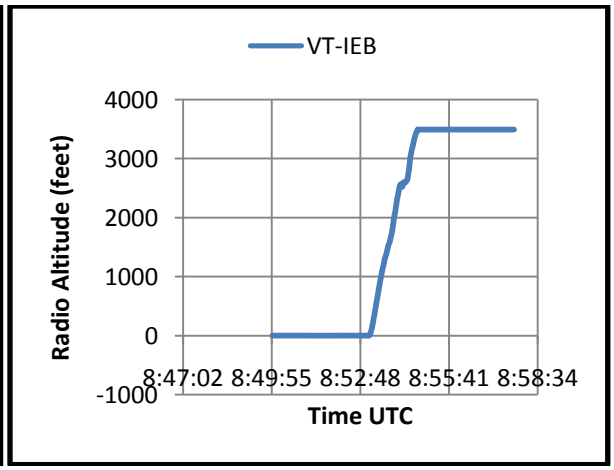
1500
1000
500
0
8:47:02
8:49:55
8:52:48
8:55:41
8:58:34
Time UTC

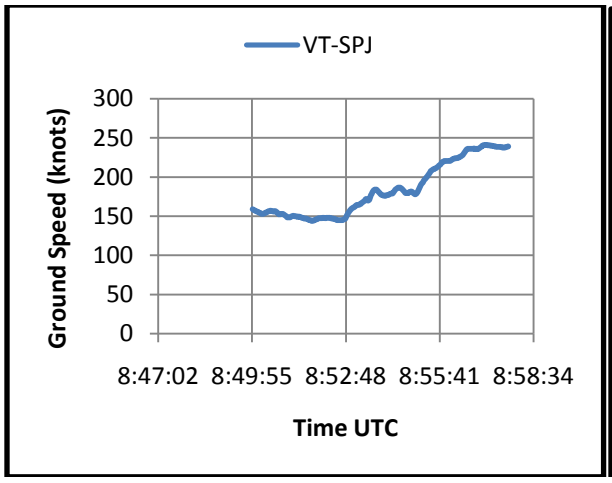

VT-IEB
Preassure Altitude (feet)
8000
7000
6000
5000
4000
3000
2000
1000
0
8:47:02
8:49:55
8:52:48
8:55:41
8:58:34
Time UTC

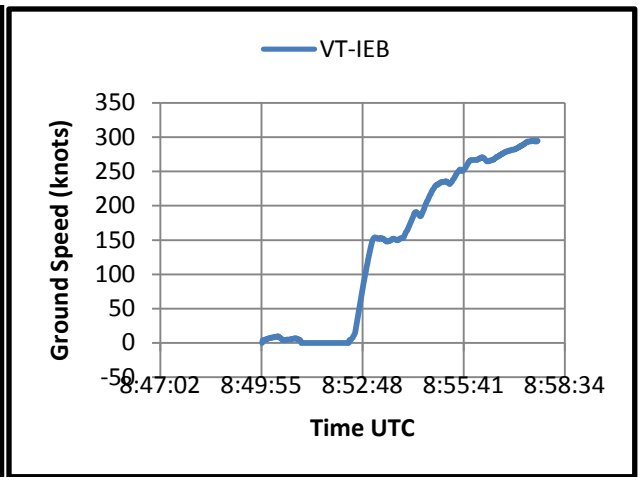

VT-SPJ
Indicated Airspeed (knots)
250
200
150
100
50
0
8:47:02
8:49:55
8:52:48
8:55:41
8:58:34
Time UTC

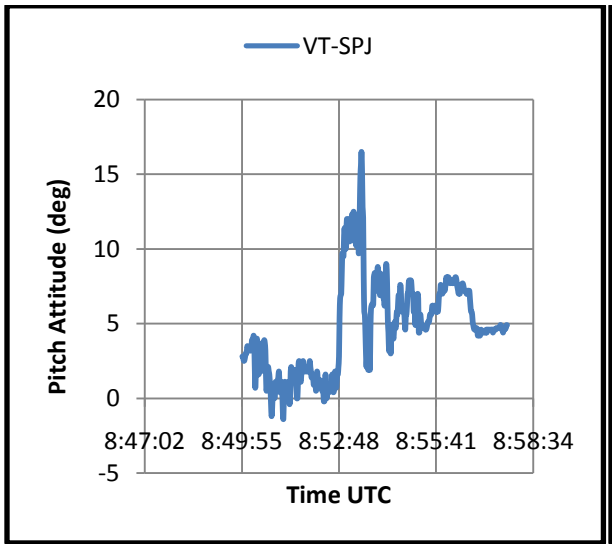

VT-IEB
Indicated Airspeed (knots)
300
250
200
150
100
50
0
8:47:02
8:49:55
8:52:48
8:55:41
8:58:34
Time UTC

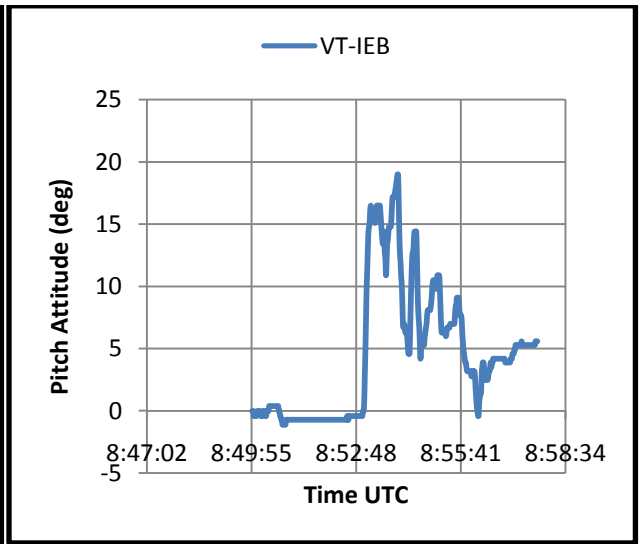

VT-SPJ
Radio Altitude (feet)
3500
3000
2500
2000
1500
1000
500
0
8:47:02
8:49:55
8:52:48
8:55:41
8:58:34
Time UTC

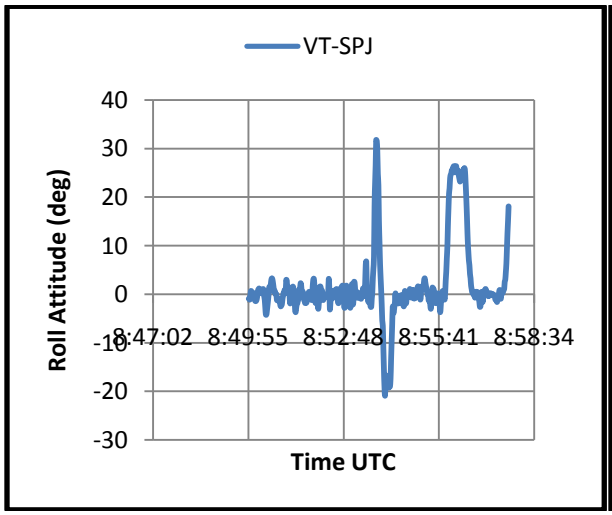

VT-IEB
Radio Altitude (feet)
4000
3000
2000
1000
0
-1000
8:47:02
8:49:55
8:52:48
8:55:41
8:58:34
Time UTC

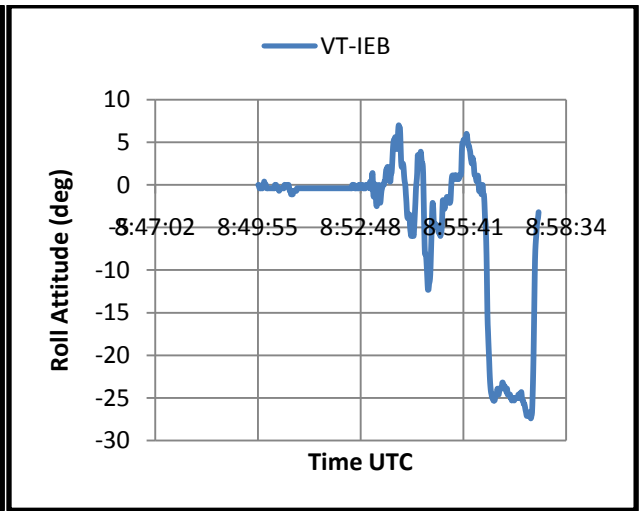

VT-SPJ
Ground Speed (knots)
300
250
200
150
100
50
0
8:47:02 8:49:55 8:52:48 8:55:41 8:58:34
Time UTC

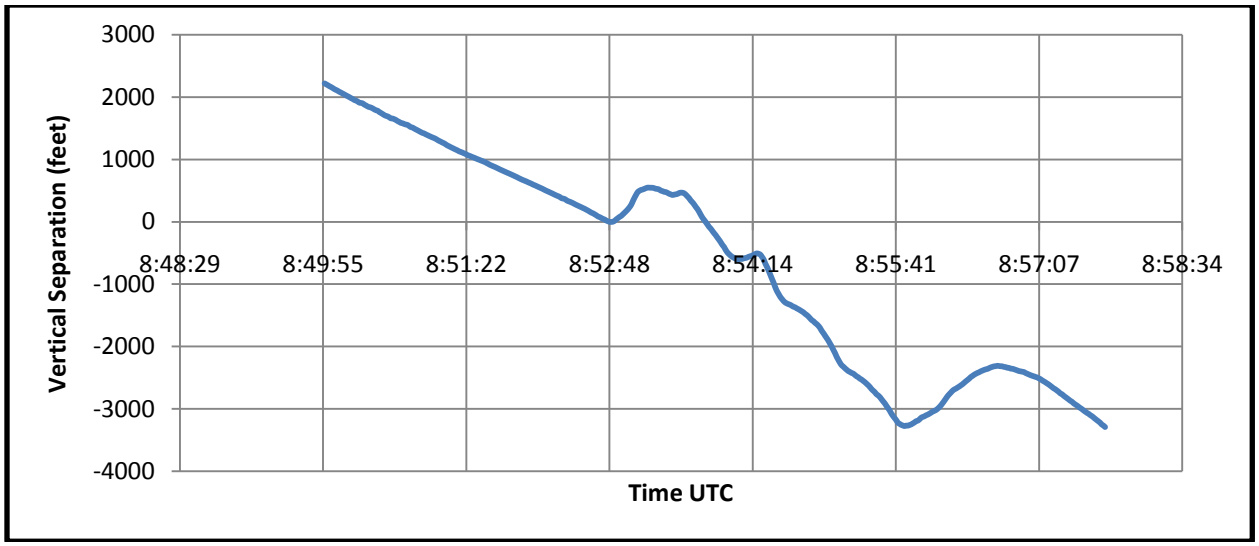

VT-IEB
Ground Speed (knots)
350
300
250
200
150
100
50
0
-50
8:47:02 8:49:55 8:52:48 8:55:41 8:58:34
Time UTC


VT-SPJ
Pitch Attitude (deg)
20
15
10
5
0
-5
8:47:02 8:49:55 8:52:48 8:55:41 8:58:34
Time UTC


VT-IEB
Pitch Attitude (deg)
25
20
15
10
5
0
-5
8:47:02 8:49:55 8:52:48 8:55:41 8:58:34
Time UTC


VT-SPJ
Roll Attitude (deg)
40
30
20
10
0
-10
-20
-30
8:47:02 8:49:55 8:52:48 8:55:41 8:58:34
Time UTC


VT-IEB
Roll Attitude (deg)
10
5
0
-5
-10
-15
-20
-25
-30
8:47:02 8:49:55 8:52:48 8:55:41 8:58:34
Time UTC


Vertical Separation (feet)
3000
2000
1000
0
-1000
-2000
-3000
-4000
8:48:29
8:49:55
8:51:22
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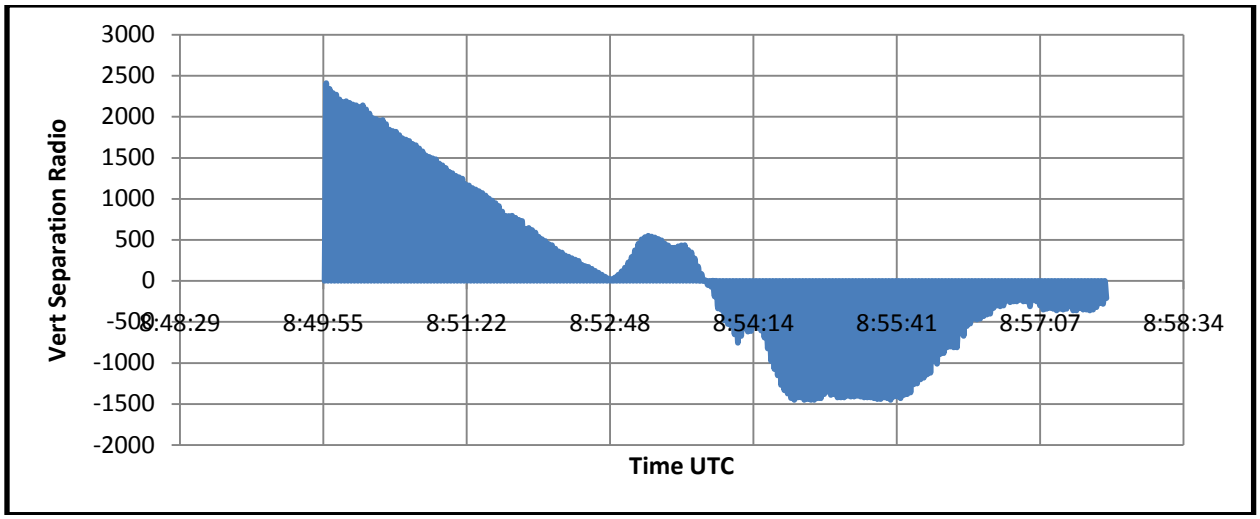
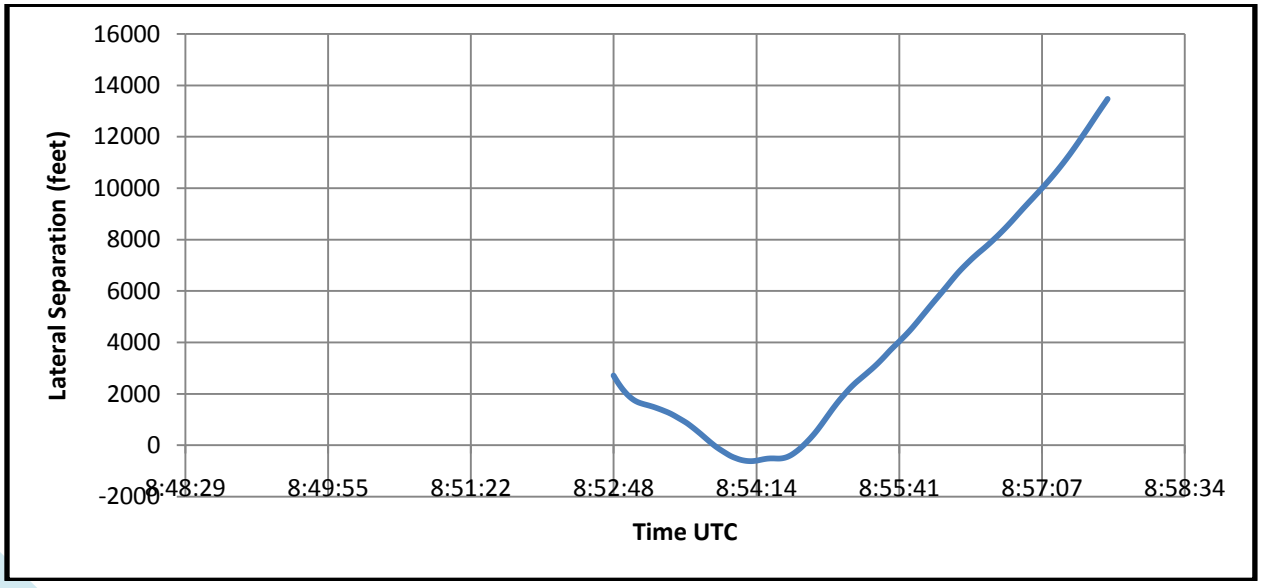
8:55:41
8:57:07
8:58:34
Time UTC


Vert Separation Radio
3000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
8:48:29
8:49:55
8:51:22
8:52:48
8:54:14
8:55:41
8:57:07
8:58:34
Time UTC


Lateral Separation (feet)
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
8:48:29
8:49:55
8:51:22
8:52:48
8:54:14
8:55:41
8:57:07
8:58:34
Time UTC

1.12 Wreckage and impact information.

There was no damage to either of the aircraft or to any ground facilities.

1.13 Medical and pathological Information:

All pilots of both involved aircraft had undergone preflight medical check prior to the flight and had successfully passed the same.

1.14 Fire :

There was no fire after the incident.

1.15 Survival aspects :

The incident was survivable.

1.16 Tests and research :

- VT-IEB has no reported aircraft snag for all sectors operated on the 2nd September, 2013. There is no reported defect related to TCAS system on this aircraft ± 15days from the date of incident.
- VT-SPJ reported snag on weather radar brightness being very low on Hyderabad Delhi Sector which was corrected before the next departure. There is no reported defect related to TCAS system on this aircraft ± 15 days from date of incident.
- All three Air Traffic controllers named above have an incident free record.
- The Captain of flight IGO 286 (VT-IEB)have been previously involved into two RA incidents of TCAS one on 19th April, 2011 at Jammu on IXJ – DEL flight and another on 9th November, 2011 at Kolkata on CCU-DIB flight.
- The Captain of flight SEJ 234 (VT-SPJ) is not involved in any previous incident of TCAS RA.

1.17 Organizational and management information :

IndiGo is a scheduled airline with a current fleet of 72 Airbus A-320 aircraft operating flights on domestic and international sectors. There are 838 pilots to operate the above fleet which include 448 Captain and 390 First Officer.

Spice Jet commenced its operations in year 2005 and as on date have 57 aircraft in their fleet which includes 36 B737-800, 6 B737-900 ER and 15 Dash 8 Q400. The Airline have their registered office in Chennai and operates to 46 domestic and 10 International stations with over 350 daily flights.

Airports authority of India (AAI) is a public sector undertaking under the Ministry of Civil Aviation. It was formed by an Act of Parliament and came into existence on 1st April 1995. AAI provides Air Navigation Services in air space measuring 2.8 million squire nautical miles which cover entire Indian air space. The Air Traffic Services at IGI airport are provided by AAI which includes Aerodrome Control Tower.

1.18 Additional information :

a) The Pilot in Command of the Indigo aircraft VT–IEB is a Type Rated Instructor who is supervising the Line Operational Flying for another Pilot in Command.

b) Functioning of Traffic Alert and Collision Avoidance System TCAS system :

The TCAS interrogates transponder of the intruder aircraft and fro m the transponder replies TCAS determines for each intruder its related bearing its range and closer rate and its relative altitude. Then the TCAS computes the intruder trajectory, the closest point of approach (CPA) and the estimated time to reach the CPA. Each time the relative time of the intruder presence a collision threat oral and visual advisories are triggered. TCAS optimizes vertical orders to ensure a sufficient trajectory separation and a minimal vertical speed variation considering all intruders.

The intruders are classified as non threat traffic / proximate intruder traffic / traffic advisories (TA) and resolution advisory (RA). A resolution advisory is issued when the intruder position possess a real collision threat to our aircraft and time available to reach the CPA is within the 25 seconds.

Some advisories are inhibited depending upon the aircraft altitude with a view to safely interface with the environment in which the aircraft is positioned and being controlled.

- All intruders flying below 380 ft. AGL when the own aircraft altitude is below 1700 ft AGL
- All RA below 1100 ft. in climb and 900 ft in descent. In this case, the RAs are converted into TAs.
- Descend' type advisory below 1200 ft AGL at take off or 1000 ft AGL in approach.
- Increase Descent' RA below 1450 ft.
- All TA aural messages below 600 ft AGL in climb and below 400 ft AGL in descent.

Because of the G-force requirement the response to the RA cannot be flown using the auto pilot. The auto pilot must be disconnect prior to responding to the RA.

The TCAS advisories are issued complementing between the two conflicting aircraft. If one aircraft is issued the climb advisories the another would be provided the descend to ensure that the two cross over through CPA point with minimum safe separation.

If TCAS advised instructions are not complied with the resolution advisories are changed from those previously issued and such reversal commands would be suffixed with "Now" to the advisory. For example if the TCAS advisory is changed from climb to descend the voice command in the cockpit would be "Climb, Climb Now" which would essentially mean that it is not just a climb command but it is a command which is reversal of the previous command and hence climb, climb now. Such reversal commands are required to be executed by the pilots by reduced response time and the flight maneuver would be of higher G (0.35 G instead of .25 G in normal maneuvers). The change resolution advisories may be a complete

reverser like fro m climb to descend or from descend to climb and it may also be increase climb rate or increase descend rate.

c) All pilots are given academic training on TCAS / ACAS during their type endorsement and this training is reinforced during the periodic refresher training pilots undergo. Flight training on TCAS / ACAS is given during the type / command simulator training for profiles. This training is reinforced during the biannual competence and licence renewal checks the pilots undergoes

1.19 Useful or effective investigation techniques:

The synchronized Flight data recorders along with the cockpit and ATC voice recorders on common time scale helped in reconstructing the event and hence the investigation.

2. ANALYSIS

Flight IGO 286 of 2nd Sep., 2013 (sector Delhi- Coimbatore) operated by VT-IEB (A320) aircraft of Indigo came in contact to Delhi ATC tower at 118.1 at 08:46:01 UTC. At this instance there were three aircraft in contact with tower. IGO 286 for departure, AIC 312 for departure and IGO 168 in approach to land.

Flight AIC 312 is operated by heavy category aircraft B 787 and is expected to generate significant wake turbulence in its take off path. It is an operational guidelines that a gap of three minutes should succeed following a heavy aircraft departure before another aircraft is cleared in the same path.

ATC Jr. Executive (ATM) named “X” is on control channel 118.1 (ATC Tower) since 08:30:00 and at 08:45:00 the OJT instructor named “Y” along with a trainee named “Z” came over to the station with the purpose of imparting training. The standard procedure on Hand Over / take over of the channel was not followed and Instructor, Controller Y allowed the trainee, Controller Z to plug in the headset without the instructor being in supervision on channel and before having taken over the channel by the procedure. The VHF receiver settings were made to speaker instead. Controller Z who does not hold the applicable rating made transmissions beginning 08:47:44. The Tower freq was therefore in control with the trainee expectedly under supervision of the Instructor who stood offline. Controller X made an entry in log book at 08:50:00 having handed over the channel while there is no entry in the Log of Controller Y takeover till this time.

The Air Traffic Control from Tower 118.1 MHz between time 08:47:44 and until shortly after 08:52:47 (Go around by VT-SPJ) are therefore conducted by controller Z.

By the laid down procedure on Handover / Takeover by the manual of Air Traffic services Airports Authority of India, it is expected that a mandatory 15 minutes overlap period is provided in which the relieved ATCO shall brief the relieving ATCO of Complete traffic situation. The relieving officer shall plug-in the headset and monitor the progress of the traffic. The relieving ATCO shall make a log entry of having received briefing and understood the traffic

situation before assuming charge of Air Traffic Control duties. The procedure was not complied with in the present scenario.

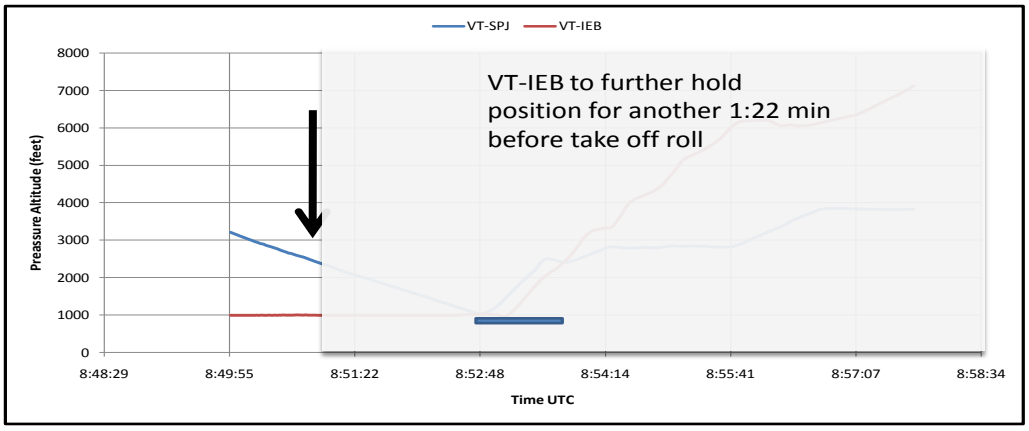
Following to the landing of flight IGO 168, AIC 312 was initially cleared for take off and in further sequence IGO 286 was advised to be ready for departure. IGO 286 however conveyed its intention to wait for three minutes after the last take off on account of expected wake turbulence. ATC acknowledged the intention. By this time another flight SEJ 234 operated by B737 aircraft of SpiceJet operating sector Shamshabad to Delhi was also in Contact with ATC Tower in its approach to Land at Delhi. At this stage therefore ATC had two aircrafts to handle, Vt-IEB for departure and VT-SPJ for landing for Runway 28 at Delhi.

Flight Recorders analysis as in para 1.11 may be referred in supplement for the progressive reconstruction of the event.

VT-IEB was cleared to enter the active runway and line up for take off from 'C' intersection, while VT-SPJ was at altitude 3465 ft (2795 AGL) and approx 8 nm to touch down. VT-IEB conveyed that they still have 2 minutes and 40 seconds more to wait before the departure. ATC however approved runway entry to VT-IEB and VT-SPJ to continue the approach. VT-IEB was at the Line up point at the Runway 28 at 08:51:03 and at this stage they still had another 1 minute and twenty two seconds to go before they commenced the take off roll. VT-SPJ at this time was at altitude 2321 ft (1482 ft AGL).

Sync time : 08:51:03

	Altitude (ft)	Radio Height (ft)	Speed –IAS kts	Vert Speed fpm	Hdg
VT-SPJ	2321	1482	152	- 825	284
VT-IEB	On Line up Rwy 28 and holding position				

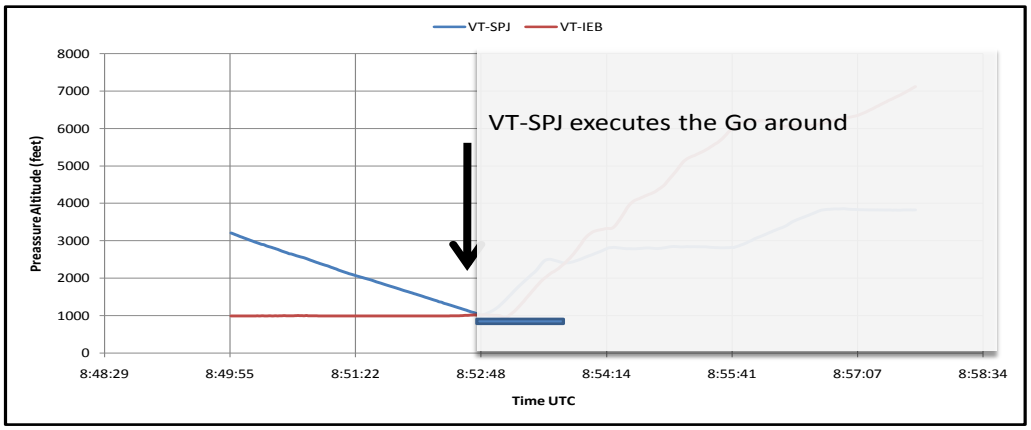


The active runway was occupied by VT-IEB holding at lineup from 'C' intersection while VT-SPJ continued its approach and was advised to expect landing clearance at short final. The CVR of VT-SPJ has recordings to infer that it was being apprehended by this crew that ATC is pushing them into very tight situation and the Go Around procedure was also reviewed by them.

VT-IEB rolled out for take off at 08:52:25 and by this time VT-SPJ was at 275 ft. AGL in approach. The landing clearance for VT-SPJ was yet not given and the aircraft was advised to expect landing clearance at "Short Short final".
On its take off roll about 22 seconds from its beginning at time 08:52:47 while VT-IEB was on runway having attained speed of 82 knots, VT-SPJ executed a go around from height of 29 ft. AGL after just having crossed the runway threshold point. The decision to go around was taken by the pilots of the aircraft and ATC did not give any instructions to this effect. ATC also didn't issue any instructions to the aircraft on runway in its take off roll. Consequent upon the Go around ATC cleared VT-SPJ by transmission "Expedite, Report passing 2600".

Sync time : 08:52:47

	Altitude (ft)	Radio Height (ft)	Speed –IAS kts	Vert Speed fpm	Hdg
VT-SPJ	1028	29	150	----------	284
VT-IEB	On Runway in take off roll with speed 82 knots				



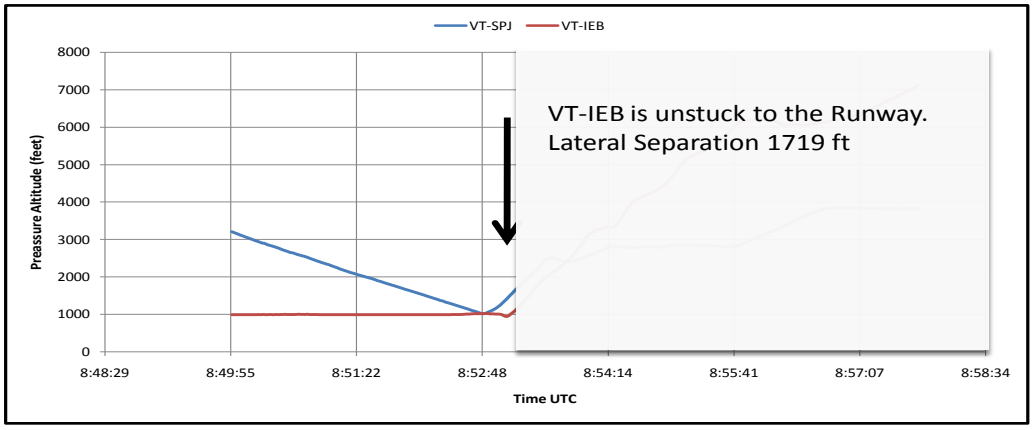
Controller Z (Trainee) at this stage seeing the conflict left the channel and the instructor who was still offline was also not in control. The Air Traffic Control was therefore unattended for few seconds till such time the controller X who had earlier handed over the channel took over again seeing the situation and passed instructions. He remained on channel till the conflict was over and subsequently handed over to the instructor again at 08:56:00.

The take off of VT-IEB therefore continued and VT–IEB was unstuck to runway at 08: 53:05 and at this instance VT-SPJ having gone around was at 455 ft AGL and climbing. VT-SPJ was laterally positioned behind VT-IEB but was flying faster. VT-IEB was vertically below VT-SPJ but was climbing faster. The two traffic therefore were in conflict in the take off path and were converging both vertically and laterally.

ATC clearance for VT-SPJ was corrected to state "Expedite report passing 3600" and VT-IEB was cleared for initial climb to 2600.

Sync time : 08:53:05

	Altitude (ft)	Radio Height (ft)	Speed –IAS kts	Vert Speed fpm	Hdg
VT-SPJ	1420	455	171	2370	284
VT-IEB	Un Stuck	0	151	-------	285



The Traffic Alert and Collision Avoidance System (TCAS) all resolution advisories (RA) in such phase are inhibited below 1100 ft AGL, while descend advisories below 1200 ft. AGL and Increased Descend advisories are inhibited below 1450 AGL. It is therefore that both aircraft in conflict at this stage did not get any TCAS resolution advisories. The TCAS traffic display and TA display are however available for Pilots situational awareness and their updates on the progress of the intruder aircraft for guidance. The bearing, the range the relative altitude and the closure rate of the intruder aircraft is available progressively on the TCAS display.

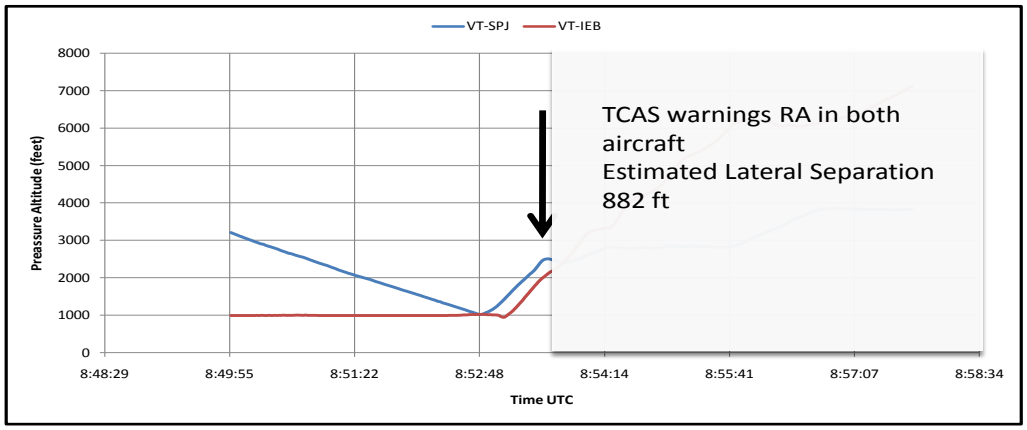
The first TCAS (RA) annunciates in VT-SPJ at time 08:53:22 at altitude 2067 ft(radio height 1160ft)and climbing at speed 175 knots and rate of climb of 2070 fpm. At this time VT-IEB was at altitude 1592, radio height 717 and climbing with speed 161 knots and rate of climb 2784 fpm. The vertical separation at this stage is 443 feet and the estimated lateral separation is about 1340 ft. Further the speed diff between two aircraft is 14 knots and VT SPJ which is behind the VT-IEB travelling faster and hence converging. The rate of climb difference between them is about 700 fpm with VT-IEB which is below climbing faster and hence converging. VT-SPJ at this stage having crossed the inhibition threshold of 1100 ft received its first RA. VT-SPJ initially received the UP Corrective advisory (Climb) just for a second which are reversed to Descend immediately with audio “Descend Descend NOW”. This is attributable to the aspect that the conflicting traffic on its takeoff was seen climbing (by TCAS)and hence the Climb advisory to VT-SPJ (complimenting Descent to conflicting traffic) was not sustained. The guided descend advisory for VT-SPJ was with -1500 fpm.VT-IEB being below 1200 feet radio height in this position the TCAS RA are inhibited to them. Such programmed RA in such inhibited phase are however converted to display as TA for the reference of Pilots to monitor and comply.

At 08:53:34 VT-IEB received the TCAS RA (the RA inhibition zone of 1200 radio height is now crossed). At this instance the aircraft parameters are altitude 2068 feet, radio height 1252 feet speed 155 knots and rate of climb 1745 fpm. Correspondingly VT-SPJ at this time is at altitude 2501, radio height 1657 ft speed 181 knots and climbing at 465 fpm. The lateral separation

between the two is estimated at 882 ft. This is another turn of events as beginning this time VT-SPJ has started to convert their climb into descend loosing height and therefore increasing the convergence rate. VT-IEB from below was still climbing at about 1700 fpm. VT-SPJ had excess speed in comparison to VT-IEB by about 20 knots and this being behind and flying faster was converging the traffic laterally also.

Sync time : 08:53:34

	Altitude (ft)	Radio Height (ft)	Speed –IAS kts	Vert Speed fpm	Hdg
VT-SPJ	2501	1657	181	465	286
VT-IEB	2068	1252	155	1745	286

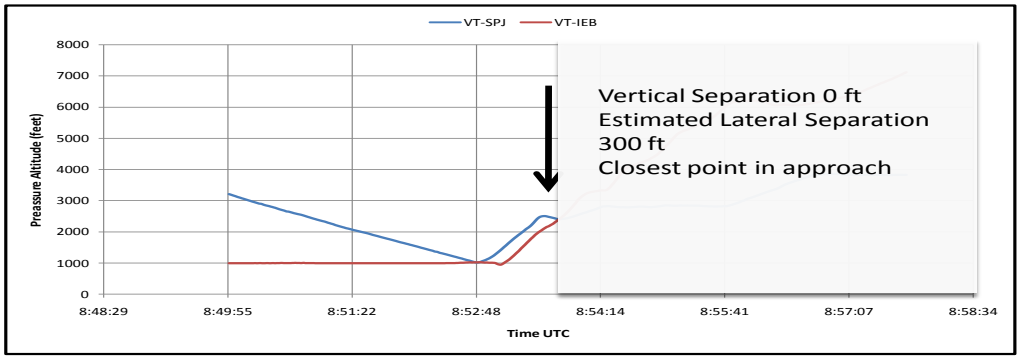


At 08:53:41 VT-IEB (altitude 2248 altitude, 1490 AGL 156 knots and roc of 1727 fpm) and VT-SPJ (altitude 2451 1666AGL, 186 knots and rod of – 690 fpm) were converging into each other very fast. The vertical separation is 176 feet and estimated lateral separation 521 ft. The TCAS RA annunciation was increased to record "increased descend" to -2500 fpm for VT-SPJ and complimenting to VT-IEB..The synchronized CVR recording of VT-SPJ also records "Increase descend, increase descend". Both aircraft being above the 1450 feet radio height at this instance the increased rate commands were admissible as being out of its inhibition range. Approaching 2600' their last ATC clearance VT-IEB was called by ATC to stop climbing to which VT-IEB responded to say "we have TCAS and got to follow TCAS" and hence continued the climb.

08:53:45 is considered the "Closest Point in Approach" (CPA). VT-IEB at this stage crosses the level flown by VT-SPJ and the lateral separation at this point is estimated at 300 feet.

Sync time : 08:53:45

	Altitude (ft)	Radio Height (ft)	Speed –IAS kts	Vert Speed fpm	Hdg
VT-SPJ	2410	1606	184	- 255	291
VT-IEB	2380	1600	155	1958	289



As is also confirmed from the synchronized voice recordings VT-SPJ spotted the conflict aircraft visually at this stage and executed the roll maneuver to right by 30 deg roll attitude and corrected back by time 08:53:56. A mid air collision is hence narrowly avoided.

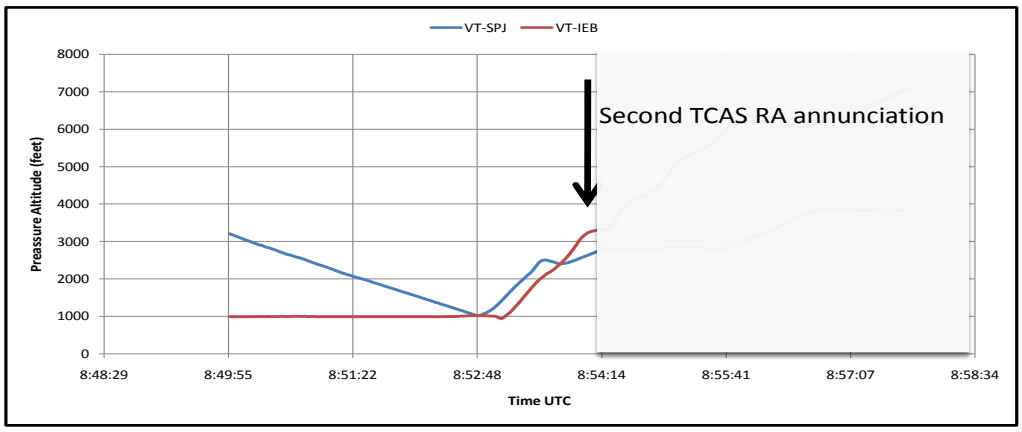
08:53:56 VT-IEB (altitude 2868, 2132 AGL, 159 knots) and VT-SPJ (altitude 2499 ft, 1712 AGL, 178 knots) stands clear of Conflict and their respective FDRs and CVR records the same. The vertical separation is increasing with VT-IEB having flown through the VT-SPJ altitude higher in height and climbing fast. Lateral separation on account of VT-SPJ flying off from the extended centre line is also in safe limit. Consequent upon the Clear of Conflict and at 08:54:07 VT-IEB transmitted to ATC Tower "Leveling out at 3000, Confirm that". In absence of any ATC advise VT-IEB leveled at 3000.

Subsequent thereof to the 'Clear of Conflict' VT-SPJ is climbing at approx 800 – 900 fpm rate and VT IEB which was till this time climbing at increased rates of about 3300 – 3400 fpm began to reduce climb to almost fly level by 08:54:07 at altitude of 3264 (2551 AGL). By this time VT-SPJ is at altitude 2669 ft (1879 AGL) and climbing at 945 fpm at 175 knots. This generated another conflict situation.

Another TCAS RA is generated at 08:54:12 with VT-SPJ at altitude 2744 ft. (1974 ft. AGL) speed 178 knots and climbing at 1050 fpm. VT-IEB at this time is 3304 ft. altitude (2599 ft AGL) speed 176 knots and flying almost level at roc of 243 fpm. Two aircraft are again seen converging with VT-IEB at this time flying level and VT-SPJ climbing from below. The RA generated to VT-SPJ is Preventive as "Don't Climb" and expectedly the Climb" for VT-IEB. Both aircraft this time followed the RA Commands with VT-SPJ flying level at prevailing height (No Climb) and VT-IEB climbing at about 3000 fpm initially. ATC Tower also responded by advising VT-SPJ to "maintain 2600" which was acknowledged and followed.

Sync time : 08:54:12

	Altitude (ft)	Radio Height (ft)	Speed –IAS kts	Vert Speed fpm	Hdg
VT-SPJ	2744	1974	178	1050	289
VT-IEB	3304	2599	176	243	295

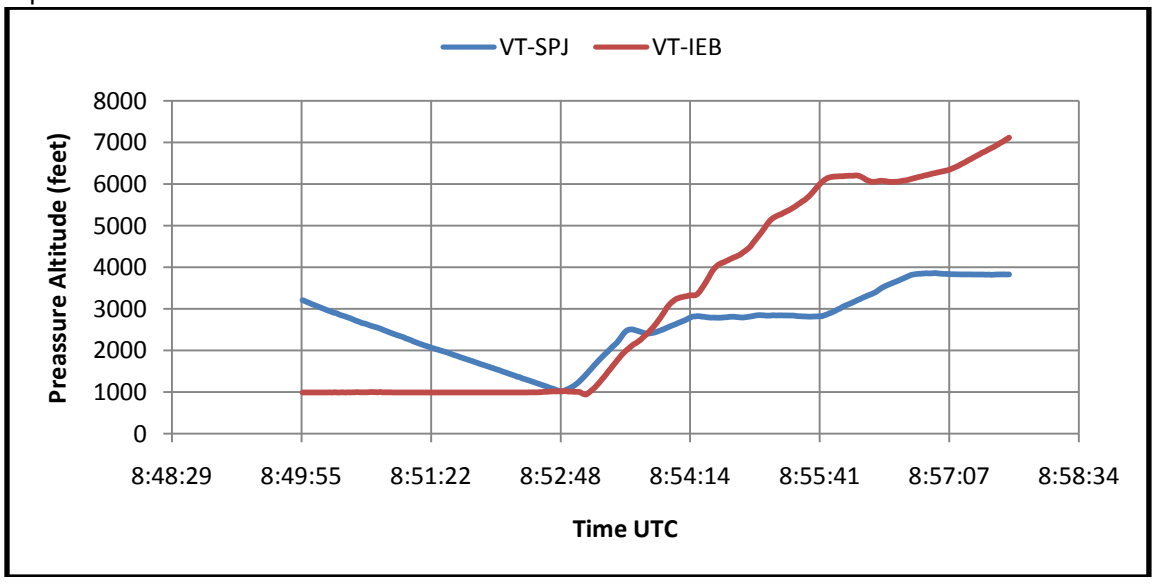


While still in the TCAS RA annunciated phase of Conflict, the Tower called upon both aircraft to change over to Radar freq 126.35.

08:54:47 the TCAS off ("Clear of Conflict") is recorded on the FDRs and also the CVR. At this instance VT-IEB is at altitude 4392ft 3491ftAGLand VT-SPJ at altitude 2797 ft and 2050 AGL.

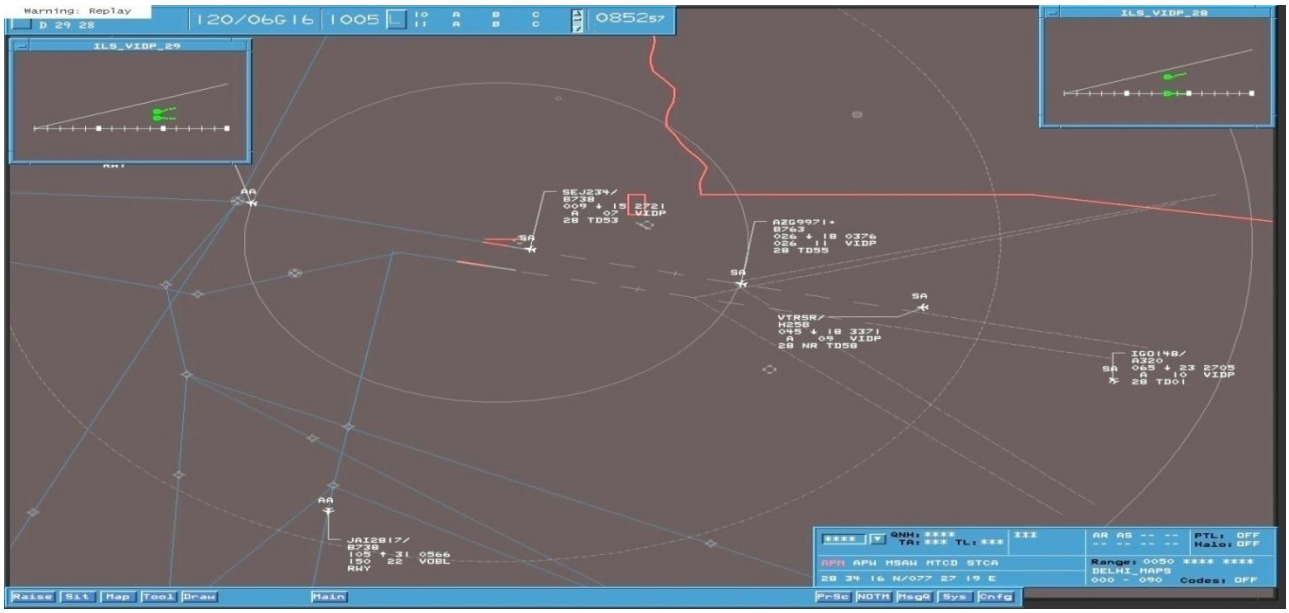
VT-IEB leveled off at 5000' conveyed the same to Radar and climbed further in their coordination.

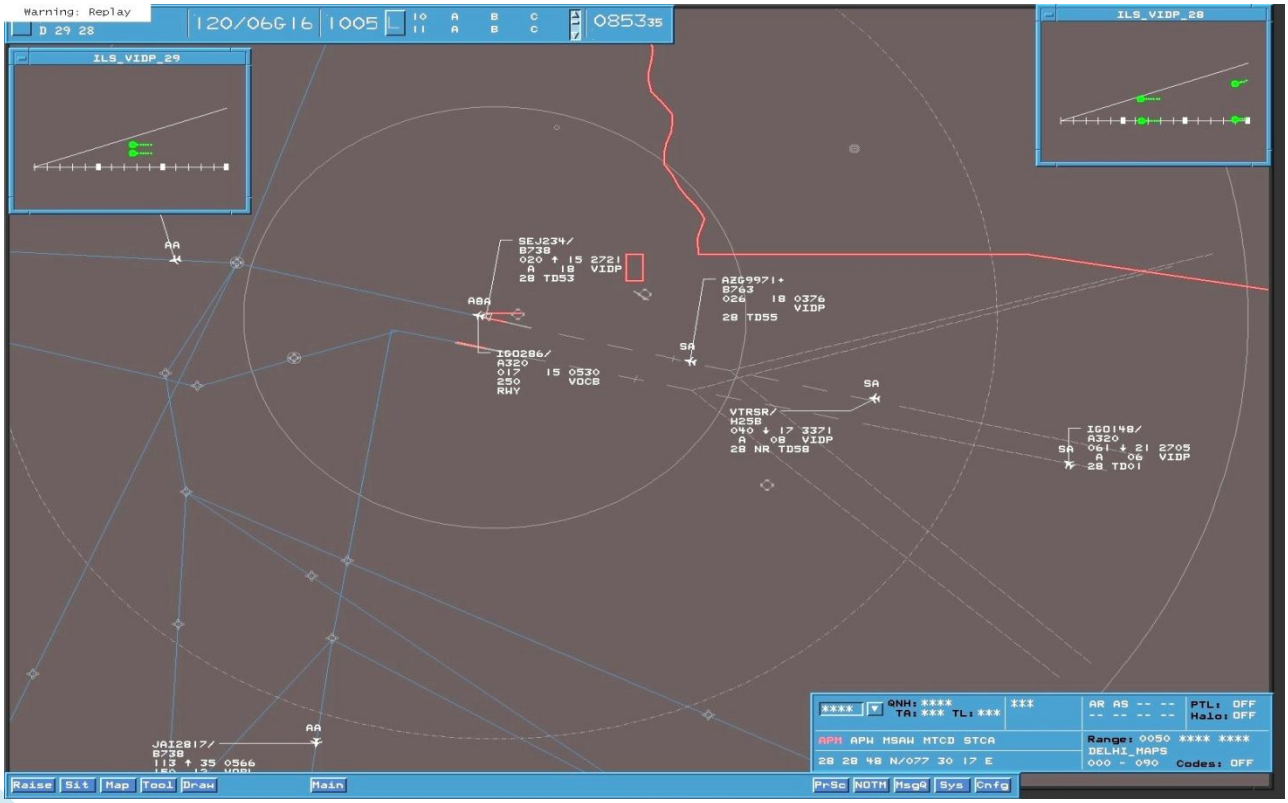
The profiles flown by two aircraft subsequent to this stage increased their lateral and vertical separations into safe limits.

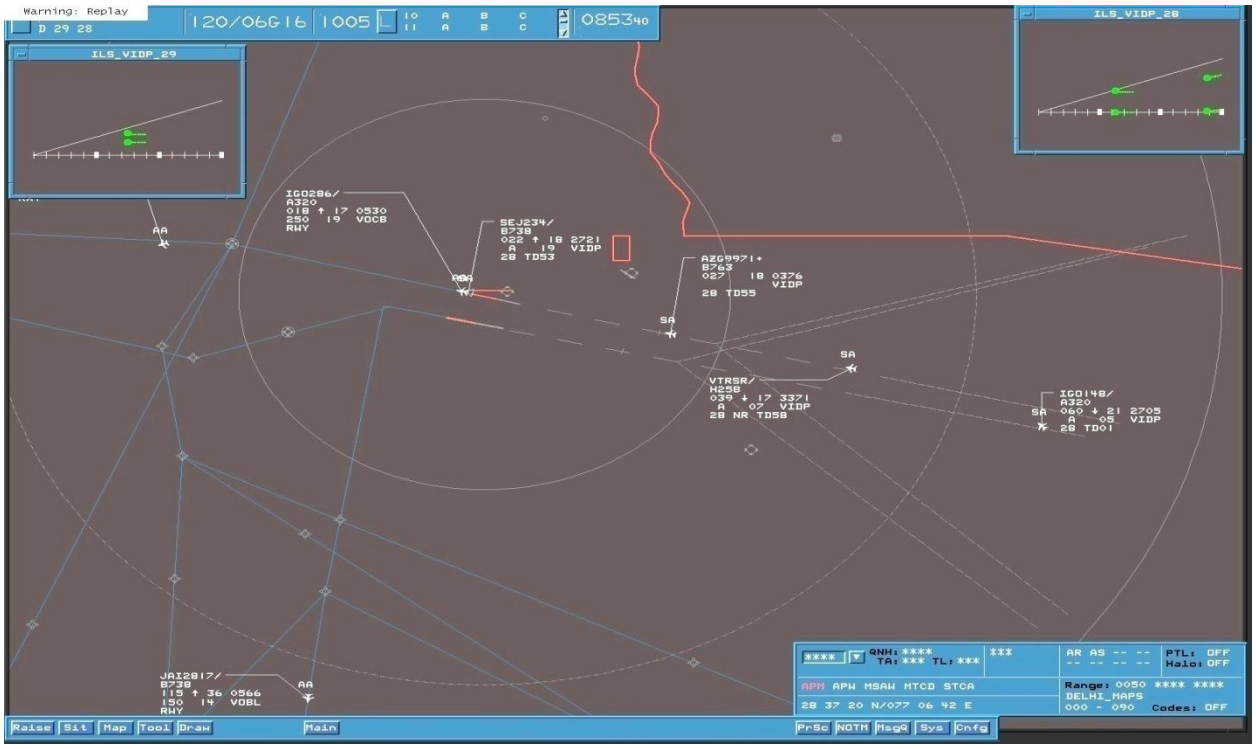


The inferences as above are further confirmed with the Advanced Surface Movement Guidance and Control System (ASMGCS) recordings with the Air Traffic Services.

The snapshots of ASMCGS for the relevant period are as under :



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120/06G16
1005
085340
ILS_VIDP_29
ILS_VIDP_28
IGO286/
A320
018 ↑ 17 0530
250 19 VOCB
RWY
SEJ234/
B738
022 ↑ 18 2721
A 19 VIDP
28 TD53
AZG9971+
B763
027 18 0376
VIDP
28 TD55
VTRSR/
H25B
039 ↓ 17 3371
A 07 VIDP
28 NR TD58
IGO148/
A320
060 ↓ 21 2705
A 05 VIDP
28 TD01
JAI2817/
B738
115 ↑ 36 0566
150 14 VOBL
RWY
QNH: ****
TA: *** TL: ***
AR AS -- --
-- -- -- --
PTL: OFF
Halo: OFF
APM APW MSAW MTCD STCA
28 37 20 N/077 06 42 E
Range: 0050 **** ****
DELHI_MAPS
000 - 090 Codes: OFF
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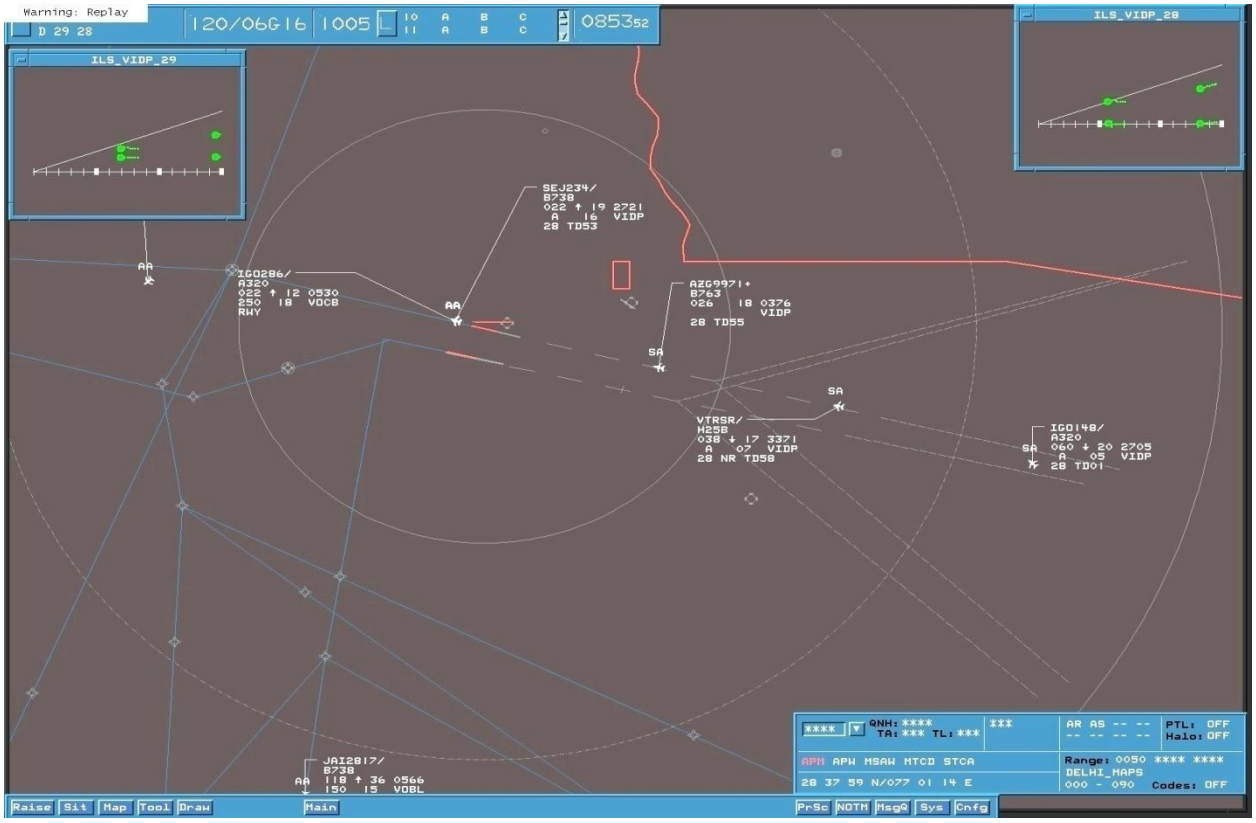
PrSc NOTM MsgQ Sys Cnfg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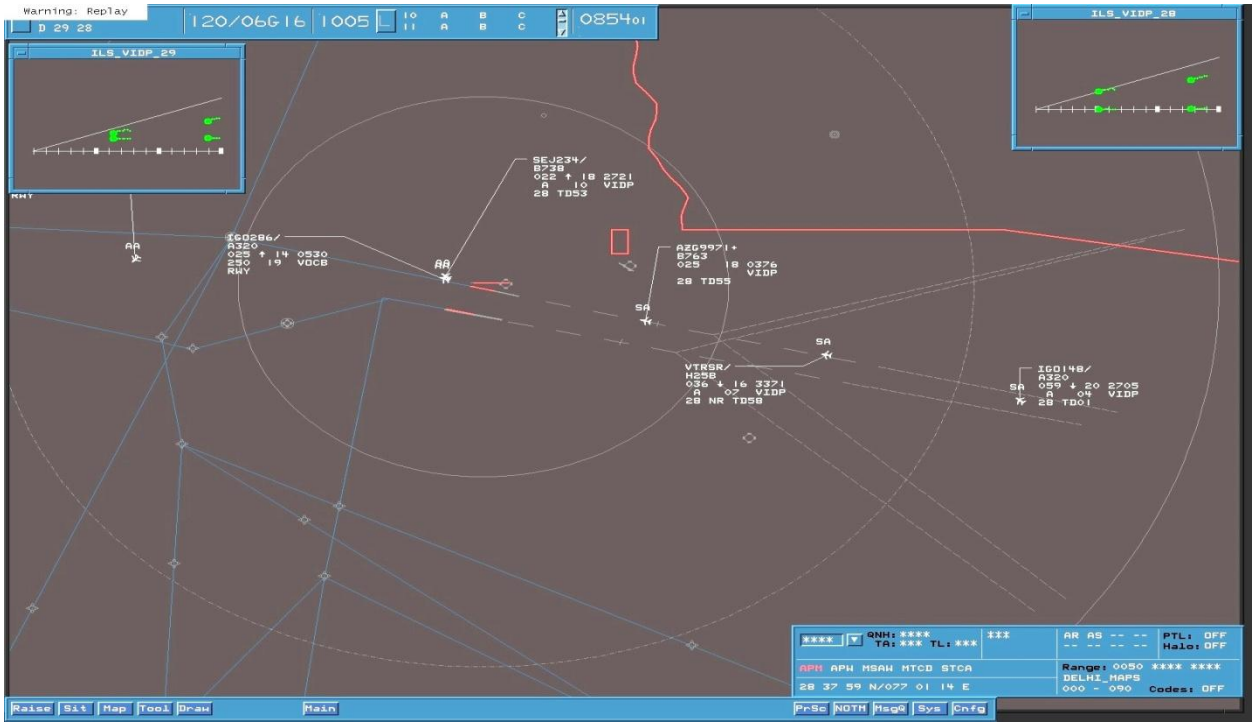
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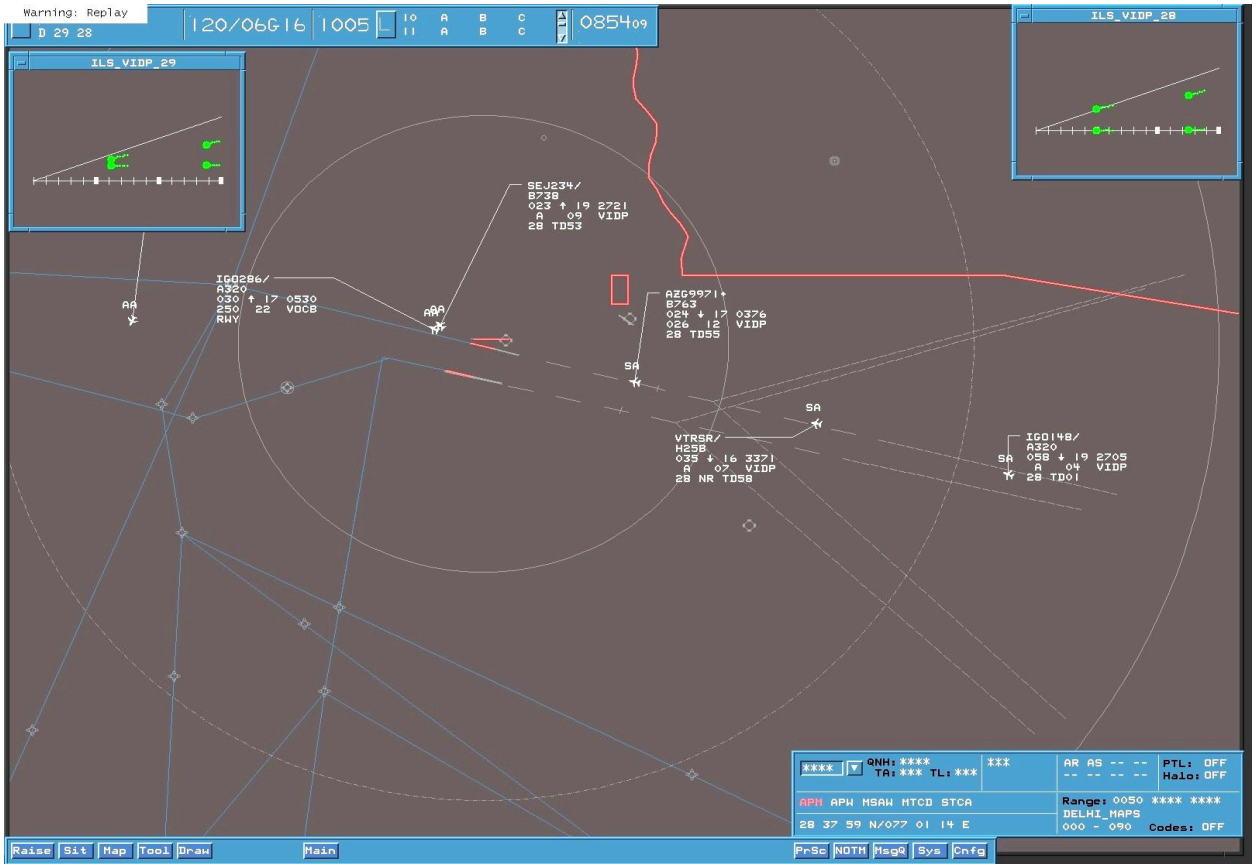
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3 CONCLUSIONS :

3.1 Findings :

A) The chain of error which resulted in an unsafe vertical and lateral separations between two aircraft VT-IEB and VT-SPJ is considered to have progressed through the following links :

i. Initially at 08:46:01 when two aircraft AIC 312 (B 787) aircraft and IGO 286 (A 320) are to be sequenced for take off from the same runway, keeping the wake turbulence in view A 320 aircraft operating IGO 286 should have been sequenced to take off ahead of the heavy aircraft AIC 312.

ii. Following AIC 312 take off and a recognized prevailing wake turbulence situation SEJ 234 landing on Runway 28 should have been preferred ahead of IGO 286 take off. To achieve this IGO 286 (VT-IEB) should have been advised to take the waiting time of three minutes at the taxi holding instead of being put in at the line up of Runway 28.

iii. Taking stock of current situation progressively when VT-IEB is occupying the Runway asking to wait for another approx. two minutes time and SEJ 234 checking about 7 miles to touchdown it should have been preempted that either IGO 286 is advised in time to vacate active Runway. or advise VT-SPJ to discontinue approach. This would have given ample time to create sufficient separations and avoid a conflict situation.

iv. VT–SPJ continued its approach without the landing Clearance and continued it beyond the 'Decision Height'. ATC controller instruction to state "expect Landing Clearance at Short Short Final" is non standard.

v. There is a complete breakdown of ATC control in the Tower with Channel freq having been handed over to another Controller (Instructor) for training to a trainee but the Instructor is staying offline. The trainee who was on Control left the channel control seeing the conflict. The duty controller took over seeing no one at the control and passed instructions. Some crucial time is lost in which inputs from the ATC were critical.

vi. VT-SPJ having gone around with VT-IEB on Runway on take off roll with speed 82 knots., VT-IEB should have rejected the take off recognizing the built up of the conflict by extrapolation.

vii. The pilots in VT-IEB and in VT-SPJ by the expected situational awareness are ought to be familiar of the in coming and developing conflict situation and with progress of the conflicting intruder traffic should have been monitored on the TCAS display beside other available means. The resolution advisories are inhibited in the TCAS by design up to 1200 ft. radio height and the onus of separations between the aircraft is on controllers / pilots flying.

viii. The ATC controllers failed to respond to the Resolution advisories situation in the aircraft and passed no guidance to the conflicting aircraft about the proximate traffic.

ix. Both aircraft being of the same category and in clean configurations were equally entitled to receive climb / descend advisories and in the occurrence VT-SPJ being higher was entitled for climb and VT-IEB for reduce climb / descend. VT-IEB continuation on take off with normal climb rate and disregard of the TCAS display on conflicting aircraft generated the reversal commands from the TCAS and hence complicating the situation. The incomplete understanding by pilots on part of TCAS reversal commands further let the event error progressed to its next link.

x. VT-SPJ decision to fly level at 1600 ft. is in disregard to the go around expected profile and also disregard to the TCAS advisory. This progressed the chain of error to its next link and further complicating the situation.

xi. Consequent upon the crossing of flight levels and having met the closest point in approach VT-IEB continued its climb with VT-SPJ maintaining level. Continuation of this situation should have increased the safety margins progressively but with VT-SPJ resuming to climb on the same flight path generated yet another conflict between the two aircraft and generated another TCAS Resolution Advisory.

B) Traffic alert and Collision avoidance system (TCAS) does not effectively resolve the situation as in this Scenario wherein both aircraft while flying in the Controlled environment develops a conflict situation in the Take off path. TCAS advisories are initially inhibited and when out of the inhibition zone it expects one of the two aircraft to descend and also descend at the increased rates. The responsibility of conflict resolution in such controlled zone is with pilots and the Air Traffic Control. This may be considered as the TCAS System Limitation. However TCAS provides Bearing, range, relative altitude and the rate of convergence data for the intruder aircraft on its display, the information which may be effectively interpreted by pilots to understand intruder flight trajectory and reach conflict resolution.

C) There was a breakdown in laid down procedure implementations as far as the Hand Over / Take over of an active channel in the ATC is concerned. The relieved ATCO signs the Log book and assumes having handed over the channel when the relieving ATCO though physically present, has yet not taken over by the Log Book. Expectedly relieving ATCO, Controller Y in this case is expected to have overlapped 15 minutes on briefing by the relieved ATCO, controller X , followed by relieving ATCO Log entry of having taken over ahead of the log entry by the relieved ATCO. This procedure is violated. Further violated is the norm that a trainee Controller who does not hold the rating for the channel should not take over the channel without the supervision of the rated Instructor. Trainee, Controller Z in this case not only assumes station, he controls traffic and made transmissions on the active channel. Trainee further leaves the station unattended in the conflict situation.

It is also noted that the equipment in aerodrome control tower are not ergonomically placed and some of them are placed over each other, thereby creating the situation which is prone for human errors. The loose and hanging wires behind the control panels are identified hazards which needs be addressed for operational safety in the environment.

D) As the conflict situation prevailed, ATC control tower had in presence three controllers of varied experience levels. In absence of the demarcated control hierarchy for succession of Command, the confusion prevailed in the control tower and some crucial time is lost wherein critical inputs may have been provided to resolve the conflict.

E) Flight Crew of VT-SPJ did not interpret and responded to the TCAS resolution advisories especially the Change advisories e.g. Descend, Descend NOW appropriately

F) ATC further did not report this occurrence by the applicable procedures till this was detected in the departmental review.

3.2 Probable cause of Incident :

The Air Traffic Control made the initial error placing two aircraft in the conflict positioning and all opportunities that were available subsequently to block the progress of the error were not affected and the error was allowed to progress. The possibility of a machine related failure is ruled out and the Human Error attributable to different extent is seen manifested in all three work areas, ATC Tower and the Pilots in Both aircraft.

Following are the considered extents of Human Errors in their respective stations :

ATC Tower :

1.1 Decision to Hold an aircraft on active runway which is to delay its take off till the wake turbulence conditions subside and in this time allowing the other to continue its approach for same runway thereby reducing their lateral separations.

1.2 Inability to assess Conflict and thereby the risk in allowing the event to progress till the aircraft in approach executes the Go around from runway threshold point while the other is still occupying the runway and is about another 20 sec away in time before it rotated for take off un-sticking from the surface.

1.3 Inability in exercising Judgment and decision to order rejection of the take off by the aircraft on the runway, an omission that allowed the take off aircraft to conflict in the take off path with another that has gone around from the same runway.

1.4 No effective Air Traffic Control was exercised in the conflict situation with no transmissions to advise intruder traffic position or the instructions to resolve. The traffic conflict in this case are developed at altitudes in which the TCAS resolution advisories are kept inhibited and the Air Traffic Control has the major responsibility on conflict resolution.

1.5 Air Traffic Control further failed in allowing traffic to progress adversely following the 1st traffic conflict resolution and thereby allowing another conflict TCAS RA event.

1.6 Failure in exercising the effective Command Hierarchy system for situations where there are more then one controller on the station and are to handle Normal / Non Normal / Emergency situations.

1.7 Hand over / take over procedure implementation as in para 3.1 C above

1.9 In absence of any formal hand over / take over it is assumed that all three controllers named X,Y and Z are available on the channel. In emergency situation as in the present case the more experienced Controller (the instructor) should have contributed generating thereby the synergy in the system by effective resource management.

Indigo VT IEB :

2.1 Recognizing that the aircraft in approach for same runway has just gone around discontinuing its approach, IEB should have rejected its take off and avoided thereby a traffic conflict situation in the take off path. VT-IEB was on runway at speed 82 knots when VT SPJ initiated the Go around and announced so.

2.2 The progress of the intruder traffic in such conflict situation was not adequately monitored either by TCAS display or by other available means. This led to Vt IEB crossing over through the level of the intruder traffic VT SPJ with very low lateral Separations.

Spice Jet VT SPJ

3.1 Failure to Preempt a developing situation (aircraft at position about 6 nm to touch down progressing in approach to land at speed about 160 knots and another aircraft on runway is going to take approx 2 more minutes before it initiated the take off roll which further lasts another 45 seconds before the runway is available)

3.2 Aircraft continues its approach without the Landing Clearance and continues till the runway threshold, below the point marked as 'Decision Height'

3.3 Aircraft on its Go Around follows the expected Go around flight path till about 1600 feet radio height and then begins to descend for some time and climbs again. This maneuver is neither in compliance to Go around flight path or the commanded TCAS resolution advisories.

3.4 The progress of the intruder traffic in such conflict situation was not adequately monitored either by TCAS display or by other available means. This resulted in aircraft maneuvers which converged the conflicting traffic instead of separations. (It is however acknowledged that the maneuver of right banking the aircraft after visually sighting the intruder aircraft in close proximity only saved this serious situation from a possible mid air collision accident).

4 Safety Recommendations

1. The Decision Height DH (or Decision Altitude, DA when applicable) by its definition is the specified height in approach by which a missed approach must be initiated if the required visual reference to continue the approach has not been established. This is considered the height by which a decision should be reached to continue to not to continue the approach. By an extended definition to this aspect an approach should also be discontinued if the landing clearance has not been obtained by the point in approach marked as 'Decision Height' (or Decision Altitude)

2. A situation wherein more than one Air Traffic Controller is present on the active channel is possible under various scenarios such as the overlap period of handover-takeover situations or situations wherein double banking training or similar assignments are executed. Such situations need a clearly defined Command hierarchy to ensures appropriate transfer of controls and responsibilities for both Normal and Non normal situations.

3. This is observed that the laid down procedure on ATC Channel hand over / Takeover are not followed in practice and are deviated significantly from the Standard Procedures. The procedure implementations and thereby the Safety Management to this identified hazard should be ensured by the AAI.

4. Air Traffic Controller Trainee need be given the on-job practical operational experience till one attains the required level of proficiency. Such training are conducted in live environment under supervision by the qualified Instructor. This is also considered that probability of making a mistake by a trainee who is yet not certified to standards are relatively higher and hence it is the instructors function to takeover the command in time before the error is manifested in consequences. The thresholds may therefore be clearly laid down by which an instructor must takeover the function keeping adequate

safety margins. The guiding threshold limits must be inculcated in the instructor's training and standardization checks.

5. The professional and judgmental errors as observed in para 3.2 "Probable cause of incident" for the respective functions be addressed by the appropriate competent authority and corrective measures taken to ensure no future replication. Air Traffic Services also to review the aspect on non reporting of incident of such magnitude.

6. The TCAS system limitations in addressing the conflicts of this nature may be included in Crew training curriculum.

Vijay Ginotra **N.S Dagar**

(Committee of Inquiry appointed by Ministry of Civil Aviation vide notification AV.15013/06/2013-DG dated 11th Nov 2013)

Place : New Delhi
Date : 4th Feb, 2014