Final Investigation Report on Accident involving Spice Jet's B-737-800 aircraft bearing registration VT SLH while en-route Durgapur on 01 May 2022

Aircraft Accident Investigation Bureau

Government of India

Ministry of Civil Aviation

FOREWORD

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2017, the sole objective of the investigation of an Accident/Incident shall be the prevention of accidents and incidents and not to apportion blame or liability. The investigation conducted in accordance with the provisions of the above said rules shall be separate from any judicial or administrative proceedings to apportion blame or liability.

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

Contents

GLOSSARY

AAIB	Aircraft Accident Investigation Bureau
AME	Aircraft Maintenance Engineer
AMSL	Above Mean Sea Level
APM	Airworthiness Procedures Manual
ARC	Airworthiness Review Certificate
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATPL	Airline Transport Pilot License
AUW	All Up Weight
CAME	Continuing Airworthiness Management Exposition
CAT	Clear Air Turbulence
CG	Centre of Gravity
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CPL	Commercial Pilot License
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DGCA	Directorate General of Civil Aviation
FCOM	Flight Crew Operation Manual
FCTM	Flight Crew Training Manual
FL	Flight Level
fpm	Feet per Minute
FRTO	Flight Radio Telephone Operator
Hrs	Hours
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
LLZ	Localiser
MCC	Maintenance Control Centre
MEL	Minimum Equipment List
MTOW	Maximum Take Off Weight
NDB	Non Directional Beacon
NM	Nautical Miles
OEM	Original Equipment Manufacturer

PA	Passenger Address
PF	Pilot Flying
PIC	Pilot in Command
PM	Pilot Monitoring
PSU	Passenger Service Units
QRH	Quick Reference Handbook
RA	Radio Altitude
SB	Service Bulletin
TAT	Total Air Temperature
UKW	Kolkata ACC West
ULB	Underwater Locator Beacon
URP	Upper Raipur Controller
VABB	Mumbai Airport
VECC	Kolkata Airport
VEDG	Durgapur Airport
VEGT	Guwahati Airport
VERC	Ranchi Airport
VOGO	Goa Airport
VMC	Visual Meteorological Conditions
VOR	VHF Omni directional Range
UTC	Universal Time Coordinated

SUMMARY

1.	**Aircraft**	**Type**	Boeing 737-800
		Nationality	Indian
		Registration	VT-SLH
2.	**Owner**		M/S KLAAT Aircraft Leasing (Ireland) Ltd
3.	**Operator**		M/S Spicejet Ltd
4.	**Country of Manufacture**		United States of America
5.	**Pilot**		ATPL
6.	**No. of Persons on board**		189 passengers 06 Crew (02 Flight crew and 04 Cabin crew)
7.	**Date & Time of Accident**		01 May 2022, 1327 UTC approx.
8.	**Place of Accident**		En-route Durgapur
9.	**Co-ordinates of Accident Site, AMSL**		E086 02.94, N23 48.91; Passing FL150
10.	**Last point of Departure**		Mumbai
11.	**Intended landing place**		Durgapur
12.	**Type of Operation**		Scheduled
13.	**Phase of operation**		Descent
14.	**Type of Occurrence**		Turbulence Encounter
15.	**Extent of Injuries**		01 Fatal, 03 Serious

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

SYNOPSIS

On 01-05-2022 a Boeing 737-800 aircraft, registered as VT-SLH was scheduled to operate Flight SG-945 on Mumbai-Durgapur sector with call sign SEJ945. The aircraft was under the Command of a PIC, holding a current Airline Transport Pilot License (ATPL) and assisted by a Co-Pilot, holding a current Commercial Pilot License (CPL). There were 189 passengers and 06 crew members (02 Flight crew and 04 Cabin crew) on board.

Aircraft departed from Mumbai at 11:43 UTC and at about 13:19 UTC, the aircraft started descent for Durgapur. At 13:19:39 UTC, the aircraft informed Kolkata Radar that it was maintaining a Heading of 065 due to weather. Expecting weather and turbulence, the PIC advised the passengers to remain seated for the next 15 minutes over PA and this was followed by an advice to cabin crew to remain seated till the expected rough weather is cleared. The seatbelt signs were ON. The Cabin Crew who were in process of securing the cabin were near 8th row and returned to their seats. The Cabin crew made an announcement over PA for the passengers to remain seated and wear seatbelts. Announcements to remain seated were repeated by PIC and Cabin Crew. At about, 13:27 UTC the aircraft encountered severe turbulence. Many passengers, not wearing seatbelts, were thrown off their seats and suffered injuries.

The aircraft landed at Durgapur at about 13:47 UTC and medical assistance was provided to the injured passengers including hospitalization. One passenger later passed away while undergoing treatment. The occurrence was classified as Accident under Aircraft (Investigation of Accidents and Incidents) Rules, 2017 and investigation was ordered vide order dated 20 May 2022.

1. Factual Information

1.1 History of Flight

On 01-05-2022 a Boeing 737-800 aircraft, registered as VT-SLH was scheduled to operate Flight SG-945 on Mumbai-Durgapur sector. The ETD from Mumbai (VABB) was 1135Z and ETA at Durgapur (VEDG) was 1415Z. The alternate destination as per the flight plan was Guwahati (VEGT). VEBN and VECC were second and third alternate destination. The aircraft had operated VABB-VIJP-VABB and VABB-VOGO-VABB sectors earlier during the day before the occurrence flight

The aircraft was under the Command of a PIC, holding a current Airline Transport Pilot License (ATPL) and assisted by a Co-Pilot, holding a current Commercial Pilot License (CPL). The crew was qualified on and current to operate the Boeing 737-800 aircraft. There were 189 passengers and 06 crew members (02 Flight crew and 04 Cabin crew) on board.

During dispatch briefing the crew was provided Prognostic Chart as a part of Met Report which showed weather patch in area between Durgapur and Kolkata. As per PIC Cabin Crew were briefed in this respect during the pre-flight briefing, however, Cabin Crew stated to have not been provided any briefing in this regard at the start of flight.

The aircraft departed from Mumbai at 1143 UTC. The aircraft changed over from Nagpur ATC to Upper Raipur Controller (URP) at 1244 UTC. Later URP handed over to Kolkata ACC-West (UKW) at 13:11:35 UTC while it was maintaining FL 390 and Heading 055. UKW controller asked VT-SLH to contact Durgapur. The aircraft contacted with Durgapur tower at 13:11:46 UTC and requested for Durgapur weather and runway in use at 13:12:12 UTC. Durgapur tower passed the weather observed at 1300 UTC to the aircraft, as Winds 120/08, Temp 31, QNH 1001 Trend NE, Clouds FEW 2000ft, SCT 9000 ft and to expect ILS approach to Runway 16.

At 13:19:24 UTC, the aircraft requested UKW controller for descent and at 13:19:26 UTC was permitted to descend to FL 250. At 13:19:39 UTC, the aircraft informed UKW controller that it was maintaining a Heading of 065 due to weather and at 13:19:45 UTC, the same was approved by the UKW controller.

Thereafter, the PIC made an announcement over PA that they have commenced descent and will be landing at Durgapur in 25 minutes. At about 13:21 UTC, the PIC advised the passengers to remain seated for the next 15 minutes followed by an advice to cabin crew to finish their work in next three to four minutes and remain seated till the expected rough weather is cleared.

The flight crew completed the descent checklist and requested for a further descent at 13:22:42 UTC and at 13:22:45 they were approved to descend to FL 70 by UKW controller. Meanwhile, the cabin crew made a PA asking passenger to remain seated as they are expecting turbulence and the seat belt sign has been turned ON.

At 13:23 UTC, PIC discussed the weather ahead with co-pilot and decided to proceed another 10 miles and turn left in case weather remains same. Aircraft are equipped with Video Surveillance

cameras, for the pilots to monitor from their seats the entire area outside the flight deck entry door so as to identify persons requesting entry and to detect suspicious behavior or potential threat.

As a precaution, the PIC then asked Co-Pilot to check in surveillance camera to see if all are seated in the cockpit. Co-Pilot responded affirmatively after checking. At 13:27 UTC, CC made another PA for passengers to remain seated. Thereafter, the aircraft encountered severe turbulence.

As per the ATCO, the aircraft was maintaining descent rate of 1900-2200 fpm. However, while about 85 NM from Durgapur VOR and passing FL254 the descent rate was observed to have suddenly increased to 3800 fpm and then to 4300 fpm while passing FL238. The descent rate further increased to 4800 fpm and finally 5000fpm while passing FL231. While passing FL207 the descent rate was again 3700 fpm and later increased to 4100fpm while passing FL165. The aircraft descended to FL151 and then climbed to FL157 before starting to descend again. At 1329, UKW controller initiated call to VT-SLH and was informed *"WE ARE EXPERIENCING HEAVY TURBULENCE, WE ARE PASSING FL140, STANDBY"*

As per the statement of Cabin Crew, PIC initially informed that they have commenced descent and will be landing in 25 mins. He also informed that Turbulence may be expected. This was the month of Ramadan and various passengers were yet to eat their meal as they were waiting for sunset time which was expected at 1900 hrs (at Mumbai) to break their fast. The PIC later asked them to secure the cabin in 03-04 minutes. The cabin crew anyhow started pre-landing checks and starting securing the cabin. By the time cabin crew reached 8th row, the PIC made a PA for passengers and crew to remain seated. So all cabin crew rushed to their seats. Seatbelt sign was already ON and the Cabin crew made PA asking passengers to wear seatbelts.

Thereafter, aircraft encountered severe turbulence. Many passengers were thrown up their seats and hit the ceiling. A passenger fell from the seat to the aisle. A ceiling panel separated and fell in the aft cabin. Unsecured passenger belongings and food items got thrown across the cabin. Some of the passenger oxygen masks had fallen off, from some passenger service units (PSUs). There was panic amongst passengers and the Cabin Crew were continuously screaming out asking the passengers to remain seated. Cockpit Crew also made repeated calls over PA informing pax that the aircraft encountered turbulence and they should remain seated. The turbulence lasted for about five minutes.

At 1335 UTC, while passing FL90 and at around 31NM to Durgapur, the aircraft was changed over by UKW controller to Durgapur ATC. Cabin Crew informed PIC of the situation in cabin including injuries to passengers. ATC Durgapur was apprised of the situation and request for medical assistance was made. At 13:40 UTC, the PIC instructed cabin crew and passengers to be seated for landing. At 13:47 UTC the aircraft made a safe landing on Runway 16 at Durgapur. Aircraft was provided medical assistance on arrival. While some passengers were provided first aid at airport clinic, others were taken to hospital for treatment.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	Nil	01	Nil
Serious	Nil	03	Nil
Minor/ ~~None~~	03	14	Nil

1.3 Damage to Aircraft

No visible external damage was found on the aircraft. No other external damage was found. A post flight severe turbulence and stall inspection carried out revealed no abnormalities.

However due to severe Weather encountered, the cabin of the aircraft was damaged at various places. Impact Dents were observed in cabin ceiling at various places. These damages were noticed over seat numbers 16D, 21D, 22D, 23D, 25D, 30D, 31D. Overhead panel above seat number 32 row was damaged and required replacement.

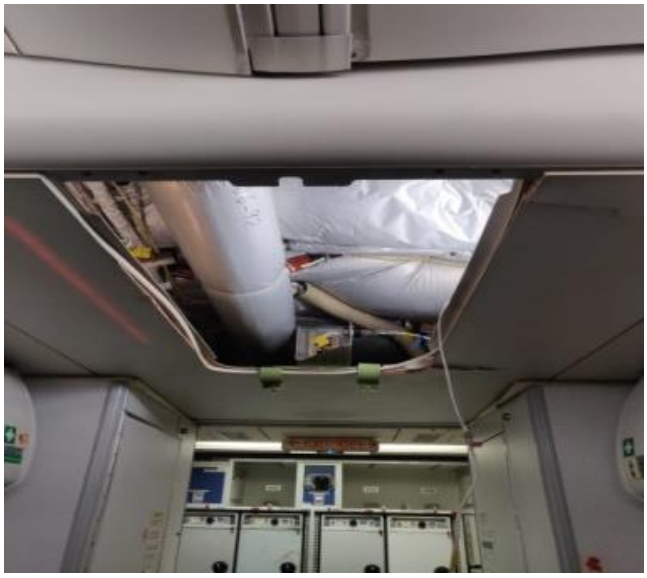


Figure 1

Oxygen mask from Passenger service units, above seat numbers 10ABC, 25ABC, 30ABC, 31DEF, 27DEF, 13DEF, and 10DEF had fallen off from their units. Oxygen generators in passenger service units above seat nos. 10ABC, 11ABC, 31DEF and 32ABC required a replacement. Nineteen Passengers Service Units (PSU) were found either damaged/ loose. The corresponding seat no. of the PSUs are 7DEF, 8ABC, 8DEF, 9ABC, 9DEF, 10DEF, 11ABC, 11DEF, 15DEF, 16DEF, 17ABC, 19ABC, 19DEF, 21DEF, 25ABC, 26DEF, 27DEF, 29ABC, 31DEF. Four seat handles for seat no. 13BC, 16A, 27C, 17DEF were found broken. Cabin hat rack lock was found broken for seat no 30ABC. Packing foams were found dislocated and coming out for seats 4 ABC and DEF. Call lights lens were missing for seats 17ABC, 19ABC, 26 DEF.

Figure 2

1.4 Other damage

Nil

1.5 Personnel Information

1.5.1 Crew Information – Pilot In Command

Nationality	Indian
Age	33
Date of Issue of License	06 Apr 2016
Valid up to	29 Mar 2026
Category	ATPL
Date of Class I Med. Exam	19 Jun 2021
Class I Medical Valid up to	22 Jun 2022
Date of issue FRTOL License	02 Apr 2008
FRTO License Valid up to	01 Apr 2023
Endorsements as PIC	C152A, BE76, B737NG/700-900/700F/900F
Total flying experience	5246.43
Total flying experience on type	5048.39
Last Flown on type	30 Apr 2022
Total flying experience during last 1 year	328.53
Total flying experience during last 6 Months	172.34
Total flying experience during last 30 days	58.39
Total flying experience during last 07 Days	14.47
Total flying experience during last 24 Hours	00.00
Date of latest Flight Checks, Ground Classes & Refresher	Last AGTR Details: 20-12-21 to 24-12-21 Last PPC Details: 06-04-22

The PIC was an ATPL holder and had a total flying experience of 5246.43 hs and 1493.41 hrs on type. The PIC had completed all the required route checks and recurrent training on the Simulator as specified in the Company's Operational / Training Manual. The PIC's Training records were satisfactory in all route checks and recurrent checks; however he was advised consistency in landings during one of the route checks. The PIC's Cat A medical was valid till 22 Jun 2022 and as per report dated 19 Jun 2021, he was advised to wear corrective spectacles for exercising the privileges of the license and advised to reduce weight.

1.5.2 Crew Information – Co Pilot

Nationality	Indian
Age	34
Date of Issue of License	07 Feb 2011
Valid up to	06 Feb 2026
Category	CPL
Date of Class I Medical Exam	24 Sep 2021
Class I Medical valid up to	28 Sep 2022
Date of issue FRTOL License	07 Feb 2011
FRTO License valid up to	06 Feb 2026
Endorsements as PIC	C-152, P68
Total flying experience	1333.09

Total flying experience on type	1111.04
Last Flown on type	30 Apr 2022
Total flying experience during last 1 year	125.55
Total flying experience during last 6 Months	70.30
Total flying experience during last 30 days	32.50
Total flying experience during last 07 Days	11.33
Total flying experience during last 24 Hours	04.58
Date of latest Flight Checks, Ground Classes & Refresher	Last AGTR Details : 04-10-21 to 08-10-21 Last PPC Details : 15-12-21

The Co-pilot was an ATPL holder with a total flying experience of 1333.09 hrs and 1111.04 on type. He had completed all the required Route checks and recurrent training on the Simulator, as specified in the Company's Operational / Training Manual. The Co pilot's training records were satisfactory in all route checks and recurrent checks, however in one of the route checks he was advised to revise CCs and FTCM maneuvers. The Co pilot's current CAT A medical was valid till 28 Sep 2022 and was advised to wear corrective glasses while exercising the privilege of license.

1.6 Aircraft Information

1.6.1 System Information

VT-SLH is a Boeing 737-800 aircraft, with a maximum takeoff weight (MTOW) 70533 Kilograms and its principal dimensions are given below.

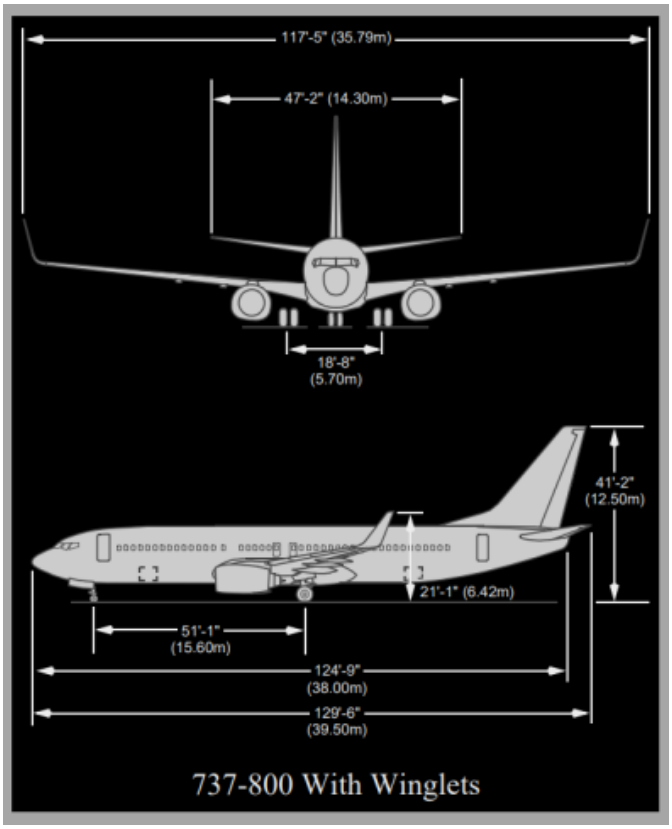


Figure 3: Principal Dimensions - VT-SLH

1.6.2 Weather Radar

Majority of company's aircraft were fitted with Rockwell Collins Multiscan Weather Radar which has both Auto and Manual operating features. However, six aircraft including VT-SLH was fitted with Honeywell RDR-4B weather radar system, which has only manual operating features. The RDR-4B weather radar (WXR) system that supplies following visual indications:

- Weather conditions
- Windshear events
- Land contours

The basic RDR-4B System consists of several units: The Receiver/Transmitter (RTA-4B), the Display Unit (PPI-4B), the Antenna Assembly (DAA-4A or -4B drive unit and REA-4A or -4B Array), and the control panel (CON-4A/B).

The WXR system transmits very short, intense pulses of microwave energy in a 180 degree area forward of the airplane. These pulses are reflected within the range of the radar system and returned along the same path to the aircraft where it is received by a scanning antenna and converted into digital data that is representative of target size. The received signal is amplified and digitized by the RTA-4B R-T and then serially formatted into 1,600-bit ARINC 453 words that are transmitted to as many as three independent radar indicators over separate data buses.

The RTA-4B Receiver/Transmitter operates at a nominal frequency of 9,345 MHz. A frequency agility feature is incorporated to shift frequency up or down to reduce mutual interference with nearby transmitters. In weather mode, it transmits alternating 6 µS and 18 µS coherent pulses at a 363 Hz rate. Additional 6 µS pulses at a 1,600-Hz rate are used in turbulence mode.

For windshear detection/avoidance, the transmitted pulses are 1.5 µS wide at a 6,000 Hz rate, and the antenna is operated in the dual-scan mode, in which windshear operation alternates with normal operation on alternate sweeps of the antenna. The RTA-4B Receiver/Transmitter has a selectable range from 5 to 320 NM. For windshear operation, the range is 5 NM.

The PPI-4B receives and processes the video data from the Receiver/ Transmitter unit and presents this information as a continuous display of weather or terrain mapping. The information is displayed in up to four distinct colors — green, yellow, red and magenta. Colors of the indications give the crew information about the intensity of the returns. Areas of heaviest rainfall appear in red, the next level of rainfall in amber, and the least rainfall in green.

RDR-4B systems having the turbulence detection option process the weather returns to indicate areas of precipitation with moderate to high turbulence. This capability enhances the rainfall intensity information provided by the basic radar to enable pilots to avoid threatening weather. Areas of moderate to heavy turbulence within a 40 NM range are displayed on the Electronic Indicator in an extra color-magenta-which is overlaid on the conventional weather (precipitation) returns displayed in red, yellow, or green if turbulence detection is selected.

When the radar detects a horizontal flow of precipitation with velocities of 5 or more meters per second toward or away from the radar antenna, that target display becomes magenta. The system detects turbulence associated with precipitation, not clear air turbulence, up to a range of 40 nautical miles. The conventional weather display is available to the pilot for all selectable ranges when TURB is selected. For example, if the 80 NM range is selected, the system will display weather plus turbulence to 40 NM, and weather only from 40 to 80 NM.

It is important to remember that radar detects the presence of precipitation. Storm associated turbulence without precipitation can extend several thousand feet above a storm and outward more than 20 miles. When using turbulence detection, the TILT angle should be set so as to eliminate all ground returns within 90 NM if possible. Weather Radar Panel CON-4A/B is shown in the Figure 4. The panel has various switches performing different functions. The description of switches and function performed by them is as below:-

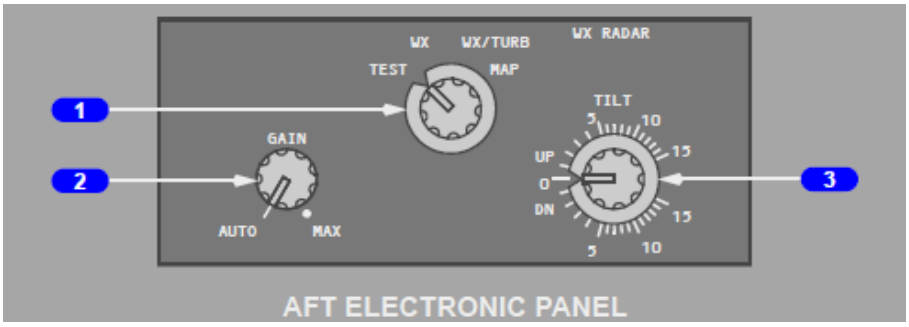


Figure 4: Weather Radar Panel

1. Mode Selector Switch: Mode Selector switch can be rotated to select mode as below:-

TEST –

- tests weather radar system operation
- shows test pattern and any fault messages on navigation display MAP, center MAP, VOR, and APP modes, with WXR selected.

Note: If the airplane is on the ground and the thrust levers are not advanced for takeoff, WXR tests the predictive windshear system (PWS) indications. These include PWS caution, PWS FAIL, and PWS warning. Deactivating

WXR on the EFIS control panel will discontinue the test. The PWS test lasts approximately 15 to 60 seconds.

WX (weather) – shows weather radar returns at selected gain level.

WX/TURB (turbulence) –

- shows weather radar returns
- shows turbulence within 40 miles.

Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.

MAP – shows ground returns.

2. GAIN Control: Rotation of Gain Control sets receiver sensitivity in WX, WX/TURB, and MAP modes.

AUTO (automatic) – maintains optimum receiver sensitivity.

MAX (maximum) – gain control at MAXimum sensitivity.

3. TILT Control: Rotation of Tilt Control knob

Rotate clockwise– radar antenna tilts up to selected degrees above horizon.

Rotate counterclockwise– radar antenna tilts down to selected degrees below horizon.

The RDR-4B User Manual, document number 006-18167-0000, makes the following suggestion on page 21:

"As descent begins, [the pilot should] increase TILT control setting in +1 degree increments for each 10,000 feet of planned descent. This keeps the display relatively free of ground clutter."

As per the RDR-4B user manual and operating guidelines, the shape of a storm displayed on your radar is just as important as the intensity levels. Some shapes such as U-shapes, Thin protruding fingers, Scalloped edges, Hooks are strong indicators of hail.

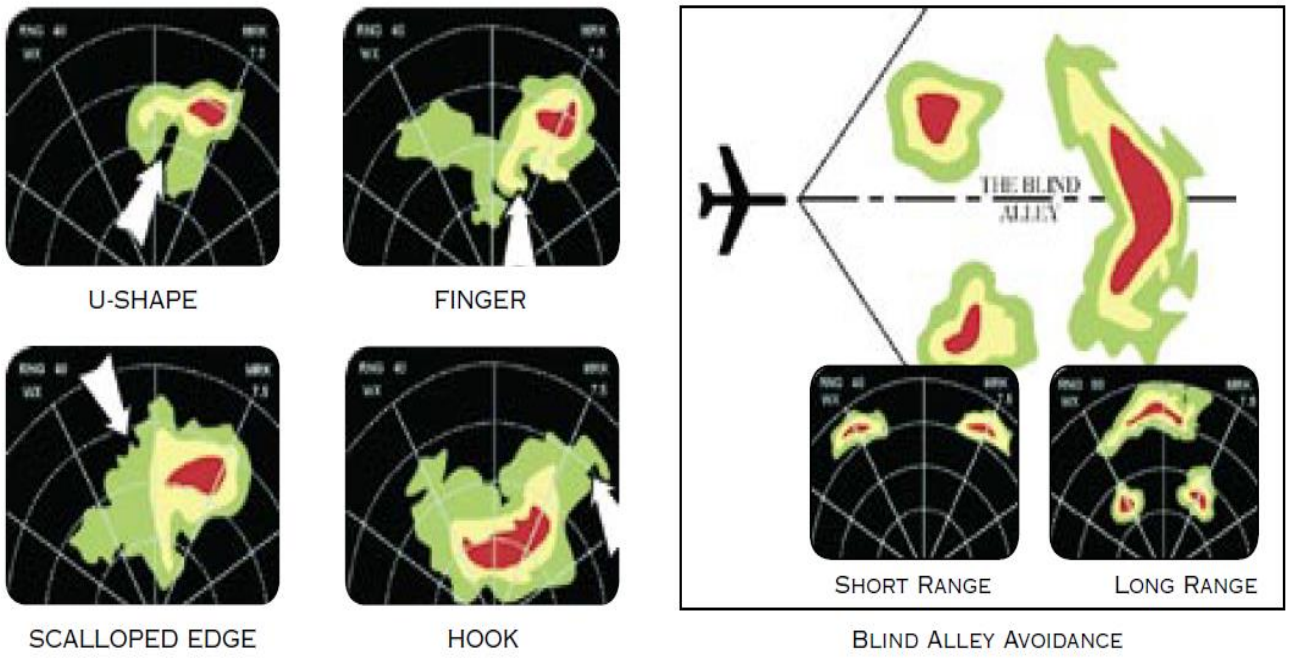


Figure 5

A "Blind Alley" or "Box Canyon" situation can be very dangerous. When viewing the short ranges, periodically switch to longer-range displays to observe distant conditions. As shown in figure 5, the short-range returns show an obvious corridor between two areas of heavy rainfall but the long-range setting shows a larger area of heavy rainfall.

1.6.2 Aircraft Specific Information

Aircraft Model	B 737-800
Aircraft S/N	33597
Year of Manufacturer	22 Sep 2006
Name of Owner	M/S KLAATU Aircraft Leasing (Ireland) Ltd
C of R	11 Apr 2017
C of A	10 Apr 2017
Category	Normal
C of A Validity	14 Apr 2022
ARC issued on	15 Feb 2022
ARC valid up to	14 Oct 2022
Aircraft Empty Weight & Empty weight CG	41104.15 Kgs
Maximum Take-off weight	70522 Kgs
Date of Aircraft Weighing	06 Mar 2022
Empty Weight	41104.15 Kg
Max Usable Fuel	22137 Kg
Max Payload with full fuel	6235.85 Kg
Next Weighing due	05 Mar 2027
Total Aircraft Hours	47708.30 Hrs
Last major inspection	8 Yearly Inspection + 25000 FH Inspection
List of Repairs carried out after last major inspection till date of incidence	Nil
Engine Type	CFM56-7B
Engine Sl. No.(LH)	894217
Date of Manufacture (LH)	Aug 2006
Last major inspection (LH)	Shop visit on 21 Feb 2019
List of Repairs carried out after last major inspection till date of incidence(LH)	Nil
Total Engine Hours/Cycles (LH)	43012:57
Engine Sl. No. (RH)	894219
Date of Manufacture (RH)	Aug 2006
Last major inspection(RH)	Shop visit on 19 Oct 2018
List of Repairs carried out after last major inspection till date of incidence(RH)	Nil
Total Engine Hours/Cycles(RH)	42310:04
Aero mobile License	A-010/086-RLO(NR) valid till 31 May 2022
AD, SB, Modification	Complied

1.6.3 Weather Radar defects

VT SLH had three weather radar defects logged before the accident; two of the defects were logged on 30 Apr 2022, the day before the accident. All defects pertained to weather radar not displaying weather in air. As per the PIC who operated the aircraft on 30 Apr 2022 and who logged both the defects, during the first sector the weather radar was only displaying the weather ahead as a *"Dot"* and not as the weather ahead should be actually displayed and in the second sector the weather radar was serviceable but not displaying weather. This was informed to the MCC and the Chief Pilot. As per the statement of the AME who carried out the rectification on 30 Apr 2022 when the Weather

radar defect was logged in first, the defect was briefed to MCC and MCC was informed that the same would be logged again in the next sector, if the operation of the weather radar was not satisfactory. The same defect was logged in after the next sector and the defect was cleared after cleaning the RT Unit connector and by carrying out an operational test on ground.

The MCC shift hand/over soft copies of the briefing provided to the MCC by AMEs who cleared the defect that was logged twice on 30-04-2022 or the rectification action proposed by the MCC to rectify the repeated defect in Mumbai were not available as they were lost due to a ransomware attack on company's IT infrastructure as per the MCC. It was also stated that the defects were observed to be intermittent.

The aircraft was ferried to Kolkata after the accident for maintenance and repair. There was no defect reported by the pilot related to weather radar during the accident flight or ferry flight after the accident. However, operator replaced the weather radar RT unit post the accident. The reason for removal was stated as directions from DGCA. On enquiry, the DGCA officer stated to have given no such directions. The weather radar RT unit removed from the aircraft was therefore sealed by the AAIB.

Functional check of the weather radar carried out after replacement of weather radar RT was found satisfactory. The operator was asked to make arrangements for carrying out full functional check of the Weather radar RT removed from the aircraft at an approved facility and provide AAIB with the Shop Report. Aircraft was released for service after completion of Investigation activities on aircraft, however, the operator was asked to keep AAIB appraised of any defect reported on the weather radar after the aircraft was released for operational flying, to ascertain if the weather radar system was functioning satisfactorily on the day of accident.

The operator did not provide AAIB with any update on status of testing of RT unit or information regarding any repeated defects related to weather radar system. The aircraft was removed from service and returned to the lessor in Oct 2022. The AAIB was not informed by the operator regarding the aircraft being de-registered and returned to the lessor. As per DGCA's APM Part II, Chapter 1, Appendix D, DGCA is required to Check for clearance or closing report from Aircraft Accident Investigation Board (AAIB) if the aircraft has met with accident before the aircraft is de-registered, however, no such clearance was sought by the DGCA.

Later, after significant delay the information was made available to AAIB. As per the information made available, the RT unit was shipped to OEM's facility in Oct 2022. Apart from that it was informed that the aircraft VT SLH reported defects related to weather radar were logged 13 times post 01 May 2022. As per the record of maintenance actions carried out, the weather radar RT units were replaced twice and the antenna, antenna drive, wave guide and the control panel were replaced on repeated occurrence of the defect. Details are placed at Appendix A.

After the replacement of the control panel on 14 Aug 2022 the defect appeared twice on 14 Aug 2022 and 26 Aug 2022. There was no repetition of the defect till 03 Oct 2022 when the aircraft was removed from service for pre-delivery checks and return to Lessor.

Similar weather radar defects were logged in other aircraft too that were installed with similar weather radars. A total of 60 similar defects were found logged in the 06 aircraft installed with manual tilt control weather radar during the period between Jan 2022 to Aug 2022. Most of the defects were rectified by carrying out an operational test on ground and clearing the aircraft for flight. Though the company's CAME 1.8.8 MCC Procedures 2.5.2 states that the defect cell would analyze repeated defects however no records of callouts to assist in finding the root cause of the repeated Weather Radar defects were observed.

1.6.4 Cockpit En-route Check post-accident

After the aircraft was back in service, DGCA Flight Operations Inspector carried out Cockpit Enroute Check on 05 May 2022. FOI was tasked to observe weather radar system performance. The Wx Radar performance was found satisfactory, however, the following observations were made.

1. Wx Radar knob paint is worn out. During night flights, it is difficult to ascertain the required setting for better weather avoidance strategy and planning.

Figure 6

2. EFIS Control Panel (P2 side), the range figures are not readable at all to the pilot.

Figure 7

1.7 Meteorological Information

The METAR from Kolkata (VECC), Durgapur (VEDG) and Ranchi (VERC) for the time close to the time of event is as below:

TIME (UTC)	WIND	TEMP °C	DEW POINT °C	WEATHER	VIS(M)	CLOUDS	QNH hpa	QFE	TREND
VECC									
1230	180°/12KT	33	26	HZ	3500	FEW 3000 M	1001	1000	NOSIG
1300	180°/08 KT	32	26	HZ	3500	FEW 3000 M	1001	1001	NOSIG
1330	160°/12 KT	32	26	HZ	3500	FEW3000 M	1002	1001	NOSIG
1400	170°/12 KT	31	25	HZ	3500	FEW3000M	1002	1001	NOSIG
1430	180°/10 KT	31	26	HZ	3500	FEW 1000	1003	1002	NOSIG
VEDG									
1300	120°/08 KT	31	25	HZ	4000	FEW600M SCT2700M	1001	0990	NOSIG
1330	100°/05 KT	31	26	HZ	3500	SCT600M BKN2700M	1001	0991	NOSIG
1400	100°/05 KT	30	26	HZ	3500	SCT600M BKN2700M	1002	0992	NOSIG
1430	150°/07 KT	31	25	HZ	3200	SCT540M FEWCB750M BKN2700M	1003	0992	NOSIG
1500	260°/22 KT G34KT	26	19	TS RA	2000	SCT540M FEWCB750M BKN2700M	1003	0992	NOSIG
1500	290°/16 KT G26KT	22	21	TS RA	2000	SCT540M FEWCB750M BKN2700M	1006	0995	NOSIG
VERC									
1230	240°/06 KT	26	17	TS RA	3500	SCT540M FEWCB900M BKN3050M	1005		NOSIG
1300	010°/09 KT	29	15	TS RA	3500	SCT540M FEWCB900M BKN3050M	1006		NOSIG
1330	360°/09 KT	28	16	TS RA	3500	SCT550M FEWCB900M BKN3050M	1006		NOSIG

Thunderstorm activity was reported at Ranchi and Durgapur from 1200-1300 UTC and 1500-1700 UTC respectively. The weather information from the Kolkata Doppler Radar from 1322 – 1502 UTC and Satellite weather images from IMD were obtained. The images are are placed at Appendix B.

The weather images obtained from Kolkata Doppler Radar show significant weather buildup in the flight path enroute Durgapur. The Doppler images of 1322 UTC, 1342 UTC and 1342 UTC (Figure 8) and later till 1502 UTC show weather buildup moving eastwards.

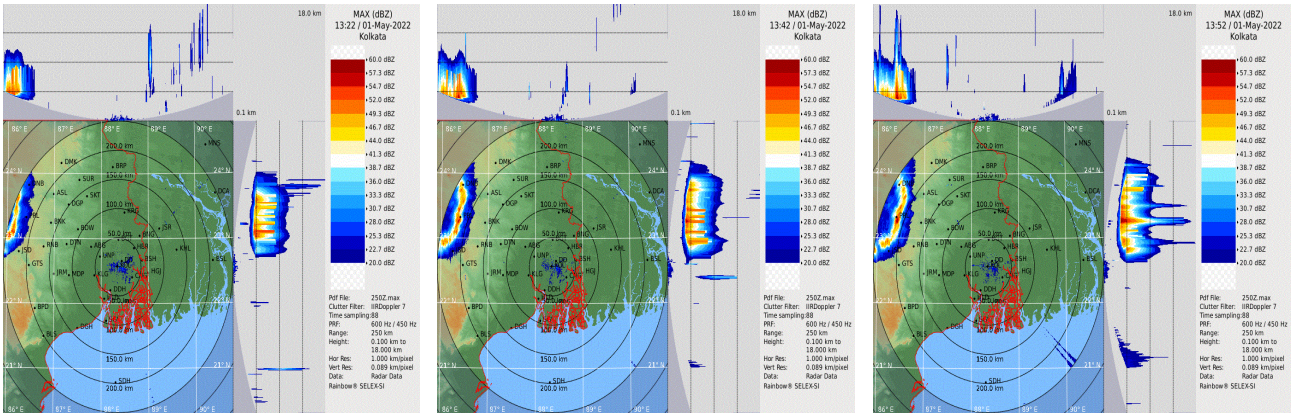


Figure 8 : Kolkata Doppler Radar images

The figure 9 shows the lightning image provided by Boeing for May 1. It indicates a significant amount of lightning present in the flight path taken by VT-SLH. The temporal resolution of this tool is poor, but the shape of the lightning matches the shape of the thunderstorms from radar and satellite imagery. There is high concentration near the incident location which is also matching the strongest satellite indicated storm position.

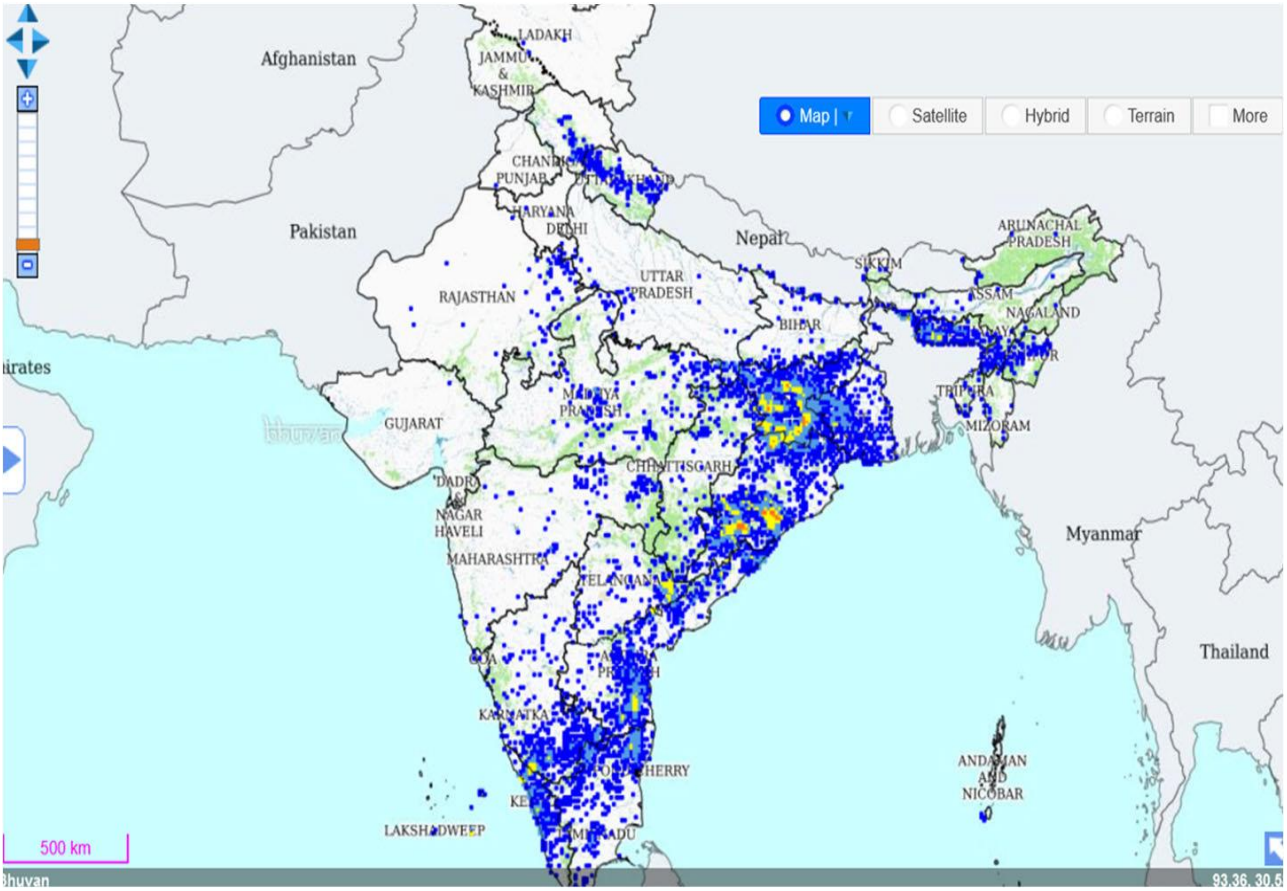


Figure 9: Lightning presence

1.8 Aids to Navigation

All navigational aids available at the aerodrome were serviceable at the time of the occurrence. The aircraft was equipped with standard navigational equipment and there was no reported defect or failure of any of the equipment during/post occurrence.

1.9 Communications

Two way communications between the aircraft and the ATC was available throughout the flight. All the communication systems in the aircraft were serviceable. The transcript of relevant ATC communication made available by the ATC Durgapur and ATC Kolkata. The transcript are placed at Appendix C.

1.10 Aerodrome Information

Kazri Nasrul Islam Airport is located at Khandra village at about 16 km from Durgapur in Bhardhaman District of West Bengal in India. It is situated at an elevation of 302 ft. The aerodrome is operated by the Airport Authority of India (AAI). The IATA location identifier code is RDP and the ICAO location identifier code is VEDG. The aerodrome Category is 4C. The Radio navigation and Landing aids available at the aerodrome are LOC, GP, DME ILS and DVOR/DME for runway 16. The co-ordinates of the aerodrome are 233728N and 0871433E.

Figure 10: Sattelite image of Durgapur Airport and Runway

The Air traffic service communication facilities are available on 119.450MHZ for DGP APP and 118.550MHZ & 119.450MHZ for DGP TWR. Aerodrome and firefighting category of the aerodrome falls under CAT-7. Rescue and firefighting equipment are available as per the Category. The orientation of the runway is 16/34. The details of runway distances are as below;

RUNWAY	TORA (M)	TODA (M)	ASDA (M)	LDA (M)	WIDTH (M)	REMARKS
16	2800	2800	2860	2550	45	THR displaced by 250m due obstacle in Approach area.
34	2550	2550	2860	2550	45	TORA/TODA/LDA reduced to 2550m due to obstacles in take off and climb area.

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder

The voice recorder continuously records flight crew communications and flight compartment sounds. The CVR uses four independent channels to record flight deck audio for 120 minutes. Recordings older than 120 minutes are automatically erased. One channel records flight deck area conversations using the area microphone. The other channels record individual ACP output (headset) audio and transmissions for the pilots and observer. The container for the voice recorder is watertight, shock and heat resistant and survives deep sea pressure up to 20,000 feet (6096 m). The voice recorder unit has an underwater locator beacon (ULB) on the front panel. The ULB helps find the voice recorder unit in water. The CVR is located in the aft cargo compartment.

The transcript of Cockpit Voice Recording is placed below. Description of events observed in the CVR are stated in bold italics in lower case. The conversation in Hindi is stated in bold italics uppercase followed by English translation in brackets.

ELAPSED TIME IN CVR	NARRATOR	TRANSMISSION
23:48	ATC	SG 945 RADAR SERVICE TERMINATED CONTACT NAGPUR 133.65
22:51	SG945	133.65 SG 945
53:56	ATC -	SG 945 RADAR SERVICE TERMINATED CONTACT KOLKATA 125.9
53:58	SG945	125.9 SG 945
1:18:14	SG945	RADAR SG 945 REQUESTING HEADING 060 DUE WX
1:18:18	ATC - URP	SG 945 APPROVED
1:20:51	ATC - URP	SG 945 CONTACT KOLKATA RADAR 132.25
1:20:52	SG945	132.25 SG 945
1:21:24	SG945	RADAR SG 945 FL 390 ON A HEADING 055
1:21:26	ATC - UKW	SG 945 ROGER REPORT IN CONTACT WITH DURGAPUR
1:21:31	SG945	WILCO SG 945
1:21:37	SG945	DURGAPUR TOWER SG 945 GE
1:21:56	ATC	SG 045 DURGAPUR TOWER GOOD EVENING
1:22:11	SG945	FL 390 HEADING 055 182 DME, IN CONTACT WITH KOLKATA. REQUESTING LATEST WEATHER, RUNWAY IN USEAND TYOE OF APP
1:22:34	ATC	SG 945 TOB 1300, WIND 120/08, CLOUD SCT 9000 FT TEMP 31 DP 25 QNH 1001 TREND NS, EXP ILS APP RW 16
1:22:41	SG945	ILS RW 16, QNH 1001
1:29:10	SG945	SG N45, WILL REP RELEASE
1:29:12	ATC - UKW	SG 945 KOLKATA DESCEND TO FL 250
1:29:16	SG945	DESCEND FL250 AND CONTACT WITH DURGAPUR SG 945
1:29:20	ATC - UKW	ROGER WHEN ABLE PROCEED DIRECT TO DELTA GOLF PAPA

1:29:28	SG945	WILCO, SG945 SIR NOW WE ARE HEADING MAINTAINING HEADING 065 DUE WEATHER SIR
1:29:45	CO-PILOT	MY RADIO MY CONTROLS
1:29:47	PIC	YOUR RADIO YOUR CONTROLS
1:30:01	PIC	GOOD EVENING LADIES AND GENTLEMEN THIS IS YOUR CAPTAIN FROM FLIGHT DECK. AS YOU MAY HAVE NOTICED WE HAVE COMMENCED OUR DESCENT AND WE ARE PROCEEDING TO DURGAPUR. CURRENTLY WE ARE PASSING 35000 FEET …
1:30:13		***Seatbelt Chime is heard in the CVR***
1:30:14	PIC	…AND WE ARE EXPECTING TOUCHDOWN AT DURGAPUR IN NEXT 25 MINUTES. THAT SHOULD BE ROUGHLY 15 MINUTES PAST SEVEN PM FOR TOUCHDOWN AND ANOTHER 3-4 MINUTES OF TAXI TIME TO REACH THE BAY. AS FOR THE WEATHER IS CONCERNED, IT IS QUITE WARM 31 DEGREE TEMPERATURE WITH SOUTHERLY WINDS OF 13-4 KMPH IN SOME CLOUDING SCATTERED AROUND THE FIELD. VISIBILITY IS APPROXIMATELY 4 KM ……
1:30:56	PIC	AND THERE IS SOME STRONG WEATHER IN THE APPROACH PATH WILL STRONGLY REQUEST YOU ALL TO BE SEATED FOR THE NEXT 15 MINUTES
01:31:08	PIC	HELLO
01:31:10	CC	SIR THE ANNOUNCEMENT WAS LOUD AND CLEAR
1:31:13	PIC	THANK YOU AND ***ABHI THODA STRONG PATCH AYEGA TOH (THERE WILL BE A STRONG PATCH NOW SO)*** YOU HAVE ANOTHER 3-4 MINUTES ***USKE BAAD (AFTER THAT*)** YOU HAVE TO BE SEATED FOR SOME TIME ONCE I BUZZ AGAIN YOU CAN GET UP
1:32:23	CC	***Cabin crew makes announcement in Hindi for passengers about turbulence and requests them to be seated with seat belts fastened.***
1:32:27	ATC	SG 945 FURTHER DESCEND
1:32:31	ATC - UKW	SG 945 DESCEND TO FL 70
1:32:35	CC	***Cabin crew makes announcement in English for passengers about turbulence and requests them to be seated with seat belts fastened.***
1:33:05	PIC	ALL PASSENGER AND CABIN CREW TO BE SEATED
1:33:10	PIC	***AGAR ZARURAT HAI NA (IF NEEDED)*** WE WILL TAKE A LEFT TURN. ANOTHER 10 MILE ***AUR JAA KE DEKHTE HAIN AGAR YEH ITNA HI KHARAB DIKHTA RAHEGA TO (WE WILL GO AND SEE IF IT KEEP LOOKING THIS BAD THEN)*** WE WILL TAKE LEFT….
1:33:20	CC	PASSENGER BE SEATED
1:34:08	PIC	***PICHE CAMERA MEIN DEKHN YEH LOG SEATED HAI KI NAHI (LOOK AT CAMERA IN REAR IF THESE PEOPLE ARE SEATED OR NOT)***
1:34:13	CO-PILOT	YES
1:34:43	CO-PILOT	WANNA GO LEFT?
1:34:48	PIC	I DON'T THINK ***ITNA BURA HONA CHAHIYE (IT WILL BE THIS BAD)*** YOU SAY IF YOU SAY SO I WILL TURN LEFT.
1:36:27	PIC	DOME LIGHT TO BRIGHT
1:36:57	CC	***Making announcement requesting passengers to remain seated***
1:37:46	CO-PILOT	CHECK SPEED
1:37:54	PIC	START SWITCH TO FLIGHT
1:37:58	CO-PILOT	OH….WO…. WO…. WO

1:37:59	PIC	CHECK
1:38:07	CO-PILOT	CHECK SPEED CHECK SPEED OH F***
1:38:12		***Auto Pilot gets Disconnected***
1:38:12	CO-PILOT	COMMAND
1:38:12	PIC	***NAHI (NO)***
1:38:16	PIC	DON'T DON'T DON'T
1:38:20	CO-PILOT	OH F***
1:38:24	CO-PILOT	CHECK SPEED CHECK SPEED
1:38:29	CO-PILOT	***Screams from passenger compartment audible in CVR*** BE SEATED
1:38:31	CC	SIR, SIR THAT WAS EXTREME EXTREME SIR…..
1:38:35	CO-PILOT	I KNOW, I KNOW, BE SEATED WE ARE GOING THROUGH TURBULENCE, BE SEATED
1:38:42	CO-PILOT	CHECK SPEED
1:38:44	CO-PILOT	BANK ANGLE
1:38:46	PIC	CORRECT IT CORRECT IT
1:38:48	CO-PILOT	***Screams from passenger compartment audible in CVR*** PLEASE BE SEATED, PLEASE BE SEATED, WE ARE GOING THROUGH TURBULENCE
1:38:52	CO-PILOT	CHECK SPEED, STALL CHECK SPEED
1:39:00	CO-PILOT	STALL CHECK SPEED
1:39:02	CO-PILOT	OK CHECK SPEED SPEED SPEED
1:39:04	CO-PILOT	***Aural alert "BANK ANGLE" is heard in CVR*** BANK ANGLE. FDs, DOOR OPEN, CHECK WE HAVE GOT DOOR OPEN
1:39:13	ATC - UKW	SG 945 KOLKATA
01:39:18	ATC - UKW	SG 945 KOLKATA
1:39:20	CO-PILOT	SG 945 SIR WE ARE EXPERIENCING HEAVY TURBULENCE WE ARE PASSING FL140 STANDBY
1:39:30	ATC - UKW	SG 945 ROGER
1:39:40	PIC	IT'S ALL GOOD FOR NOW
1:39:42	CO-PILOT	AFT DOOR OPEN
1:39:43	PIC	AFT DOOR OPEN NNC
1:39:46	CO-PILOT	F****** HELL
1:39:49	CO-PILOT	PLEASE BE SEATED
1:40:15	CO-PILOT	**Reads out NNC for Aft door open**
1:40:30	PIC	PRESSURISATION IS OK
1:40:34	CO-PILOT	I WILL ASK THEM TO CHECK DOOR HANDLE
1:40:38	PIC	ASK THEM, WE ARE OUT OF WEATHER NOW. DON'T WORRY ABOUT IT
1:40:42	CO-PILOT	FLT DECK
1:40:44	CC	CAPTAIN THERE IS AN INJURY IN THE CABIN THAT LADY HAS FALLEN DOWN SIR CAN WE …
1:40:48	CO-PILOT	MADAM PLEASE WAIT I HAVE TO DO SOME CHECK LISTS. LISTEN TO ME CAREFULLY. AFT DOOR, INSTRUCT THE CABIN CREW TO VERIFY THE DOOR

		HANDLE IS IN CLOSED POSITION. OK WE ARE OUT OF WEATHER RIGHT NOW. PLEASE CALM DOWN. CALM DOWN THE PASSENGER. INSTRUCT THE CABIN CREW TO VERIFY HANDLE IS IN CLOSED POSITION AND LET ME KNOW
1:41:15	CC	OK CAPTAIN I WILL JUST CROSS CHECK WITH THEM AND CALL YOU BACK
1:41:26	CC (1)	***Audio of crew call bells in passenger compartment can be heard in CVR*** ….***UNKO BITHAO (MAKE THEM SIT)*** PLEASE ASK THEM TO BE SEATED…..
1:41:28	CC (2)	… ***GIR GAYA HAI PASSENGER BEHOSH HO KE (A PASSENGER HAS FALLEN DOWN UNCONCIOUS)…***
1:41:34	CC (1)	***…..JAANE DE PLEASE UNKO BAITHNE KO BOL (LET IT BE PLEASE ASK THEM TO BE SEATED)***
1:41:39	CC (2)	PLEASE BE SEATED. ***Screams from passenger compartment audible in CVR. There is panic and confusion and CC-1 & CC-2 are asking PASSENGER to remain seated***
1:42:14	CC (1)	ASKS THE OTHER CABIN CREW TO CHECK FOR AFT DOOR HANDLE AND REPORT
1:42:17	PIC	**Announcement** WE ARE OUT OF TURBULENCE AND WEATHER PATCH. PLEASE REMAIN SEATED AND FOLLOW CREW INSTRUCTIONS ….
1:42:26	PIC	WE WILL BE LANDING IN DURGAPUR IN THE NEXT 12 MINUTES OR SO
1:42:32	CC	CAPTAIN THERE IS AN INJURY. I WILL JUST HANDLE THE INJURY
1:42:34	PIC	OK LET ME KNOW
1:42:44	CC	BOTH THE DOORS ARE LOCKED AND HANDLE IS PARALLEL TO THE FLOOR.
1:42:48	PIC	PERFECT PRESSURISATION SYSTEM IS GOOD DON'T WORRY. INDICATION IS GONE, YOU CAN CONTINUE YOUR SERVICE WE HAVE APPROX 10 MINUTES FOR LANDING
1:42:55	CC	OK
1:43:11	CO-PILOT	KOLKATA RADAR SG 945
1:43:17	CC	YES CAPTAIN
1:43:20	PIC	COULD YOU GIVE ME THE BRIEF SITUATON OF THE INJURY
1:43:22	CC	SIR INJURIES ARE… I AM JUST GETTING INTO THE CABIN. THERE ARE MANY INJURIES BECAUSE IT WAS AN EXTREME LEVEL AND THE CABIN IS LIKE OXYGEN BOX ***AA GAYA HAI BAHAR (HAS COME OUT)*** PASSENGER WERE LITERALLY BOUNCING TO THE TOP OF AIRCRAFT
1:43:39	PIC	OK THEY WERE NOT SEATED AT THAT TIME
1:43:42	CC	NO, THEY WERE SEATED. I ANNOUNCED A LOT FOR SEATBELT ALSO I DON'T KNOW I NEED TO CHECK IF THEY WERE SEATED WITH SEAT BELTS FASTENED BCOZ I HAVE ALREADY MADE AN ANNOUNCEMENT. I WILL CHECK WHAT HAPPENED
1:43:52	PIC	OK PLEASE CHECK WITH IT
1:43:55	PIC	I WILL SLOW DOWN THE AIRCRAFT, SO THAT YOU HAVE MORE TIME TO CHECK. AND LET ME KNOW WHAT IS IT OR YOU WANT ME TO CONTINUE AND LAND IMMEDIATELY
1:44:01	CC	YOU CAN LAND IMMEDIATELY CAPTAIN BCOZ I DON'T HAVE THAT MUCH OF TIME
1:44:07	PIC	YOU WANT ME TO INFORM ATC THAT THERE ARE SOME INJURIES
1:44:10	CC	YES. YES CAPTAIN
1:44:12	PIC	OK OK

1:46:38	ATC	SG 945 ROGER. SG 945 AT YOUR OWN DISCRETION PROCEED DIRECT TO INTERCEPT LOC RUNWAY 26
1:46:48	PIC	ON OWN DISCRETION PROCEED DIRECT TO INTERCEOT LOC RUNWAY 26. SG 945
1:46:49	ATC	RUNWAY 16
1:46:51	PIC	RUNWAY 16
1:47:30	PIC	MAY WE DESCEND AS PER PROCEDURE SG 945
1:47:33	ATC	SG 945 AFFIRM SIR
1:48:01	CC	YES CAPTAIN
1:48:04	PIC	WE ARE LANDING IN EXACTLY 04 MINS IS EVERYTHING OK NOW
1:48:06	CC	CAPTAIN MANY PASSENGER ARE INJURED AND BLEEDING
1:48:11	PIC	***THEEK HAI (OK)***…WE HAVE ALREADY INFORMED ATC THAT WE WILL BE REQUIRING ASSISTANCE
1:48:23	PIC	OK CABIN IS SECURED NOW FOR LANDING
1:48:25	CC	YES CAPTAIN I WILL CHECK WITH MY SENIOR, CAPTAIN.
1:48:33	PIC	YOU HAVE 04 MINS TO SECURE EVERYTHING
1:48:33	CC	OK CAPTAIN
1:49:36	CO-PILOT	YOU WANT TO HOLD TO GIVE THEM TIME
1:49:38	PIC	DON'T WORRY
1:50:12	PIC	ALL PASSENGER AND CREW MEMBERS TO BE SEATED FOR LANDING
1:50:55	CC	10 SECS PLEASE
1:50:58	CO-PILOT	MA'AM PLEASE HURRY UP
	CC	OK
	CO-PILOT	PLEASE HURRY UP HURRY UP
1:51:06	AURAL	***Aural Alert "TWENTY FIVE HUNDRED"***
1:51:30	PIC	MA'AM DO YOU WANT ME TO CONTINUE THE APPROACH OR DISCONTINUE
1:51:37	CC	SIR ACTUALLY CCIC SHE IS IN THE CABIN SHE IS COMING AHEAD. SHE IS DOING THE CHECK RT NOW.
1:51:39	PIC	OK YOU HAVE LESS THAN 1 MIN
1:51:51	CAOT	LANDING CHECK LIST PLEASE
1:51:58	CC	CAPTAIN SECURED
1:51:59	PIC	THANK YOU EVERYTHING IS FINE
1:52:03	CC	NOT ACTUALLY SIR
1:52:04	PIC	***THEEK HAI (OK)….***WE WILL SEE ON GROUND DON'T WORRY
1:52:33	ATC	SG 945 CLEAR TO LAND WINDS 100/05
1:52:36	CO-PILOT	OK CLEAR TO LAND SG 945
1:53:17	AURAL	***Aural Alert "ONE THOUSAND"***
1:53:19	PIC	RUNWAY IN SIGHT LANDING CHECKLIST COMPLETE EVERYTHING IS NORMAL
1:54:07	PIC	500 FT STABILISED
1:54:19	PIC	CONTINUE LANDING
1:54:24	AURAL	***Aural Alert "ONE HUNDRED"***
1:54:44	AURAL	***Aural Alert "*****FIFTY FORTY THIRTY TWENTY TEN**"

1.11.2 Digital Flight Data Recorder

The aircraft is installed with a DFDR that provides a permanent record of operational and systems information including time, heading, altitude, airspeed, acceleration, attitude, engine thrust, and flight control surface position. The recorder is a solid state device and complies with Federal Aviation Administration and European Aviation Safety Agency requirements for data sampling rates and number/type of parameters sampled. Operational and systems information is automatically recorded whenever the flight recorder is powered. The DFDR continuously records the most recent flight data, saving the most current data of the last 25 hours of operation. The DFDR is housed in a sealed container located behind an access door in the far aft cabin ceiling. The DFDR is corrosion,

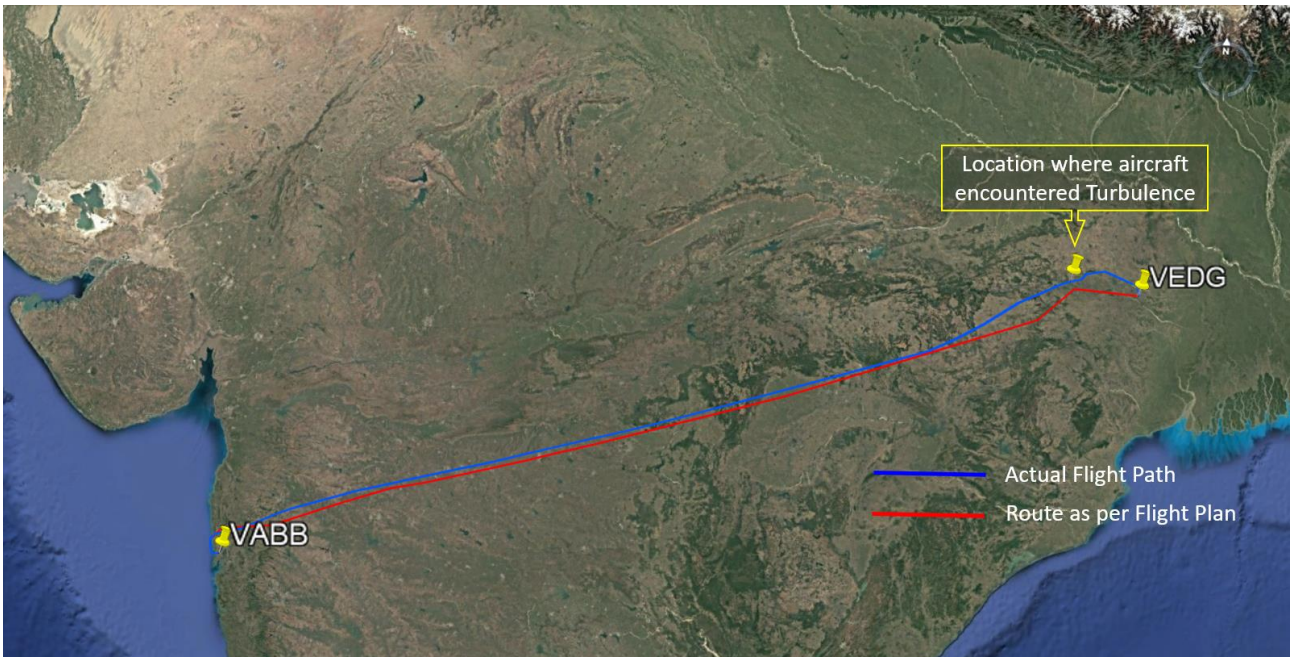


Figure 11

fire and impact resistant and survives deep sea pressures upto 20,000 feet (6096 m). The DFDR has an underwater locator beacon (ULB) on the front panel. The ULB helps find the voice recorder unit in water. For purpose of DFDR data analysis, the DFDR unit was retrieved from the aircraft and brought to DGCA's Flight Recorder Lab.

The raw data was downloaded and converted to engineering parameters with assistance from the OEM and the Operator. The DFDR plot has been used to create the flight path plotted on a satellite map shown in figure 11. The flight path as per the Flight Plan is shown in red. The actual flight path flown by aircraft is shown in blue. The location where the aircraft encountered weather is also shown. The DFDR Data Analysis provided by the OEM was not time aligned as the time-stamps were not available. The plots made with respect to elapsed time are shown in Appendix C.

The Figures (34-41) in Appendix C show the pertinent longitudinal and lateral-directional parameters from the QAR data. Figures 40 and 41 show the calculated vertical wind and recorded column deflection and normal load factor overlaid for comparison. Figures 34, 36, and 38 show longitudinal parameters for the incident with an increasingly closer focus on the time period with

the largest excursions in normal load factor. Figures 35, 37, and 39 show lateral-directional parameters on those same time scales.

The QAR data show the airplane on descent at approximately 20,000 feet pressure altitude on a magnetic heading of approximately 76 degrees (Figures 34 and 35). The early portion of the presented QAR data, before time 7200 seconds, show stable flight with some turbulence (based on increased fluctuations in the acceleration data, air data parameters, and control deflections). The autopilot and the autothrottle were both engaged (Figure 34). The autopilot pitch mode was Flight Level Change (FLCH), and the autothrottle was in the armed mode. The speedbrakes were also deployed as the speedbrake handle was at approximately 40 degrees. During this period, the calculated vertical winds remained within -40 fps (downdraft) and +40 fps (updraft).

Pitch attitude was nose-down on average (maximum of 3 degrees) as the airplane continued to descend, and the computed airspeed was approximately 280 knots. Longitudinal acceleration variations were between -0.01 and +0.05 g's relative to the steady state average value (Figures 34 and 36). Lateral acceleration was between -0.1 and +0.1 g's (Figures 35 and 37). Control wheel deflections remained between -18 and +18 degrees (Figure 35). These deflections were likely at least partly the result of the wheel being back-driven by the autopilot.

Around time 7202 seconds, the autopilot disconnected. At this time, control wheel inputs increased in magnitude as the flight crew took over the controls. Over the next 60 seconds, control wheel inputs ranging between +/- 45 degrees were commanded.

After time 7210 seconds, the airplane began to experience greater positive and negative calculated vertical wind gusts and larger variations in normal load factor (Figures 36 and 38). Over the next 60 seconds, normal load factor cycles between g-levels of -1.3 and +2.6 occurred. During this time, calculated vertical winds were between -91 fps (downdraft) and +109 fps (updraft). Column inputs became more frequent and larger, between -3.2 (push) and 6.9 degrees (pull). Calculated column force ranged between -30 pounds (push) and +50 pounds (pull).

The largest excursion in normal load factor occurred at time 7246 seconds (Figure 38). Over 3 seconds, the normal load factor changed from +2.6 g's to -1.3 g's. During this period, the stick shaker activated for at least 1 second. Around time 7220 seconds, airplane heading began to deviate to the left of the Mode Control Panel (MCP) selected heading and eventually changed approximately 50 degrees to the east over a period of 40 seconds, consistent with the varying bank angle that was to the left, on average (Figures 37 and 39). Later at time 7310 seconds, the heading eventually returned to the original course. The DFDR data was used to create flight path on a satellite map and various events were plotted on the map.

1.12 Wreckage and Impact Information

Not relevant to this Investigation

1.13 Medical and Pathological Information

As per the information received from the operator, total 21 person including 03 cabin crew received injuries. 06 person took first aid at the airport and went home. 15 person were hospitalized. 12 of the hospitalized were discharged after first aid and 03 person with critical injuries remain admitted for treatment. 01 passenger had brain injury and two passenger had spinal injury. One of the discharged passenger later complained of pain and was diagnosed with an un-displaced fracture in left hand. Two of the passengers responded to the treatment and were discharged on recovery, while one passenger with spinal injury did not respond to the treatment provided and succumbed to his injuries on 26 Sept 2022. The cause of death was Sepsis in Shock due to Polytrauma with Spinal Injury.

1.14 Fire

There was no fire.

1.15 Survival Aspects

There were 189 passengers including an infant. And there were 06 Crew members (Two Cockpit crew and 04 Cabin crew) onboard. 18 passengers were injured during the flight through turbulence. Some of the passengers were having their food when the PIC announced over the PA of landing within the next 25 minutes and the seat belt signs were switched ON. The cabin crew commenced their Pre Landing Check and could complete only till the 8th row when there was a second PA from the PIC for the Crew and passengers to remain seated.

The Cabin crew had to rush back to their jump seats from the 8th row and could not check if passengers after 8th row had their seat belts fastened. The aircraft encountered turbulence. Some passengers were reported to have got thrown out of their seats, hitting the ceiling and falling to the aisle, probably because they were having their food and the seat belts were not fastened.

All seats and seat belts were operational prior to the flight and had no defects reported on them. Post flight an inspection of all the seats and seat belts were found to be in a satisfactory condition. All the passengers who required treatment at the hospital, had occupied seats from the mid to the aft part of the cabin. The three seriously injured passengers were occupying seats 16D, 27E and 31D. The passenger occupying seat 16D succumbed to his injuries. Since all the seat belts were serviceable the accident would have been survivable had all the passengers were seated with their seat belts fastened.

1.16 Tests and Research

The weather radar RT serial number 10798 that was removed from the aircraft by the operator after the accident was shipped to Honeywell's facility in Oct 2022. Honeywell no longer provided support for the said unit and therefore the unit was shipped to its vendor Ontic. The testing was carried out in May 2024. The purpose was to test and evaluate the RTA-4B Weather Radar Receiver Transmitter on the bases of functionality and flight acceptability.

The RTA-4B with was subjected to automated ATP testing in accordance with all requirements of document 076-0890-000 - Return to Service Test Procedure. The stand used to test the unit was MRO RWT-4B automated test stand. The software part number used to test the unit was 998-2643-537 with radar matrix 998-2991-514. RTA-4B unit passed all testing.

The RT unit was also disassembled to examine internals. There was no significant damage or physical abnormality observed that would suggest a degradation of performance of the RTA-4B unit. Minimal evidence of heat and potential moisture build-up was noted, though performance was not affected in a way typical with units that suffer similar symptoms of a significant degree.

The RTA-4B Receiver Transmitter unit, SN 10798, passed well within the limits of automated testing per 076-0890-000.

1.17 Organizational and Management information

1.17.1 Operations Manual

INTED OM PART-A GENERAL SEJ-OPS-01-OM CHAPTER 17 SOP FOR EACH PHASE OF FLIGHT Ed.-7 Rev. 0 07 Jan. 2021, has the following to state about Turbulence.

> *" **A17.3.6.3 Turbulence:** Turbulence is defined as a disturbed, irregular flow of air with embedded whirls or eddies and waves. An aeroplane in turbulent flow is subjected to irregular and random motions while more or less maintaining its intended path. Types of Turbulence are as follows:*
>
> *(a) **Convective turbulence:** Convective turbulence is caused by thermal instability. It can cause extreme air motion with vertical speeds up to 6000 ft / min. Mostly it is encountered with severe turbulence in connection with thunderstorm activity.*
>
> *(b) **Orographic turbulence:** These are mountain waves at the lee side of a mountain.*
>
> *(c) **Clear Air Turbulence (CAT):** Clear Air Turbulence is of special significance, since its presence cannot be detected before it is encountered. It is caused by large wind shears with rapid changes of wind direction horizontally and / or vertically.*
>
> *(d) **Wake turbulence:** Wake turbulence, also known as "jetwash", is turbulence that forms behind an aircraft as it passes through the air. This turbulence can be especially hazardous during the landing and Take-off phases of flight, where an aircraft's proximity to the ground makes a timely recovery from turbulence-induced problems unlikely. Wingtip vortices make up the primary and most dangerous component of wake turbulence, but normal wake effects are also an important part.*
>
> ***Note:** Areas of general turbulence normally found in and near thunderstorms, in regions of strong wind or temperature shear*
>
> *or in sharp trough lines and mountain waves. Turbulence that is not associated with cloud conditions (i.e. Clear Air Turbulence) is difficult to detect. However, a knowledge of the*

conditions associated with the presence of turbulence, both CAT and turbulence associated with cloud, can aid in avoidance.

A17.3.6.3.1 Guidelines to avoid / penetrate turbulence

(a) Plan a deviation from course or altitude around areas of significant turbulence.

(b) If deviation is not possible for some reason and it is required to penetrate the areas of turbulence, then:

(i) Follow laid down procedures indicated in the FCOM / AOM in respect of IAS / Mach No, Engine RPM, Engine Start Switches,

TAI etc and

(ii) Take the following actions in respect of Fasten Seat Belt sign and Passenger Address:

	Light Turbulence	***Moderate Turbulence***	***Severe Turbulence***
Likely indication in Cockpit	*TAT changes by about 3°*	*TAT changes by about 6°*	*TAT changes by about 9°*
Conditions	*Occupants may feel a sight strain against seat belts. Unsecured object may be displaced slightly Food service may be conducted Little or no difficulty encountered in walking*	*Occupants feel definite strain against seat belts Unsecured objects are dislodged Food service may be difficult Difficulty in walking*	*Occupants are forced violently against seat belts. Unsecured objects are tossed about Food service is impossible Walking is impossible*
Actions	*PIC: FASTEN SEAT BELT sign ON at PIC's discretion.*	*PIC: Avoid Flying Through FASTEN SEAT BELT sign shall be ON. Confers with Senior Cabin Crew to determine if service is to be interrupted and C/A's to be seated. Make PA instructing passengers and C/ 's to be seated followed by interphone call to C/ A's. (If such turbulence is imminent, the PIC may advise Cabin Crew directly via the following PA Announcement:*	*PIC: Avoid Flying Through FASTEN SEAT BELT sign shall be ON. Make PA instructing passengers and C /A's to be seated followed by interphone call to C / A's. (If such turbulence is imminent, the PIC may advise Cabin Crew directly via the following PA announcement: "Cabin Crew Take Your Seats".)*

		"Cabin Crew Take Your Seats".)	
	Cabin Crews: *Verify passenger Seat belts fastened* *when FASTEN SEAT BELT sign on.* *Verify that the bassinets are unoccupied.* *Secure unattended carts, loose service and galley items Verify lavatories unoccupied.*	*Cabin Crews:* *Sit down and secure seat belts.* *Advise passengers to be seated and fasten seat belts.*	*Cabin Crews:* *Sit down immediately and secure nearest seat belt.* *Advise passengers to be seated and fasten seat belts.*

(c) If ATC can not approve a requested change in route or altitude, then in conditions of 'severe turbulence', the PIC may use his emergency authority and select such courses and altitudes as he considers necessary for safety. Use of emergency authority shall be immediately reported to ATC.

(d) When entering areas of turbulence, the "The Fasten Seat Belt" Sign shall be switched ON well in time.

(e) Before turbulence penetration, Flight Crew shall fasten seat harness.

(f) The pilot shall determine the best penetration altitude and heading, establish target penetration speed, set thrust to hold target speed and use the autopilot to best advantage (if the auto pilot is off for any reason, maintain Yaw Damper ON).

(g) B737 - In case of 'severe turbulence', the PIC shall, in addition to the above, turn the 'altitude hold' off if the auto pilot is being used. If the auto pilot is OFF, leave the stabiliser in the level flight trim setting and use moderate elevator forces to resist pitch changes.

(h) Use ailerons as necessary to maintain wings level."

For avoidance of Thunderstorms, INTED OM PART-A GENERAL SEJ-OPS-01-OM CHAPTER 17 SOP FOR EACH PHASE OF FLIGHT Ed.-7 Rev. 0 07 Jan. 2021 states the following:-

"A17.3.6.1.2 Avoidance of Thunderstorms

(a) With thunderstorms in the vicinity of the aerodrome, request radar vectoring through thunderstorm free areas and arrange the climb out to provide ample safety distance from active CB clouds.

(b) Use all available information such as airborne weather data, Pilot reports etc.

(c) During cruise, thunderstorm shall be avoided:

(i) Visually by staying well clear of CB clouds.

(ii) By using the airborne weather radar.

(iii) By requesting vectors from ATS radar.

(d) Whenever possible, the following shall be avoided:

(i) Flights in cirrus clouds if thunderstorm activity is expected along the route, as they may be hiding anvil tops and reducing the effectiveness of the airborne weather radar.

(ii) Flight at or near the freezing level where heaviest icing and hail shall be expected.

(iii) Flying below the overhang of CB clouds. This is the area where heavy hail shall be expected.

(iv) Strong echoes shall be avoided by 40km (20 NM) or more. This is most important at FL200 and above and for circumnavigation of echoes which have prominent scallops or other protrusions.

A17.3.6.1.3 Preparation:

When flying in a thunderstorm area is anticipated or unavoidable the following preparations shall be made:

(a) Monitor airborne weather radar closely.

(b) Advice Cabin Crews about the presence of adverse weather conditions switch on cabin signs and ensure that all passengers are securely strapped in.

(c) Reduce to turbulence speed according to FCOM / AOM.

(d) Operate anti-icing equipment as required.

***A17.3.6.1.4 Lateral Deviation**:*

(a) Use the airborne weather radar to find the most suitable corridor. Plan an avoidance path as soon as possible for all weather echoes, which appear beyond one hundred miles since this indicates they are significant storms.

(b) Do avoid by at least 20 miles any thunderstorm identified as severe or giving an intense radar echo and deviate upwind if possible. This is especially true under the anvil of a large cumulonimbus.

*(c) Follow the instructions for flight in turbulence**."***

The Flight Crew to Cabin Crew Communication Procedures are given in at Appendix A3 of Chapter 17 of OM. Appendix 4 of Chapter 17 lay down Flight Crew – Cabin Crew Emergency Communication procedures and Appendix 5 lays down Cockpit PA Announcements for Emergency and Non-Normal Situations. In a scenario where Turbulence is imminent the Appendix 5 requires the Cockpit Crew to give command **"Cabin crew take your seats."**

1.17.2 FCOM Procedures

The Supplementary Procedures for Adverse Weather given at SP.16.26 Turbulence as per the FCOM D6-27370-8GJ-ROJ, Rev 44 dated 03 Mar 2022 are given below:-

"Turbulence

During flight in light to moderate turbulence, the autopilot and/or autothrottle may remain engaged unless performance is objectionable. Increased thrust lever activity can be expected when encountering wind, temperature changes and large pressure changes. Short–time airspeed excursions of 10 to 15 knots can be expected.

Passenger signs ..... ON

Severe Turbulence

Yaw Damper..... ON

Autothrottle ..... Disengage

AUTOPILOT ..... CWS

A/P status annunciators display CWS for pitch and roll.

***Note:** If sustained trimming occurs, disengage the autopilot.*

ENGINE START switches ..... FLT

Thrust ..... Set

Set thrust as needed for the phase of flight. Change thrust setting only if needed to modify an unacceptable speed trend.

PHASE OF FLIGHT	***AIRSPEED***
CLIMB	*280 knots or .76 Mach whichever is lower.*
CRUISE	*Use FMC recommended thrust settings. If the FMC is inoperative, refer to the Unreliable Airspeed page in the Performance–Inflight section of the QRH for approximate N1 settings that maintain near optimum penetration airspeed.*
DESCENT	*.76 Mach/280/250 knots whichever is lower. If severe turbulence is encountered at altitudes below 15,000 feet and the airplane gross weight is less than the maximum landing weight, the airplane may be slowed to 250 knots in the clean configuration."*

***Note:** If an approach must be made into an area of severe turbulence, delay flap extension as long as possible. The airplane can withstand higher gust loads in the clean configuration."*

1.17.3 B737 NG Operations Circular; OC 16/2021

Spice Jet has issued Operation Circular 16/21 dated 06 June 2021 on B737 Monsoon Operations. The circular at para 7 and 8 details of Weather Radar Use and Limitations and Aircraft Operating Procedures respectively. The extract from the Para 7 and 8 of the OC16/21 is quoated below:-

" 7. WEATHER RADAR : USE AND LIMITATIONS

A detailed description of the theory of weather (Thunderstorms, Hail, Windshear) and the theory and use of the onboard weather radar is provided to all Spicejet Pilots on AERODOCS (ipad) and 'edocs center' in CREWNET. All Spicejet Pilots are to read and be completely conversant with the contents.

In addition, the paragraphs below are provided as a 'Ready Recknor' for the purpose of Revision and to re- emphasize the salient points. Weather radar can show precipitation in clouds and by relating the strength of the return signal received can show thunderstorm activity, so identify storm cells within the thunderstorm.

It is emphasized that Weather Radar is used for avoidance of thunderstorm and not for penetration of areas of storm activity.

Weather Detection:

Weather radar detects droplets of precipitation size. The strength of the radar signal (echo) depends on drop size and number. The greater the water concentration, the stronger shall be the echo. Drop size determines echo intensity to a much greater extent than number of drops. Hailstones usually are covered with a film of water and therefore act as large water droplets giving the strongest of all echoes. Water concentration is greatest within the updrafts and downdrafts of a thunderstorms cell which thus show up as an area of higher echo intensity. Airborne weather radar has the facility to efficiently highlight strong echo returns by means of contouring function thus separating out the storm cell location/areas of turbulence from more widespread areas of general precipitation. Remember that while wet hail always gives a radar echo it may fall several miles from the nearest visible cloud, and hazardous turbulence may extend to as much as 20 miles from the echo edge.

Pilots should use the Antenna Tilt Function to identify the strongest echoes. Interpret this in the context of the aircraft altitude and phase of flight, whether in climb- out, cruise and descent or intendent descent. Adjust the tilt to assess whether the cell top is below or above the aircraft. This will obviously determine what evasive action must to be take clouds and cells at high altitude, the potential for turbulence and hail should be considered as greater than an echo of similar intensity at lower. This is because of generally lower liquid water content at higher altitudes and an increasing conversion of water vapor into Ice crystals. Strong high altitudes echoes must therefore be avoided because of the potential severity of such cells. The high rate of vertical growth of thunderstorms and the danger of flying over or near to the tops of both the main storm and the small convective cells close to it must be remembered when using weather radar for storm avoidance.

Limitations of Weather Radar:

Radar signals are subject to attention when passing through precipitation. Consequently, heavy intervening precipitation can create shadow area on the screen beyond it in which other storm cell activity beyond will not show up. The echo pattern needs to be examined more carefully and critically for possible shadow areas. Flight around, or more particularly, between storm centers needs to be critically assessed in this context.

The performance of weather radar may vary from aircraft to aircraft. Since the gain control is set in the workshop, variations occur. Also, moisture ingress to the radome structure can increase the attention losses. For such reasons and because the echo patterns and their intensity need to be carefully interpreted, weather radar must be used conservatively. It is strongly re-emphasized the weather radar is a storm avoidance aid and must not be used for storm penetration.

Weather radar echoes do not differentiate between heavy rain precipitation and hail and although echoes which have "scalloped' edges or "hooked" fingers are reported to be indicative of hail this does required skilled interpretation and reinforces the need to adopt a conservative approach with avoidance distances.

8. AIRCRAFT OPERATING PROCEDURES:

i. *The essential policy is to avoid penetration of active thunderstorms and not to attempt flight through any area which is more than ¾ covered by active thunderstorms under any circumstances.*
ii. *Such a stricture requires both contingency planning at the preflight stage and timely anticipation of circumnavigation and detour decision when airborne.*
iii. *Severe thunderstorms require avoidance even at the cost of delay or cancellation at the preflight stage or diversion or intermediate landing while enroute.*
iv. *Avoid take off / landing in the face of an approaching thunderstorm, windshear.*
v. *The design load factor with flaps extended is less than with the flaps retracted, 0 to +2G compared with -1 to +2.5G.*
vi. *Avoid flight under a thunderstorm, even if you can see through to the other side. Turbulence and windshear under the storm could be disastrous.*
vii. *Never fly into a cloud mass containing scattered embedded thunderstorm cells without properly functioning airborne radar.*
viii. *Scattered thunderstorms not embelled usually can be visually circumnavigated.*
ix. *Avoid radar echoes by the following distances:*
    1. *5nm* at 0-20,000 ft flight altitude.*
    2. *10nm at 20- 25,000 ft flight altitude.*
    3. *15nm at 25-30,000 ft flight altitude.*
    4. *20nm above 30,000 ft flight altitude.*

    ** If the echo is growing rapidly in size and height or showing, "hooks" fingers" or scalloped" edges, increase the avoidance distance to 10nm.*

x. *Be exceptionally careful at night when storm delineation can only be achieved with the help of frequent lightning discharge.*
xi. *Never trust the visual appearance as a reliable indicator of turbulence inside thunderstorms.*
xii. *Lightning is an indication of well – developed cell activity in a storm, while wind and frequent lightning indicates the probability of a severe storm.*
xiii. *The height of the storm tops is also indicative of severity. Tops of 35,000 ft or higher whether visually sighted or determined by radar must be regarded as extreme and hazardous.*
xiv. *Scan ahead regularly using the range facility particularly at night or when flying in cloud having regard to the enroute forecast.*
xv. *Assess the intensity be means of pattern sharpness and size and storm severity by number and proximity of such cells.*
xvi. *Critically examine the pattern for possible shadows areas.*

xvii. *Scan for cell activity at other levels by use of antenna tilt. Assess the echo tops and whether they are below the aircraft height. You can use the below given formula :*
Ht. of Cloud Top (in ft)= A?C Altitude + (Tilt – ½ Bean width) distance *100*
If the answer is +ve Cloud Top is higher than the Aircraft Altitude If –ve Cloud Top Is that much below the Aircraft Altitude.

xviii. *Try to determine if the echo is growing with time or whether the cell may be decaying.*

xix. *The magnitude of these distances is determined by the need to avoid turbulence which may exist outside the confines of severe storms/high intensity contouring echoes.*

xx. *If thunderstorms are to be over flown then the vertical separation should be at least 5,000 ft. This is particularly important if the forecast upper wind is high.*

xxi. *Avoid flying under a CB anvil or overhanging. Tilt the radar antenna up towards the over hang to check for the possibility of hail.*

xxii. *If flight through a thunderstorm is absolutely unavoidable, then the following procedure must be followed:*

(a) *Instruct SSC to secure passenger cabin, and brief the passengers;*
(b) *Secure all loose equipment;*
(c) *Fasten full safety harness;*
(d) *Select engine anti-ice ON;*
(e) *Use of wing anti-ice: Ice accumulation on the flight deck window frames, windshield center post, or on the windshield wiper arm may be used as an indication of structural icing conditions and the need to turn on wing anti-ice. Refer to FCOM VOL-1 Pg SP. 16.11*
(f) *Plan altitude to avoid worst icing (i.e. whenever practical avoid temp. ranges 0 degree Celsius to minus 15 degree Celsius).*
(g) *Plan and hold course for optimum penetration. Continue to monitor the weather radar;*
(h) *Do not turn back once storm has been entered.*
(i) *Establish turbulence penetration indicated airspeed and power setting ---- as FCOM Vol 1, SP.16.25; (The turbulence penetration airspeed provides the appropriate trade-off between structural strength and aircraft control considerations)*
(j) *The auto pilot should remain engaged. The Mach trim should remain engaged. This should produce lower structural loads than would result from flying manually. If major pitch trim movements occur and / or autopilots does not adequately control the aircraft then the autopilot must be disengaged and flown manually. Fly altitudes and avoid large control inputs.*
(k) *Set cockpit lightning to maximum intensity -whether day or night.*
(l) *Keep eyes on instruments to minimize risk of temporary blinding by lightning.*
(m) *The PF shall direct his attention exclusively to the flight instruments whether an autopilot or flying manually.*

xxiii. *In severe turbulence there will be large fluctuations of flight instruments indications which may be very difficult to read because of the turbulence which itself, additionally, will be physically stressful. Heavy rain, hail, lightning and static discharges will be distracting because of the high noise level and light flashes particularly at night.*

xxiv. *The turbulence penetration speed provides a target pitch attitude reference about which the aircraft should be controlled. Concentrate on maintaining this pitch attitude appropriate to the climb, cruise or descent phase of flight.*

xxv. *Avoid over control; control in outs should be smooth, sufficient to restore pitch and roll excursions but not excessive. Maintain attitude while accepting variations of speed and height which may occur.*

xxvi. *Do not correct for height gain or loss due to up or down draughts until the severity of the turbulence has moderated and only slowly adjust back to the cruise level.*

xxvii. *Avoid pitch trim changes and maintain the in-trim setting for the penetration airspeed.*

xxviii. *Maintain the thrust setting except where speed variations become excessive and it is necessary to restore margins above the stall warning /stick shake or below high-speed buffet.*

xxix. *Where a mean airspeed variation of 20kts or so is sustained, adjust the target attitude first of all and then make small thrust adjustments to hold or slowly adjust the aircraft height.*

xxx. *Apart from making roll control difficult, turn maneuvers increase structural loading in conditions where the aircraft structures may already be subject to excessive gust loads. Do not turn back once the thunderstorm. Maintain heading. The original chosen course and heading is likely to get the aircraft through the storm in the shortest time."*

1.17.4 CAME

1.17.4.1 Defect handling procedure

The Company procedures for Continuous Airworthiness are specified in the Continuous Airworthiness management exposition. The procedures for handling defect reports and repetitive defects are provided in CAME 1.8.8 General 2.5.1. Wherever necessary, callouts are issued through work order for additional maintenance action to support the CAR-145 maintenance organization with inputs and methodology used in previous repair attempts on fleet (especially for recurring problems). It state that, 'All defects and related rectification action are documented and certified in the work order. Any defect through PIREP shall be analyzed and rectified by Line Maintenance personnel. When the defect is repeated, it would be analyzed by Defect Cell in MCC for necessary rectification action and methodology used in previous repair attempts to isolate the root cause and rectify the repeat defect. In case all the source of maintenance documents likes FIM, WDM, SSM, AMM, maintenance tips & FTDs are exhausted then matter should be forwarded to TSD/OEM for further guidance.

1.17.4.2 Recurring defect monitoring and control

CAME 1.8.8, MCC Procedures 2.5 under Procedures for Repeated Defect monitoring and controlling procedures 2.5.2 specify the role of the MCC and Defect cell in monitoring and control of repetitive defects on a daily basis.

"MCC Procedures 2.5. 2.

Following process to be used for Recurring defect monitoring and control on daily basis.

1. Defect Cell Engineer will review all defects reported on the fleet through AMOS APN1 [work order information system] and will export them on excel format.

2. The defect data will be reviewed for repeat, significant, fleet defect as per the defined criteria of repeat and significant as mentioned above.

3. Defect Cell Engineer will extract the repeat / significant after review and will maintain them in excel format with both ATA Chapter and Aircraft Registration wise on MCC server in soft copy.

4. Data base will be updated in soft copy which will include the troubleshooting history and corrective actions taken. The data base will be available 24×7 for all MCC staff for review of defect history and to share the data with certifying staff as and when required for effective troubleshooting and rectification of defect.

5. Defect Cell will review the action taken by certifying staff for the recurring defect and various inputs taken in to account by referring AMM/FIM/SRM/WDM/FTD/MT/other available maintenance data, during the course of troubleshooting. This will be analyzed along with MCC data base of previous similar defect troubleshooting history and methodology used in previous rectification on different aircraft. Then Defect Cell Engineer will prepare the work order which includes the maintenance steps need to be performed for defect isolation and rectification on case to case basis which will take in to account various inputs from maintenance data and OEM recommendations if any.

6. After the defect is rectified, defect cell will analyze the root cause for that repeat defect/ significant defect and will share the monthly record of such defects to Reliability cell of TSD /Post Holders /LMMs by e-mail communication for information and guidance.

7. If all the source of maintenance documents likes FIM, WDM, SSM, AMM, maintenance tips & FTDs are exhausted then matter should be forwarded to TSD/OEM for further guidance."

1.17.5 Manual Tilt Control weather radar

VT SLH is installed with weather radar that has a manual tilt control function and as such the tilt has to be manually controlled by the pilots to monitor the weather ahead. The Company operates 06 aircraft including VT SLH that are fitted with Honeywell Weather Radar having only Manual tilt operating features available. The other aircraft have auto tilt features available. Since the Company has aircraft installed with both Manual and Auto tilt controlled weather radar in its fleet, pilots have to frequently switch between Auto and Manual systems during operation. The pilots hence have to continuously update themselves on the "User's Manual and Operating Guidelines" for both types of weather radar that is given in the Company's Crew Web Portal (crew net) under 'EDOCS CENTER' in B737 MANUALS tab.

As part of corrective action, the airline reiterated the Weather Radar Manuals (Collins and Honeywell) along with DGCA Monsoon OC and DGCA Monsoon Guidelines forwarded to all pilots

on 24th May 2022 with subject Monsoon Operations. In addition, these manuals and other related material is also available on Company Web portal and EFB iPads.

The Informatory Circular on Monsoon Operations, OC16/21 containing “Turbulent Air Penetration” procedure and “Weather Radar Use and Limitations” was revised and revision 15/2022 dated 28th May 2022 issued was issued. Online training session conducted for available pilots and ground instructors on Honeywell Weather Radar by Honeywell team on 16 June 2022.

1.18 Additional Information

NIL

1.19 Useful or effective Investigation Techniques

Nil

2. Analysis

2.1 Serviceability of Aircraft

The aircraft had a current and valid Certificate of Airworthiness, an airworthiness review certificate, and an Aero Mobile License as required by applicable regulations on the day of the accident. Prior to the accident flight, all applicable Airworthiness Directives, mandatory Service Bulletins, and DGCA Mandatory Modifications for both the aircraft and its engines had been satisfactorily addressed.

2.1.1 Weather Radar System Defects

On 01 May 2022, the aircraft operated VABB-VIJP-VABB and VABB-VOGO-VABB sectors before the occurrence flight. No defect related to weather radar system was observed during any of these sectors. After the occurrence, the aircraft was ferried to Kolkata base for maintenance and repair based on the defects observed by the engineering team at Durgapur and report raised by the pilot in the Tech Log Book. Although, there was no defect pertaining to Weather Radar System logged by the pilot during the occurrence flight or the ferry flight. The Transceiver RTA-4B of Weather Radar System was removed from the aircraft and replaced. The reason cited in the work order was "DGCA instructions". However, DGCA officer did not confirm giving any such direction.

From further scrutiny of the Technical Log Book, it was observed that the VT SLH had three weather radar defects logged before the accident during the preceding month. Similar weather radar defects were also logged in other aircraft that were installed with similar weather radars. A total of 60 similar defects were found logged in the 06 aircraft installed with manual tilt control weather radar during the period between Jan 2022 to Aug 2022.

As per the MCC procedure 2.5.2, in case of repeated defects Defect Cell was to review the action taken by certifying staff for the recurring defect and various inputs taken into account by referring AMM/FIM/SRM/WDM/FTD/MT/other available maintenance data, during the course of troubleshooting. This should be analyzed along with MCC data base of previous similar defect troubleshooting history and methodology used in previous rectification on different aircraft. Thereafter, the Defect Cell Engineer prepares the work order which includes the maintenance steps needed to be performed for defect isolation and rectification on case to case basis which will take in to account various inputs from maintenance data and OEM recommendations if any. After the defect is rectified, analysis of the root cause is carried out by the defect cell and the monthly record of such defects are shared with the Reliability cell of TSD /Post Holders /LMMs by e-mail communication. If all the source of maintenance documents likes FIM, WDM, SSM, AMM, maintenance tips & FTDs are exhausted then matter should be forwarded to TSD/OEM for further guidance.

However, MCC procedure stated above were not followed and no records of callouts to assist in finding the root cause of the repeated Weather Radar defects were observed.

During the maintenance actions carried out at Kolkata after the ferry flight, the functional check of the weather radar system was carried out after replacement of RTA-4B and system was found

satisfactory. Cockpit En-route Check was carried out by the DGCA FOI after aircraft was released for operations and weather radar system performance was observed to be satisfactory. There were, however, 02 observations related to paint worn out on Weather Radar knob and unreadable range figures on EFIS Control Panel given by the DGCA FOI. Any settings selected on the Weather Radar knobs is reflected on the Navigation Display. Similarly, range setting are also visible on the ND and worn out knob or unreadable range figures would not have posed any significant challenge in operation of Wx Radar System.

The RTA-4B transceiver removed from aircraft was subjected to examination and functional checks at OEM approved facility. No significant damage or physical abnormality observed that would affect system performance was observed and the unit passed all functional checks.

AAIB had advised the Operator, to keep AAIB updated on any defect reported by pilots on the Wx radar system. As per the information made available by operator 13 defects related to weather radar were logged post 01 May 2022 on VT-SLH. As per the record of maintenance actions carried out, the defects could not be confirmed on ground in most cases. In majority of cases the connector of RT, Wx Radar Antenna Drive were cleaned and the aircraft were released to service. RT was replaced on confirmation of snag on one occasion, but snags were reported again, which were again not conformed on ground. On few occasions where snags were not confirmed on ground, Flat Plate, Wave Guide and Control Panel were replaced as precaution.

After replacement of control panel, the snag was reported twice. On both occasions, the aircraft was cleared after cleaning the connectors. No snag was reported after 21 Aug 2022 till 03 Oct 2022, when the aircraft was de-registered and returned to the Lessor without any information or obtaining clearance from AAIB.

The MCC shift hand/over soft copies of the briefing provided to the MCC by AMEs who cleared the defect that was logged twice on 30-04-2022 or the rectification action proposed by the MCC to rectify the repeated defect in Mumbai were not available as they were lost due to a ransomware attack on company's IT infrastructure as per the MCC. It was also stated that the defects were observed to be intermittent.

2.1.2 Seat Belts

The passenger seats attach to the seat tracks on the floor and each seat has a lap belt. There were no reported defects on the seatbelts before flight. The Seat Belt sign was ON and the PIC and Cabin Crew had made announcements for the passengers to fasten seatbelts. Post occurrence, the seatbelts of seats where passengers received injuries were inspected and were found serviceable. The injuries were resultant of not adhering to seatbelt instructions and not failure or defect in any seatbelt.

2.2 Operation of Flight

The occurrence flight took off from Mumbai for Durgapur and the destination alternate as per flight plan was Guwahati (VEGT). Varanasi and Kolkata were second and third alternate destination. As

per statement of Cabin Crew they were not briefed about the route weather by the Flight crew during pre-departure flight briefing.

After being Handed over by ATC Nagpur to URP control, the aircraft was flying on route W64 but deviated from its route due weather. At about 1308 UTC, the crew had sought Heading 060 from Kolkata ATC due weather. At 1311 UTC crew informed ATC about maintaining Heading 055. Later the crew informed ATC of maintaining heading 065 due weather.

The bad weather patch was west of Durgapur, extending from North to South. The weather was across the flight path to destination Durgapur and the overall length of the weather patch was more than 160 nm. It can also be seen from the flight path plotted on satellite map that the aircraft had deviated from the route to be followed as per flight plan. The weather images from Kolkata Doppler Radar showing weather up to 250 Km from Kolkata weather station were obtained. The images for the time ranging from 1322-1502 UTC (Figure 15-24) shows that the weather patch was advancing eastwards with time.

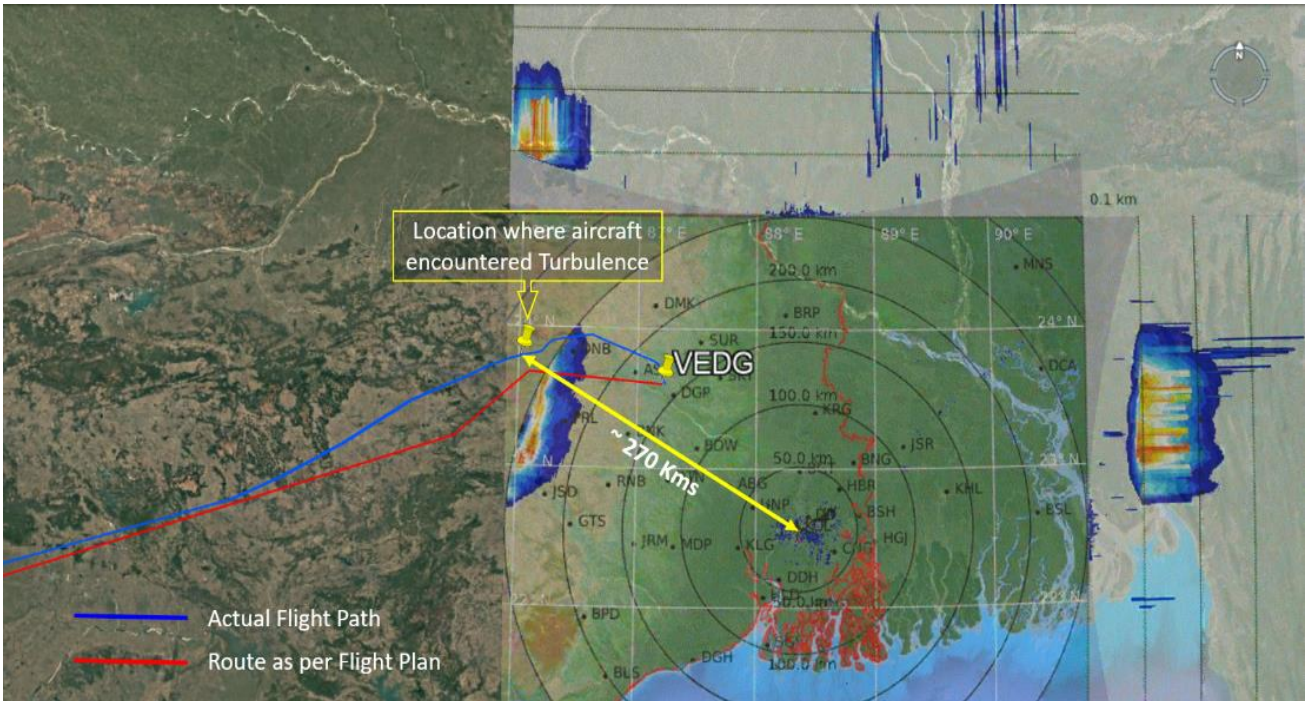


Figure 12

The aircraft encountered turbulence at about 1327 UTC and was approximately 270 Km from Kolkata. Hence, exact position of aircraft with reference to weather patch could not be established. However, by negative extrapolation of weather patch movement towards west, it can be presumed that the weather patch would have existed in the area surrounding the flight path at 1327 UTC.

Further, by plotting the location over INSAT-3D weather image of time 1300-1326 UTC it can be seen that the flight path crossed through an area surrounded by CB clouds (Figure 13)

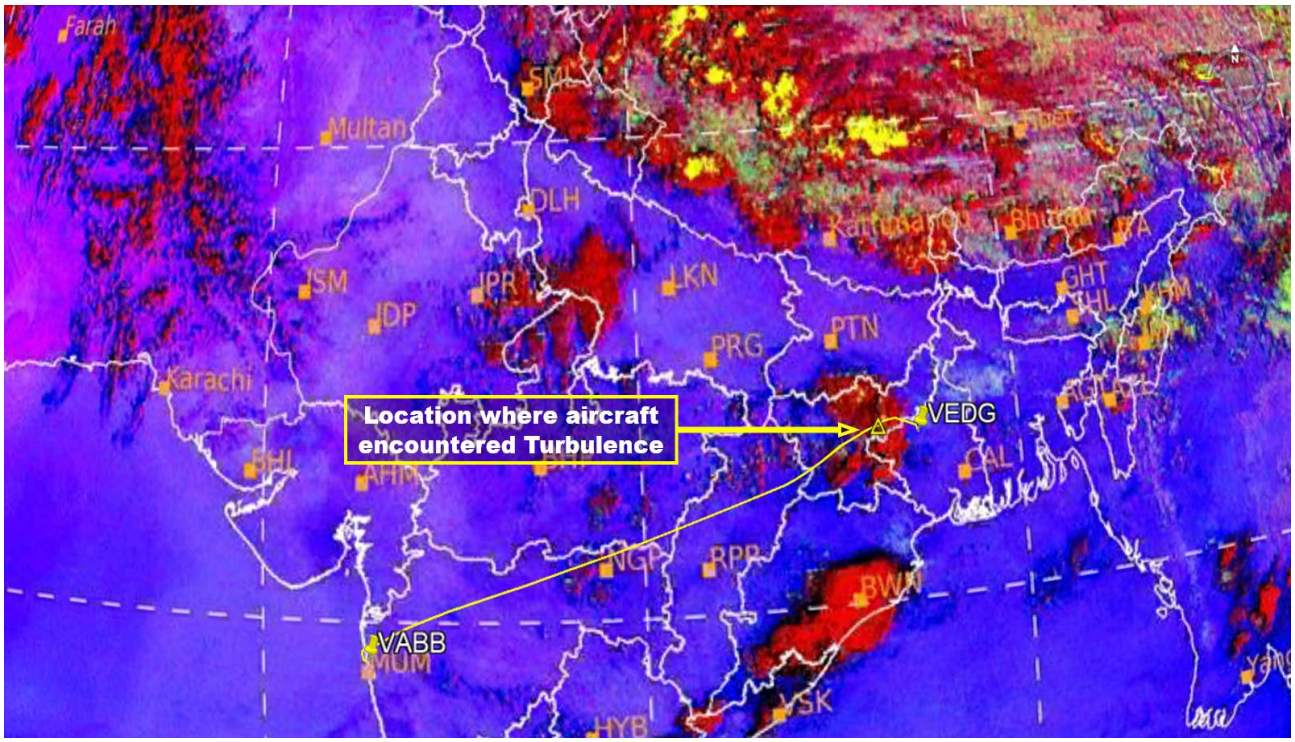


Figure 13

Aircraft had began its descent at about 1319 UTC and the PIC made an announcement to passengers about landing in 25 minutes and also informed passenger of expected turbulence. Seat belt sign was switched ON and the passengers were asked to remain seated for next 15 minutes. Immediately thereafter he informed the cabin crew that they have about 3-4 minutes to secure the cabin. Cabin crew made announcements to passengers about expected turbulence and asked them to remain seated with seatbelts fastened. After information by PIC to prepare cabin for landing, the Cabin Crew started their pre-landing checks. Due to ongoing month of Ramadan, there were many fasting passengers on board. They had not eaten their meals yet as they had expected to break their fast at about 1330 UTC, which was evening prayer time at Mumbai.

Therefore, the tray tables also remained open on many seats. Few minutes into the checks, PIC announced all passengers and cabin crew to be seated. Only, first 08 rows had been secured by the cabin crew by then. Hence, cabin crew did not get time to ascertain if passengers beyond 08th row had their seat belt fastened.

It is observed from the CVR that at about 1321 UTC, the PIC had advised cabin crew "THANK YOU AND ***ABHI THODA STRONG PATCH AYEGA TOH (THERE WILL BE A STRONG PATCH NOW SO)*** YOU HAVE ANOTHER 3-4 MINUTES ***USKE BAAD (AFTER THAT)*** YOU HAVE TO BE SEATED FOR SOME TIME ONCE I BUZZ AGAIN YOU CAN GET UP.

At about 1323 UTC the crew is heard in the CVR *"**AGAR ZARURAT HAI NA (IF NEEDED)*** WE WILL TAKE A LEFT TURN. ANOTHER 10 MILE AUR JAA KE DEKHTE HAIN ***AGAR YEH ITNA HI KHARAB DIKHTA RAHEGA TO (WE WILL GO AND SEE IF IT KEEP LOOKING THIS BAD THEN)*** WE WILL…."

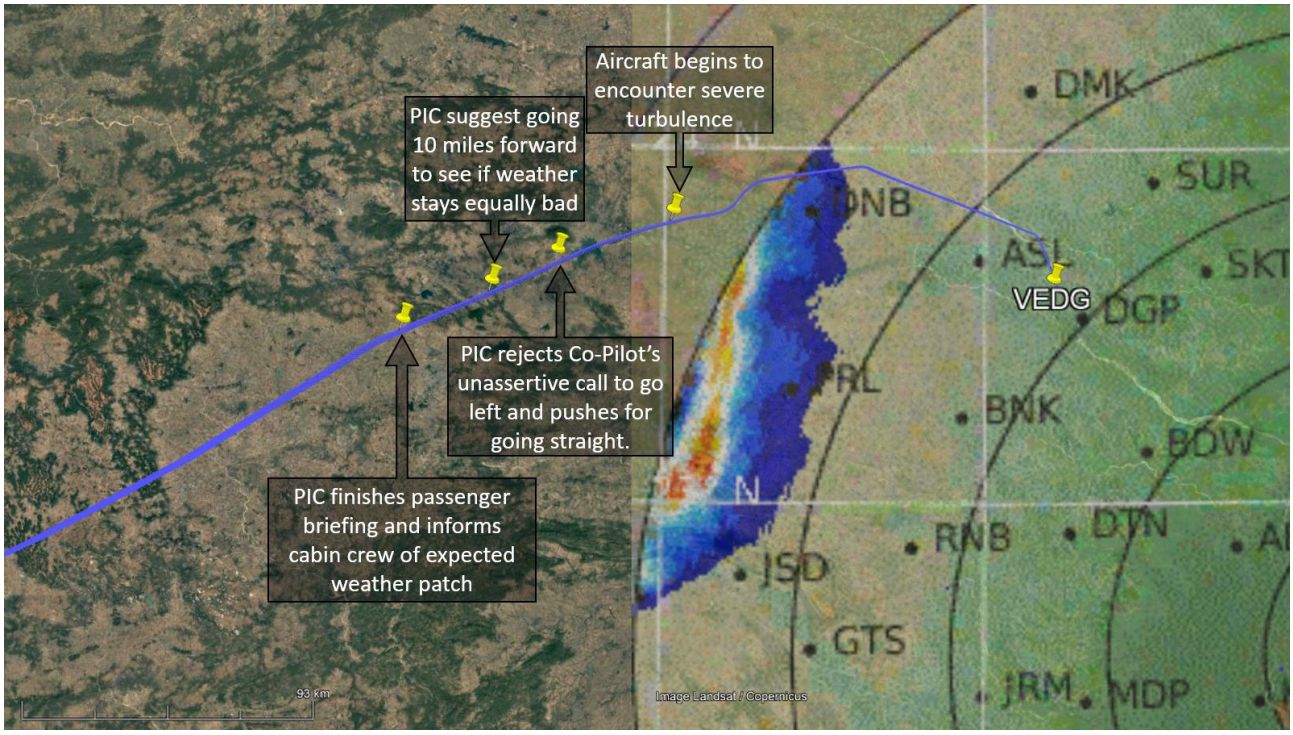


Figure 14

Later at about 1325 UTC, after advancing about 10 NM, the co-pilot makes an unassertive suggestion to go left, however, the PIC is heard saying *"*I DON'T THINK ***ITNA BURA HONA CHAHIYE (IT WILL BE THIS BAD)*** YOU SAY IF YOU SAY SO I WILL TURN LEFT.*"* These conversations indicate that the weather radar was functional and the crew anticipated a strong weather patch in their path. They considered the weather to be bad enough. However, they decided to penetrate the weather another 10 NM before making a clear call to deviate or divert.

On advancing 10 NM further also, co-pilot was not very confident of the weather situation getting any better and called *"WANNA GO LEFT"*, but on suggestion of PIC they decided against deviating left and advanced further. PIC had already made announcement for passengers and cabin crew to remain seated. The cabin could not be secured by the Cabin Crew in the limited time available to them before call from the PIC to remain seated. No call about cabin being secure was therefore passed to the Flight Deck by the Cabin Crew.

As a caution, the PIC asked the Co-Pilot to check surveillance camera so as to ascertain if the cabin crew were seated. Co-pilot checked in the camera and responded in affirmative. The primary purpose of surveillance camera is security of cockpit door and it does not show area beyond the forward galley. The camera would have not provided the crew with any confirmation weather passengers were seated with their seat belts fastened. Cockpit Crew did not confirm status from the cabin crew before they tried to penetrate weather patch.

As per the OM, change in TAT is a likely indication of turbulence and warrants precautionary actions. The aircraft was in descent and there was significant change in TAT observed from the DFDR data, however, this change was commensurate with change in altitude and hence not reliable means to predict turbulence.

As per the crew, they tried going through a patch that was shown green on the weather radar system. However, the severity of turbulence encountered and extent of damage in cabin suggest otherwise. The aircraft had not remained clear of bad weather by sufficient margin and had encountered severe turbulence at about 1327 UTC.

The severity of turbulence caused the passengers who did not have seat belts fastened to bounce from their seats. Some passengers hit the ceiling and also fell in the aisle. The jolts and resulting impacts caused injuries amongst the passengers including spinal injury that later resulted in fatality during treatment.

In the cockpit, the Autopilot got disengaged and control wheel inputs increased in magnitude as the flight crew took over the controls. Control wheel inputs ranging between +/- 45 degrees were commanded. The vertical acceleration touched a peak of 2.6G and normal acceleration touched -1.36 g. Stall warnings and Master caution warnings triggered. The bank angle momentarily reached 35deg before being corrected. The rate of descent as observed from Radar displays went up to 5000 ft/min. AFT DOOR warning appeared and Non-Normal Checklist was carried out by the crew. The pressurization remained normal through turbulence and throughout the flight.

2.3 Guidelines to avoid / penetrate turbulence

Guidelines to avoid / penetrate turbulence given in the OM Chapter 17 requires the cockpit crew to Plan a deviation from course or altitude around areas of significant turbulence. However, when deviation is not possible for some reason and it is required to penetrate the areas of turbulence, the various actions are laid for cockpit and cabin crew to carry out.

Use the airborne weather radar to find the most suitable corridor is advised and crew is required to follow laid down procedures indicated in the FCOM / AOM in respect of IAS / Mach No, Engine RPM, Engine Start Switches, TAI etc.

PIC are permitted to use emergency authority to select flight courses and altitudes as he considers necessary for safety even if the ATC has not approved a requested change in route or altitude in conditions of ‘severe turbulence’. No requirement to use this authority arose and all deviations requested by the cockpit crew were approved by the ATC. Required actions for switching ON Seatbelt signs, making PA Announcements were carried out.

2.4 CRM

The primary goal of CRM is enhanced situational awareness, leadership, assertiveness, decision making, flexibility, adaptability, and communication. The cabin crew stated to have not been briefed about bad weather at the time of pre-departure briefing. They were informed of expected turbulence by the cockpit crew when aircraft started to descent. As it was the month of Ramadan, many fasting passengers were on board. They had not eaten their meals and were waiting for sunset time to start eating, hence the tray tables were not closed. Cabin Crew would have required sufficient time to secure the cabin and ensure that all passengers have their seat belts fastened and

tray tables are closed. Due to lack of information about bad weather during pre-departure briefing they carried out their duties as routine. Information on weather during pre-departure briefing would have increased cabin crew's situational awareness and would have helped them to plan and adapt according to the situation.

In the flight deck, the pilots were able to observe weather and had also taken deviation due to weather. From the CVR, it is observed that weather was considered to be bad enough, but it was decided to advance 10 NM further before deciding to deviate and completely avoid weather. Co-Pilot did suggest taking left as they were advancing into weather. PIC was doubtful and sought Co-pilot's response on deviating left to avoid weather. No firm or decisive response was received from the co-pilot and flight was continued without any further deviation. Better communication and an assertive response from co-pilot may have influenced the decision making process.

Cabin Crew had not passed any call to flight deck about cabin being secure. The cockpit crew used surveillance camera to check the status of cabin, when they decided not to go further left to completely avoid weather. The action of cockpit crew were aligned for weather penetration rather than weather avoidance.

Better situation awareness amongst cabin crew and better CRM could have influenced the decision of the pilot to advance ahead instead of turning further left and would have resulted in safer outcome.

3. Conclusion

3.1 Findings

3.1.1 The aircraft had a current and valid Certificate of Airworthiness before operation of the occurrence flight.

3.1.2 Both cockpit Crew had valid licenses and ratings for operating the occurrence flight.

3.1.3 Six aircraft in the Operator's fleet of 35 B-737 aircraft were fitted with Weather Radar System with manual tilt control against automatic tilt control which were available in majority of the fleet.

3.1.4 60 defects were reported in all B-737 aircraft equipped with Honeywell RDR-4B weather system from Jan – Aug 2022. 15 of these defects precede date of accident.

3.1.5 No deferred defect or MEL/CDL was present related to weather Radar System on the aircraft before the occurrence flight. However, 03 defects had been reported from 14 April to 30 April 2022.

3.1.6 The procedures for recurring defect monitoring and control were not being followed meticulously in the organization.

3.1.7 Before complete information from the airline could be obtained regarding repeated weather radar related snags, the aircraft was deregistered and returned to the lessor without DGCA or Airline obtaining clearance from AAIB.

3.1.8 Crew were able to observe weather physically as well as on the Navigation Display and necessary announcements to the cabin crew and passengers were made.

3.1.9 As announcement from flight deck was made for all crew and passengers to be seated, cabin crew did not get sufficient time to ascertain if passengers beyond 08th row had their seat belt fastened.

3.1.10 The action of cockpit crew were more inclined towards weather penetration rather than weather avoidance.

3.1.11 The seat belts were functional and serviceable during the flight.

3.2 Probable causes of the accident

Accident was caused by the poor CRM and decision making on part of crew to penetrate bad weather and not maintaining specified separation from turbulence prone weather.

Due to insufficient time for securing cabin, the cabin crew could not ascertain if all passengers had seat belts ON. Passenger not complying with seat belt instructions led to avoidable injuries as aircraft encountered severe turbulence.

4. Safety Recommendations

4.1 Operator should ensure that procedure for Recurring defect monitoring and control is followed in letter and spirit.

4.2 DGCA, Airport Operators and Airlines should conduct campaigns to raise awareness about importance of seatbelts amongst passengers travelling by air.

4.3 DGCA should ensure that its officers follow the procedure laid in APM for obtaining clearance from AAIB during de-registration of aircraft.

Date: 25 Feb 2025

5. Appendices

Appendix A

Details of Wx Radar related snag reported on the aircraft before and after the occurrence.

DATE	DESCRIPTION Defect Reported	Maintenance Action Taken
14.APR.2022	RECEPTION OF WX RADAR IS POOR. TEST MODE ON GROUND IS SAT	WEATHER RADAR TRANSCEIVER REMOVED. CONNECTORS CLEANED AND FITTED BACK (AMM 34-43-41 REFERRED). FURTHER WEATHER RADAR MOUNT FILTER CLEANING CARRIED OUT AS PER AMM 34-43-09. OPS TEST OF WEATHER RADAR SYSTEM CARRIED OUT, FOUND SATISFACTORY. AIRCRAFT CLEARED FOR FURTHER FLIGHT.
30.APR.2022	WX RADAR NOT DISPLAYING WX.	WEATHER RADAR OPERATIONAL TEST AS PER AMM 34-43-00 REV 77B SATISFACTORY, AIRCRAFT RELEASED FOR FLIGHT.
30.APR.2022	PDR REFER TLP6032/26 WXR IS SERVICABLE BUT NOT DISPLAYING IN AIR	WXR R/T UNIT CONNECTION CLEANED, OPERATIONAL CHECK C/0 AS PER AMM, FOUND SATISFACTORY, HENCE PDR CLEARED.
10.MAY.2022	WX RADAR NOT PICKING UP CLOUDS, ON GND TEST MODE IS OK	WXR OERATIONAL CHECK CARRIED OUT AS PER 34-43-00-710-802, FOUND DISPLAY TEST AND PATTERN SATISFACTORY GAIN AND MODE CHECK CARRIED OUT ON GROUND, DISPLAY FOUND SATISFACTORY ON GROUND. PRECAUTIONARY WEATHER RADAR ANTENNA FLAT PLATE REPLACED AS PER AMM 34-43-11. REV 77B, 15 APR 2022, OPERATIONAL TEST CARRIED OUT, FOUND SATISFACTORY. OFF UNIT GIVEN HOLD ON TAG TAG.
11.MAY.2022	WHILE CARRYING OUT WEATHER RADAR TEST, GOT THE THAT RT WEAK	WEATHER RADAR OPERATIONAL TEST CARRIED OUT AS PER AMM TASK 34-43-00-710-803-002, (REV 77B DT 15 APR 2022) FOUND PWS FAIL. WXR FAIL AND RT WEAK FAULT MESSAGES FIM 34-43-801,802 AND 815 REFERRED. WEATHER RADAR TRANSCEIVER REMOVED, CONNECTOR CLEANED AND FITTED BACK (AMM TASK 34-43-41-000/400-801 REFERRED). FURTHER WEATHER RADAR DRIVE UNIT REPLACED AS PER AMM TASK 34-43-11-000/400-802. POST INSTALLATION OPERATIONAL TEST CARRIED OUT, FOUND NIL FIX. FURTHER WEATHER RADAR DRIVE UNIT REPLACED AS PER AMM TASK34-43-11-000/400-802. POST INSTALLATION OPERATIONAL TEST CARRIED OUT, FOUND NIL FIX. WEATHER RADAR TRANSCIEVER REPLACED WITH SERVICEABLE ONE AS PER AMM TASK 34-43-41-000/400-801. POST INSTALLATION CHECK CARRIED OUT. FOUND SATISFACTORY. NO FAULT MESSAGES OBSERVED. AIRCARFT CLEARED FOR FURTHER FLIGHT.
22.MAY.2022	DURING APPROACH PHASE, PWS FAIL AND WXR FAIL ANNUNCIATED ON ND	SNAG CONFIRMED, WEATHER RADAR TEST FAILED WITH PWS FAIL ON ND

		WEATHER RADAR SYSTEM BITE CARRIED OUT ON R/T UNIT AS PER FIM 34-43 TASK 801, REV 77B, FOUND FOLLWING FAULTS CODES: BAD STAB AZ RATE DIS LABEL ERROE XRNG_1 N/R XRNG_2 N/R XRNG_3 N/R XRNG_ 4N/R *FIM 34-83 TASK 803 FOLLOWED FOR MSG ”BAD STAB AZ RATE” AND FIM 34-*43-TASK 802 FOLLOWED FOR REST OF THE MSG. *WX RX TXRX REMOVED CLEANING AND FITTED BACK AS PER AMM 34-43-41 REV 77B. POST INSTALLATION WXRX REST C/O, TEST FAILED. *OBSERVED TX NOT POWERING UP (TEST NOT INITIATED) *WXRX MOUNT BLOWER OPT C/O FOUND WORKING SAT. FURTHER T/S TO BECARRIED OUT. ACTION 2: FURTHER WIRING CHECK C/O AS WDM 34-41-11 REV 52 SHEET 4, *CHECKED CONTINUITY BETWEEN WXRX TXRX AND WXRX CONTROL PANEL AFTER REMOVING UNIT: D193 D189 PIN PIN DD8 VB6 LD6 MD7 H-B7 J-B8 ATO GND FOUND CONTINUITY IN ABOVE ALL, FOUND SAT, GVI PF CONMECTOR D193 AND D 189B CARIED OUT, FOUND SAT, ALL PINS, INTACT. *WXRX TXRX AND CONTROL PANEL INSTALLED BACK. *SUSPCTED WXRX TXRX UNIT FAULTY . OTHER T/S TO BE CARRIED OUT. ACTION 3: PDR AS PER PREVIOUS T/S CARRIED OUT SUSPECTED WEATHER RADAR R/T UNIT FAULTY SAME REPLACED WITH S ONE AS PER AMM 34-43-31 REV 77B. POST INSTALLATION OPERATION TEST CARRIED OUT FOUND NO FAULTS. NO FAI MESSAGE OBSERVED. NO ABNORMALITIES OBSERVED. R/T UNIT FRONT PANEL BITE C/O FOUND NO FAULTS. AS THE INSTALLED R/T UNIT DOES NOT SUPPORT AUTO TILT FUNCTION, HENCE AUTO TILT FUNCTION C/F UNDER MEL 34-15-04 CAT -C VALID TILL 26-05-2022 MIDNIGHT. CREW BRIEFED COCKPIT PLACARDED.
23.MAY.2022	WXR PAINTING ERRATIC REFER TLP@ 229/033 ITEM#1	ACTION 1: OPERATIONALTEST CARRIED OUT ON AS PER AMM REF: 34-43-00. SAME FOUND SATISFACTORY. HOWEVER DUE

	PDR : "WXR RADAR PAINTING ERRATIC EVEN IN MANUAL MODE MAX GAIN (LINE OF SQUALL OBSERVED VISUALLY BUT NOT PAINTE ON ND) EVEN AT DIFFERENT TILTS,"	REPEATED REPORTS OF INACURATE WEATHER REPLIES WX RADAR AND PWS SYSTEM DECLARED INOP VIDE MEL 34-15-01B CAT 'C' VALID TILL 01.06.2022 MIDNGHT. CRW BRIEFED AND COCKPIT PLACARDED. ACTION 2: PDR : WXR PAINTING ERRATIC WEATHER RADAR ANTENNA DRIVE UNIT CONNECTIONS FOUND DIRTY. SAME CLEANED W.R.T. AMM 34-43-11. POST CLEANING WEATHER RADAR OPERATIONALTEST CARRIED OUT AS PER AMM 34-43-00. FOUND SATISFACTORY.MEL REVOKED. A/C NORMALISED.
28.MAY.2022	WXR RADAR NOT PAINTING/ DISPLAYING WXR PROPERLY	ACTION 1: WXR RADAR DEFECT CF IAW MEL 34-15-01B, WXR SYS DECLARED INOP, DDPG COMPLIED, CAT C VALID TILL 06/06/2022. CREW BRIEFED, COCKPIT PLACARDED, AIRCRAFT RELEASED FOR FURTHER FLIGHT. ACTION 2: WXR RADAR TASK 34-43 TASK 801, FOLLOWED TEST CARRED OUT FOUND SATISFACTORY, NO MAINTENANCE MSG, FURTHER CB CYCLED AND LRU RERACKED POST INSTALLATION CHECK AND FOUND SATISFACTORY MEL 34-15-01B REVOKED, CREW BREIFED AND PLACARDING REMOVED.
15.JUNE.2022	WXR RETURNS FOR ACTIVE CELL AT 40 NM WXR RADAR UN RELIABLE	WXR TEST CARRIED OUT ON GROUND SHOWS NO FAULTS, FIM 34-43 TASK 801 SATISFACTORY
22.JUL.2022	WXR SUBOPTIMAL PERFORMANCE OF WXR RADAR ONLY STRONG /LARGE CONNECTIVE BUILD UP DETECTED WITH MAC GAIN PERFORMANCE WITH MAX GAIN AND TILT PERFORMANCE ADJUSTMENT SETTING	BITE CHECK OF WXR SYSTEM CARRIED OUT AS PER FIM 34-43 TASK 801 TEST PATTERN SATISFACTORY. WXR TESTED ON GROUND RETURN FOUND SATISFACTORY. COMPUTER CLEANED AND RERACHED.
24.JULY.2022	WEATHER RADAR TEST ON GROUND IS SATISFACTORY. IN THE AIR TILT NEEDS TO BE RE-CALIBRATED, TILT SELECTED -2 BELOW REQUIRES SHOWS WEATHER. GAIN IS WEAK. NO DIFFERENCE IN GAIN IN AUTO/MAX GAIN. RADAR PICKS LARGE CB CLOUDS AS SMALL CB.	WEATHER RADAR CONTROL PANEL REMOVED, CONNECTIONS CLEANED AND FITTED BACK (AMM TASK 34-43-91-000/400-801 REFERRED). WEATHER RADAR TRANSCEILVER REMOVED, CONNECTORS CLEANED AND FITTED BACK (AMM TASK34-43-41-000/400-801 REFERRED). WEATHER RADAR MOUNT BLOWER FILTER CHECKED FOR CLOGS, FOUND SATISFACTORY. OPERATIONAL TEST OF WEATHER RADAR CRRIED OUT AS PER AMM 34-43-00-710-803-002, FOUND SATISFACTORY. AMM REV 78A DATED 15 JULY 2022 REFERRED.
28.JUL.2022	PDR W/X RADAR NOT WORKING PROPERLY	PDR WETHER RADAR (WXR) SYSTEM OPERATIONAL C/O IAW 4-43-00 FOUND SAT. NO FAULT MESSAGE OBSERVED.

		WEATHER RADAR R/T MOUNT FILTER REMOVED CLEANED AND INSTALLED BACK IAW AMM 34-43-09. WEATHER RADAR/ RECIEVER/TRANSMITTER REMOVED CONTACTS CLEANED AND INSTALLED BACK IAW AMM 34-43-41. WEATHER RADAR (WXR) SYSTEM OPERATIONAL TEST C/O IAW AMM 34-43-00 FOUND SAT. NO FAULT MESSAGE OBSERVED. A/C NORMALISED. AMM REV 78A, 15 JULY 2022
30.JUL.2022	PDR 1.WEATHER RADAR NOT PAINTING WEATHER UNRELIABLE WEATHER INFORMATION WEATHER RADAR TEST ON GROUND SATISFACTORY.	TROUBLESHOOTING AND FAULT ISOLATION-PREVENTIVE MAINTENANCE REPLACE WEATHER RADAR WAVE GUIDE FIM 34-43 TASK 802 FOLLOWEDWEATHER RADAR OPERATION TEST CARRIED OUT IAW 34-43-00 FOUND OPERATION TEST PASSED. WEATHER RADAR WAVE GUIDE REMOVED IAW AMM 34-43-21 P/N 10-60897-69 AND P/N 10-60897-70. WEATHER RADAR WAVE GUIDE INSTALLED IAW 34-43-21. P/N 10-60897-69 AND P/N 10-60897-70. POST INSTALLATION OPERATION TEST OF WEATHER RADAR ON GROUND CHECKED IAW AMM 34-43-00 FOUND SATISFACTORY.
13.AUG.2022	PDR 1 – RADAR TILT NEED CALIBRATON, -2 FROM CURRENT TILT SHOWS LITTLE WEAKER. 2 – CONTROL OF AUTO AND TILT IS SAME NO CHANGE. 3 – PITCH VERT LITTLE WEATHER 4 – GROUND TEST SATISFACTORY	PDR WX RADAR TRANSRECIVER BITE TEST CARRIED OUT 34-43 TASK 801 FOUND NO FAULT, GROUND TEST PASSED, HOWEVER AS A PRECAUTIONARY MEASURE WX RADAR CONTROL PANEL REPLACED WITH SERVICABLE 34-43-91, POST REPLACEMENT WX RADAR OPERATION CHECKED A PER AMM 34-43-00-710-001 FOUND SATISFACTORY. A/C CLEARED FOR FURTHER FLIGHTS.
14.AUG.2022	REFER AIRCRAFT TECHNICAL LOG 152/ 008 ITEM 3: “NO PICKUP ON WEATHER RADAR DESPITE VISIBLE LIGHTNING OF CB CELLS”	T/S CARRIED OUT AS PER FIM34-43 TASK 802. WEATHER RADAR (WXR) SYSTEM – OPERATIONAL TEST CARRIED OUT AS PER AMM TASK HENCE A/C CLEARED FOR FURTHER FLIGHT.
21.AUG.2022	REFER TLP #02/6419 WEATHER RADAR NOT PAINTING CORRECT PICTURE. BOTH ON AUTO GAIN MANUAL.	WEATHER RADAR SYSTEM OPERATIONAL TEST CARRIED OUT AS PER AMM 34-43-720-803-002. REV. 78A. TEST PASSED NO FAULT MESSAGE OBSERVED. HOWEVER WEATHER RADAR RECIEVER/TRANSMITTER REMOVED. CONTACTS CLEANED AND INSTALLED BACK AS PER AMM 34-43-41-000/400-801, REV. 78A. WEATHER RADAR SYSTEM OPERATIONAL TEST CARRIED OUT AS PER AMM 34-43-00-710-803-002,REV. TES PASSED. AIRCRAFT RESTORED TO NORMAL CONFIGURATION.

Appendix B

Weather images from Kolkata Doppler Radar and INSAT-3D

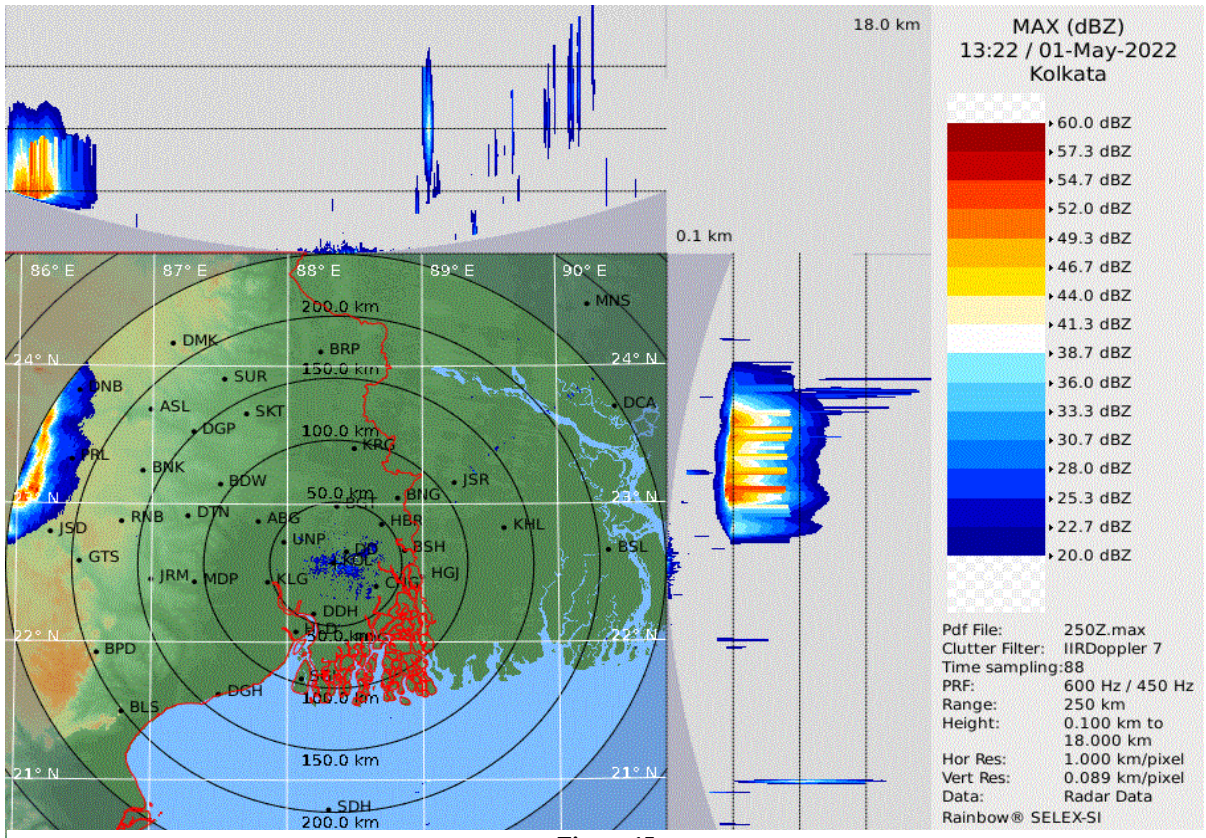


Figure 15

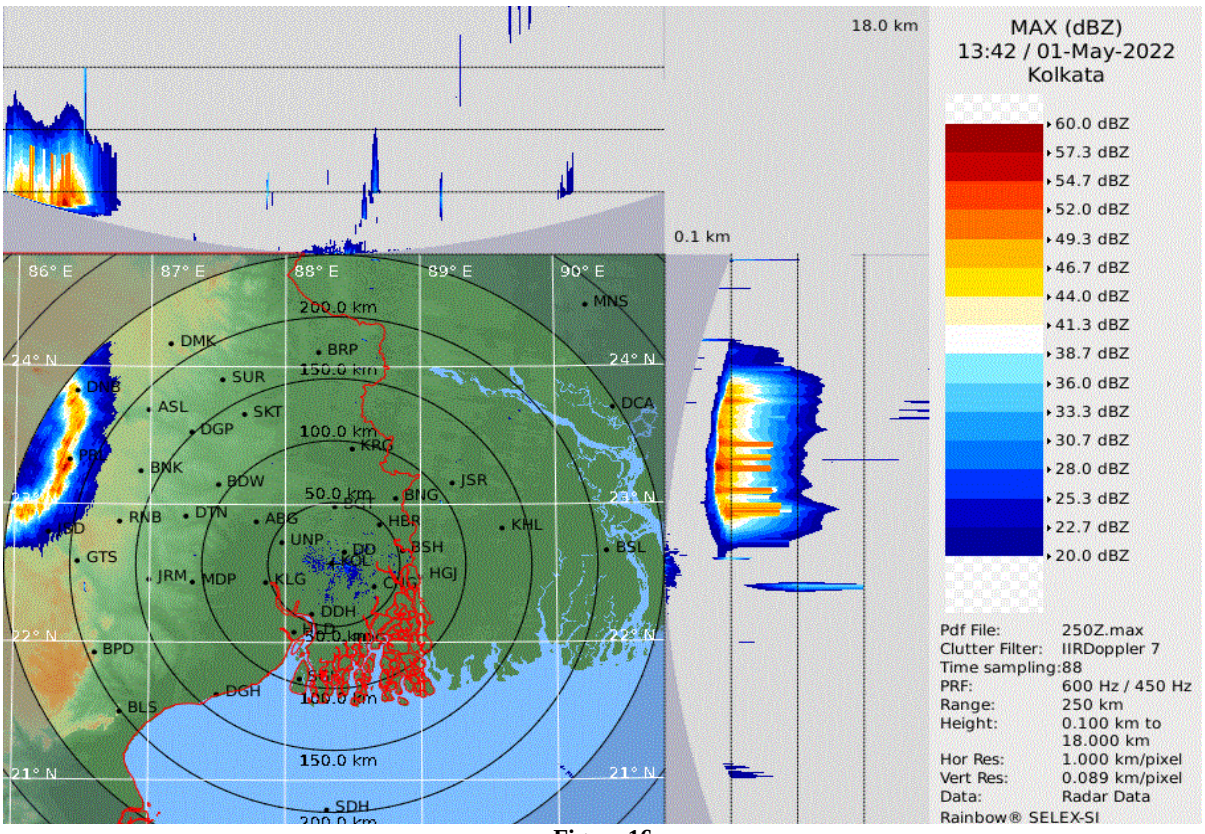


Figure 16

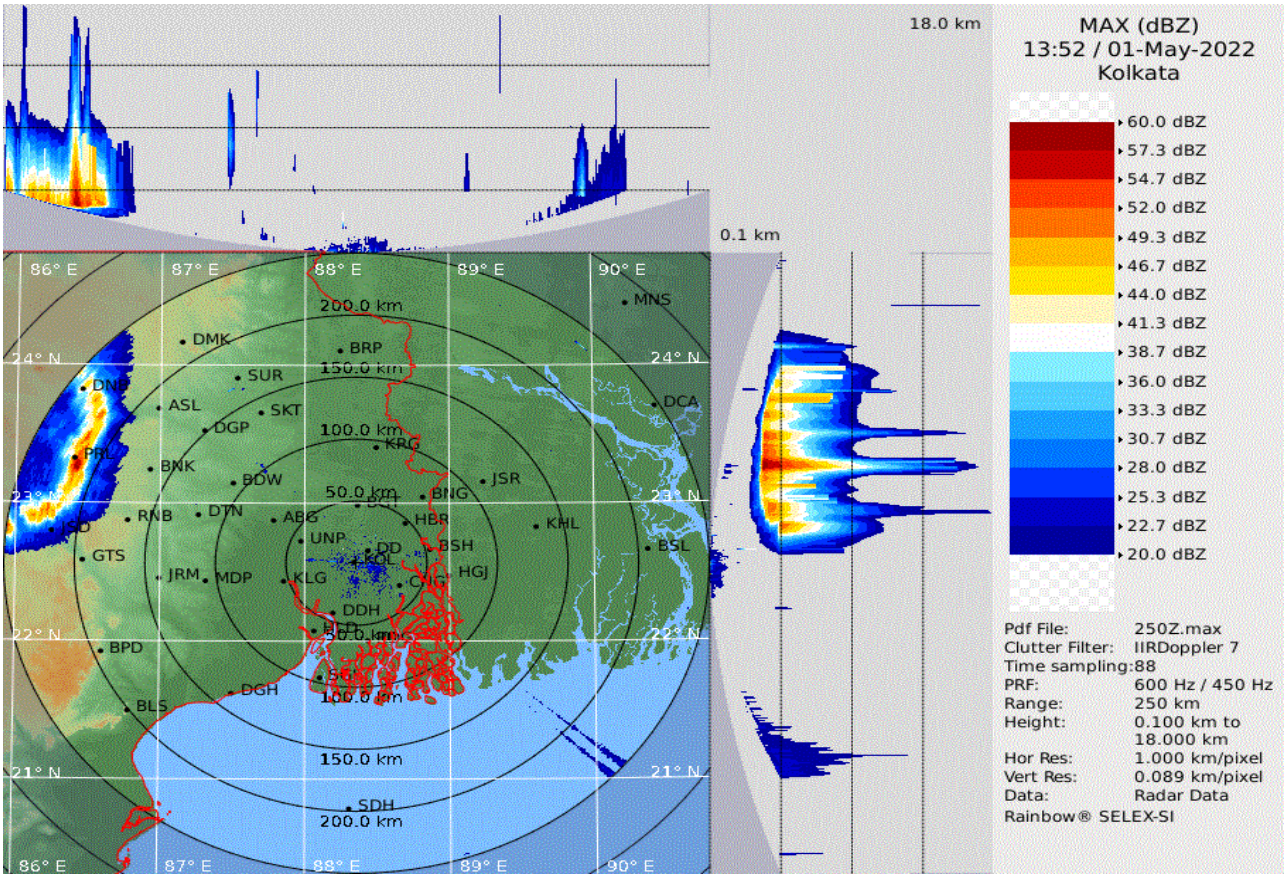


Figure 17

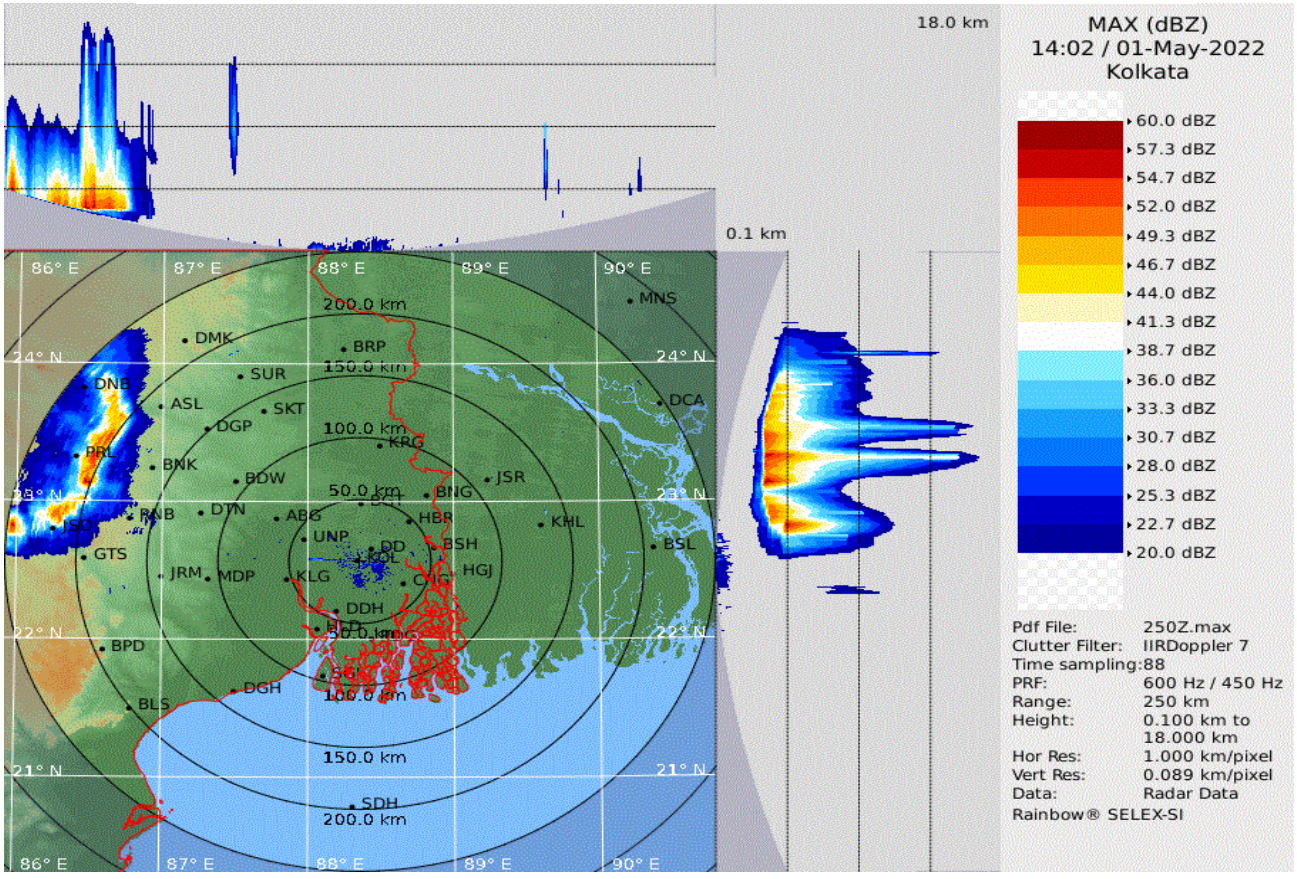


Figure 18

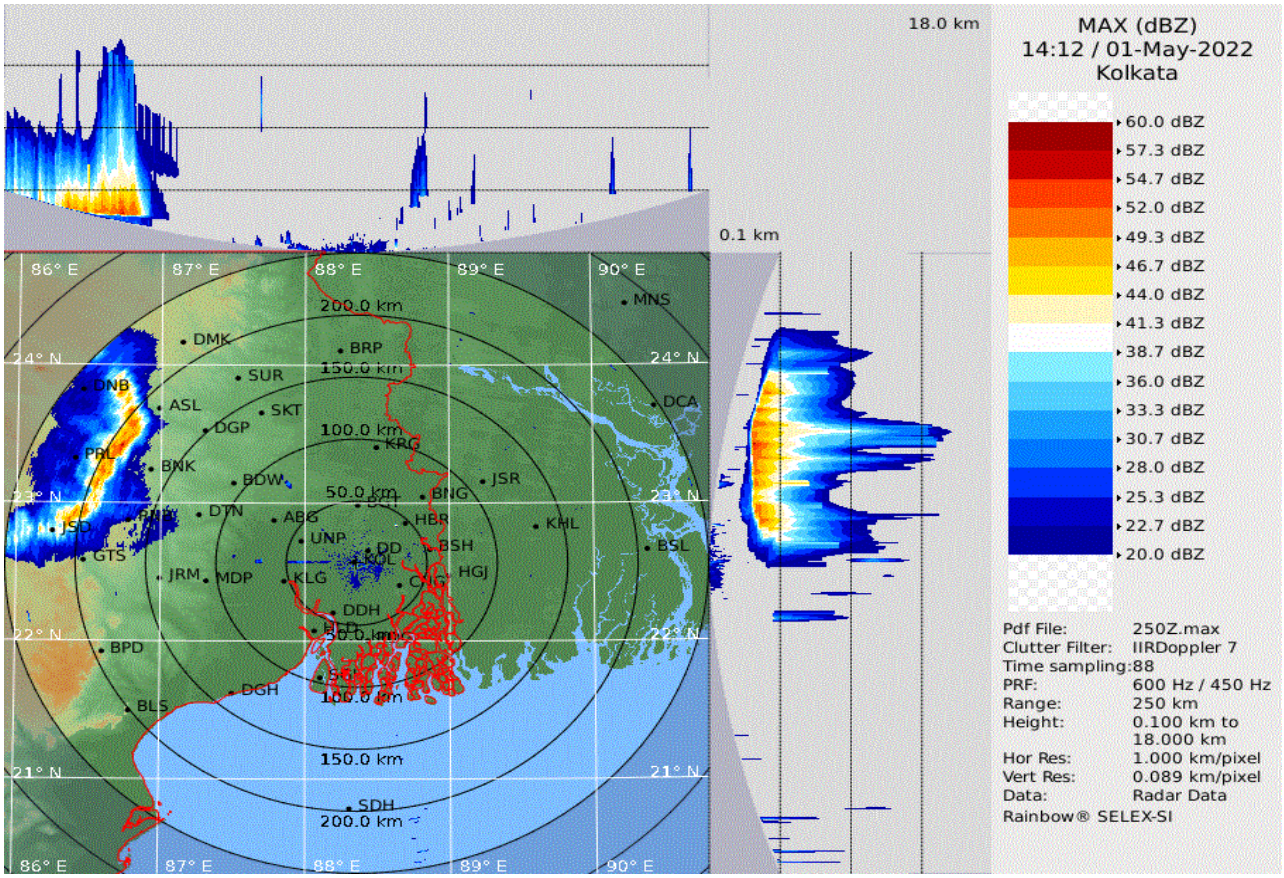


Figure 19

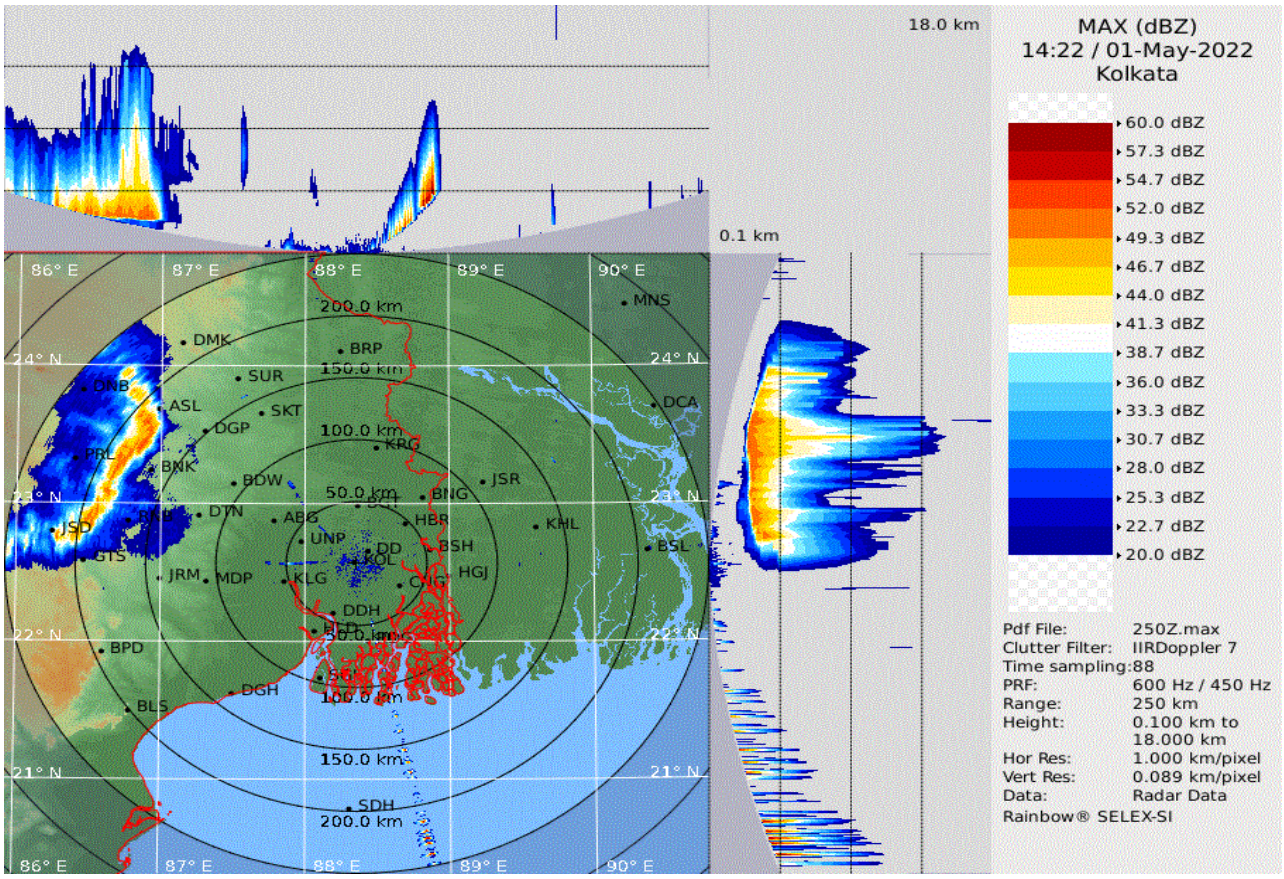


Figure 20

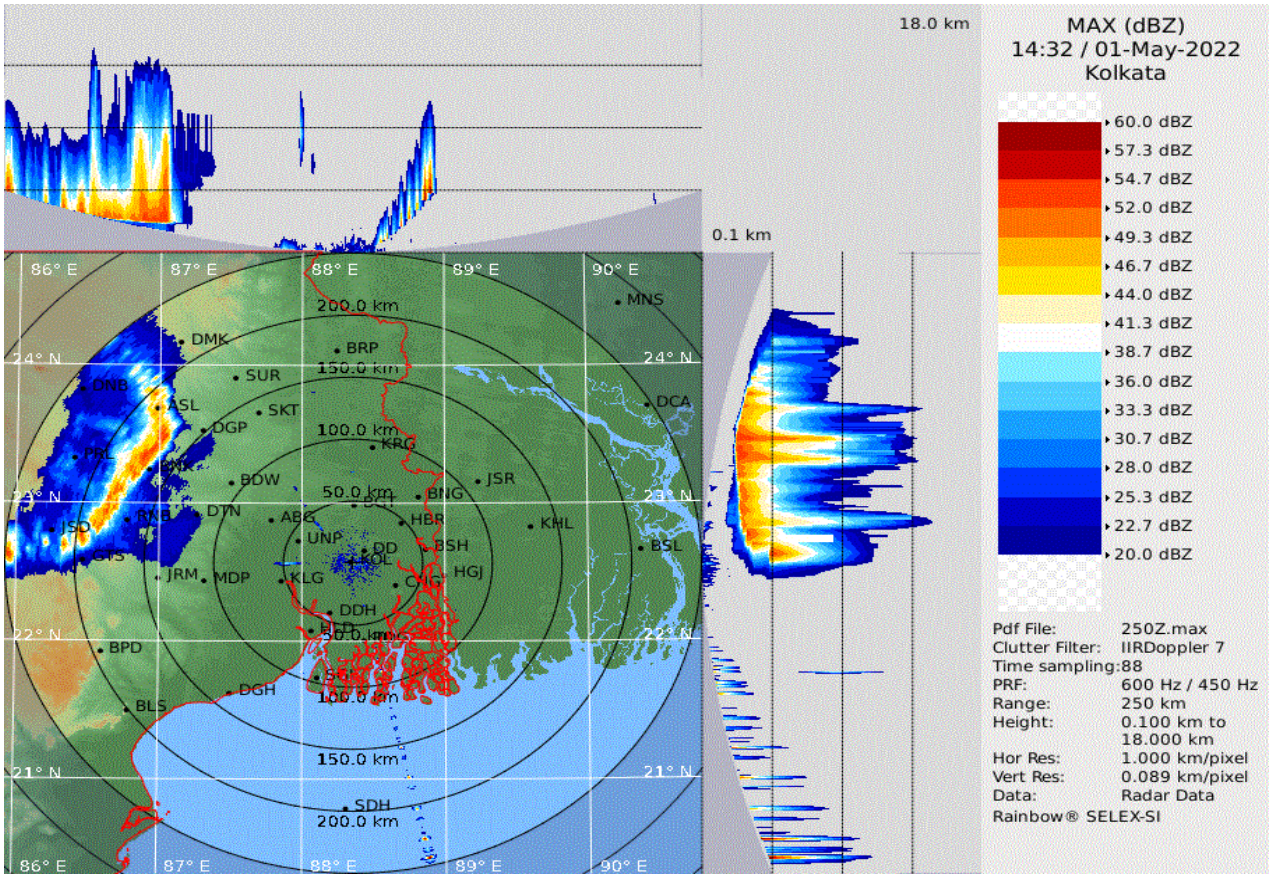


Figure 21

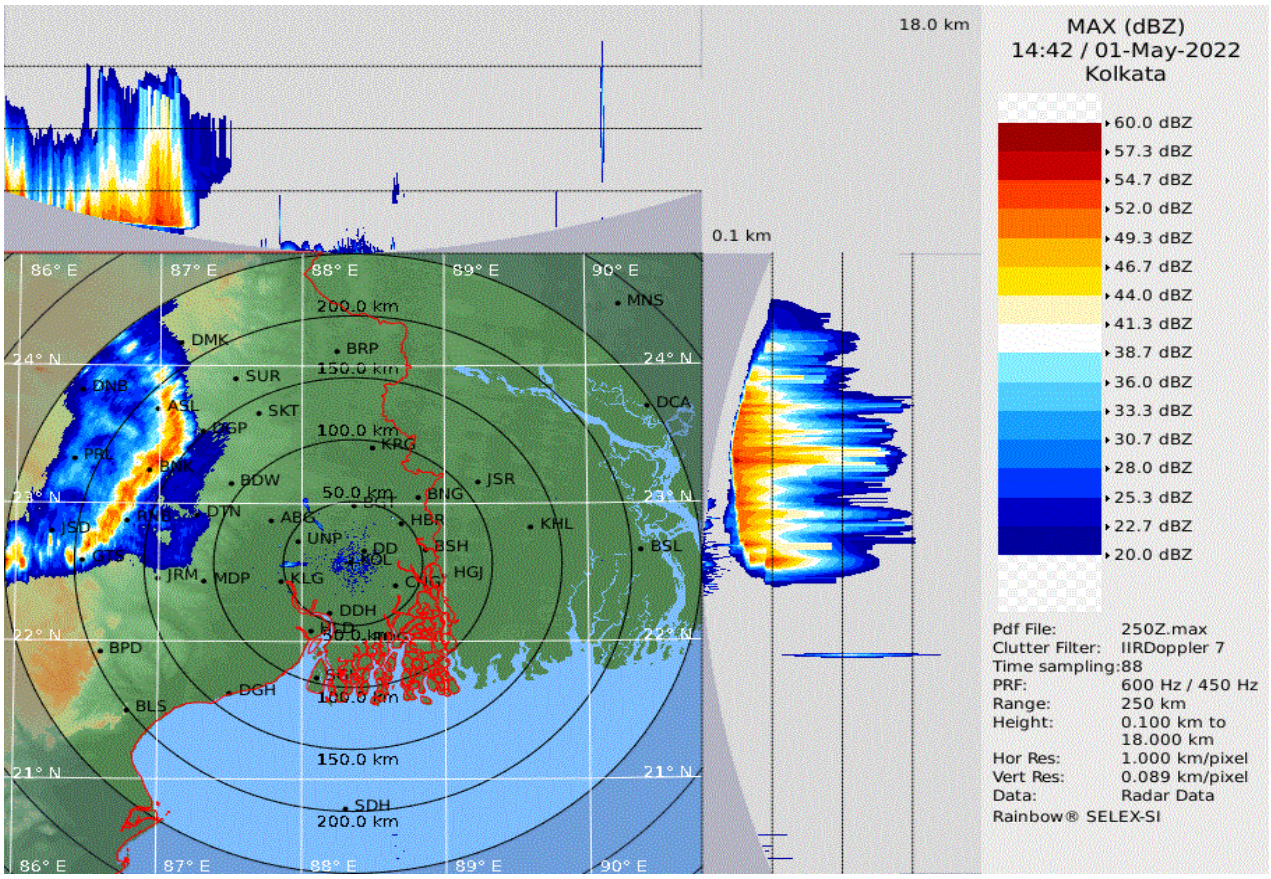


Figure 22

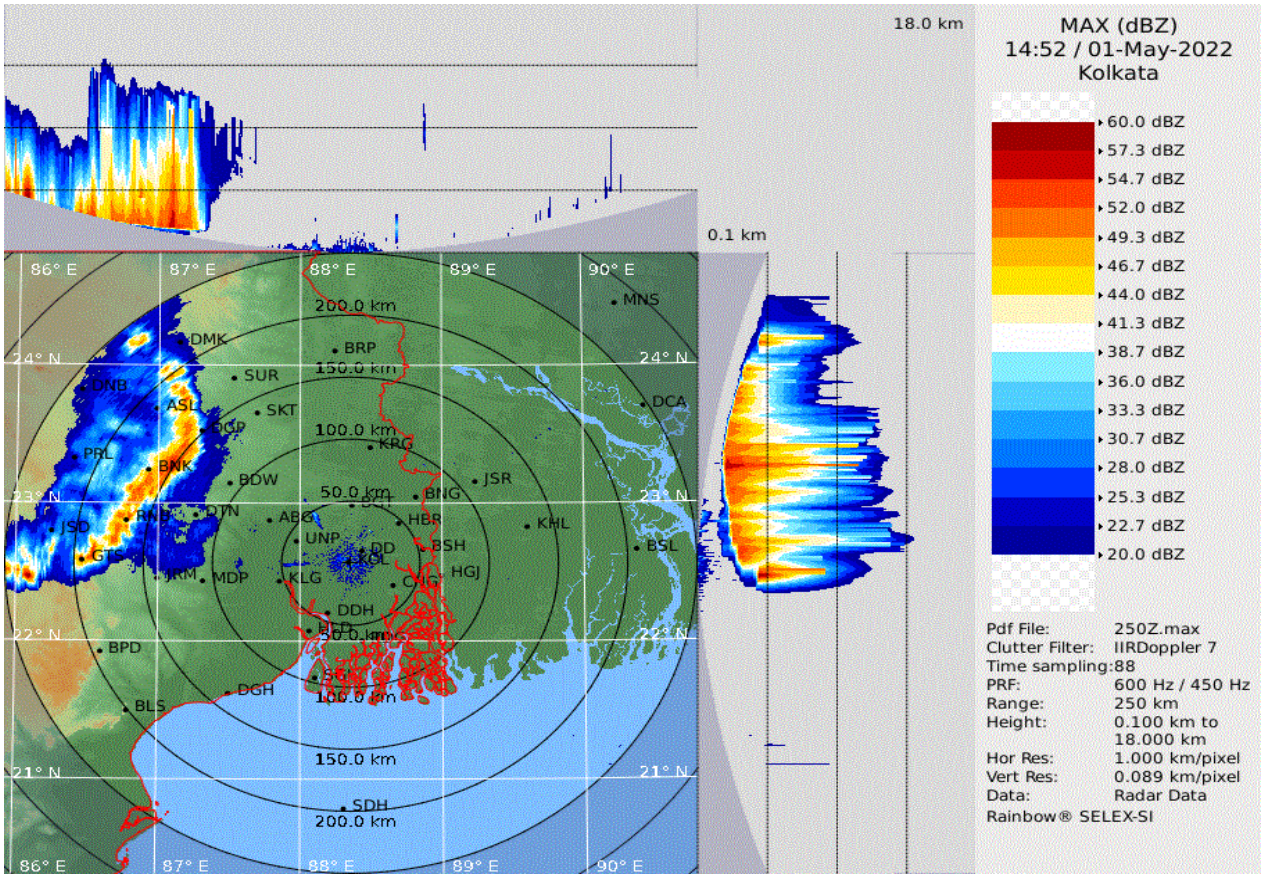


Figure 23

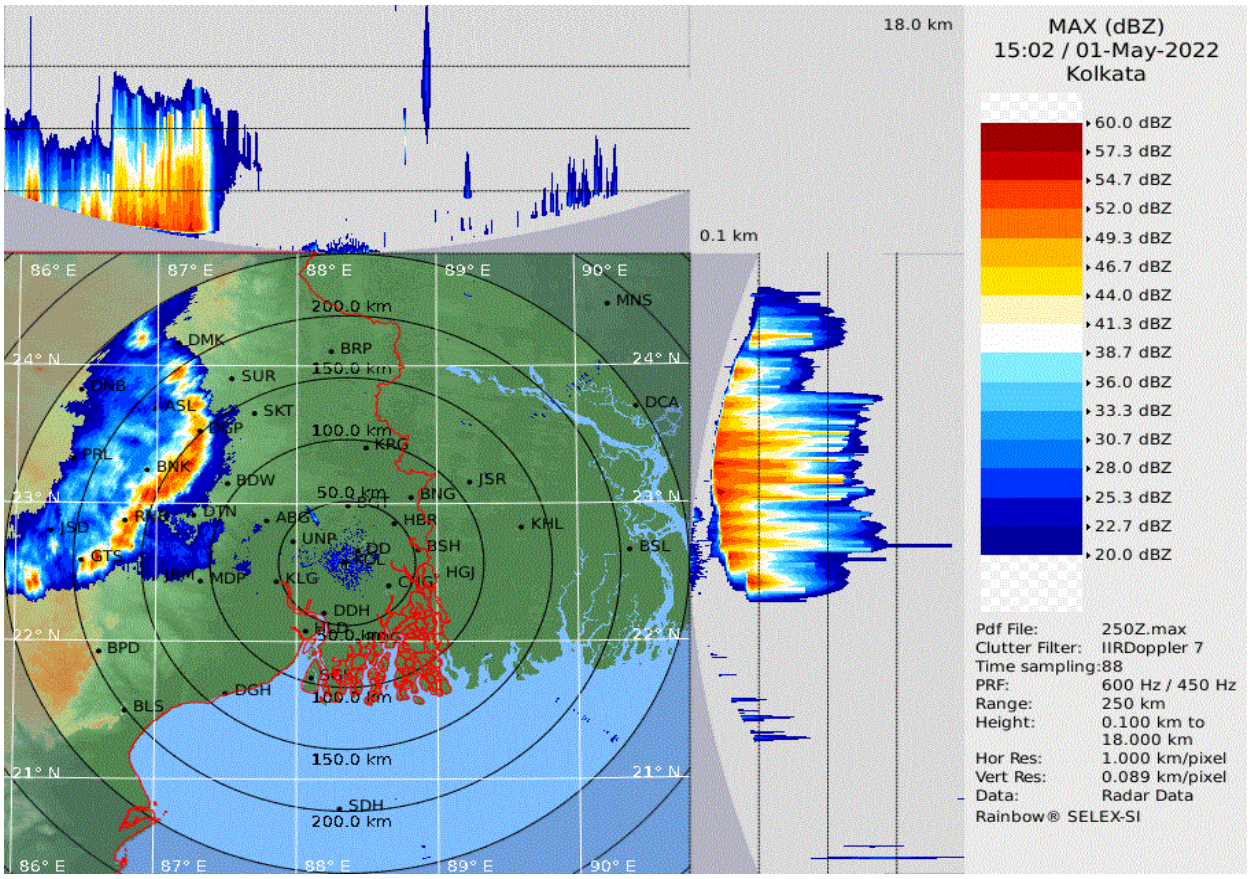


Figure 24

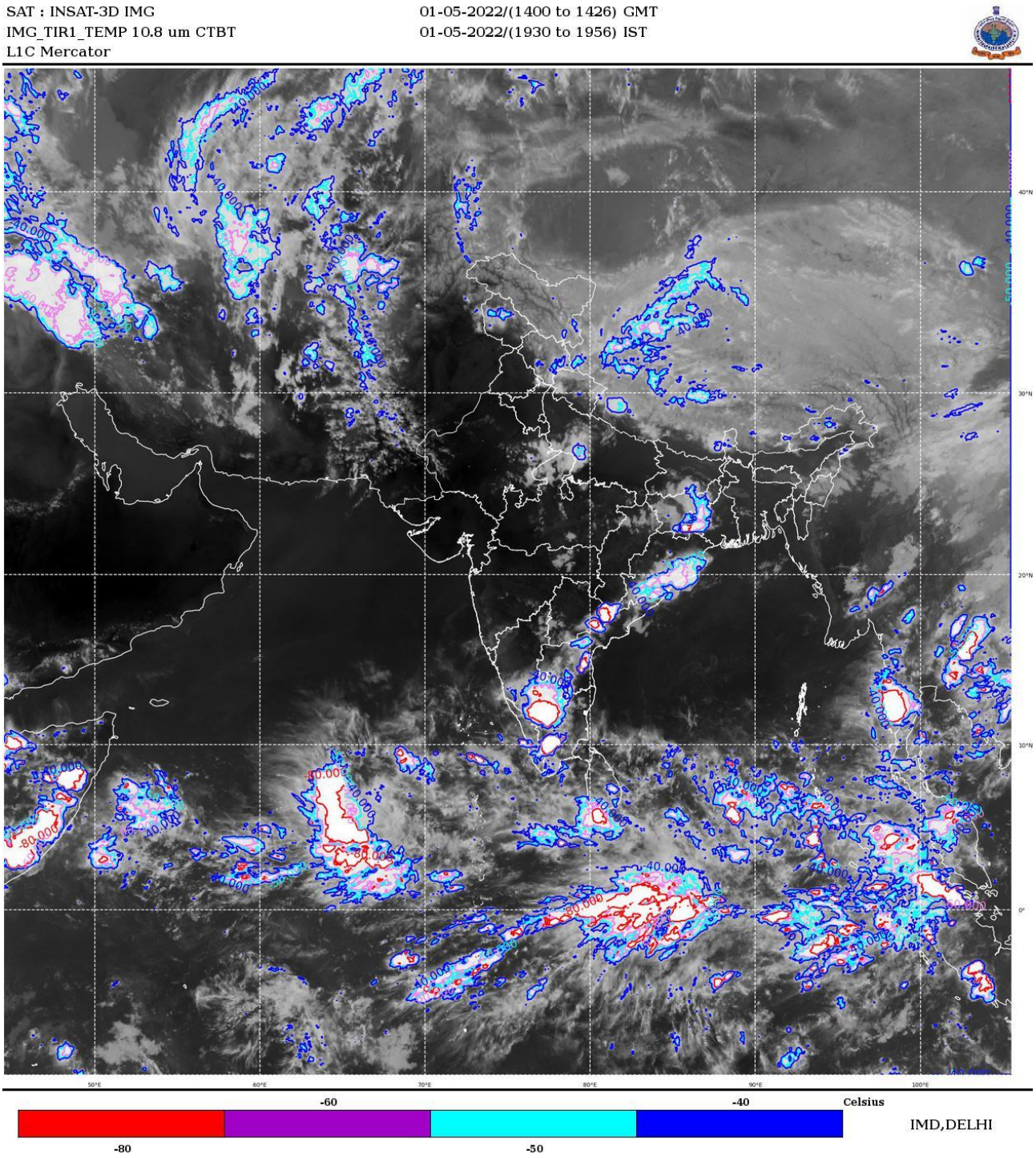

SAT : INSAT-3D IMG
IMG_TIR1_TEMP 10.8 um CTBT
L1C Mercator
01-05-2022/(1400 to 1426) GMT
01-05-2022/(1930 to 1956) IST
-60
-40
Celsius
-80
-50
IMD,DELHI

Figure 25

SAT : INSAT-3D IMG
IMG_TIR1 10.8 um
L1C Mercator

01-05-2022/(1400 to 1426) GMT
01-05-2022/(1930 to 1956) IST

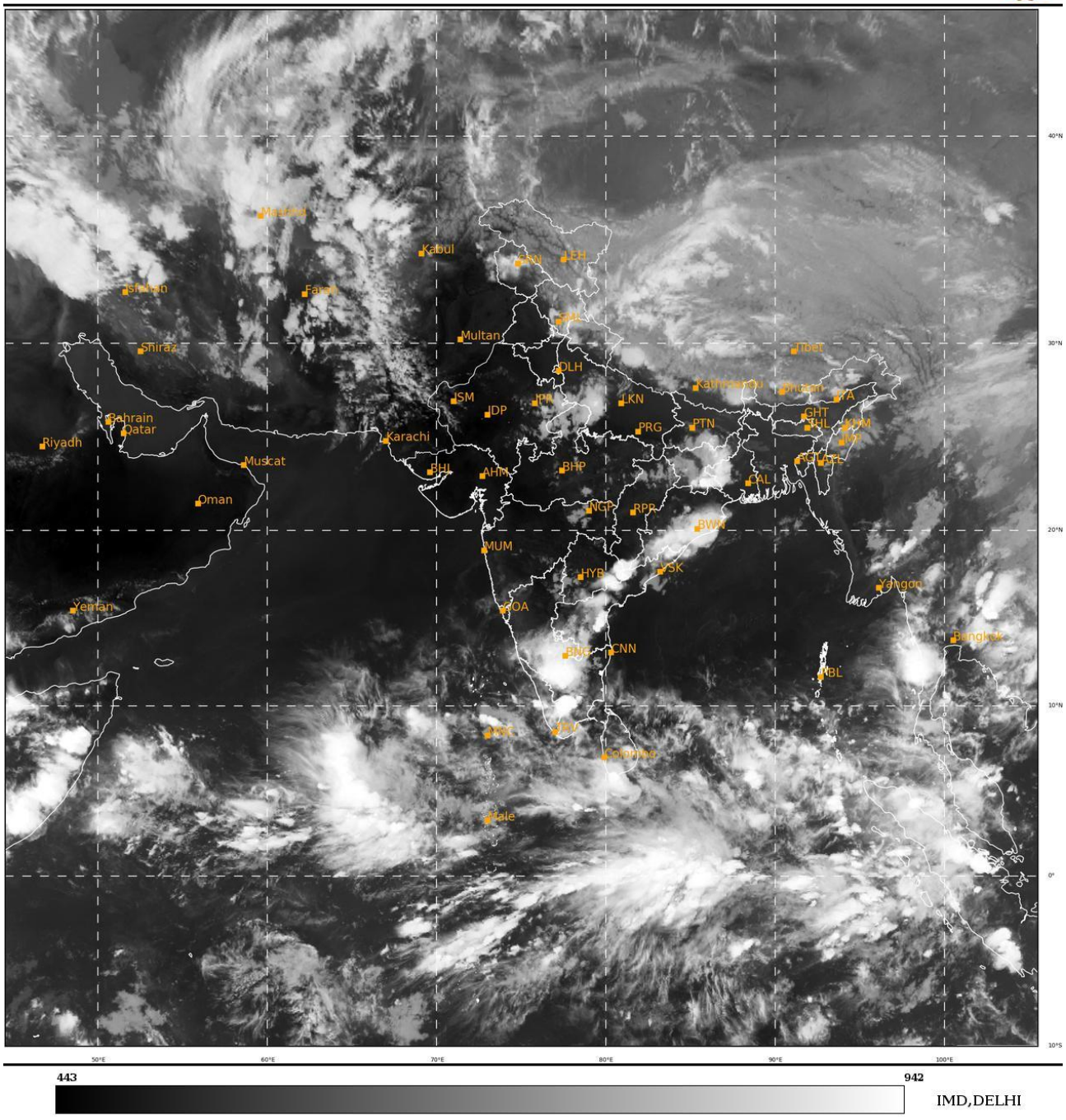
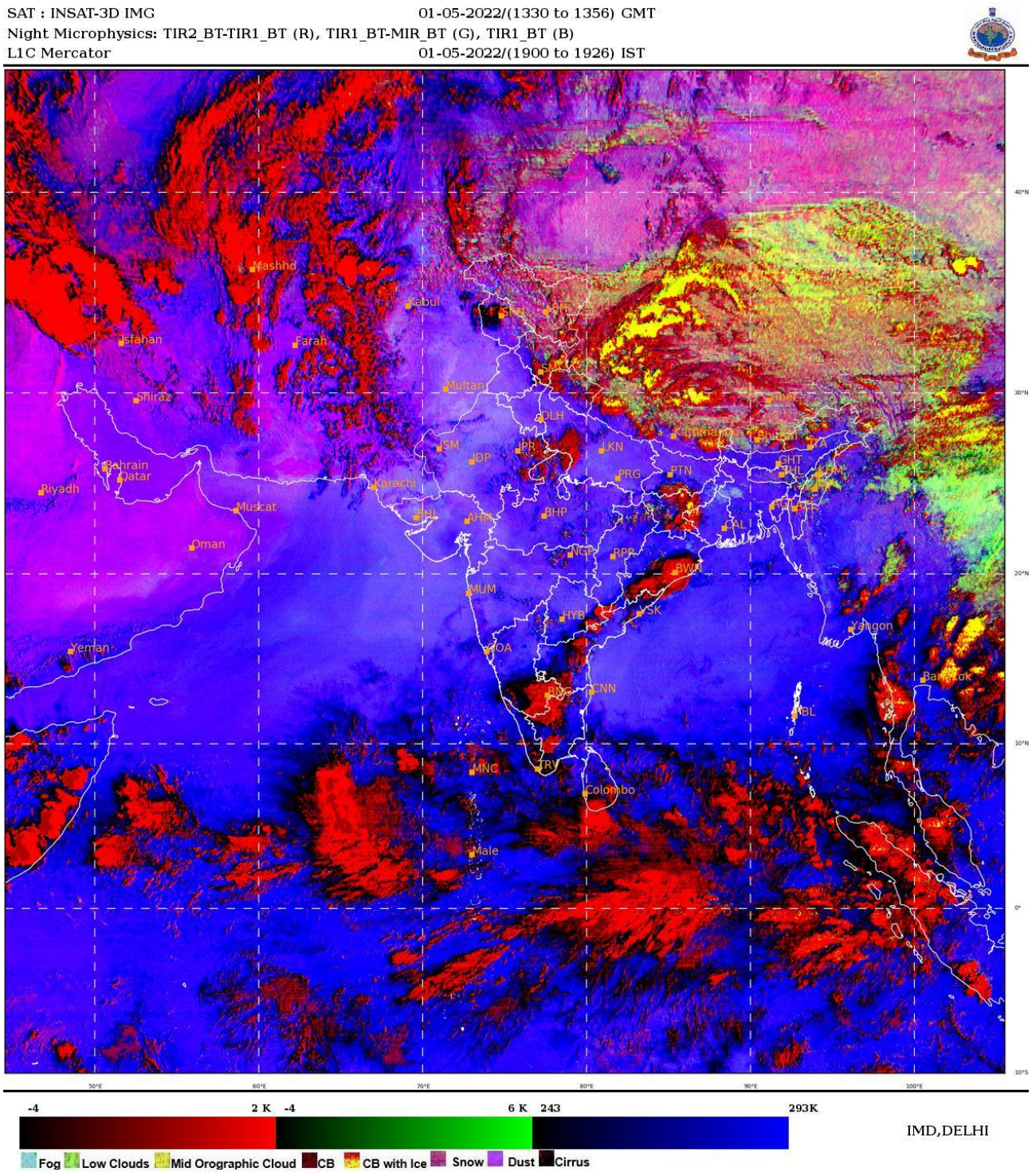


Figure 26


SAT : INSAT-3D IMG
01-05-2022/(1330 to 1356) GMT
Night Microphysics: TIR2_BT-TIR1_BT (R), TIR1_BT-MIR_BT (G), TIR1_BT (B)
L1C Mercator
01-05-2022/(1900 to 1926) IST
Mashhd
Kabul
Isfahan
Farah
Multan
Shiraz
DLH
Bahrain
Qatar
Riyadh
Karachi
Muscat
Oman
Yemen
MUM
HYB
GOA
MNG
Colombo
Male
Yangon
Bangkok
-4
2 K
-4
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Fog
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Mid Orographic Cloud
CB
CB with Ice
Snow
Dust
Cirrus

Figure 27

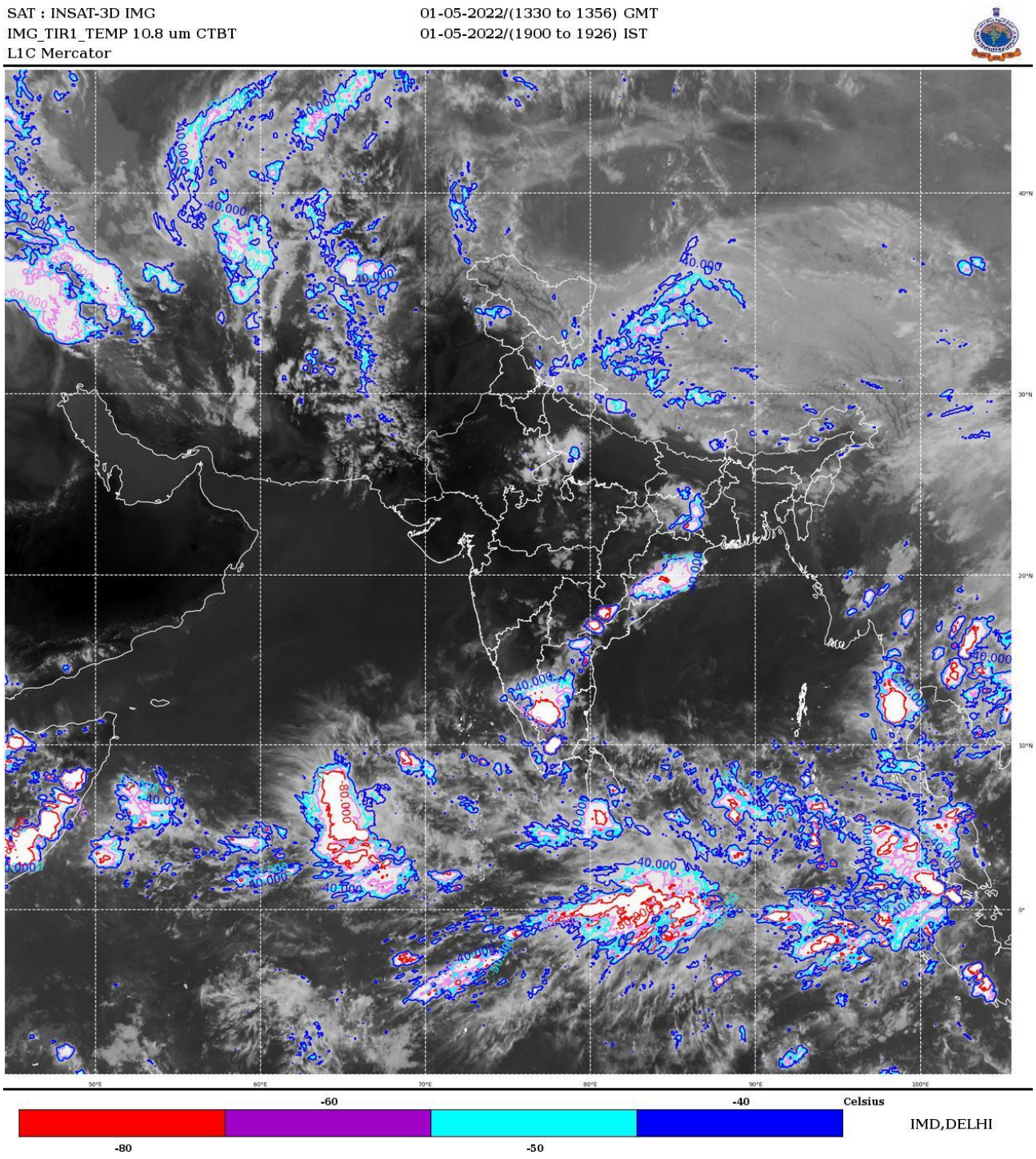
SAT : INSAT-3D IMG
IMG_TIR1_TEMP 10.8 um CTBT
L1C Mercator
01-05-2022/(1330 to 1356) GMT
01-05-2022/(1900 to 1926) IST
-60
-40
Celsius
-80
-50
IMD,DELHI

Figure 28

SAT : INSAT-3D IMG
IMG_TIR1 10.8 um
L1C Mercator

01-05-2022/(1330 to 1356) GMT
01-05-2022/(1900 to 1926) IST

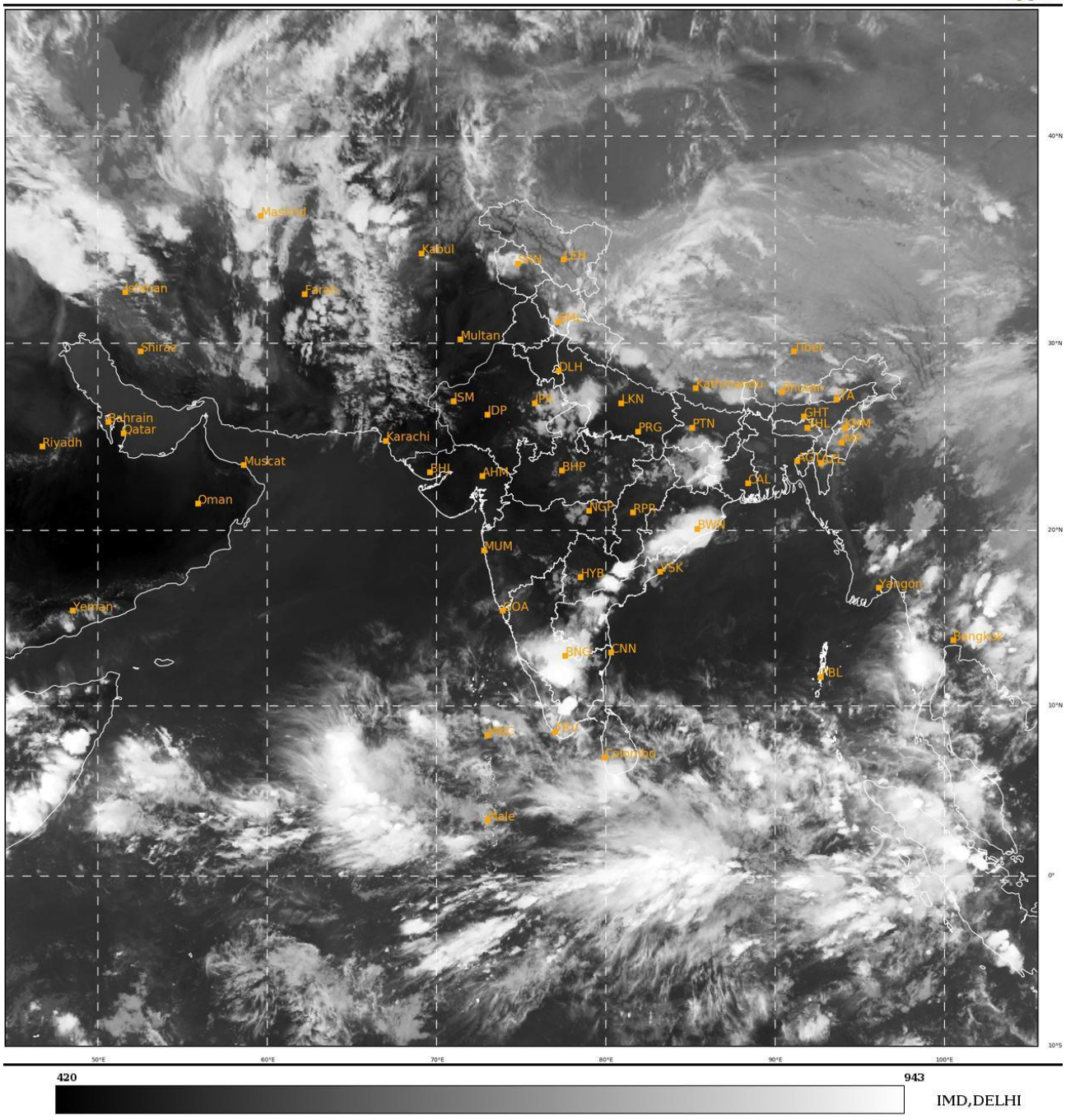

Figure 29

SAT : INSAT-3D IMG 01-05-2022/(1300 to 1326) GMT
Night Microphysics: TIR2_BT-TIR1_BT (R), TIR1_BT-MIR_BT (G), TIR1_BT (B)
L1C Mercator 01-05-2022/(1830 to 1856) IST

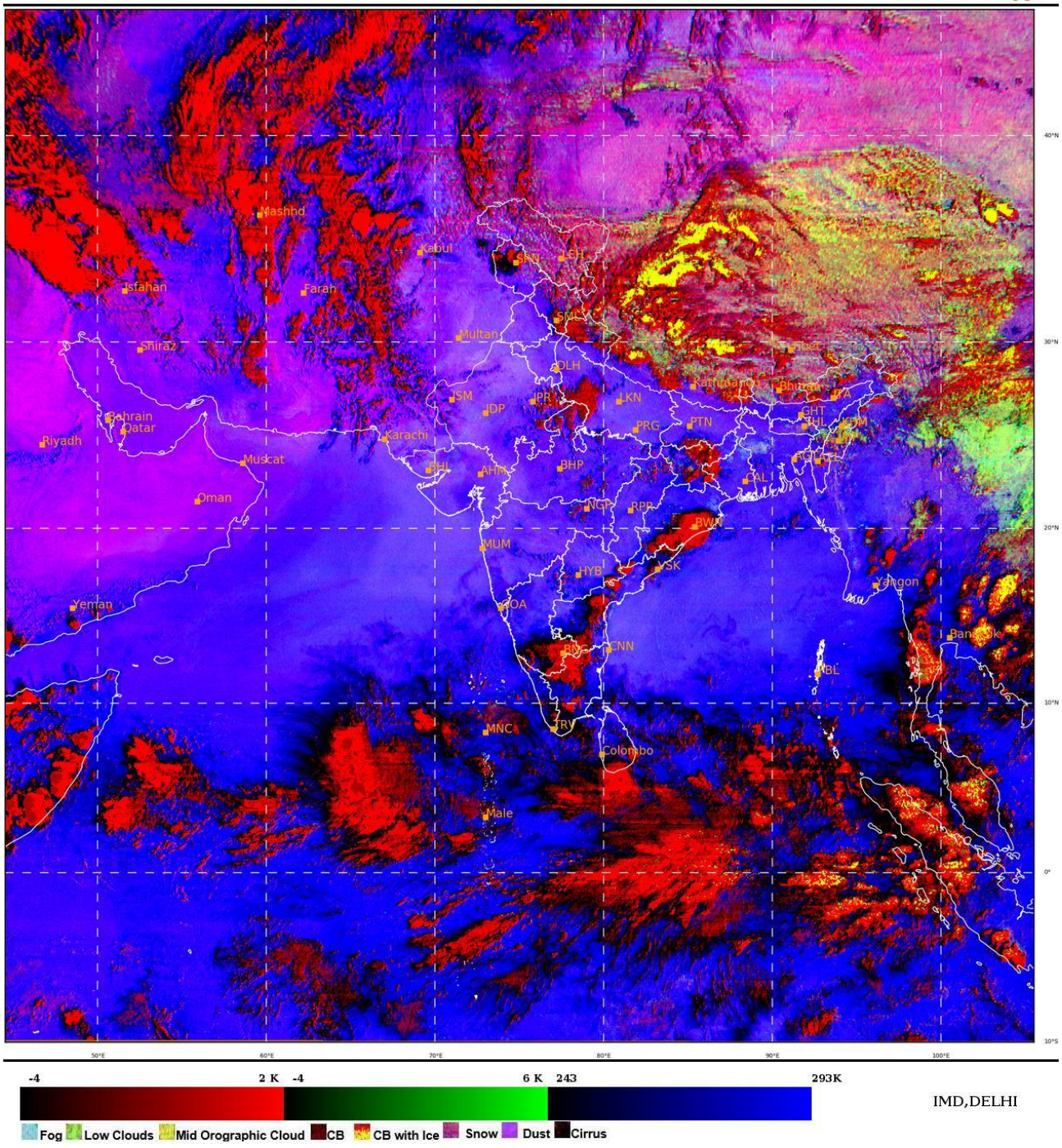

Figure 30

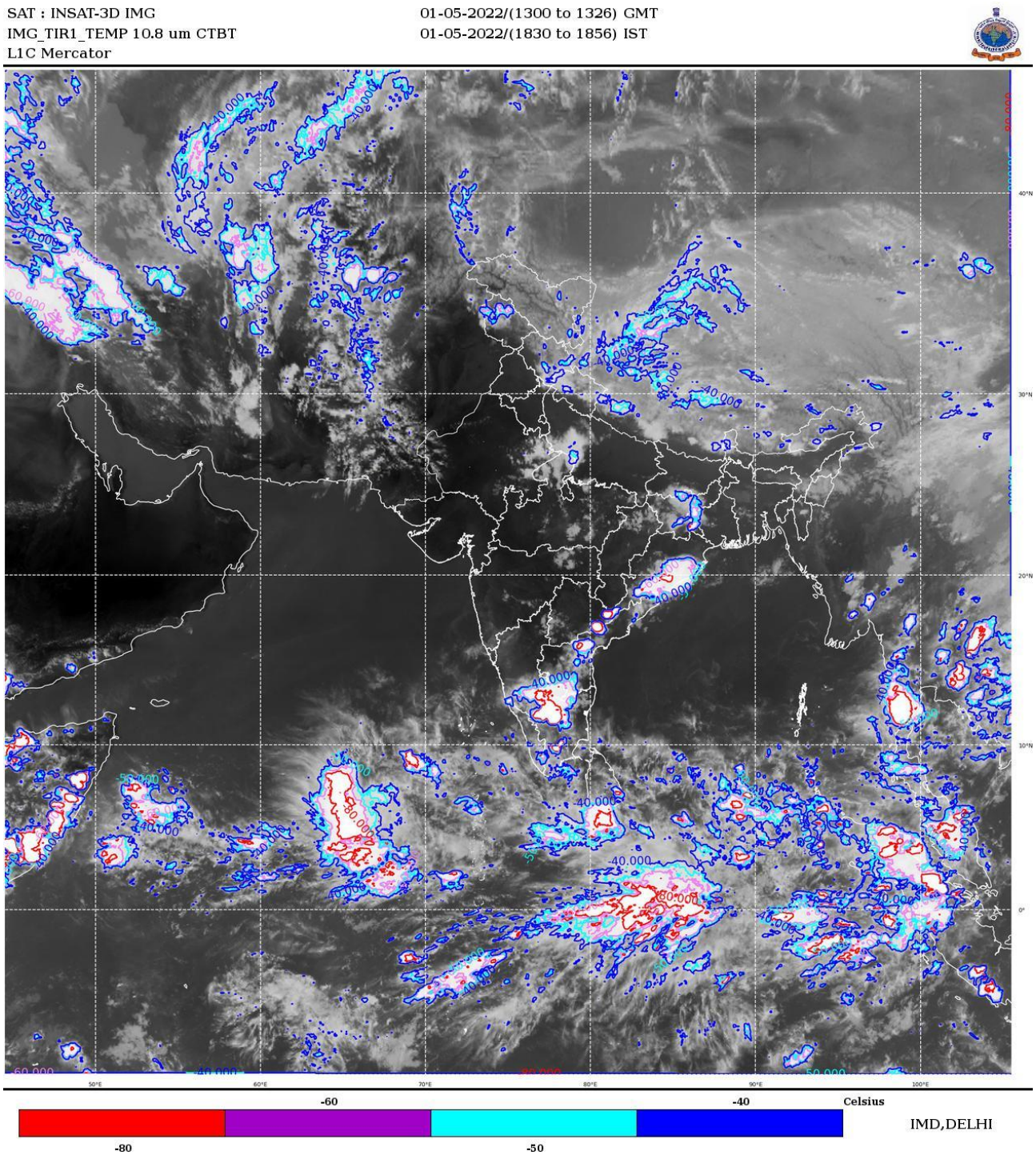
SAT : INSAT-3D IMG
IMG_TIR1_TEMP 10.8 um CTBT
L1C Mercator
01-05-2022/(1300 to 1326) GMT
01-05-2022/(1830 to 1856) IST
-60
-40
Celsius
-80
-50
IMD,DELHI

Figure 31

SAT : INSAT-3D IMG
IMG_TIR1 10.8 um
L1C Mercator

01-05-2022/(1300 to 1326) GMT
01-05-2022/(1830 to 1856) IST

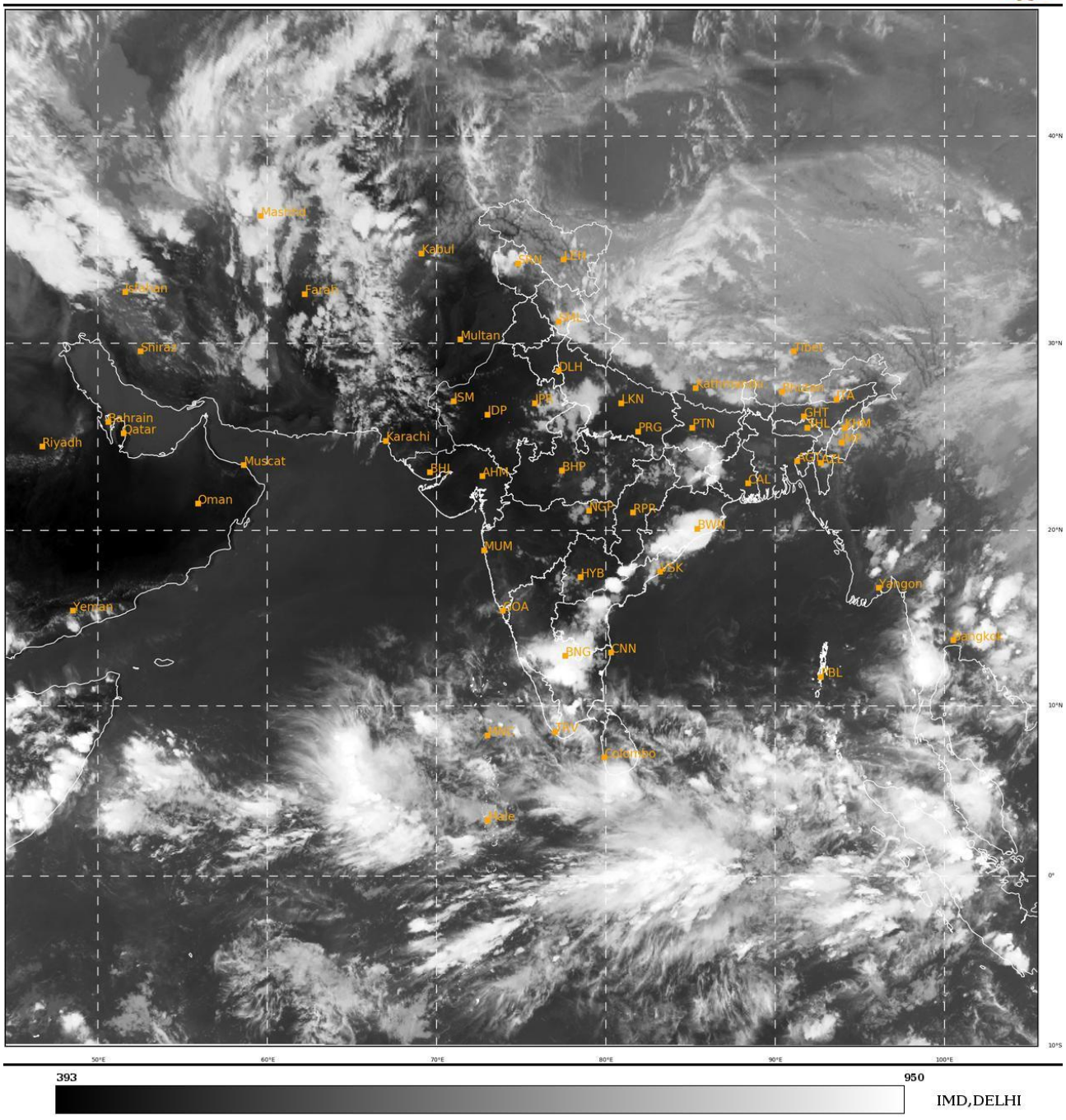

Figure 32

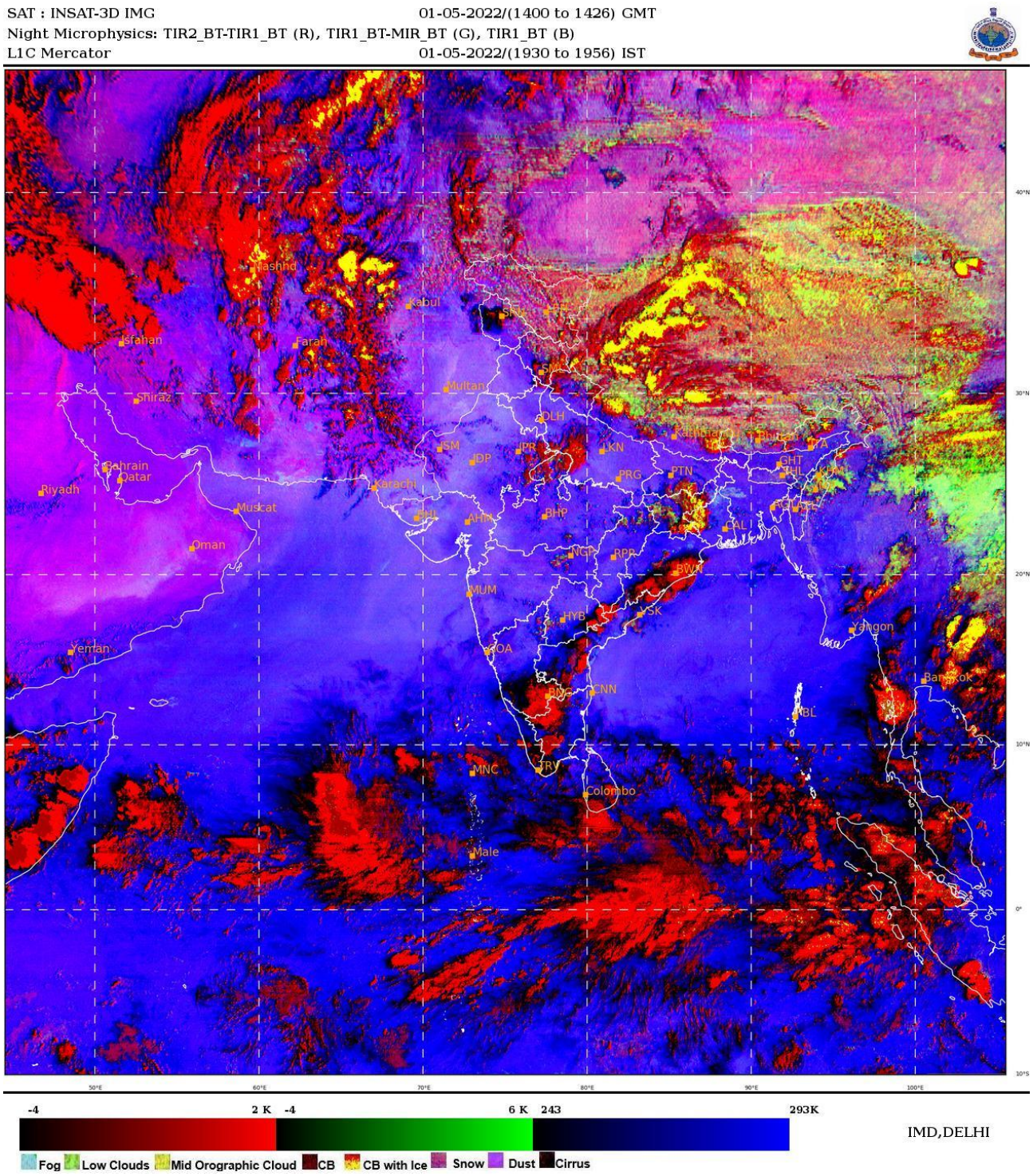
SAT : INSAT-3D IMG
01-05-2022/(1400 to 1426) GMT
Night Microphysics: TIR2_BT-TIR1_BT (R), TIR1_BT-MIR_BT (G), TIR1_BT (B)
L1C Mercator
01-05-2022/(1930 to 1956) IST
Tashhd
Kabul
Sfahan
Farah
Multan
Shiraz
DLH
Bahrain
Qatar
Riyadh
Karachi
Muscat
Oman
Yemen
MUM
HYB
GOA
Yangon
Bangkok
MNC
Colombo
Male
-4
2 K
-4
6 K
243
293K
IMD,DELHI
Fog
Low Clouds
Mid Orographic Cloud
CB
CB with Ice
Snow
Dust
Cirrus

Figure 33

Appendix C

Plots from DFDR parameters

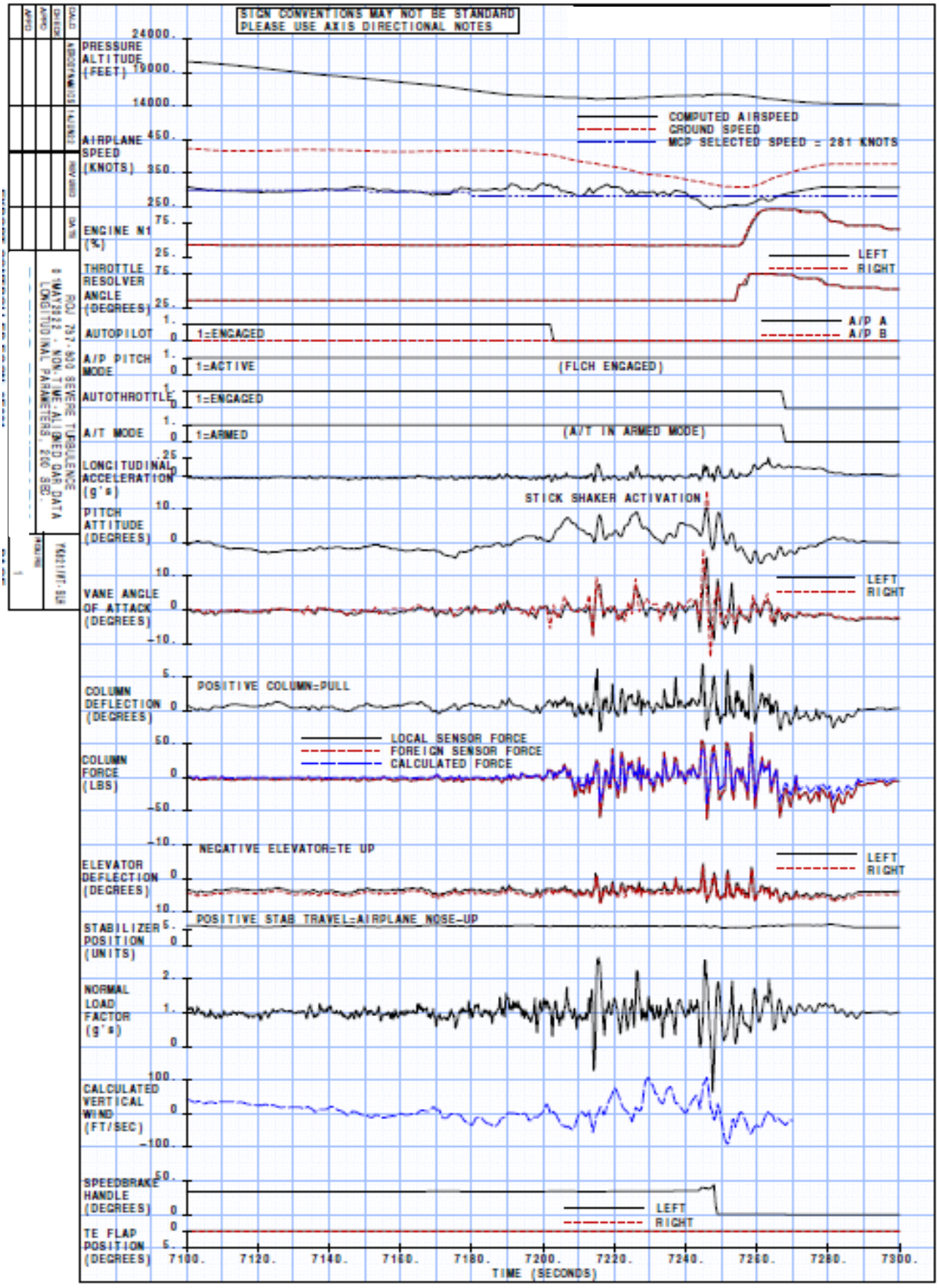

Figure 34

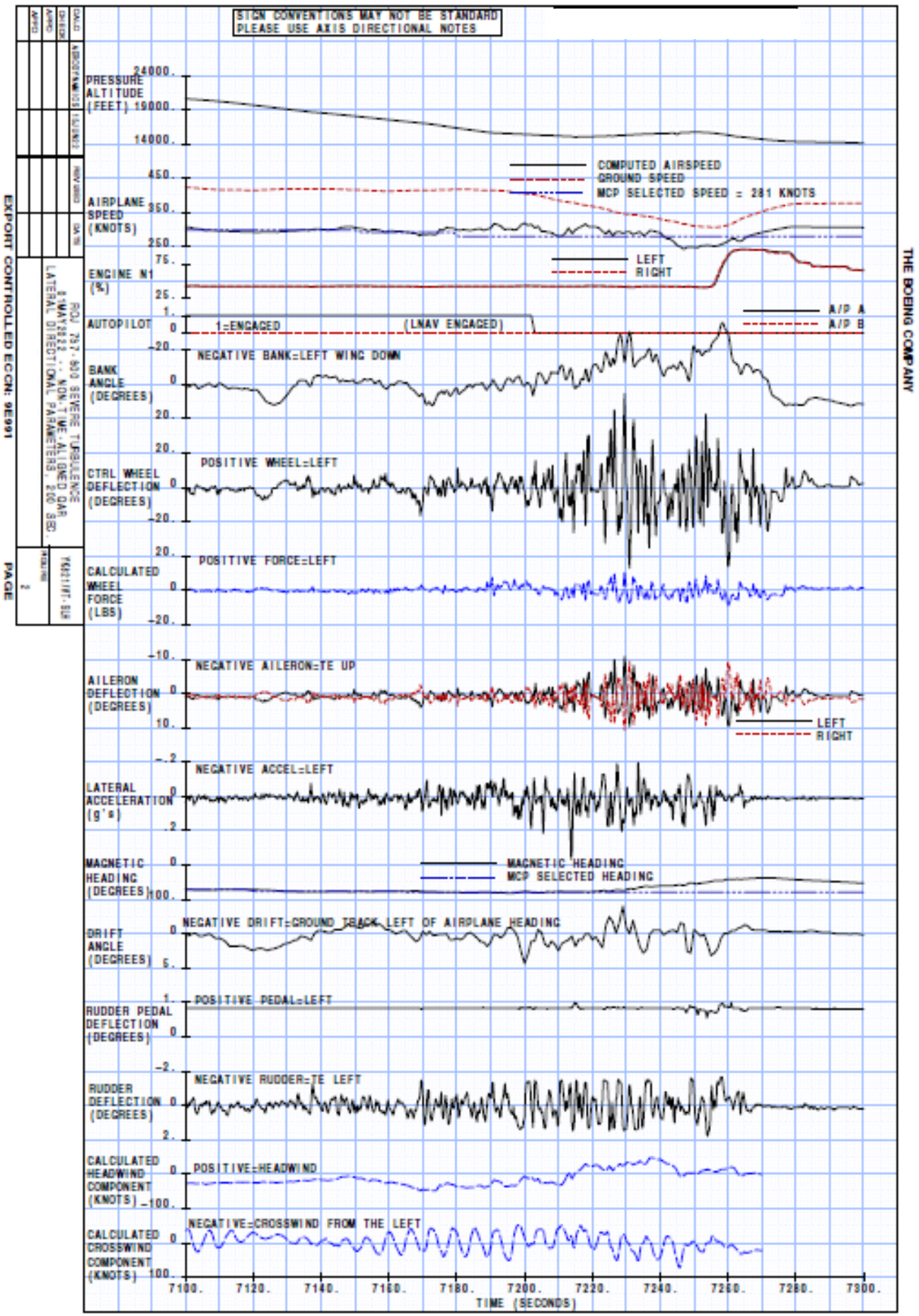
EXPORT CONTROLLED ECCN: 9E991
PAGE
THE BOEING COMPANY
SIGN CONVENTIONS MAY NOT BE STANDARD
PLEASE USE AXIS DIRECTIONAL NOTES
PRESSURE ALTITUDE (FEET)
24000.
19000.
14000.
AIRPLANE SPEED (KNOTS)
450.
350.
250.
COMPUTED AIRSPEED
GROUND SPEED
MCP SELECTED SPEED = 281 KNOTS
ENGINE N1 (%)
75.
25.
LEFT
RIGHT
AUTOPILOT
1.
0
-20.
1=ENGAGED
(LNAV ENGAGED)
A/P A
A/P B
BANK ANGLE (DEGREES)
NEGATIVE BANK=LEFT WING DOWN
20.
0
20.
CTRL WHEEL DEFLECTION (DEGREES)
POSITIVE WHEEL=LEFT
CALCULATED WHEEL FORCE (LBS)
POSITIVE FORCE=LEFT
AILERON DEFLECTION (DEGREES)
-10.
10.
NEGATIVE AILERON=TE UP
LEFT
RIGHT
LATERAL ACCELERATION (g's)
-.2
.2
NEGATIVE ACCEL=LEFT
MAGNETIC HEADING (DEGREES)
100.
MAGNETIC HEADING
MCP SELECTED HEADING
DRIFT ANGLE (DEGREES)
5.
NEGATIVE DRIFT=GROUND TRACK LEFT OF AIRPLANE HEADING
RUDDER PEDAL DEFLECTION (DEGREES)
POSITIVE PEDAL=LEFT
RUDDER DEFLECTION (DEGREES)
-2.
2.
NEGATIVE RUDDER=TE LEFT
CALCULATED HEADWIND COMPONENT (KNOTS)
-100.
POSITIVE=HEADWIND
CALCULATED CROSSWIND COMPONENT (KNOTS)
NEGATIVE=CROSSWIND FROM THE LEFT
7100.
7120.
7140.
7160.
7180.
7200.
7220.
7240.
7260.
7280.
7300.
TIME (SECONDS)

Figure 35

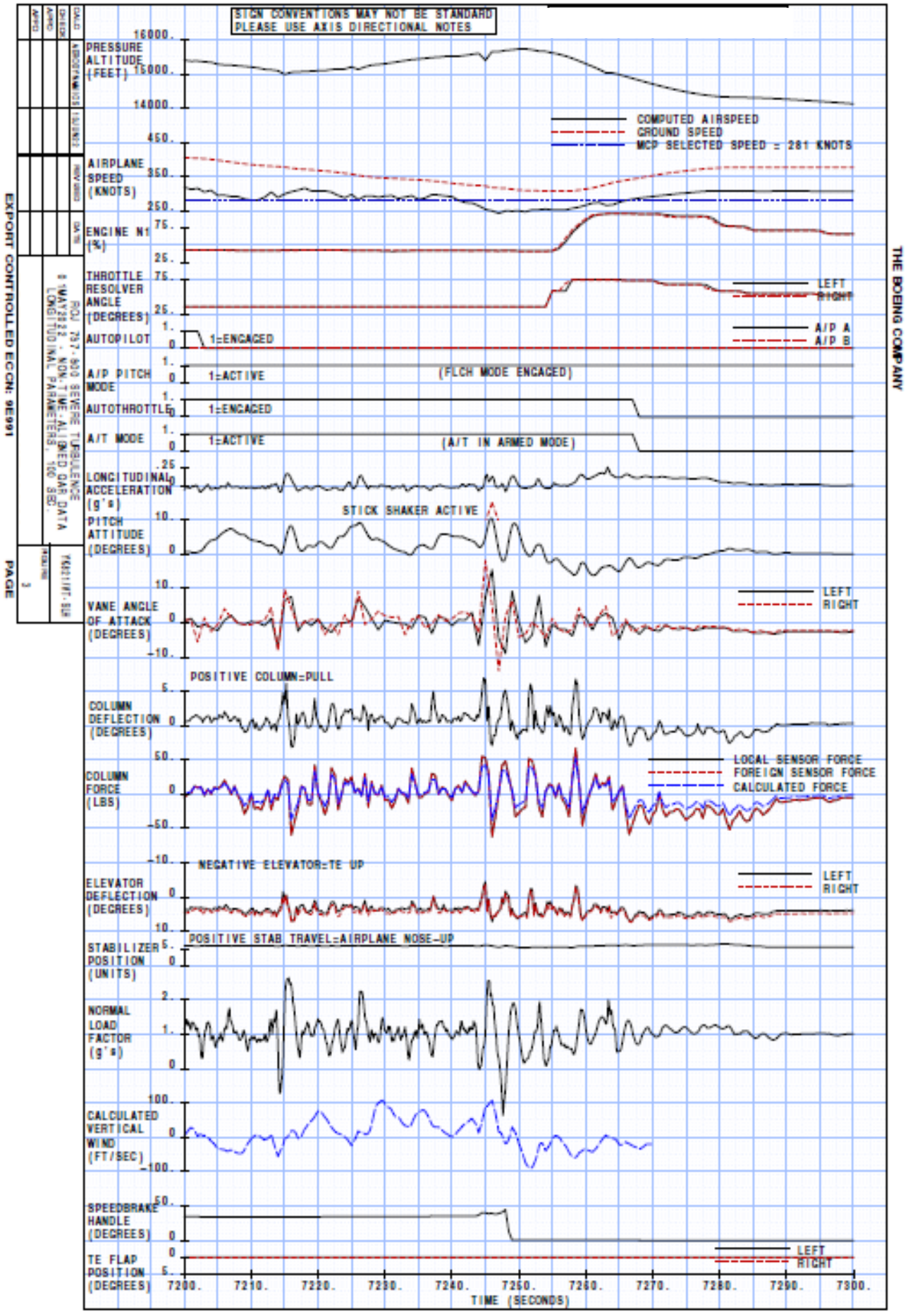
STICK CONVENTIONS MAY NOT BE STANDARD
PLEASE USE AXIS DIRECTIONAL NOTES
PRESSURE ALTITUDE (FEET)
AIRPLANE SPEED (KNOTS)
COMPUTED AIRSPEED
GROUND SPEED
MCP SELECTED SPEED = 281 KNOTS
ENGINE N1 (%)
THROTTLE RESOLVER ANGLE (DEGREES)
LEFT
RIGHT
AUTOPILOT
1=ENGAGED
A/P A
A/P B
A/P PITCH MODE
1=ACTIVE
(FLCH MODE ENGAGED)
AUTOTHROTTLE
1=ENGAGED
A/T MODE
1=ACTIVE
(A/T IN ARMED MODE)
LONGITUDINAL ACCELERATION (g's)
STICK SHAKER ACTIVE
PITCH ATTITUDE (DEGREES)
VANE ANGLE OF ATTACK (DEGREES)
LEFT
RIGHT
POSITIVE COLUMN=PULL
COLUMN DEFLECTION (DEGREES)
COLUMN FORCE (LBS)
LOCAL SENSOR FORCE
FOREIGN SENSOR FORCE
CALCULATED FORCE
NEGATIVE ELEVATOR=TE UP
ELEVATOR DEFLECTION (DEGREES)
LEFT
RIGHT
POSITIVE STAB TRAVEL=AIRPLANE NOSE-UP
STABILIZER POSITION (UNITS)
NORMAL LOAD FACTOR (g's)
CALCULATED VERTICAL WIND (FT/SEC)
SPEEDBRAKE HANDLE (DEGREES)
TE FLAP POSITION (DEGREES)
LEFT
RIGHT
7200. 7210. 7220. 7230. 7240. 7250. 7260. 7270. 7280. 7290. 7300.
TIME (SECONDS)
EXPORT CONTROLLED ECCN: 9E991
THE BOEING COMPANY
PAGE 3

Figure 36

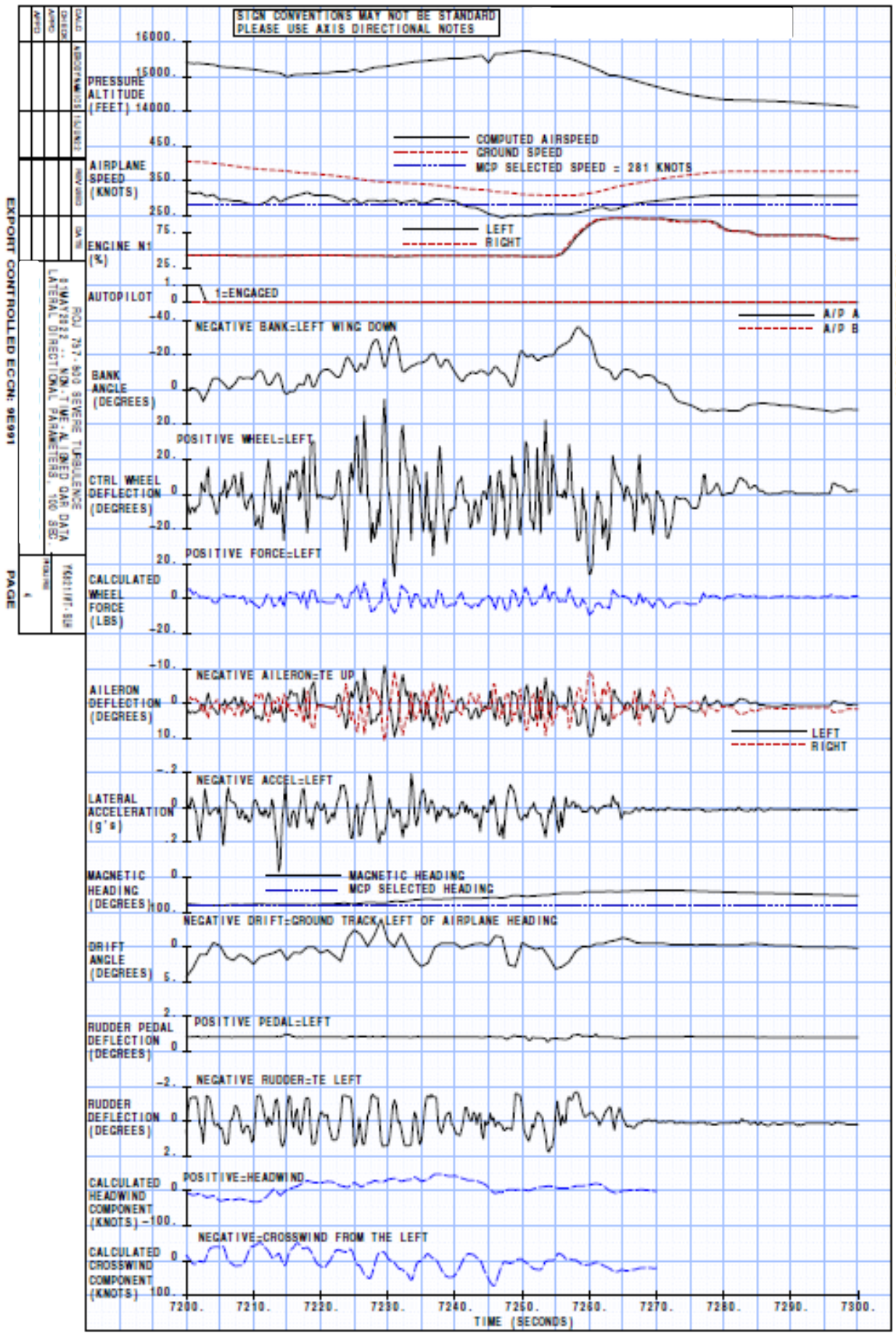
SIGN CONVENTIONS MAY NOT BE STANDARD
PLEASE USE AXIS DIRECTIONAL NOTES
PRESSURE ALTITUDE (FEET)
AIRPLANE SPEED (KNOTS)
COMPUTED AIRSPEED
GROUND SPEED
MCP SELECTED SPEED = 281 KNOTS
ENGINE N1 (%)
LEFT
RIGHT
AUTOPILOT
1=ENGAGED
A/P A
A/P B
BANK ANGLE (DEGREES)
NEGATIVE BANK=LEFT WING DOWN
CTRL WHEEL DEFLECTION (DEGREES)
POSITIVE WHEEL=LEFT
CALCULATED WHEEL FORCE (LBS)
POSITIVE FORCE=LEFT
AILERON DEFLECTION (DEGREES)
NEGATIVE AILERON=TE UP
LEFT
RIGHT
LATERAL ACCELERATION (g's)
NEGATIVE ACCEL=LEFT
MAGNETIC HEADING (DEGREES)
MAGNETIC HEADING
MCP SELECTED HEADING
DRIFT ANGLE (DEGREES)
NEGATIVE DRIFT=GROUND TRACK LEFT OF AIRPLANE HEADING
RUDDER PEDAL DEFLECTION (DEGREES)
POSITIVE PEDAL=LEFT
RUDDER DEFLECTION (DEGREES)
NEGATIVE RUDDER=TE LEFT
CALCULATED HEADWIND COMPONENT (KNOTS)
POSITIVE=HEADWIND
CALCULATED CROSSWIND COMPONENT (KNOTS)
NEGATIVE=CROSSWIND FROM THE LEFT
7200. 7210. 7220. 7230. 7240. 7250. 7260. 7270. 7280. 7290. 7300.
TIME (SECONDS)
EXPORT CONTROLLED ECCN: 9E991
THE BOEING COMPANY

Figure 37

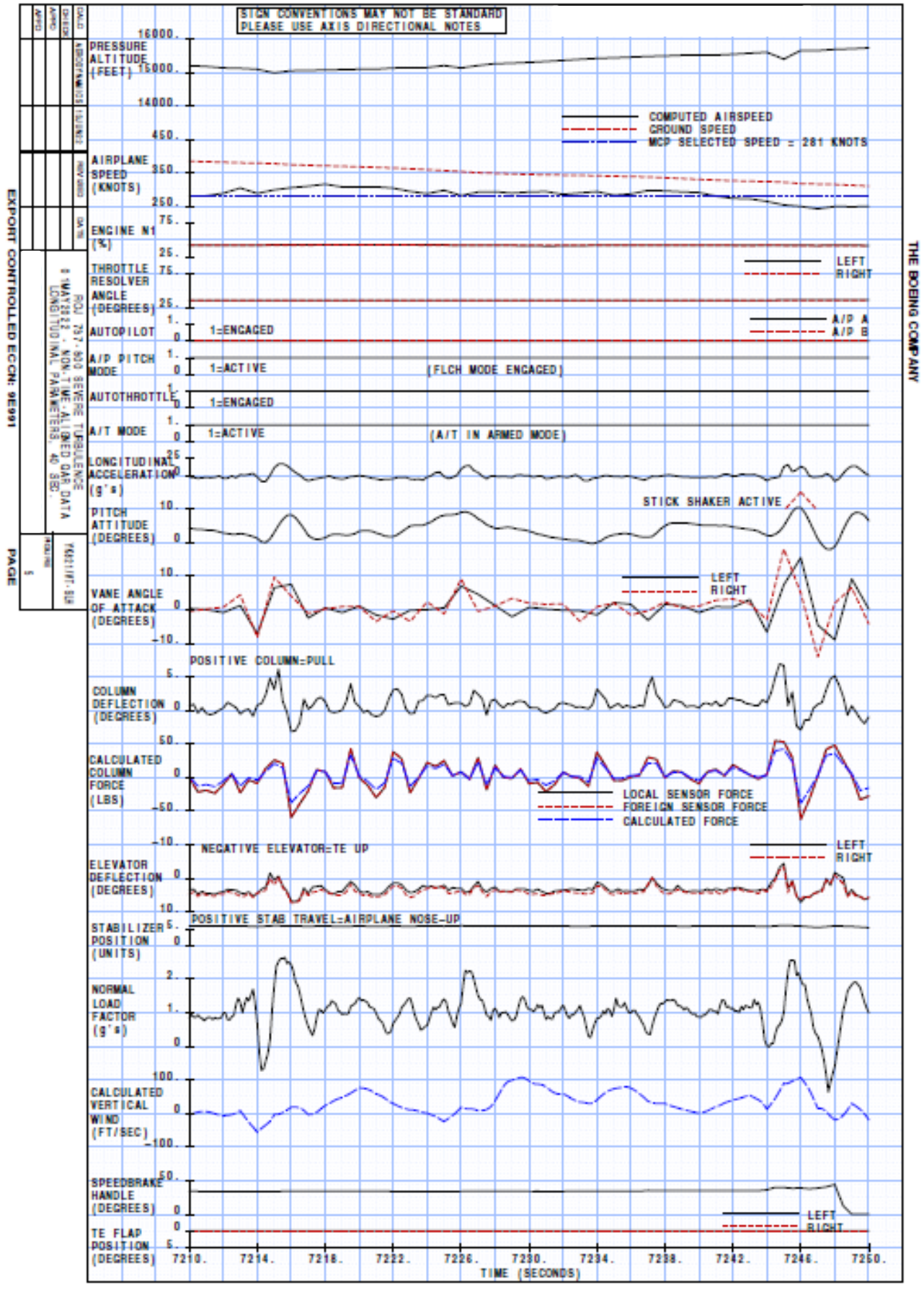
STICK CONVENTIONS MAY NOT BE STANDARD
PLEASE USE AXIS DIRECTIONAL NOTES
PRESSURE ALTITUDE (FEET)
AIRPLANE SPEED (KNOTS)
COMPUTED AIRSPEED
GROUND SPEED
MCP SELECTED SPEED = 281 KNOTS
ENGINE N1 (%)
THROTTLE RESOLVER ANGLE (DEGREES)
LEFT
RIGHT
AUTOPILOT
1=ENGAGED
A/P A
A/P B
A/P PITCH MODE
1=ACTIVE
(FLCH MODE ENGAGED)
AUTOTHROTTLE
1=ENGAGED
A/T MODE
1=ACTIVE
(A/T IN ARMED MODE)
LONGITUDINAL ACCELERATION (g's)
PITCH ATTITUDE (DEGREES)
STICK SHAKER ACTIVE
VANE ANGLE OF ATTACK (DEGREES)
POSITIVE COLUMN=PULL
COLUMN DEFLECTION (DEGREES)
CALCULATED COLUMN FORCE (LBS)
LOCAL SENSOR FORCE
FOREIGN SENSOR FORCE
CALCULATED FORCE
NEGATIVE ELEVATOR=TE UP
ELEVATOR DEFLECTION (DEGREES)
POSITIVE STAB TRAVEL=AIRPLANE NOSE-UP
STABILIZER POSITION (UNITS)
NORMAL LOAD FACTOR (g's)
CALCULATED VERTICAL WIND (FT/SEC)
SPEEDBRAKE HANDLE (DEGREES)
TE FLAP POSITION (DEGREES)
7210. 7214. 7218. 7222. 7226. 7230. 7234. 7238. 7242. 7246. 7250.
TIME (SECONDS)
EXPORT CONTROLLED ECCN: 9E991
THE BOEING COMPANY
PAGE

Figure 38

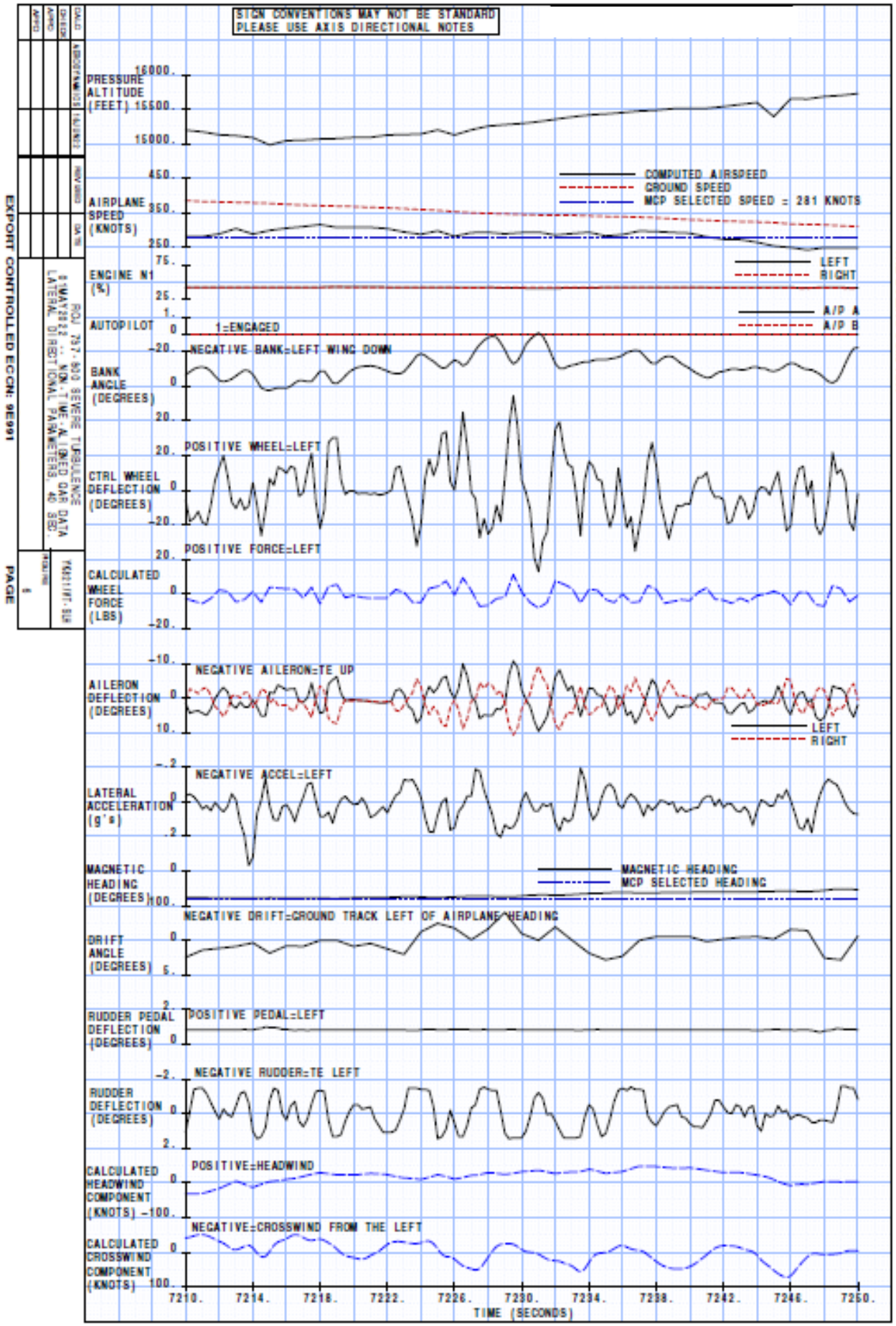
STCM CONVENTIONS MAY NOT BE STANDARD
PLEASE USE AXIS DIRECTIONAL NOTES
PRESSURE ALTITUDE (FEET)
16000.
15500.
15000.
AIRPLANE SPEED (KNOTS)
450.
350.
250.
COMPUTED AIRSPEED
GROUND SPEED
MCP SELECTED SPEED = 281 KNOTS
ENGINE N1 (%)
75.
25.
LEFT
RIGHT
AUTOPILOT
1.
0
1=ENGAGED
A/P A
A/P B
BANK ANGLE (DEGREES)
-20.
0
20.
NEGATIVE BANK=LEFT WING DOWN
CTRL WHEEL DEFLECTION (DEGREES)
20.
0
-20.
POSITIVE WHEEL=LEFT
CALCULATED WHEEL FORCE (LBS)
20.
0
-20.
POSITIVE FORCE=LEFT
AILERON DEFLECTION (DEGREES)
-10.
0
10.
NEGATIVE AILERON=TE UP
LEFT
RIGHT
LATERAL ACCELERATION (g's)
-.2
0
.2
NEGATIVE ACCEL=LEFT
MAGNETIC HEADING (DEGREES)
0
100.
MAGNETIC HEADING
MCP SELECTED HEADING
DRIFT ANGLE (DEGREES)
0
5.
NEGATIVE DRIFT=GROUND TRACK LEFT OF AIRPLANE HEADING
RUDDER PEDAL DEFLECTION (DEGREES)
2
0
POSITIVE PEDAL=LEFT
RUDDER DEFLECTION (DEGREES)
-2.
0
2.
NEGATIVE RUDDER=TE LEFT
CALCULATED HEADWIND COMPONENT (KNOTS)
0
-100.
POSITIVE=HEADWIND
CALCULATED CROSSWIND COMPONENT (KNOTS)
0
100.
NEGATIVE=CROSSWIND FROM THE LEFT
7210.
7214.
7218.
7222.
7226.
7230.
7234.
7238.
7242.
7246.
7250.
TIME (SECONDS)
EXPORT CONTROLLED ECCN: 9E991
PAGE
THE BOEING COMPANY

Figure 39

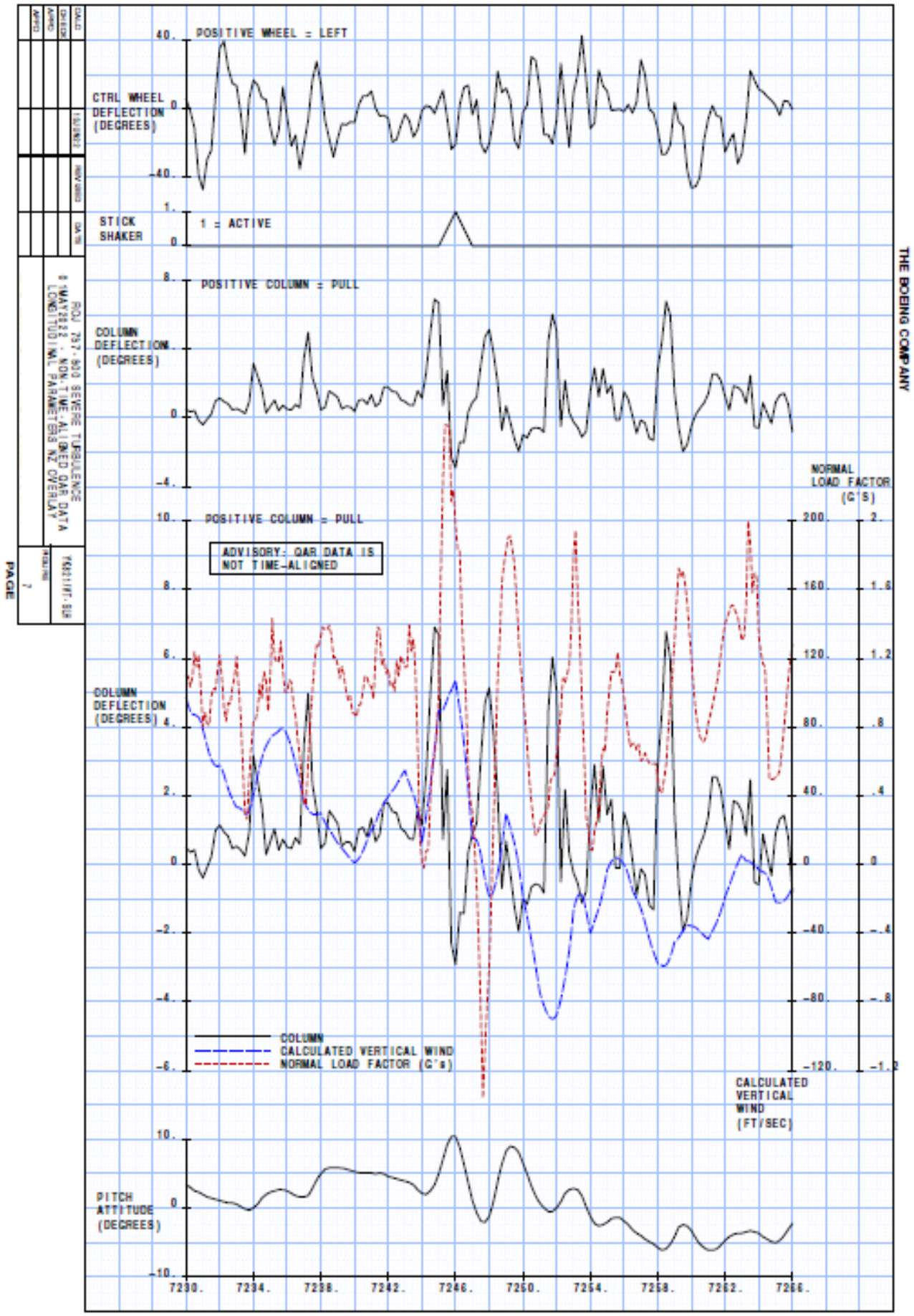
POSITIVE WHEEL = LEFT
CTRL WHEEL DEFLECTION (DEGREES)
STICK SHAKER
1 = ACTIVE
POSITIVE COLUMN = PULL
COLUMN DEFLECTION (DEGREES)
POSITIVE COLUMN = PULL
ADVISORY: QAR DATA IS NOT TIME-ALIGNED
COLUMN DEFLECTION (DEGREES)
NORMAL LOAD FACTOR (G'S)
CALCULATED VERTICAL WIND (FT/SEC)
COLUMN
CALCULATED VERTICAL WIND
NORMAL LOAD FACTOR (G's)
PITCH ATTITUDE (DEGREES)
7230. 7234. 7238. 7242. 7246. 7250. 7254. 7258. 7262. 7266.
THE BOEING COMPANY
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Figure 40

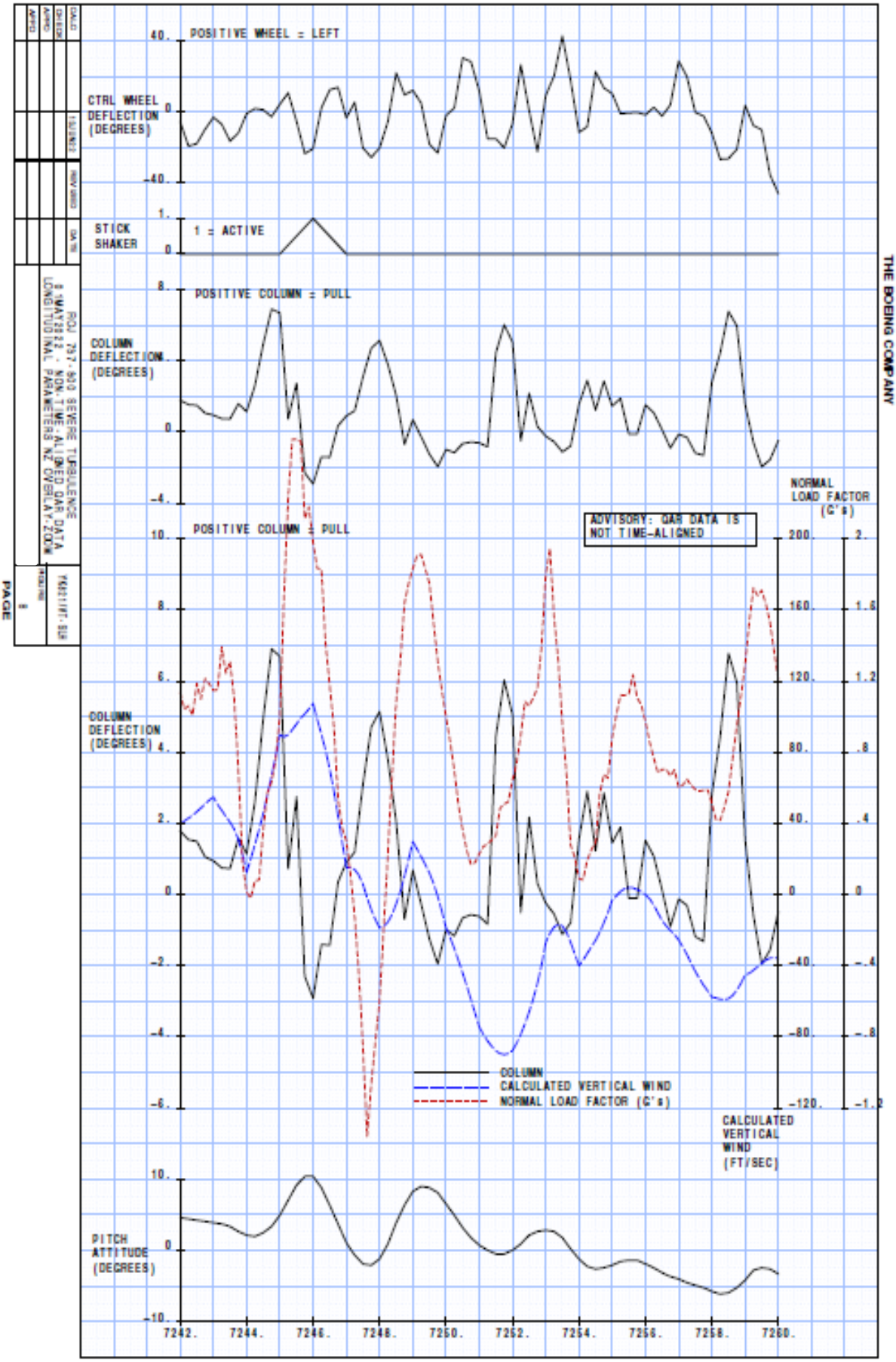
POSITIVE WHEEL = LEFT
CTRL WHEEL DEFLECTION (DEGREES)
STICK SHAKER
1 = ACTIVE
POSITIVE COLUMN = PULL
COLUMN DEFLECTION (DEGREES)
POSITIVE COLUMN = PULL
ADVISORY: QAR DATA IS NOT TIME-ALIGNED
NORMAL LOAD FACTOR (C's)
COLUMN DEFLECTION (DEGREES)
COLUMN
CALCULATED VERTICAL WIND
NORMAL LOAD FACTOR (C's)
CALCULATED VERTICAL WIND (FT/SEC)
PITCH ATTITUDE (DEGREES)
7242.
7244.
7246.
7248.
7250.
7252.
7254.
7256.
7258.
7260.
THE BOEING COMPANY
PAGE

Figure 41

Appendix D

1. Transcript of communication between aircraft and Upper Raipur Controller on frequency 125.9 Mhz.

TIME IN UTC (HHMMSS)	FROM	TO	TEXT
125.9 MHZ (URP)			
124435	SEJ 945	URP	RADAR GOOD EVENING SPICE JET NINER FOUR FIVE
124438	URP	SEJ 945	SPICEJET NINER FOUR FIVE KOLKATA
124441	SEJ 945	URP	SPICEJET NINER FOUR FIVE FLIGHT LEVEL THREE SEVEN ZERO REQUESTING FLIGHT LEVEL THREE NINER ZERO
124446	URP	SEJ 945	STANDBY FOR HIGHER PROCEED
124449	SEJ 945		DIRECT DURGAPUR SPICEJET NINER FOUR FIVE
124702	URP	SEJ 945	SPICEJET NINE FOUR FIVE CLIMB TO FLIGHT LEVEL THREE NINER ZERO
124706	SEJ 945	URP	CLIMB LEVEL THREE NINER ZERO SPICE JET NINER FOUR FIVE THANK YOU SO MUCH
130827	SEJ 945	URP	RADAR SPICEJET NINER FOUR FIVE REQUEST HEADING OF ZERO SIX ZERO DUE WEATHER
130832	URP	SEJ 945	SPICEJET NINER FOUR FIVE APPROVED
130838	URP	SEJ 945	SPICEJET NINER FOUR FIVE HEADING ZERO SIX APPROVED
130842	SEJ 945	URP	SPICEJET NINER FOUR FIVE
131104	URP	SEJ 945	SPICE JET NINE FOUR FIVE CONTACT KOLKATA RADAR ONE THREE TWO DECIMAL TWO FIVE
131108	SEJ 945	URP	ONE THREE TWO DECIMAL TWO FIVE SPICEJET NINER FOUR FIVE

2. Transcript of communication between aircraft and Kolkata ATC on frequency 132.25 Mhz.

TIME IN UTC (HHMMSS)	FROM	TO	TEXT
132.25 MHz (UKW)			
131135	SG 945	UKW	RADAR SPICE JET NINER FOUR FIVE FLIGHT LEVEL THREE NINER ZERO ON A HEADING OF ZERO FIVE FIVE
131142	UKW	SG 945	SPICE JET NINER FOUR FIVE ROGER REPORT IN CONTACTWITH DURGAPUR
131146	SG 945	UKW	WILCO SPICE JET NINER FOUR FIVE
131924	SG 945	UKW	SPICEJET NINER FOUR FIVE REQUEST DESCEND
131926	UKW	SG 945	SPICEJET NINER FOUR FIVE KOLKATA DESCEND TO FLIGHT LEVEL TWO FIVE ZERO
131930	SG 945	UKW	DESCEND FLIGHT LEVEL TWO FIVE ZERO ANDCONTACT WITH DURGAPUR SPICEJET NINER FOUR FIVE
131934	UKW	SG 945	ROGER WHEN ABLE PROCEED DIRECT DELTA GOLF PAPA
131939	SG 945	UKW	WILCO SPICE JET NINER FOUR FIVE SIR NOW WE ARE HEADING… MAINTAINING HEADING OF ZERO SIX FIVE DUE WEATHER SIR
131945	UKW	SG 945	ROGER APPROVED
132237	SG 945	UKW	FURTHER DESCEND SPICE JET NINER FOUR FIVE

132240	UKW	SG 945	SPICE JET NINER FOUR FIVE SAY AGAIN
132242	SG 945	UKW	FURTHER DESCEND SPICE JET NINER FOUR FIVE
132245	UKW	SG 945	SPICE JET NINER FOUR FIVE DESCEND TO FLIGHT LEVEL SEVEN ZERO
132249	SG 945	UKW	DESCEND SEVEN ZERO SPICE JET NINER FOUR FIVE
132251	UKW	SG 945	AFFIRM
132929	UKW	SG 945	SPICE JET NINER FOUR FIVE KOLKATA
132934	UKW	SG 945	SPICE JET NINER FOUR FIVE KOLKATA
132936	SG 945	UKW	SPICE JET NINER FOUR FIVE SIR WE AH…. EXPERIENCING HEAVY TURBULENCE AH.. WE ARE PASSING FLIGHT LEVEL ON FOUR ZERO STANDBY
132946	UKW	SG 945	SPICE JET NINER FOUR FIVE ROGER
133510	UKW	SG 945	BREAK SPICE JET NINER FOUR FIVE CONFIRM IN CONTACT WITH DURGAPUR AND PANAGARH
133516	SG 945	UKW	AFFIRM SIR SPICE JET NINER FOUR FIVE
133518	UKW	SG 945	ROGER RADAR SERVICE TERMINATED BELOW LEVEL SEVEN ZERO DESCEND WITH PANAGARH FREQUENCY CHANGE APPROVED GOODDAY
133527	SG 945	UKW	CHANGE OVER TO DURGAPUR AND PANAGARH SPICEJET NINER FOUR FIVE GOODBYE
133531	UKW	SEJ 945	BYE

3. Transcript of communication between aircraft and Durgapur ATC on frequency 118.55 Mhz.

TIME	TO	FROM	RADIO TELEPHONY COMMUNICATION
1313 UTC	DURGAPUR	SEJ 945	GOOD EVENING
1313 UTC	SEJ 945	DURGAPUR	GOOD EVENING
1313 UTC		SEJ 945	WE ARE FLIGHT LEVEL THREE NINER ZERO (FL390). 182…. GOOD DAY SEJ3722 (GARBLED)… IN CONTACT WITH KOLKATA…. REQUEST LATEST WEATHER…. TYPE OF APPROACH…. RUNWAY IN USE
1313 UTC	SEJ 945		LATEST WEATHER…TIME OF OBSERVATION 1300… WIND 120 DEGREES 08 KNOTS… VISIBILITY 4000 METRES. WEATHER HAZE. CLOUD FEW 2000 FEET… SCATTERED 9000 FEET. TEMPERATURE 31… DEW POINT 25... QNH 1001… TREND NOSIG AND EXPECT ILS APPROACH RUNWAY 16
1314 UTC		SEJ 945	ILS RUNWAY 16… QNH 1001... SPICEJET 945... WILL REPORT RELEASE
1314 UTC		SEJ 945	ILS RUNWAY 16... QNH 1001… SEJ945... WILL REPORT RELEASE
1314 UTC			ROGER
1314 UTC	SEJ 945		SAY AGAIN ETA DURGAPUR
1314 UTC			STANDBY
1314 UTC			ETA DGP 13……. (GARBLED)
1314 UTC			1337 CONFIRM
1314 UTC			AFFIRM
1314 UTC			REPORT RELEASE BY KOLKATA

1337 UTC	Durgapur	SEJ 945	GOOD EVENING……. PASSING FLIGHT LEVEL 86 (FL86). AND REQUEST PANAGARH REQUENCY
1337 UTC	SEJ 945		PANAGARH FREQUENCY ONE TWO FOUR DECIMAL ZERO (124.0) BUT PANAGARH IS THE OFF THE AIR
1337 UTC	SEJ 945		CONFIRM COPIED
1337 UTC		SEJ 945	AFFIRM
1337 UTC			CONFIRM RELEASE BY KOLKATA
1337 UTC			WE ARE RELEASED BY KOLKATA SIR……COORDINATING WITH PANAGARH
1337 UTC	Durgapur	SEJ 945	
1337 UTC	SEJ 945	Durgapur	NO JOIN WITH PANAGARH AND WE ARE CURRENTLY 25 MILES… WE WILL PROCEED TO THE FINAL APPROACH FIX RUNWAY 16 AND JUST TO INFORM THERE ARE CERTAIN INJURIES ON THE PASSENGER'S DUE BAD WEATHER AT TURBULENCE. REQUEST COMPANY TO BE INFORMED ABOUT MEDICAL SERVICES REQUIRED ON ARRIVAL.
1338 UTC	SEJ 945		ROGER
1338 UTC	SEJ 945		AT OWN DISCRETION PROCEED DIRECT TO INTERCEPT LOCALIZER RUNWAY 16
1338 UTC		SEJ 945	OWN DISCRETION LOCALIZER RUNWAY 26… CALL YOU ESTABLISH SEJ 945... THANK YOU
1338 UTC			RUNWAY 16 SIR
1338 UTC			RUNWAY 16
1338 UTC		SEJ 945	MAY BE DESCEND AS PER PROCEDURES SIR SEJ945
1338 UTC	SEJ 945		AFFIRM SIR
1338 UTC			THANK YOU SO MUCH SIR
1340 UTC	Durgapur Tower	SEJ 945	ONE ZERO (10) DME… PASSING TWO THOUSAND NINE HUNDRED EIGHTY (2980)
1341 UTC	SEJ 945		ROGER... REPORT ESTABLISH LOCALIZER RUNWAY 16
1341 UTC		SEJ 945	REPORT ESTABLISHES LOCALIZER RUNWAY 16
1343 UTC		SEJ 945	ESTABLISH ILS RUNWAY 16 SEJ945
1343 UTC	SEJ 945		ROGER RUNWAY 16 CLEARED TO LAND…. WIND 100 DEGREES 05 KNOTS
1343 UTC		SEJ 945	OKAY…… CLEARED TO LAND RUNWAY 16
1343 UTC			LATEST QNH 1002
1343 UTC		SEJ 945	ONE ZERO ZERO TWO (1002)
1343 UTC			WIND CHECK
1343 UTC			ONE ZERO ZERO (100) DEGREES… ZERO FIVE KNOTS (05)
1343 UTC			ROGER
1345 UTC	SEJ 945		MAKE ONE EIGHTY (180) DEGREE AT DUMB-BELL RUNWAY 34…. BACKTRACK AND VACATE VI ALPHA (A)
1345 UTC		SEJ 945	MAKE ONE EIGHTY (180) AT DUMB-BELL BACKTRACK AND VACATE VIA ALPHA (A)
1345 UTC		SEJ 945	REQUEST TAXI INSTRUCTIONS AGAIN
1346 UTC	SEJ 945		VACATE RUNWAY VIA TAXIWAY ALPHA (A)…. STAND NUMBER FOUR (4)
1346 UTC		SEJ 945	VACATE VIA ALPHA (A)…. STAND NUMBER FOUR (4)
1346 UTC			REPORT REGISTRATION
1346 UTC		SEJ 945	REGISTRATION VTSLH
1346 UTC			ROGER……. COPIED

-End of Report-