FINAL INVESTIGATION REPORT ON

ACCIDENT INVOLVING M/S VSR VENTURES PVT. LTD.

LEARJET 45XR AIRCRAFT VT-DBL AT MUMBAI ON 14 SEPTEMBER 2023

AIRCRAFT ACCIDENT INVESTIGATION BUREAU
MINISTRY OF CIVIL AVIATION
GOVERNMENT OF INDIA

FOREWORD

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2025, 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.

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

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

Note: Figures used in this report are taken from different sources and are adjusted from the original for the sole purpose to improve the clarity of the Report. Modifications to images used in this report are limited to cropping, magnification or addition of text boxes, arrows or lines

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GLOSSARY

ACAS	Airborne Collision Avoidance System
A-SMGCS	Advanced Surface Movement Guidance and Control System
ADC	Aerodrome Control
AGL	Above Ground Level
AIP	Aeronautical Information Publication
AoA	Angle of Attack
AFM	Aircraft Flight Manual
AP	Auto Pilot
APAD	Approach departure
APP	Approach Control
APU	Auxiliary Power Unit
ATM	Air Traffic Management
ARFF	Aircraft Resue and Fire Fighting
ATC	Air Traffic Control
ATPL	Airline Transport Pilot License
ATS	Air Traffic Services
ATIS	Automatic Terminal Information Service
C of A	Certificate of Airworthiness
CAR	Civil Aviation Requirement
CDIS	Current Distance (between tracks in STCA)
CFP	Computerized Flight Planning
CLD	Clearance Delivery
CPL	Commercial Pilot License
C of R	Certificate of Registration
CVR	Cockpit Voice Recorder
C. G.	Centre of Gravity
DFDR	Digital Flight Data Recorder
DGCA	Director General of Civil Aviation
DCL	Data Link Clearance
DEP	Departure
DME	Distance Measuring Equipment
EGPWS	Enhanced Ground Proximity Warning System
EFS	Electronic Flight Strip
FO	First Officer

FCOM	Flight Crew Operation Manual
FCTM	Flight Crew Training Manual
FCU	Flight Control Unit
FL	Flight level
FMGS	Flight management and guidance System
FPM	Feet per minute
FRTO	Flight Radio Telephone Operator's License
GS	Glide Slope
GPWS	Ground Proximity Warning System
Hrs	Hours
HVYRA	Heavy Rain
ICAO	International Civil Aviation Organization
IST	Indian Standard Time
IIC	Investigator-in-charge
ILS	Instrument Landing System
IR/PPC	Instrument rating / Pilot Proficiency check
INMCC	Indian Mission Control Centre
LAC	Local Area Control
LOC	Localizer
MATS	Manual of Air Traffic Services
MEL	Minimum Equipment List
MDIS	Minimum predicted distance
NCR	National Capital Region, India
ND	Navigation display
NM	Nautical miles
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board
OEM	Original Equipment Manufacturer
OM	Operations Manual
PF	Pilot Flying
PIB	Permanent Investigation Board
PIC	Pilot in Command
PM	Pilot monitoring
ROC	Rate Of Climb
RT	Radio Telephony

RVR	Runway Visual Range
RWY	Runway
SHRA	Rain Showers
SoP	Standard Operating Procedure
STAR	Standard Instrument Arrival Route
STCA	Short term conflict alert
TLA	Thrust Lever Angle
T/o	Take-off
TWR	Tower
UTC	Universal Time Coordinated
VOR	VHF Omnidirectional Range

Final Investigation Report on Accident involving M/s VSR Ventures' Pvt. Ltd. Learjet 45XR aircraft VT-DBL at Mumbai on 14 September 2023			
1.	Aircraft	Type	Learjet 45XR
		Nationality	Indian
		Registration	VT- DBL
2.	Owner and Operator		M/s VSR Ventures Pvt. Ltd.
3.	Pilot		ATPL Holder
	Extent of Injuries		Serious
4.	Co Pilot		CPL Holder
	Extent of Injuries		Serious
5.	No. of Passengers on board		06
	Extent of Injuries		Serious
6.	Date & Time of Accident		14.09.2023, 1132 UTC
7.	Place of Accident		Mumbai Airport
8.	Co-ordinates of Accident Site		Lat: 19° 5' 27.9'' N, Long: 72° 51' 46.9'' E
9.	Last point of Departure		Visakhapatnam Airport
10.	Intended landing place		Mumbai Airport
11.	Type of Operation		Non scheduled
12.	Phase of operation		Landing
13.	Type of accident		Loss of control – In flight (LOC-I)

SYNOPSIS

On 14 September 2023, a Learjet 45XR aircraft VT-DBL owned and operated by M/s VSR Ventures was involved in an accident while landing at Mumbai Airport at approximately 11:32 UTC. The aircraft was operating a non-scheduled passenger flight from Visakhapatnam to Mumbai, under the command of a PIC (an ATPL holder) and a Co-pilot (a CPL holder). There were six passengers on board (including one flight attendant).

The aircraft took off normally from Visakhapatnam and the flight en-route was uneventful. The aircraft established contact with Mumbai tower and was instructed to prepare for landing. At 113109 UTC, the aircraft was given clearance to land on Runway 27. At the time of landing, Mumbai airport was experiencing heavy rains and reduced visibility. The ATC, Mumbai while giving landing clearance reported winds as "WIND 140 DEGREES 7 KTS RWY27".

At 113133 UTC, the crew continued approach and decided to land on Runway 27. During the approach, the aircraft was not stabilized and it initially deviated to the left of the runway and thereafter continuously drifted right of the Runway 27. About 40 seconds after the autopilot was disconnected, Stick Shaker alert sounded in the cockpit accompanied by a Stall warning. Thereafter, EGPWS warnings were generated and the aircraft crash landed at the shoulder of the intersection of Taxiway W and Taxiway N. The aircraft thereafter skidded and finally coming to a stop near the intersection of Taxiway U and Taxiway N on an unpaved area (near stand C80).

Following the crash, a fire broke out and fire tenders rushed to the site and extinguished the fire. All occupants of the aircraft were evacuated, but they sustained various injuries due to the impact and were immediately admitted to the nearest hospital.

The occurrence was classified as an accident as per Aircraft (Investigation of Accidents and Incidents) Rules, 2017 and an Investigation into circumstances of this accident was ordered vide No. INV- 11011/10/2022-AAIB dated 15.09.2023. The state of manufacturer i.e. NTSB, USA had appointed an accredited representative along with Technical Advisers from the Manufacturer to participate and assist in the investigation as per relevant standards of ICAO Annex 13.

Unless otherwise indicated, recommendations in this report are addressed to the regulatory authorities of the State having the responsibility for the matters with which the recommendation is concerned. It is for those authorities to decide what action is taken.

1. Factual Information

1.1 History of Flight

On 14 September 2023, the Learjet 45XR aircraft VT-DBL belonging to M/s VSR Ventures Pvt. Ltd. while operating a non-scheduled flight from Vishakhapatnam to Mumbai met with an accident while landing at Mumbai.

On 13th September 2023 i.e. a day prior to the day of accident, the aircraft VT-DBL operated sector Kolkata to Kandla (a ferry flight) and then from Kandla to Vishakhapatnam with same set of crew along with 06 passengers on board. As per the statement of the crew, the aircraft was refueled at Vishakhapatnam on 13 September 2023 after arrival from Kandla. The aircraft was then planned to operate the flight from Vishakhapatnam to Mumbai on 14 September 2023 with same set of crew and 06 passengers. On 14 September 2023, the crew reported to Vishakhapatnam airport in the afternoon and did their pre-flight medical BA test. The crew stated that they did not find any abnormality in the aircraft during the pre-flight checks. The aircraft then took-off from Vishakhapatnam at around 0945 UTC under the command of a PIC who was the Pilot Flying (PF) and co-pilot who was Pilot Monitoring (PM) along with 06 passengers (including 01 cabin attendant) for Mumbai. The en-route flight was uneventful.

The crew obtained the weather from Mumbai ATIS, and an approach briefing was performed by the crew. The aircraft was maintaining FL400 and was routed via ATS Route W18. The aircraft was instructed to proceed direct to waypoint OPAKA, thereafter to OLGUS by the Mumbai, ATC (ACC-N) controller. It was initially descended to FL320, subsequently to F290 before changing over to LAC at time 110629 UTC. The LAC controller gave descend in intervals up to F170 and instructed the aircraft to reduce to minimum clean speed. The aircraft complied with the instructions. The aircraft was then changed over to APP (Departure) and came in contact with them at 111455 UTC. The APP(D) controller instructed the aircraft to descend initially to FL130, then to FL100 and FL080. The aircraft was then changed over to APP(Arrival) controller and came in contact with them at 111953 UTC. The descend and speed profile maintained by the aircraft was normal for ILS Rwy 27. In the first contact with APP(A), the aircraft was instructed to turn right heading H290 to intercept Localizer Rwy 27, and descend to FL070. The aircraft was also instructed to descend to 3800 feet at 25 DME, with QNH/1005 which was read back by the crew. Once established ILS RWY 27, the aircraft was changed over to Tower at 9 ILS DME, time 112819 UTC. Position report was communicated & the aircraft was instructed to reduce speed to 160 knots before changeover. The aircraft VT-DBL established contact with Tower at time 112824. The aircraft was advised to continue approach and the wind was reported as 150°/08 knots. At time 112919, the aircraft was advised of the planned heavy departure B777, VTI531 by Tower controller.

The aircraft was issued landing clearance at around 113109 UTC as “VTDBL WIND 140 DEGREES 7 KTS RWY27 CLEAR TO LAND” when it was 1.5 NM from the threshold of RWY 27. The landing clearance was acknowledged by the aircraft. Thereafter there was no

communication made by the aircraft with tower. At the time of landing, Mumbai Airport was experiencing heavy rains and reduced visibility. The PIC stated that runway lights and runway was visible till 1000 feet height and there were heavy rains on airfield. While approaching 500 feet, the crew encountered dark patch of clouds and the PIC lost sight of runway. Thereafter, the aircraft was not stabilized and was not aligned to the runway. The aircraft first drifted to the left and then started continuous drift towards right of the Runway 27. About 40 seconds after the autopilot was disconnected, Stick Shaker alert sounded in the cockpit accompanied by a Stall warning. The PIC further stated that immediately after increasing the power to initiate a go-around, stick shaker alert came. However, PIC upon concluding that recovery from the stall was not possible at that stage, reduced the power to idle and deliberately turned the aircraft further to the right to avoid inhabited area ahead in the flight path. During this process, the EGPWS warnings were generated and the aircraft crash landed at the shoulder of the intersection of Taxiway W and Taxiway N. The aircraft then skidded, before coming to a stop near the intersection of Taxiway U and Taxiway N on an unpaved area (near stand C80).

Following the crash, a fire broke out and fire tenders rushed to the site and extinguished the fire. All occupants of the aircraft were evacuated, but they sustained various injuries due to the impact and were immediately admitted to the nearest hospital.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	02	06	Nil
Minor/None	Nil	Nil	Nil

1.3 Damage to Aircraft

The aircraft was destroyed during the accident. Details of the aircraft's damages are given in section 1.12 of this report.

1.4 Other damage

One of the taxiway lights was found to be broken in front of the crash site near stand C80.

1.5 Personnel Information

1.5.1 Crew Information

Crew	Pilot-In-Command	Co-Pilot
Date of Birth	31/08/1977	12/11/1996
Date of joining company	27/01/2023	01/03/2023
License	ATPL Holder	CPL Holder
Date of Issue	21/06/2013	30/03/2021
Valid up to	26/01/2028	29/03/2026

Category	Aeroplane	Aeroplane
Date of Class I Med. Exam.	26/09/2022	28/11/2022
Class I Medical Valid up to	12/10/2023	19/12/2023
Date of issue FRTOL License	17/04/2001	30/03/2021
FRTO License Valid up to	30/08/2057	29/03/2026
Endorsements as PIC	C172, PC12 SET, B737 300-900, Learjet 45/75.	Cessna 172, Tecnam 2006T
Total flying experience	6100 Hours	540 Hours
Total flying experience on type	430 Hours	340 Hours
Last Flown on type	13/09/2023	13/09/2023
Total flying experience during last 1 year	430 Hours	340 Hours
Total flying experience during last 6 Months	301 Hours	340 Hours
Total flying experience during last 90 Days	187:40 Hours	162:50 Hours
Total flying experience during last 30 days	62:40 Hours	61:50 Hours
Total flying experience during last 07 Days	23:50 Hours	23:50 Hours
Total flying experience during last 24 Hours	05:15 Hours	05:15 Hours
Whether involved in Accident/Incident earlier	No	No
Date of latest Flight Checks and Ground Classes	Ground Classes & Simulator Training with Flight Checks Undertaken at the CAE, U. K in November-2022	Ground Classes & Simulator Training with Flight Checks Undertaken at the CAE, U. K in December-2022

Both the PIC and the co-pilot were adequately rested before operating the accident flight. Both the crew were based in Mumbai and had previously operated number of flights to Mumbai. Hence, they were aware of the topography of the Mumbai airport.

1.6 Aircraft Information

1.6.1 General Description of Learjet 45XR aircraft

The Learjet 45XR is a pressurized, low-wing, turbofan-powered aircraft featuring high aspect ratio swept wings and winglets, certified for all-weather operation at altitudes up to 51,000 feet. Wing construction follows conventional rivet methods throughout, with the exception of the upper winglet sections, which incorporate a honeycomb core bonded to the outer skin.

The fuselage employs a semi-monocoque design with a constant circular cross-section in the upper half transitioning to an elongated cross-section in the lower half. Two delta fins mounted on the underside of the tail cone improve stall recovery characteristics and enhance lateral stability.

Power is delivered by two pylon-mounted Honeywell turbofan engines. Fuel is stored in both wing and fuselage tanks, with fuselage fuel transferred to the wing tanks before being supplied to the respective engine. A crossflow valve interconnects the wing tanks to allow fuel transfer between sides as needed.

Hydraulic power is generated by an engine-driven pump on each engine, supporting operation of the wheel brakes, landing gear, flaps, spoilers, and thrust reversers. An electric auxiliary pump serves as a backup, primarily used to pressurize the brake accumulator, though it can also pressurize the normal braking system. Via the hydraulic crossflow, the auxiliary pump is additionally capable of operating the landing gear and flaps.

The landing gear uses conventional oleo-pneumatic struts for shock absorption on both the main and nose gear. The main gear is fitted with dual wheels, while the nose gear carries a single wheel. Nosewheel steering is electrically controlled, and wheel braking is managed through a brake-by-wire antiskid system.

Primary flight controls (ailerons, rudder, and elevator) are operated manually through a conventional system of cables, bellcranks, and push-pull tubes. Spoiler and spoileron panels are hydraulically actuated and electrically controlled, while the flaps are hydraulically driven. Roll and yaw trim are provided by electric trim tabs on the left aileron and rudder, respectively, and balance tabs on each aileron reduce control wheel forces during aileron deflection. Pitch trim is achieved through a variable-incidence horizontal stabilizer driven by an electric actuator.

Cabin environment is maintained by electronically controlled air conditioning and pressurization systems. Supplemental cooling is provided by an air cycle machine supplied with bleed air from the engines in flight, or from the APU while on the ground. The aft baggage compartment is lit and heated but remains unpressurized, while the cabin stowage compartment integrated within the lavatory is both heated and pressurized, remaining accessible during flight.

The fully glass cockpit features four display units presenting flight data, navigation, weather radar, engine parameters, and crew alerting information. Radio management units (RMUs) provide direct radio tuning and serve as a reversionary backup for engine and navigational displays in the event of a primary display failure.

1.6.2 Aircraft VT-DBL

Aircraft Model	Learjet 45XR
Aircraft S. No.	404
Year of Manufacture	2009
C of R issue date & validity	07 May 2021 & Valid
C of A issue date & validity	17 June 2021, subject to validity of ARC
ARC issue date & validity	15 June 2023 & Valid
Maximum Take-off weight	9752.00 kg / 21500 lbs
Total Aircraft Hours	3586:34
Last major inspection	1200 Hours/72 Months on 11-04-2023
Engine Type	Honeywell TFE731-20BR-1B
Engine Sl. No.	#1: P-132172C (LH) #2: P111113C (RH)
Last major inspection	1200 Hours/72 Months on 11-04-2023
Total Engine Hours Since New	#1- 3586:34 #2- 4458:50
Repairs carried out after last major inspection till date of accident	NIL
Type of fuel uplifted before the occurrence	Jet A1

The aircraft was equipped with flight recorders, an Enhanced Ground Proximity Warning System (EGPWS), and a Digital Electronic Engine Control (DEEC) system installed on both engines. All these instruments were serviceable at that time of occurrence.

The Learjet 45XR was certified with no windshield wipers. Further, the windshields outer faceply are coated with a water repellant coating capable of removing water.

No major defects or repair work had been carried out following the last major maintenance, and no Minimum Equipment List (MEL) items were recorded in the technical log.

According to the Load and Trim calculations, the landing weight was 17,867 lbs, which is well within the maximum certified landing weight of 19,200 lbs. The center of gravity was confirmed to be within the prescribed aircraft limits. Reference speeds were calculated for the flight as V-ref: 119 knots and V-app as 128 knots.

The aircraft maintenance log contained no record of any technical issues pending prior to the accident flight.

1.6.3 Maintenance documents

The investigation team perused the various maintenance documents pertaining to the aircraft VT-DBL submitted by the operator. Following are some salient observations.

- **Technical log-book**

  The scrutiny of technical logbook revealed the following salient observations: -

  - Details like aircraft Registration, last Inspection carried out, work order number, next inspection due, CRS number details were not filled in some of the pages of the logbook.
  - Pilot Acceptance certificate details were not filled in some of pages of the logbook as per sector wise.
  - Rectification Action column (even if NIL) was not filled in some pages of logbook.

- **Airframe Logbook:**

  - Aircraft Registration, details of Engine(s) fitted were not filled in some of pages of the logbook.
  - Hours brought forward is not filled in some of the pages of the logbook.
  - Certifying Staff Stamp/Seal was not found in some of the tasks, pages of the logbook.
  - In some of the scheduled maintenance task/checks which were carried out by other DGCA approved CAR 145 Organizations for which the Work order details were not mentioned in the slips pasted on log book.
  - Certifying staff name was not mentioned in some of the tasks mentioned in the pages of the logbook.

1.7 Meteorological Information

Weather as per the METAR at Mumbai during the time of accident was as follows:

Time (UTC)	Wind (°/Knots)	Visibility	RVR (RWY 27)	Temperature	QNH	Weather
1100	090/10	1600 m	-	26°C	1005 hPa	SHRA
1106	130/05	500 m	700 m	26°C	1005 hPa	+RA
1130	150/08	800 m	1000 m	26°C	1005 hPa	HVY RA
1200	170/05	800 m	1000 m	25°C	1006 hPa	HVY RA

The MET reports showed changing weather conditions with increasing rainfall and reduced visibility.

1.8 Aids to Navigation

All navigational aids available at Mumbai airport were reported to be serviceable at the time

of accident.

1.9 Communications

At the time of accident, the aircraft was in contact with Mumbai tower on frequency 118.1 MHz. There was two-way communication between the aircraft and ATC. No abnormality was reported in any communication system. Some of the salient communication between the aircraft (VT-DBL) and ATC, Mumbai (Tower-TWR) is given below: -

TIME (UTC)	SOURCE	COMMUNICATION
112824	VT-DBL	TOWER VTDBL NAMASKAR ON ILS
112828	TWR	NAMASKAR VTDBL CONTINUE APPROACH RWY27 WIND 150 DEGREES 8 KTS
112833	VT-DBL	CONTINUE APPROACH RUNWAY 27 VBL
112859	TWR	VTI531 REPORT AIRBUS 320 SHORT FINAL IN SIGHT
112903	VTI531	IN SIGHT VTI531
112905	TWR	ALRIGHT VTI531 BEHIND AIRBUS320 SHORT FINAL LINE-UP RWY27 BEHIND BE READY
112910	VTI531	BEHIND TRAFFIC LINE-UP RWY27 BEHIND VTI531
112919	TWR	VBL PLANNED HEAVY DEPARTURE AHEAD
112922	VT-DBL	COPIED SIR VBL
112948	AIC732	N7
112951	TWR	APPROVED N7 VACATION APPROVED
112953	AIC732	AIC732
113001	TWR	AIC732 TURN RIGHT ON N CONTACT GROUND 121.9 BYE BYE
113005	AIC732	1219 NAMASKAR
113013	TWR	VTI531 WIND 150 DEGREE 7 KTS RWY27 CLERAD FOR TAKE-OFF
113019	VTI531	TAKE-OFF 27 VTI531 HEAVY
113109	TWR	VTDBL WIND 140 DEGREES 7 KTS RWY27 CLEAR TO LAND
113115	VT-DBL	RWY27 CLEAR TO LAND VBL
113121	AIC692	TWR AIC692 ILS RWY27
113125	TWR	AIC692 CONTINUE APPROACH RWY27 WIND 140 DEGREE 6 KTS
113129	AIC692	CONTINUE APPROACH RWY27 AIC692
113144	TWR	AIC582 REPORT LEARJET ON SHORT FINAL IN SIGHT
113148	AIC581	AICRCRAFT SHORT FINAL IS IN SIGHT AIC581
113151	TWR	AIC581 BEHIND LANDING TRAFFIC ON SHORT FINAL LINE-UP BEHIND
113154	AIC581	BEHIND LANDING AIRCRAFT SHORT FINAL LINE-UP BEHIND AIC581
113229	TWR	CRASH CRASH CRASH
113235	TWR	FOLLOW ME FOLLOW ME

113239	TWR	AIC581 VACATE RUNWAY VIA ‘N3’
113242	AIC581	VACATE VIA ‘N3’ AIC581
113245	TWR	AIC692 GO AROUND
113250	AIC692	GO AROUND AIC692
113315	TWR	VTDBL
113334	AIC581	VACATED ‘N3’ AIC581

1.10 Aerodrome Information

As on date of the accident, Chhatrapati Shivaji International Airport (CSIA) was managed by Mumbai International Airport Limited (MIAL) and holds licenses for the operation of both IFR (Instrument Flight Rules) and VFR (Visual Flight Rules) traffic. The airport features two cross runways constructed with asphalt, specifically RWY 09/27 and RWY 14/32.

Each runway is marked with designations, threshold markers, touchdown zones, centrelines, and is equipped with lighting for threshold, edge, end, touchdown zone, and centreline.

Runway 27 has a displaced threshold. The landing distance available (LDA) for Runway 27 is 2,965 meters (9,727 feet), and the takeoff distance available (TODA) is 3,448 meters (11,312 feet). Runway 27 is equipped with Category II (Cat II) landing facilities.

ATC services are provided by AAI. The Airport Rescue and Fire Fighting Services are classified as Category 10.

1.11 Flight Recorders

The aircraft was fitted with a solid-state Honeywell Cockpit Voice Recorder (CVR) and an L-3 Communications Fairchild Model FA2100 Flight Data Recorder (FDR). The CVR and FDR record cockpit audio and aircraft flight information, respectively, in digital format using solid-state flash memory as the recording medium.

Both recorders were recovered from the accident site in good condition, and the data were successfully extracted from both units. The downloaded FDR data were read out successfully with manufacturer assistance. The downloaded CVR data were corroborated with the FDR data for analysis. A total of about 02 hours 05 minutes of CVR recording was available for analysis which contained the accident flight.

1.11.1 Synchronization of FDR & CVR Data

Time synchronization was accomplished by aligning the sound of the autopilot (AP) disconnect heard on the CVR (50 seconds from the end of the CVR recording) with the AP disconnect discrete recorded on the FDR. Other key points in the event sequence, such as landing gear deployment and stall warning activation, were used to validate the accuracy of the time synchronization. The conversation between cockpit crew were in Hindi and English but mostly in Hindi. The conversations in Hindi are translated to English for better understanding and continuity. The following salient points were observed:

CVR Time (seconds to end of recording)	Source	Description
5928		The aircraft took-off from Vishakhapatnam Airport
240		Came in contact with Mumbai Tower (118.1 MHz)
225	FO	Speed below 200 kts flaps 20
215	PIC	Calls out …it is raining heavily
180	ATC	Planned Heavy Departure Ahead
175	PIC	Ok..we will slow down…Put the gear down
160	PIC	Take flaps 40
157	FO	Gear down three greens..flaps four zero
145	FO	Carries out landing checklist (No challenge and response)
130	PIC	Again referring to heavy rains in Mumbai
123	ATC	Take-off clearance given to Vistara flight VTI531
100	PIC	Runway Lights in sight
98	FO	Approach Lights in sight
88	PIC	Did you see runway lights?
72	FO	I saw then it vanished
75	Tower	VICTOR TANGO DELTA BRAVO LIMA WIND ONE FOUR ZERO DEGREES SEVEN KNOTS RUNWAY TWO SEVEN CLEAR TO LAND
	At this time the aircraft is on approach to VABB runway 27. The aircraft was at 654 feet AGL, the airspeed was 133kt, while selected airspeed was 132kt, landing gear was down, and flaps were at 40° (fully extended; landing flaps). The AP was engaged on GS (Glide Slope) and LOC (Localizer) mode for an ILS approach. The LOC and GS deviations were approximately 0 dots.	
66	FO	RUNWAY TWO SEVEN CLEAR TO LAND VICTOR BRAVO LIMA
62	PIC	Saw the runway
61	PIC	Ok, Got the lights
59	AI692	TOWER AIR INDIA SIX NINER TWO ILS RUNWAY TWO SEVEN
57	Tower	AIR INDIA SIX NINER TWO CONTINUE APPROACH RUNWAY TWO SEVEN WIND ONE FOUR ZERO DEGREES SIX KNOTS
56	AI692	CONTINUE APPROACH AIR INDIA SIX NINE TWO
52	PIC	Disconnect the Auto pilot
50	FO	Auto pilot disconnected (Sound of auto pilot disconnected BEEP)

	At this point, the aircraft was at 364 feet AGL and airspeed was 138kt. The LOC and GS deviations were approximately 0 dots. Left/Right Throttle Lever Angles (TLA) were 64/62°, and pitch angle was approximately 0° (nose level).	
47	FO	Lighting In Sight
44	FO	A little, yes
39	PIC	Where is it…?(Probably referring to losing sight of runway)
38	Tower	AIR INDIA FIVE EIGHT ONE REPORT LEARJET ON SHORT FINAL IN SIGHT
35	At this point, the aircraft was at 212 feet AGL and airspeed was 131kt. Left/Right TLA were reduced to 59/58°, and pitch angle increased to 3° (nose up). LOC deviation was approximately -0.3 dot (aircraft to the left of centre line). GS deviation was approximately 0 dots but started increasing (aircraft above glideslope) at this time.	
34	AI581	AIRCRAFT ON SHORT FINALS IN SIGHT AIR INDIA FIVE EIGHT ONE
29	Tower	AIR INDIA FIVE EIGHT ONE BEHIND LANDING SHORT FINAL LINE UP BEHIND
27	**Sound of MINIMUMs Aural**	
24	The aircraft was at 172 feet AGL and airspeed was 127kt. Left/Right TLA were reduced to 55/50°, and pitch angle decreased to 2° (nose up). GS deviation was approximately 4 dots (aircraft above glideslope). LOC deviation was approximately 0 dot.	
23	FO	A little right
18	FO	Come on, come to the right, sir
17	PIC	Have we come? (probably asking FO if we are aligned now?)
	FO	RIGHT RIGHT RIGHT
16	PIC	More right?
	At this point, the aircraft was at 122 feet AGL and airspeed was 118kt. Left/Right TLA were reduced to 46/46°, and pitch angle increased to 6° (nose up). The FDR recorded normalized Angle-of-Attack (AoA) at this time was approximately 70%.	
12	FO	No No…Go Around, Go Around, Go Around
	At this point, Left/Right TLA were reduced to 21/21° (approximately idle power). Pitch angle increased to 8° (nose up) and the normalized AoA was approximately 80% (for reference: stick shaker activation occurs at 83% normalized AoA; the maximum value of normalized AoA is 100%; actual stall occurs above 100% of normalized AoA). The aircraft was at 112 feet AGL and airspeed was 111kt.	
10	**Sound of shaker firing accompanied by STALL Aural**	

	At this point Left/Right TLA were advanced to approximately 116° (approximately full power). Pitch angle increased to 12° (nose up) and the normalized AoA was approximately 90%. The aircraft was at 112 feet AGL and airspeed was 105kt.	
9	Normalized AoA reached approximately 100%. Pitch angle had increased to 15° (nose up). Left/Right TLA remained at approximately 116° (approximately full power). The aircraft was at 113 feet AGL and airspeed was 102kt.	
7	**Repeated STALL Aural**	
	Pitch angle decreased to 10° (nose up) and normalized AoA decreased to approximately 90%, however Left/Right TLA were again reduced to 19/19° (idle power). The aircraft was at 122 feet AGL and airspeed was 101kt. Roll angle was approximately 2° (right wing down) and increasing. The FDR recorded the right wing spoileron deploying at approximately one second before this.	
5	Normalized AoA again reached approximately 100%. Pitch angle increased to 13° (nose up). Left/Right TLA remained at approximately 19/19° (idle power). The aircraft was at 122 feet AGL and airspeed was 98kt. Roll angle increased to 10° (right wing down).	
4	**Repeated STALL Aural**	
	FO	SIR SIR SIR
	Normalized AoA remained at 100%. Left/Right TLA remained at approximately 19/19° (idle power). The aircraft was at 122 feet AGL and airspeed was 98kt. Pitch angle was 13° (nose up) but started decreasing at this time, and continued to decrease until the end of the recording. Roll angle increased to 23° (right wing down). The FDR recorded left wing spoileron deploying at this time, and it remained deployed until the end of the recording.	
2	Roll angle reached 53° (right wing down). Pitch angle was -1° (nose down). Left/Right TLA remained at approximately 19/19° (idle power). The aircraft was at 119 feet AGL and airspeed was 96 kt. Subsequent to this point until the end of FDR recording i.e. 0.8 seconds later, the data becomes unreliable.	
1		**Sound of SINK RATE PULL UP**
0		End of CVR recording

1.11.2 Aircraft flight path

The latitude and longitude recorded by the FDR was not precise enough to describe the aircraft path with the required precision. The aircraft path was estimated using the FDR-recorded ground speed, magnetic heading, and the aircraft impact point.

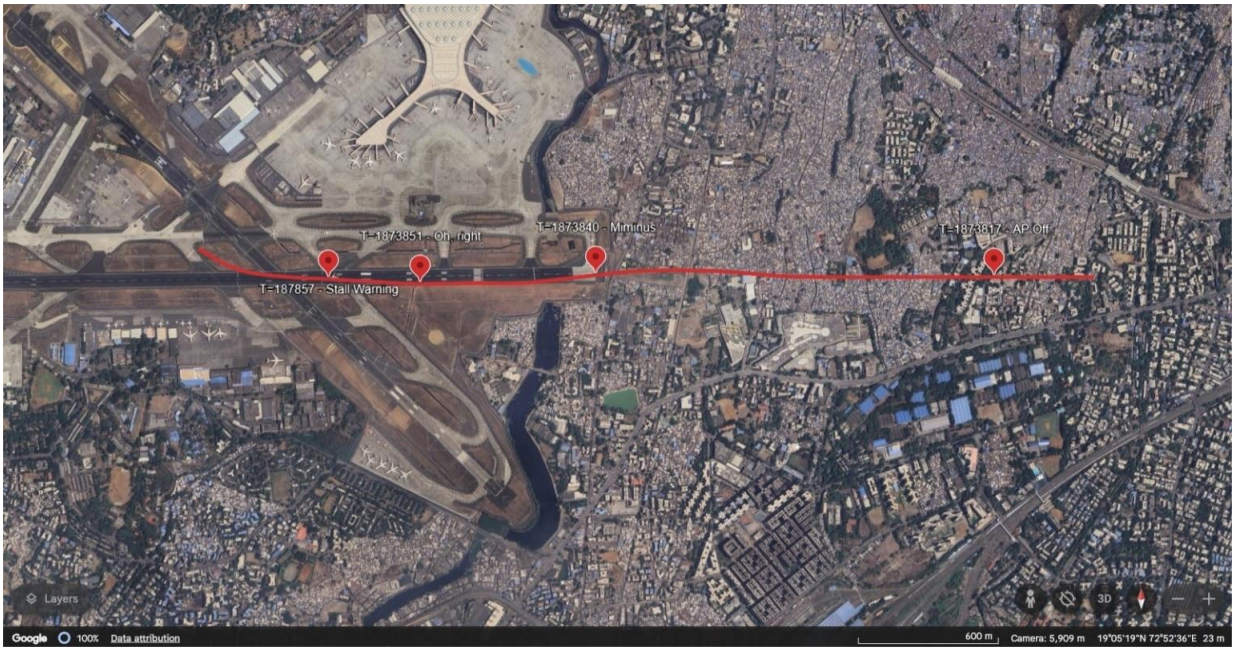

Figure 1: Aircraft Horizontal Path (1- A/P disconnect, 2- sound of MINIMUMS aural, 3 – FO calling out Right Right Right, 4 – Stall Warning

The aircraft vertical path was also estimated using the FDR recorded altitude, GS deviation, and the runway 27 ILS approach features. Figure 2 shows the estimated aircraft vertical path, along with an extract of the runway 27 ILS approach chart for reference.

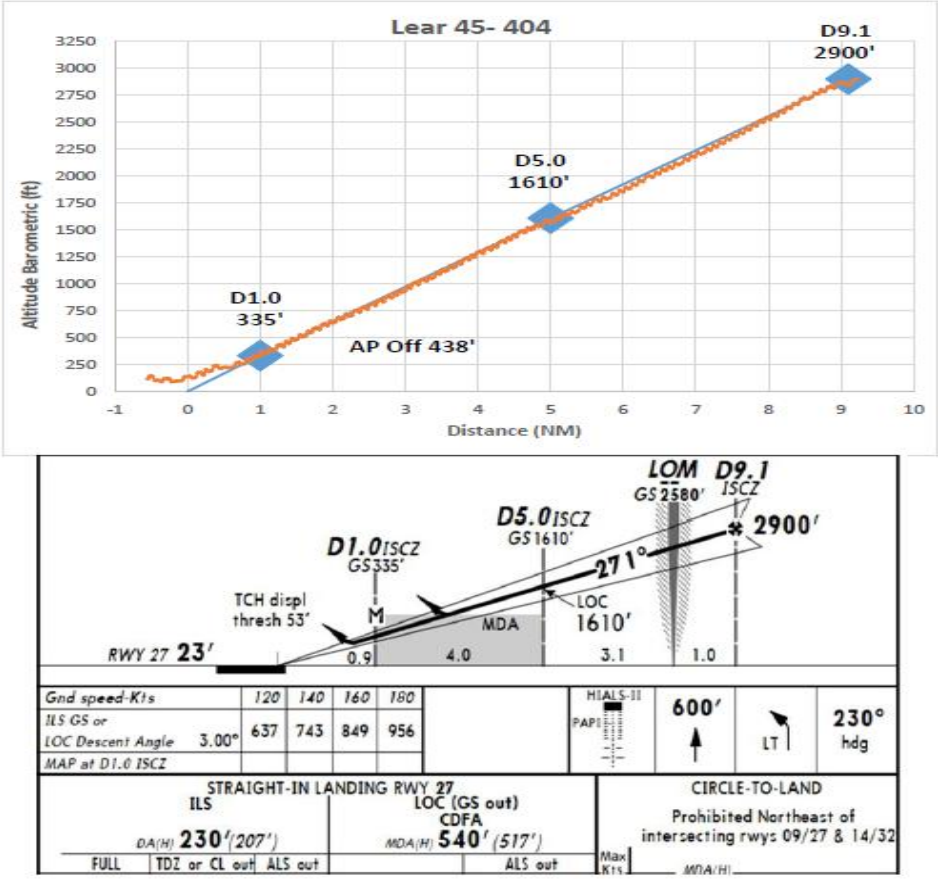

Figure 2: Aircraft vertical path (Reference Jeppesen chart)

1.11.3 Relevant Cockpit Conversation

During the replay of the CVR recordings, it was observed that the crew discussed the AIP, India restrictions for Mumbai airport referring it as a NOTAM and stating that the Mumbai airport is closed for non-scheduled operations after 1200 UTC (1730 IST) and expressed their intentions to land by 1130 UTC (1700 IST). It was further observed that the crew checked with ATC about the availability of "direct-routings" waypoints on multiple occasions throughout the flight.

1.2 Wreckage and Impact Information

1.12.1 Impact information

During the approach the aircraft kept on deviating towards right of runway 27. The roll angle reached upto 53° (right wing down) before impacting the ground at a speed of about 96 Knots. The right wing first impacted the ground followed by the fuselage. The first point of impact with ground was on an unpaved area near the intersection of Taxiway W and Taxiway N, causing the fuselage to fracture into two segments. The aircraft then skidded on the paved surface crossing taxiway N and ultimately coming to a final halt on an unpaved area close to the intersection of Taxiway U and Taxiway N, near stand C80. Broken parts of the aircraft were scattered along its skid path between first point of impact and the final resting position. The first point of impact and the wreckage scatter can be seen in figure 3 below.

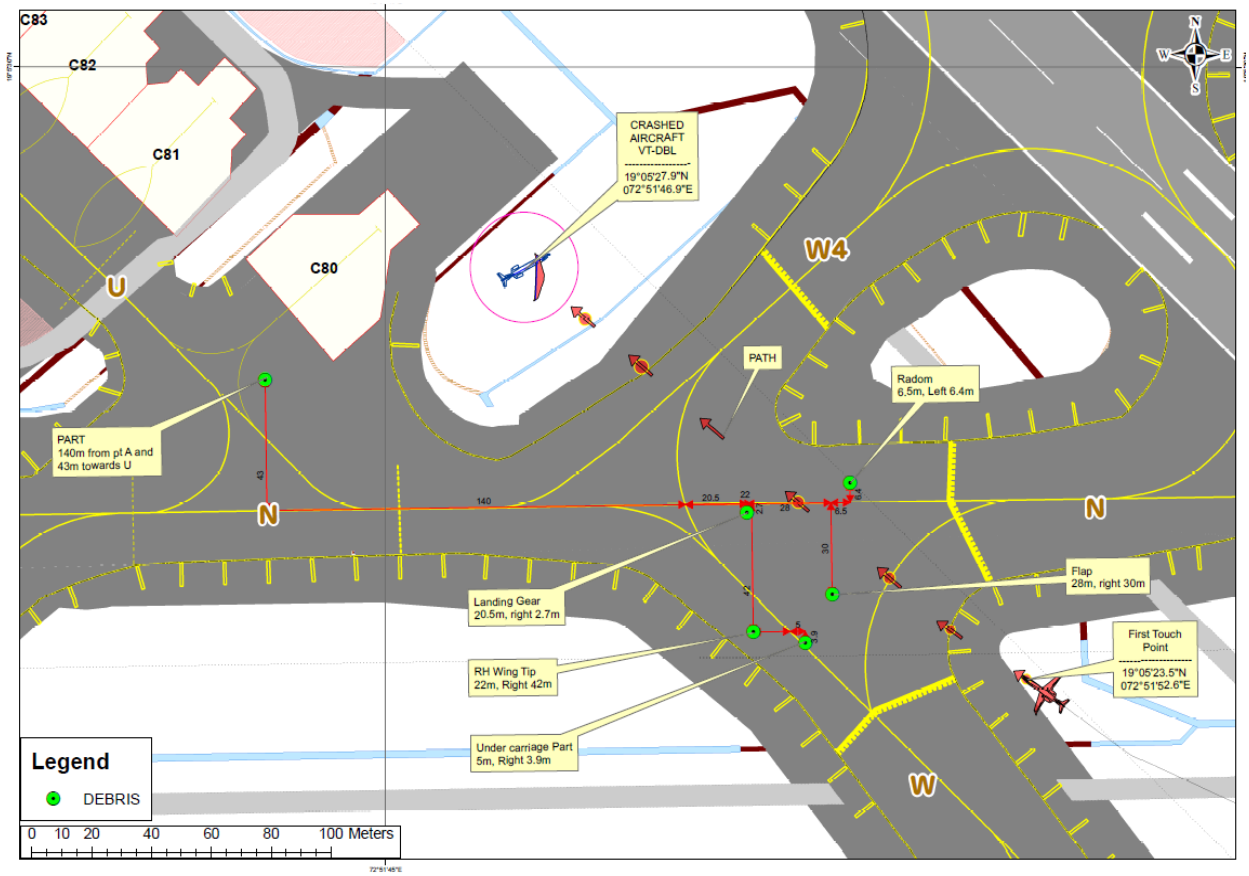

Figure 3: Point of First Impact and wreckage distribution.

Figure 4: Final resting position of Aircraft

1.12.2 Damage Information

During the onsite inspection, following main damages were observed: -

- Nose section of the aircraft sustained impact damages.
- Both the wings got separated from the fuselage structure but found beside the main wreckage area.
- The forward section of the fuselage was found fractured and separated from the central fuselage section.
- Both the nose landing gear (NLG) and main landing gear (MLG) were found broken.
- The empennage and both engines remained attached to the fuselage.
- There were scorch marks beneath the right-hand side engine.

1.13 Medical and Pathological Information

Pre-flight breath analyzer test was conducted for crew members at Vishakhapatnam and the results were satisfactory. Following the accident, a post-flight medical examination was also performed for the crew and no abnormalities were observed.

1.14 Fire

CCTV footage indicates that, following impact, a localized fire occurred on the aircraft's right side, along with several fire pockets in the surrounding wreckage area. At 1132 UTC, upon observing the crash, the tower activated the crash siren and fire bell. The firefighting vehicle proceeded to the accident site and extinguished the fire within two minutes. The fire intensity was low, aided by heavy rainfall. As stated by the fire personnel, approximately 1,760 litres of foam and 32,000 litres of water were used to fully suppress the fire.

1.15 Survival Aspects

Following the accident, the Emergency Locator Transmitter (ELT) was activated and its signal was detected at 1133 UTC. A notification was subsequently received from INMCC, Bangalore.

The ARFF team along with fire tenders reached the site immediately after the crash. After the fire was extinguished, rescue operations were initiated by the responding agencies. As per the statement of ARFF personnel, five injured passengers were able to evacuate the aircraft wreckage unaided and were immediately transported by ambulance to the casualty centre. One passenger was found trapped partially underneath the aircraft on the port side below the cockpit area. The pilot-in-command and co-pilot were trapped in the cockpit and were unable to extricate themselves.

A crane was deployed to slightly lift the aircraft, enabling the successful rescue of the trapped passenger, who was then transferred to the casualty centre. Thereafter, the flight crew were rescued by cutting the starboard side of the windshield. The complete rescue and evacuation process took approximately one hour. All the passengers and crew were moved to nearby hospitals.

All eight occupants sustained injuries of varying severity, consistent with the aircraft's impact profile. The six passengers and the pilot-in-command were discharged after few days of treatment. However, the co-pilot who was occupying the right seat sustained serious spinal and pelvic injuries and was hospitalized for longer period and subsequently underwent surgical intervention. Hence, the accident was survivable.

1.16 Tests and Research

1.16.1 Data retrieved from Enhanced Ground Proximity Warning System (EGPWS)

The aircraft was fitted with a Honeywell MKV Enhanced Ground Proximity Warning System (EGPWS), which provides Class A Terrain Awareness and Warning System (TAWS) functionality, along with reactive windshear detection and warnings for excessive bank angle and radio altitude. The EGPWS unit was removed from the aircraft and sent to the OEM for data download and analysis.

The data was successfully downloaded, and information from the EGPWS unit indicates that it was functional during the flight leg in which the accident occurred.

The EGPWS records 20 seconds of data prior to each caution or warning alert and 10 seconds of data after the alert. During the accident flight leg, a warning was recorded while the aircraft was at VABB Airport. The warning was a Mode 1 "Pull Up" alert, which occurs when an aircraft experiences an excessive descent rate close to terrain. The associated voice alert was "Sink Rate, Pull Up." The location where the Mode 1 "Pull Up" alert occurred, at a radio altitude of 116.8 feet, is shown below.

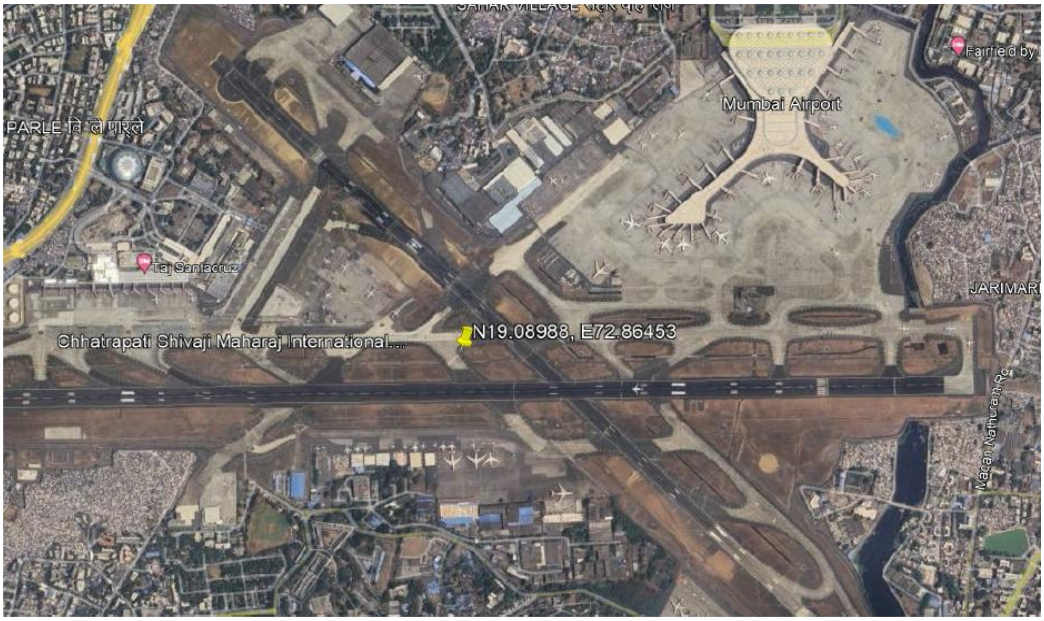

Figure 5: Mode 1 Pull Up Alert

The recorded flight path from the 20 seconds of data prior to the Mode 1 alert shows the aircraft beginning to veer to the right approximately 6 seconds before the alert. The aircraft rolled from 2.1 degrees to 49.2 degrees and pitched from 9 degrees nose-up to 17 degrees nose-down. Subsequently, the Mode 1 alert was recorded. No data was recorded after this alert. The recorded flight path is shown below.

Figure 6: Recorded Flight path for 20 Seconds Prior to Mode 1 Alert

Further, the recorded elevation information from the 20 seconds of data prior to the Mode 1 alert is shown in the image below. It indicates that the aircraft crossed the runway threshold at an unusually higher height (approximately 137 feet above ground level). Based on the difference between computed airspeed and groundspeed, an estimated tailwind of 8–10 knots were present. The aircraft then pitched up and decelerated to approximately 100 knots

calibrated airspeed (CAS) before deviating beyond the right edge of the runway. Approximately 2 seconds before the Mode 1 alert, the aircraft entered a steeper descent.

Figure 7: Aircraft Elevation Information as per EGPWS data.

No data was recorded immediately after the warning because the EGPWS lost power due to impact. Under normal circumstances, 10 seconds of data is expected to be recorded following the alert.

1.16.2 Data retrieved from Digital Electronic Engine Control (DEEC)

The DEECs collect engine and aircraft operational data and record it in non-volatile memory (NVM) for post-accident/incident download and analysis. The purpose of this function is to provide a record of engine speeds, inter-turbine temperatures, aircraft parameters related to engine operation, and control modes during operation. The NVM may contain up to three sets of data useful for accident investigation: event data, incident data, and fault history.

Following the accident, the N1 Digital Electronic Engine Controllers (DEECs), serial number 24-AU0052 installed on the left engine (S/N 132172C) and serial number 51-AJ0001 installed on the right engine (S/N 111113C), were removed from the aircraft and forwarded to the OEM for data retrieval.

The download of the DEEC non-volatile memory (NVM) from both units was completed successfully and included event recorder data, incident recorder data, and fault history data. Analysis of the recorded information showed that both engines were rotating and operating normally and responded appropriately to power lever inputs throughout the approach and the period leading up to the accident. No recorded anomalies were identified that would have inhibited normal engine operation.

1.17 Organizational and management information

1.17.1 VSR Ventures Pvt. Ltd.

M/s VSR Ventures Pvt. Ltd. holds a Non-Scheduled Air Operator Permit issued by the DGCA, which was valid until 20.04.2028. The operator uses a mixed type of fleet which are SKA B200, Pilatus PC-12, Learjet 45 / 45XR / 40XR and EMB 135 BJ (Legacy 600/650) type of aircraft. The maximum seating capacity of these aircraft are 07 to 14 passengers. The operator is undertaking non-scheduled flight operations to airports situated within India, South East Asia, West Asia, and Europe.

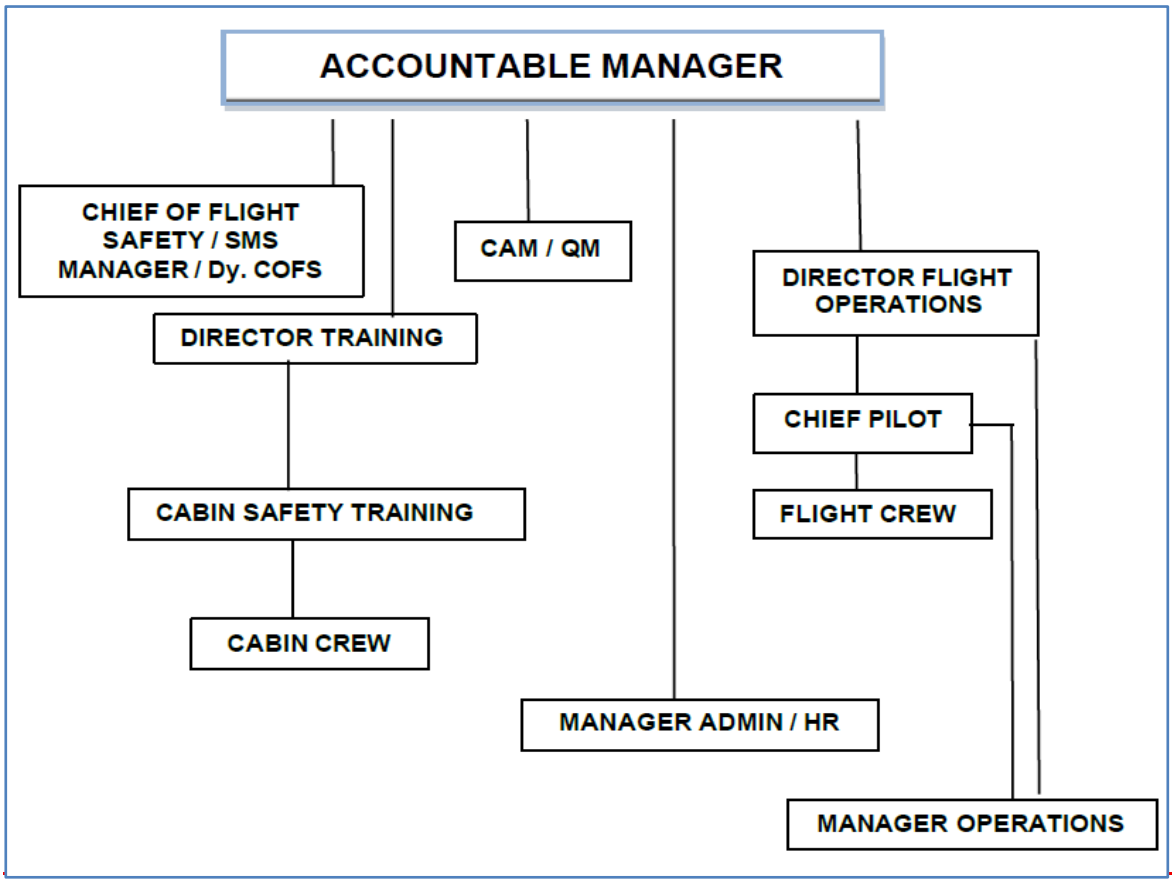

Figure 8: Organization Chart of the operator.

1.17.1.1 Operations Manual of M/s VSR Ventures Pvt. Ltd.

The organization has formulated an operations manual which is approved by DGCA. The salient procedures from the operations manual are discussed in the following paragraphs.

- **<u>Mandatory Missed Approach</u>**

Para 27.a(iii) of the Operations Manual describes the discontinuation of an instrument approach / mandatory missed approach. Pilots shall execute an immediate missed approach if any of the following situations arise:

a) Nav Transmitter or flight instrument failure occurs which will affect the ability to

safely complete the approach in IMC.

b) When on an ILS approach either the localiser and/or glide slope indicator show full deflection in IMC and if at 100 ft to DA/H the glide slope and / or localiser show a deviation of more than 1 dot.

c) When the instruments show significant disagreement and visual contact has not been made.

d) The approach is not stabilised as laid down in Chapter 25.

e) Whenever a GPWS 'PULL UP PULL UP' warning is triggered below 500 ft in IMC.

- **Unstabilised approach**

Para 25 & 27 of the operations manual describes procedures to follow in case of unstabilised approach.

25 (b) Minimum altitude for being stabilized and a description of procedures to be followed in case approach is not stabilized at minimum altitude:

i. Minimum altitude for an approach to be stabilized in case of instrument approach is not later than 1000 ft. and not later than 500 ft. in case of a visual approach.

ii. In case, the approach cannot be stabilized or it gets destabilized, the PM will call "Approach Not Stabilized". If there is no reaction from the Pilot flying, he will again call "Approach Not Stabilized Go Around".

iii. VSR Ventures flight crew will follow the following procedure for GO Around following unstabilised approach:

   a. First Call - "Approach Not Stabilized"

   b. Second Call - If insufficient, incorrect or no response from flying pilot; loudly say "Go around Captain".

   c. Intervention - If no response from Captain, the pilot monitoring / PM shall announce loudly "My controls Captain" and immediately initiate a Go Around" and immediately initiate appropriate go around procedure safely with all available automation and inform the ATC.

iv. Such a situation may arise in case of a visual approach, a non-precision approach or a precision approach being dictated manually in VMC condition. In no case should aero plane continue unstabilised approach below 500ft AGL. Therefore, these actions must be initiated from about 500 feet AGL.

27(a) A description of procedures to be used under which decisions are taken to commence, continue or discontinue an instrument approach.

i. Commencement of Instrument Approach:

a) No VSR Ventures aircraft shall continue an instrument approach to land at any airport beyond a point at which the limits of the operating minima specified for the approach in use would be infringed.

b) A precision approach shall not be commenced if the reported visibility is below 800m, unless an RVR is reported and in which case not below 550m RVR.

c) An instrument approach (ILS/Non-Precision/ Approach) to land procedure will only be commenced when the crew are duly qualified (Restricted/ Normal Minima/LVP qualified).

d) In commencing an approach based on reported RVR/Visibility criteria only, Commander should assess the extent of cloud layers of fog/mist conditions with a view to ensuring that there is a reasonable possibility of acquiring visual reference at DA/H or MDA/H.

- **Internal Audit**

Para 34.36 to para 34.37.3 of the OM provides procedures for internal audit which includes Team Composition, Qualification and Experience of the Members and procedure for Internal Audit (including guidelines).
The investigation team perused the records of internal audits made available to the investigation team and observed that the findings/observations were very generic and did not cover any findings of this investigation. Further, scrutiny of the DGCA Audit/Surveillance reports along with Action Taken report submitted by the operator did not reveal any substantial safety concern. These reports also did not contain any of the findings observed during this investigation.

- **Notification of accidents**

Para 34.21 of the OM provides procedure for accident reporting. As per para 34.21.1

***"Notification of an Accident**: The notice and information of an accident shall be sent as defined under Rule 68 Para 4 of the Aircraft Rules 1937. The accident shall be reported to DGCA and other external and internal agencies as soon as possible, and by the quickest means available and in any case, within 24 hours of their occurrence of the accident. In accordance with Annexure III."*

In the above para and the subsequent paras in respect of Accident/Incident reporting procedures in the OM there are references of old rules i.e. obsolete rules of Aircraft Rules,

1937 which were superseded by the Aircraft (Investigation of Accident and Incidents) Rules, which were initially published in the year 2012 and being amended from time to time. Further, there is no mention of AAIB in any of the reporting channel.

1.17.1.2 Trainings undergone by the pilots

The investigation team perused the training records of the involved crew. On scrutiny of the Performa of the Pilot Proficiency Checks during the one-year checking cycle and also the training on simulators, it was observed that, the remarks against some items listed under 3.6 (Abnormal and Emergency Procedures) such as smoke control and removal, were marked as "Not applicable". Further, the performa for the last simulator training undergone by the co-pilot on 02.01.2023, the training exercise as per item 3.8.1 regarding "recovery from a full stall, or after activation of the stall warning device in climb, cruise, and approach" which is to be carried out during each simulator training was also marked as "Not Applicable". However, the item 3.8.1 during the last simulator training in respect of the PIC, was marked as "Satisfactory".

On observing this discrepancy, the investigation team perused the performa of some of the other pilots of the organisation and in some instances the same discrepancies were observed i.e. some of the mandatory items as specified above and item 3.8.1 which is required to be carried out on each simulator training were marked as "Not Applicable". In order to further examine this, the complete simulator training package of some of the pilots for whom this discrepancy was observed was perused which indicated that some of these items were probably missed during the conduct of simulator training. On enquiring about the same, the Director Training of the operator, stated that the stall recovery item is a mandatory item which is required to be carried out on each simulator training.

Further, on scrutiny of the performa for pilot proficiency checks carried out on the aeroplane for some of the pilots, it was observed that the item 3.8.1 "recovery from a full stall, or after activation of the stall warning device in climb, cruise, and approach" was marked as "Satisfactory". This implies that the training exercise which as per the prevalent regulations is required to be carried out on the simulators only was carried out on the aeroplane. As per the regulatory requirements the Items which are required to be carried out on simulators only can be simulated on aeroplane but only through touch drills. However, the exercise of stall recovery cannot be simulated by touch drills and hence they can be carried out on simulators only. On enquiring about the same with the Director training, it was informed that they were carrying out this exercise on aeroplane by keeping safe margins but discontinued the practice after intervention of DGCA.

1.17.2 DGCA Civil Aviation Requirements (CAR)

1.17.2.1 DGCA CAR on format of the IR/PPC checks

DGCA CAR Section 8, Series F, Part VIII provides flight crew training and qualification

requirements for scheduled commuter and non-scheduled operators having aeroplanes with AUW exceeding 5700 Kgs. Appendix 6 of the said CAR provides the format for License/Type Rating Skill Test/IR PPC Form wherein the exercises which are required to be conducted during various flight crew training is provided.

As per the format, the item 3.8.1 requires following exercise

"Recovery from full stall or after activation of stall warning device in climb, cruise and approach configuration."

The above exercise does not specifically include landing configurations.

1.17.2.2 DGCA CAR on stabilized Approach

Para 4.7 of DGCA CAR section 8 series C part I on All-weather operations prescribes the following procedure

"All approaches shall be flown as stabilized approaches (SAp) unless otherwise approved by DGCA for a particular approach to a particular runway"

1.18 Additional Information

1.18.1 AIP, India – Mumbai Airport

As per the published AIP for Mumbai airport, the General Aviation aircraft and Military aircraft including helicopters are not permitted to operate into Mumbai during the period between 0230 UTC to 0430 UTC and between 1200 UTC to 1400 UTC daily. Only VIP & Scheduled flights are permitted to operate during this period.

The AIP mentions the above operating restrictions to General Aviation and Military aircraft but does not mention about NSOP operations. However, it was observed that the same is applicable to NSOP operations also. In one of the AAI documents (MATS-II) for Mumbai Airport, under para for duties and responsibilities of tower supervisor it is mentioned that

"*As per AIP, India, restrictions exist for non-scheduled operators between 0230-0430 UTC and 1200-1400 UTC. However, if the non-scheduled operations get spilled-over due to congestion, such flights shall be accommodated during the period mentioned in coordination with SMC/TWR controller*"

This implies that the above restrictions were applicable to NSOP operations also.

1.18.2 Wake Turbulence separation minima in case of operation from displaced threshold.

The AAI Manual of Air Traffic Services – Part 1 classifies aircraft into three categories based on maximum certificated take-off mass for the purpose of applying wake turbulence separation minima, namely Heavy (136,000 kg or more), Medium (less than 136,000 kg but

more than 7,000 kg), and Light (7,000 kg or less).

When aircraft are operating on a runway with a displaced landing threshold, wake turbulence separation minima are applied if the projected flight paths are expected to cross in accordance with Para 5.9.6.1 of MATS-I which states that when a Heavy aircraft is departing and is followed by a Light or Medium aircraft arriving on a runway with a displaced landing threshold, a minimum wake turbulence separation of 2 minutes shall be ensured.

1.18.3 Time interval between Departing Heavy aircraft and VT-DBL.

Corroboration of the A-SMGCS recording and DFDR data received from the HEAVY departure operating flight VTI531 rotated near Holding Point N6 at a ground speed of 160 kt. The rotation point of VTI531 is indicated as follows:

Figure 9: Rotating point of VTI531

The MEDIUM category Learjet crossed the displaced runway threshold 45 seconds after the VTI531 became airborne. The threshold crossing time of VT-DBL is indicated as follows:

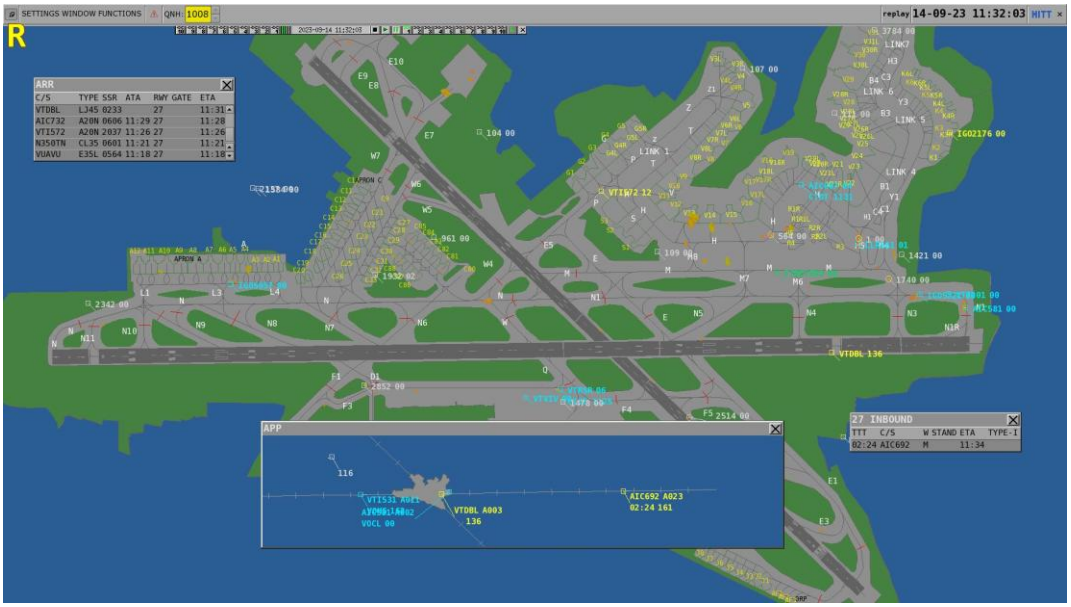

Figure 10: Threshold crossing time of VT-DBL

1.18.4 Stall recovery procedure

As per AFM, the following are the recovery procedure, if the stall warning is activated.

- "**STALL**" **Voice Activates**

The stall warning computer has sensed a limit angle of attack. This warning will also be accompanied with the activation of the control column stick shaker.

Note: If the aircraft is allowed to decelerate below stall warning angle of attack, priority must be given to immediately reducing the angle of attack rather than attempting to maintain altitude. Stall recovery from typical cruise altitudes and other relatively low thrust conditions will require a significant loss of altitude.

1. Lower the pitch attitude to reduce angle of attack.
2. Thrust Levers — T/O (manual APR if required).
3. Level the wings.
4. Accelerate out of stall condition.

1.9 Useful or effective Investigation Techniques

Nil

2. Analysis

The analysis was carried out based on the available evidence such as Crew & Controllers Statements, ATC Tape, DFDR data, CVR data, RADAR display, relevant aircraft documents, etc.

2.1 General

The aircraft had a valid Certificate of Registration, Certificate of Airworthiness, and all other relevant certificates, which were valid as on date of the accident. All applicable Airworthiness Directives, mandatory Service Bulletins, and DGCA Mandatory Modifications pertaining to the aircraft and its engines had been complied with as of the date of the event. The centre of gravity was within the prescribed aircraft limits. Flight recorders data, CVR recording and the aircraft maintenance/technical log did not indicate any abnormality in the aircraft prior to the accident.

The flight crew held valid licences and met all regulatory requirements to operate the flight. Their medical certifications and required training were current as of the date of occurrence. Both the pilots were based in Mumbai and had previously operated flights to Mumbai. Hence, they were aware of the topography of the Mumbai airport.

The ATC controller held a valid licence and was qualified to operate radiotelephony services at Mumbai Tower at the time of the accident.

2.2 Weather Aspect

At the time of the accident, the reported visibility was 800 m and the runway visual range (RVR) was 1000 m. Heavy rain was prevailing in the area. As per the company SOP, an approach shall not be continued below an RVR of 550 m; therefore, the reported RVR was within the prescribed limits. Subsequently, aircraft continued its approach and was within its approach path. The crew called out “Approach/runway lights in sight” and subsequently autopilot was disengagement at about 364 feet. However, the approach thereafter became unstable. The aircraft did not align with the runway centreline for rest of the approach barring for a few seconds while attempting to align with the runway from left deviation. However, the aircraft again crossed the runway centreline and kept on deviating further to the right of the centreline.

The aircraft descended below the glideslope while the pilot attempted corrective inputs. During this process the PIC called out “Where it is?” probably referring that he lost the sight of runway. Further, the PIC in his statement mentioned that they encountered dark clouds during this period and it was reported to be raining heavily at that time. The forward visibility was possibly further degraded due to heavy rain conditions and the PIC momentarily lost sight of the runway. During this time, approach lights was ON and crew did not report any abnormality regarding the intensity of the approach/runway lights.

Further, the winds at the time of landing clearance were reported to be 140^{o}/07 knots and

subsequently during the approach clearance given to the next aircraft behind VT-DBL, it was reported to be 140°/06 knots. However, as per the DFDR/EGPWS data based on difference between computed airspeed and groundspeed, an estimated tailwind of 8–10 knots were present.

In view of the above, it is highly probable that heavy rain and reduced visual cues may have degraded the pilots' external references during the visual segment of the flight due to which the crew were unable to align the aircraft with the runway centerline. Also, the tail wind component further degraded the situation. Hence, weather was a contributory factor to the accident.

2.3 Human factors and Non-adherence to Standard Operating Procedures

2.3.1 Non-adherence to Standard Operating Procedures

The flight data recorder showed that the approach remained normal until the aircraft passed 364 feet where the autopilot was disconnected and the remainder of the flight was flown manually.

Subsequent to the disengagement of autopilot, the aircraft was not stabilized wherein glideslope deviation exceeded one dot and later increased to approximately four dots (the ILS deviation limit is one dot). The operator policies require a go-around if the deviation exceeds one dot below 1,000 feet during IMC conditions. Instead, the crew continued the approach.

Further, during the approach, the PIC observed that the aircraft is right of the centerline and in order to align with the runway centerline did an overcorrection resulting in aircraft deviating towards left. The FO kept on calling out "Right..Right" in order to correct the deviation and the PIC was trying to align the aircraft with runway centerline. The aircraft thereafter started deviating towards right of the centerline. During this process the PIC lost visual contact with runway as a result of heavy rain and encountering dark clouds (as stated by PIC) but instead of initiating a go-around decided to continue the approach.

The FO called for a go-around when the aircraft crossed the runway centerline and started deviating to the right of the centerline. However, by this time the airspeed had already dropped below Vref with substantial increase in pitch angle. The power at this time was approximately close to idle power. Thereafter, the PIC tried to initiate a go-around by advancing the throttle to almost maximum power, however, by this time, stick shaker got activated. The PIC after evaluating the situation found that the recovery from stall was not possible at that stage as the aircraft had already entered into an low-altitude stall. Hence, the PIC instead of carrying out the stall recovery procedure as laid down in the AFM, retarded the power to idle and reduced the pitch. However, the pitch attitude thereafter continued to increase and the aircraft began rolling towards right, with roll angle towards right (right wing down) increasing.

The aircraft then entered into an unrecoverable low-altitude stall with significant roll (53° right wing down), decreasing airspeed, and increasing nose-down pitch attitude. This was consistent with the statement of PIC who stated that once the aircraft entered into unrecoverable low-altitude stall and continuous deviation towards right of the runway centerline, the PIC deliberately turned the aircraft further to the right by banking the aircraft further to the right to avoid the inhabited area ahead in the flight path.

In view of the above, it is evident that the loss of control was resulted from an aerodynamic stall induced by excessive nose-up pitch attitude, insufficient airspeed, and inappropriate power management during the final approach phase. It is therefore inferred that despite continuous deviations from the stabilized criteria during approach, the landing was continued while attempting to regain centerline alignment, resulting in unstable lateral control. Hence, non-adherence to the standard operating procedures for delaying the initiation of go around when the aircraft was not stabilized and improper handling of controls during the final approach led to the accident.

2.3.2 Checklists & procedures

During the analysis of the CVR recordings, it was observed that the crew did not carry out the landing checklists thoroughly as per the laid down procedures. Further, the checklist was carried out by one pilot only without following the laid down procedures of challenge and response wherein one pilot (pilot monitoring) reads an item ("challenge") and the second pilot (pilot flying) verifies it and responds to it.

Further, the FO performing the duties of pilot monitoring, was aware that the aircraft was not meeting the stabilized criteria during the final approach but did not call out for “go-around” during the initial phase of unstabilized approach. Also, no call out was made by the FO during the phase wherein the airspeed was washing out (approaching Vref) with substantial increase in pitch and Normalized AoA. Subsequently, the FO did call out for go-around, however, the stall warning got activated after 5.2 seconds of the call out.

Hence, despite the awareness of the deviation from the stabilized criteria during the final approach, the FO, as the pilot monitoring, did not intervene to call out for go-around during the initial phase of unstabilized approach thereby not adhering to the standard operating procedures which was a contributory factor to the accident.

2.3.3 Human Factors

The analysis of the CVR recordings revealed that the crew intended to land before the operating restriction are evoked at Mumbai Airport as per the AIP, India which does not allow non-scheduled operations between 1200 UTC to 1400 UTC. This was evident from the conversation the crew had between them regarding the said restriction and the regular request made by them to the ATC to provide the direct routes to Mumbai in order to save time. Hence, it is highly probable that the crew continued the unstabilized approach and

delayed initiating a go-around contrary to the SOPs as they were committed to land before the time restrictions as per the AIP, India at Mumbai airport. By the time the go-around was initiated, the stick shaker followed by stall warning got activated.

In view of the above, it is inferred that the undue commitment of the crew to land the aircraft before the existing restrictions in Mumbai which probably prompted them to continue the unstablized approach contrary to the laid down SOPs was a contributory factor to the accident.

2.3.4 ATC Aspect

ASMGCS replay and CVR recordings indicated that the aircraft VT-DBL established initial contact with Tower at 112827 UTC. The aircraft was instructed to continue the approach, with the surface wind reported as 150°/08 knots. At 112921 UTC, the Tower controller informed VT-DBL of the planned heavy-category departure of flight VTI531.

As the departing heavy-category aircraft Boeing B777 and the arriving medium-category Learjet 45XR were operating on the same runway, and the arriving aircraft was carrying out a long landing, the prescribed wake-turbulence separation criteria under the applicable provisions of MATS Part I were applicable. This requires a minimum separation of 2 minutes between a heavy departure and a medium arrival when the flight path of the arriving medium aircraft is expected to cross that of the departing heavy aircraft.

In the present case, heavy aircraft B777 operating flight VTI531 departed prior to the arrival of the aircraft VT-DBL and as per the ASMGCS recordings, the medium aircraft VT-DBL crossed the displaced threshold approximately 45 seconds after the heavy aircraft VTI531 became airborne. The ATC controller evaluated that the separation between the two aircraft was sufficient and the arriving aircraft VT-DBL will not cross the wake left by the preceding heavy aircraft at the point of its lift-off. However, the controller did not account for the prevailing weather conditions wherein there was a possibility for a go-around or a delayed landing in which case the aircraft VT-DBL could have entered into the wake zone created by the preceding heavy aircraft. Hence, it was probable that the required procedural separation was not maintained in accordance with the MATS 1 procedure.

On analyzing the ASMGCS recordings and DFDR data, it was evident that the rotation point of the heavy aircraft was well beyond the actual flight path of VT-DBL and the aircraft VT-DBL did not cross the wake zone created by the preceding heavy aircraft. Hence, there was no wake-vortex interaction with the approaching aircraft VT-DBL which may have affected its controllability.

From the above, it can be concluded that there was no evidence of wake turbulence which may have contributed to the accident, even though the minimum separation requirement was not met.

2.4 Organizational Factors

2.4.1 Record Keeping

The investigation team perused the various maintenance documents pertaining to the aircraft VT-DBL submitted by the operator. There were some discrepancies found in these documents which are mentioned below.

Technical log-book

The scrutiny of technical logbook revealed the following salient observations: -

- Details like aircraft Registration, last Inspection carried out, work order number, next inspection due, CRS number details were not filled in some of the pages of the logbook.
- Pilot Acceptance certificate details were not filled in some of pages of the logbook as per sector wise.
- Rectification Action column (even if NIL) were not filled in the pages of logbook.

Airframe Logbook:

- Aircraft Registration, details of Engine(s) fitted were not filled in some of pages of the logbook.
- Hours brought forward is not filled in some of the pages of the logbook.
- Certifying Staff Stamp/Seal is not found/missing in some of the tasks, pages of the logbook.
- Some of the scheduled maintenance task/checks were carried out by other DGCA Approved CAR 145 Organizations for which the Work order details were not mentioned in the slips pasted on log book.
- Certifying Staff Name was not found/missing in some of the tasks mentioned in the pages of the logbook.

In view of the above, it is inferred that the upkeep of the maintenance documentation in the company was not as per the standard practices.

2.4.2 Training of company pilots

Appendix 6 of DGCA CAR Section 8, Series F, Part VIII provides the format for License/Type Rating Skill Test/IR PPC Form wherein the exercises which are required to be conducted during various flight crew training is provided.

The investigation team perused the training records of the involved crew. On scrutiny of the Performa of the Pilot Proficiency Checks during the one-year checking cycle and also the training on simulators, it was observed that, the remarks against some items listed under 3.6 (Abnormal and Emergency Procedures) such as smoke control and removal, were marked as “Not applicable”. Further, the performa for the last simulator training undergone by the co-

pilot on 02.01.2023, the training exercise as per item 3.8.1 regarding “recovery from a full stall, or after activation of the stall warning device in climb, cruise, and approach” which is to be carried out during each simulator training was also marked as “Not Applicable”. However, the item 3.8.1 during the last simulator training in respect of the PIC, was marked as “Satisfactory”.

On observing this discrepancy, the investigation team perused the performa of some of the other pilots of the organisation and in some instances the same discrepancies were observed i.e. some of the mandatory items as specified above and item 3.8.1 which is required to be carried out on each simulator training were marked as “Not Applicable”. In order to further examine this, the complete simulator training package of some of the pilots for whom this discrepancy was observed was perused which indicated that some of these items were probably missed during the conduct of simulator training. On enquiring about the same, the Director Training of the operator, stated that the stall recovery item is a mandatory item which is required to be carried out on each simulator training.

Further, on scrutiny of the performa for pilot proficiency checks carried out on the aeroplane for some of the pilots, it was observed that the item 3.8.1 “recovery from a full stall, or after activation of the stall warning device in climb, cruise, and approach” was marked as “Satisfactory”. This implies that the training exercise which as per the prevalent regulations is required to be carried out on the simulators only was carried out on the aeroplane. As per the regulatory requirements the Items which are required to be carried out on simulators only can be simulated on aeroplane but only through touch drills. However, the exercise of stall recovery cannot be simulated by touch drills and hence they can be carried out on simulators only. On enquiring about the same with the Director training, it was informed that they were carrying out this exercise on aeroplane by keeping safe margins but discontinued the practice after intervention of DGCA.

Hence, the training department of the operator did not identify this discrepancy thereby not complying with the company policy/ regulatory requirements which requires them to ensure that each mandatory items as per the laid down regulatory requirements are carried out during each simulator training of company pilots. Further, the exercise as per item 3.8.1 does not specifically mention landing configuration.

2.4.3 Operations Manual

The operations manual of the organisation was approved by DGCA. During the investigation, it was observed that in many places in the document, references of previously existing Accident Investigation Rules of Aircraft Rules, 1937 are mentioned which have been omitted and superseded by the Aircraft (Investigation of Accidents & Incidents) Rules in the year 2012 and subsequently gone through various amendments. Further, the rules mentioned in the document are not in line with the prevailing regulations in respect of aircraft accident investigation.

The above observations had no bearing on the accident. However, there is a need to address these issues so that the operators/organizations are aware of the current regulations in place. This will help them to act accordingly and take necessary actions in case of any accidents/serious incidents/incidents without any ambiguity.

2.4.4 Audits and Surveillance

During the investigation process, the investigation team brought out various findings which could have been identified by the organisation during their internal audits. The investigation team also perused the records of internal audits made available to the investigation team and observed that the findings/observations were very generic and did not cover any findings of this investigation. Hence, the internal audits were not being carried out diligently by the company as per the laid down procedures.

Further, scrutiny of the DGCA Audit/Surveillance reports along with Action Taken report submitted by the operator did not reveal any substantial safety concern. These reports did not contain any of the findings observed during this investigation.

2.5 Circumstances leading to the accident

The take-off from Vishakhapatnam and subsequent flight until approach to Mumbai was uneventful. The crew did not observe any abnormality in the aircraft during the entire flight. The aircraft came in contact with Mumbai tower at 112824 UTC and as per the MET information of 1130 UTC, the reported visibility was 800 m and the RVR was 1000 m which was within limits as per SOP. Hence, the crew continued the approach and the aircraft was within its approach path. However, heavy rain was prevailing in the area during that time. The crew called out “Approach/runway lights in sight” and subsequently autopilot was disengaged at about 364 feet. However, the approach thereafter became unstable.

Initially, the PIC reported a perception of being to the right of the runway centreline and initiated a correction towards it. When the aircraft was at 212 feet AGL, the airspeed was 131 knots, pitch angle was 3 degrees, the LOC deviation was -0.3 dot and the aircraft just started to come above glideslope. At 172 feet AGL, the airspeed got reduced to 127 knots, GS deviation was 4 dots (aircraft above glideslope) and the LOC deviation was 0 dot. As per the EGPWS data at the time of crossing the threshold of runway 27, the aircraft was approximately 137 feet AGL which was higher than normal and was slightly left of the runway centreline. This was due to an overcorrection towards the left side of the runway wherein the aircraft started deviating further to the left. Despite the approach not meeting the stabilized criteria, the crew did not initiate a go-around at that stage and instead kept on trying to align the aircraft with the runway centreline as they were probably committed to land the aircraft before the time restriction for NSOP operations at Mumbai.

During this process, the PIC lost visual contact with the runway due to heavy showers and probably encountering dark clouds which further degraded the visibility of PIC. The EGPWS

data showed tail wind component of about 8 to 10 knots which again adversely affected the approach. The co-pilot kept calling out “right right” and the PIC was following the callouts given by the co-pilot and was trying to align the aircraft with runway centreline. The aircraft thereafter started moving towards the right and when the aircraft was at 122 feet AGL, the airspeed got reduced to 118 knots i.e. below the Vref speed of 119 knots. The pitch angle was 6 degrees and normalised AoA was about 80%. As the airspeed was decaying throughout this process which eventually got reduced below Vref, no call outs for speeds were made by the PM. Thereafter, on realising that the aircraft is deviating further to the right of the runway centreline, the PM calls out for a Go Around. At this point the aircraft was at 122 feet AGL, both TLA was reduced to 21 degrees (approximately idle power), with pitch increased to 8^{o} nose up and normalised AoA increased to 80% and speed got reduced to 111 knots.

‘Within 02 seconds, when the aircraft was at 112 feet AGL, the speed further reduced to 105 knots, and the PF in order to initiate a Go around increased the power as both TLA’s were advanced to 116 degrees (Approximately full power). However, simultaneous to this input by the PIC, stick shaker got activated. The pitch was then increased to 12 degrees (Nose up) and normalised AoA was increased to approximately 90%.

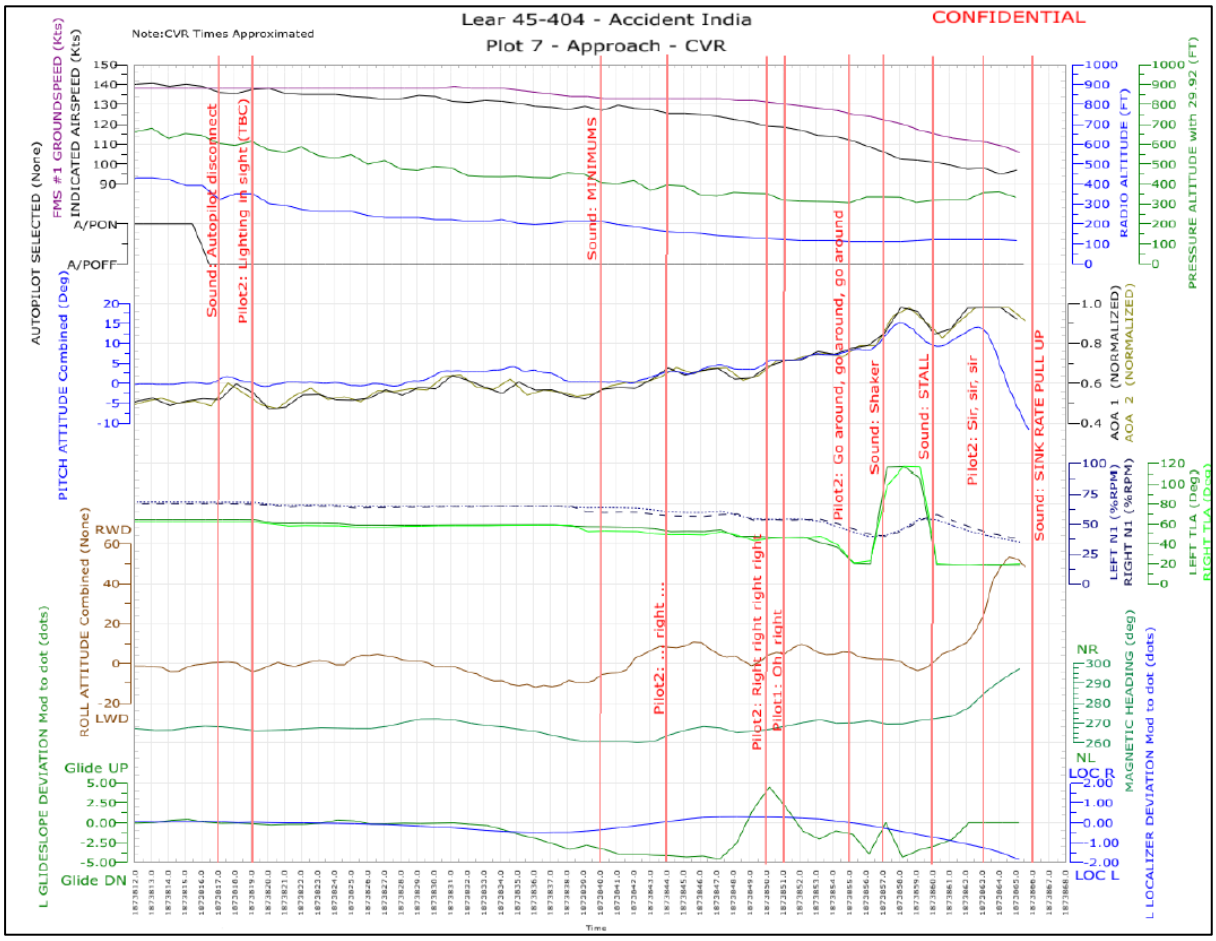

Figure 11: FDR plot depicting the approach phase with CVR synchronization.

Thereafter, the normalised AoA and pitch angle were further increased upto 100% and 15

degrees (nose up) respectively with TLA remained at 116 degrees for further 02 seconds. During this period, there was repeated stick shaker activation.

The PIC on observing that the aircraft is not climbing as expected with stick shaker activated, suddenly reduced both the TLAs to 19 degrees with pitch angle reduced to 10 degrees (Nose up) and the speed got reduced to 101 knots. This input by the PF was inconsistent with the published stall recovery techniques which requires pilot to increase the power and lower the nose of the aircraft. However, this input was given based on the assessment of the PF that the aircraft was not climbing as it had already entered into low altitude stall from where recovery was very difficult. Simultaneous to this input by the PF, the stall warning got activated. As the aircraft was still moving towards the right side and with reduction in airspeed, the right side spoileron got deployed first which further reduced the speed and increased the drag on the right side thereby initiating a roll towards right (right wing down). In the next 02 seconds, the pitch and Normalised AoA again increased to 13 degrees (nose up) and 100 % respectively with speed getting further reduced to 98 knots. As the aircraft was close to/attained stall speed, the roll angle kept on increasing towards right. Thereafter, the PF on realizing that the aircraft had lost control and in order to avoid the inhabited area ahead, initiated further roll to the right. This was consistent with the DFDR data wherein within 02 seconds, the pitch as well as Normalised AoA started decreasing with roll towards right side increased to 23 degrees. During this time, the left wing spoileron also got activated. The aircraft kept on rolling towards right with roll angle increasing upto 53 degrees (right wing down) and deviating further away towards right of the runway. The aircraft then impacted the ground heavily in a nose down attitude at a speed of about 96 knots and skidded on the ground before coming to final halt.

3. Conclusion

3.1 Findings

3.1.1 The Certificate of Airworthiness, Certificate of Registration and Airworthiness Review Certificate of the aircraft were valid on the day of accident

3.1.2 The load & trim for the flight was prepared and the C.G was within the limits.

3.1.3 There was no reported snag pending on the aircraft prior to the accident.

3.1.4 Both the crew were qualified to operate the flight.

3.1.5 The ATC controller (Tower) was having valid license and was qualified as on date of the accident to perform the controller duties.

3.1.6 The crew did not find any abnormality in the aircraft before operating the flight. There was no abnormality observed on the aircraft by the flight crew during the entire accident flight.

3.1.7 The DEEC data analysis also revealed that both the engines were running normally at the time of accident and responded to the commands given by the crew during the entire flight. Hence, serviceability of the aircraft did not contribute to the accident.

3.1.8 The log books pertaining to the aircraft like technical log book, airframe log book was not maintained properly as per the laid down procedures.

3.1.9 Scrutiny of training records of Learjet pilots of the company reveled that during the recurrent trainings of some pilots the critical emergency items listed in the Performa of the IR/PPC/Skill Checks were not carried out "in toto" during the one-year checking cycle, including the training on simulators.

3.1.10 The internal audits were not carried out diligently by the company.

3.1.11 The DGCA audit/surveillance reports of the organization perused by the investigation team did not had any significant safety findings. The reports did not contain any of the findings of this investigation.

3.1.12 The crew discussed about the restriction of Non-Scheduled/General Aviation operations after 1200 Hrs UTC at Mumbai. The crew on multiple occasions checked with ATC about the availability of "direct-routings" waypoints throughout the flight as they were concerned about the aerodrome closure and were committed to land before the restricted time.

3.1.13 At the time of the accident, the reported visibility was 800 m and the runway visual range (RVR) was 1000 m due to heavy rain prevailing in the area at that time. Although the reported RVR was within the prescribed limits, however, it is highly probable that heavy rain and reduced visual cues may have degraded the pilots' external references during the visual segment of the flight. Further, during the approach the tail wind component varied between 8 to 10 knots which again hampered the approach. Hence, weather was a contributory factor to the accident.

3.1.14 The approach lights were ON and the crew did not report any abnormality regarding the intensity of the approach lights.

3.1.15 The approach into Mumbai was normal till 364 feet altitude where the autopilot was disconnected and the aircraft was flown manually thereafter.

3.1.16 The approach after autopilot disconnect at 364 feet was not stabilized; however, the crew continued the approach even with marginal weather conditions thereby not adhering to the SOPs which requires initiation of go-around under such circumstances.

3.1.17 The PIC who was pilot flying kept on trying to align the aircraft with the runway centerline as per the call out made by the first officer for correction. However, during

this process did not realize the substantial reduction in airspeed and increase in nose up pitch attitude and normalized AoA due to inappropriate power management. This resulted into aerodynamic stall and subsequently to loss of control of the aircraft at low altitude.

3.1.18 Once the aircraft entered into low altitude stall with aircraft deviating right of runway and rolling towards right, the PF deliberately banked the aircraft further to the right to avoid inhabited area ahead.

3.1.19 The first officer as pilot monitoring did not call out for go around during the initial phase of approach when the aircraft was not maintaining the stabilized criteria thereby not adhering to the SOP which was a contributory factor to the accident. The go around call was made at a very lower height close to aircraft attaining stall from where the recovery was difficult.

3.1.20 The landing checklists were carried out by only one pilot without following the standard practice of challenge and response.

3.1.21 The minimum separation requirement as per the laid down procedures in the MATS-I was not met in this case as a heavy aircraft departed approximately 45 seconds prior to the arrival of accident aircraft VT-DBL against the minimum separation requirement of 02 minutes. The controller however, informed the aircraft VT-DBL about the departure of heavy aircraft.

3.1.22 The rotation point of the heavy aircraft was well beyond the touchdown zone and the actual flight path of VT-DBL. Hence, the wake turbulence of the heavy aircraft was not a contributory factor, even though the minimum separation requirement was not met.

3.1.23 The rules mentioned in the operations manual of the organization approved by DGCA are not in line with the prevailing regulations in respect of aircraft accident/incident investigation.

3.1.24 The exercise corresponding to Item 3.8.1 of the format for License/Type Rating Skill Test/IR PPC Form does not specifically mention about landing configuration.

3.2 Probable cause of the accident

The probable cause of the accident was the flight crew's decision to continue the un-stabilized approach under marginal weather conditions and inappropriate handling of aircraft which led to an aerodynamic stall at low altitude from which the aircraft did not recover.

The following were the contributory factors to the accident: -

- Flight crew's non-adherence to SOP for not monitoring the airspeed against a rising low-speed cue.

- Pilot Monitoring's non-adherence to SOP for delay in calling out for go-around.
- Marginal weather conditions prevailing at that time which impaired flight crew's visual cues and high tail wind component.
- Undue commitment to land the aircraft before the restricted time as per the existing restriction at Mumbai.

4. Safety Recommendations

It is recommended that

4.1 DGCA may re-look into the training requirements for re-current training as per the Performa for IR/PPC/skill check and consider amending the item 3.8.1 to include stall recovery in landing configuration also i.e. the pilots during each simulator training shall undergo training exercise of "recovery from a full stall, or after activation of the stall warning device in climb, cruise, approach and landing configurations."

4.2 DGCA may carry out one time check of all the training records of fixed wing pilots specially for Non-Scheduled/General Aviation organizations to verify whether all mandatory exercises are carried out during each simulator training.

4.3 DGCA may issue specific directions as deemed fit to all Non-Scheduled/General Aviation operators to develop specific methodologies to ensure that the pilots undergo all the mandatory training including critical emergencies as per laid down regulatory requirements. Further, these methodologies should also include verification of the training records of the pilots from time to time to ensure there are no discrepancies in the trainings undergone by the pilots.

4.4 DGCA may issue specific direction to all NSOP/General Aviation (GA) operators to strictly adhere to the laid down procedures wherein the pilots are sensitized to carry out a go-around during any time of the approach if it is not stabilized.

4.5 DGCA may issue specific directions to all NSOP/GA operators to ensure that the internal audits are carried out in true letter and spirit. The effectiveness of the internal audits may be checked during the audits/surveillance of these organisations.

4.6 DGCA may issue specific direction to all NSOP/GA Operators to enhance crew resource management training and emphasising the requirement of flight crew assertiveness of callout(s) to be made by the pilot monitoring, when there is any deviation from the flight parameters particularly during critical phases of flight.

4.7 M/s VSR Ventures may sensitize their pilots to ensure that cockpit crew carry out proper challenge-and-response checklists by verifying the settings and ensuring all systems are properly configured for safe operations as per the SOP.

4.8 M/s VSR Ventures may sensitize their maintenance/engineering personnel to maintain the aircraft documents such as technical log books, airframe log-books as per the laid down procedures in order to ensure that all entries are recorded without fail.

4.9 AAI may sensitize their controllers to maintain the required separation between the aircraft to mitigate wake turbulence as per the laid down procedures in MATS-I.

4.10 DGCA may verify the manuals submitted by the operators to ensure that these are in line with the existing regulations.