



**Final Investigation Report on Serious Incident of Runway Undershoot involving
M/s Alliance Aircraft VT-RKF on 08.10.2024 at Bhubaneswar Airport**

**Aircraft Accident Investigation Bureau
Government of India
Ministry of Civil Aviation**

FOREWORD

This document has been prepared based on the evidence and various statements of the personnel involved collected during the investigation and opinions obtained from experts. The investigation has been carried out in accordance with **Annex 13 to the Convention on International Civil Aviation Organization (ICAO)** and under **the Aircraft (Investigation of Accidents and Incidents) Rules, 2025 of India**. The investigation is conducted not to apportion blame or to assess individual or collective responsibility. The sole objective is to draw lessons from this incident, which may help prevent similar incidents in the future.

GLOSSARY

Abbreviation	Meaning
AAIB	Aircraft Accident Investigation Bureau, India
ARC	Airworthiness Review Certificate
ATC	Air Traffic Control
ATS	Air Traffic Service
AP	Auto pilot
C of A	Certificate of Airworthiness
CVR	Cockpit Voice Recorder
CRM	Crew Resource Management
CFIT	Control flight into terrain
DFDR	Digital Flight Data Recorder
DGCA	Directorate General of Civil Aviation
daN	Dekanewton
ELT	Emergency Locator Transmitter
FDMA	Flight Data Monitoring Analysis
Hrs	Hours
YD	Yaw Dampers
IST	Indian Standard Time
IAS	Indicated Air Speed
GPWS	Ground Proximity Warning System.
FADEC	Full Authority Digital Engine Control
GPS	Global Positioning system
LAT	Latitude
LONG	Longitude
LLZ	Localizer
RALT	Radio Altitude
METAR	Metrological Report
MFD	Multi Function Display
OEM	Original Equipment Manufacture
ROD	Rate of Descent
SB	Service Bulletin
SOP	Standard Operating Procedure
T2CAS	Traffic and Terrain Collision Avoidance System
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
IFR	Instrument flight rules
ILS	Instrument Landing System

Section no.	Title	Page no
1.0	Factual Information	
1.1	History of Flight	7
1.2	Injuries to Persons	8
1.3	Damage to Aircraft	8
1.4	Other Damage	13
1.5	Personnel Information	14
1.5.1	Pilot in Command (Pilot Flying)	14
1.6	Aircraft Information	15
1.7	Meteorological Information	18
1.8	Aids to Navigation	19
1.9	Communication	19
1.10	Aerodrome Information	23
1.11	Flight Recorders & CVR	25
1.12	Wreckage and Impact Information	33
1.13	Medical and Pathological Information	33
1.14	Fire	33
1.15	Survival Aspects	34
1.16	Tests and Research	34
1.17	Organizational and Management Information	35
2.0	Analysis	
2.1	Serviceability of Aircraft	42
2.2	Weather analysis	42
2.3	DFDR Analysis	44
2.4	Mode 5 Transponder Data Analysis	49
2.5	FDMA Analysis	49
2.6	Human Factor	50
3.0	Conclusion	
3.1	Findings	52
3.2	Contributory factor	53
3.3	Probable cause	53
3.4	Conclusion	53
4.0	Safety Recommendation	54

Synopsis

On 08 October 2024, aircraft VT-RKF was operating a scheduled sector from Rourkela to Bhubaneswar with 43 passengers and four crew members on board. Prior to this flight, the aircraft had completed four uneventful sorties. During the initial approach to Bhubaneswar, when the aircraft was at 10 DME on the ILS approach, Bhubaneswar ATC instructed the crew to hold due to adverse weather conditions and traffic congestion at the airport. Subsequently, after briefing the crew on the prevailing weather conditions, which included heavy rain and a visibility of 800 metres, ATC cleared the aircraft to continue the ILS approach from 10 DME.

As the aircraft approached the minimum descent altitude/decision altitude, the crew encountered heavy rain. While nearing the threshold of Runway 14, the crew reportedly experienced a sudden sinking sensation and unusual vibrations in the cockpit. Consequently, the aircraft undershot the runway and touched down approximately 30.5 metres before the runway threshold.

There were no injuries to any of the occupants, and no fire occurred. Following the landing, the Pilot-in-Command (PIC) informed ATC via landline of a suspected tail strike during the landing. The occurrence was subsequently reported to the Aircraft Accident Investigation Bureau (AAIB) by ATC. After preliminary assessment, the AAIB classified the occurrence as a serious incident.

Initial notification of the accident was sent to concerned states along with ICAO as per requirement of ICAO Annex 13 and state(s) appointed Accredited Representative and Technical Advisor(s) to Support in the investigation.

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.

General Information

1.	Aircraft	Type	ATR 72-212A(600 Version)
		Nationality	Indian
		Registration	VT-RKF
2.	Operator		M/s Alliance Air
3.	Pilot in Command		Valid ATPL holder
	Extent of Injuries		Nil
	First Officer		Valid CPL holder
	Extent of Injuries		Nil
4.	No. Of Persons on board		43 Pax & 2 Flight Crew + 2 Cabin Crew
5.	Type of Occurrence		Serious Incident(Runway undershoot)
6.	Date& Time of Serious Incident		08.10.2024 & 0850 UTC
7.	Place of Serious Incident		Biju Patnaik International Airport, Bhubaneswar (VEBS)
8.	Co-ordinates of Serious Incident Site		Lat: 20° 14' 40" N, Long:85° 49' 4" E
9.	Last point of Departure		Rourkela airport (VERK)
10.	Intended landing place		Biju Patnaik International Airport, Bhubaneswar (VEBS)
11.	Type of Operation		Scheduled
12.	Phase of operation		Landing

1. Factual Information

1.1. History of Flight

On 8 October 2024, an Alliance Air aircraft with registration VT-RKF operated a scheduled flight from Rourkela to Bhubaneswar. There were 47 people on board the aircraft, including 43 passengers and 2 Flight Crew + 2 Cabin Crew. Earlier in the day, the same aircraft had completed four flights successfully without any abnormality. All systems were working normally, and no issues were reported before this flight. The departure from Rourkela was normal, and the flight continued smoothly during the cruise phase. Everything remained stable until the aircraft started its descent toward Bhubaneswar airport.

As the aircraft approached Bhubaneswar, the weather conditions were not favourable. There was heavy rain in the area, and visibility was reduced to about 800 meters. The crew prepared for an Instrument Landing System (ILS) approach to Runway 14. At around 10 DME, Air Traffic Control (ATC) instructed the aircraft to enter a holding pattern. This instruction was given due to bad weather conditions and traffic congestion at the airport. The crew followed the instruction and entered the holding pattern as directed.

After some time, ATC assessed the situation and decided to allow the aircraft to continue the approach. The crew was then cleared to proceed with the ILS approach from 10 DME. During the approach, ATC instructed the crew to report their position at 5 DME and again at 4.8 DME. The crew acknowledged these instructions and reported their position correctly at both points. When the aircraft reached 4.8 DME, ATC cleared it to land on Runway 14. ATC also informed the crew that if a go-around was required, they should turn left to a heading of 120 degrees. The crew acknowledged this instruction.

The approach remained stable up to an altitude of about 1000 feet. At that stage, there was no rainfall, and the visibility was 4000m. However, as the aircraft descended further, it suddenly encountered heavy rain. The visibility reduced quickly, making the situation more challenging for the crew. Despite the sudden change in weather, the crew was able to see the approach lights of the runway. To improve visibility further, the crew requested ATC to increase the intensity of the approach lights. ATC responded immediately and increased the brightness of the lights.

At approximately 08:50 UTC, the aircraft was on final approach to Runway 14. During the final phase of the approach, the crew experienced an unusual situation. They felt that the aircraft was sinking, and they also noticed vibrations inside the cockpit. Shortly after this, the aircraft struck one Category I approach light and four Category II approach lights. These lights were located before the runway threshold. After hitting the lights, the aircraft touched down approximately 30.5 meters short of the runway.

Even after this impact, the aircraft remained under control. The pilots managed the situation effectively and continued the landing roll. The aircraft successfully completed the landing and exited the runway safely. It then taxied to parking stand number 2 without any further issues.

After the landing, another aircraft that was waiting for take-off reported the presence of foreign object debris on the runway. This aircraft was positioned at the holding point of Runway 14. As a safety measure, ATC immediately cancelled its take-off clearance. Airport authorities were informed, and action was taken to inspect the runway. At around 09:07 UTC, the pilot-in-command of VT-RKF contacted Bhubaneswar ATC through a landline. He reported that there might have been a tail strike during landing. Following this report, airport staff carried out a runway inspection and removed the debris caused by the damaged approach lights. Maintenance personnel were also assigned to inspect the aircraft for any structural damage. There were no injuries to any passengers or crew members. There was no fire or smoke reported during or after the landing. All passengers safely disembarked after the aircraft reached the parking stand. However,

the aircraft sustained structural damage due to the runway undershoot. In addition, several approach lights were damaged during the incident.

1.2 Injuries to Persons

INJURIES	CREW	PASSENGERS	OTHERS
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
None	04(02+02)	43	Nil

1.3 Damage to the Aircraft

Damage was observed on the lower fuselage belly panel located between Frame 19 and Frame 21, along Stringer 21R (STR 21R) due to the Aircraft hit the ILS light pole. The affected area forms the bottom skin of the fuselage and is subject to cabin pressurization and bending loads. The damage extends within the belly/fairing region and involves adjacent structural members including Rib 23C, Rib 23D, Rib 27, and Rib 28A, which serve as transverse supports.

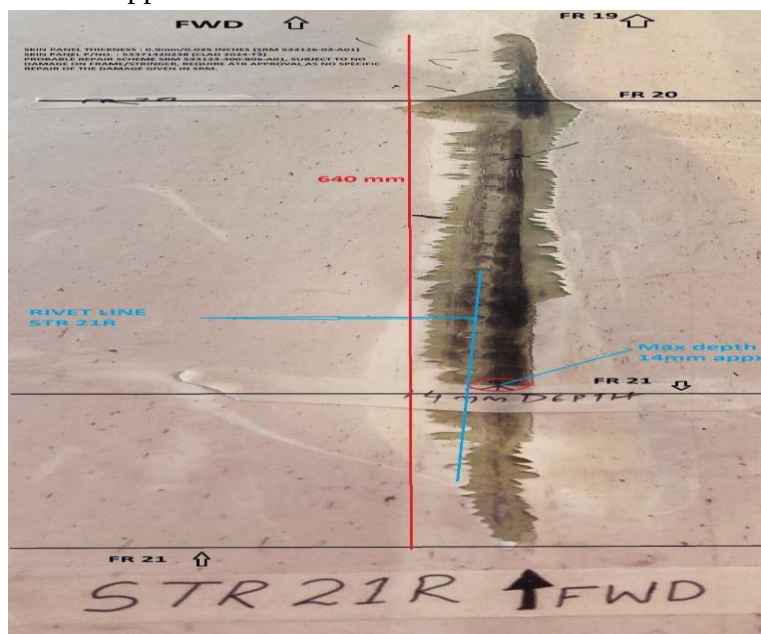


Figure1. Damage observed at Aircraft Belly.

Damage was observed in the LH landing gear bay structure in the vicinity of Rib 27 after impact with the small electric Concrete tank. A vertical tear is present in Rib 27 web, with the crack extending through the rib material and showing local deformation around the torn area. The tear appears to initiate near the rib flange and propagates downward toward the fastener row. The supporting strip adjacent to Rib 27 is also found cracked in the aft LH landing gear bay area. In addition, a nearby stiffener is observed bent with local

deformation at the attachment location and bottom stiffener. Surface scraping and paint removal are visible around the damaged zone, indicating impact contact. The damage affects Rib 27, the supporting strip, and adjacent stiffener, which may influence local load transfer in the LH landing gear bay structure.



Figure2. Damage observed at LH landing gear bay structure.

During approach the Aircraft initially impacted ILS light pole and damage the ILS pole, due to this sharp impact with the Aircraft belly and ILS Pole, A puncture hole was formed in the lower fuselage skin panel located between Stringer 19L and Stringer 20L, in the bay bounded by Frame 28D (forward) and Frame 29 (aft). The damage is an irregular tear-out in the skin with an approximate maximum vertical length of 105 mm and a width of about 55 mm at the lower section. The hole is positioned approximately 30 mm forward of FR29 and about 32–35 mm from STR19L, and approximately 65 mm from STR20L. The affected skin thickness is 0.9 mm, and the puncture fully penetrates the panel. The damage is within the lower belly skin area, which is subject to pressurization and fuselage bending loads.

The surrounding structure, including FR28D, FR29, STR19L, and STR20L, appears in close proximity to the damaged zone and may be affected by load redistribution.

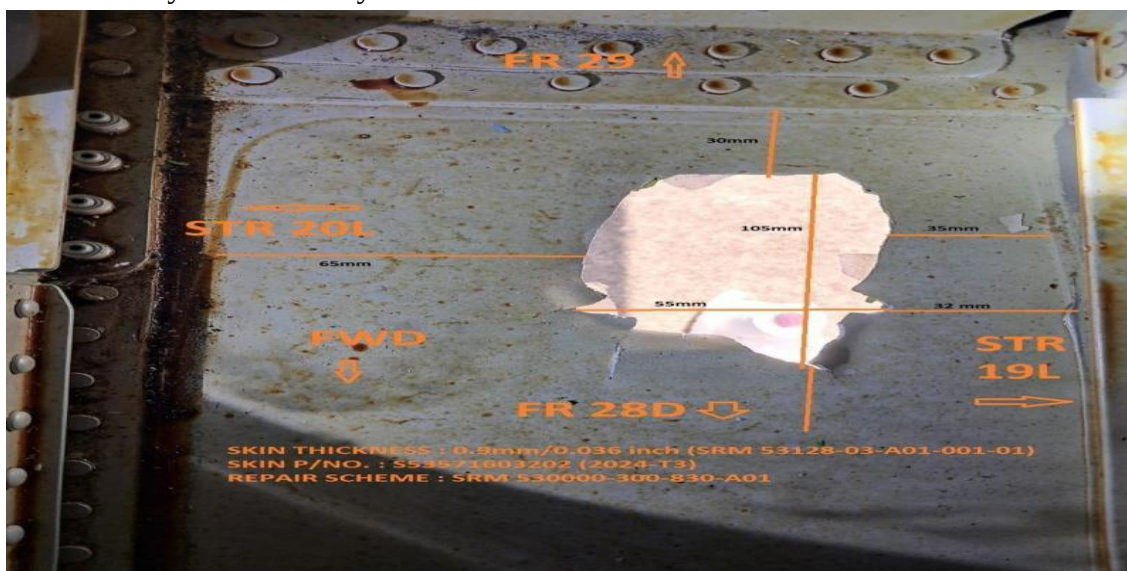


Figure 3. A puncture hole was formed in the lower fuselage skin panel

Damage in the form of a penetration hole was observed on the LH inboard flap, located forward of the front spar between Rib 8 and Rib 9. The damage extends through the outer skin and into the core honeycomb area. The affected region is part of the flap sandwich structure, and the penetration may compromise local skin-to-core bonding and structural stiffness. This damaged has confirmed the aircraft has landed before runway on unpaved land, The damage is confined to the area between Rib 8 and Rib 9 and forward of the spar, with potential impact on load transfer and aerodynamic surface contour. A detailed inspection was carried out after the occurrence of the surrounding skin, core material, spar, and adjacent ribs to determine the extent of disbond, core crush, moisture ingress, or additional hidden damage.

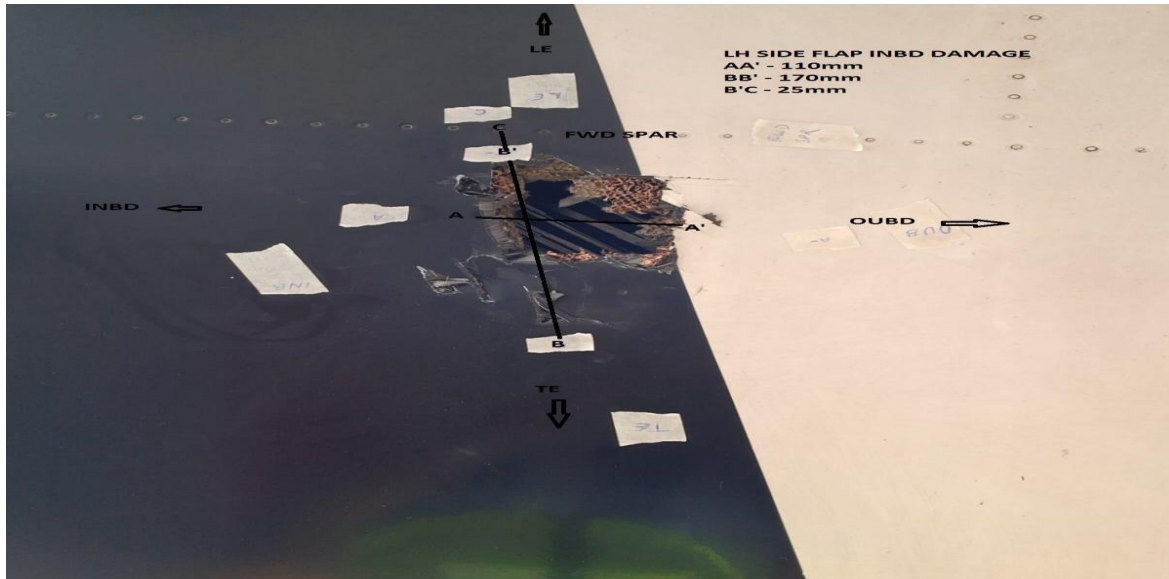


Figure 4. Penetration hole was observed on the LH inboard flap.

Damage was observed in the lower fuselage structure in the vicinity of Frame 20 (FR20), extending between FR19 and FR21. Stringer 21R is cracked between FR19 and FR20, adjacent to FR20, with separation noted at the frame-stringer junction. The crack initiates near the fastener row and the stringer shows local lifting in the affected area. Further deformation of STR21R is observed within the FR20–FR21 bay. Stringer 20R between FR20 and FR21 is deformed and bent. The stringer is also locally loose in the same region. A missing rivet is observed at the skin-to-stringer attachment level. Frame 20 is locally deformed at the STR21R cleat attachment location. The cleat attached to FR20 is bent and damaged. The associated bracket is also found deformed. Local deformation is visible on the FR20 web and flange. The damage affects load transfer at the frame-stringer interface. The surrounding skin in the area may be subjected to load redistribution. The damage is confined to the FR19–FR21 bay.



Figure 5. Damage was observed in the lower fuselage structure.



Figure 6. Damages on LH Landing gear

Damage was observed on the LH landing gear (L/G) door assembly affecting both the fixed and folding panels. The outer skin is torn and peeled back, exposing the internal honeycomb core with visible core crush and skin-to-core separation. The damage extends along the door edge near the hinge/attachment area, with local deformation and fractured sandwich structure evident. Panel edges are bent, affecting the aerodynamic contour and stiffness of the LH L/G door. Nearby cables routed in the LH L/G door area are also found damaged, showing signs of abrasion and possible severing. In addition, the baffle plate covering the weight-on-wheels (WOW) sensors of the LH landing gear leg assembly is found deformed.



Figure 7. Damages on belly Panel skin

Damage was observed on the bottom panel assembly located between FR23A and FR23C at 191 JL. The panel skin is torn with an elongated penetration, exposing the internal honeycomb core. The damage extends longitudinally along the panel with fractured skin edges and crushed core

material visible. Local skin-to-core disbond is evident around the tear, with irregular edges indicating impact-related failure. The penetration appears to pass completely through the sandwich panel thickness. The surrounding panel area shows additional cracking and de-lamination adjacent to the primary tear. The damage may affect local stiffness and load distribution of the bottom panel assembly. Internal structure beneath the panel is visible through the opening, indicating full-thickness penetration.

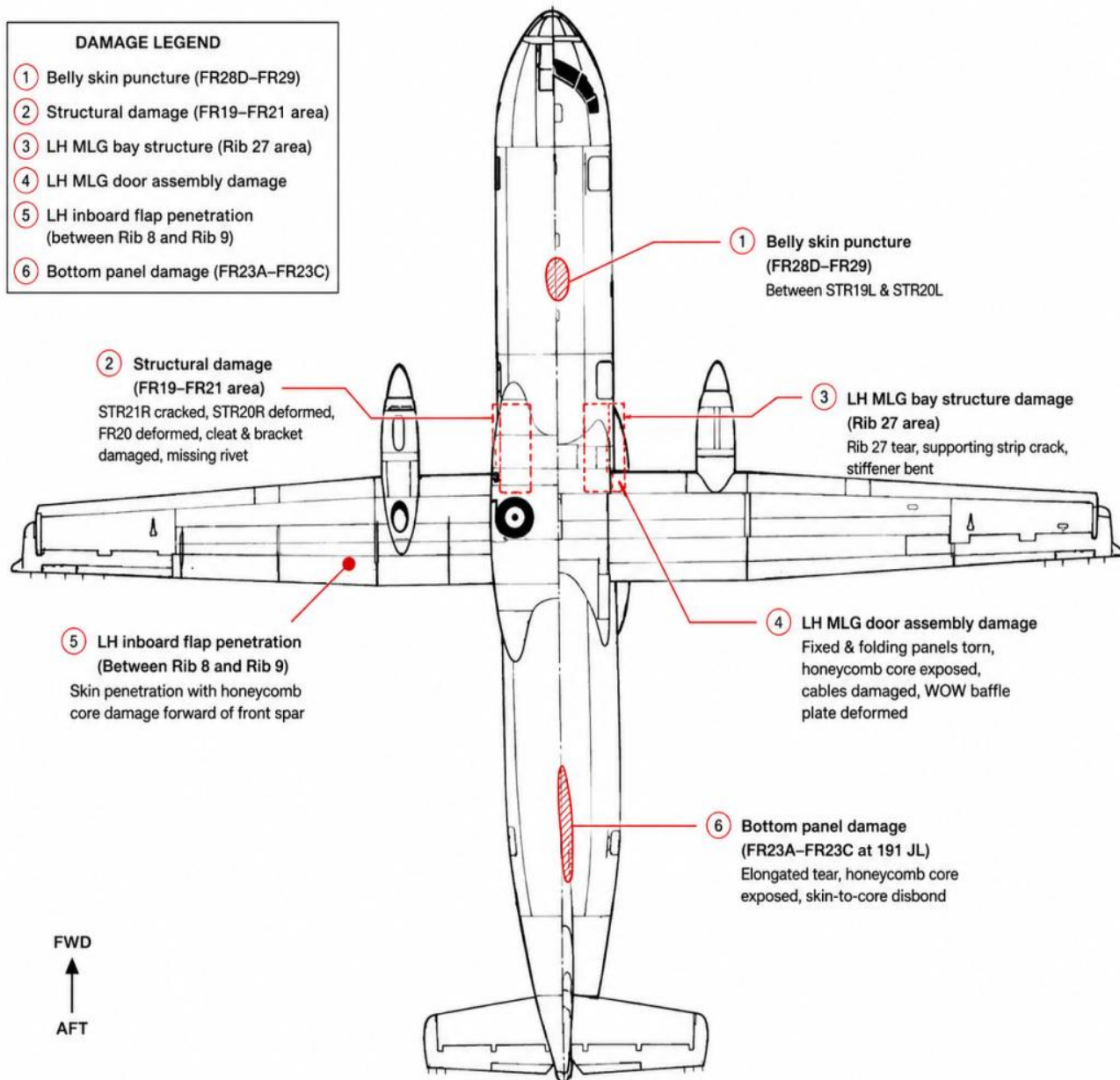


Figure 8. Aircraft Damages from Bottom view

The aircraft also sustained structural impact. The aircraft wing shows clear signs of contact with ground equipment. The belly section of the aircraft was impacted during the premature touchdown. Visible scraping and stress marks are present along the underside of the fuselage. The left landing gear has also been damaged during the occurrence. This includes signs of possible deformation or misalignment in the gear assembly.

1.4 Other Damage

After the occurrence, an inspection of the runway approach was carried out and the area revealed damage resulting from an aircraft touching down before reaching the designated runway threshold. The early ground

contact occurred within the ILS approach lighting zone, causing significant impact to ground installations.

Four CAT I ILS approach lights have been confirmed as damaged due to the incident. The damage affects both the light fixtures and their supporting structures. Electrical cables connected to the system have been disturbed and are partially exposed. Additionally, one electrical pit has been identified as broken and displaced from its original location.

Several components are misaligned and are no longer in a serviceable condition. This includes signs of possible deformation or misalignment in the gear assembly. Overall, both the ground infrastructure and the aircraft structure were affected by the event.

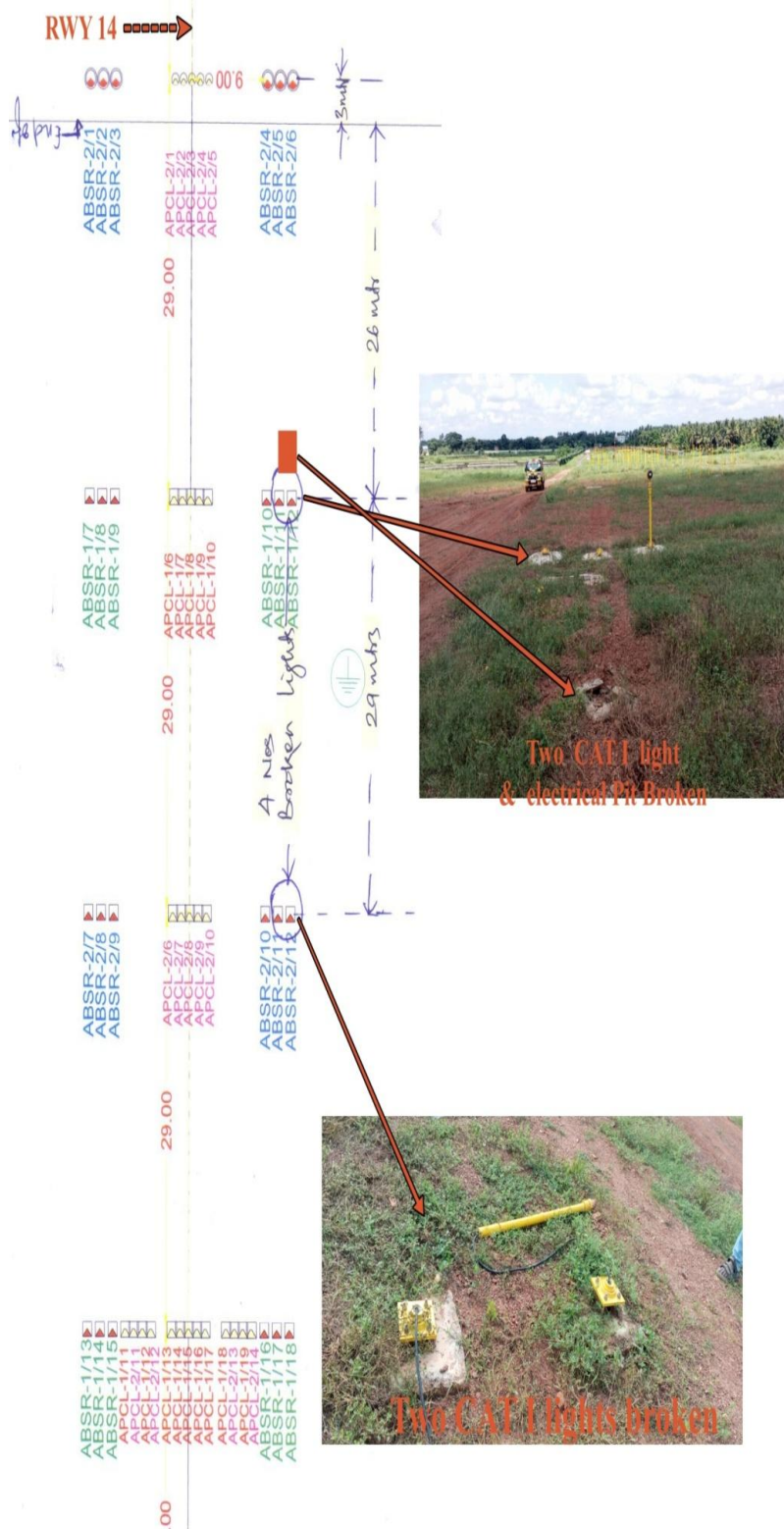


Figure 9.Damages on ILS CAT I& CAT II lights.

1.5. Personnel information.

The crew held valid licenses with all necessary certifications were up to date to operate this flight

	PIC (Pilot Flying)	F/O(Pilot Monitoring)
Nationality	INDIAN	INDIAN
Age	44 YEARS & 07 MONTH (AS ON 08-10-2024)	56 YEARS & 10 MONTH (AS ON 08-10-2024)
Date of Joining the Organization	11-09-2015	28-07-2009
License Category	ATPL	CPL
License issue date	08-04-2022	03-04-2007
License valid Up to	07-04-2027	02-04-2027
Endorsements as PIC	Endorsements 13-04-2023 (AS P1)	-
Date of Medical Exam	10-09-2024	13-11-2024
Medical Validity	15-09-2025	09-11-2025
FRTOL Date of Issue/Validity	Issue date 05-09-2009 valid till 04-12-2024	Issue date 10-12-2006 valid till 09-04-2026
RTR Date of Issue	Issue date 25-09-2014 valid till 24-09-2034	Issue date 26-10-2015 valid till 25-10-2035
Total Flying Experience	4979:43 hrs as per ARMS	6983 hrs as per ARMS
Hours Flown on Type	849:04 AS P1 FROM P1-LINE RELEASED	2666:25 AS P2 FROM P2-LINE-RELEASED
Experience as PIC on Type	849:04 AS P1 FROM P1-LINE RELEASED	2666:25 AS P2 FROM P2-LINE-RELEASED
Hours flown in last 365 days	552:07 AS PER ARMS	822:05 AS PER ARMS
Hours flown in last 180 days	288:55 AS PER ARMS	403:40 AS PER ARMS
Hours flown in last 30 days	26:07 AS PER ARMS	59:36 AS PER ARMS
Hours flown in last 7 days	Data were not shared by Operator	Data were not shared by Operator
Hours flown in last 24 hrs	Data were not shared by Operator	Data were not shared by Operator
Last IR/PPC	10-08-2024 (DONE DATE)	02-08-2024 (DONE DATE)
Last Ground Refresher	03-06-2024 TO 06-06 -2024 (DONE DATE)	15-11-2023 TO 18-NOV -2023 (DONE DATE)
Special operation training received	03-06-2024 TO 06-06 -2024 (DONE DATE)	15-11-2023 TO 18-NOV -2023 (DONE DATE)
Special operations training validity	03-06-2024 TO 06-06 -2024 (DONE DATE)	15-11-2023 TO 18-NOV -2023 (DONE DATE)

1.6 Aircraft Information

M/s Alliance Air aircraft registration VT-RKF is an ATR 72-212 A (600 Version) aircraft with Serial Number 1423, manufactured in 2017. It is equipped with high wing with 27 meters span, twin turbo prop engine configuration with Pratt & Whitney engine PW 127 M and total 8 propeller blades made by Hamilton Sundstrand. The aircraft is configured with 70 seats. The aircraft features a retractable landing gear configuration with two main landing gears on the right and left sides, as well as a nose landing gear. During the time of occurrence, all necessary certifications for this aircraft have been obtained from DGCA and other agencies was valid

1.6.1 Engine:

The **PW127M turboprop engine**, developed by Pratt & Whitney Canada, is a highly efficient power plant used mainly in regional aircraft like the ATR 72. It belongs to the PW100 series and is designed for short- to medium-haul operations. The engine produces approximately 2,750 shaft horsepower and uses a three-spool gas turbine configuration. Air enters through the intake and is compressed by axial and centrifugal compressors before entering the combustion chamber. Air enters through the intake and is compressed by axial and centrifugal compressors before entering the combustion chamber.

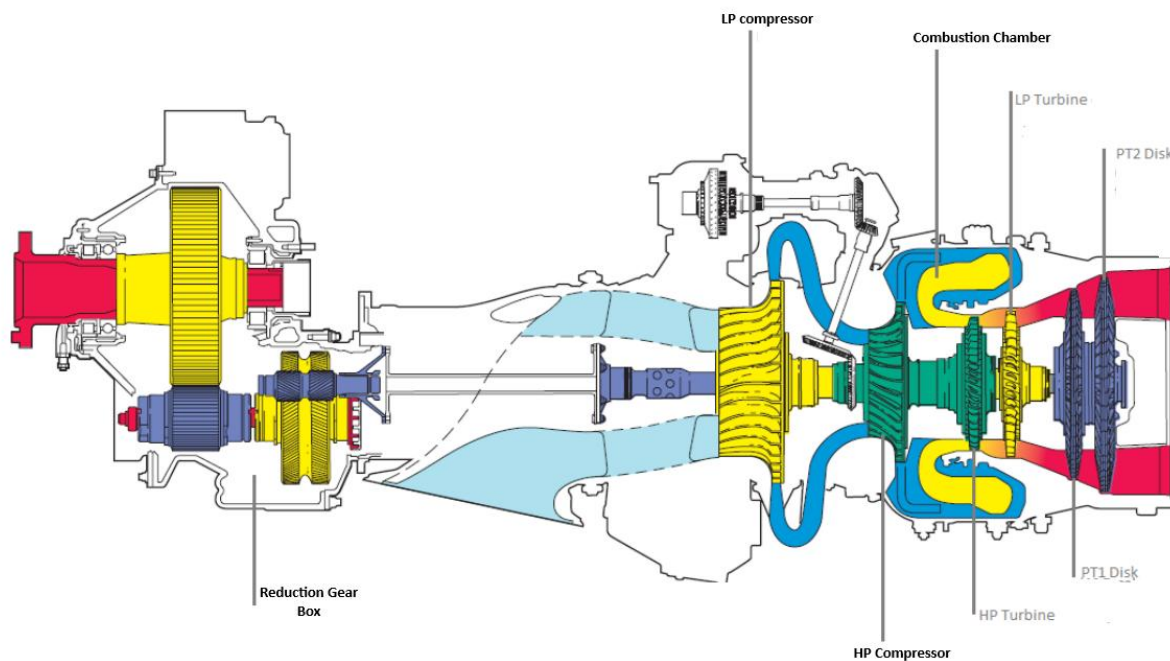


Figure 10. PW127M turboprop engine.

Fuel is injected and ignited, producing high-energy gases that drive the turbine stages. These turbines extract energy to power both the compressor and the propeller through a reduction gearbox. The gearbox reduces high turbine speed to a suitable propeller speed. The engine drives a multi-blade propeller that generates thrust efficiently at lower speeds. A Full Authority Digital Engine Control (FADEC) system ensures precise control and optimal performance. The PW127M is known for its excellent fuel efficiency and low operating cost. It performs reliably even in hot and high environmental conditions. The engine incorporates advanced materials for durability and long service life. It has improved thermodynamic efficiency compared to earlier models.

	Engine #1	Engine #2
Type	PW 127M	PW 127M
Serial number	ED 1080	ED 1454
Total time since new	11994:01	10509:35
Total cycles since new	11096	11427

1.6.2 Propellers Information:

The engine comprises two spool gas generators driving a six-blade propeller via a free turbine/concentric shaft/reduction gearbox assembly. Propeller regulation is hydro-mechanically controlled. The propeller is a Hamilton Sun standard 247 F-1

- Diameter : 3.96 m (13 ft)
- Rotation : clockwise (looking forward)
- 100 % Np : 1200 RPM
- Weight : 147 kg

	Propeller #1	Propeller #2
Manufacturer	Hamilton	Sun standard
Type	568 F-1	568 F-1
Serial number	FR20150424	FR20150425
Total time since new	11931:17	10861:29
Total time since overhaul	2398:25	1329:07

1.6.3 Aircraft certification

Sl. No.	Particulars	Status / Details
1.	Certificate of Registration (C of R)	Issued on 13-07-2021
2.	Certificate of Airworthiness (C of A)	Issued on 23-08-2017
3.	Airworthiness Review Certificate (ARC)	Valid up to 31-07-2025
4.	Aircraft Radio Station Licence (ARSL)	Valid up to 30-09-2027
5.	Aircraft Total Flight Hours since New, at the time of the incident	13,385:03 hours
6.	Aircraft Total Flight Cycles since New, at the time of the incident	12,623 cycles

1.6.4 Automatic Flight System:

The aircraft is provided with an Automatic Flight Control System (AFCS). It achieves:

- Autopilot (AP) function with automatic pitch trim, rudder auto trim, Yaw Damper (YD), and turn coordination
- Flight Director (FD) function
- Altitude alert.

Main components are:

- Two Core Avionics Cabinet (CAC 1 which controls the autopilot functions, and CAC 2 which monitors the autopilots functions)
- Three control panel : one Flight Guidance and Control Panel (FGCP) and two Index

Control Panel (ICP)

- Two Flight Mode Annunciator (FMA), one on each PFD upper part
- Three identical servo actuators on the three axes (pitch, roll, yaw)
- Two Power Trim Box (to interface with the pitch trim actuator and yaw trim actuator).

The CACs use information from other system such as the Attitude and Heading Reference System (AHRS) and the Air Data System (ADC). The system does not include automatic throttle.

The auto flight control system represents a standard level of automation in commercial transport aircraft and is designed to reduce crew workload. The autopilot can be disengaged either manually—by a quick action on the control column or by using the associated push button—or automatically under certain conditions. The DAFCS is a fully automatic flight control system that provides fail-passive flight director guidance, along with autopilot, yaw damper, and pitch trim functions.

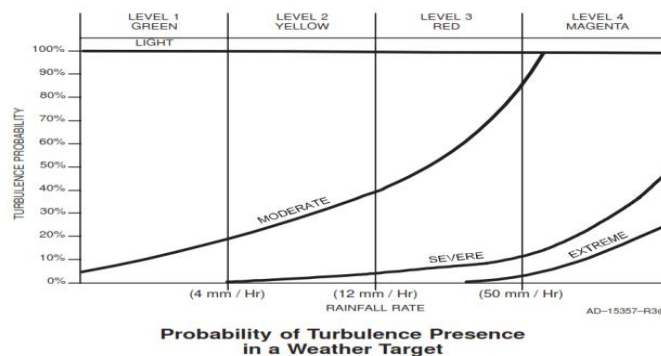
Autopilot can be disengaged:

- Manually by action on either one of the following devices Quick pushbutton on the yoke
 - Action on pitch trim
 - A/P pushbutton on the AFCS
 - YD pushbutton on the AFCS
 - GA pushbutton on the PL
 - Pilot's force on the pedal over 30 daN
 - Force of pilot on the control column (pitch axis) over 10 daN
 - One of the engagement conditions of the AP and/or YD is no longer met
- Stall warning indicator threshold is achieved
There is a disagreement between the two AHRS, or between the two ADCs
There is a mismatch between the two pitch trims
There is a failure of one AHRS, or one ADC.

The aircraft speed should be monitored by the pilots and required throttle be applied by the pilot to reach the desired speed.

1.6.5 Weather Radar:

The aircraft VT-RKF is equipped with the Honeywell PRIMUS-660 weather radar system. The radar emits radio wave whenever it is operating in any mode other than standby (STBY). By reception of the reflection of the wave on the water droplets, the radar is able to detect precipitation in the air. Intensity of precipitation is calculated using radar echo returns that are proportional to droplet size (small droplets will return fewer echoes whereas heavy droplets will return the majority of radar waves). The information is displayed in the cockpit on the Multi-Function Display (MFD) in Navigation mode.



In addition, the Electronic Horizontal Situation Indicator (EHSI) incorporates a four-color weather radar display capable of depicting four levels of detectable moisture intensity, each represented by distinct colors. According to the ATR 72 Flight Crew Operating Manual (FCOM), the following colors are used to depict the various cloud densities and percentage of turbulences.

Level(storm)	Weather Mode	Map Mode
Level 0	No Detectable Clouds	Black
Level 1	Normal Clouds	Green
Level 2	Dense Clouds	Yellow
Level 3	Severe Turbulence	Red
Level 4	Extreme Turbulence	Magenta

This information is not recorded on the FDR, and the pilots did not make any comments referencing the weather radar; it could not be determined during the investigation if the weather radar was being used during the accident flight. The first officer noted no weather abnormality so PIC has continued the flight to land.

1.6.6 EGPWS Mode 5 monitors the aircraft's position relative to the Instrument Landing System (ILS) glideslope during an approach. It provides aural warnings such as "GLIDESLOPE" when the aircraft deviates below the correct descent path, with increasing urgency as the deviation becomes greater. The system is typically active at lower altitudes during ILS approaches and can be manually inhibited if required. Its primary purpose is to prevent unsafe descent below the glideslope and reduce the risk of controlled flight into terrain (CFIT).

1.7 Meteorological Information

The AAI Bhubaneswar receives METAR information from the IMD MET Centre Bhubaneswar.

The METAR of Bhubaneswar Airport which was captured at the time of occurrence on 08.10.2024 is given below:

Sl. No.	METAR Time (UTC)	Wind	Visibility	Weather	Cloud / Ceiling	Temperature / Dew Point (°C)	QNH (hPa)	Trend / TEMPO
1	08/0830Z	110° / 06 kt	4000 m	Haze (HZ)	BKN 1800 ft, FEW CB 3000 ft, BKN 10,000 ft	32 / 25	1011	TEMPO 3000 m, -TSRA
2	08/0900Z	320° / 04 kt	0500 m	Rain (RA)	BKN 1600 ft, FEW CB 3000 ft, OVC 8000 ft	27 / 23	1011	TEMPO 0150 m, +TSRA
3	08/0930Z	340° / 02 kt	1500 m	Thunderstorm with rain (TSRA)	BKN 1600 ft, FEW CB 3000 ft, BKN 9000 ft	26 / 25	1012	TEMPO 0800 m, +TSRA

The closest METAR of the event indicated rain (RA), and within the next 2 hours heavy thunderstorm with rain were expected. The sequence of METAR indicated the presence of haze and a reduction of the visibility 4000m then 500m at 0900Z, with a reduction down to 350m expected within the following 2 hours.

The Crew also reported “HEAVY RAIN, DOWNDRAFTS “.

From 1000ft RA to 250ft, the FDR data indicated,

- A headwind component around 10-15kt (up to 20 kts).
- A right crosswind component around 5kt (up to 12 kts). Below 250ft RA the wind components changed:
- The 10kt headwind at 250ft RA became a 15kt tailwind close to the ground.
- The crosswind decreased from ~10kt at 200ft to ~0kt on the ground

The event occurred at 0851 UTC.

Time UTC HH:MM	Winds degree /Knots	Visibility meters	QNH HPa/ In hg	Temp °C	DP°C	Weather/ cloud
08:50	220/04 KT	150	1019	27	26	Heavy Rain

1.8 Aids to Navigation

The Bhubaneswar airport features a CAT I Instrument Landing System (ILS) on Runway 14, including a Localizer (LLZ), Glide Path (GP), and collocated Distance Measuring Equipment (DME) for precision approaches. For Runway 32, conventional navigation support is provided through a DVOR and collocated DME. The airport also supports GAGAN-based satellite navigation, enhancing navigation accuracy and approach capability. Visual aids include High-Intensity Runway Lights (HIRL), runway end lights, green threshold lighting, a 778-meter CAT I approach lighting system for Runway 14, and a Simplified Short Approach Lighting System (SALS) for Runway 32. Additionally, Precision Approach Path Indicators (PAPI) is installed on the left side of Runway 14 with a 3.00° glide slope. During the occurrence, all navigation aids were functioning properly and operated.

1.9 Communication

The Communication was made between Crew and Bhubaneswar ATC Tower on frequency of 118.15 MHz prior to the occurrence as given below

TIME	FROM	TO	TWR 118.15 MHz
0846	LLR746	TWR	NAMASKAR LLR746 WITH YOU
	TWR	LLR746	LLR746 REPORT ILS DME
	LLR746	TWR	SIR WE ARE 9 ILS DME
	TWR	LLR746	ROGER, REPORT 5 ILS DME BBS
	LLR746	TWR	LLR746
0849	LLR746	TWR	LLR746, 4.8 ILS DME
	TWR	LLR746	LLR746 TOWER, WIND CALM RUNWAY-14 CLEARED TO LAND

	LLR746	TWR	CLEARED TO LAND RUNWAY-14 AND SIR IN CASE OF GO-AROUND WILL BE TURN LEFT HEADING 120
	TWR	LLR746	ROGER.
0851	LLR746	TWR	REQUEST ALL LIGHTS ON MAX, LLR746
	TWR	LLR746	ROGER
	LLR746	TWR	TOWER, LANDED 51 VACATE BY B, STAND 02
	TWR	LLR746	STAND 02, LLR746
0852	TWR	AXB1327	AXB1327 CLIMB RUNWAY HEADING FL240, RESUME NORMAL WITH BHUBANESWAR APPROACH.
	AXB1327	TWR	CLIMB FL240, RUNWAY HEADING, RESUME WITH BHUBANESWAR APPROACH, AXB1327, SQUAWK 2634
	TWR	AXB1327	SQUAWK 2634
	AXB1327	TWR	SQUAWK 2634 SIR, AXB1327
	LLR746	TWR	LLR746 WITH MARSHALLER DOCKING STAND 02
	TWR	LLR746	ROGER REPORT REGISTRATION
	LLR746	TWR	RKF
	TWR	LLR746	ROGER
0853	AXB1327	TWR	AXB1327 WILL LET YOU KNOW THE HEADING AFTER DEPARTURE
	AXB1327	TWR	AXB1327 WE ARE LINING UP AND WAIT FOD JUST NEAR THE DUMBELL SIR LIKE WHERE WE HAVE LINE UP
	TWR	AXB1327	ROGER SIR HOLD POSITION WE ARE SENDING JEEP
0854	AXB1562	TWR	REQUEST TAXI AXB 1562
	TWR	AXB1562	AXB1562 TWR TAXI TO HOLDING POINT RWY 14 VIA TAXIWAY C-J TIME 54
	AXB1562	TWR	C-J HOLDING POINT FOR 14 AXB 1562
	AXB1562	TWR	READY TO COPY CLEARANCE AXB 1562
	TWR	AXB1562	AXB1562 TWR STAND BY
	AXB1327	TWR	AXB1327 FOD IS NEAR OUR POSITION
0855	TWR	AXB1327	AXB1327 TWR, CONFIRM ABLE TO BACKTRACK AND VACATE

			VIA J
0855	AXB1327	TWR	SIR INSPECTION BE DONE AROUND US
	TWR	AXB1327	AROUND DUMBELL
	AXB1327	TWR	NO CAN BE JEEP INSPECT THE AREA AROUND US
	AXB1327	TWR	ENGINE STARTING, IT WILL BE TOO CLOSE FOR JEEP SIR BECAUSE FOD IS THERE NEAR BY US SIR
0856	AXB1327	TWR	LOOK LIKE PART OF LIGHT
	TWR	AXB1327	AFFIRM SIR JEEP ALSO INSTRUCTED THE SAME SIR AND IT IS VERY DIFFICULT FOR JEEP TO REACH YOUR SIDE
0857	AXB1327	TWR	TWR AXB1327 WE CAN USE TURN PAD ON THE RIGHT MAKE 180 DEGREE BUT COMPANY AIRCRAFT COMING ON J
	TWR	AXB1327	AXB1327 TWR YOU CAN MAKE RIGHT TURN ON TURN PAD AND REMAIN CLEAR OF THAT AREA
	AXB1327	TWR	ROGER SIR WE WILL TAKE A RIGHT TURN AND HOLD ON TURN PAD
	TWR	AXB1327	AFFIRM SIR
0858	TWR	AXB1562	AXB1562 TWR HOLD AT HOLDING POINT
	AXB1562	TWR	HOLD AT HOLDING POINT AXB 1562
	AXB1327	TWR	AND AXB 1327 LET US KNOW IF POSITION IS OK
	TWR	AXB1327	ROGER
	TWR	AXB1327	AXB1327 TWR IT WILL BE CLEAR SIR HOLD POSITION HOLD AT THE SAME POSITION
	AXB1327	TWR	HOLDING POSITION
0859	AXB1327	TWR	TWR AXB 1327
	TWR	AXB1327	AXB1327 TWR
	AXB1327	TWR	ROGER DISREGARD
0900	AXB1327	TWR	AXB1327 CONFIRM PREVIOUS AIRCRAFT LANDED VACATED VIA B
	TWR	AXB1327	AFFIRM SIR IT WILL BE BACK TRACK FROM DUMBELL AND VACATING VIA B
	AXB1327	TWR	NO PREVIOUS AIRCRAFT WHICH LANDED IT VACATED VIA B

			FROM OR ANY TWY
	TWR	AXB1327	VACATED VIA B, ALLIANCE AIR ATR
	AXB1327	TWR	I WOULD LIKE TO GET IT INSPECTED AT LEAST B
	TWR	AXB1327	AXB1327 TWR FOD IS NOW CLEAR CONFIRM READY FOR LINE UP
	AXB1327	TWR	AFFIRM SIR
	TWR	AXB1327	ROGER LINE UP RWY 14 REPORT READY
	AXB1327	TWR	CALL YOU WHEN READY AXB1327
0902	AXB1327	TWR	AXB1327 SIR THERE IS ANOTHER FOD WHICH IS ON DUMBELL
	TWR	AXB1327	ROGER
	AXB1327	TWR	TWR AXB1327
	TWR	AXB1327	AXB1327 TWR
	AXB1327	TWR	THERE IS ANOTHER FOD WHICH IS LYING ON DUMBELL EXACTLY ON DUMBELL
	TWR	AXB1327	AXB1327 CONFIRM LINE UP AND CLEAR OF FOD
	AXB1327	TWR	NEGATIVE MADAM
	TWR	AXB1327	ROGER HOLD POSITION
	AXB1327	TWR	ITS ON MARKERS, THRESHOLD MARKING
	TWR	AXB1327	ROGER
0903	AXB1327	TWR	AXB1327 CONFIRM JEEP IS COMING
	TWR	AXB1327	AFFIRM
	AXB1327	TWR	AXB1327 LET us KNOW WHEN WE CAN LINE UP
0905	TWR	AXB1327	AXB1327 LINE UP RWY 14 REPORT READY FOR DEPARTURE
	AXB1327	TWR	LINE UP RWY 14 AND CALL YOU AXB1327
	AXB1562	TWR	READY TO COPY CLEARANCE AXB 1562
	TWR	AXB1562	AXB1562 STAND BY
0906	AXB1327	TWR	WE ARE READY FOR DEPARTURE AXB 1327
	TWR	AXB1327	AXB1327 TWR WIND 220 03 KNOTS RWY-14 CLEAR FOR TAKE OFF

	AXB1327	TWR	RWY 14 CLEAR FOR TAKE OFF AXB 1327
--	---------	-----	------------------------------------

1.10 Aerodrome Information

The Aerodrome information as provided in the eAIP is given below:

AIRPORT	LAT/LONG	DIMENSION	ORIENTATION
Bhubaneswar	Lat: 20° 14' 40" N, Long:85° 49' 4" E	2743 x 45 M	14 / 32
Slope	+0.11% on both orientation of the runway.		
Elevation	138 ft		
Approach and Runway Lighting	RWY 14 CAT-I/778M PAPI Left / 3° 15.103M RWY 32 SALS/240 M PAPI Left / 3° 15.103M		
Types of traffic permitted	IFR/VFR		
Radio navigation and landing aids	Bhubaneswar Airport is equipped with LLZ, DME (ILS) and GP at RWY 14 side and NDB, DVOR (DME) at RWY 32 side.		
AD category for Fire fighting	CAT:6		
ATS Communication	APPROACH TOWER ATIS	125.15 MHz 118.15 MHz 126.8 MHz	
MET Office	Indian Meteorological Department, Bhubaneswar		
Facilitation	Adequate infrastructure for handling of arrival/departure. Security and frisking of passengers is available.		

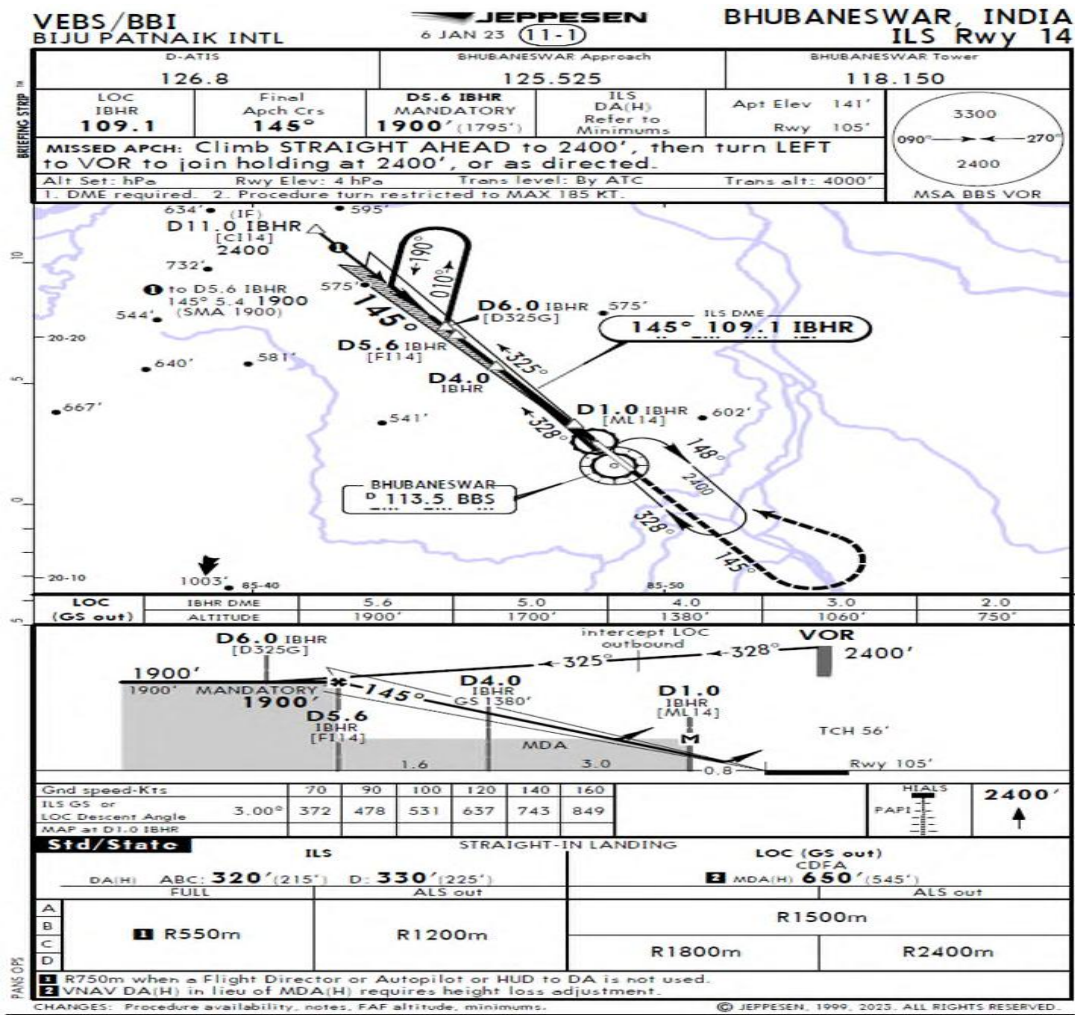


Figure 11. Jeppesen chart of VEBS.



Figure 12. VEBS Airport

1.11 Flight Recorders:

The characteristics of the aircraft's flight recorders, based on the airline's existing technical records, are as follows

Name of Appliance	Type	Manufacturer	Part Number	Type of Memory
Cockpit Voice Recorder	CVR	L3-Communications	2100-1225-60	Solid State
Digital Flight Data Recorder	SSFDR	L3-Communications	2100-4245-00	Solid State

1.11.1 DFDR

The DFDR and CVR were removed from the aircraft and sent to DGCA for data downloading, which was completed successfully. The raw DFDR data file was then sent to the ATR facility for decoding and analysis, and the OEM completed the analysis successfully within the required time. The following flight performance observations are observed from the DFDR data.

Between 1000ft and 200ft RA

- The IAS varied between 110kt and 130kt without significant movement on power levers.
- The pitch angle varied between +2° and -6°.
- The rate of descent varied between -200ft/min and -900ft/min.
- The glide deviation remained between ~ +/- ¼ DOT and the Localizer remained around 0.

The high variation of the different parameters while AP was engaged is consistent with an approach in turbulent conditions.

The DFDR data reveals that, at approximately 200 ft RA, while the AP was engaged, a nose-down input began to be recorded on the CM1 side, eventually reaching 11 daN. The data also shows the progression of the control inputs leading to the disengaged of the AP and YD. It should be noted that the AP/YD parameter is sampled at a rate of 1 second; therefore, the recorded disconnection may appear slightly later than the actual event, which most likely occurred when the control effort reached 10 daN.

At around 20ft RA,

- The elevators were deflected in a nose up order (-17°) and the pitch angle increased from -2° to +3°
- The IAS was around the selected IAS and the power levers were briefly pushed close to the notch.

Based on the GPS position the aircraft touched down at ~100m before the runway threshold.

- The maximum lateral deviation was reached at touchdown also and was recorded at 16m (1/3 DOT).
- The IAS was 111kt and the ground speed was 126kt.
- The pitch angle was at +2° nose up and the roll angle was -5° left.
- The load factor reached 1.7G

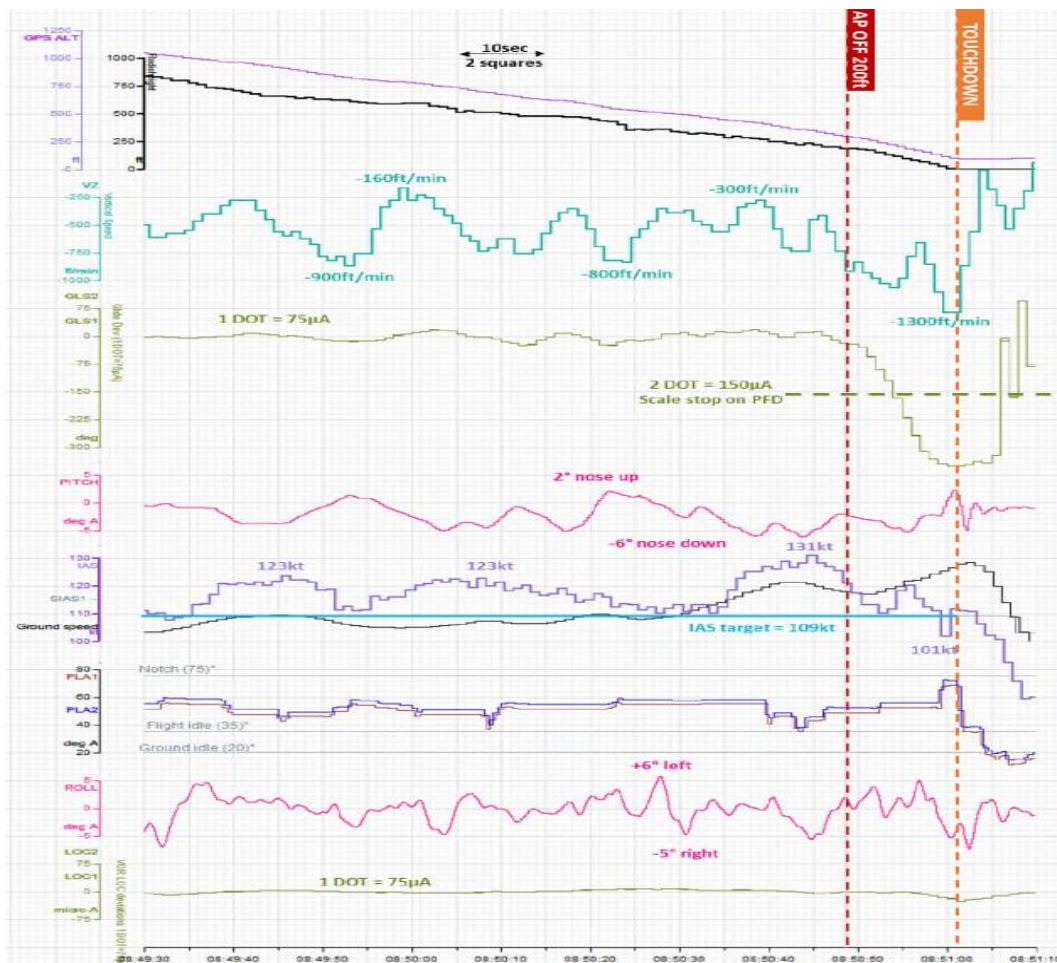


Figure 13.DFDR analysis of the occurrence Aircraft

The detailed analysis of DFDR is given in analysis chapter

1.11.2 Cockpit Voice Recorder:

The Cockpit Voice Recorder was SSCVR type model FA2100-1225-60 with S/N: 1209467 Four channels with 30-minute audio channels recording and two 2-hour audio channels can be recorded on this recorder. Channel filtering was performed. The audio files from the engine start in Rourkela airport were available.

CVR (Timing)	NARRATOR	TEXT
01:50:15	ATC	ALLIED 746, DESEND TO THREE THOUSAND THREE HUNDRED FEET, QNH-1011, TRANSITION LEVEL FIVE FIVE
01:50:21	CO PILOT	THREE THOUSAND HUNDRED FEET, QNH-1011, TRANSITION LEVEL FIVE FIVE ALLIED 746
01:50:25	CO PILOT	SET 1011

01:50:25	ATC	AND ALLIED 746 YOU CAN TURN RIGHT HDG 1-2-5 TO INTERCEPT LOCALIZER RWY 14, REPORT ESTABLISHED.
01:50:30	CO PILOT	RIGHT 1-2-5 TO INTERCEPT LOCALIZER. CALL YOU ON LOCALIZER RWY 14ALLIED 746
01:50:37		COCKPIT CUE SOUND
01:50:39	CO PILOT	1-2-5
01:50:39		(OTHER A/C R/T)
01:50:39		CHECKLIST IN BACKGROUND. UNREADABLE
01:50:48	CO PILOT	CHECKED. SEAT BELT SIGN
01:50:48	CAPT	ON
01:50:49	CO PILOT	LANDING LIGHTS
01:50:49	CAPT	ON
01:51:01	CAPT	VOR ALIGNED
01:51:21	CO PILOT	ADVISE THE CABIN
01:51:22	CAPT	YES INFORMED
01:51:24	CAPT	CREW ALL STATIONS LANDING IN 5 MINS
		(OTHER A/C R/T)
01:51:36	CAPT	WE WILL GO AROUND, WE WILL TAKE THE RADIAL 1-4-0----- 1-4-0 AND TEN LEFT TURN
01:51:50	CAPT	OKAY TOH IT IS A LEFT HOLD, LEFT TURN ONLY, BUT WE WON'T BECOMING OVERHEAD WE WILL BE JUST EXTENDING OUR PATH. OK LEFT HEADING 1-2-0
01:51:54	CO PILOT	OKAY LEFT HEADING 1-2-0
01:51:55		1-2-0 KARKE WE WILL BE HEADING OUT. WE WONT BE COMING BACK.
01:52:01	CO PILOT	WE WILL CLIMB TO THREE THOUSAND FOUR HUNDRED THEN WE WILL SEE
01:52:02	CAPT	HAAN THEN WE WILL SEE THEEKHAI BECAUSE EXPECTED WEATHER
01:52:03	CO PILOT	WE WILL ADVISE TOWER
01:52:05	CAPT	HAAN EXPECT GO AROUND
01:52:06	CO PILOT	ALRIGHT

01:52:17	CAPT	LOCK IS TURNED
01:52:18	CO PILOT	LOCK TURNED
01:52:18	CAPT	SETTING TO LRSB, RWY
01:52:26		(COCKPIT CHIMES)
01:52:27	CAPT	S**T
01:52:30	CAPT	APPROACH MODE ON. REQUEST FURTHER DESCEND
01:52:31		(COCKPIT CHIMES)
01:52:32	CO PILOT	ALLIED 746, ESTABLISHED LOCALIZER
01:52:36	BBSR APPROACH	ALLIED 746, DECENT TO ONE THOUSAND NINE HUNDRED FT, CLEARED FOR ILS APPROACH RWY 14 AND NO RAIN SIR
01:52:42	CO PILOT	COPIED SIR, ONE THOUSAND NINE HUNDRED FT, CLEARED FOR ILS APPROACH RWY 14, ALLIED 746
01:52:45	CO PILOT	1900FT
01:52:56	CAPT	OKAY SO NO RAINFALL, EXPECT WINDSHEAR
01:53:00	CAPT	AND REMEMBER IN CASE OF WIND SHEAR, CALL OUT WIND SHEAR GO AROUND DO NOT CHANGE CONFIGURATION. THAT IS COMPLETE CALL THEEK HAI. SO JUST IN CASE I FORGET
01:53:09	CO PILOT	EYES LOW
01:53:36		(COCKPIT CHIME)
01:53:36	CO PILOT	ONE TO GO
01:53:37	CAPT	CHECKED
		(OTHER A/C R/T)
01:54:40	CAPT	YOU CAN SEE THE RUNWAY NA
01:54:43	CO PILOT	YES
01:54:58	BBSR APPROACH	SIR HALF PART OF RUNWAY VERY HEAVY RAIN, SECOND HALF PART IS VERY DRY
01:54:59	CO PILOT	OK THANK YOU
01:54:59	CAPT	CHECKED
01:55:00	BBSR APPROACH	ALLIED 746, ONE ZERO MILES FROM TOUCH DOWN CONTACT TOWER 1-1-8 DECIMAL 1-5
01:55:04	CO PILOT	1-1-8 DECIMAL 1-5 GOOD DAY SIR ALLIED 746

01:55:15	CO PILOT	BHUBANESWAR NAMASHKAR, ALLIED 746 WITH YOU
01:55:16	BBSR TOWER	ALLIED 746 TOWER REPORT ILS DME
01:55:19	CO PILOT	SIR WE ARE 9 ILS DME ALLIED 746
01:55:22	BBSR TOWER	ALLIED 746 TOWER ROGER, REPORT 5 ILS DME BRAVO BRAVO SIERRA
01:55:26	CO PILOT	ALLIED 746
		(OTHER A/C R/T)(CHECKLIST IN BACKGROUND UNREADABLE)
01:55:45	CO PILOT	IGNITION 140 MAGENTA
01:55:46	CAPT	CHECKED
01:55:47		(COCKPIT CUE SOUND)
01:55:56	CO PILOT	OKAY HEARD SET
01:55:57	CAPT	LANDING GEAR DOWN PLEASE
01:56:01	CO PILOT	ONE DOT SPEEDS CHECKED
01:56:10	CO PILOT	GLIDE STARTS AT GROUND ALTITUDE TWO THOUSAND FOUR HUNDRED
		(OTHER A/C R/T)
01:56:23	CAPT	ONE ZERO NINE MAGENTA BECAUSE
01:56:26	CO PILOT	BEFORE LANDING CAPTAIN, CABIN CREW
01:56:28	CAPT	ADVISED
01:56:28	CO PILOT	LANDING GEAR
01:56:28	CAPT	3 GREEN
01:56:29	CO PILOT	FLAPS
01:56:29	CAPT	THREE ZERO
01:56:30	CO PILOT	POWER MANAGER
01:56:30	CAPT	TAKE OFF
01:56:31	CO PILOT	TLLU SPEED
01:56:31	CAPT	CHECKED
01:56:33	CO PILOT	RTU LIGHTS
01:56:33	CAPT	OFF

01:56:34	CO PILOT	AND EXTERNAL LIGHT
01:56:34	CAPT	ON
		(OTHER A/C R/T)
01:56:56	CO PILOT	BREAK BREAK ALLIED 746 POINT 8 ILS DME
01:57:01	BBSR TOWER	ALLIED 746, WIND CALM RWY 14, CLEAR TO LAND
01:57:02	CAPT	CLEARED TO LAND RWY 14 AND IN CASE OF GO AROUND, WE WILL BE TURNING LEFT HEADING 1-4-0
01:57:09	BBSR TOWER	ROGER
		(OTHER A/C R/T)
01:57:49	CAPT	REQUEST ALL LIGHTS ON MAX
01:57:50	CO PILOT	REQUEST ALL LIGHTS ON MAX SIR, ALLIED 746
01:57:55	BBSR TOWER	ROGER
01:58:12	CAPT	FIVE HUNDRED ON MDA WE CONTINUE
01:58:36		(COCKPIT CUE SOUND) FIVE HUNDRED
01:58:38	CO PILOT	SIR
01:58:46		(COCKPIT CUE SOUND)
01:59:03	CO PILOT	HUNDRED ABOVE
01:59:04		(COCKPIT CUE SOUND)
01:59:05	CO PILOT	APPROACH LIGHT IN SIGHT
01:59:05	CAPT	IN SIGHT
01:59:13		(COCKPIT CUE SOUND) TWO HUNDRED, MINIMUM
01:59:13	CAPT	DECISION LANDING
01:59:15	CAPT	SET YOUR---AMPER OFF
01:59:27	CAPT	S**T
01:59:40	CAPT	WE HAVE BROKEN THE LIGHTS NA
01:59:41	CO PILOT	YA
01:59:43	CAPT	TOO LOW PITCH
01:59:44		CABIN ANNOUNCEMENT SOUND IN BACKGROUND
01:59:51	BBSR TOWER	BHUBANESHWAR ALLIED 764 LANDED 51 VACATE

		VIA BRAVO STAND 2
01:59:55	CAPT	BRAVO STAND 2 ALLIED 764
01:59:59	CAPT	BRAVO STAND 2 ALLIED 746
		(OTHER A/C R/T)
02:00:25	CAPT	AFTER LANDING
02:00:25		(CABIN ANNOUNCEMENTS IN THE BACKGROUND)
02:01:04	CO PILOT	ALLIED 746 WITH MARSHALLER STAND DOCKING STAND 2
02:01:06	BBSR TOWER	REPORT REGISTRATION
02:01:08	CO PILOT	ROMEO KILO FOXTROT
02:01:10	BBSR TOWER	ROGER
		(OTHER A/C R/T)
02:01:34	CAPT	RED LIGHTS
02:01:35	CO PILOT	CHECKED THIRTY SECONDS
02:01:37	CAPT	WE CAN FINISH SHUT OFF
		(OTHER A/C R/T)
	(CABIN ANNOUNCEMENTS IN THE BACKGROUND)	
02:01:54	CO PILOT	PROPELLOR RECON
02:01:55	CAPT	CHECKED
02:02:01	CO PILOT	RIGHT PROPELLOR STOPPED
02:02:01	CAPT	LEFT STOPPED
	(OTHER A/C R/T)	
02:02:09	CAPT	YOU CAN OPEN THE DOORS PLEASE
02:02:10	CABIN CREW	OKAY SIR
02:02:15	OTHER A/C PIC EXP-1327	WE HAVE FOD JUST NEAR THE DUMBBELL SIR, WHERE WE HAVE LINED UP
02:02:18	ATC	ROGER SIR HOLD POSITION WE ARE SENDING JEEP
		(OTHER A/C R/T)
02:02:20	OTHER A/C PIC	WILCO
02:02:27	CAPT	PARKING CHECKLIST

02:02:28	CO PILOT	PARKING BRAKE
02:02:29	CAPT	ENGAGED
02:02:29	CO PILOT	TAXI TAKE OFF LIGHT
02:02:29	CAPT	OFF
02:02:30	CO PILOT	TL2
02:02:30	CAPT	FEATHER
02:02:31	CO PILOT	PROP BRAKE
02:02:31	CAPT	ON
02:02:32	CO PILOT	BEACON
02:02:32	CAPT	OFF
02:02:33	CO PILOT	TRANSPONDER
02:02:34	CAPT	STAND BY
02:02:35	CAPT	HEAD SETS OFF PLEASE.
		(OTHER A/C R/T)
02:02:54	CAPT	HELLO
02:02:55	CABIN CREW	CAPTAIN, TELEPORT CONNECTED
02:02:56	CAPT	ROGER
02:02:57	CABIN CREW	OK THANK YOU
02:02:57		CABIN INSTRUCTIONS ON PASSENGER EXIT, BELT INFORMATION.
02:04:10		ENGINE SOUND STOPS.

1.12 Wreckage information:

Due to the too low pitch the aircraft was initially contacted with the CAT I& CAT II ILS (under commissioning) light pole which was approx 6-8 ft height and aircraft met with sustained substantial structural damage in the lower fuselage belly area, LH main landing gear (MLG) bay, LH inboard flap, and Aircraft made on landing at un paved surface and hit the small concrete tank the LH landing gear door assembly was damaged. Damage was concentrated primarily on the LH lower fuselage and adjacent aerodynamic fairing structures.

A puncture hole with torn skin was observed on the lower fuselage belly panel between FR28D and FR29, bounded by STR19L and STR20L. Additional structural damage was identified between FR19 and FR21 involving STR21R, STR20R, FR20, associated cleats, and brackets. Stringer 21R was found cracked and separated adjacent to FR20, while Stringer 20R was deformed and locally loose with missing fasteners. Local deformation of FR20 web/flange and associated attachments was also noted. The missing fasteners

and some debris of the skin were witnessed at the threshold of the Runway 14. This all damages happened due to the Aircraft made the initial contact at the ILS Light poles during landing.

Damage was also observed in the LH MLG bay area around Rib 27. Rib 27 exhibited tearing and local deformation, with adjacent supporting strip cracking and bent stiffeners. The LH MLG door assembly, including fixed and folding panels, sustained severe damage with torn skin, exposed honeycomb core, crushed sandwich structure, and deformation near hinge/attachment areas. Nearby cables routed through the LH landing gear bay area were also found damaged due to the rub with small plants and stones at the unpaved surface. The wire remaining and paint markings were found at the small concrete electrical tank. In addition, the baffle plate covering the LH WOW sensor assembly was deformed.

The LH inboard flap sustained penetration damage forward of the forward spar between Rib 8 and Rib 9. The outer skin was penetrated with exposure and crushing of the honeycomb core. Local skin-to-core disbond and tearing were evident around the damaged area. The honeycomb core of the wing surface are scattered found at near to the ILS lights. Additional damage was observed on the bottom panel assembly between FR23A and FR23C at 191 JL, where elongated tearing and full-thickness penetration exposed the internal honeycomb core. Surrounding sandwich panel structure showed cracking, delaminating, and local disbond. The observed wreckage damage indicates significant impact-related structural loading affecting fuselage skin panels, stringers, frames, flap sandwich structure, landing gear bay structural members, and associated system installation.

1.13 Medical and Pathological Information

The flight crew was subjected to the post flight BA test as per the DGCA requirements and the tested negative (found satisfactory)

1.14 Fire:

There was no evidence of fire in flight. Also, there were no signs of post impact fire.

1.15 Survival Aspects

The aircraft is installed with ELT which can get activated by the G switch due to G forces or it can also be manually activated by crew with switch at lower left instrument panel in flight deck. The occurrence was survivable. The ELT was not activated.

1.16 Test and Research

After the occurrence, fuel and hydraulic fluid samples were collected from the aircraft in glass jars. The fuel sample was sent to the DGCA laboratory for analysis, and the report confirmed that the fuel quality was satisfactory. After comparing the CVR and DFDR data, it was found that at approximately 180 ft Radio Altitude (RA), the aircraft deviated from the -3° glide slope path. However, no aural warning was generated. Therefore, the T2CAS component was removed from the aircraft and sent to the OEM facility, M/s Acron Aviation, for further analysis of the Mode 5 transponder data. Further examination of the T2CAS component and the downloaded data is discussed in the Analysis section of this report.

Mode 5 transponder data Analysis

As per DFDR report of occurrence involved Aircraft, at 100ft RA, the glide deviation was -2 DOTS. However, during the CVR playback, no glideslope aural alert was heard in the cockpit. Therefore, in order to confirm whether any Mode 5 Glideslope warning was triggered by the T2CAS during this event. So T2CAS computer has removed and sent to the OEM facility for further analysis.

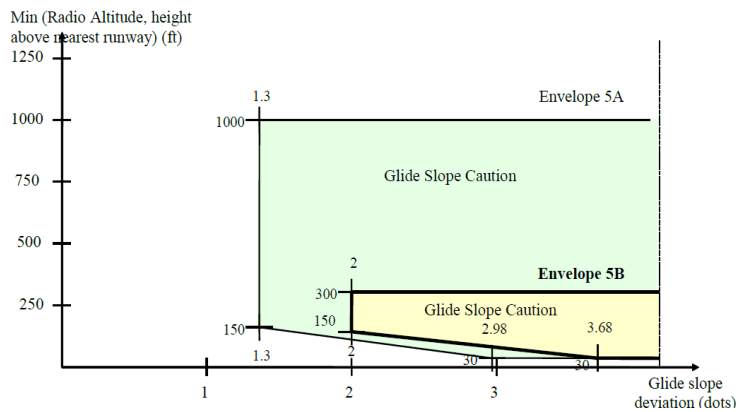


Figure 14. Actual Mode 5 Envelope for Aural Warning

At OEM facility, the T2CAS Mode 5 transponder data were downloaded as per the below procedure

- a) Obtain a New or Blank Compact Flash (CF) card.
- b) Copy to the New or Blank Compact Flash (CF) card the appropriate 'Header File'. If no header is copied onto the CF card, the unit will default with writing flight data recording to the card."
 - 1) Header files are files copied to the New or Blank Compact Flash (CF) card that will instruct the Computer Unit what is required to be downloaded.
 - 2) Header files needed to download Maintenance Data, Event Data and CRC Part Numbers can be obtained from ACSS Customer Services.
- c) For downloading Maintenance Data, Event Data and CRC Part Numbers, the aircraft does not need to be in an on-ground configuration.
- d) Apply power to the Computer Unit.
- e) Insert the Compact Flash Card.
 - The 'DATA STATUS' LED will blink Green once; this indicates the unit recognized a CF card was inserted.
 - The 'DATA STATUS' LED will then remain a solid Green while reading the header file.
 - The 'DATA STATUS' LED will start blinking to indicate the unit is performing the action defined in the header file.
 - The 'DATA STATUS' LED will change from blinking to a solid Green when action is complete.

The Mode 5 data has downloaded as per the above procedure and decode the Glideslope data. This Envelope analysis indicates the relationship between glideslope deviation and radio altitude during the aircraft's approach phase.

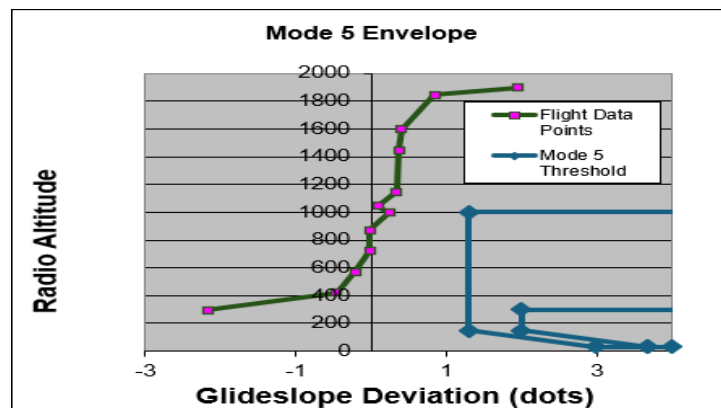


Figure15. Actual Mode 5 Envelope VS Altitude

The graph demonstrates that the aircraft progressively deviated below the glideslope as the radio altitude decreased, eventually entering the Mode 5A and Mode 5B warning regions associated with excessive glideslope deviation. The plotted flight points show that the deviation increased significantly during the final stages of approach, particularly below 300 feet Radio Altitude, indicating an unstable approach profile. Analysis of the slope between the 1.3 dot / 150 feet point and the 2.98 dot / 30 feet point shows a calculated descent gradient of approximately -71 feet per dot. Based on this slope projection, when the glideslope deviation increased from 1.3 dots to 2 dots, the aircraft would be approximately 50 feet lower, resulting in an altitude difference consistent with the reported 100 feet deviation observed during the occurrence.

1.17 Organization information.

Alliance Air is a scheduled Air Transport Operator. It is an autonomous, wholly owned subsidiary of Air India Asset Holding Limited (AIAHL) and is registered as Alliance Air Aviation Limited. The airline operates ATR 72-600 aircraft fitted with PW-127M engines configured for 70-72 seats, ATR 42-600 aircraft fitted with PW-127F engines configured for 48 pax seats and Do-228 aircraft fitted with TPE331-10GP-511D engines configured for 16 pax seats.

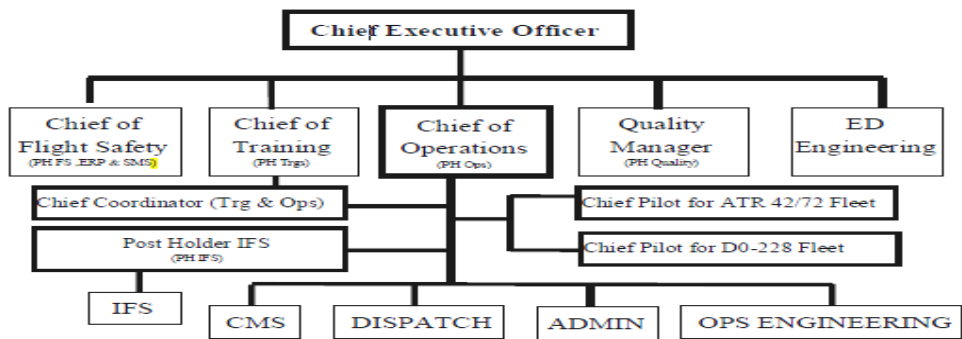


Figure 16.M/s Alliance Air Organizational chart.

Training division

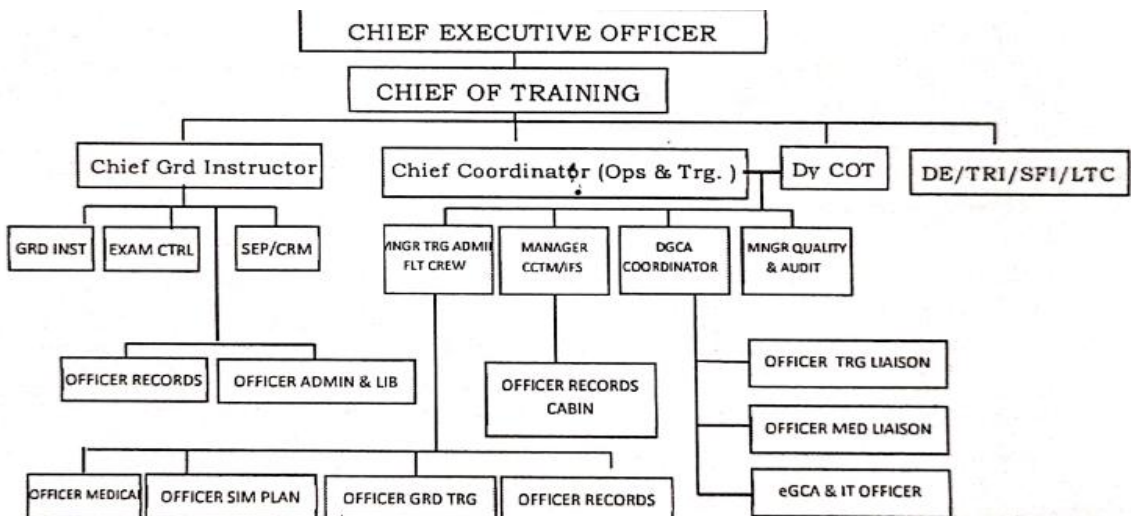


Figure17. M/s Alliance Air Training setup

1.17.1 Organization Procedures:

M/s Alliance Air has issued detailed Safety Recommendations for Safe Landing with the objective of ensuring maximum operational safety during approach and landing phases of flight. The guidelines emphasize that runway selection plays a critical role in ensuring aircraft safety and therefore, as far as practicable, landings should always be conducted into headwinds in order to improve aircraft controllability and reduce landing distance.

The following guidelines are recommended for safe landing

(a) The preference of runway — The runway selection plays an important role to ensure safety of aircraft. It is therefore advised, as far as practical landings must be performed in headwinds.

(b) Stabilized Approach — Approach should be stabilized by 1000ft AAL in IMC and 500 ft AAL in VMC conditions (Stabilization criteria is mentioned in OM Part A Chapter 25, para A 25.1). If the approach is not stabilized,

(c) Executing a missed approach/ Go-Around is a safe procedure and non-punitive in nature. It is encouraged anytime situation becomes unsafe for landing.

(d) Approach Speed — The Approach Speed (V_{app}) must be maintained during approach and it provides sufficient safety margins. Any variations between $V_{app} -0$ and $V_{app} +10$ are permissible.

(f) Touchdown Zone—during landing, the aircraft should touchdown within the touchdown zone of the runway. For any reason if aircraft starts floating on the runway or landing can't be performed within specified touchdown area, a Go-Around must be performed.

M/s Alliance Air also places significant responsibility upon the Commander during Low Visibility Operations. For Low Visibility operations, it is the Commander's responsibility to evaluate through his own observations that the actual conditions at the time of take off/ landing are at least equal to or better than the field minima even though, the reported visibility is above minima and ATC has given him clearance. Even if Met, conditions meet the minima required the Commander may use his discretion to delay a take-off or a landing if the weather has deteriorated or is likely to deteriorate.

Furthermore, Alliance Air strictly prohibits landing operations below the prescribed minima. All operations below the field minima are strictly prohibited. No aircraft shall commence or continue an approach to landing at an airfield if the reported visibility/RVR is below minima. Landing below the minima is only permissible in an emergency.

1.17.3 Rate of Descent Policy

M/s Alliance Air has established a comprehensive Rate of Descent Policy for ATR 42/72-600 aircraft with the objective of enhancing operational safety and minimizing the risk of Controlled Flight into Terrain (CFIT), particularly during approach and descent phases. The airline recognizes that high rates of descent in close proximity to terrain can create hazardous situations and therefore strongly discourages excessive sink rates near the ground. In accordance with this policy, the Pilot-in-Command (PIC) is responsible for ensuring that the Rate of Descent (ROD) remains within prescribed safety limits at various altitude levels. The ROD must not exceed 2000 feet per minute while descending up to 5000 feet Above Ground Level (AGL), 1500 feet per minute between 5000 feet and 2000 feet AGL, and 1000 feet per minute below 2000 feet AGL and throughout the approach phase. In circumstances where an approach requires a higher sink

rate than the prescribed limits, a special briefing is mandatory in order to ensure that all operational risks are fully understood and mitigated. These restrictions are intended to maintain aircraft stability, improve situational awareness, reduce pilot workload, and ensure safe terrain clearance during critical phases of flight operations.

In addition to the descent policy, Alliance Air has also laid down detailed procedures governing decisions related to the commencement, continuation, or discontinuation of instrument approaches under varying visibility conditions. The procedures clearly state that the PIC shall not commence an instrument approach if the reported Runway Visual Range (RVR) or visibility is below the applicable operational minima. Furthermore, if the reported RVR or visibility falls below the prescribed minima after the approach has commenced, the approach shall not be continued below 1000 feet above the aerodrome elevation or into the final approach segment. Where RVR information is unavailable, equivalent RVR values may be determined by converting the reported visibility. However, if visibility deteriorates below the applicable minima after entering the final approach segment or after descending below 1000 feet above the aerodrome elevation, the approach may be continued only up to the Decision Altitude/Height (DA/H) or Minimum Descent Altitude/Height (MDA/H). The approach may proceed below DA/H or MDA/H and the landing may be completed only if the required visual references for the runway environment are clearly established and continuously maintained. These procedures highlight Alliance Air's strong commitment towards operational discipline, strict compliance with safety minima, sound pilot judgment, and the safe conduct of instrument flight operations under all weather conditions

1.17.4 M/s Alliance air ILS Approach policy

- (a) Both Pilots must positively determine that the ILS is operating normally. It shall be checked by observing the movement of the indicator needles, Hag warning and by the coded identification.
- (b) The procedure turn is to be flown as charted.
- (c) A straight in ILS approach is permissible when the Commander is assured that localizer will be intercepted at least 3 miles outside the outer marker. This distance may be reduced if he is satisfied that he can be properly positioned for the approach by the time he passes the outer marker.
- (d) The outer marker/outer locator or other specified final approach fix must be crossed at the approved altitude. Positive identification of that point must be made before descent is initialed. Altimeter must be cross checked while crossing the final approach fix.
- (e) If at any time there is any doubt of proper functioning of either the required air borne or ground operating equipment the approach shall be discontinued. However, the Pilot should be prepared at the time of reaching the outer marker/FAF to execute an approach without glide slope to localizer MDA if so authorized in a particular approach.

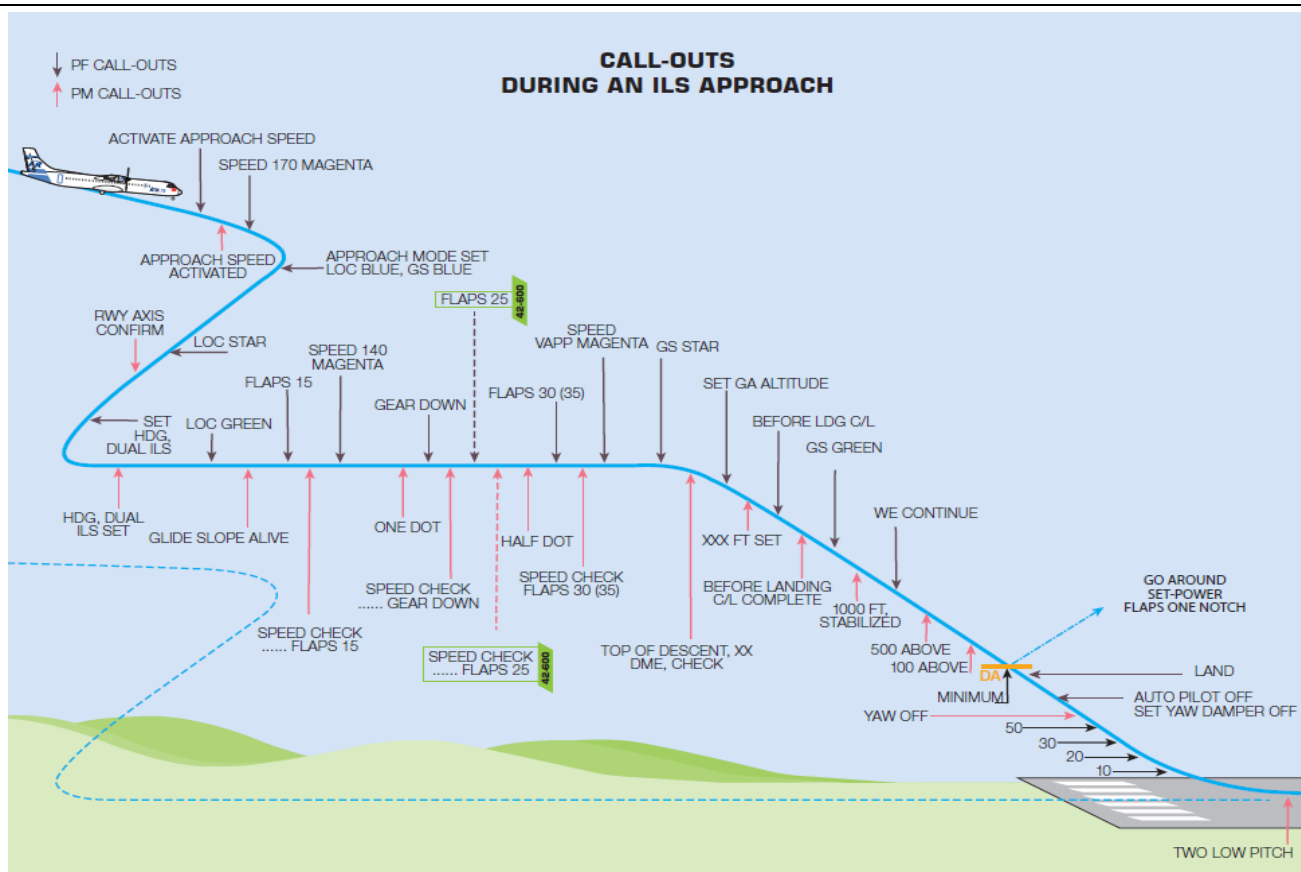


Figure 18.ATR 72 ILS Approach Call out

During the final approach the aircraft engaged modes were LOC GS in CATI ILS DUAL, from the DFDR data it is revealed that the aircraft performance as follows.

- At 100 ft RA, the glide deviation reached -2 dots (scale stop on the PFD).
- On the lateral axis, the aircraft began drifting to the right, with the localizer deviation reaching 1/4 dot.
- The rudder trim remained set at 7° nose-right and was not re-centred following AP disengaged. Consequently, greater pedal force was required to apply left rudder input than to apply right rudder input.
- The recorded crosswind was from the right and remained below 5 kts.
- It should be noted that the rudder trim parameter is recorded at -3° when in the centred position. For clarity and improved interpretation, a +3° offset was manually applied in this analysis.
- The maximum recorded rudder trim values were [+13° ; -19°], corresponding to actual values of [+/- 16°].

M/s Alliance air MANDATORY MISSED APPROACH: “IF THE LANDING RUNWAY VISUAL REFERENCE IS LOST DO NOT SIT AROUND HOPING YOU WILL SOON SEE THE RUNWAY. DO NOT WAIT-CARRY OUT' A GO AROUND.

- The Pilot shall execute an immediate missed approach under the following conditions:
- (a) If a Nav. transmitter or flight instrument failure occurs which will affect the ability to safely complete the approach in instrument conditions?

- (b) When on an ILS approach either the localizer and/or glideslope indicator show full deflection in instrument conditions and if at 100 ft to DA (DH) the glideslope and localizer show a deviation of more than 1 dot.
- (c) When the instruments show significant disagreement and visual contact has not been made.
- (d) When visual reference to the runway gets lost below DA/MDA.
- (e) The approach is not stabilized.

On reveal of DFDR data it shown that clearly the aircraft is destabilized due to wind shear and/or the Pilot is unable to maintain the aircraft within the prescribed flight path. As the aircraft continued descending toward touchdown, additional significant flight control inputs were recorded at approximately 20 ft radio altitude. At that point, the elevators were deflected to a strong nose-up position, reaching approximately -17 degrees. This input generated a rapid pitch response, causing the aircraft attitude to change from about 2 degrees nose-down to nearly 3 degrees nose-up within a very short period of time. MANDATORY MISSED APPROACH is failed to follow by the crews at this unstabilized approach.

1.17.5 FLIGHT DATA ANALYSIS PROGRAM

As per CAR Section 5, Series F, Part I. Flight data analysis program provides a systematic tool for proactive identification of hazards in aircraft operations before they may result in an accident, serious incident and incidents. FDAP is a non-punitive programme for routine collection and analysis of flight data to develop objective and predictive information for advancing safety, e.g. through improvements in flight crew performance, training effectiveness and operational & engineering procedures. All scheduled operators as an aeroplane of certified take-off mass in excess of 20000kg and part of their Safety management system shall establish Flight Data Analysis Program to determine hazards/ shortcomings in the operation of the aircraft.

All the aircraft installed with FDR should be fitted with QAR or equivalent device for easy retrieval of the recorded data. Data retrieval may also be achieved through an optical disc/PC card or a wireless QAR that automatically transmits the encrypted data through a ground link to the ground station. For aircraft where such facilities do not exist, manual downloading of the data from DFDR units shall be carried out regularly to ensure that the data of flight.

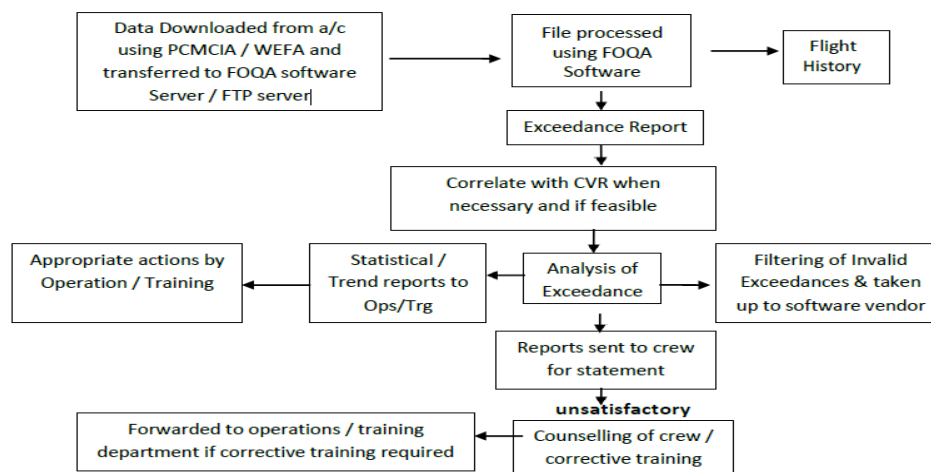


Figure19. M/s Alliance Air – Methodology for Analysis and Monitoring of FDR Data

Operator Procedure for analysis of data and exceedance trend monitoring

1. Entire data of each flight to be analysed to determine if any flight parameter had exceeded the laid down limit. If any exceedance is detected appropriate report for the same shall be generated in the given standard format, giving the actual value of the parameter, the specified limit for the same, the time of the event and the other relevant flight details. Hard / Soft copy of the report shall be generated for further analysis and review.
2. For the flights in which the exceedances are detected, a detailed analysis of flight shall be carried out to check whether or not the flight was handled as per the Standard Operating Procedures. As the approach and landing are critical phases of the flight, detailed analysis of the approach and landing phases of all flights shall be carried out, to detect any deviations from the normal approach profile and whether the approach was stabilized or not.
3. Daily reports for the exceedances of parameters shall be generated for all the types of aircraft and shall be put up for review and analysis by a type-rated captain, who makes an assessment of the exceedance. Suitable follow up action is taken in consultation with Chief / Dy. Chief of Flight Safety.
4. Suitable corrective action shall be taken up to overcome the deficiencies/shortcomings observed during analysis of the data.
5. Counselling of the crew members on the deficiencies observed shall be carried out.
6. A quarterly trend analysis report giving summary of exceedances and suggested corrective measures shall be shared with training Department for EBT.
7. During the refresher courses, the results and findings of the analysis shall be discussed for the benefit of the crew members.
8. Proper records are maintained of all red exceedances and corrective measures taken.
9. The Flight Safety Department of Alliance Air ensures effective functioning of the program in coordination with the operations, training and other concerned Divisions/Departments.
10. In case of significant incidents, SSFDR Data is correlated with CVR readouts as per CAR Section 5 Series F Part II.

On scrutiny of the FDMA Exceedance Report of both the crews covering the period from January 2024 to 10 October 2024 presents a detailed overview of operational exceedances recorded on ATR 72-600 and ATR 42-600 aircraft across various phases of flight, including approach, landing, take-off, and taxi operations. The report primarily focuses on exceedance trends associated with the captains and first officers involved in these occurrences and highlight several recurring operational deviations.

The exceedance report relating to captain's was scrutinized and revealed multiple FDMA exceedances approximately 12, across a range of flights and operational environments. The most frequent exceedances observed included long flare events, high rates of descent (ROD) between 1000 and 500 feet during approach, taxi speed exceedances, and pitch rate exceedances during take-off, and GPWS cautions. A significant number of these events occurred during the approach and landing phases, suggesting recurring challenges related to approach stabilization and landing energy management. The analysis identified several instances of high ROD values on approach sectors, indicating unstable descent profiles. Repeated long flare events further suggest delayed touchdown tendencies and excessive float during landing, which may contribute to increased landing distances and runway performance concerns.

Additionally, taxi speed exceedances recorded during both taxi-in and taxi-out phases indicate procedural deviations during ground operations, while pitch rate exceedances during take-off point toward aggressive rotation techniques. GPWS caution events noted in the report are operationally significant, as they reflect terrain or flight path warning activations that typically arise from unstable approach profiles or deviations from prescribed descent parameters. These events were recorded on

multiple aircraft registrations, including VT-RKE, VT-RKK, VT-RKC, VT-AIY, and VT-UDA, involving several co-pilots. Overall, the pattern of exceedances associated with the captains indicates recurring issues primarily linked to approach stability, landing technique, and operational discipline during taxi and take-off phases.

The exceedance report relating to first officers reflects a comparatively higher number of events, with approximately 18 exceedance occurrences recorded within a ten-month period, the majority of which were concentrated during approach and landing operations. A prominent trend identified in this section is the repeated occurrence of GPWS caution alerts during approach phases, indicating possible unstable approaches, inadequate descent path management, or delayed corrective actions during critical flight segments. Several long landing events were also recorded, suggesting that aircraft touchdown occurred significantly beyond the intended touchdown zone, potentially increasing runway occupancy and reducing landing safety margins. The report further identifies long flare events, taxi speed exceedances, and one particularly significant event involving low approach speed below 1000 feet, which is a critical parameter in stabilized approach criteria and may indicate improper energy management or excessive reduction in airspeed during final approach. The data reveals that many of these events occurred within a concentrated period between September and October 2024, potentially suggesting a recurring operational pattern or route-specific operational challenges. Aircraft frequently associated with these exceedances included VT-RKF, VT-AKH, VT-AIT, and VT-AIV. The repeated GPWS cautions and long landing trends indicate deficiencies in stabilized approach adherence, runway touchdown management, and situational awareness during final approach and landing phases.

1.18 Additional Information

NIL

1.19 Useful or effective investigation techniques.

Standard investigation procedures and techniques were used during investigation.

2. ANALYSIS

2.1 General

- i) Both pilots had the required licenses and qualifications to operate the flight.
- ii) Aircraft was airworthy. The aircraft had a valid Certificate of Airworthiness and a Valid Certificate of Registration at the time of Occurrence. The scrutiny of the Airframe Logbook revealed that as on 8th October 2024 the aircraft had completed 13385 Hrs (TSN). The aircraft is powered by two PW127 Engines. The Engine # 1 had logged 11994 hrs, 11096 cycles and Engine # 2 had logged 10509 hrs, 11427 cycles since new. Scrutiny of the aircraft records further revealed that all the modifications on the aircraft were found to be complied with at the time of Occurrence. Scrutiny of the snag register revealed that there was no snag reported on the aircraft prior to the occurrence flight. The aircraft weight & balance was well within the operating limits. The aircraft and its Engines were maintained as per the maintenance program consisting of calendar period/flying Hours or Cycles based maintenance as per maintenance program approved by DGCA.

2.2 Weather

The weather conditions at the time of the event played a significant and direct role in the development of the incident. The occurrence took place at approximately 08:51 UTC, and the METAR reports recorded around this time indicate a rapidly deteriorating weather. The sequence of METAR observations shows a clear progression from relatively moderate conditions to highly adverse weather within a short time span. Initially, visibility was around 5000 meters with haze present, but it progressively reduced to 4000 meters and then dropped sharply to approximately 500 meters by 09:00 UTC, with forecasts indicating further reduction to as low as 350 meters due to heavy thunderstorms. The presence of rain (RA), cumulonimbus clouds (CB), and thunderstorm activity (TSRA) suggests a highly unstable convective atmosphere characterized by strong vertical air movements. These conditions are typically associated with turbulence, downdrafts, and wind shear, all of which can significantly affect aircraft performance during approach and landing.

The Crew also reported heavy rain and downdrafts, further confirming the presence of severe weather phenomena. From the flight data recorder (FDR) analysis, it is evident that between 1000 ft and 250 ft radio altitude, the aircraft encountered a headwind component ranging from approximately 10 to 15 knots, occasionally reaching up to 20 knots. Additionally, a right crosswind component of about 5 knots, increasing up to 12 knots, was present during this phase. Under normal circumstances, a headwind is beneficial during landing as it increases lift and reduces ground speed. However, the situation changed dramatically below 250 ft radio altitude, where a significant wind shift occurred. The headwind component rapidly transitioned into a tailwind of approximately 15 knots near the ground, representing a low-level wind shear.

Simultaneously, the crosswind component decreased from around 10 knots at 200 ft to nearly zero at ground level. This sudden change in wind characteristics had a critical aerodynamic impact on the aircraft. The loss of headwind resulted in a reduction of relative airflow over the wings, thereby decreasing lift and increasing the aircraft's sink rate. The transition to tailwind further increased ground speed and reduced the effectiveness of lift generation. The diminishing crosswind also altered lateral aerodynamic forces, potentially affecting directional control. Such rapid changes in wind speed and direction at low altitude are

particularly hazardous because they occur during the final phase of flight, where there is minimal time and altitude available for corrective action.

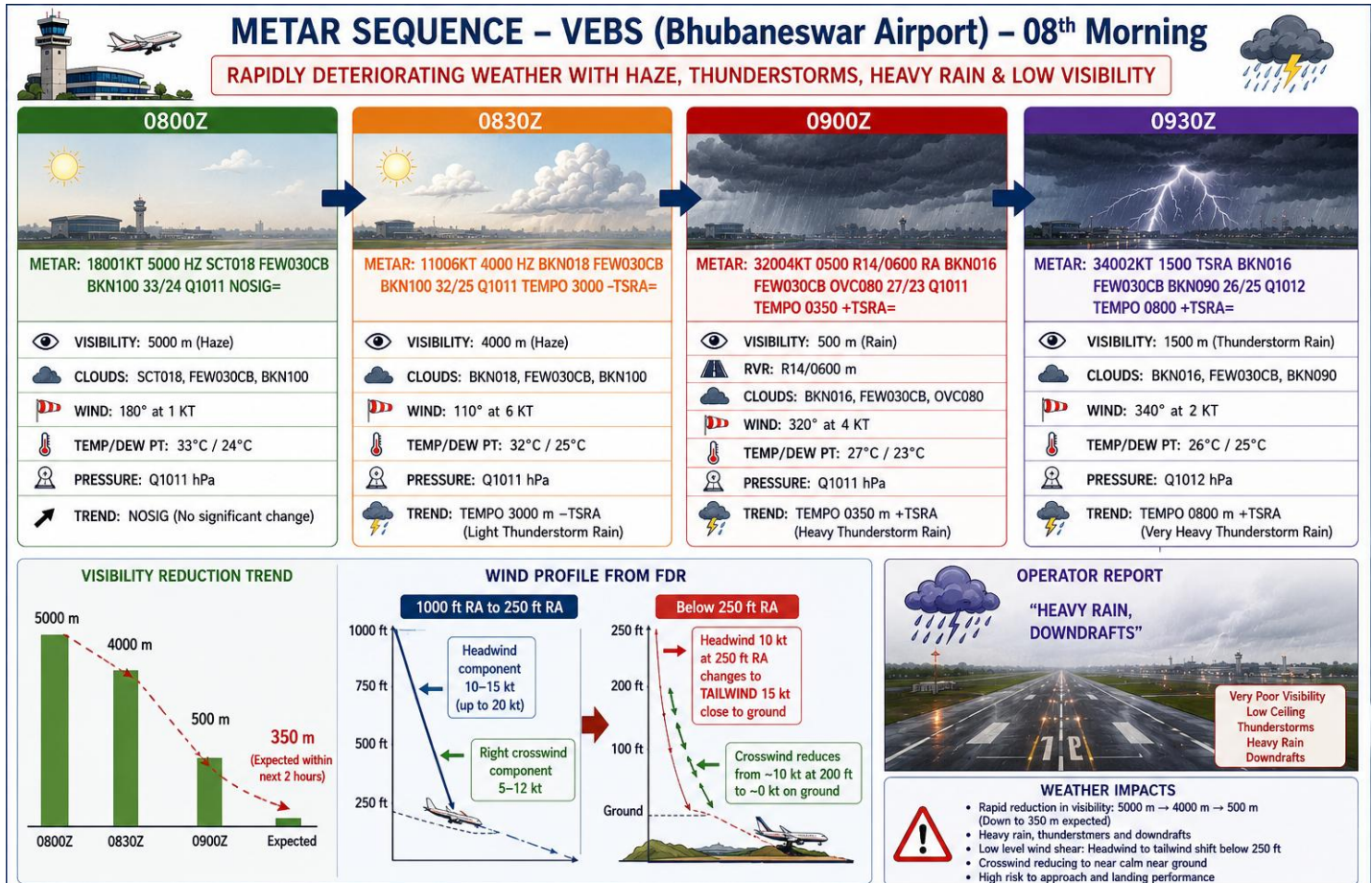


Figure 20.VEBS METAR Sequence at time of occurrence.

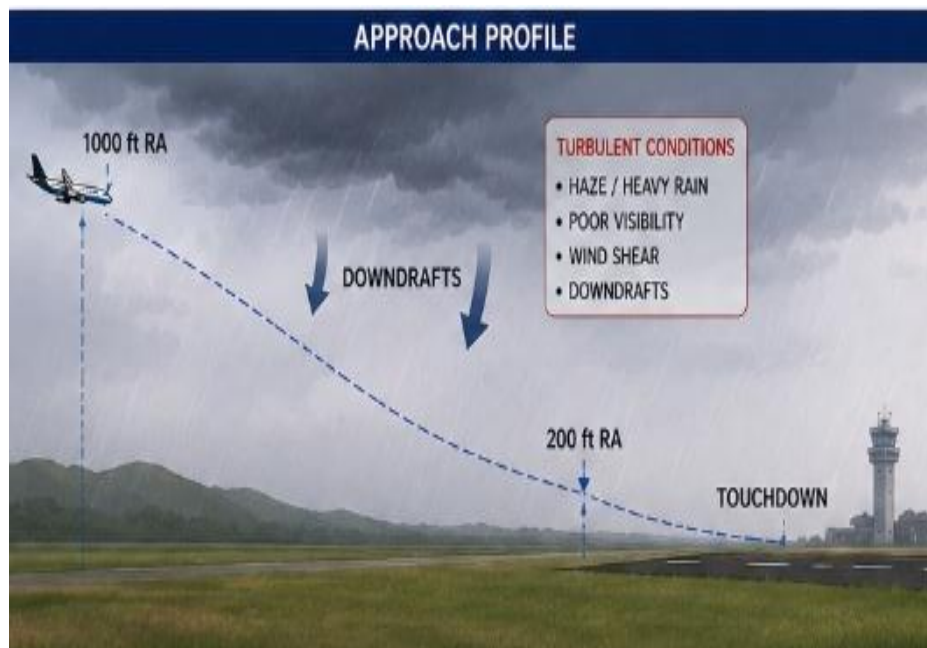


Figure 21.VT-RKF Approach profile from 1000 ft.

The rapid transition from headwind to tailwind would have caused a sudden loss of aircraft performance and lift during the critical landing phase. Combined with heavy rainfall, poor visibility, cumulonimbus clouds, and intense downdrafts, the meteorological environment was extremely unfavorable for safe flight operations. Overall, the sequence of METAR reports together with the operator's weather observations and recorded wind data clearly demonstrate the presence of severe convective weather, heavy precipitation, deteriorating visibility, and low-level wind shear conditions over Bhubaneswar airport during the observation period.

2.3 DFDR Analysis:

2.3.1 between 1000ft and 200ft RA

During the final approach phase between 1000 feet and 200 feet radio altitude, significant variations were observed in several flight parameters while the autopilot remained engaged. The indicated airspeed fluctuated between 110 knots and 130 knots despite no significant movement of the power levers, indicating that the speed changes were primarily caused by atmospheric disturbances rather than pilot thrust inputs. The aircraft pitch angle also varied considerably, ranging from +2 degrees nose up to -6 degrees nose down during the descent. These pitch oscillations reflected continuous aircraft response to unstable airflow and turbulence in the approach environment.

Simultaneously, the rate of descent showed large fluctuations between -200 feet per minute and -900 feet per minute, demonstrating unstable vertical flight path conditions. Despite these variations in air speed, pitch, and descent rate, the aircraft remained relatively stable laterally and vertically on the instrument approach guidance. The glide slope deviation remained within approximately plus or minus one quarter dot throughout the monitored phase, while the localizer deviation remained close to zero, indicating that the aircraft stayed accurately aligned with the runway centerline and glide path. The combination of stable guidance tracking with highly variable flight parameters suggests that the autopilot system was continuously compensating for rapidly changing wind and turbulence effects. Such fluctuations are consistent with flight in convective weather conditions involving turbulence, downdrafts, and wind shear. The absence of major power lever movement further supports the conclusion that the atmospheric conditions, rather than pilot control inputs, were the primary factor influencing aircraft performance variations. These rapid parameter changes during a critical phase of flight would have increased pilot workload and reduced aircraft energy stability.

Nose down Input and Autopilot Disengagement.

During the final stage of the approach, at approximately 200 feet radio altitude, a significant nose-down control effort started to be recorded from the Commander 1 (CM1) side while the autopilot remained engaged. The recorded nose-down force progressively increased and reached approximately 11 daN, indicating a strong forward input on the control column. Analysis of the flight data shows that the autopilot and yaw damper systems were still engaged during the initial phase of this control input. Due to the one-second sampling rate limitation of the autopilot and yaw damper parameters, the recorded disconnection times may not exactly represent the precise moment of disengagement. It is therefore highly probable that the autopilot disengaged when the control column force reached approximately 10 daN. Simultaneously, an effort was also detected on the rudder pedals while both the autopilot and yaw damper were still active. This rudder pedal input caused the automatic rudder trim system to react in opposition to the applied force. As a consequence, the rudder trim progressively moved toward the nose-right direction

in order to counterbalance the rudder pedal pressure. The rudder trim value eventually reached approximately 7 degrees nose-right, corresponding to nearly one dot of trim indication. Shortly afterward, the yaw damper system was re-engaged and then disengaged again approximately two seconds later, most likely through manual activation of the yaw damper push button.

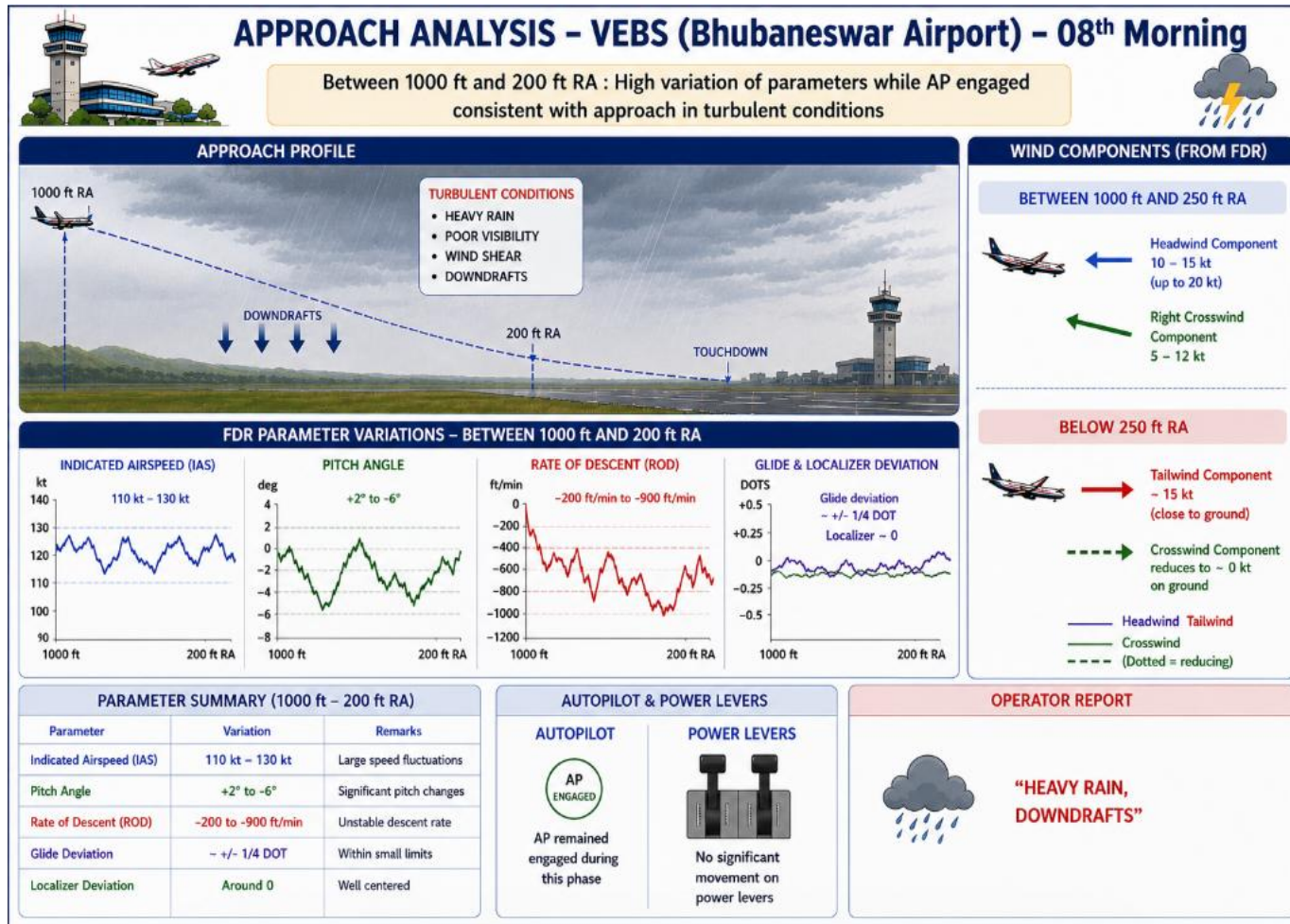


Figure22. VT-RFK Approach analysis from 1000ft to landing.

These repeated yaw damper engagement changes indicate a rapidly evolving flight control situation during the critical final phase of approach. As soon as the autopilot disengaged, the aircraft response became directly influenced by the previously applied nose-down control input. The pitch attitude rapidly changed from approximately 2 degrees nose-down to nearly 5 degrees nose-down within a period of only six seconds. This pitch decreases significantly altered the aircraft flight path and contributed to a rapid increase in descent rate. During the same time interval, the vertical speed increased from approximately 600 feet per minute descent to nearly 1000 feet per minute descent when the aircraft was around 100 feet radio altitude. Such a rapid increase in descent rate during low altitude flight represented a critical degradation of approach stability. Concurrently, meteorological conditions in the runway environment were deteriorating due to significant low-level wind variations associated with convective weather activity. As indicated by the weather analysis, the wind component transitioned from a headwind of approximately 10 knots at 250 feet radio altitude into a tailwind of approximately 15 knots close to the ground. This sudden wind reversal is characteristic of low-level wind shear and possible microburst activity generated

by thunderstorm downdrafts. The rapid change from headwind to tailwind would have caused an abrupt loss of aircraft energy and lift, further aggravating the increasing descent rate and nose-down flight path.

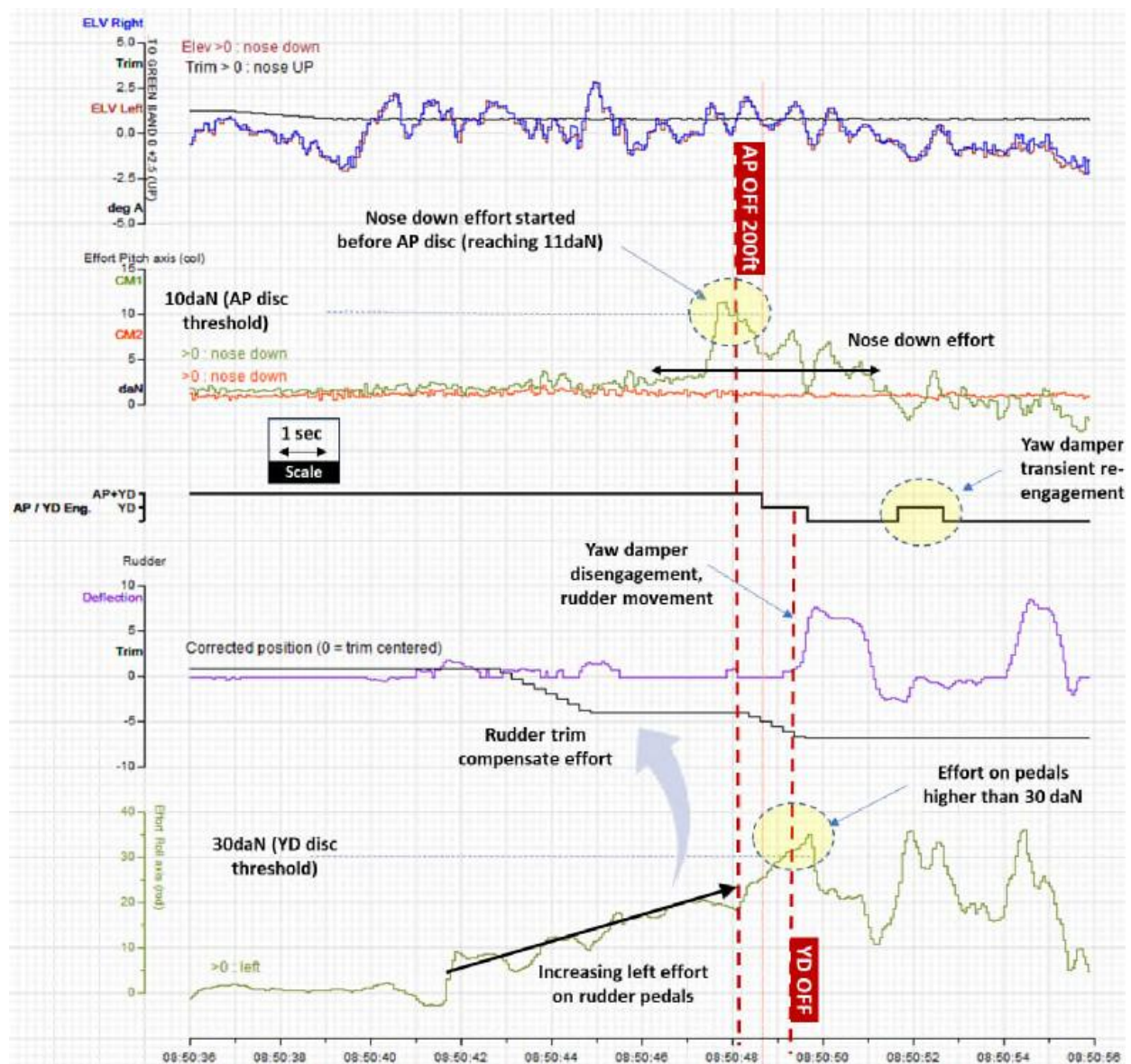


Figure 23. Trim and efforts during AP/YD disengagement

The combination of the nose-down control input, autopilot disengaged, and deteriorating wind conditions significantly affected the aircraft's vertical profile. As the descent continued, the aircraft deviated below the nominal 3-degree ILS and PAPI approach slope. Flight data analysis indicates that no significant corrective control column efforts were subsequently recorded to recover the flight path deviation. This absence of strong corrective pitch input suggests that the aircraft remained in a continued descent below the stabilized approach profile. The Precision Approach Path Indicator (PAPI), located approximately 270 meters beyond the runway threshold, provides a visual glide path corresponding closely to the Instrument Landing System glide slope. Since both the PAPI and ILS define essentially the same 3-degree approach path, the aircraft deviation below the glide slope confirms that the aircraft was descending beneath the safe visual and instrument guidance profile during the final moments of the approach.

The combination of unstable atmospheric conditions, strong control inputs, autopilot disengagement, changing wind components, and increasing descent rate created a highly critical flight situation at very low altitude. Overall, the recorded flight data indicate that the aircraft encountered severe operational difficulties associated with turbulent weather, low-level wind shear, and destabilized flight path conditions during the final approach segment.

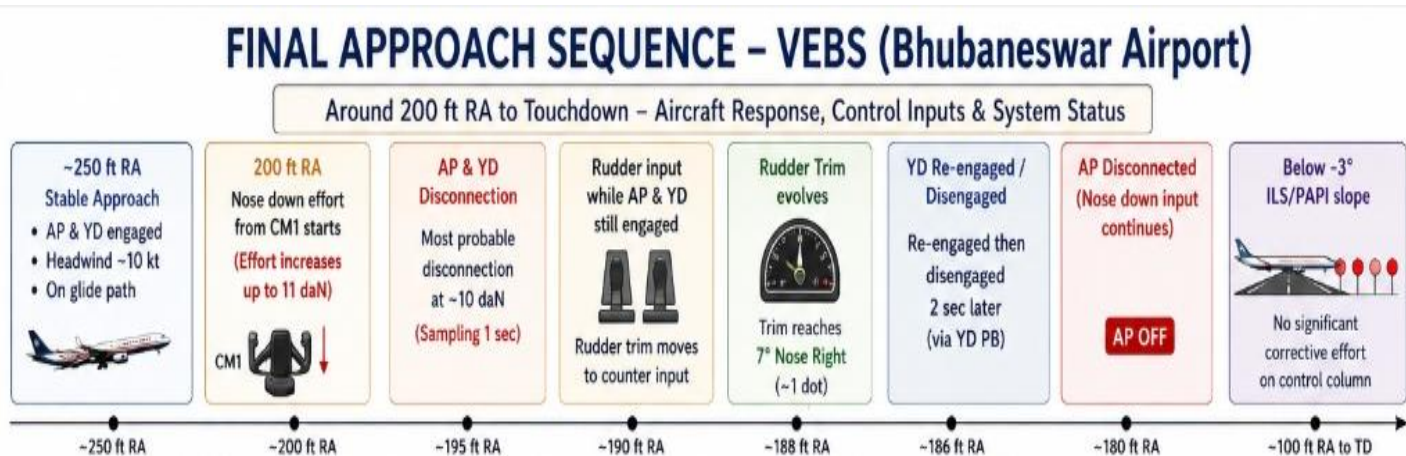


Figure 24. Sequence of Final approach

At approximately 100 feet radio altitude, the glide slope deviation reached minus 2 dots, corresponding to the lower scale stop indication on the Primary Flight Display. This indicated that the aircraft had significantly deviated below the normal ILS glide path. The deviation below the expected vertical profile confirmed that the aircraft was no longer maintaining a stabilized approach condition. On the lateral axis, the aircraft also began to drift progressively toward the right side of the runway centerline. Flight data showed that the localizer deviation increased and reached approximately one quarter dot to the right. Although the lateral deviation remained relatively limited, it demonstrated the beginning of directional instability during the final approach segment. One of the contributing factors to this lateral behavior was the rudder trim position. At the time of the autopilot disengage the rudder trim remained positioned at approximately 7 degrees nose-right and was not re-centered afterward. This trim position had initially been generated automatically to compensate for rudder pedal inputs while the autopilot and yaw damper were still engaged. Since the trim remained displaced after autopilot disengagement, the aircraft required greater pilot effort to apply left rudder input compared with right rudder input. Consequently, directional corrections toward the left side became more difficult during the critical low-altitude phase of flight. At the same time, the prevailing crosswind component was from the right side and remained below approximately 5 knots near the ground.

Although the crosswind magnitude was relatively weak, its direction combined with the existing rudder trim condition may have further influenced the aircraft tendency to drift to the right. The analysis of the rudder trim parameter also required correction due to the recording reference system. The recorded rudder trim value corresponds to minus 3 degrees when the trim is physically centered. For analysis purposes, a manual offset of plus 3 degrees was therefore applied in order to obtain a more accurate representation of the actual trim position. After applying this correction, the rudder trim displacement was determined to have reached approximately 7 degrees nose-right during the final approach phase. Flight data further indicated that the maximum recorded rudder trim values ranged between plus 13 degrees and minus 19 degrees, corresponding to approximately plus or minus 16 degrees of actual rudder trim displacement capability. These values demonstrate the significant authority available within the rudder trim system and highlight the importance of trim centering during critical flight phases. Overall, the combination of the nose-down input, low-level wind reversal, uncorrected glide path deviation, residual rudder trim

displacement, and increasing lateral deviation contributed to a destabilized final approach condition below the expected ILS and PAPI guidance path.

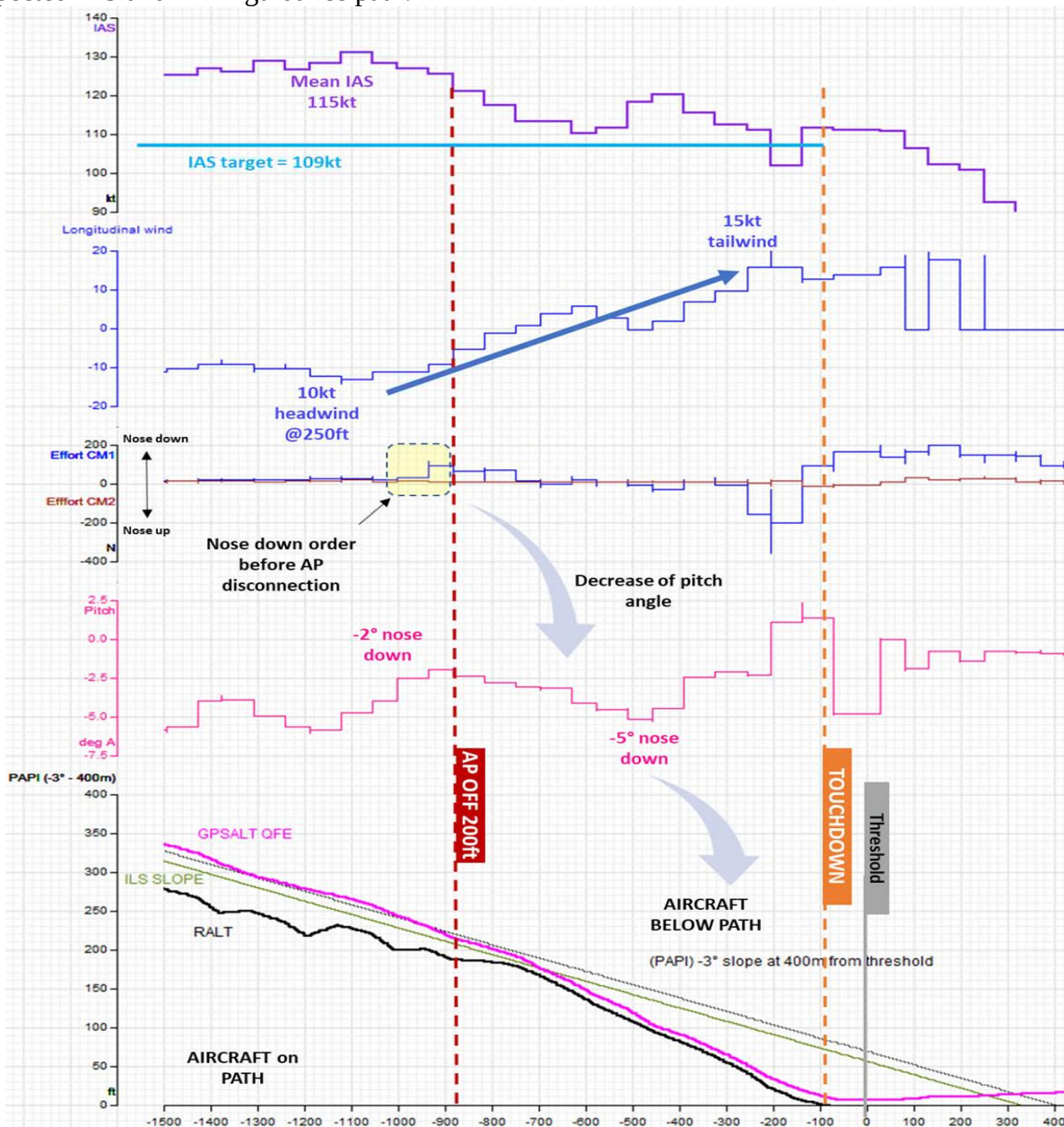


Figure 25. Trajectory and parameter around the AP disengaged

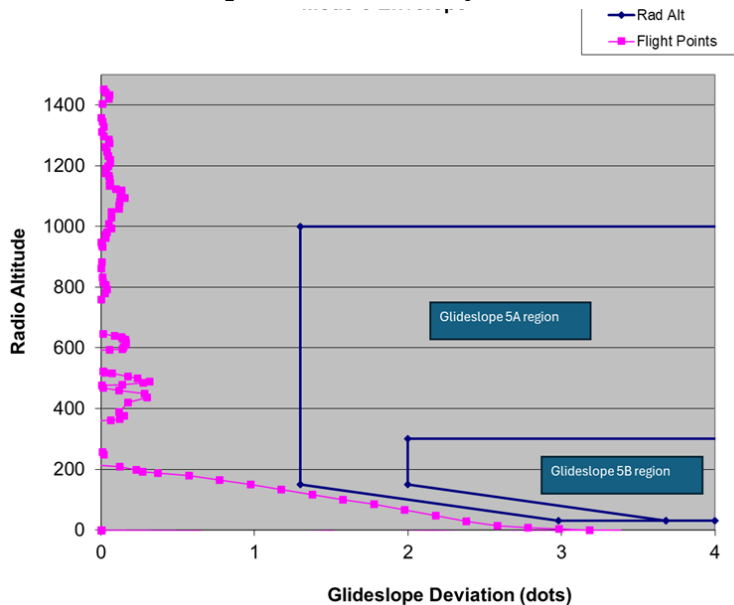
2.3.2 Touchdown before Runway 14 (Undershoot)

The aircraft ultimately made ground contact approximately 100 meters before the runway threshold, confirming a runway undershoot condition. At the moment of touchdown, the aircraft exhibited specific performance and attitude parameters that reflect the unstable approach. The indicated air speed was approximately 111 knots, which is close to the target approach speed and indicates that the aircraft was not in a stall condition. However, the ground speed was significantly higher at approximately 126 knots due to the tailwind component. This increased ground speed resulted in higher kinetic energy impact. The aircraft pitch angle was approximately +2° nose-up, indicating that a flare maneuver had initiated. However, the flare was executed late and was insufficient to fully arrest the descent rate. The roll angle was recorded at -5° left, suggesting a corrective bank to counteract lateral deviation. The load factor reached approximately

1.7G, indicating a firm landing. This elevated load factor reflects the high descent rate at the moment of ground contact. Although within structural limits, it is significantly higher than a typical smooth landing. The combination of these parameters confirms that the aircraft did not stabilize at touchdown.

The landing conditions were compromised by both vertical and lateral deviations. Despite this, the aircraft remained controllable after touchdown. This touchdown location indicates that the aircraft's descent trajectory intersected the terrain prior to reaching the runway. The touchdown occurred on the right side of the approach path, consistent with the earlier lateral deviation. The aircraft likely impacted the CAT I approach lighting system, indicating the severity of the vertical path error. This undershoot is a direct consequence of the sustained deviation below the glide slope. The absence of corrective input allowed the aircraft to continue descending on an incorrect trajectory. The late flare maneuver was insufficient to alter this trajectory significantly. The aircraft remained in low-energy condition with limited recovery capability. Despite the runway undershoot the aircraft maintained structural integrity and controllability.

2.4 Mode 5 Transponder data Analysis



This analysis supports the conclusion that the aircraft descended substantially below the intended glide path during the final approach phase which is MUST NOT ALERT region. The analysis also highlights the effect of the glideslope rate limiting filter incorporated within the system. Flight testing conducted by ACSS revealed that several parameters, including ILS glideslope signals, are susceptible to noise, fluctuations, and momentary signal disturbances. To prevent nuisance warnings and false alerts caused by these signal irregularities. The non-alerting is acceptable via the TAWS regulations and filtering mechanisms are applied to smooth the glideslope operation.

2.5 FDMA Exceedance Analysis

The most common trend observed across both crew involved in this occurrence is unstable approach behaviour, reflected through high rates of descent, GPWS cautions, low approach speed events, and long flare occurrences. These indicators collectively point toward challenges in maintaining stabilized approach parameters and proper energy management during descent and landing. Another significant trend is the frequency of long landing and flare exceedances, which may result from delayed flare initiation, excessive threshold crossing speed, or insufficient touchdown zone discipline. Taxi speed exceedances were also observed in multiple events, indicating deviations during ground operations. Take-off pitch rate exceedances suggest aggressive rotation inputs during departure operations. Importantly, most of exceedances documented in the report appear operational rather than technical in nature, indicating that aircraft systems themselves were not the primary cause of the events.

However, the training records and related documents for both crew members were scrutinized and it was observed that the crew had undergone the required training in accordance with organizational procedures. Following the exceedance events, the organizations not conducted any appropriate counselling sessions and not provide any corrective training to address the identified operational deviations except email information

to the involved flight crew. During the refresher courses, the results and findings of the analysis also are discussed. Despite undergoing corrective training and counselling, similar occurrences were recorded subsequently, indicating the recurrence of such operational exceedances it reflects the Crew may have habitual of this exceedance pattern in Aircraft operation.

2.6 Human Factors Analysis

This Runway undershoot occurrence highlights important human factor issues related to pilot decision-making, situational awareness, and handling of the aircraft during bad weather conditions. The flight crew continued the approach and landing in heavy rain and rapidly reducing visibility, which increased the risk during the final phase of flight at 500 ft RA. Heavy rain can create visual illusions and reduce outside visibility, making it difficult for pilots to correctly judge the aircraft's position, height, runway alignment, and descent rate. Due to the worsening weather conditions, the crew's situational awareness may have reduced, and the unstable approach may not have been identified at the proper time. Even though the approach conditions became unsafe, no Go-Around was initiated. Failure to carry out a timely Go-Around indicates a lapse in judgment and decision-making by the crew as per the operator's Operation Manual. The organization operational manual strictly advised the pilots may not continue the approach with the intention of completing the landing despite worsening weather conditions and plan for Go around. However, the crew continued the approach to land which is a common human factor known as "plan continuation bias." The rapidly changing weather and high cockpit workload may also have affected the crew's ability to properly monitor the aircraft and respond quickly.

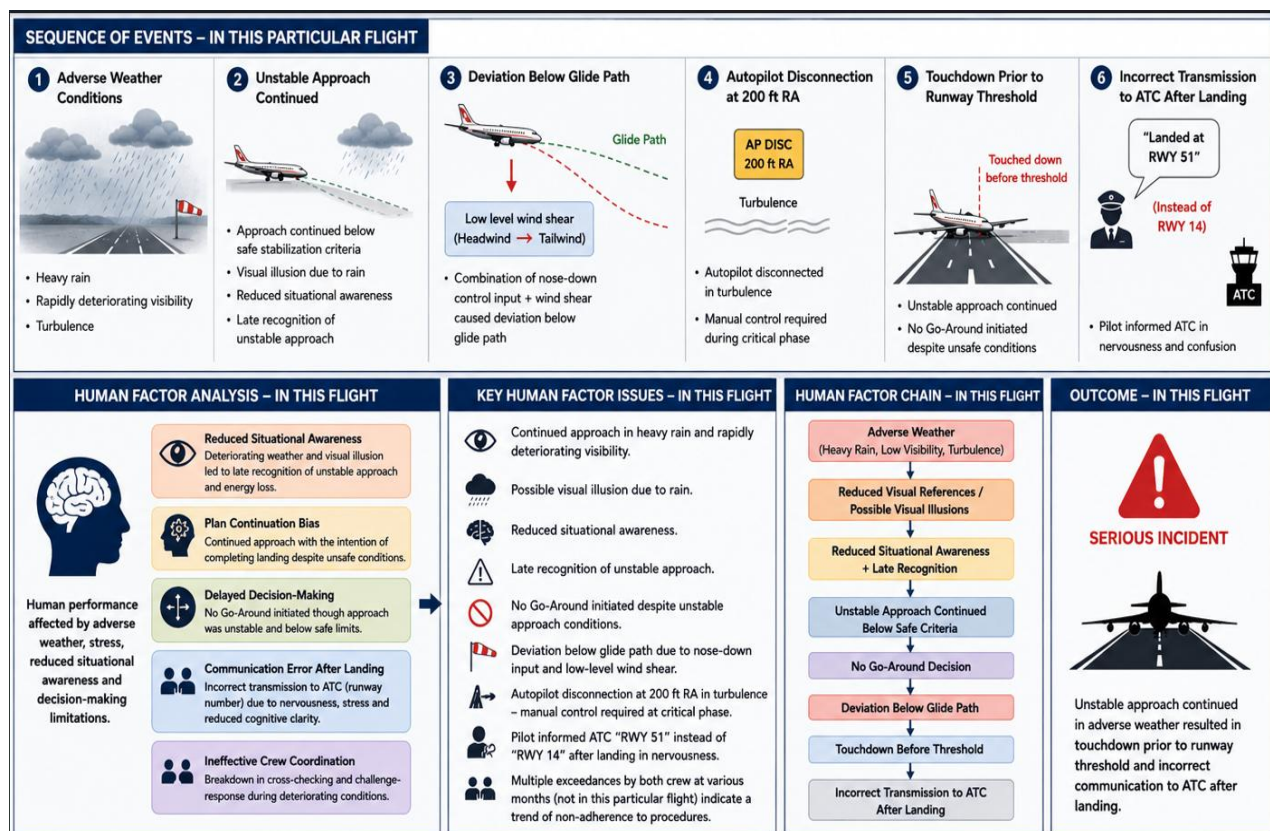


Figure 26. Human Factors Analysis of VT-RKF Runway overshoots occurrence.

The continuation of the approach without initiating a Go-Around indicates a critical lapse in operational judgment and decision-making. Failure to execute a timely Go-Around despite deteriorating weather, possible energy loss, and unstable approach indications suggests reduced threat perception and delayed cognitive response under high workload conditions, also there was shortcoming in Crew Resource

Management (CRM), such as inadequate communication, monitoring, and cross-checking between the pilots regarding the unstable approach and deteriorating weather conditions. Overall, the occurrence shows that poor weather, reduced visibility, delayed recognition of unstable approach conditions, and failure to initiate a Go-Around together contributed to the unsafe situation. The incident highlights the importance of maintaining situational awareness, following stabilized approach procedures, making timely decisions, and carrying out a Go-Around whenever landing conditions become unsafe.

The incident further reflects reduced situational awareness and delayed cognitive response under stressful operational conditions. Additionally, both crew members committed multiple exceedances during the approach phase, indicating deficiencies in compliance with stabilized approach procedures, monitoring of flight parameters, and timely corrective action. This occurrence also suggests shortcomings in Crew Resource Management (CRM), including inadequate communication, insufficient cross-checking, limited mutual intervention, and ineffective challenge-response coordination between the pilots during the deteriorating approach conditions. Overall, the serious incident demonstrates how adverse weather, reduced situational awareness, delayed recognition of unstable approach conditions, ineffective decision-making, communication errors, and inadequate CRM collectively contributed to the unsafe continuation of the approach and the subsequent touchdown prior to the runway threshold.

3. Conclusion

3.1 Findings

1. The aircraft conducted the approach in rapidly deteriorating weather conditions associated with heavy rain, thunderstorms, turbulence, downdrafts, and low visibility.
2. Visibility reduced progressively from 5000 meters to 500 meters, with temporary reductions forecast down to 350 meters.
3. Significant weather activity was present near the runway environment, including cumulonimbus cloud development.
4. The Crew reported heavy rain and downdrafts during the approach phase.
5. Between 1000 feet and 250 feet radio altitude, the aircraft encountered unstable wind conditions with headwind components between 10 and 20 knots and right crosswind components up to 12 knots.
6. Below 250 feet radio altitude, the wind changed rapidly from a headwind of approximately 10 knots to a tailwind of approximately 15 knots near the ground.
7. The rapid wind reversal consists of low-level wind shear and possible microburst activity.
8. Between 1000 feet and 200 feet radio altitude, the indicated air speed fluctuated between 110 knots and 130 knots while the autopilot remained engaged.
9. During the same period, pitch attitude varied between +2 degrees and -6 degrees.
10. The rate of descent fluctuated between -200 ft/min and -900 ft/min.
11. Glide slope deviation remained within approximately $\pm 1/4$ dot and localizer deviation remained close to zero during the early part of the approach.
12. The large variations in flight parameters while maintaining glide path tracking are consistent with an approach conducted in turbulent atmospheric conditions.
13. Around 200 feet radio altitude, a significant nose-down control input from the CM1 (Captain) side was recorded while the autopilot remained engaged.
14. The recorded nose-down effort increased up to approximately 11 daN.
15. The autopilot most probably got disengaged when the control column force reached approximately 10 daN.
16. Rudder pedal inputs were recorded while the autopilot and yaw damper remained engaged.
17. The rudder trim system automatically moved in response to the rudder pedal input and reached approximately 7 degrees nose-right.
18. The rudder trim was not re-centered after autopilot disengaged.
19. The yaw damper was re-engaged and disengaged again approximately two seconds later.
20. The autopilot and yaw damper were disengaged without any pilot callouts.
21. Following autopilot disengaged, the aircraft's pitch attitude decreased from approximately -2 degrees to -5 degrees nose-down within six seconds.
22. The descent rate increased from approximately -600 ft/min to nearly -1000 ft/min near 100 feet radio altitude.
23. The aircraft deviated below the nominal 3-degree ILS/PAPI glide path.
24. At 100 feet radio altitude, the glide slope deviation reached approximately -2 dots, corresponding to the lower scale limit on the Primary Flight Display.
25. No significant corrective control column input was recorded after the aircraft deviated below the glide path.
26. On the lateral axis, the aircraft deviated slightly to the right and the localizer deviation reached approximately $1/4$ dot.
27. The right rudder trim condition increased the force required to apply corrective left rudder input.
28. The crosswind near the ground remained from the right and below approximately 5 knots.
29. At approximately 100 feet radio altitude, the indicated air speed decreased rapidly from 118 knots to 101 knots within five seconds.

30. The airspeed variations were consistent with severe atmospheric disturbances and heavy precipitation effects.
31. At approximately 20 feet radio altitude, strong nose-up elevator inputs reaching approximately -17 degrees were recorded.
32. The aircraft pitch attitude increased from approximately -2 degrees nose-down to +3 degrees nose-up during the flare phase.
33. The exceedance events, the organizations not conducted any appropriate counseling sessions and not provide any corrective training to the flight crew to address the identified operational deviations.
34. **Shortcomings in Crew Resource Management (CRM):** Inadequate communication, cross-checking, mutual intervention, and challenge-response coordination between the pilots contributed to the ineffective management of deteriorating approach conditions and the failure to initiate a timely Go-Around.
35. After landing, the PIC informed ATC that the aircraft had landed on Runway 51 instead of Runway 14, possibly due to nervousness, stress, and confusion following the serious incident, indicating a temporary lapse in situational awareness.
36. M/s Alliance Air did not provide the crew flying-hours data in a complete and satisfactory manner.

3.2 Probable Cause:

This Runway undershoot occurred due to the continuation of an unstabilized approach below the prescribed stabilization criteria during adverse weather conditions. While approaching the runway, the aircraft deviated below the glide path because of nose-down control inputs combined with the effects of low-level wind shear, involving a transition from headwind to tailwind conditions. Poor weather, reduced visibility, delayed recognition of unstable approach conditions, and failure to initiate a Go-Around leads to the occurrence. Consequently, the aircraft touched down before reaching the runway threshold. The situation was further aggravated when the autopilot got disengaged at approximately 200 feet Radio Altitude (RA) in turbulent weather conditions, significantly increasing pilot workload at a critical phase of flight. The occurrence highlights deficiencies in approach stabilization, adverse weather handling, situational awareness, and timely decision-making during landing operations.

3.3 Contributory Factors

1. Severe convective weather conditions include heavy rain, turbulence, downdrafts, and low visibility in the runway environment.
2. Presence of significant low-level wind shear characterized by rapid transition from headwind to tailwind close to the ground.
3. Rapid loss of aerodynamic energy due to the longitudinal wind reversal below 250 feet radio altitude.
4. High fluctuations in air speed, pitch attitude, and rate of descent caused by turbulent atmospheric conditions.
5. Sustained nose-down control input around 200 feet radio altitude while the autopilot remained engaged.
6. Failure to adequately correct the increasing deviation below the ILS/PAPI glide path.
7. Residual Rudder trims displacement of approximately 7 degrees nose-right after autopilot disengaged.
8. Increased pilot effort required to apply left rudder correction because of the displaced rudder trim position.
9. Progressive deviation below the stabilized approach profile during the final approach segment.
10. Rapid and large air speed fluctuations near the ground associated with wind shear and heavy rain. .
11. Combined effect of adverse weather, wind shear, destabilized flight path, and delayed corrective response during the final stages of approach.

4. Safety Recommendations.

- 1.** The Operator should strengthen simulator training requirements for flight crew by incorporating advanced scenarios involving heavy rain, low-visibility approaches, and rapidly deteriorating weather conditions. Special emphasis should be placed on pilots who have recorded operational exceedances within a six-month period, with mandatory recurrent simulator sessions and targeted remedial training to enhance decision-making, situational awareness, and adherence to standard operating procedures during adverse weather operations.