FINAL INVESTIGATION REPORT ON INCIDENT TO M/s TRU JET LTD. ATR 72-212A (500 Series) INDIAN REGISTERED AIRCRAFT VT-TMK ON 18-11-2021 AT KANDLA

GOVERNMENT OF INDIA
OFFICE OF DIRECTOR AIR SAFETY (WESTERN REGION)
INTEGRATED OFFICE, NEW AIRPORT COLONY, MUMBAI-400099

FOREWORD

This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and examination of various aeronautical documents. The investigation has been carried out in accordance with Annex 13 to the convention on International Civil Aviation.

The investigation is conducted not to apportion blame or to assess individual or collective responsibility. Sole objective is to draw lessons from this incident which may help to prevent recurrence of such future incidents.

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1. Aircraft	**Type**	:	ATR 72-212A (500 Version)
	Nationality	:	Indian
	Registration	:	VT-TMK
2. Owner and Operator		:	M/s Trujet limited.
3. Pilot-in-Command		**:**	ATPL holder
Extend of Injuries		:	NIL
Co-Pilot/First Officer		:	CPL holder
Extend of Injuries		:	NIL
4. Date of incident		:	18.11.2021
Time of incident		:	09:31 UTC
5. Place of incident		**:**	(VAKE)Kandla Airport
6. Co-ordinates of incident site		**:**	23° 6′ 46″ N, 70° 6′ 1″ E
7. Last point of Departure		**:**	(VAAH)Sardar Vallabhbhai Patel International Airport
8. Intended Place of landing		:	(VAKE)Kandla Airport Kandla
9. No. of passengers on board		**:**	62(excluding operating crew)
10. Type of operation		:	Scheduled Commercial Air Transport Operation
11. Phase of operation		:	Landing
12. Type of incident		:	Runway excursion and Tail strike

(All the times are in UTC unless or otherwise specified)

SYNOPSIS:

On 18/11/2021 at 0847 UTC , M/s. Trujet ATR 72-500 aircraft Registration VT-TMK Sector Ahmedabad -Kandla (TRJ 711), departed from Ahmedabad Airport with 62 passengers on board alongwith 04 crew and 01 AME onboard. The final approach was stabilized. However the aircraft touch down at the right side of the runway with a bounce. Further the aircraft had Lateral excursions on both sides of the runway followed by tail strike and overrun prior to lift off from a distance beyond the end of the runway. Further the aircraft flew back, requested to carry out precautionary landing, however the same was converted to full emergency by the aerodrome operator. Further the aircraft landed safely at Ahmedabad. All the passengers were disembarked safely. There was no fire or injury to anyone.

The incident was investigated by an Investigator In-Charge appointed by DGCA, India vide letter No. DGCA-15018(13)/4/2021-DAS dated 29/11/2021 in exercise of power under Rule 13(1) of the Aircraft (Investigation of Accidents and Incidents) Rule 2017.

The probable cause of the incident was as the crew continued landing with aircraft speed less than V_{app} in the prevailing gusty wind condition. This led to touchdown on right side of the runway. Subsequent use of excessive rudder inputs resulted in the Lateral runway excursions to the left and right. Further attempts to lift off without setting proper Take-off configuration resulted in tail strike and overrun before attaining a delayed Go Around.

1. FACTUAL INFORMATION

1.1 HISTORY OF THE FLIGHT

On 18th November 2021, ATR 72-212A aircraft with registration VT-TMK and flight number TRJ 711 departed from Ahmedabad at 08:47 hrs. UTC to Kandla with 67 persons on board (including 04 crew members and 1 AME for the sector). The aircraft was cleared by qualified AME at Ahmedabad.

Both the cockpit crew had undergone pre-flight B.A test at Ahmedabad before departing for the flight and result was 'negative' for alcohol breath analyser test.

At time 0910 UTC, the aircraft came in contact with Kandla Tower for latest METAR, and same was provided as per report generated at 0900 UTC. At time 0921 UTC, aircraft again came in contact after release from Bhuj ATC at 26 miles inbound and was descending to 5000 feet. Aircraft was then cleared by Kandla ATC to descend to 2300ft as per established procedure. Aircraft was asked to report, established final approach track, runway 23.

At Time 0927 UTC, aircraft reported, established final approach track runway 23. Landing clearance was given to TRJ711 with spot wind as 350 degrees/11 knots which was observed on Wind Direction Indicator (WDI). At time 0930 UTC, aircraft touched on the runway towards right from runway center line (point A) followed by a bounce.

Attempts by the crew were made to keep the aircraft on runway center line, however the aircraft had veered off towards left of runway. Therefore the PIC decided to Go Around, however as the Take-off configuration was not set and the aircraft continued rolling towards the left. Thereafter, the LH Main Landing Gear wheel had exited the paved surface (890m from threshold) and entered the soft ground. During this, one of the runway edge light was damaged (point B). Thereafter, the LH Main Landing gear wheel re-entered the paved surface (955m from threshold). After entering the paved surface the aircraft once again veered off to right side on the runway, with all the wheels of the aircraft exiting the paved surface(at 1089 meters from threshold). As the aircraft was still not in Take-off configuration followed by the crew trying to rotate the aircraft prior to aircraft

attaining the rotational speed resulted in the aircraft experiencing a tail strike(point C). Further, the aircraft rolled on the strip (soft ground) for approximately 300 meter. After entering the paved surface, the aircraft had crossed the runway end of RWY23, overrun by 58m and then took off from the end on strip(point D).

Illustrations of aircraft movement on runway 23 till go around (Not as per scale)

At time 0933 UTC on enquiry by the controller, crew informed that a go around maneuver had been initiated, and after climbing to 2300 feet, will hold over NDB. The reason for go around procedure was reported as technical.

At Time 0946 UTC aircraft requested for diversion to Ahmedabad and was cleared in coordination with Bhuj ATC and Ahmedabad Area Control. At Ahmedabad time 1020UTC aircraft requested to carry out precautionary landing due to suspected tyre burst, however the same was converted to Full emergency by the aerodrome operator at 1023UTC. Aircraft landed safely at Ahmedabad at time 1032 UTC.

Aircraft's Take-off weight was 22800 kg and fuel on board before departure was 2200 kg.

1.2 INJURIES TO PERSON

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor/None	Nil/(2+2+1)	Nil/62	

Total persons on board: 67

1.3 DAMAGE TO AIRCRAFT

1.3.1 Damage to Aircraft: The following damages to aircraft were observed during aircraft inspection at Ahmedabad:-

A. Damage to LH main L/G door-

- From the edge of main L/G door, 130 mm delamination in the upward direction.
- From the edge, 150mm inward direction, rubber bulb seal was found missing.
- Bending from edge of the main L/G door 170mm in length, 2mm depth and radius of curvature is 80mm.

- LH main wheel No.01 hub missing (material 250mm)
- Main wheel no. 03 Tyre peeled off & inner ply layer visible.

Fig 1. Door of Left MLG

B. Damage to RH main L/G door-

- Delamination of main landing door of size, 800 mm(L) & 230mm (w).
- Cracked (02) from the door edge 350mm and 480mm.

C. Tail skid observed with rubbing mark.

Fig 2: Scratches on Tail shoe

Fig 3. Peeled off tyre No. 3 of Left MLG

Fig 4. Broken rim of Left MLG

1.4 Other Damage

The following damages were observed during site visit at Kandla Aerodrome.

a. Runway Edge light fitting No. B-88 broken from tangible coupling and shattered to pieces.

b. Scratch marks on Runway Edge light fitting No. B-88 foundation.
c. No damage on runway surface found.

Fig 5. Broken Runway Edge light

Fig 6. Damage to foundation of B-88

1.5 Personnel information:

Details of Crew:

Details	**Pilot-Captain**	**First Officer**
Date of Issue of License	ATPL -22.08.2019	CPL-25.07.2013
License valid upto	21.08.2024	24.07.2023
Category	ATPL	CPL
Date of Med Exam	12.11.2020	01.12.2020
Medical Exam Valid Upto	01.12.2021	03.12.2021
FRTO License Date of Issue of	08.02.2011	25.07.2013
FRTO License Valid up to	14.01.2026	25.07.2023
Total Flying Experience	3291:51	1371 hrs
Experience on Type	375:26	1126 hrs
Experience as PIC on Type	247:11	NA
Last flown on Type	14-11-21	17.11.21
Total Flying Experience during last 180 days	from 22.05.2021-(243:51)	from 22.05.2021-(98:25)
Total Flying Experience during last 90 days	from 20.08.2021-(124:50)	from 20.08.2021-(47:55)
Total Flying Experience during last 30 days	from 19.10.2021-(49:20)	from 19.10.2021-(42:05)

Total Flying Experience during last 07 days	from 12.11.2021-(15:25)	from 12.11.2021-(16:25)
Total Flying Experience during last 24 hours	from 18.11.2021- (02:00)	from 18.11.2021- (07:05)

During interview Captain he submitted that he has operated flights to Kandla first time as PIC. However, First Officer submitted that he had operated as FO to Kandla many times It was also submitted by them that they were flying with each other for the first time.

Controller Details

Details	Tower Controller
Log Time	0910-1100 UTC
Medical	Class 3
Medical Validity	03/01/2022
ELPA	5
ELPA Validity	02/10/2026
Rating	ADC (Previously held ADC, Area &Procedural)

1.6 Aircraft information:

Sl No	DESCRIPTION	REMARKS
1	Manufacture	GIE Avions De Transport Regional , France
2	Aircraft Type	ATR 72-212A (500 Version)
3	Aircraft Registration	VT-TMK
4	Manufacture SL No	858
5	Year of Manufacture	2009
6	Certificate of Registration No	4587/3
7	Certificate of Airworthiness No	6697/2 , ARC - TMK/6697/2/ARC/2021/08
8	C of A Renewed on	16-MAR-2021
9	C of A valid up to	16-MAR-2022

10	ARC issued on	16-MAR-2021
11	ARC valid up to	16-MAR-2022
12	Category of C of A	Normal
13	Subdivision category of C of A	Passenger / Mail / Goods
14	Minimum crew	2
15	Maximum zero fuel Weight	20800
16	Maximum Take-off weight	22800 Kgs
17	Date of Aircraft Weighment	13-MAR-2020
18	Last major Inspection	4C+2C+1C+2Y+4Y+12Y
19	Last major Insp. carried out on	25-FEB-2021 (CRS DATE)
20	Airframe Hours Since New	20582:27
21	Airframe Hours since last C of A	1580 FH
22	Aircraft Hours since last ARC	1580 FH
23	Aircraft usual Station as per C of R	Hyderabad
24	Aero Mobile license No	L-14012/01/07-RLO(SR)/ 1306
25	Aero mobile License valid up to	07 January 2022

Engine Details

S/N	DESCRIPTION	LH Engine	RH Engine
1	Manufacturer	PRATT & WHITNEY	PRATT & WHITNEY
2	Type	TURBOPROP	TURBOPROP
3	SI. No	ED0362 (LH)	ED1314 (RH)
4	Engine Hours since New	14920:45	11565:48
5	Engine Hours since O/H	10548:09	Not Applicable
6	Date of O/H	15-JUL-2016	N/A
7	Last Major Inspection	HSI / REPAIRED	REPAIRED
8	Last Major Inspection carried out on	29-JUL-2018 / 13-OCT-2019	30-AUG-2018
9	Average Fuel consumption as per Fuel/Oil Register	270 KG/hr	270 KG/hr

10	Manufactured specified Max. Fuel Consumption	504 kg / hr (Cruise at 22.6 deg Celsius)	504 kg / hr (Cruise at 22.6 deg Celsius)
11	Average Oil consumption as per Fuel/Oil Register	0.19 QTS/HR	0.17 QTS/HR

As per the L&T sheet, the sector load (RTOW) was 21414 Kgs and maximum landing weight was calculated as 20855 kgs. As per pax. Manifest, there were 62 passengers, 04 crew (2+2) and 01 AME were onboard.

Information from Fault history check post incident:

a) EEC/PEC fault code checked- No Fault code found Latched.
b) MFC fault code checked- found no fault latched.

Tyre pressure measured after the incident:

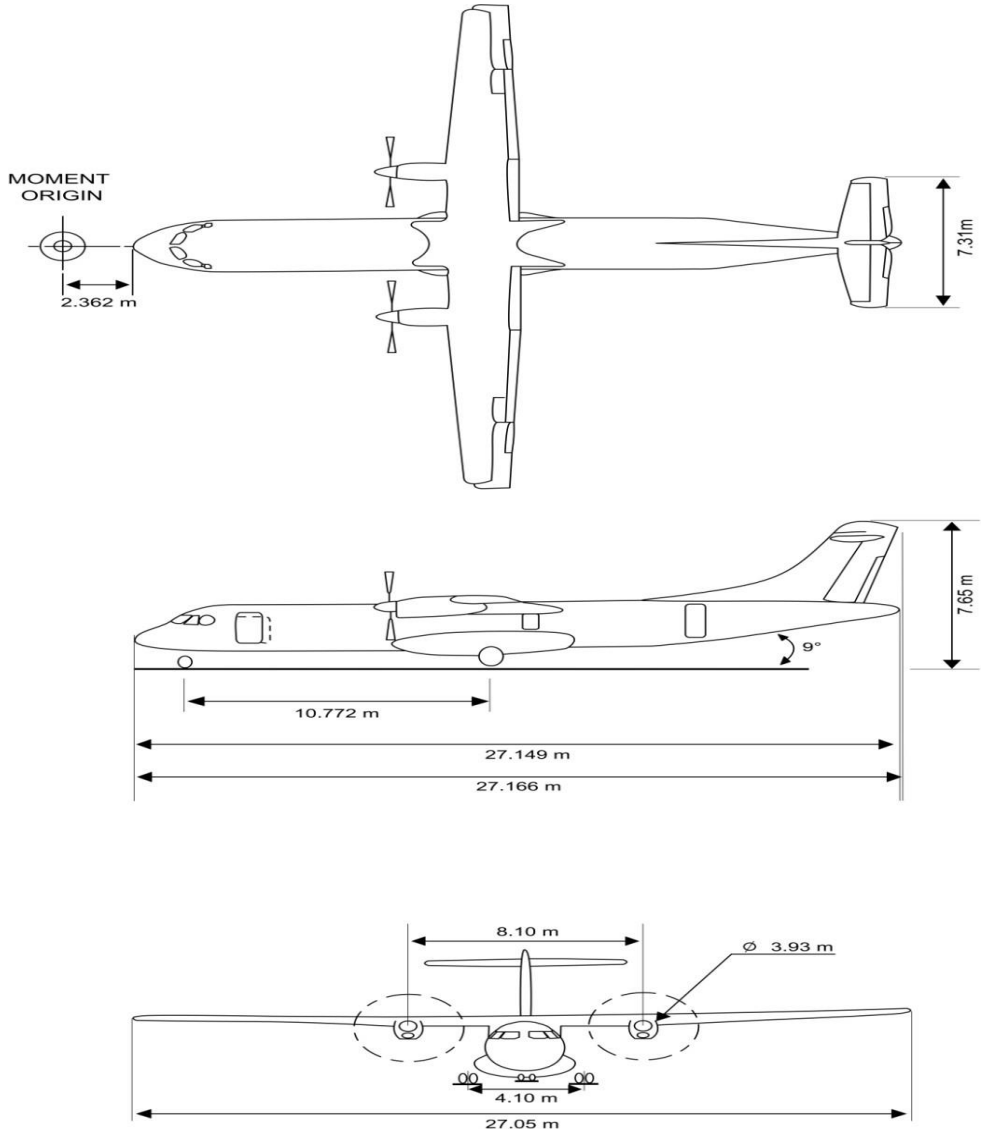
MLG
a)No 1 tyre- 121 PSI
b)No 2 tyre- 121 PSI
c)No 3 tyre- 120 PSI (peeled off tyre)
d)No 4 tyre- 121 PSI

NLG
a)No 1 tyre- 63 PSI
b)No 2 tyre- 63 PSI

As per the daily inspection carried out on 17.11.2021, all tyre pressure were within limits, i.e 121 PSI for MLGs and 64 PSI for NLG. Post Incident, the OEM had instructed Hard Landing inspection checks as the aircraft had sensed high "G "value of 3.97 units. There is no history of snag in primary flight controls including rudder, brakes and control column. The aircraft is certified in the transport category for day and night operations.

The aircrafts has 72 seats and can be operated with minimum 02 fligh crews with the following limitations.

i. The maximum operating altitude = 25000 ft.
ii. Maneuvering limit load factors with Gear and flaps retracted = +2.5g to -1g
iii. Maneuvering limit load factors with Gear and flaps extended= +2g to 0 g
iv. Tailwind limitation(Takeoff and landing) = 15 kt
v. Maximum demonstrated Crosswind = 35 Kts for dry runway (Takeoff/Landing Flaps 30)
vi. Maximum demonstrated Crosswind = 28 Kts for Wet up to 3mm depth (TO/Landing Flaps 30)
vii. Maximum Take-off weight = 22800 Kg
viii. Maximum Landing Weight = 22350 Kg
ix. Maximum mean runway slope = ± 2%M/s Trujet has its own maintenance setup for the maintenance of ATR 72-212A aircraft to maintain airworthy.

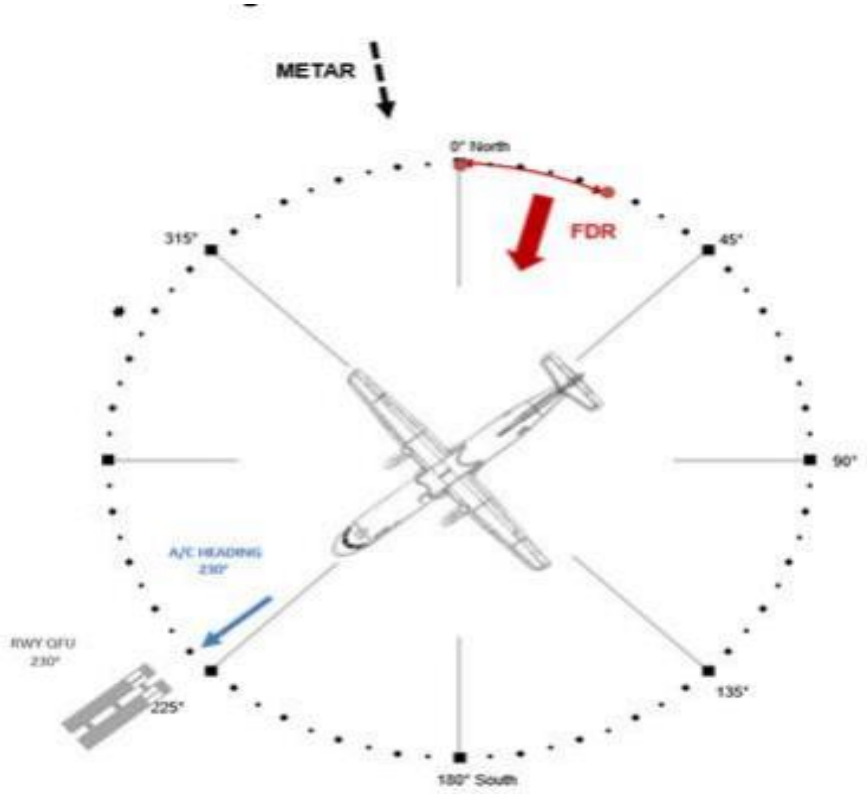


1.7 **Meteorological information:**

Weather information at VAKE as per the Met report of IMD is as follows:

	18/11/2021			
Time (UTC)	0900	0930	1000	1030
Wind	010/ 09 Knots	350/ 10 Knots	350/ 10 Knots	010/09 knots
Gust	No gust	20 Knots	20 Knots	No Gust
Visibility	1500 meter	1500 meter	1500 meter	1500 meter
Clouds	SCT 2500 Ft, OVC 8000Ft	SCT 2500 Ft, OVC 8000Ft	SCT 2500 Ft, OVC 8000Ft	SCT 2500 Ft, OVC 8000Ft

Temperature	27 ºC	27 ºC	27 ºC	26 ºC
Dew Point	18 ºC	17 ºC	18 ºC	18 ºC
QNH	1008 hPa	1008 hPa	1008 hPa	1007 hPa
QFE	1004 hPa	1004 hPa	1004 hPa	1004 hPa



During landing, 350/11 knots of winds was reported and the same was conveyed to the crew at 09:26:51 UTC(00:13:08 relative time from CVR).

Even the FDR indicated the same.

As per BEA, the DFDR records the wind strength and so using a recording mean wind speed of 16 kt, it has been found that the aircraft experienced:

- 12 kt of tail winds (The computed tailwinds on touchdown.)
- 10 kt of right cross winds (The computed cross winds on touchdown.)

1.8 Aids to navigation

PAPI at runway 05 and 23 side were available at kandla airport. The ground calibration for both were carried put on 27.08.2021 and found satisfactory.

NDB/DME is also available at the airport. DME was calibrated on 22.07.2021

1.9 Communications:

There was always two-way communication established between the Air Traffic Controller and the aircraft.

1.10 Aerodrome Information:

Aerodrome Code	: VAKE
Runway Orientation	: 05/23
Elevation	: 91 ft
Runway Length	: 1524 m
Runway Width	: 30 m
Last Friction Test	: 13/03/2021
PCN 05	: 21/F/C/W/T
PCN 27	: 21/F/C/W/T
ARFF Category	: CAT-VI

Declared Distances

RWY Designation	TORA (m)	TODA (m)	ASDA (m)	LDA (m)
1	2	3	4	5
05	1524	1524	1524	1524
23	1524	1524	1524	1524

Kandla Airport Runway 23 is the NDB approach runway and no navigation aid for landing is available except PAPI which was operational at the time of landing. During preliminary investigation, it was observed Air calibration of PAPI was carried out on 14.07.2021 and ground calibration was carried out on 08.09.2021 which is valid.

i) Kandla Airport was fitted with wind speed, direction, temperature and pressure sensors on airfield. Digital indicators are installed in ATC. However, the calibration validity of these sensors is not available with MET.

ii) The previous Runway surface friction test at Kandla Airport was carried out on 13.03.2021 which was within limits.

iii) Kandla Airport was installed with NDB. The station frequency is 335 KHz with call sign KD. Daily monitoring was done on 18/11/2021 and all parameters were found within limit.

iv) Kandla Airport was installed with DME. The station frequency is 117.7 MHz. Flight calibration of the same was carried out on 14/07/2021 and the same is valid.

v) Runway markings and signages were in place. Aerodrome license is valid 27 Nov 2021.

vi) During runway inspection it was found that in touch down zone of RWY23 a lot of metal aggregates are coming out of runway surface and becoming FOD. The area requires resurfacing. Last runway resurfacing carried out was in Oct 2013.

Fig 7. Metal aggregates on Touch Down Zone of RWY 23

Fig 8. Large Grass on strip

Fig 9. Broken and non-transparent ATC Glass

1.11 Flight Recorders:

1.11.1 Cockpit Voice Recorder: -

The aircraft was installed with a Solid State Cockpit Voice Recorder. The CVR unit was replaced after landing at Ahmedabad, the data was retrieved and it was utilized in the investigation. Following are the observations made:-

a. At 00:13:08 relative time, on establishing final approach Rwy 23, Controller passed the winds condition as 350/11 kt.
b. By 00:13:39 relative time, Check lists like Approach checklist, before landing checklist were performed by the crew and completed.
c. From 00:14:03 relative time to 00:14:53 relative time, Profile checks were carried out by Challenge and response, FO calling out Distance /Altitude information at 6 NM, 5 NM, 4 NM and 3 NM and PF verifying/acknowledging it
d. From 00:15:40 relative time to 00:15:50 relative time, Landing visual call was made by PIC followed by AP being disengaged.
e. At 00:16:05 relative time, Aircraft stabilized call at 500 ft by First officer was found recorded.
f. From 00:16:12 relative time to 00:16:25 relative time, between 500ft RA and 300ft RA auto call, FO calls out Yaw Dampers off and PIC confirms.
g. 06 seconds after touch down at 00:16:57 relative time, and master caution warning alert is heard and it goes off after 7 seconds
h. At 00:17:03 relative time, Multiple Go Around call(7 times) were made by the PIC. Take off checklist procedures/callout is not heard.
i. Again after 7 seconds(at 00:17:10 relative time), Master caution warning alert is heard and stopped after 4 seconds(at 00:17:14 relative time).
j. At 00:17:33 relative time,Further FO is heard calling out positive rate followed by PIC calling out Vga, positive rate , gear up & insisted Flap 15 twice. Take off check list was followed.
k. From 00:18:14 relative time to 00:19:45 relative time, On enquiry by the controller, crew informed that a go around maneuver had been initiated, and after climbing to 2300 feet, will hold over NDB. The reason for go around procedure was reported as technical. Further all Engine parameters were confirmed normal by FO.
l. At 00:20:12 relative time, the ELEC fault (Inverter 2) and EFIS COMP fault were confirmed.
m. Further, at 00:21:31 relative time, the tower was informed about the overrun and RWY conditions were enquired so as to attempt one more landing on RWY 05.
n. At 00:28:42 relative time, the tower informed that no debris had been reported in the RWY inspection and found fit for Operations.
o. From 00:29:39 relative time to 00:30:50 relative time, AME was allowed inside the Cockpit and after discussion about the 2 persisting faults(ELEC fault and EFIS COMP fault, the AME informed the PIC to land back at Ahmedabad as that there was no Maintenance facility at Kandla. Further the PIC mentioned about not knowing about the extent of damage caused due to overrun of the RWY. The AME still convinced the PIC that there is nothing to worry and the aircraft must have just hit the RWY edge lights after touchdown.
p. Subsequently by 00:31:57 relative time, aircraft requested for diversion to Ahmedabad and was cleared in coordination with Bhuj ATC and Ahmedabad Area Control. Initially, aircraft requested to carry out precautionary landing due to suspected tyre burst, however the same was converted to Full emergency by the aerodrome operator. Thereafter, Aircraft landed safely at Ahmedabad.

1.11.2 Flight Data Recorder:-

The aircraft was fitted with L3HARRIS FA2100 Flight Data Recorder. The times are indicated in UTC. During this flight, the Pilot Flying was the pilot/captain, and the Pilot Monitoring was First Officer. The DFDR raw Data was sent to BEA facility for conversion and analysis.

As per the DFDR data and the analysis report by BEA, the following have been observed:

Time (UTC)	**Aircraft configuration**	**Comments**
09:29:33	At height 730ft RA, ➢ the AP is disconnected ➢ IAS=111kt ➢ Heading= 234° ➢ Tailwind+13kt ➢ Lateral wind=-7kt (wind from the right) ➢ Vz=-450ft/ min ➢ HMU PLA=48-49^{o} ➢	As the DME parameter in DFDR data was not reliable, Altitude/distance information was derived from the Latitude/Longitude parameters (corroborated with google map) and compared to the radio altitude. It is observed that the aircraft was on proper configuration of distance/altitude information as per approach chart. AP disengaged at 730 ft. and aircraft was stabilized 500 ft till touch down. Yaw damper selected Off. About 12 kt Tail wind and 10 kt right cross wind experienced on touch down. The aircraft was approaching with an average of 114 kt IAS which was higher than the crew calculated Vapp of 107 kt IAS. This is within limits and normal as per FCOM. Ailerons & rudder position and roll attitude showed a left bank Pilot made the flare with a left bank. The aircraft was positioned on the right of the runway centerline
09:29:52	At 500 ft RA, ➢ Estimated Vz=-600ft/min ➢ HMU PLA = 41^{0}-42^{0} IAS=114 kt Vapp calculated as per the wind conditions mentioned to the crew by ATC at 09:26:51 UTC was 107 kt.	
09:29:57	At 400ft RA ➢ YAW DAMPER selected OFF ➢ Tail wind from 400 ft RA up to touchdown: between 15 to 10 kt ➢ Lateral wind from 400FT RA down to touchdown around -10kt (right cross wind) ➢ The selected vertical speed is recorded and was set a -600ft/min from 400ft RA.	
09:30:26	At 15 ft RA ➢ Elevator position changed from 3^{0}(nose down) to -11^{0}(nose up) rapidly. ➢ Pitch changing from -1^{0} to 5^{0} within next 2 seconds ➢ HMU PLA=42 to 32. Notch position to Flight Idle position ➢ IAS=114 kt	

	➢ Vapp calculated post incident considering the suddenly developed gusty conditions was 119 kt as per METAR at 0930 UTC. ➢ Roll angle increased to -7° (left) ➢ Then Ailerons were deflected in a right turn order and roll angle changed from -7° to +6° (right)	
09:30:29	➢ Touchdown ➢ The Advisory Display Unit Caution Active parameter is active ➢ LNAV mode changed to OFF. ➢ Pitch =5^{o} ➢ Vertical acceleration 1.46G ➢ MLG & NLG not compressed ➢ Ailerons & rudder position and roll attitude show a left bank ➢ The roll reaches a peak of -7. ➢ HMU PLA= 35^{0},corresponding to Flight Idle position ➢ Ground speed: 124kt ➢ IAS=104 kt ➢ Tail wind:12 kt Right cross wind:10 kt	At the time of touchdown, sudden gusts developed with strength 20 kt. After considering the Gusty wind condition, the Vapp is calculated to be 119 kt. Hence, it is evident that the aircraft touched down with a much lower aircraft speed of 104 kt as against a required Vapp of 119 kt. The aircraft did a bounce, given the increase in the vertical acceleration. The sampling rate of the MLG and NLG gears was not sufficient to see the short touchdown. The Advisory Display Unit Caution Active parameter got active when the LNAV mode parameter turned off
09:30:33	At 0 Ft RA ➢ Pitch=3^{o} ➢ Vertical acceleration= 1.53G ➢ Main landing gears were compressed ➢ Ailerons & rudder position and roll attitude showed a left turn ➢ HMU PLA=27°, between Flight Idle position (FI-35°) and Ground Idle position (GI=20°) ➢ Ground speed=117kt, IAS: 100 kt	Second touchdown on the right part of the runway.
09:30:35	➢ Rudder positions= from +24° to -28°. ➢ Aileron and rudder positions show a left turn ➢ Heading changes from 234 ^{O} to 219 ^{O} within next 5 seconds (QFU-230 ^{O}) ➢ HMU PLA=19 (Note: Ground Idle position GI=20 ^{O})	Max rudder deflection is -/+ 27°. Pilot is still correcting to align the aircraft from the right to the left.

09:30:40	➢ Master Warning triggered during 7 seconds, ➢ HMU PLA change from 19 to 91 (Note Ground Idle to Ramp position) ➢ GS 90 kt, IAS 70 kt ➢ Flaps are still in position 30 ➢ MLG are still compressed	Go Around attempted(as heard from CVR) The Master Warning triggered probably due to a Take-off configuration warning because the PLA was set to Ramp position with flaps in landing configuration.
09:30:42	➢ Opposite inputs on pitch control column. Pilot made a pitch down action whereas the co-pilot makes a pitch up action. (Only effort above 10 daN triggers a record, down or up) ➢ Pitch=-1^{O} ➢ Vertical acceleration=1.97 G ➢ Rudders +17 (left turn) ➢ HMU PLA= 66 ^{O} below the Notch position. (Note: Notch Position=75°) ➢ MLG & NLG compressed	The aircraft exited on the left side of the runway. The 3.97G value was most probably due to the contact with either a left lateral edge light or its concrete base. Pilot applied right rudder pedal input.
09:30:43	➢ Vertical acceleration= 3.97G ➢ Just before the 3.97G, heading changed from 219° to 254° ➢ Just before the 3.97G, rudder changed: from +24° to -27° then +21° (Convention: >0,turn left ➢ After the 3.97G, loss of recorded data by FDR is estimated between 2.6 and 4.4 seconds	
09:30:47	➢ Data recovery ➢ Vertical acceleration= 3G ➢ Pitch= 4 ➢ Elevator. -22° ➢ Minor left Rudder deflections observed ➢ MLG, compressed ➢ HMU PLA=87° (Note Ramp Position=81°) ➢ Heading=219° ➢ Ground speed= 85kt	During the data loss, the aircraft experienced a runway excursion on the right side of the runway (traces on the ground). The heading shows the pilot wanted to control the aircraft on the center line. The high value of vertical acceleration could be due to a contact with either a light or a concrete base or a change from soft ground to runway surface. Elevator and power levers are consistent with a go around action

09:30:49	➢ Pitch= 9 ➢ MLG not compressed ➢ HMU PLA-83 to 92^{o}, Ramp to Max position ➢ Minor left Rudder deflections observed. ➢ GS 89 kt, IAS 80 kt ➢ Radio altitude increases to about 4 ft and makes ground contact. ➢ Both pilots made a pitch up action one second later ➢ Heading 219°	The crew applied back pressure and attempted to take off. However as speed was less than the minimum stall speed, the aircraft just lifted off landed back immediately experiencing a tail strike. Refer to 4.2.4 for the contact ground angles.
09:30:53	➢ Master warning is triggered ➢ HMU PLA=83 (Note: Ramp Position =81^{o}) ➢ GS=89kt ➢ Flaps are still at 30^{o} landing configuration ➢ MLG Compressed	As the aircraft is entering back to the Runway paved surface, The Master warning triggered probably due to a Take-off configuration warning because the PLA was set to Ramp position with flaps in landing configuration.
09:30:57	➢ Pitch=7^{o} and increasing ➢ HMU PLA=80^{O}, Ramp Position ➢ Heading 218° ➢ GS=94kt and increasing ➢ IAS=91kt and increasing ➢ Vz=690ft/min and increasing ➢ MLG &NLG=flight position ➢ Flaps are still at 30^{o} landing configuration	The aircraft lifted off for the go-around. Based on ground evidences, it occurred at 60m beyond the runway threshold
09:31:08	➢ Flaps 15 are selected	Then the crew returned to the departure airport

Note: The below relevant parameters have been computed by BEA as they were not recorded by the FDR:

• Computed vertical speed (-C-Vertical speed);

• Computed wind, in order to get lateral, longitudinal (headwind) and vertical wind.

• Computed barometric altitude (-C- altitude) to get the altitude in relation with the QNH of the day event, 1008 hpa. The FDR only records the Altitude parameter set to 29.92 in.Hg, ie pressure altitude.

• LNAV-VPATH. It was computed considering a path angle of 3°.

Headwind, cross wind and vertical wind parameters were calculated by BEA.

The computed tailwind shows wind values between 10kt and 15kt from 2300ft RA until the touchdown.

1.11.3 Excerpts from the CVR-DFDR correlation and crew statements:-

The aircraft was carrying out a visual approach on to RWY 23 for landing. The ATC Controller passed the winds condition to crew as 350/11 kt, 4 minutes prior to touch down. Profile checks were carried out by Challenge and response, FO calling out

Distance /Altitude callouts at 6 NM, 5 NM, 4 NM and 3 NM and PF verifying/acknowledging it. Also from the DFDR, it has been established that throughout the approach phase, the vertical path management was consistent with the vertical flight path angle.

The Auto pilot was disengaged at 730 ft. Then at about 300 ft till touchdown, there was a slight roll of aircraft observed towards right but not beyond limit. The aircraft which was flying under VMC conditions was stabilized by 500 ft AAL. The aircraft touched down with 104 kt IAS and had a slight bounce after which there was a second touch down at 100 kt IAS with a thud sound (as heard from CVR). The vertical acceleration was 1.26 g at the time of touch down. On touch down, the aircraft had a cross wind & tail wind of approximately 10 kt and 12 kt (wind direction varying from 350 Deg to 21 Deg). Subsequently, immediate & considerable application of left rudder pedals for next 5 seconds resulting in the aircraft veering towards the left. Subsequently it is observed the thrust has been increased to 90 % and the PIC is heard calling out Go Around. At the same time there is some warning (probably config warning due to sudden application of thrust and when landing configuration prevailed). The aircraft veers towards the extreme left of the runway with left MLG going through the soft ground and breaking the light (loud sound heard from CVR and 3.97 g recorded in DFDR).

The aircraft travels approx. 90 mts on the left side of the runway. Subsequently the right rudder pedal application is observed with aircraft veering towards the right and completely exits the right side of the runway. Then it is observed that pitch attitude increases to 9 deg wherein the speed is just 78-80 kts. The aircraft at this time is seen lifting up to about 4 ft for 4 seconds and touching back on the soft ground during which tail strike has happened (2.94 and 2.67 g recorded during lift off and touch down. The aircraft has rolled on the soft ground for about 300 mts before it is observed veering back on to the runway towards the centerline. During this the master warning triggered probably due to Take-off configuration warning because the PLA was set to Ramp position with flaps in landing configuration.

The pitch is again seen gradually increasing to 11 deg wherein the aircraft is seen lifting off when the indicated speed was 91 kts. The rash application of rudder pedals while the aircraft had considerable speeds caused the zig zag movement of aircraft in an uncontrolled manner prior to Go Around. The aircraft after liftoff did hold for 10 minutes and the crew after consultation with AME decided to divert to the 1st alternate, ie back to Ahmedabad. The landing in Ahmedabad was uneventful.

Note: It may be noted that there were some data observed to be missing just after impact with the runway edge lights(as recorded 3.97 g from DFDR) for about 2.6-4.4 seconds.

1.12 Wreckage and Impact Information:

During site visit, it was observed from marks (Refer Fig 10), that the aircraft touched on the runway 23 towards 7 m right from center line and 420 meters beyond the threshold of runway 23.

Further it was found the aircraft had veered off towards left of runway and the LH Main Landing Gear wheel had exited the paved surface (891m from threshold) and entered the soft ground. In the process, one of the runway edge lights got damaged. Thereafter, the LH Main Landing gear wheel was found to have entered the paved surface (955m from threshold).

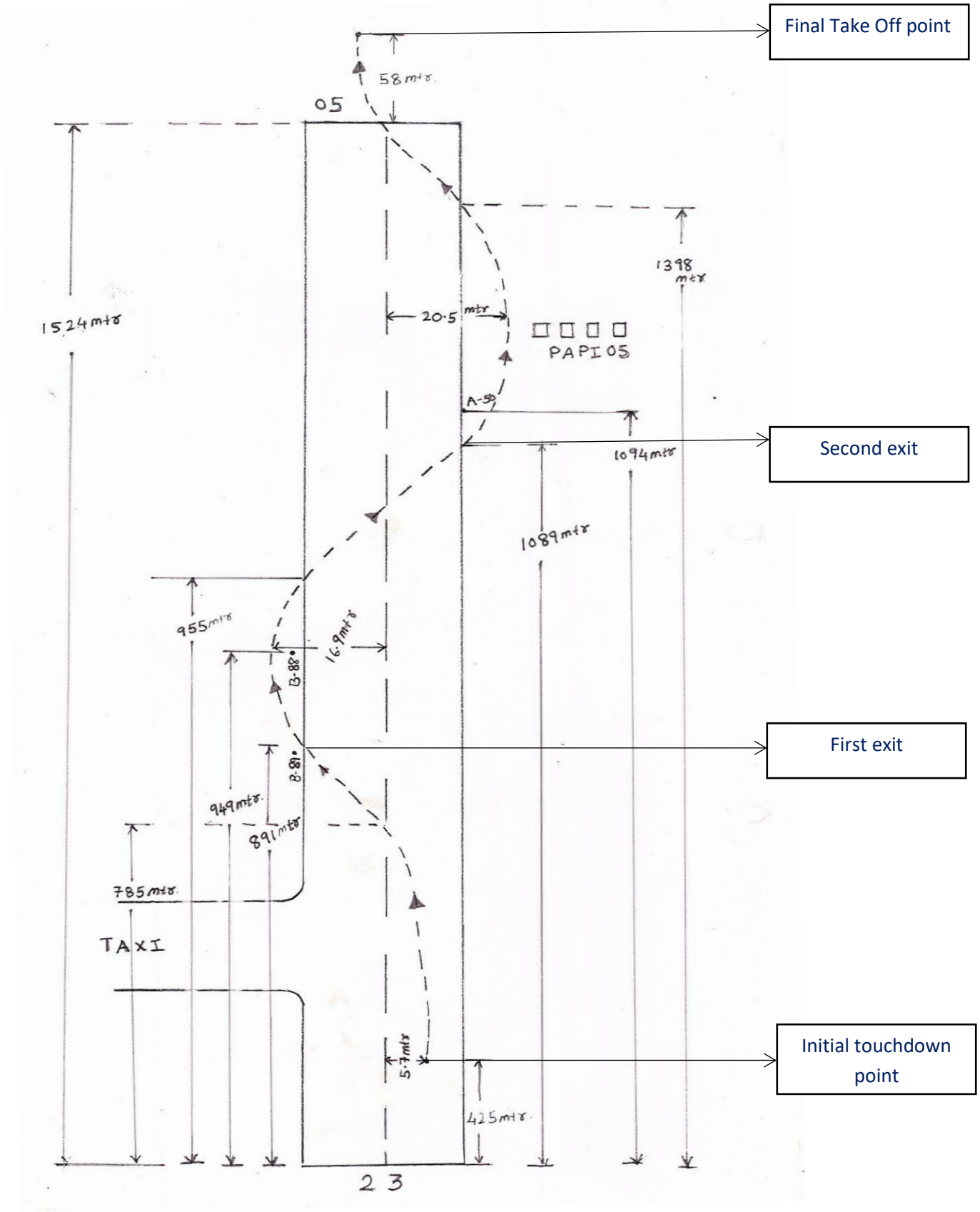


Fig 10

After entering the paved surface the aircraft once again the aircraft veered off to right side on the runway, and it was found that all the wheels of the aircraft had exited the paved surface(at 1089 meters from threshold). The aircraft rolled on the strip (soft ground) for approximately 300 meter due which it experienced a tail strike. After

entering the paved surface, the aircraft had crossed the runway end of RWY23, overrun by 58m and then took off from the end on strip.

1.13 Medical and Pathological Information

The flight crew undergone preflight & post incident Breathalyzer test and found negative.

1.14 Fire

There was no fire or fumes.

1.15 Survival Aspects

The incident was survivable.

1.16 Tests and Research

Nil

1.17 Organizational and Management Information

M/s Turbo Megha Airways Pvt. Ltd. (M/s. Trujet), Hyderabad has its initial Air Operator Certificate in 15/05/2017 valid up to 11/05/2025 has total of 07 passenger aircrafts. Out of 07, 05 aircraft are of ATR 72-500 and 02 aircraft are ATR72-600.

1.18 Additional Information:

1.18.1 Stabilization criteria:

This paragraph is issued from the FCTM 42-500 and 72-500.

Approaches must be stabilized:

- 1000ft AAL in IMC Conditions
- 500ft AAL in VMC Conditions
- 300ft AAL following circle-to-land

An Approach is considered stabilized when all of the following criteria are met:

- Lateral path (Loc, Radial or RNAV path) is tracked
- Landing configuration is established
- Energy management:
  - -Vertical path (Glide, Altitude versus distance or RNAV path) is tracked
  - -Power setting is consistent with appropriate aircraft weight, had/tail wind component and vertical guidance requirements
  - -Speed and pitch attitude are relevant to actual conditions
- Briefing and checklist are completed.

1.18.2 Required elements of a stabilized approach:

This paragraph is issued from Operator's Operations Manual Part A.

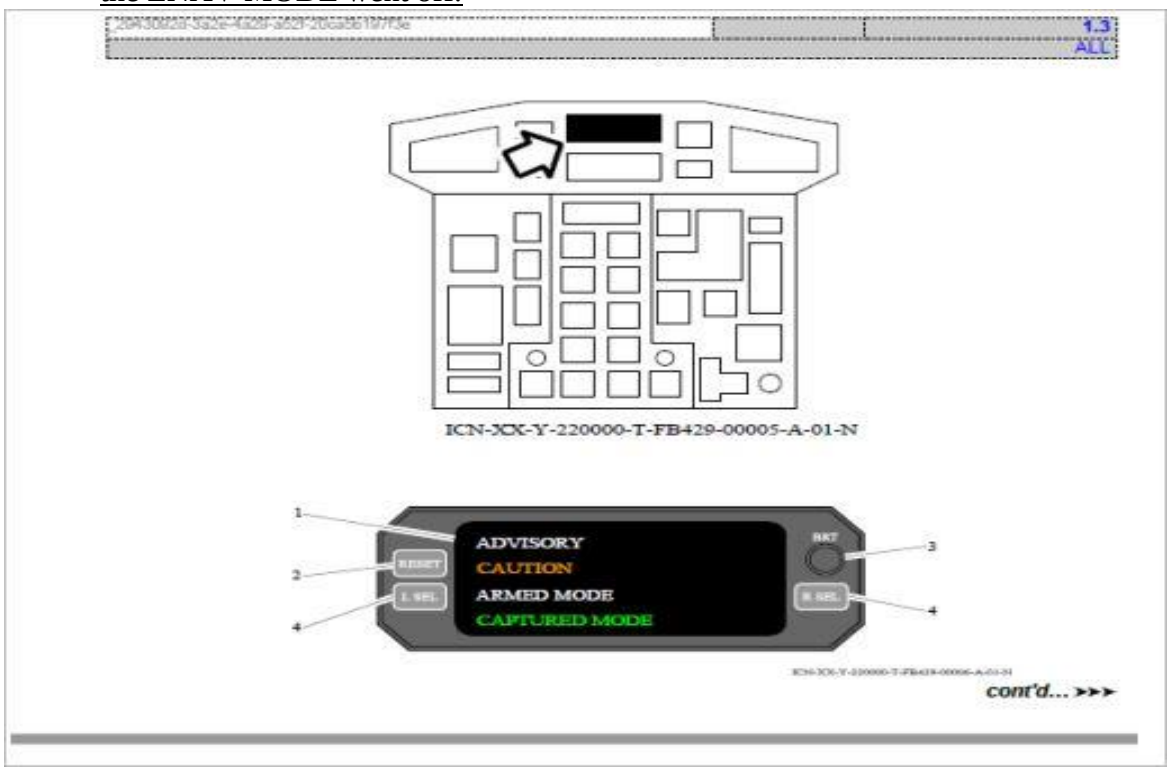
A stabilized approach is one of the key features of safe approaches and landings especially those involving transport category airplanes. A stabilized approach is characterized by a constant-angle, constant rate of descent approach profile ending near the touchdown point, where the landing maneuver begins. A stabilized approach is the safest profile in all but special cases, in which another profile may be required by unusual conditions.
All appropriate briefing and checklists should be accomplished before 1000' height above threshold (HAT) in instrument metrological conditions (IMC) and before 500' HAT in

visual metrological conditions (VMC). An approach that becomes un-stabilised below the altitudes shown here requires an immediate go-around.
An approach is stabilized when all of the following criteria are met:

(a) The aircraft in on the correct lateral and vertical flights path.
(b) Only minor changes in heading/pitch are required to maintain the correct flight path after glide path intercept or after final approach fix.
(c) Aircraft speed should not be lower than VAPP nor be greater than VAPP +10.Only as a consequence of particular speed instructions by ATC, a deviation from the stabilized speed criteria including the associated power setting is permitted below 1000 feet AFE down to 500 feet AFE. In this case, the stabilized speed criteria and the associated power setting must be reached by 500 feet AFE latest. At 500 feet AFE the PM shall call-out "STABILISED"/ "NOT STABILISED".
(d) The aircraft is in the correct landing configuration. (Flap configuration shall not be changes below stabilized gate)
(e) All briefings and checklists have been completed.

1.18.3 ADU

(f) The ADU, Advisory Display Unit is a display showing advisory (white) and caution messages related to any change to AP functions, such as lateral modes. The recorded FDR parameter Advisory Display Unit is ACTIVE when a message is displayed. This description is issued from the FCOM of the company (Rev 29-June 21). During the event, the parameter Advisory Display Unit Caution Active became active when the LNAV MODE went off.



1)Display:

The first the displays advisory messages in white letters.

The second line displays caution messages in amber letters.

The third line displays armed modes in white letters.

The fourth line displays active modes in green letters.

2)Reset pb:

The button is used to cancel a caution message or to confirm an AFCS automatic choice.

3)BRT Knob:

Is used to adjust ADU brightness.

4)L SEL-R SEL pb:

Is used in AP ground maintenance test.

1.18.4 Take Off Configuration:

CONDITION	VISUAL	AURAL
Flaps not in appropriate TO position when PL at TO position or simulated so by the TO CONFIG TEST	-MW light flashing red -CONFIG red message on CAP -FLT CTL amber message on CAP	**CRC**

Note: During the event, it seems that "Take-off Configuration" warning occurred twice. The above part is written in FCOM chapter flights controls/Flaps.

1.18.5 ATR Contact ground angles:-

ATR72 contact ground angles (pitch effect)

1.18.5 ATR Approach speed computation:-

The Vapp calculation method is described in ATR 72-500 FCOM LIM 3, § 4.9.1. LANDING SPEEDS and detailed as below:

Vapp= (VmHB+ WIND FACTOR) or VMCL, whichever is higher. VMCL is 98 kt for the ATR-72-500, for flaps 30.

The wind factor is the highest of:

- 1/3 of the head wind velocity
- Or the gust in full

As the MOD 3522 was applied on this aircraft MSN 858, the certification tailwind limit is 15 kt. (FCOM, Chap LIM.4, "2 Wind Limitation").

WIND LIMITATION:

1) Tailwind
   AFM DATA
   Takeoff and landing

Tailwind limit…… ……..15kt

Note: The Limitation for tailwinds greater than 10kt reflects the capability of the aircraft as evaluated in terms of airworthiness but does not constitute approval for operations under tailwinds exceeding 10kt in case such operational approval is required by the National Authorities to the operators.

1.18.6 Approach Speed Calculations

Approach speed based on 0900 UTC and TWR information at 0926 UTC

With the 0900 UTC information (wind of 010/9kt) the theorical tailwind was 7kt

With the tower information (wind of 350/10kt) the theorical tailwind was 5kt.

The landing weight was 21.5 T (confirmed by recorded parameters). For this weight, the VmHB was 109kt. (see QRH, section PER.3.OPS DATA).

As no headwind and no gust were present, Vapp= VmHB=109kt

ATR TRJ / 75	OPSDATA 21.5 T	PER 3 Page n°10

_77b292ed-0357-4ac1-9415-3d68f61ce51d 2.1 ALL

	Speeds	Normal	Icing
NON LIMITING RWY TAKEOFF Flaps 15	V1 = VR V2	109 113	118 123
FINAL TAKEOFF	VFTO	138 (Flaps 0)	126 (Flaps 15)
DRIFT DOWN	VmLB	138 (Flaps 0)	130 (Flaps 15)
MINI EN ROUTE			164 (Flaps 0)
FINAL APPROACH	VmHB (Flaps 30)	109	118
GO AROUND	VGA (Flaps 15)	121	123

Approach speed based on 0930 UTC information

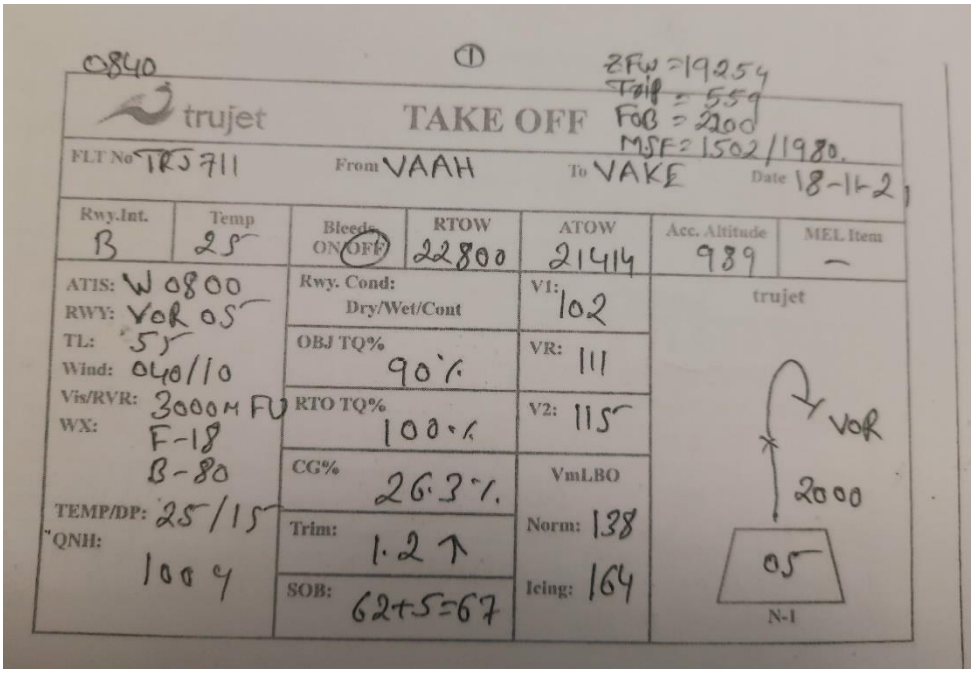
The 0930 UTC information passed a wind of 350/10kt gusting 20kt. The gust should be considered, 20-10=10kt. The latter should be the wind factor for this event.

Consequently, with gust conditions, the Vapp should be 109+10=119kt.

- The Indicated Airspeed was fluctuating between 110 and 114kt during approach till touch down
- The Ground speed was around 125 kt.

1.18.8 Bug Card Information:-

a)Take off from VAAH


0840 ①

trujet **TAKE OFF**

ZFW = 19.254
Trip = 559
FOB = 2200
MSF = 1502/1980.

FLT No TRJ 711 From VAAH To VAKE Date 18-1-22

Rwy.Int.	Temp	Bleeds ON/OFF	RTOW	ATOW	Acc. Altitude	MEL Item
B	25	ON/OFF	22800	21414	989	—

ATIS: W 0800
RWY: VOR 05
TL: 55
Wind: 040/10
Vis/RVR: 3000M FU
WX: F-18 B-80
TEMP/DP: 25/15
QNH: 1004

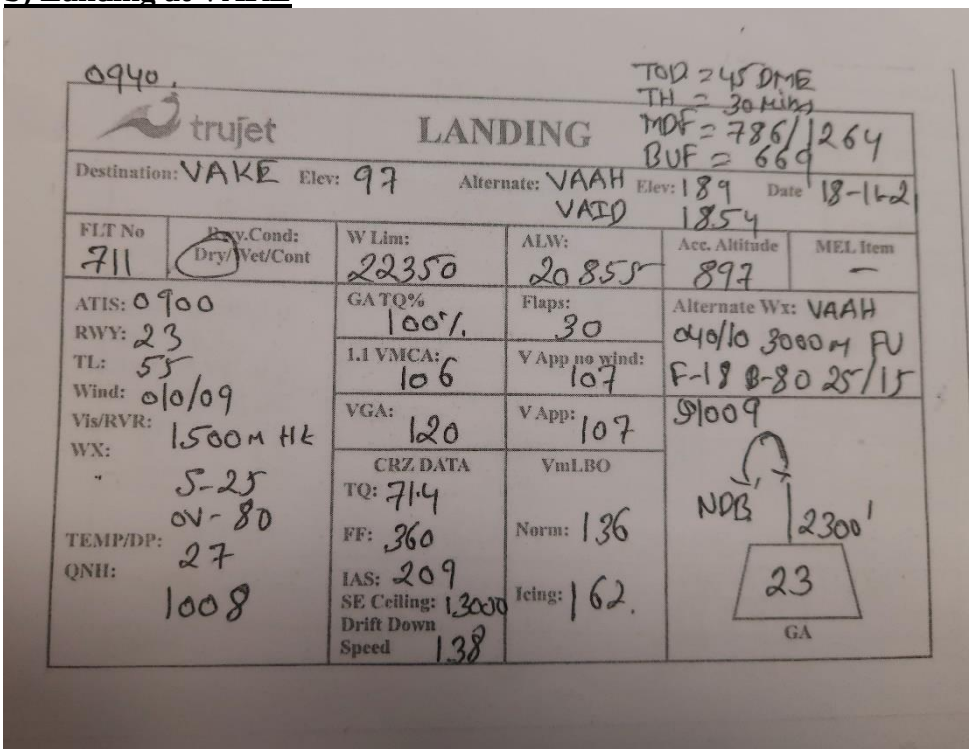
Rwy. Cond: Dry/Wet/Cont
OBJ TQ% 90%
RTO TQ% 100%
CG% 26.3%
Trim: 1.2 ↑
SOB: 62+5=67

V1: 102
VR: 111
V2: 115
VmLBO
Norm: 138
Icing: 164

trujet
VOR
2000
05
N-1

Fig 11

b) Landing at VAKE


0940

trujet **LANDING**

TOD = 45 DME
TH = 30 Mins
MDF = 786/1264
BUF = 669

Destination: VAKE Elev: 97 Alternate: VAAH VAID Elev: 189 1854 Date 18-1-22

FLT No	Rwy.Cond: Dry/Wet/Cont	W Lim:	ALW:	Acc. Altitude	MEL Item
711	Dry/Wet/Cont	22350	20855	897	—

ATIS: 0900
RWY: 23
TL: 55
Wind: 010/09
Vis/RVR: 1500M HZ
WX: S-25 OV-80
TEMP/DP: 27
QNH: 1008

GA TQ% 100%
1.1 VMCA: 106
VGA: 120

CRZ DATA
TQ: 71.4
FF: 360
IAS: 209
SE Ceiling: 13000
Drift Down Speed 138

Flaps: 30
V App no wind: 107
V App: 107

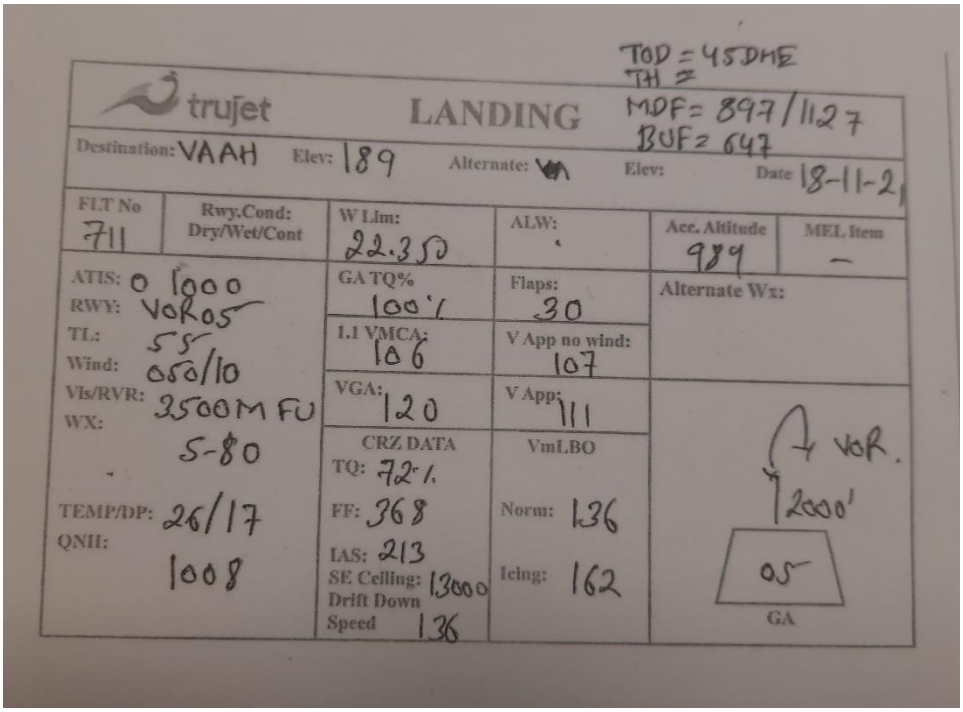
VmLBO
Norm: 136
Icing: 162.

Alternate Wx: VAAH
040/10 3000M FU
F-18 B-80 25/15
Q1009

NDB
2300'
23
GA

Fig 12

c) **<u>Landing at VAAH after Go Around</u>**


TOD = 45DME
TH =
MDF = 897/1127
BUF = 647

trujet LANDING

Destination: VAAH Elev: 189 Alternate: Elev: Date 18-11-21

FLT No	Rwy.Cond: Dry/Wet/Cont	W Lim:	ALW:	Acc. Altitude	MEL Item
711		22.350		984	—

ATIS: O 1000
RWY: VOR05
TL: 55
Wind: 050/10
Vis/RVR: 3500M FU
WX: S-80
TEMP/DP: 26/17
QNH: 1008

GA TQ%	Flaps:	Alternate Wx:
100%	30	
1.1 VMCA: 106	V App no wind: 107	
VGA: 120	V App: 111	

CRZ DATA
TQ: 72%
FF: 368
IAS: 213
SE Ceiling: 13000
Drift Down Speed 136

VmLBO
Norm: 136
Icing: 162

VOR.
2000'
05
GA

Fig 13

1.18.8 ATR CLARIFICATIONS:-

There was loss of recording for few seconds after touchdown.
The ATR clarifications concluded that:

- The FDR data file VTTMK 18112021 1.bin was synchronized and analysed in the BEA analysis software. It contained 80,149 seconds (approx. 22 hours) of synchronized data, recorded at the rate of 128 wps (upk, Teledyne). The data contains 14 flights, including the event flight.
- The loss of recording which happened for the incident flight lasted therefore between 2.6 s and 4.4 s. BEA also added that the recording capability (FDAU power cut) had been lost for less than 1 second.
- Analysis of the FDR raw data file showed that the loss of data was due to the FDAU stopping sending data to the FDR that remained powered all along. The link between the FDAU and the FDR is managed by the Multi-Purpose Computer (MPC) which electrical power depends on the weight on wheel (WOW) state switches. The aircraft manufacturer stated that the FDAU temporarily lost power supply when the vertical acceleration reached 3.97 G, which was most probably due to the fast multiple change of the WOW switches.
- During the data loss, the aircraft experienced a runway excursion on the right side of the runway

1.18.9 As per ATC log:

At 1018 UTC, an aircraft belonging to other operator had performed a Go Around while landing on RWY 23 due to strong tail wind. Further the aircraft landed safely on RWY 23 at time 1039 UTC.

1.18.10 Excerpts from Statement of ATCO:

On-duty controller was interviewed for incident and she stated that she was on duty in Control Tower on 18/11/2021 from 0910 UTC to 1015 UTC. ATS Watch was opened at time 0910 UTC (1440 IST).

At time 0910 UTC (1440 IST) TRJ711 came in contact with Kandla ATC tower for weather report. Latest weather report of time 0900 UTC (1430 IST) was given to TRJ711. After taking weather report TRJ711 again changed over to Ahmedabad control.

At time 0921 UTC (1451 IST) TRJ711 came in contact with Kandla Control Tower after released by Bhuj approach at 26 miles inbound to Kandla, descending to 5000 feet. After confirming for negative descend traffic with Bhuj by TRJ711, 2300 feet descend was given to TRJ711 and then NDB approach runway-23 was cleared.

TRJ711 was asked to report established final approach track. The same was acknowledged by Tru-jet pilot. At time 0927 UTC (1457 IST) TRJ711 reported, established on final approach track runway-23. At time 0927 UTC (1457 IST) Landing clearance was given to TRJ711 for runway-23 with wind speed and direction.

At time 0931 UTC (1501 IST) as observed from ATC Control Tower, TRJ711 was seems unstable on runway during touchdown, and then suddenly TRJ711 skid left side of centerline and then in right side of centerline and lots of dust was observed from right side of runway-23 towards end of runway-23. By seeing this immediately crash bell was pressed from ATC control tower and rescue and firefighting services was alerted. RFFS team reached at holding point 'A' immediately.

No emergency was declared by TRJ711 at any time. After skidding right side of runway as observed from ATC Tower, TRJ711 pulled up and went around runway-23 at time 0931 UTC (1501 IST). After initiating Go-around there was no communication by TRJ711 about going around. Controller didn't disturb the pilot immediately as seeing the condition of aircraft from ATC tower.

After sometime time first call was initiated by me to TRJ711. Then TRJ711 reported "going around and climbing 2300 feet and hold over NDB". At time 0933 UTC (1503 IST) TRJ711 joined holding over NDB at 2300 feet. The same information was passed to Bhuj approach via landline.

After some time TRJ711 asked about runway condition, the same was passed as per standard format then TRJ711 asked to check runway as he reported that he went off the runway. Immediately runway inspection was carried out and no damage of runway was reported by operational jeep, the same information was passed to TRJ711.

At time 0946 UTC (1516 IST) TRJ711 requested diversion to Ahmedabad. The same information was passed to Bhuj approach with requested level of TRJ711. TRJ711 was asked reason for Go-around then he reported "Due Technical". TRJ711 was changed over to Bhuj approach at time 0948 UTC (1518 IST).

Then after some time operational jeep reported that one runway edge light from left side of Rwy-23 is broken and few small tire pieces was found near runway on soft

ground area. Bhuj Approach and Ahmedabad control was also briefed about the incident and also informed to Bhuj Approach and Ahmedabad control about broken runway edge light and small tyre pieces found near runway via landline. Information received from Ahmedabad tower TRJ711 landed safely at time 1032 UTC (1602 IST)

1.18.11 Sequence of events from ATC tape transcript:

- At time 091015 UTC TRJ711 at FL 140 came in contact with Kandla ATC tower for weather report. Latest weather report of time 0900 UTC (1430 IST) was given to TRJ711 as "TIME OF OBSERVATION 0900, WIND- 010 DEGREE 9 KNOTS, VISIBILITY-1500, WEATHER-HAZE, CLOUD-SCT-2500 OVC-8000, TEMP-27, QNH-1008."
- At time 092117 UTC TRJ711 came in contact with Kandla Control Tower and informed that aircraft is passing level 92 after released by Bhuj approach, 26 miles inbound to Kandla and descending to 5000 feet.
- At time 092143 UTC, after confirming for negative descend traffic with Bhuj by TRJ711, asked to descend to 2300 feet, QNH 1008 and cleared for NDB approach runway-23. TRJ711 was asked to report established final approach track. The same was acknowledged by Tru-jet pilot. At time 092718 UTC TRJ711 reported, established on final approach track runway-23.
- At time 092725 UTC Landing clearance was given to TRJ711 for runway-23 with wind speed 11 knots and direction 350 degree.
- At time 093233 UTC UTC Kandla Tower initiated call to aircraft, crew informed that they are going around.
- At time 093333 TRJ711 informed that they are climbing to 2300 feet and will hold over NDB to that controller approved.
- At time 093504 UTC, TRJ711 requested for runway condition. Tower reported as "TRJ711 KANDLA TOWER RUNWAY, KANDLA RUNWAY -23 SURFACE CONDITION CODE SIX SIX SIX ISSUED AT TIME 0617 AND DRY DRY DRY DEPTH-NOT REPORTED NOT REPORTED COVERAGE-NOT REPORTED NOT REPOERTED."
- At time 093607 UTC, aircraft requested ATC to check the runway condition and informed that they went off the runway to that ATC acknowledged and sent operational jeep for runway inspection.
- At time 093901 UTC TRJ711 informed that they are approaching overhead NDB and will do another hold. ATC approved the same.
- At time 094310 tower informed TRJ711 that during runway inspection, runway found fit for operations and runway condition is dry. Crew asked for any debris found to that ATC informed negative.
- At time 094620 UTC, TRJ711 requested diversion to Ahmedabad. The same was approved and FL130 was approved as per aircraft request.
- At time 094738 tower asked the reason for go around to that TRJ711 informed due technical.
- Later operational jeep reported that one runway edge light from left side of Rwy-23 is broken and few small tire pieces was found near runway on soft ground area. Immediately Bhuj Approach and Ahmedabad control was also briefed on telephone about the incident and also informed to Bhuj Approach and

Ahmedabad control about broken runway edge light and small tyre pieces found near runway via landline.

1.19 Useful or Effective Investigation techniques

Nil

2. ANALYSIS

2.1 Serviceability of the Aircraft

The maintenance document of the incident aircraft VT-TMK were scrutinized and observed to be valid as on the date of incident. On the day of incident, the aircraft was not under MEL. The review of aircraft techlog/snag register/ESR revealed that there was no defect pending to be rectified before operating the incident flight. The Fault history also did not record any system failure that might have been involved in the RWY excursion. Also the parameter Advisory Display Unit Caution Active became active when the LNAV MODE went off and this does not have a bearing to the incident. As such maintenance task post incident as per the Aircraft Maintenance Manual and as per OEM recommendations were carried out. From the above it is evident that the aircraft was fully serviceable and there was no snag reported or encountered any problem during the time of flying. Further the serviceability of the aircraft and maintenance aspect is not a contributory factor to the incident.

2.2 Weather Factor

The METAR report issued at 0900 UTC did not have Gusts, therefore the crew had calculated the Vapp accordingly and obtained 107 kt for aircraft landing weight of 21.5 T for flaps 30 which is close to the accurately calculated value of 109 kt. Prior to touch down, the towers informed only the wind condition as 350/10 kt (4 minutes prior to touchdown) and no gusts were informed. The aircraft touchdown happened at 0930 UTC and the subsequent METAR report was also issued at 0930 UTC which indicated the presence of 20 kt gusty wind. Both the events were so simultaneous that the crew were not aware about the gusts and so the aircraft touched down with much lower aircraft speed of 104 kt IAS than the required Approach speed of 119 kt IAS in the prevailing gusty winds(G20 kt).

Also the aircraft experienced tailwind of about 12 kt and right cross wind of 10 kt during touchdown. Thereafter the aircraft touched down on the right side of the runway 420 m beyond the threshold of the RWY 23 and 7 m from the centerline. Also the aircraft experienced a bounced landing.

It may be noted that another aircraft belonging to other operator had later executed a Go Around due to Gusty winds of 20 kt which was known to that crew and landed when the Gusts subsided.

Hence weather was a contributory factor.

2.3 Operational Aspect

2.3.1 Pilot Handling of aircraft:

AP disengagement and Manual pilot handling:

The aircraft was carrying out a visual approach on to RWY 23 for landing. The aircraft was in profile as per the approach chart till 1010 ft. Further the Auto pilot

was disengaged at 730 ft. During this landing, the Pilot Flying was the pilot/captain, and the Pilot Monitoring was co-pilot.

The selected vertical speed is recorded and was set a -600ft/min from 400ft RA. During the manual handling phase, the magnetic heading was modified between 227° and 240°. According to the GPS trajectory, this manoeuver was performed most probably to align the aircraft. Then at about 300 ft till touchdown, there was left and right roll inputs of aircraft observed dominantly towards right, however this was within limits. All the approach and landing checklists were carried out satisfactorily. The aircraft was stabilized from final approach(500 ft for VMC condition) till touch down.

Flare and Bounce touch down:

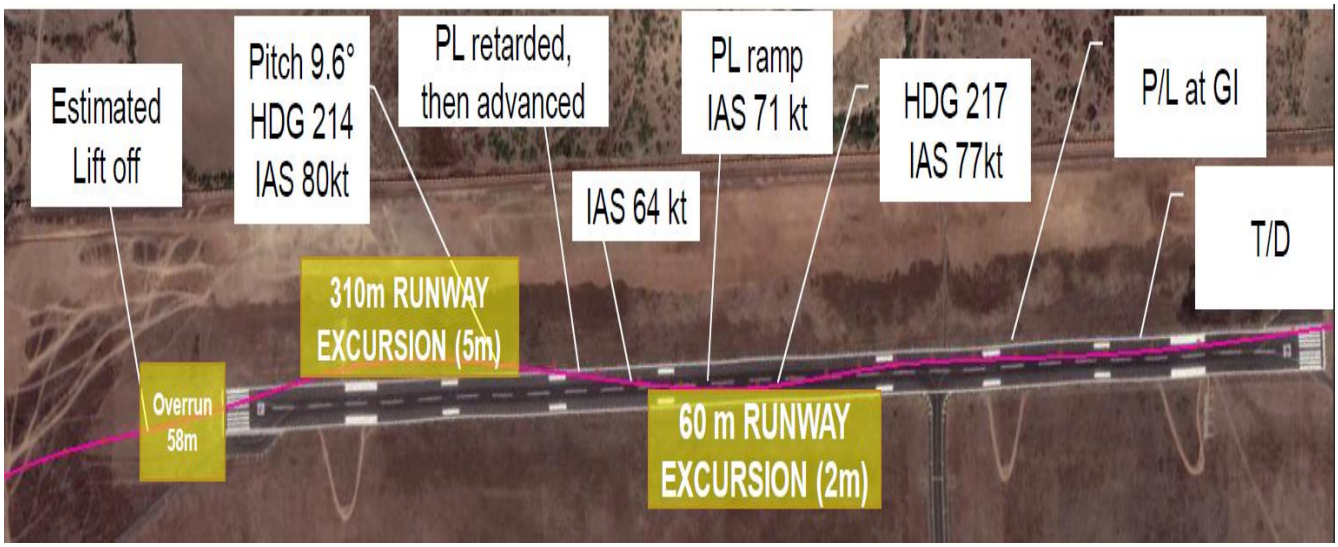
At 15 ft RA, the PIC made a flare with left bank. Further the aircraft touched down 420 meters beyond the threshold of runway 23 and 7 m to right of centerline with 105 kt IAS and power levers were moved forward, from Flight idle(FI) (35°) to 44°,however MLG is seen not compressed with 1 ft RA. Further the RA increases to 4 ft and again the aircraft touches down at 100 kt IAS with MLG compressed (recorded Vrtg as 1.26 G). On touch down, the aircraft had a right cross wind of 10 kt & tail wind of approximately 12 kt (wind direction varying from 350 Deg to 21 Deg).From this it is evident that the aircraft made a bounce during touch down. Power Lever were moved to Ground Idle(GI) position . The Advisory Display Unit Caution Active parameter got active when the LNAV mode parameter turned off. This does not have any bearing to the incident.

Roll out and lateral Runway excursion (left and right):

Subsequently, maximum left rudder pedals(27^{0}) have been applied by crew for next 5 seconds resulting in the aircraft veering towards the left during which heading changed from 235° to 218° and a nose down order was applied. Further dual inputs were recorded on pitch axis. Meanwhile, the thrust had been increased to 90 % and the PIC is heard calling out Go Around. At the same time there is some master warning heard (probably Take-off Configuration warning due to sudden application of thrust when landing configuration prevailed). From this it is evident that the Copilot in panic has not only given inputs opposite to the PIC, also he did not contribute any supporting action to the decision of Go Around by setting the flaps to 15^{0}.

The aircraft veered towards the extreme left of the runway with left MLG exiting the paved surface(890 m from threshold) and entering through the soft ground(the aircraft was in the soft ground for 60 m) and breaking the light (loud sound heard from CVR and 3.97 g recorded in DFDR). The 3.97G value was most probably due to the contact with either a left lateral edge light or its concrete base which has resulted in loss of data recording for 3 seconds. Pilot applied right rudder pedal input. Thereafter the aircraft has entered the paved surface(955 m from threshold). During the data loss, the aircraft experienced a runway excursion on the right side of the runway (traces on the ground). The heading shows the pilot wanted to control the aircraft on the center line. Elevator and power levers are consistent with a go around action. Continuous right rudder pedal application had caused the aircraft veering towards the right and completely exits the right side of the runway. It was found that

all the wheels of the aircraft had exited the paved surface(at 1089 meters from threshold).



Track of aircraft from touchdown to lift off

Tail Strike:

Then it is observed that pitch attitude increases to 9 deg wherein the speed is just 78-80 kts. The aircraft at this time is seen lifting up to about 4 ft RA for 4 seconds and touching back on the soft ground during which tail strike has happened (2.94 and 2.67 g recorded during lift off and touch down).

Runway Overrun:

The aircraft has rolled on the soft ground for about 310 mts before it is seen veering back on to the runway towards the centerline due to minor left rudder applications. During this the master warning triggered probably due to Take-off configuration warning because the PLA was set to Ramp position with flaps in landing configuration. The pitch is again seen gradually increasing to 11 deg wherein the aircraft is seen lifting off from approx. 58 m after the runway end area when the indicated speed was 91 kts(Stall speed in landing configuration=Approach speed/1.3)

Go Around:

The aircraft after liftoff did hold for 10 minutes and the crew after consultation with AME decided to divert to the 1st alternate, ie back to Ahmedabad. The landing in Ahmedabad was uneventful.

2.3.2 CRM:

The CVR/DFDR analysis shows that the flight crew followed company procedures till the point of touch down from the final approach & can be considered as stabilized considering the gusty wind conditions. However when the PIC called out for Go Around, the Copilot in panic gave opposite pitch inputs and did not contribute to the Go Around decision by selecting the Take-off configuration or proper callouts . Therefore his inability to execute the PM responsibility had the delayed the Go-around worsening the situation resulting into Left, right lateral excursion and tail strike followed by overrun prior to lift off.

3. CONCLUSION

3.1 Findings

1. Crew were appropriately qualified to fly the aircraft.
2. Both cockpit crew had undergone Pre-flight BA test at Ahmedabad and found negative for consumption of alcohol. After the incident crew were subjected to BA test and both were found negative.
3. Aircraft was released with adequate fuel and in airworthy condition with all valid certifications. The serviceability of the aircraft and maintenance aspect was not a factor to the incident.
4. Landing at Kandla was undertaken in VFR conditions. Approach aid used was NDB.
5. At time 0927 UTC aircraft reported established final approach track runway 23. Landing clearance was given to TRJ711 with instant wind 350 degrees/11 knots as observed on display by the controller
6. The aircraft's approach was observed to be stabilized.
7. The METAR report issued at 0900 UTC did not have Gusts and the METAR issued exactly at the touch down time 0930 UTC had 20 kts Gust. Therefore calculated Vapp for aircraft landing weight of 21.5 T for flaps 30 was 12 kt less than the required Vapp value for the prevailing weather, resulting in the aircraft landing with lower Aircraft speed than the required approach speed.
8. Also the aircraft experienced tailwind of about 12 kt and right cross wind of 10 kt during touchdown. Thereafter the aircraft touched down on the right side of the RWY 23 about 7 m from the centerline. Also the aircraft experienced a bounced landing. Therefore the weather was a contributory factor to the incident.
9. The aircraft touched down with a slight bounce on the right side of the runway 7m from the center line and 425 meters beyond the threshold of runway 23.
10. Further the aircraft experienced a left runway excursion of 60m at 2m from the runway edge due to the excessive left rudder inputs given by the crew in an attempt to bring back/align the aircraft with the centerline.
11. The captain announced, "go around" and dual inputs were recorded on the control column. Simultaneously, there is some master warning heard (probably Take-off configuration warning due to sudden application of thrust when landing configuration prevailed).
12. A vertical acceleration of 3.97G was recorded probably due to a severe contact either with a left lateral runway edge light or its concrete base when the aircraft veered to the right to reenter the runway. A loss of data recording occurred from 2.6 to 4.4 seconds.
13. During the data loss, the aircraft experienced a runway excursion on the right side of the runway of 310m at 6m from the runway edge due to the excessive right rudder inputs given by the crew in a second attempt to bring back/align the aircraft with the centerline.
14. Thereafter crew applied back pressure in an attempt to lift off without setting proper Take off configuration. However as speed was less than the minimum stall speed, the aircraft just lifted off and landed back immediately experiencing a tail strike.
15. Further the aircraft enters back to the runway paved surface followed by the aircraft experiencing a runway overrun. Thereafter the aircraft lifted-off around 60m beyond the end of the runway as it attained the stall speed.
16. The aircraft after lift-off did hold for 10 minutes and the crew after consultation with AME decided to divert to the 1st alternate, ie back to Ahmedabad.
17. Crew did not inform to the controller about veer-off and over run and further going around. It was informed only when controller enquired.
18. On Runway inspection few tyre pieces found near and on runway. No damage

found to runway surface. One runway edge light found broken completely.

19. On duty controller coordinated on telephone with Bhuj ATC and Ahmedabad ATC and informed about incident.
20. After landing at Ahmedabad, the tyre pressures of No. 3 tyre of MLG (peeled off tyre) and both tyres of NLG were not within the stipulated limits.
21. The Captain was operating his first Flight as a PIC to Kandla.. However, First Officer had operated many times as FO to Kandla . Also the incident flight was the first flight wherein the PIC and FO operated together.
22. VHF, DME, NDB PAPI and WDI were working normal at Kandla Airport. DME, PAPI and NDB were ground and air calibrated. However, no calibration records of WDI was available with MET.
23. Visibility, signage, lighting and communication are not the factor to the incident.
24. Runway in use was RWY 23. Runway Condition Dry and no rains were reported for last two weeks.
25. There was no read back or hear back error observed during communication.
26. The on duty controller was ADC rated controller and well experienced in tower position. By seeing the skidding of aircraft, the controller immediately pressed the crash bell and immediately Fire Service Team approached at runway Holding Point.
27. During inspection of runway, it was found on Touch down Zone of RWY 23, a lot of metal aggregates (bitumen) are coming out of runway surface and posing as FOD hazards.
28. Further another aircraft had later executed a Go Around at Kandla after the incident flight due to Gusty winds of 20 kt which was known/available to the respective crew and landed when the Gusts subsided.
29. Glass covers of ATC room are in dilapidated condition. The glasses were found broken and turning opaque due ageing, which lead to poor visibility of runway/approach/ go around for controller and no sound proof.
30. There was no fire or smoke.
31. There were no injuries to the occupants or any third party.

3.2 Probable Cause

The crew continued landing with aircraft speed less than V_{app} in the prevailing gusty wind condition. This led to touchdown on right side of the runway. Subsequent use of excessive rudder inputs resulted in the Lateral runway excursions to the left and right. Further attempts to lift off without setting proper Take-off configuration resulted in tail strike and overrun before attaining a delayed Go Around.

4. SAFETY RECOMMENDATIONS

1. Necessary corrective action as deemed fit by DGCA, Hqrs based on findings.

Vipin Venu Varakoth

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Vipin Venu Varakoth
Deputy Director Air Safety
IIC of VT-TMK

------End of Report------