Final Investigation Report on Accident to M/s Air India Express Ltd. B-737-800 Aircraft VT-AYB on 04-09-2017 at Cochin Airport

(Dr. Jitender Loura)
Deputy Director of Operations
Investigator, VT-AYB

(Raje Bhatnagar)
Assistant Director Airworthiness
Investigator, VT- AYB

(Amit Gupta)
Director (AED)
Investigator in-Charge, VT-AYB

Foreword

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2017, the sole objective of the investigation of an accident shall be the prevention of accidents and incidents and not apportion blame or liability.

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

INDEX

FINAL INVESTIGATION REPORT ON ACCIDENT TO M/s AIR INDIA EXPRESS LTD., BOEING B 737-800 AIRCRAFT VT-AYB AT COCHIN AIRPORT ON 04-09-2017

1.	Aircraft	Type	Boeing 737-800
		Nationality Registration	Indian VT-AYB
2.	Owner		M/s Kai Ting Aircraft LLC, Delaware
3.	Operator		M/s Air India Charters Ltd., Mumbai
4.	Pilot – in –Command		ALTP Holder
	Extent of injuries		NIL
5.	Co Pilot		CPL Holder
	Extent of injuries		NIL
6.	Date & Time of Accident		04-09-2017; 2112 UTC (05-09-2017 ; 02:42 IST)
7.	Place of Accident		Rain water drain at Taxiway C (Between E and F), Cochin International Airport, Cochin
8.	Last point of Departure		Abu Dhabi International Airport (AUH/OMAA), United Arab Emirates
9.	Intended landing place		Cochin International Airport (COK/VOCI), Cochin
10.	No. of Persons on board		102 Passengers + 06 (02+04) Crew
	Extent of injuries		03 Passengers (Minor Injuries)
11.	Type of Operation		Scheduled Passenger Flight
12.	Phase of Operation		Taxiing
13.	Type of Accident		Taxi way Excursion in the rain water drain
14.	Co-ordinates of Accident Site		Lat 10° 09’ 07” N, Long 76° 24’ 07” E, AMSL 30 feet

(All timings in the report is in UTC)

SYNOPSIS

Air India Express B 737-800 aircraft VT-AYB was involved in an occurrence on 04-09-2017 at 2112 UTC (05-09-2017 at 0242 IST) at Cochin Airport while operating Flight IX 452 from Abu Dhabi to Cochin. There were 102 passengers and 06 Crew (02 Cockpit Crew & 04 Cabin Crew) on board the aircraft. After landing while taxiing, aircraft took a 90 m early turn before Taxiway 'F' on Taxiway C (between E and F) and entered into open rain water drain. Major Structural damage occurred including damage to Nose Landing Gear (NLG), Engine inlet Cowls, Fan Cowls, Engine Strut, Belly skin etc.

The occurrence was classified as Accident by AAIB as per the Aircraft (Investigation of Accidents and Incidents) Rules, 2017. Director General, AAIB vide its order Ref AV.15020/11/2017-AAIB dated 23rd October 2017 appointed Sh. Amit Gupta, Director, AED as Investigator-in-charge and Sh. Raje Bhatnagar, Assistant Director Airworthiness- AAIB along with Dr. Jitender Loura, Deputy Director (Ops) AAIB as investigators to inquire into the circumstances of this accident.

The aircraft earlier operated flight IX 419, took off from Cochin at 1152 UTC and landed Abu Dhabi at 1533 UTC. The Cochin – Abu Dhabi flight was uneventful.

The flight IX 452 took off from Abu Dhabi at 1644 UTC and landed Cochin at 2107 UTC. Aircraft touched down runway late i.e. approx. 4900 feet from the beginning of Runway 27 in moderate rains. Vertical G at the time of landing varied from 0.81g to 1.114 g. After landing the aircraft vacated runway from C2 and was given taxi clearance to bay 23L via C-F-L and hold short of Taxiway Lima due KAC358 was taxing out from bay 20. As per CVR, while taxiing, co –pilot informed PIC about passing taxiway "E" and next is "F". Also, co-pilot requested PIC who was at controls, to go slow as runway markings were not visible and advised to call follow me jeep. However, there was no response from PIC. The aircraft after crossing abeam taxiway E on taxiway C made a premature left turn 90 m before Taxiway F. Aircraft entered in Open Rain Water Drain (3-meter-wide having depth of 1.7 meter on Taxiway side & 1 M on apron side). Nose landing gear (NLG) of aircraft collapsed and the aircraft further moved forward on damaged nose gear and main landing gears entered the drain. Both engines and rear belly of the aircraft became the weight bearing member and Main Landing Gear (MLG) were freely suspended in the drain. Crew requested ATC for follow me jeep on Taxiway 'F' and later requested ATC to send tow truck. PIC applied throttle three times for aircraft to come out of the drain, but aircraft didn't come out of drain and remained stuck into the drain. ATC advised crew to shut down the engine and informed AICL to send Tow truck. The engines were shut down at time 2118 UTC i.e. 07 minutes after the accident.

Follow me Jeep reached at the accident site at 2117 UTC and first fire fighting vehicles reached aircraft at 2137 UTC. Passengers were evacuated using step ladder from L1 door at 2150 UTC and last passenger deplaned at 2155 UTC. Three (03) persons on board the aircraft received minor injuries. There was no fire. The aircraft received major Structural damage including damage to Nose Landing Gear (NLG), Engine inlet Cowls, Fan Cowls, Engine Strut, lower skin etc.

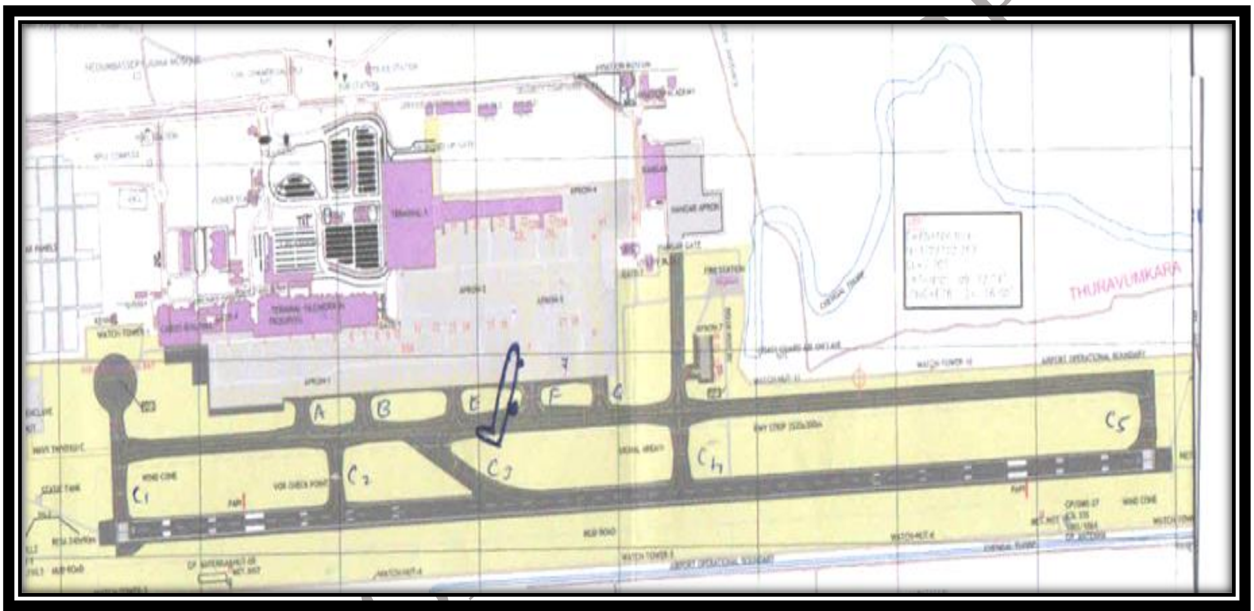
As per METAR, at 2100 UTC the visibility was 4000 meters which reduced to 3000 meters at 2130 UTC. ATC informed crew before landing regarding rains and runway surface as wet.

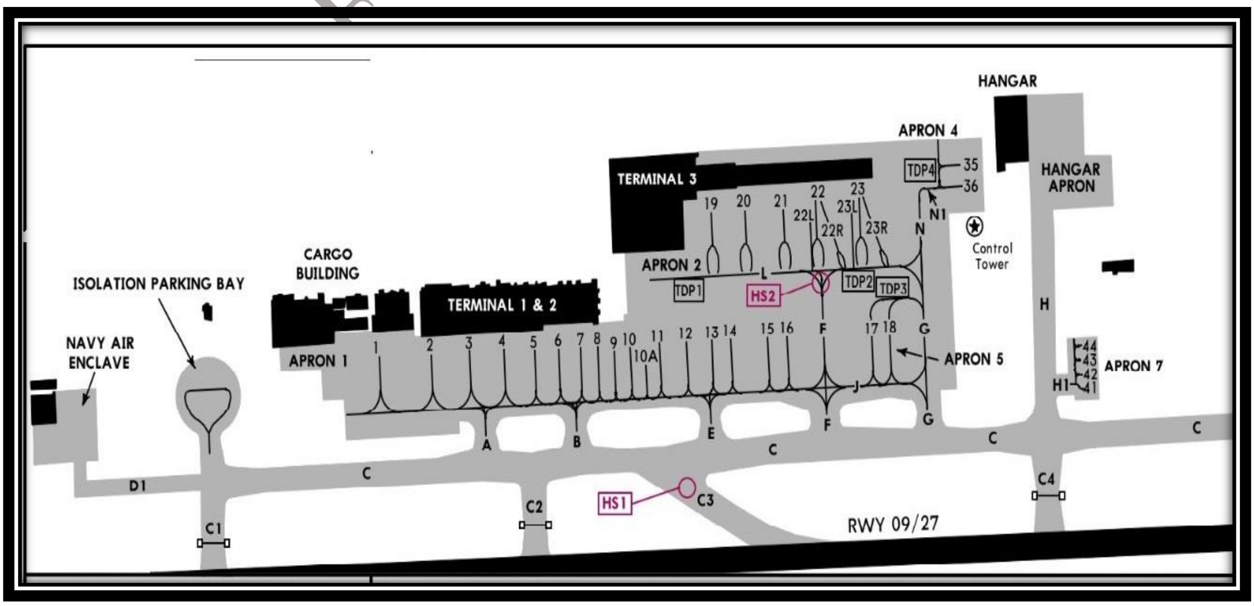
The probable cause of accident is "Incorrect judgement taken by PIC for initiating left turn short of the taxi track link (before Taxiway F), during night, in rain during reduced visibility conditions thus resulting the aircraft entering in open rain water drain.

Contributory factors

1. Taxiway C centre line was barely visible during night in rains in reduced visibility conditions.
2. Dis-agreement of PIC with Co-pilot for requesting "Follow Me" jeep at Taxiway C.
3. Window of circadian low of PIC.


Place of Accident
Taxiway C
Exit from Runway
Point of Landing


THURAVUMKARA


HANGAR
APRON 4
TDP4
35
36
TERMINAL 3
HANGAR APRON
19
20
21
22
23
22L
23L
22R
23R
N
N1
Control Tower
CARGO BUILDING
APRON 2
TDP1
HS2
TDP2
TDP3
L
ISOLATION PARKING BAY
TERMINAL 1 & 2
H
NAVY AIR ENCLAVE
APRON 1
1
2
3
4
5
6
7
8
9
10
10A
11
12
13
14
15
16
F
17
18
G
APRON 5
44
43
42
41
APRON 7
H1
J
A
B
E
C
D1
C1
C2
HS1
C3
RWY 09/27
C4

1. FACTUAL INFORMATION

1.1 History of the flight:

The Air India Express B 737-800 aircraft VT-AYB was scheduled to operate flight IX 419 and IX 452, Cochin – Abu Dhabi- Cochin on 04-09-2017. The flight IX 419 which took off from Cochin at 1152 UTC and landed Abu Dhabi at 1533 UTC. The flight was uneventful.

In return, the flight IX 452 took off from Abu Dhabi at 1644 UTC and landed Cochin at 2107 UTC. The aircraft was given landing clearance by ATC at 210324 UTC informing *"landing surface wet, Runway 27 cleared to land, wind 050 degree 03 knots.*" At 210715 UTC aircraft landed, and at 210741 UTC ATC informed aircraft to "*vacate via convenient right*". The aircraft touched runway late at approx. 4900 feet from the beginning of Runway 27 near taxiway C3 and vacated via C2 instead of usual C3 exit due to delayed touchdown. During landing, auto brake 03 were selected and window wipers were at HIGH due to rains. Vertical G at the time of landing varied from 0.81g to 1.114 g. The aircraft was given taxi clearance by ATC at 210924 UTC to "*continue taxi to stand 23L via C-F-L and hold short of Lima*". Another aircraft Kuwait Airways KAC358 was taxing out from stand 20. At 210953 UTC ATC asked IX 452 "at *what height you are able to sight the runway*", to which the crew replied as *"1000 feet".*

As per CVR, while taxiing, co –pilot informed PIC about passing taxiway "E" and next is "F". Also, co-pilot requested PIC who was at controls, to go slow as runway markings were not visible and advised to call follow me jeep. However, there was no response from PIC. The aircraft after crossing abeam taxiway E on taxiway C made a premature left turn 90 m before Taxiway F. Aircraft entered in open rain water drain parallel to taxiway C which is 3 meter wide having depth of 1.7 meter on Taxiway side & 1 M on apron side and Nose Landing Gear (NLG) collapsed. The aircraft further moved forward on damaged Nose Landing Gear and Main Landing Gears entered into the drain. Both engines and rear belly of the aircraft became the weight bearing member and main landing gear (MLG) were freely suspended in the drain. PIC requested ATC for follow me jeep on Taxiway 'F' and later requested ATC to send tow truck. PIC applied throttle three times, for aircraft to come out of the drain, but aircraft remained stuck into the drain. ATC advised PIC to shut down the engine and informed AICL to send Tow truck. The engines were shut down at time 2118 UTC i.e. 07 minutes after the accident.

Follow me Jeep reached at the accident site at 2117 UTC and First Fire fighting vehicle reached aircraft at 2137 UTC. As per CCTV recordings, the L 1 door opened at 2140 UTC and larger stair arrived at 2142 UTC. However the larger stair couldn't be aligned with L1 door and smaller

stair arrived at 2150 UTC. All passengers were evacuated using step ladder from L1 door at 2150 UTC and last passenger evacuated at 2155 UTC. Three (03) persons on board aircraft sitting at seat number 27 C, 29 A and 30C received minor injuries due to sudden jerks when aircraft entered into the drain. There was no fire. The aircraft received Structural damage including damage to Nose Landing Gear (NLG), Engine inlet Cowls, Fan Cowls, Engine Strut , lower skin etc.

As per METAR, the visibility at the time of accident was 4000 meters and the ATC informed the aircraft regarding rains and runway surface as wet. CCTV camera recordings shows that the taxiway blue lights were ON and Green leading lights to the taxi track link (Taxiway F) were ON with Low intensity when aircraft IX 452 was taxiing. After the accident the intensity of Green leading lights was increased by ATC.

As per DFDR, the ground speed of aircraft before accident was 2.5 knots. The rain water drain is running parallel to Taxiway "C" and is OPEN. The drain is situated at a shortest distance of 43.55 meters from centerline of Taxiway "C".

As per PIC's statement, he reached hotel late in the previous night while operating flight Cochin-Dubai-Cochin and was not able to sleep before the flight and was fatigued at the time of landing at Cochin. He also mentioned that Fatigue, poor weather and confusing taxi track appearance contributed to incorrect judgment of initiating the turn short of the link "F".

As per co-pilot's statement, when PIC turned aircraft left prematurely, she was adjusting her wipers and spectacles to see clearly.

The Tower Controller was handling three aircraft at the time of the accident and fourth joined after five minutes i.e. AXB 452 taxiing for Bay 23, KAC 358 taxiing from Bay 20 to runway, QTR 516 landing on runway 27 and subsequently ETD 17E landing on runway 27.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	NIL	NIL	NIL
Serious	NIL	NIL	NIL
Minor	NIL	03	NIL
None	2+4	99	NIL

1.3 Damage to Aircraft:

The aircraft sustained substantial damages.

The Nose Landing Gear (NLG) sustained major damage and needs to be replaced. The aircraft was resting with its nose landing gear collapsed inside the wheel well on the north side of the drain and the weight of the aircraft was sustained on both engines and the aft of the aircraft i.e. tail on the southern side of the drain on taxiway "C". The Main Landing Gears (MLGs) were intact and hanging in the drain. Following main damages occurred to the aircraft.

a) NLG damaged. Landing gear assembly, steering, taxi lights crushed and broken. Lower drag strut broken NLG door crushed and torn, cable assembly stretched when NLG Collapsed.

b) Heavy damage to various elements of Section 41, 43, 46 and 47 and needs replacement. For Section 41, Skin panel, splice strap, body drains, stringers, slice straps, blankets, inter costal, frame, E1 & E5 rack as well as assembly, Hydraulic tube etc were broken or bent and needs replacement.

c) Similarly for sections 43, 46 & 47, many slice straps, blankets, inter costals, frame, and were broken, twisted or bent.

d) E&E Bay surround structure needs replacement.

e) Sharklet panel, upper fairing panel and gap cover panel for both LH and RH Wings are bent or cracked and needs replacement.

f) LH engine's (Engine No. #1) inlet cowl, fan cowls, thrust reverser and strut fairing panels damaged or cracked and needs replacement.

g) RH engine's (Engine No #2) inlet cowl, fan cowls, thrust reverser and strut fairing panels damaged or cracked and needs replacement.

1.4 Other damage: NIL

1.5 Personnel information

1.5.1 Pilot – in – Command

AGE	59 yrs
Date of License Issue and Valid up to	28.07.2001/ 28.08.2020
Category	ALTP
Class	SE/ME
Endorsements as PIC	B 737-800/ B 737-200
Date of Joining Company	13.07.2006
Date of Endorsement as PIC on type	29.11.2006
Instrument Rating	17.04.2017
Date of RTR Issue and Valid up to	30.01.2011/ 29.01.2031
Date of Med. Exam & validity	31.10.2017
Date of Route Check	11.01.2017
Date of Last Proficiency Check	30.05.2017
Date of English language Proficiency & Valid up to	30.01.2017
Date of last CRM	29.03.2017
Date of last Monsoon training	05.12.2016
Date of Dangerous Goods Awareness Training	27.07.2017
Date of last Refresher/Simulator	11.01.2017
Simulator Training for Critical Emergencies	11.01.2017
Familiarity with Route/ Airport flown for last 12 months and since joining the company.	All AIX stations
Total flying experience	14495.21 hrs
Total Experience as PIC on type	4176.48 hrs
Last flown on type	B 737-800
Total flying experience during last 01 Year	922:25 hrs
Total flying experience during last 180 days	388:51 hrs
Total flying experience during last 90 days	187:12 hrs
Total flying experience during last 30 days	57:16 hrs
Total flying experience during last 07 Days	16:40 hrs
Total flying experience during last 24 Hours	08:15 hrs
Rest period before the flight	17:40 hrs

As per record submitted by AICL, PIC was found BA +ve on 17.08.2007 and 09.01.2016. The licence of PIC was suspended by DGCA for 3 Months from 09.01.2016 and endorsement was made in PIC's ALTP license.

1.5.2 Co-Pilot

AGE	28 yrs
Date of License Issue and Valid up to	19.03.2010/ 18.03.2020
Category	CPL
Class	SE/ME/IR
Endorsements as PIC	C152 and PA-34
Date of Joining Company	2.6.2014
Date of Endorsement as Co-Pilot on type	B 737-800 endorsed on 20.02.2011
Instrument Rating	9.1.2017
Date of RTR Issue and Valid up to	Issue:20.8.2014 valid:5.9.2068
Date of FRTOL issue & validity	Issue:19.3.2015 valid:18.3.2020
Date of Med. Exam & validity	Issue 17.5.2017 valid:16.05.2018
Date of Route Check	24.5.2017
Date of Last Proficiency Check	18.6.2017
Date of English language Proficiency & Valid up to	19.6.2014 level 5 Valid 18.6.2020
Date of last CRM	6.6.2017
Date of last Monsoon training	9.6.2017
Date of Dangerous Goods Awareness Training	30.6.2016
Date of last Refresher/Simulator	17.6.2017
Simulator Training for Critical Emergencies	17.6.2017
Familiarity with Route/ Airport flown for last 12 months and since joining the company.	FAMILIAR/BOM/COK/TRV/CCJ/IXE DXB/AUH/MCT/BAH/DMM/DOH/ RKT/AAN/SLL/SHJ
Total flying experience	1429:40 Hrs
Total Experience on type	1139:04 Hrs
Total Experience as PIC on type	N/A
Last flown on type	04:28
Total flying experience during last 01 Year	870:53
Total flying experience during last 180 days	438:33
Total flying experience during last 90 days	212:13
Total flying experience during last 30 days	82:56
Total flying experience during last 07 Days	24:11
Total flying experience during last 24 Hours	08:15
Rest period before the flight	61:30

Both operating crew were not involved in any serious incident/ accident in past and had adequate rest as per the Flight Duty Time Limitations (FDTL) requirement prior to operating the accident flight.

1.6 Aircraft Information:

1.6.1 General Description

Boeing 737-800 is a Twin engine aircraft fitted with CFM 56-7B Engine and is manufactured by CFM. This aircraft is certified in Normal category, for day and night operation under VFR & IFR. The maximum operating altitude is 41000 feet. Aircraft length is 39.50 meters, wingspan is 35.79 meters and height of this aircraft is 12.50 meters. Distance between main wheels is 5.70 meters, distance between engines is 9.652 meters and Engine Ground clearance is 48 cms. This airplane is certificated in the Transport Category, FAR Part 25 and Part 36.

The airframe structure is fabricated, in general, of high-strength aluminium alloys. Steel, titanium, and other FAA approved materials are also used where required. Magnesium alloy is not used in primary or secondary structural application. Aluminium alloy sheet stock are clad for gages less than 0.063 inch thick. The fuselage is a semi-monocoque structure with zee-type frames and skin stiffened with hat-type stiffeners. The fuselage skin panels are made of longitudinal stiffeners mechanically fastened to sheets or plates. Circumferential tear straps and doublers are used where necessary. A nacelle encloses each engine. A strut attached to the wing holds the engine and nacelle. A firewall made of corrosion-resistant steel or titanium alloy isolates each nacelle from its strut.

The wing is made into one piece which extends through the fuselage. The wing to body attachment is permanent. The primary wing structure is an aluminium alloy skin stiffened by stringers made of extruded aluminium alloy. The spars primarily carry the shear loads. The skin and stringers carry most of the bending loads. The wing is also an integral fuel tank. The trailing edge ribs are made of aluminium alloy. The upper surface is made of an aluminium alloy skin and reinforced honeycomb sandwich of fiberglass and graphite. The lower surface is made of an aluminium alloy skin with a reinforced 10 honeycomb sandwich of aramid/graphite and fiber glass/graphite. There is access to inside of the trailing edge for inspection, maintenance, and repair. The fixed structure of the leading edge is made of aluminium alloy, fiberglass, or composite fiber glass and aramid, as necessary. No winglets are installed on the aircraft.

The aircraft was certified for 186 passengers and VT-AYB is configured for 186 all economy-class passengers seat. At the time of accident, there are 102 passengers on board the aircraft.

1.6.2 Aircraft Technical Information

Name of Owner	M/s Kai Ting Aircraft LLC, USA
Name of Lessor	M/s Munster Aviation Leasing Ltd, Irish
Name of Operator	Air India Express
Lease Valid up to	07.07.2021
Aircraft Type	B737-800 HG
Registration Marking & S.No.	VT-AYB, MSN : 36338
Model	B737-85R
Date of Manufacture	June-2009
Date of Arrival in India	28.07.2009
Certificate of Registration No.	3997/2
Validity of Certificate of Registration	07.07.2021
Certificate of Airworthiness No.	6106
Validity of Certificate of Airworthiness	Unlimited.
C of A Category	Normal
C of A Sub Division	Passenger/ Mail/Goods
Date of Issue of ARC	24.07.2017
ARC was valid	16.07.2018
Total Flying Hrs / Cycles since manufacture as on 04.09.2017	FH: 26525:34 Hrs FC : 9180 Cycles
The last major check/inspection carried out on the aircraft	Ph – 58 (TSN: 26372:06 & CSN: 9135) on 24.08.2017 at Mumbai
Certificate of Release to Service	TSN: 26371:32 Hrs. CSN: 9134 Cycles at Mumbai on 23.08.2017
Last Weighted on with approved weight schedule	27.05.2014
Type of Engine	CFMI CFM56-7B26
Left Engine (#01) serial number and hrs/cycles logged on the day of accident	ESN 895486 FH: 28672:39, FC: 10489
Right engine (#02) serial number and hrs/cycles logged on the day of accident	ESN 865366 FH: 1470:06, FC: 456

Aero Mobile license Number and Validity	A0161051WR LO-09
Validity of Aero Mobile license Number	31.12.2017

Aircraft Empty Weight	42450.85 Kgs
Max fuel capacity (At density of 0.785 kg / litre)	20427.35 Kgs
Maximum Takeoff weight	79015.00 Kgs
Empty weight CG (cm)	657.63inches or 1670.38 cm
Datum (from forward of front spar)	540 inches or 13.716 m

Weight	Actual Weights for Flight on 04-09-2017 in Kgs	Maximum Permissible weight in Kgs
Take-off Weight	70379	79015
Landing Weight	60659	66360
Zero fuel Weight	54679	62731

Computerized Load & Trim sheet was made for the flight**.** The Details of basic weight schedule were as follows:-

There were 102 Passengers on board the aircraft. To facilitate the calculation of the position of the center of gravity (CG), the passenger cabin is divided into four sections, 0A, 0B, 0C, 0D.

Zone	**Actual Seating**
0A	76
0B	17
0C	7
0D	2

The Boeing 737 has two lower cargo compartments for Baggage & Cargo. A forward cargo compartment, which is divided in hold #1 and hold #2 and an aft cargo compartment consisting of hold #3 and hold #4. Total baggage load was 3085 Kgs & Passenger load was 7461 Kgs. Total Traffic load was 10546 Kgs. The Dry Operating Weight was as follows:

Cargo Hold	**Actual (Kgs)**
1	0
2	1420
3	1665
4	0

The Middle Aerodynamic Chord (MACTOW) was calculated as 24.95 % and Stabilizer trim for take-off was calculated as 05.4 degrees.

Dry Operating Weight for the flight was 44133 Kgs. Take off fuel was 15700 Kgs, Trip fuel was 9720 Kgs. Aircraft was under load of 5621 Kgs.

Aircraft CG was within the prescribed limit during take-off and landing.

1.7 Meteorological information

The accident occurred at 2112 UTC and the METAR of 2100 UTC was valid at the time of accident. As per the METAR, following meteorological conditions existed.

Time (UTC)	**20:30**	**21:00**	**21:30**
Wind	CALM	CALM	05006KT
Visibility	4000 M	4000 M	3000 M
Temp	27° C	27° C	26° C
Dew Point	25° C	25° C	25° C
QNH	1009 hPa	1009 hPa	1009 hPa
QFE	1008 hPa	1008 hPa	1008 hPa
Clouds	FEW 1000 Ft SCT 1200 Ft OVC 8000 Ft	FEW 800 Ft SCT 1200 Ft FEW CB 2500 Ft OVC 8000 Ft	FEW 800 Ft SCT 1200 Ft FEW CB 2500 Ft OVC 8000 Ft
Trend	NOSIG	BECMG 3000RA	NOSIG

No significant weather trend was reported by ATC. No Special Weather Report (SPECI) was issued by MET office. CVR tape transcript revealed that the weather information was also passed by the Cochin ATC to the aircraft while giving the landing clearance.

Digital CWIS for RWY 27 provided at all ATC units and DWIE for RWY 09 available at Tower only. Airport Visual Range Assessor (AVRA) is not available. Manual RVR being provided on requirement basis. No automatic RVR equipment was installed in Cochin airport at the time of accident.

At the time of landing, there were heavy rains which later turned into drizzling when the accident occurred. As per CCTV recordings, the rain started at 2052 UTC.

As per Terminal Area Forecast (TAF), 2200 UTC to 0600 UTC the visibility was 3000 meters. The visibility was declared using Grid chart method by viewing landmarks/obstructions. The met office at CIAL is of Class III category.

1.8 Aids to navigation

Cochin airport is equipped with following Radio Navigation and Landing Aids.

Cochin airport is equipped with VOR, DME, NDB, and ASDE. PAPI & ILS Cat- II is installed on Runway 27 & 09.

a. DVOR I- CIA VOR
b. DVOR I – CIB VOR
c. Localiser R 27
d. Glide Path R 27
e. Outer Marker R 27
f. NDB

1.9 Communications

At the time of accident, the aircraft was in two-way contact with Cochin ATC (SMC) on frequency 121.750 MHz. From the CVR transcript it was apparent that there was no communication problem between the Flight Crew & ATC. Aircraft maintained positive communication with the ATC throughout the flight and during Taxiing.

1.	Cochin Approach	119.75 M Hz
2.	Cochin ATIS	126.20 M Hz
3.	Cochin Tower	118.80 M Hz
4.	Distress	121.5 M Hz
5	DAVIS	126.2 M Hz
6.	SMC	121.75 M Hz

1.10 Aerodrome information

Cochin International Airport is an international airport serving the city of Kochi, in the state of Kerala, India. Located at Nedumbassery, about 045°, 28 km from Ernakulum South Railway Station. Cochin International Airport is the first airport in India developed under a Public-Private Partnership (PPP) model and was funded by nearly 10,000 Non-Resident Indians from 30 countries. It is the busiest and largest airport in the state of Kerala and7th Largest in terms of Passenger traffic in India. The first commercial service began on 10 June 1999. The airport is operated by Cochin International Airport Limited (CIAL). The airport is licensed by DGCA No. AL/Public /005 for both IFR and VFR traffic.

The Airport Reference Point is 10°09’13.8”N, 072°51'58"E. The elevation of the airport is 9.14 m (30 ft). The runway code is 4E. The IATA location Identifier code is COK and ICAO location Indicator code is VOCI. The Airport Rescue and Fire Fighting Services is Category ‘9’ (Nine). The airport has one runway designated as 27/09 made of Asphalt Concrete which can handle all types of aircraft including the Code F aircrafts. There is one parallel Taxiway of 3400 m. Aerodrome Beacon flashes 15 white & 15 green flashes per minute

The detail of runway distances is as below :-

Runway No.	**True Bearing**	**TORA TODA LDA ASDA (m)**	**Dimensions of RESA (m)**	**Width (m)**	**PCCN**	**Runway Shoulder Width (m)**	**Dimension of Strips (m)**
27	268	3400	240x90	45	60/F/B/W/T	7.5 m (on both sides)	3520 x 300
09	088	3400	240x90	45	60/F/B/W/T	7.5 m (on both sides)	3520 x 300

Basic Strip, RESA, Stopway

		Length (m)	**Width (m)**	**Surface Type**
Runway Basic Strip		3580	300	Grass/ Graded
RESA	**09**	90	300	Grass/ Graded
	27	90	300	Grass/ Graded
Stopway	**09**	NIL		
	27	NIL		

Taxiway

Taxiway	**Width**	**Surface Type**	**PCN**	**Edge Lights**
B	23 m with 10.5 m shoulder on each side	Asphalt Concrete	60/F/B/W/T	Provided
C				Provided
D				Provided
E				Provided
C1				Provided
C2				Provided
C5				Provided
C4			60/F/B/W/U	Provided
C3				Provided
H				Provided

RWY had Designation, THR, TDZ, Centre-line. Aiming Point, Side stripe, Ends markings and Edge, THR, End & Centre line lights.

Taxiways had Edge, Centre line, RWY holding positions, Intermediate, Holding Positions markings.

Taxiways Edge lights had been provided at C1, C2, C3, C4, C5, A, B, C, D, E, H & H1 and Centre line lights at F, G, J, Apron 2 Taxi lane, Taxi Lanes L, N & N1.All signage's had been illuminated except TWY D1. Also TWY D1 is not lighted.

Taxiway A, B, C, C1, C2, C3, C4, C5, D, D1, E, H, H1, F, G, and J are available.

Taxiway D1 is of width 15 M with shoulder 5 M and Taxiway H1 is of width 10.5 M with shoulder 12 M. Rest all the other taxi way are of width 23 M with shoulder on 10.5 M respectively.

Taxi lane had Edge, Centre - line, Intermediate Holding, Positions Markings. Taxi lane had Centerline - L, N & N1 Lighted and all signages are illuminated.

Approach Lighting System

- Runway 27: Approach CAT I lighting system (up to 900M) as per ICAO standards.
- Runway 09: Approach CAT I lighting system (upto 900 M) standards

PAPI

- Runway 09: PAPI, Glide angle 3 degrees
- Runway 27: PAPI, Glide angle 3 degrees

Runway Lighting

- Runway 27: Edge and Threshold lights
- Runway 09: Edge and Threshold lights

Runway Lighting System

- Runway lighting-CAT-1: High intensity runway lighting with a standby circuit.
- Approach lighting-CAT-1: Approach Lighting System at 27 and simple approach lighting at 09
- PAPI (Precision Approach Path Indication) at 27 and 09
- Taxiway Lighting-medium intensity: Taxiway lighting system with spare circuit
- Modern beacon system and illuminated wind cone
- Runway Centerline lights is of White colour of spacing at 30 M.
- Runway Edge lights is of White colour of spacing at 60 M.
- Red colour Runway end lights are available for runway 09 & 27.

Apron Flood Lights

Apron Flood Lights consist of six 30M high masts placed between the terminal and the apron to give uniform illumination on the apron.

Emergency Power Supply

Emergency power supply by Diesel Generators is available for Runway, Taxiway, Approach Lights, PAPI and Apron Flood Lights. Switch over time less than 15 seconds, satisfying ICAO requirement Cochin Airport was closed on 15th August 2018 after heavy flooding and resumed operations on 29th August 2018.

1.11 Flight Recorders:

The aircraft was fitted with Solid State CVR & DFDR as per table given below. The recorders showed no signs of damage. Data from both CVR & DFDR were downloaded and analysed after the accident.

No	Unit	Manufacturer	Part Number	Serial Number
1	CVR	Honeywell, USA	980-6022-001	08206
2	DFDR		980-4700-042	14098

1.11.1 Cockpit Voice Recorder

The CVR has been downloaded with the help of RPGSE unit and decompressed into 05 Audio channels which were found in CVR. The channels are

- 1 P Channel recordings of duration 30:18 minutes
- 2 P Channel recordings of duration 30:18 minutes
- 3 P Channel recordings of duration 30:18 minutes
- 4 P Channel recordings containing Cockpit Area microphone (CAM) of duration 02:00:54 minutes
- MP Channel recordings containing the audio information from all the individual crew positions (HOT) Microphone of duration 02:04:53 minutes.

Following are the salient observations

- At time 210324, ATC asked AXB 452 *"XI-452, Cochin tower, namaskar, landing surface wet. Runway 27, clear to land, wind 050 degree 03 knots".*
- At time 210331, Co-Pilot replied to ATC *" Runway 27 , clear to land, XI-452".*
- At time 210740, ATC asked AXB 452 *" XI-452, tower, vacate by convenient right".*
- At time 210742, Co-Pilot replied to ATC *"Vacating Charlie 2 Sir, XI-452".*
- At time 210836, ATC asked AXB 452 *"XI-452, tower, taxi via Charlie foxtrot, hold short of lima".*
- At time 210939, Co-Pilot said (to PIC) *"Sir, go extremely slow because the runway mark at the marking over there might not be seen. So then we might have to call for follow me. Because that 2, 3 left and right".*
- At time 210953, ATC asked AXB 452 *"XI-452, tower expect height you are able sight the runway".*
- At time 211000, Co-Pilot replied to ATC "1000 feet XI-452 ".
- At time 211015, Co-Pilot said (to PIC) *" Next is echo and then next foxtrot. This is .... "*
- At time 211047 - 51, Co-Pilot said (to PIC) "…….echo next is foxtrot".
- At time 211155, Co-Pilot said (to PIC) " Cannot see any marking ..... all lights are on ".
- At time 211221, Co-Pilot said (to PIC) " ...aha...aha.... a big thud type sound".
- At time 211228, Co-Pilot said (to PIC) " ...aha...aha.... a big thud type sound".
- At time 211235, ATC asked AXB 452 " AXB-452, confirm the station victor tango alpha yenki bravo ".
- At time 211241, Co-Pilot replied to ATC " affirm AXB-452, request follow me, we are on foxtrot".
- At time 211250, ATC asked AXB 452 " AXB-452, confirm you can continue via foxtrot".
- At time 211257, Co-Pilot replied to ATC " Stand by Stand by ".
- At time 211300, Co-Pilot said (to PIC) "…….check...we need we need to talk to the *Some instrument sound* ".
- At time 211317, Co-Pilot said (to PIC) "Sir don't don't..... ".
- At time 211336, Co-Pilot asked ATC " XI-452, request tow truck "
- At time 211343, ATC asked AXB 452 " XI-452, Tower, requesting reason mam".

- At time 211351, Co-Pilot replied to ATC “There was a ditch at foxtrot XI-452. unable to see ahead “.
- At time 211721, ATC asked AXB 452 “XI-452, Tower, shut down your engine sir “.
- At time 211855, AXB replied to ATC “IX 452, Engine Shut down “.
- At time 211933, Co-Pilot said (to PIC) “Sir this is ..... now this Ya so we came at Charlie 2 now we are here. We ..... “.
- At time 211947, ATC asked AXB 452 “ XI-452, Confirm u can continue taxi“.
- At time 211951, Co-Pilot replied to ATC “ Negative sir we switched off the engine. waiting for tow truck as soon as possible “.
- At time 212012, Co-Pilot said (to PIC) “ Sir i told u echo 1 and then next left Sir because that time i told u next is this is echo , next is foxtrot Nahi nahi vaha par echo likha hua hai dekho, yaha par likha hua hai foxtrot and arrow is here What can you see. Can you see .....can you see more.....in engine. Just check and let me know. Ok”.
- At time 212240, Pilot asked ATC “ XI-452, Tower can ask the company to send tow truck”.
- At time 212242, ATC replied AXB 452 “ XI-452, we have informed your company to send the tow truck, shut down the engine sir”.
- At time 212244, Pilot asked ATC “We already shut down the engine”.
- At time 212316, Co-Pilot said (to PIC) “ Sir can u see that..... there is a ditch. **Over lapping and very low intensity .....** ”.

1.11.2 Digital Flight Data Recorder

The DFDR readout was analysed and following are the salient observations:-

1.	Landing Gear was down at altitude of 2994 feet at 210313 UTC.
2.	Auto Pilot changed from “ON” to “F/D ONLY ON” position at 210623 UTC.
3.	A/T-Engage changes from “ENGAGED” to “not engaged” at 210626 UTC.
4.	Aircraft touched down at 210715 UTC with AOA – L and R as -1.8 and -2.6 degree respectively.
5.	At T/D, Computed and Airspeed Select has been recorded as 142.3 and 147 knots

	respectively. Flap Handle was at 29.8, Heading as -89.6 and Vertical Acceleration varies from 0.81 to 1.114.
6.	T/R L & R have been deployed within 2 seconds of T/D.
7.	Auto brake applied at 210715 UTC.
8.	A/T-Disengage changes from “ENGAGED” to “not engaged” at 210717 UTC.
9.	Brake Position -L changes abruptly from -102.4 to -24.5 psi. And Brake Position-R changes abruptly from -51.6 to -15.2 psi at 210715 UTC.
10.	T/R was up at 210743 UTC.
11.	Aircraft Exited the runway at 210744 UTC at 10 Knots.
12.	Ground speed at 210947 UTC was 4.5 knots which increased to 9 knots at 211123 UTC.
13.	Normal Acceleration varies from 0.016 to 2.225 within a second at 211231 UTC (May be at aircraft entering into the drain).
14.	Speed and Heading at 211232 UTC was 0 and 8.1 degree respectively.
15.	N1 TECH L/R is about 21 at 211231 UTC. It goes on increasing upto 56.5 at 211310 UTC and comes down. It again increase upto 56.5 at 211442 UTC and comes down. Again in increases upto 55.6 at 211550 UTC and comes down to 0 at 211956 UTC.
16.	N2 TECH L/R is about 61 at 211231 UTC. It goes on increasing upto 88 at 211310 UTC and comes down. It again increase upto 87 at 211442 UTC and comes down. Again in increases upto 86.8 at 211550 UTC and comes down to 0 at 211950 UTC.
17.	At 211541 UTC, VOR Left frequency was selected as 121.5 MHz till end of recording.
18.	DFDR stop recording at 213847 UTC.

1.12 Wreckage and impact information:

The aircraft carried out landing on Rwy 27 and while taxiing entered in the open rain water drain. Aircraft entered in Open Rain Water Drain (3 meter wide having depth of 1.7 meter) and Nose Landing Gear (NLG) collapsed. The aircraft further moves forward and main landing gears entered into the drain. Both engines became the weight bearing member of the aircraft and Main Landing Gear (MLG) were lying suspended in the drain.

The drain where the aircraft ditched was 43.55 meters away from taxiway centreline and 235.81 meters from Runway centreline.

1.13 Medical and pathological Information:

Prior to operating the flight (IX 419), both the cockpit crew & cabin crew had undergone pre-flight medical / Breath Analyser test at Cochin and were found negative. Post flight BA test after the accident flight (IX 452) were carried out at Cochin for crew members and none of the crew members were found under the influence of alcohol.

PIC was found BA +ve on 17.08.2007 and 09.01.2016.The licence of PIC was suspended by DGCA for 3 Months from 09.01.2016 and endorsement was made in PIC ALTP license.

1.14 Fire:

There was no pre or post impact fire.

1.15 Survival aspects:

The accident was survivable. After landing and while taxiing the aircraft entered into the open rain water drain. The aircraft suffered 4-5 jerks and stopped. Three passengers received minor injuries. Passengers seated at 27C and 29 A received cuts with bruises in the figure and passenger seated at 30C complained of pain at area below ribs. All the passengers were evacuated using step ladder at L1 at 2150 UTC and last passenger evacuated at 2155 UTC. Injured passengers were handed over to ground staff for further assistance.

1.16 Tests and research

NIL

1.17 Organisation and Management information:

Air India Limited is a Scheduled Airlines and operates a fleet of Airbus and Boeing aircraft. It is a public sector undertaking under Ministry of Civil Aviation. The airline has headquarter at New Delhi. Air India is having 02 Subsidiaries as Air India Express & Air India Regional which have separate permit.

Air India Express is an Indian low-cost airline headquartered in Kochi, Kerala. The airline is having DGCA Air Operator's Permit (AOP) No. S-14 in Category "Passenger and Cargo" valid up to 21.04.2018. The airline commenced its operations on 29th April 2005. It operates fleet of 25 Boeing 737-800 aircraft with 550 flights per week to 30 destinations including the Middle East and Southeast Asia. The airline carries around 3.8 million passengers every year connecting 107 city pairs.

The Company is headed by Chairman & Managing Director assisted by a team of professional for various departments. The Flight Safety Department is headed by Chief of Flight Safety approved by DGCA.

1.18 Additional Information

1.18.1 ATC handling the accident

The Tower Controller was handling three aircraft at the time of the accident and fourth joined after five minutes i.e. AXB 452 taxiing for Bay 23, KAC 358 taxiing from Bay 20 to runway, QTR 516 landing on runway 27 and subsequently ETD 17E landing on runway 27.

Tower Controller asked AXB452 to *"shut down your engines"* at time 211721 and AXB452 informed ATC at 211853 that " *engine shut down*". Then again at time 211945 UTC, the Controller again asks AXB452 , "*Confirm ma'am, you can taxi"*. To which AXB452 replied "*Negative Sir, We have switched off the engine. Waiting for Tow Truck as soon as possible.*" Again the Controller asked AXB452 at time 212241 to "*Shut down the engines*". To which AXB452 replied " *We have already shut down the engines*". This frequency was being monitored by ACC-Area Control.

The tower controller failed to maintain two way eye contact i.e. surveillance over the subject aircraft and lost situational awareness

There was blatant use of Non Standard ICAO language as well as Non Standard Phraseology and local language among invariably all the Units i.e Tower, Appraoch, Area, SMC, Aplha, CIAL Tower Coordinator in Tower, Operational Vehicles etc.

As per Tower "D" Controller's statement, the Controller didn't see the aircraft turning left from taxiway C. It was only when the aircraft requested "Follow Me" service, he could see the aircraft. But couldn't make out whether the aircraft was on taxiway F or in Ditch. WSO was on ATC Channel till 2125 UTC and made a logbook entry regarding the accident at the same time i.e. 2125 UTC and didn't reach the tower till 2130 UTC.

As per Alpha's statement, WSO was in Tower. But after corroboration from ATC log books and ATC tape transcripts, it was found that *WSO was on Channel at ASR till 2125 and at the same time i.e. 2125, WSO made a detailed log in WSO's log book about the accident. It means WSO has not reached Tower before 2140 and by this time, the Controller had briefed the relieving Controller and handed over watch at time 2130 UTC*.

Time of reporting the accident is not mentioned in the Tower Delta log book by the Tower Controller.

1.18.2 Crew Combination

Both PIC and Co-pilot were operating first time together for Cochin- Abu Dhabi- Cochin flight. The PIC was based at Delhi and Co-Pilot was based at Cochin by the Air India Express. The details of Flights Operated prior to 1 Month to accident by PIC and Co Pilot is as under:

Flight Operated by PIC

S. No.	Date	From	To	ATD (UTC)	ATA (UTC)
1.	04-09-2017	VOCI	OMAA	1152	1539
2.	03-09-2017	OMDB	VOCI	1249	1656
3.	03-09-2017	VOCI	OMDB	0752	1147
4.	27-08-2017	OBKH	VOCL	1753	1843
5.	27-08-2017	VOCL	VOTV	1007	1504
6.	25-08-2017	VOCL	OERK	0352	0851
7.	25-08-2017	VOTV	VOCL	0129	0230
8.	23-08-2017	VOTV	OMAA	1213	1614
9.	23-08-2017	OMAA	VOTV	1708	2146
10.	17-08-2017	VECC	WSSS	1322	1815
11.	17-08-2017	WSSS	VECC	1855	2302
12.	08-08-2017	VECC	VGHS	0109	0214
13.	08-08-2018	VGHS	VECC	0109	0214
14.	04-08-2017	VOCL	OMDB	0342	0756
15.	04-08-2017	OMDB	VOCL	0850	1223

OBBI	Bahrain International Airport	VOTV	Trivandrum International Airport
OMAA	Abu Dhabi International Airport	VECC	Netaji Subhas Chandra Bose International Airport, Kolkata
OMDB	Dubai International Airport	WSSS	Changi Airport, Singapore
OBKH	Sakhir Airbase, Sadad, Bahrain.	VGHS	Hazrat Shahjalal International Airport, Dhaka
OERK	King Khalid international Airport, Riyadh	VOCL	Calicut International Airport
OMSJ	Sharjah International Airport	VOCI	Cochin International Airport
OOMS	Muscat International Airport		

Flight Operated by Co-Pilot

S. No.	Date	From	To	ATD (UTC)	ATA (UTC)
1.	04-09-2017	VOCI	OMAA	1152	1539
2.	01-09-2017	VOCI	OMAA	1206	1549
3.	01-09-2017	OMAA	VOCI	1701	2113
4.	31-08-2017	OMAA	VOCI	0047	0456
5.	30-08-2017	VOCI	OMAA	1941	2333
6.	27-08-2017	VOCI	OMAA	1204	1558
7.	27-08-2017	OMAA	VOCI	1659	2133
8.	24-08-2017	VOCI	OMSJ	1851	2239
9.	24-08-2017	OMSJ	VOCI	2343	0340
10.	20-08-2017	OBBI	VOCL	1120	1609
11.	20-08-2017	VOCL	VOCI	1707	1753
12.	19-08-2017	VOCI	VOCL	0344	0430
13.	19-08-2017	VOCL	OBBI	0547	0958
14.	14-08-2017	VOCI	OMDB	0750	1141
15.	14-08-2017	OMDB	VOCI	1250	1708
16.	12-08-2017	VOCI	OMAA	1148	1540
17.	12-08-2017	OMAA	VOCI	1646	2117
18.	11-08-2017	VOCI	OMDB	0751	1139
19.	11-08-2017	OMDB	VOCI	1253	1710
20.	09-08-2017	VOCI	OOMS	0231	0606
21.	09-08-2017	OOMS	VOCI	0720	1108
22.	05-08-2017	OBBI	VOCL	110	1608
23.	05-08-2017	VOCL	VOCI	1659	1741
24.	04-08-2017	VOCI	VOCL	0545	0640
25.	04-08-2017	VOCL	OBBI	0733	1141

PIC was 59 years old with total flying Experience of 14495 hrs and 4176 hrs as PIC on B 737-800. Copilot was 28 years old with total flying Experience of 1429 hrs and 1139 hrs as Co- pilot on B 737800.

PIC operated 10 flights in Jan 2017, 2 flights in July 2017 and 3 flights in September 2017 to / from Cochin Airport.

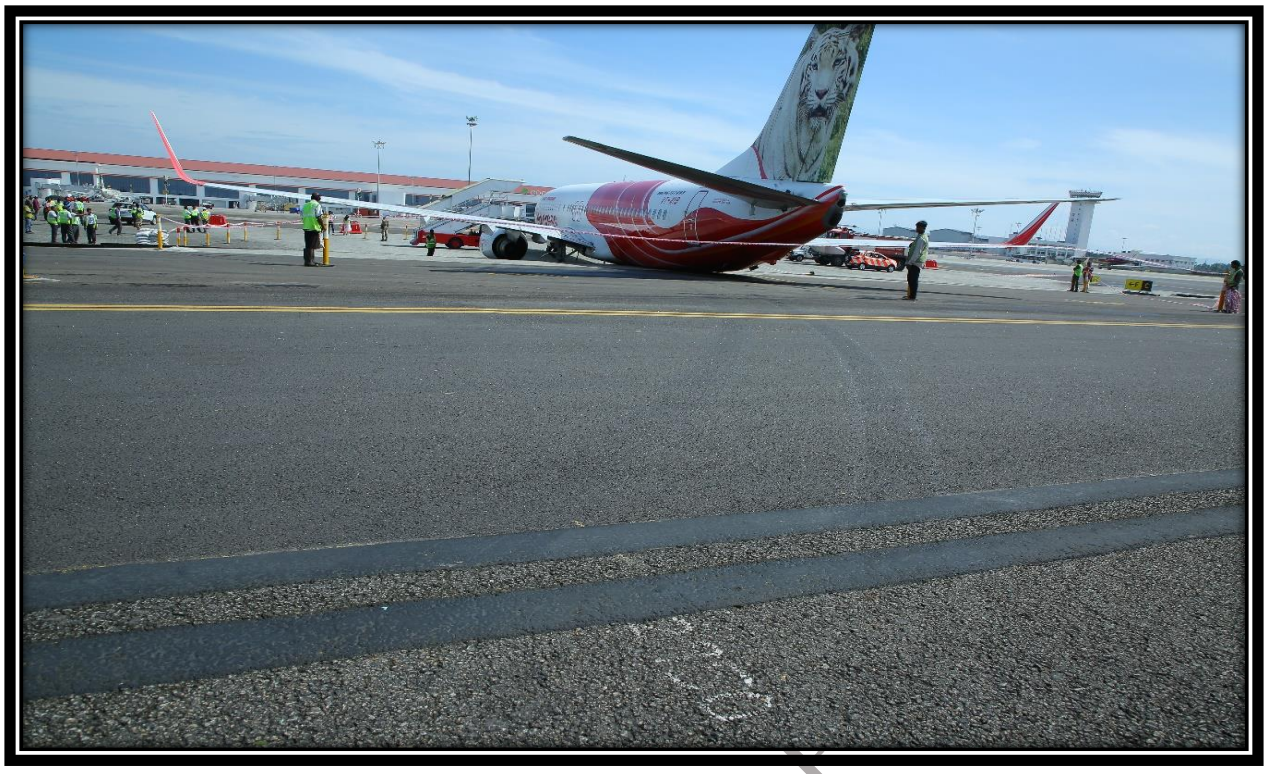
The Co –pilot had operated the same flight Cochin- Abu Dhabi- Cochin on 01-09-2017 with another PIC. Co-Pilot had operated 03 flights in September 2017, 20 flights in August 2017, 07 flights in July

2017, 11 flights in June 2017, 16 flights in May 2017, 10 flights in April 2017, 11 flights in March 2017, 10 flights in February 2017 and 07 flights in January 2017 to/ from Cochin Airport.

PIC and Co- pilot had never operated flight together earlier and Cochin – Abu Dhabi- Cochin sector was first time they operated together. The first flight Cochin – Abu Dhabi, Flight No. IX 419 on 0409-2017 was uneventful. The accident flight Abu Dhabi- Cochin Flight No. IX 452 on 04-09-2017 was their 2nd Flight.

1.18.3 Runway, Taxiway Markings and Taxiway lights.

The taxiway markings at CIAL were carried out as per specifications in DGCA CAR Section 4 Series B Part 1-Aerodrome Design & Operations and ICAO Aerodrome Design Manual Part 4 .The markings at Taxiway C were repainted in March 2017 and Markings on Taxiway F were repainted in July 2017. However as per CVR tape transcript, the taxiway marking were was not visible. The DGCA team also found on 05-09-2017 that Taxiway C Centerline Marking was not visible. As per records submitted by ATC, a few other aircraft also reported that Taxiway Marking were barely visible during the month of April, May and June 2017.

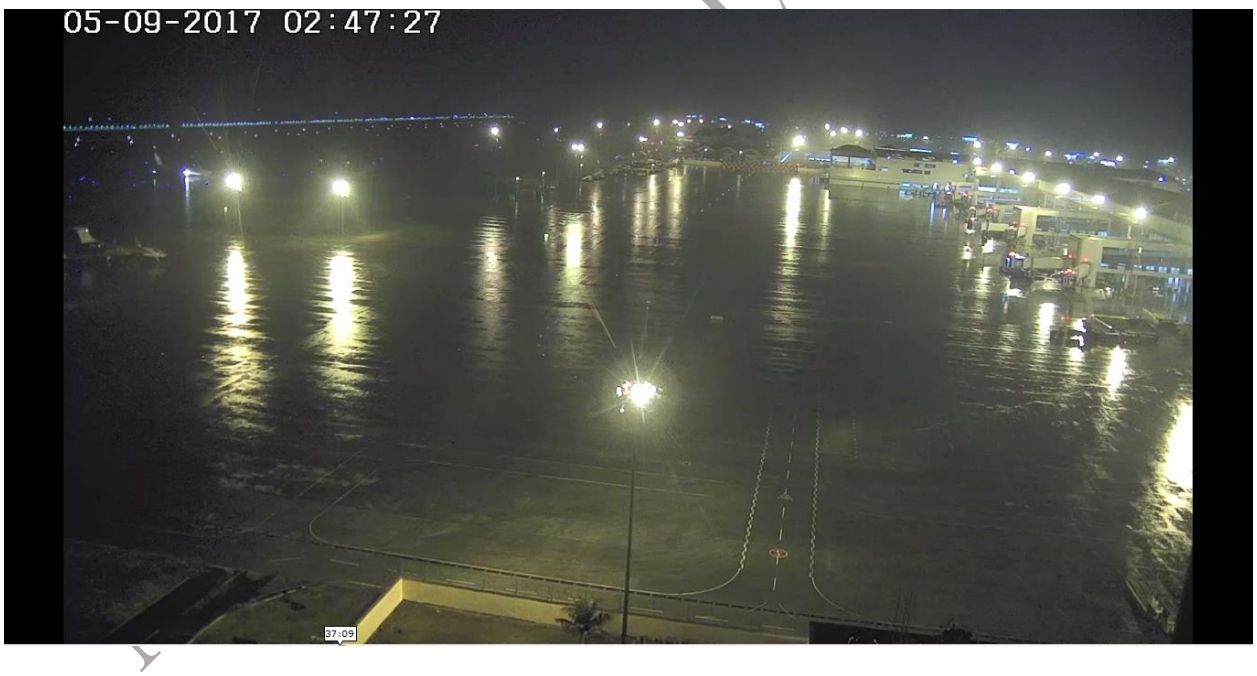


The Taxiway C was equipped with blue Taxi way edge lights. However, there were no Taxiway center lights. Taxiway edge lights are spaced 60 feet apart. At the time of taxiing, one circuit of taxi lights were working and alternate blue lights was glowing.

Taxiway information signs are usually yellow in color with black lettering. These are to provide assistance in directing the pilots while manoeuvring aircraft around the taxiway infrastructure. The black square indicates to pilots where you are right now and the yellow panels indicate directions.

Taxiway sign boards “F”, “J” & “F”, “C” were installed and light was on at the time of accident. The same was heard in CVR and seen in CCTV.

CCTV Indicates that blue Edge lights & Taxiway location signs were glowing



Apron Green taxi way center light glowing low before the accident.

Apron Green taxi way center light intensity increased to high after accident (211327 UTC)

Green Centreline light extending upto the taxy track link Taxiway F.

Review of ATC tape reveals, no request was made by VT-AYB for increasing the intensity of lights

CIAL provided CCTV recordings from three different cameras facing Apron.

- DTC -139 , CCTV -1
- ATC 2
- CCTV Apron No. 4474

There was timing error of 04:57 min and 00:09 min in recordings of CCTV ATC 2 and CCTV Apron No. 4474 with respect of actual timing as recorded in DTC-139 CCTV recordings.

1.18.4 Rain Water Drain at Cochin Airport.

At Cochin Airport, there are three main drains running parallel full length to Runway and Taxiway 'C'.

1. Northern Drain:

Length - 4160 mts.
Breadth - 3 mts (internal) at the exact spot where aircraft ditched into.
Height - 1 mts Northern wall and 1.7 mts Southern wall
This drain is onto the Northern side of the Taxiway C.
Northern Drain is situated at distance of 63.5 meters from centerline of Apron Taxi lane and 45 Meters from center line of Taxiway "C".

2. Central Drain:

Length – 4080 mts.
Central drain is situated immediately South of Parallel TWY C.
Central Drain is situated is situated at distance of 152.5 m from Runway centerline and 39.5 Meters from center line of Taxiway "C".

3. Southern drain:

Length – 4160 mts.
Southern drain runs on the South side of the Runway
Southern drain is situated is situated at distance of 152.5 m from Runway centerline.

1.18.5 Retroreflective Markers / Delineation Markers

Markers are an object displayed above ground level in order to indicate an obstacle or delineate a boundary. Retroreflective Markers / Delineation Markers are the self-illuminating pavement markers designed to provide visual guidance at night and particularly in adverse weather when traditional marker performance is more limited.

Those markers located near a runway or taxiway shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft & shall be frangible. Anchors or chains are sometimes used to prevent markers which have broken from their mounting from blowing away.

Markers installed near airport drains act as hazard identification and risk mitigation. Markers installations near drains are not mandatory. The markers were not installed at drains at Cochin. However, Markers installed near few airport drains are as under.

Darin Parallel to Taxiway C at Cochin Airport

Marker Poles at drain at Delhi Airport

Marker Poles installed at drains at Mumbai Airport

Drains covered with Steel Grills at Mumbai Airport

Drains at Dubai Airport with Marker poles

1.18.6 Pilot Fatigue

Fatigue refers to a physiological state in which there is a decreased capacity to perform cognitive tasks and an increased variability in performance as a function of time on task. Fatigue is also associated with tiredness, weakness, lack of energy, lethargy, depression, lack of motivation, and sleepiness.

Physical fatigue concerns the inability to exert force with one's muscles to the degree that would be expected. It may be an overall tiredness of the whole body, or be confined to a particular muscle group. Physical fatigue most commonly results from physical exercise or loss of sleep. Physical fatigue often leads to mental fatigue.

Mental fatigue, which may include sleepiness, concerns a general decrease of attention and ability to perform complex, or even quite simple tasks with customary efficiency. Mental fatigue often results from loss or interruption of the normal sleep pattern and is therefore of great concern to pilots and ATCOs, who are frequently required to work early in the morning or late at night.

Sleep patterns are naturally associated with the body's circadian rhythms. Shift patterns and transit across time zones can interrupt circadian rhythms. For example, it may be difficult for flight crew or pilots on duty in the early hours of the morning or flight crew operating long-haul routes through multiple time zones to achieve satisfactory rest prior to commencing duty.

It is important to note that people are not the best evaluators of their own alertness state. They are often sleepier than they report.

There are three types of fatigue: transient, cumulative, and circadian:

- **Transient fatigue** is acute fatigue brought on by extreme sleep restriction or extended hours awake within 1 or 2 days.
- **Cumulative fatigue** is fatigue brought on by repeated mild sleep restriction or extended hours awake across a series of days.
- **Circadian fatigue** refers to the reduced performance during nighttime hours, particularly during an individual's "Window of Circadian Low" (WOCL) (typically between 2:00 a.m. and 05:59 a.m.).

Accumulation of "sleep debt", e.g. by having an hour less of sleep for several consecutive days needs a series of days with more-than-usual sleep for a person to fully recover from cumulative fatigue.

Fatigue usually results in impaired standards of operation with increased likeliness of error. For example:

- Increased reaction time;
- Reduced attentiveness;
- Impaired memory; and,
- Withdrawn mood.

In a pilot and an ATCO, fatigue may evident by:-

- Inaccurate flying;
- Missed radio calls;
- Symptoms of equipment malfunctions being missed;
- Routine tasks being performed inaccurately or even forgotten; and, in extreme cases,
- Falling asleep - either a short "micro-sleep" or for a longer period.

In an ATCO, fatigue may evident by:-

- Poor decision making;
- Slow reaction to changing situation;
- Failure to notice an impending confliction;
- Loss of situational awareness;
- Forgetfulness.

Contributory Factors for fatigues are :-

- Circadian adaptation, i.e. adjustment of the body internal clock (e.g. due to the shift pattern, jet lag, etc.)
- Length of previous rest period;
- Time on duty
- Time awake prior to duty (duties that start in the evening are more likely to cause fatigue than those beginning at e.g. 8 a.m.)
- Sleep/nap opportunities (during the duty but also at layover destinations)
- Physical conditions (temperature, airlessness, noise, comfort, etc.)
- Workload (high or low)
- Emotional stress (in family life or at work)
- Lifestyle (including sleeping, eating, drinking and smoking habits) and fitness and,
- Health.

The involved PIC operated Cochin- Dubai- Cochin flight on 03-09-2017 and landed Cochin at 1659 UTC (2130 IST). As per his statement, he reached hotel around midnight and was not able to sleep. In CVR, there are noise of PIC yawning in the flight.

The co-pilot operated Cochin- Abu Dhabi- Cochin flight on 01-09-2017 and landed Cochin at 2113 UTC (0243 IST on 02-09-2017).

1.18.7 Window of circadian low (WOCL) and Jet Lag

Individuals living on a regular 24-hour routine with sleep at night have two periods of maximum sleepiness, also called the window of circadian low (WOCL). One occurs at night that is, roughly 0200 to 0600 (for individuals adapted to a usual day-wake/night-sleep schedule), called the window of circadian low (WOCL) identified as a time when the body is programmed to sleep, and during which alertness and performance are degraded. The other is in the afternoon, roughly from 3 p.m. to 5 p.m. Fatigue suffered due to window of circadian low is known as “Circadian Fatigue”.

When it’s dark at night, eyes send a signal to the hypothalamus that it’s time to feel tired. Brain, in turn, sends a signal to the body to release melatonin, which makes body tired. That’s why circadian rhythm tends to coincide with the cycle of daytime and night time. The circadian rhythm will likely change as one gets older.

Jet lag, resulting from crossing multiple time zones is another challenge in aviation operations, even for experienced flight crews. The rate of adaptation after crossing multiple time zones depends on both the number of time zones crossed and the direction of travel. Adjustment to westward travel is quicker than adjustment to eastward travel. Eastbound travel requires the individual to reduce their day to less than 24 hours (i.e., the circadian period is shortened), whereas westbound travel lengthens the circadian period. Lengthening the day and staying awake longer than 24-hours is easier because of the inherent period of the circadian rhythm being slightly longer than 24 hours.

Circadian adaptation is less likely to occur during long-haul trips of less than 3 days because it does not allow enough time for resynchronization of internal biological rhythms with the external environment; therefore, pilots can minimize circadian disruption by keeping the most similar sleep/wake schedule to their home time zone as possible. However, the exact timing of the circadian clock and rate of adaptation with multiple time zone crossings is not easily predictable, and thus a prescriptive formula for calculating a precise number of days needed for circadian adaptation in long haul crews is difficult without considering physiological, environmental, and operational factors.

1.18.8 Taxiway Edge Lights — "Sea Of Blue" Effect

As per ICAO the Aerodrome Design Manual (Part IV) para 9.2, the concentration of taxiway edge lights in the operational area often results in a confusing mass of blue lights commonly referred to as a "sea of blue". In some cases, this can result in pilots finding it difficult to correctly identify the taxiway boundaries. This problem particularly occurs in complex taxiway layouts with small radius curves.

This problem can be removed by the use of taxiway centre line lights, thereby eliminating the need to install edge lights in much of the taxiway system. Edge lights are normally still installed on curved portions of taxiways, at taxiway intersections and at taxiway/runway intersections.

At Cochin Airport when the aircraft moved forward from the eastern end of the taxiway towards exit F, the pilots must've been seeing clearly the taxiway stretching ahead. The thick yellow line marking and the centre-line of the taxiway too must've been visible, due to the edge lighting. A little farther ahead on the right, there were five links-taxiways perpendicular to the taxiway that connect the taxiway with aprons. These links -denoted by Roman alphabets G, F, E, B & A- too had blue edge lights. When any aircraft initiates the 90 degree turn to enter the link-taxiway, the glow of the blue lights fitted along the edges of the five parallel exit paths can together appear as a huge, rectangular illuminated surface. This optical illusion is the Sea of Blue Effect.

It occurs because blue light that travels as shorter, smaller waves gets scattered more than other colors. The light thus scattered from the edges of the five link-taxiways spaced just 125m apart can easily overlap, hiding the open land between them. So the chances are abundant for the pilot either to totally miss the actual exit that got submerged in the 'blue sea' or to confuse between the exit (link-taxiway) and the area between the link-taxiways.

1.18.9 Disabled Aircraft Recovery Team (DART) at CIAL.

Cochin International Airport Limited (CIAL) had a dedicated "Disabled Aircraft Recovery Team" (DART) trained and certified by the Fraport AG Fire Training Center in Frankfurt, Germany.

DART is a specialised team of people and equipment which enables the airport to safely remove a disabled aircraft on time, keeping runway closure to the minimum. CIAL requisitioned the Aircraft Recovery Equipment (ARE) of international standards from Resqtec B.V Zumro, Netherlands and M/s KUNZ GmbH, Germany. The newly-inducted equipment consists of a complete set of debogging kit and ground reinforcement system to pull narrow body aircraft without damage to the undercarriage.

It took the members of the Disabled Aircraft Recovery Team (DART) around 17 hours to remove the aircraft from the accident site and take it to the aircraft maintenance hangar. The aircraft maintenance engineers and DART members first leveled the pit with hollow bricks and sand. They then placed five low-pressure bags, each having a lifting capacity of 30 tonnes, under the plane's wings to lift it from the pit. Then, the team raised the aircraft's front portion using a hydraulic system and connected the damaged wheels with a dolly, which was later pulled by a truck into the maintenance hangar. The 17-member DART and 25 employees from the civil and electrical section of the airport were involved in the exercise, which concluded by 2245 UTC on 05-09-2017 (4.45 am IST on 06-09-2017).

1.18.10 Sequence of Engineering Events after Accident

The aircraft VT-AYB was retrieved from accident site and positioned at CIASL hanger on 06th September 2017. Boeing survey team assessed the aircraft damage and submitted Aircraft Survey Report to Air India Express.

The repair was carried out by Boeing AOG Team along AIESL (MRO) team. Necessary repair permissions were obtained from O/o DDG (DGCA, Bengaluru Region). AIESL (MRO) carried out other maintenance work i.e. hard landing inspection, removal/installation of engines/MLG, cabin normalization and other functional checks gear retraction test. The team completed the repair on 07th March, 2018 under supervision of AIESL (MRO) and the repair was approved by O/o DDG (DGCA, Bengaluru Region) on completion of work.

Aircraft underwent a Test Flight successfully on 15th March 2018 subsequently, aircraft was ferry flown with 'Special Fight Permit' from O/o DDG (DGCA, Bengaluru Region) to position in the hanger at Trivandrum on 16th March 2018 for scheduled maintenance by AIESL (MRO).

DDAW (Kochi) scrutinized airworthiness documents and revalidated the C of A and ARC of aircraft VT-AYB on 24th March 2018.

1.19 Useful or effective investigation techniques: NIL

2 ANALYSIS

2.1 Serviceability of the aircraft.

The aircraft had a valid Certificate of Airworthiness and a valid Certificate of Registration on the day of accident. The aircraft had completed 26525:34 Hrs Airframe hours and 9180 Flight Cycles. The aircraft is powered by two CFM Engines. The Engine # 1 had logged flight hours 28672:39 hours, Flight Cycles 10489 and Engine # 2 had logged flight hours 1470:06 hours, Flight Cycles 456 cycles. Scrutiny of the snag register revealed that there was no snag reported on the

aircraft prior to the accident flight. Prior to accident 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. The aircraft was last weighed on 27.05.2014 at Mumbai, and the weight schedule was prepared and duly approved by the O/o DDG (WR), DGCA, Mumbai.

2.2 Weather:

As per METAR issued at 2100 hrs UTC, visibility was 4000 m which reduced to 3000 m at 2130 hrs UTC. ATC informed crew before landing about rains and runway surface as wet. Crew after landing informed ATC that runway was sighted at 1000 feet. There was no weather special report issued during the period. RVR system was not installed at Cochin Airport.

2.3 CVR, DFDR & ATC Correlation:

The CVR, DFDR and ATC tape Correlation carried out and following are the salient findings:-

a) At 210324 UTC, ATC cleared aircraft for runway 27 intimating rains and runway surface wet with winds 050 degree 03 knots.
b) Aircraft touched down at 210715 UTC at distance of 4900 feet from starting of runway 27 with computed airspeed 142.3 knots and vertical Acceleration varies from 0.81 to 1.114.
c) Due to late touchdown, aircraft vacated C2 instead of C3. ATC gave taxi instruction to aircraft to taxi via Charlie, foxtrot, hold short of Lima for Bay No.23L
d) There was confusion in cockpit regarding sighting of Taxiway E & F due rains.
e) Co-pilot advised PIC who was taxiing to go extremely slow because the marking over there might not be seen and might call for “Follow Me”.
f) Ground speed at 210947 UTC was 4.5 knots which increased to 9 knots at 211123 UTC.
g) Co-pilot again informed PIC that she cannot see any markings.
h) At 2112 UTC the aircraft entered in rain water drain as Normal Acceleration varies from 0.016 to 2.225.
i) Co-pilot requested ATC for follow me later for tow truck.
j) PIC applied throttle three times for aircraft to come out of the drain.
k) ATC instructed crew to shut down the engine.
l) “Follow Me” jeep reached near aircraft at 2117 UTC and CFT reached near aircraft at 2137 UTC.
m) Passengers were evacuated using step ladder at 2150 UTC.
n) There was confusion in ATC as tower controller lost situational awareness and two way eye contact with the aircraft. Also, there was use of Non Standard ICAO language as well as Non

Standard Phraseology among invariably all the Units i.e. Tower, Approach, Area, SMC, Alpha, CIAL Tower Coordinator in Tower, Operational Vehicles etc.

o) WSO was on ATC Channel till 2125 UTC and made a logbook entry regarding the accident at the same time i.e. 2125 UTC and didn't reach the tower till 2130 UTC.

2.4 Operational factor

a) Both PIC and Co-pilot were operating first time together.

b) The PIC was based at Delhi and Co-Pilot was based at Cochin by the Air India Express. There was a gap of over 30 years & difference of 13000 hours in cockpit crew and the coordination was lacking from PIC side.

c) During last 8 Month, PIC had operated 05 flights to / from Cochin whereas Co-pilot operated regular flights to/from Cochin.

d) PIC was found BA +ve on 17.08.2007 and 09.01.2016.The licence of PIC was suspended by DGCA for 3 Months from 09.01.2016.

e) After landing, co-pilot requested PIC who was at controls, to go slow as runway markings were not visible and call for "Follow Me" jeep. However, there was no response from PIC.

f) PIC applied throttle three times for aircraft to come out of the drain, but aircraft stuck into the drain. Co- Pilot requested PIC not to apply the throttle.

g) The accident occurred at 2112 UTC (0242 IST) which is window of circadian low (WOCL) cycle. PIC operated flight previous night and landed cochin at 1656 UTC (2224 IST). As per statement, he reached hotel late and could not sleep properly.

h) In rains & night, the concentration of taxiway edge lights called "sea of blue" may result causing the pilot either to miss the actual exit that got submerged in the 'blue sea' or to confuse between the exit (link-taxiway) and the area between the link-taxiways.

i) During landing and Taxiing, Windshield wipers were used.

2.5 Aerodrome factor

a) As per CVR, Taxiway Centerline Markings were not visible.

b) DGCA Team which visited site also reported that the Centerline Markings were barely visible.

c) Markings at Taxiway C were repainted in March 2017 and Markings on Taxiway F were repainted in July 2017.

d) Few other aircraft also reported that Taxiway Marking were barely visible during the month of April, May and June 2017.

e) There were no Taxiway center lights.

f) The CCTV installed by CIAL in the operational area were not synchronized.

g) "Follow Me" Jeep reached at the accident site at 2117 UTC and first fire fighting vehicles reached aircraft at 2137 UTC.

h) Airport is equipped with CAT-I Approach CAT I lighting system.

i) Alternate Taxiway C blue lights were "ON" at the time of accident. There was no request received from crew to ATC to switch "ON" all Taxiway lights or increase the intensity of Taxiway light.

j) Taxiway sign lights were on at the time of accident.

k) The Retroreflective Markers / Delineation Markers markers were not installed at drains at Cochin. Markers installed near airport drains act as hazard identification and risk mitigation.

2.6 Circumstances leading to the Accident:

The flight IX452 took off from Abu Dhabi at 1644 UTC and landed in Cochin at 2107 UTC. The aircraft touched Runway late (approximately 4900 feet) from starting of Runway 27 in moderate rains. After landing, the aircraft vacated runway from C2 instead of C3 due to late touch down. The aircraft was given taxi clearance to bay 23L via C-F-L.

While taxiing, co –pilot informed PIC about passing taxiway "E" and next is "F". Co-pilot also requested PIC who was at controls, to go slow as runway markings were not visible and advised to call follow me jeep. However, there was no response from PIC.

The PIC after crossing a beam taxiway E on taxiway C made premature left turn 90 meters before taxiway "F". Aircraft entered in the open Rain water drain at 2112 UTC and the nose landing gear (NLG) collapsed. The drain is situated at approximately 43.55m from the centerline of taxiway "C". The aircraft further moved forward and main landing gears entered into the drain. Both engines and rear belly of the aircraft became the weight bearing member and main landing gear (MLG) were suspended in the drain. Co-Pilot requested ATC for "tow truck". PIC applied throttle three times for aircraft to come out of the drain, which was resisted by co-pilot, but aircraft was stuck in the drain. ATC advised crew to shut down the engines and informed AICL to send tow truck. The engines were shut down at time 2119 UTC i.e 07 minutes after the accident.

Follow me Jeep reached at the accident site at 2117 UTC and first fire fighting vehicles reached aircraft at 2137 UTC. Passengers were evacuated using step ladder from L1 door at 2150 UTC and 03 passengers received minor injuries.

As per METAR, at 2100 UTC the visibility was 4000 meters which reduced to 3000 meters at 2130 UTC. ATC informed IX 452 crew before landing regarding rains and runway surface as wet. Crew after landing informed ATC that runway was sighted at 1000 feet. RVR Equipment was not installed at Cochin Airport.

3. CONCLUSIONS

3.1 Findings:

1. The Certificate of Airworthiness, Certificate of Registration and Certificate of Flight Release of the aircraft was current/valid on the date of accident.
2. Both pilots were qualified on type to operate the flight.

3. The landing was carried out by PIC and Co-pilot was PM for the flight.
4. Aircraft touched down at 210715 UTC at distance of 4900 feet from starting of runway 27 in rains and vertical acceleration varied from 0.81 to 1.114.
5. Due to late touchdown, aircraft vacated C2 instead of C3. The aircraft was given taxi clearance to bay 23L via C-F-L.
6. While taxiing, co –pilot informed PIC about passing taxiway "E" and next is "F".
7. Co-pilot advised PIC who was taxiing to go extremely slow because the marking were not seen and insisted on calling "Follow Me" jeep also. However, there was no response from PIC.
8. Ground speed at 210947 UTC was 4.5 knots which increased to 9 knots at 211123 UTC.
9. Co-pilot again informed PIC that she cannot see any markings. However, there was no response from PIC.
10. At 2112 UTC, the aircraft took a 90 m early turn before the Taxiway 'F' at Taxiway C (between E and F) and entered into open rain water drain.
11. During landing and Taxiing, Windshield wipers were used.
12. PIC applied throttle three times for aircraft to come out of the drain, but aircraft stuck into the drain. Co- Pilot requested PIC not to apply throttle.
13. The accident occurred at 2112 UTC (0242 IST) which is window of circadian low (WOCL) cycle.
14. Alternate Taxiway C blue lights and Taxiway Sign Board lights were on at the time of accident.
15. As it was raining, there are chances that the pilot may have been influenced by "blue sea effect" resulting in missing the actual exit.
16. During last 8 Month, PIC had operated 05 flights to / from Cochin whereas Co-pilot operated regular flights to/from Cochin.
17. "Follow Me" Jeep reached at the accident site at 2117 UTC and first fire fighting vehicles reached aircraft at 2137 UTC.
18. Taxiway C centreline was painted in March 2017 and was barely visible. There were no Taxiway centerline lights nor Retro reflective Markers / Delineation Markers near drains.
19. During the simulation of accident scene on 05-09-2017 by another Air India Express aircraft, Taxiway C centreline was barely visible.
20. The visibility at the time of accident was 4000 meters which reduced to 3000 meters. However, ATC asked crew after touchdown that at what height the runway was sighted, which Co-pilot replied as 1000 feet.
21. RVR equipment/ SMR was not installed at Cochin Airport.
22. Tower controller was situationally not aware of the accident and handed over watch at 2130 UTC.
23. WSO was on ATC Channel till 2125 UTC and made a logbook entry regarding the accident at the same time i.e. 2125 UTC and didn't reach the tower till 2130 UTC.

3.2 Probable cause of the Accident:

The probable cause of accident is "Incorrect judgement taken by PIC for initiating left turn short of the taxi track link (before Taxiway F), during night, in rain during reduced visibility conditions thus resulting the aircraft entering in open rain water drain.

Contributory factors

1. Taxiway C centre line was barely visible during night in rains in reduced visibility conditions.
2. Dis-agreement of PIC with Co-pilot for requesting "Follow Me" jeep at Taxiway C.
3. Window of circadian low of PIC.

4. Safety Recommendations:

4.1 DGCA

1) In the interest of Safety, RVR Equipment shall be installed at airports where night landing of Scheduled Airlines is carried out.
2) DGCA may issue circular, highlighting this accident and advising pilots to take "Follow Me" jeep wherever required.

4.2 M/s Air India Express:

1) M/s Air India express shall ensure proper crew pairing taking into consideration age factor, experience etc.
2) M/s Air India Express may issue circular regarding proper crew coordination.

4.3 Aerodrome Operator (CIAL):

1) The Aerodrome Operator, CIAL shall repaint the taxiway markings with Fluorescent material and put additional conspicuous markings on the taxiways.
2) CIAL shall sensitize its operational staff to avoid use of Vernacular/Non Standard language during coordination with ATC.
3) All the CCTV cameras installed at the Apron side should be synchronized and time difference should be removed.
4) Frequency of "Follow Me" jeep as well as Operational Jeep for spot inspection should be augmented.
5) The drains may be properly illuminated and the obstructions to be indicated.
6) CIAL may also explore the possibility of installing the centreline lights for taxiway C for better visibility.

4.4 AAI

1. The duty Tower Controller shall be given corrective training for not maintaining surveillance over the aircraft, lack of situational awareness, handling such emergency situations and to follow laid down SOP's.
2. All Controllers including WSOs shall be counselled & sensitized to avoid use of Non Standard Phraseology and insist on using Standard ICAO Language. AAI may see the feasibility of installing SMR in the interest of safety.

18/4/19

(Dr. Jitender Loura)
Deputy Director of Operations
Investigator, VT-AYB

18/4/19.

(Raje Bhatnagar)
Assistant Director Airworthiness
Investigator, VT-AYB

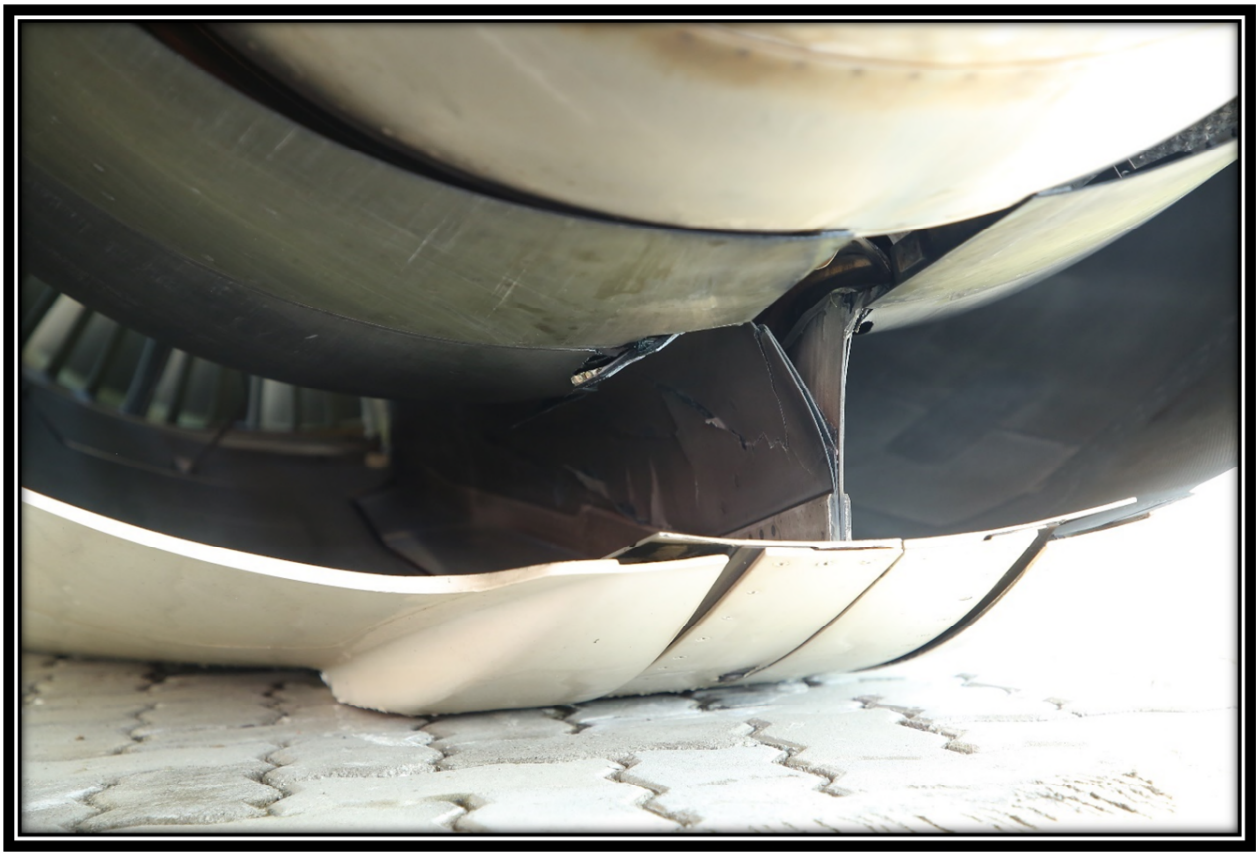
Amit Gupta 18/4/2019

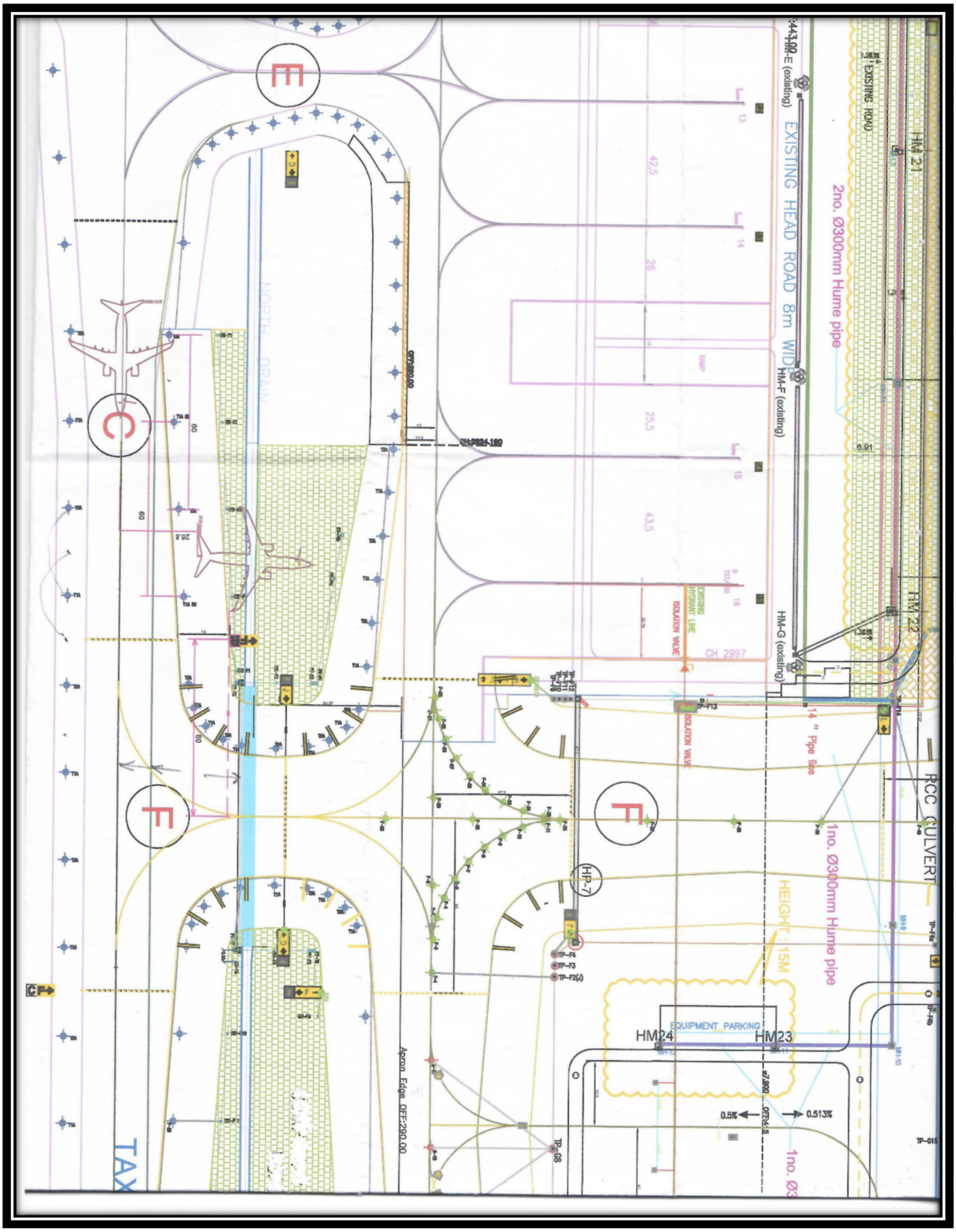
(Amit Gupta)
Director(AED)
Investigator in-Charge, VT-AYB

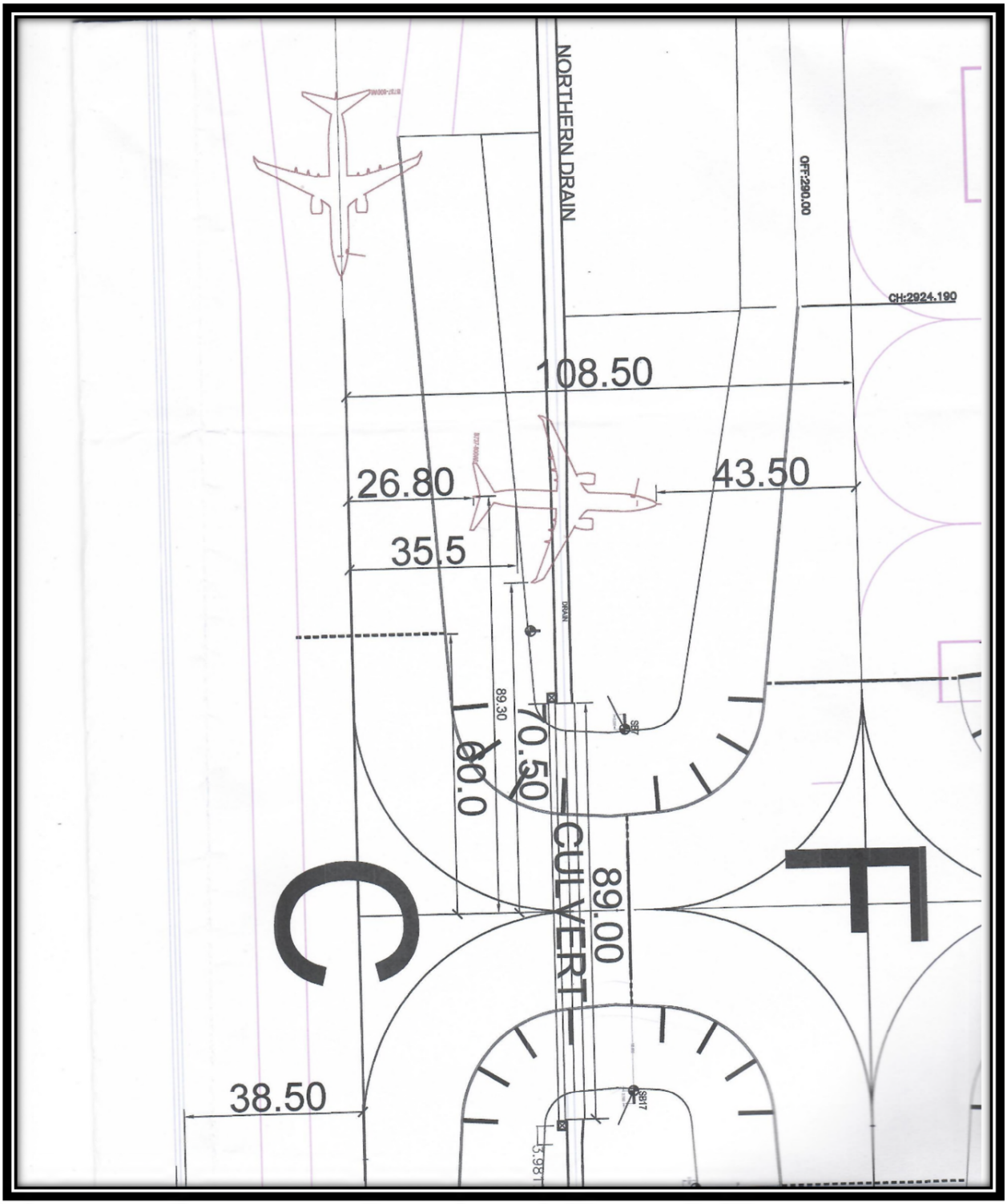
Date: 18-04-2019
Place: New Delhi


AIR INDIA
express
www.airindiaexpress.in


www.airindiaexpress.in




E
C
F
F
NORTH DRAIN
EXISTING HEAD ROAD 8m WIDE
HM-F (existing)
HM-G (existing)
EXISTING ROAD
HM 21
HM 22
2no. Ø300mm Hume pipe
14 " Pipe line
RCC CULVERT
1no. Ø300mm Hume pipe
HEIGHT : 15M
EQUIPMENT PARKING
HM24
HM23
HP-7
Apron Edge OFF:290.00
0.5%
0.513%


NORTHERN DRAIN
OFF:290.00
CH:2924.190
108.50
26.80
43.50
35.5
89.30
70.50
90.0
CULVERT
89.00
38.50
SB16
SB17
3.98