Final report
on the

INVESTIGATION OF RUNWAY EXCURSION ACCIDENT OF TURKISH AIRLINES TC-JOC, A330-303, AT TIA, KATHMANDU, NEPAL ON 4th MARCH 2015

SUBMITTED BY:

Accident investigation commission (TC-JOC, A330-303) 2015

TO:

The Government of Nepal
Ministry of culture tourism and Civil Aviation

After the accident the Government of Nepal constituted an Aircraft Accident Investigation Commission to determine the cause and the circumstances of the accident as per the provision of the Aircraft Accident Investigation Regulation (2071 B.S.) 2014. The Commission conducted the investigation based on the principle of ICAO Annex 13. The sole objective of the investigation of this accident is the prevention of recurrence of similar nature of accidents in future. It is not the purpose of this investigation to apportion blame or liability to anyone.

FOREWORD

This final Report on the accident (on 4 March 2015, at Tribhuvan International Airport of Nepal) of the Scheduled Flight of Turkish Airlines TC-JOC, A330-303 (Airbus) aircraft has been prepared by the Aircraft Accident Investigation Commission constituted by the Government of Nepal, Ministry of Culture, Tourism and Civil Aviation (on 4 March 2015), in accordance with Annex 13 to the Convention on International Civil Aviation and Civil Aviation (Accident Investigation) Regulation, 2071 B.S. to identify the probable cause of the accident and suggest remedial measures so as to prevent the recurrence of such accidents in future.

The sole objective of the investigation of this accident is the prevention of accidents of similar nature in future. It is not the purpose of this investigation to apportion blame or liability.

The Commission carried out thorough investigation and extensive analysis of the available information and evidences, statements and interviews with concerned persons, study of reports, records and documents etc.

The Commission in its final report presented safety recommendations to be implemented by the Civil Aviation Authority of Nepal, Turkish Airlines, LIDO and Department of Hydrology and Meteorology respectively.

_____
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Former Secretary, Government of Nepal

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Date: 2015/10/06 (2072/6/19)

Table of Contents

List of Abbreviations

Synopsis

Operator:	Turkish Airlines
Aircraft Type and Model:	Airbus 330-303
Registration:	TC-JOC
Type of Flight:	International Public Transport of passengers, TK-726
Accident Location:	Tribhuvan International Airport, Kathmandu, Nepal N 27° 41'46" E 85°21' 29"
Persons on board:	Flight Crew- 2, Cabin Crew-9, Passengers-224
Date and Time of Accident:	4th March 2015 at 01:59hrs All times in this report are UTC

On March 4th 2015, Turkish Airlines Flight TK-726 experienced a runway excursion whilst landing at Tribhuvan International Airport (TIA) at 01:59 hrs. TK-726 was operating a scheduled passenger flight from Istanbul to Kathmandu with a total of 224 passengers with 11 crew members (2 Cockpit and 9 cabin crew). During landing the aircraft touched down towards the left edge of Runway 02 with the left hand main landing gear off the paved runway surface. The aircraft veered further to the left and came to a stop on the grass area between taxiway D and C. All passengers were evacuated safely after a brief period of time. There was no injury to passengers and crew. Fire did not occur at the time of accident.

The accident was notified to the International Civil Aviation Organization (ICAO), BEA France, and Turkey Aircraft Accident Investigation Board as per the standard of ICAO Annex 13.

The Government of Nepal constituted an Aircraft Accident Investigation Commission to determine the cause and the circumstances of the accident as per the provision of the Aircraft Accident Investigation Regulation (2071 B.S.) 2014.

In accordance with the provision of the ICAO Annex 13 French, Turkish and Singaporean Investigators are associated with this investigation.

The probable cause of this accident is the decision of the flight crew to continue approach and landing below the minima with inadequate visual reference and not to perform a missed approach in accordance to the published approach procedure.

Other contributing factors of the accident are probable fixation of the flight crew to land at Kathmandu, and the deterioration of weather conditions that resulted in fog over the airport reducing the visibility below the required minima.

Twenty one safety Recommendations are made for advancement of aviation safety.

1 Factual Information

1.1 History of the flight

On 3rd March 2015 Turkish Airlines flight TK-726 with registration No. TC-JOC departed from Istanbul at 18:18 hrs on a scheduled flight to Tribhuvan International Airport (TIA), Kathmandu with 11 crew members and 224 passengers .The aircraft started contacting Kathmandu Control from 00:02 hrs to 00:11hrs while the aircraft was under control of Varanasi and descending to FL 250 but there was no response because Katmandu Control was not yet in operation (refer to para 1.11.1 for operation hours of the various communication facilities). The airport opened at its scheduled time of 00:15hrs. The aircraft established its first contact with Kathmandu Approach at 00:17 hrs and reported holding over Parsa at FL 270. Kathmandu Approach reported visibility 100 meters and airport status as closed. At 00:22 hrs the aircraft requested to proceed to Simara due to moderate turbulence. The Kathmandu Approach instructed the aircraft to descend to FL 210 and proceed to Simara and hold. At 01:05 hrs when Kathmandu Approach provided an updated visibility of 1000 meters and asked the flight crew of their intentions, the flight crew reported ready for RNAV (RNP) APCH for runway 02.

The aircraft was given clearance to make an RNP AR APCH. At 01:23 hrs when the aircraft reported Dovan, Kathmandu Approach instructed the flight crew to contact Kathmandu Tower. Kathmandu Tower issued a landing clearance at 01:24 hrs and provided wind information of 100° at 03kts. At 01:27 hrs the aircraft carried out a missed approach due to lack of visual reference. The aircraft was given clearance to proceed to RATAN hold via MANRI climbing to 10500 feet as per the missed approach procedure. During the missed approach the aircraft was instructed to contact Kathmandu Approach.

At 01:43 hrs the aircraft requested the latest visibility to which Kathmandu Approach provided visibility 3000 m and Kathmandu Tower observation of 1000 meters towards the south east and few clouds at 1000 ft, SCT 2000 ft and BKN 10000 ft. When the flight crew reported their intention to continue approach at 01:44 hrs, Kathmandu Approach cleared the aircraft for RNAV RNP APCH runway 02 and instructed to report RATAN. The aircraft reported crossing 6700 ft at 01:55 hrs to Kathmandu Tower. Kathmandu Tower cleared the aircraft to land and provided wind information of 160° at 04 kts. At 01:57 hrs Kathmandu Tower asked the aircraft if the runway was insight. The aircraft responded that they were not able to see the runway but were continuing the approach. The aircraft was at 880 ft AGL at that time. At 783 ft AGL the aircraft asked Kathmandu Tower if the approach lights were on. Kathmandu Tower informed the aircraft that the approach lights were on at full intensity.

The auto-pilots remained coupled to the aircraft until 14 ft AGL, when it was disconnected, a flare was attempted. The maximum vertical acceleration recorded on the flight data recorder was approximately 2.7 G. The aircraft pitch at touchdown was 1.8 degree nose up up which is lower than a normal flare attitude for other landings.

From physical evidence recorded on the runway and the GPS latitude and longitude coordinate data the aircraft touched down to the left of the runway centerline with the left hand main gear off the paved runway surface.

The aircraft crossed taxiways E and D and came to a stop on the grass area between taxiway D and C with the heading of the aircraft on rest position being 345 degrees (North North West) and the position of the aircraft on rest position was at N 27° 41' 46", E 85° 21'29"

At 02:00 hrs Kathmandu Tower asked if the aircraft had landed. The aircraft requested medical and fire assistance reporting its position at the end of the runway. At 02:03 hrs the aircraft requested for bridge and stairs to open the door and vacate passengers instead of evacuation. The fire and rescue team opened the left cabin door and requested the cabin attendant as well as to pilot through Kathmandu Tower to deploy the evacuation slides.

At 02:10 hrs evacuation signal was given to disembark the passengers.

1.2 Witness Information:

At 02:00 hrs a domestic aircraft which was taxiing on the parallel taxi way in between taxi way C and D for runway 02 reported that the visibility condition was almost zero. While returning to the domestic bay it also heard the fire vehicle informing the Kathmandu Tower that Turkish Airlines had landed on the grass.

A soldier at the security post nearby the runway 02 threshold reported that because of the moving fog, he could not see the aircraft but heard the unusual loud sounds during the second landing.

1.3 CCTV recording from outside the international terminal toward Airside:

A review of CCTV camera footage, installed at different locations of airside areas, showed that the weather had deteriorated during the second approach into Kathmandu as compared to the first approach. Landing clearance was issued by the Kathmandu Tower at 01:55:48 hours. At that time it was observed from the CCTV camera footage that the visibility already started deteriorating and by the time of landing the visibility was well below the prescribed minima. The tower did not provide the deterioration in visibility to the aircraft

The photos captured from different CCTV Footages are as shown below.

Picture by CCTV Footage camera A-67 Sd83X1 channel at 01:22 Hrs,

First Go around

Picture by CCTV Footage B-91. SD73X3 Channel 1 Fire N at 01:21 Hours

First Go around

Picture by CCTV Footage C-67,Sd83X1 Channel 1 at 01:56 Hours,

Seen one Domestic Aircraft Taxiing

Picture by CCTV Footage E-74, FD 7141 Channel 1 Cargo at 01:58 Hours,

Weather Just before the Aircraft Landing

1.4 Injuries to persons

Injuries to Persons:

Injuries	Crew	Passengers	Others
Fatal	-	-	–
Serious	–	–	–
Minor	_	1*	_
			–
Total	2+9	224	

(*): All passengers were safely evacuated via emergency slides and one passenger was slightly injured during the emergency evacuation.

1.5 Damage to the aircraft

A damage assessment of the accident aircraft as viewed from ground was carried out and its finding were as follows:

– Nose landing gear was completely collapsed and inserted into the nose well.
– Nose section of fuselage was dragged on the ground and multiple wrinkles were observed on fuselage from nose to angle of attack probe

location.

- Belly fairings on both sides of fuselage were damaged.
- Multiple foreign objects damage was seen on the right hand inboard slat.
- Left & right engines had sustained major damage and pylon bended. Thrust reversers were fully deployed, left and right fan cowl were out from engine, inlet cowls were severe damaged, and severe damages were found on fan blades.
- On the left main landing gear all the wheels were broken and out from its hubs, hydraulic fluid leakage observed.
- On the right main landing gear, three wheels were severely damaged and flat, strut door had substantial damage.
- Aircraft was completely out from runway and lying on grass field.
- Significant holes were found on the top of the inboard wing

Damages on frames were:

- Frame 10-13 noticeable damage.
- Frame 13-24 sustained major damage.
- Below S43R, avionics compartment damage, including damage on radio altimeter antenna, ground electric connection and interphone service.

Nose LG collapsed and inserted inside the wheel well

Left Engine of the Aircraft

Left Engine Side view Front View

Right Engine

Right Engine front view, side view

Several damages were also observed on the Fuselage:

RH side of the Belly Fairing

behind of the NLG bay

Belly of the aircraft--Fairing

Wrinkles in the Body of the Aircraft

The NLG separated from aircraft (RH hinge pin sheared off):

Inlet, fan and reverse cowls were sheared off on both Engines:

Eng #1 Eng #2

1.6 Other damage

1.6.1 Damage to the Lights:

Taxiway Edge Light – Taxiway E -4 nos.

Taxiway Edge Light – Taxiway D -4 nos.

Runway Edge Light -5 nos. (Taxiway D & E Area)

Some of the transformer (Hand hole) secondary and connection cable on that area was damaged.

1.6.2 Damage to the Signage

Take Off Distance Remaining Signage (1770m)

Take Off Distance Remaining Signage (2242m)

Take Off Distance Remaining Signage (1281m)

Broken lights and signage were meet frangibility criteria.

1.6.3 Damage on Runway/ Taxiway:

No significant Runway/Taxiway damage observed on preliminary observation. There were some minor scratches seen on Taxiway D pavement.

Right Landing gear Marking on the Runway just before entering into the grass area

Both Landing Gears of aircraft rolling outside the runway in Grass area

1.7 Personnel information

1.7.1 Commander/ Pilot-in-Command

Age:	55 years	
Gender:	Male	
Type of License:	ATPL	
Aircraft Rating:	A330	
License Proficiency Check:	Valid to June 2015	
Instrument Rating:	Valid to June 2015	
Operator's Line Check:	Valid to 7 April 2016	
Medical Certificate:	Valid to 5 July 2015	
Flying Experience:	Total all types	14942 hours
	On Type:	1456 hours
	Last 90 days:	191 hours
	Last 30 days:	63.67 hours
	Last 24 hours:	00.00 hours
Previous rest period:	93:51 hours	

1.7.1.1 Background of Pilot -in -Command

Captain joined the Turkish Airline on 26/11/2004 and promoted as Captain on 26/08/2007. He had been flying A-330 since June 2013 to March 2015.Previously, he had flown A310 and B737/300-800 in Turkish Airlines. Prior to joining Turkish airlines he had flown F4, F100, T34 and Boeing 757 and

A300B4 for other air operators as well as Turkish Air Force. He held an appropriate and current medical categories of class I and class II which is valid till 05/07/2015. He had been given special purpose training of RNAV/RNP KTM in simulator on 29th Jan 2015. This was the first time the Captain operated into Tribhuvan International Airport (TIA) of Kathmandu. The commander's last flying duty before the accident was on 27 Feb 2015 IST-ADB-IST.

1.7.2 Co-pilot

Age:	47 years	
Gender:	Male	
Type of License:	Commercial Pilot's License (With frozen ATPL)	
Aircraft Rating:	A330	
License Proficiency Check:	Valid to Nov. 2015	
Instrument Rating:	Valid to May 2015	
Operator's Line Check:	Valid to 14 April 2016	
Medical Certificate:	Valid to 29 July 2015	
Flying Experience:	Total all types	7659 hours
	On Type:	1269 hours
	Last 90 days:	222 hours
	Last 30 days:	75 hours
	Last 24 hours:	02 hours
Previous rest period:	22 hours	

1.7.2.1 Background of Co-pilot

Prior to joining the Turkish Airlines, he was flying various aircrafts including helicopter for Turkish Air Force. He was trained in Cessna 172 and 402 with frozen ATPL and ATR-72-500 for other air operator. The copilot had joined the Turkish Airlines on 15th August 2011 as a co-pilot with frozen ATPL. After joining the Turkish Airlines, he had been engaged in flying Boeing 737/300-900 and Airbus A330. He held an appropriate and current medical categories of class I and class II which is valid till 29/7/2015. He had been given special purpose training of RNAV/RNP KTM in simulator on 30/01/2015. The duty record shows that he had not been flying as active crew member to Tribhuvan International Airport Kathmandu within the three months period. His last flying duty before the accident was on 02 March 2015 from Istanbul, IST-LHR-IST.

1.8 Aircraft information:

1.8.1 General Information:

Manufacturer:	Airbus Company, France
Type:	A330-303
Aircraft Registration Number:	TC-JOC
Aircraft Manufacturing Serial Number:	1522
Year of manufacture:	2014
Owner of the Aircraft:	Yamasa Aircraft TK 10 Kumiai 362-1 Takao, Nilimi city Japan
Operator of Aircraft:	Turkish Airlines INC Istanbul Turkey
Number and type of engines:	2 & CF6-80E1A3
Left Engine Serial No.:	811693
Right Engine Serial No.:	811694
Total airframe hours:	4139 hours
Landing Cycle:	732
Certificate of Registration Number:	2916 (Given by DGCA Turkey)
Certificate of Airworthiness review:	Valid up to 29-05-2015

1.8.2 Maintenance History of Aircraft:

This aircraft has undergone standard maintenance as per maintenance program Document No. EK 50-105 Revision 17 as approved by DGCA Turkey on 17 Oct 2014. The aircraft maintenance history was reviewed and there were not considerable repetitive problems reported by the aircraft. The aircraft was serviceable.

1.8.3 Accident site evidence

Based on the evidence available at the site of accident, as well as, from the

information from the FDR/CVR, ATC Transcript, Radar information, there was no evidence of any pre-impact fire, aircraft failure, or explosion and the total aircraft appeared to be within the main accident site

1.8.4 Engineering aspect:

The aircraft maintenance Log Books for the last three month and ACARS messages reported by aircraft itself revealed that there were not considerable problems on aircraft and also no repetitive problems were found. Certificate of airworthiness and certificate of release to service (CRS) of aircraft are found valid. It has been found that maintenance of aircraft has been done with approved maintenance programme. Daily inspection and pre-flight inspection was done on 3 March 2015 at 17:45 hrs by Maintenance Inspector having License Number 3725 before departure of flight TK 726 from Istanbul to Kathmandu. The FDR data showed that since last departure from Istanbul to landing at Kathmandu there were no master caution, master warning also there were no any ECAM warning, caution and system failure messages. Pilot and co-pilot written and verbal reports showed that there was not any technical problem on the aircraft.

1.9 Meteorological information

1.9.1 METAR

Time (UTC)	Wind	Visibility	Weather	Clouds	Temp.	QNH	TREND
040020	00000kt	4000m 1000 m S/E		Few 020	07/07	1014	No Sig.
040050	00000kt	3000m 1000 m S/E		Few 010 SCT 020 BKN-100	06/06	1014	No Sig.
040120	00000kt	3000 1000 m S/E		Few 010 SCT-020 BKN-100	07/07	1015	No Sig.
040150	00000kt	3000m		Few 010 SCT-020 BKN-100	07/07	1015	No Sig.
040220	00000kt	0200m	FG	Few 010 SCT-020 BKN-100	07/07	1015	No Sig.

1.9.2 Weather parameters at the time of Accident

a. Wind

Wind was almost calm, 1-2 knots, direction was variable.

b. Visibility

Prevailing visibility was fluctuating three thousand, south-east direction it was 1 km. At the time of accident visibility was 200 m.

c. Present weather

Fog and mist at the time of accident.

d. Cloudiness

Sky was obstructed by fog during mist the cloud few to scattered 2000 ft height.

e. Temperature and humidity

Temperature was between 5 and 8 degrees Celsius and air was very humid, dew point was same as temperature.

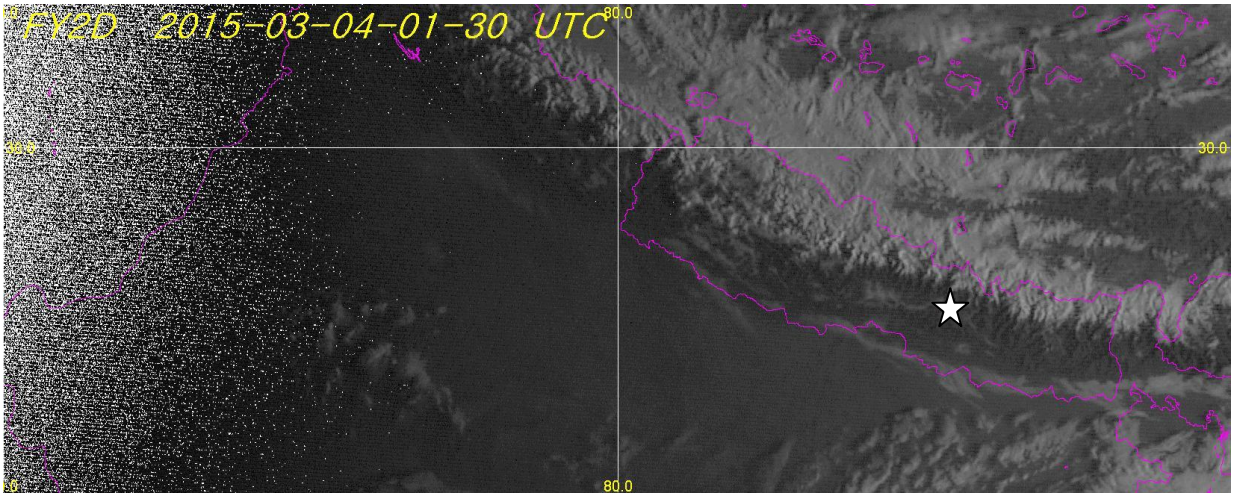
f. Meteorological Conclusion

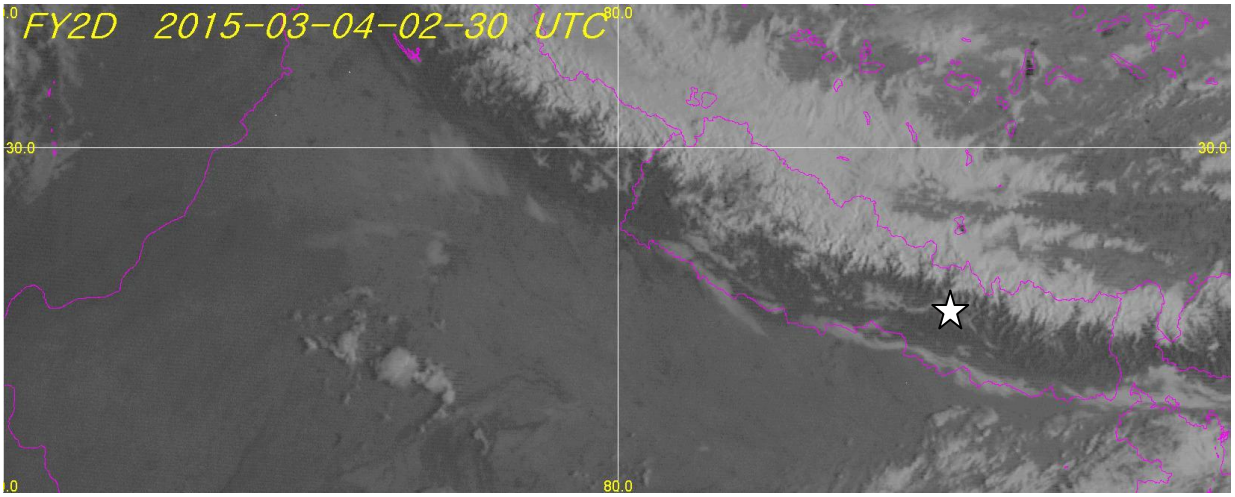
Only poor and fluctuating visibility.

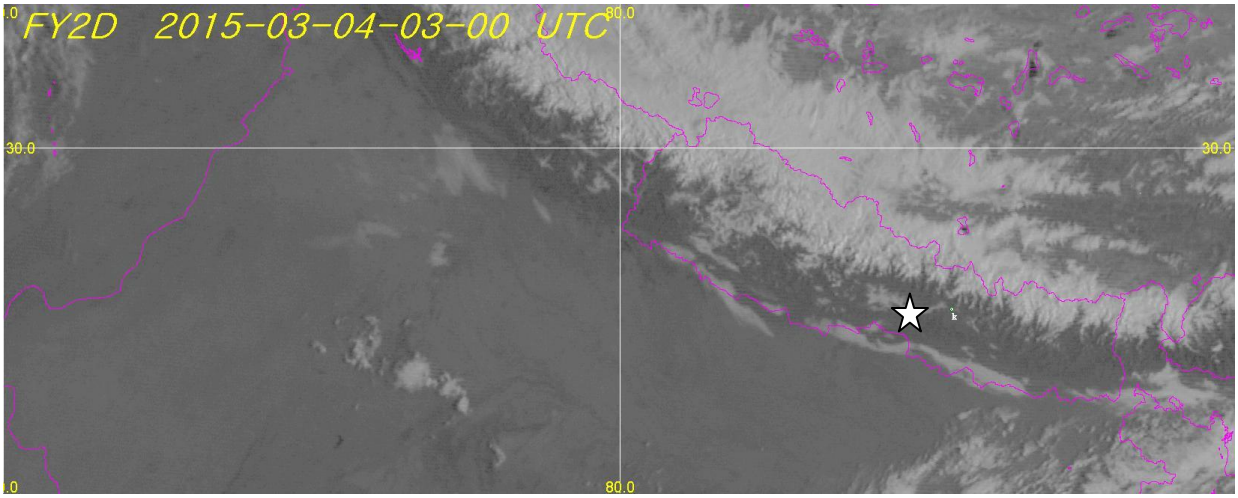
1.9.3 Satellite Images of Weather

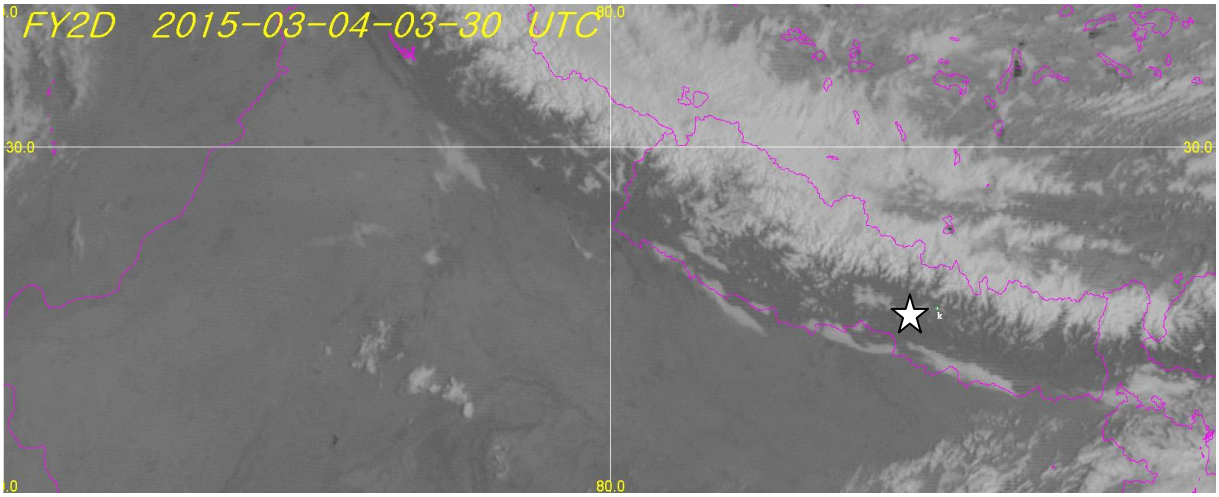
The infrared imagery for 0230 hrs showed the partly cloudy condition in the eastern hilly region of Nepal and central and eastern high mountainous region. Moreover, the visible imagery showed the isolated foggy condition in the southern most border of Tarai belt of Nepal.

The infrared satellite images for 0130 hrs, 0230 hrs, 0300 hrs and 0330 hrs are shown below.









(☆ -- Location of Airport)

(Source of Satellite Image and Interpretation: Meteorological forecasting Division, Government of Nepal)

1.9.4 Provision of METAR and Tower Observation by MET Office & ATC:

It is noted that the MET Office did not disseminate the SPECI representing deterioration in visibility in accordance with the ICAO Annex 3. Similarly Kathmandu Tower also did not provide the latest tower observation representing deterioration in visibility to the aircraft. During the interview with ATC working at TIA it was observed that most of the ATCs at TIA Kathmandu were not provided with refresher training at regular interval.

1.10 Aids to Navigation:

Kathmandu International Airport is equipped with navigation aids like VOR/DME and NDB and RADAR as a surveillance aid. As per the flight inspection report conducted in April and May, 2014, by Flight Inspection Services Bureau of Aerothai, Kathmandu NDB, VOR/DME and RADAR are certified for operation.

A PAPI is installed at Kathmandu as landing aids for runway 02. As per the flight inspection report of May 7, 2014 Kathmandu PAPI is certified for operation and that day the operation of PAPI was normal.

The Radar showed that during second approach, the aircraft profile was normal as compared to a normal approach.

1.11 Communications

1.11.1 Communication facilities

Service Designation	Call Sign	Frequency	Hours of Operation	Remarks
TWR	Kathmandu Tower	118.1 MHZ	0015-1845	
SMC	Kathmandu Ground	121.9 MHZ	0015-1845	
APP	Kathmandu Approach	120.6 MHZ 125.1 MHZ	0015-1845	
ACC	Kathmandu Control	126.5 MHZ 124.7 MHZ	0015-1845	
ATIS	Kathmandu Terminal	127.0 MHZ	0015-1845	

A/G	Kathmandu Radio	6607 KHZ	0015-1245	For Domestic Flights

1.11.2 Communications

The aircraft started contacting Area Control from 00:02:20 hrs to 00:11:23 hrs while under control of Varanasi and descending to FL 250 but there was no response because the airport was not opened. The communication facilities and the airport only open at 00:15 hrs.

The aircraft established contact with Kathmandu Approach at 00:17 hrs and reported holding over Parsa at FL 270. Kathmandu Approach reported a visibility of 100 meters and the airport was closed.

As per the pilot report the flight crew did not get ATIS information on the published frequency. It was also found that the status of ATIS was not reflected in the daily inspection form of the TIA.

1.12 Aerodrome information

1.12.1 General Information:

Tribhuvan International Airport (TIA) is the only International airport of Nepal serving both Domestic and International flights, it is situated at an elevation of 4390 ft. AMSL.

Runway 02/20 is a paved runway with a length of 10,000ft.and a width of 150 ft. Runway 02 has high intensity approach runway lighting and equipped with a PAPI that provides glide path information. The threshold height of runway 02 is 4318 ft AMSL.

1.12.2 Standard Instrument Arrivals:

The RNAV (RNP) Approach procedure for Kathmandu airport was designed in accordance with the criteria as stipulated in the ICAO PANS-OPS (DOC 8168) Vol. 2: and ICAO RNPAR Manual (DOC. 9905). The RNAV (RNP) Instrument Approach Procedure for Kathmandu Airport was designed to enhance the overall safety of the operation by facilitating the aircraft energy management and to improve the airport access, while taking into account the ATC constraint.

Kathmandu Airport RNP AR APCH for RWY 02 chart includes the approach procedures for arriving aircrafts from west , south, and east sectors to RATAN Fix and then carry out the RNP AR APCH procedures as cleared by ATC to Initial Fix maintaining 8700 feet at KT 532 and continue to Final Approach Fix

(APP) KT 530. Then commence the approach from KT 530(14.4 DME) with full landing configuration till Minimum Descend Altitude (MDA)/ Minimum Descend Height (MDH) to Missed Approach Point (MAP).

The aircraft must initiate missed approach at Missed Approach Point (MAP) unless required visual reference has been established and the aircraft position and approach path have been visually assessed as satisfactory to continue the approach and landing safely. In case of missed approach, climb to 10500 feet and proceed to MANRI.

From the start of Turkish Airlines flight to Kathmandu since the end of 2014, Turkish Airlines did not have certification for RNP AR approach. Therefore Kathmandu flights were operated according to VOR/DME approach procedure.

Based on the requirements for RNP - AR authorization for foreign air carriers into Nepal, Flight Safety Standard Department (FSSD) issued approval to conduct RNP AR APCH at TIA, Kathmandu to Turkish Airline on 26th December 2014 in accordance with CAAN requirements. Since then Turkish Airlines was conducting RNP AR approach to Kathmandu airport with RNP-AR certified Airbus A330-300 aircraft.

1.13 Flight recorders:

1.13.1 CVR:

The CVR along with under water locator beacon (ULB) was installed on the aft section of the fuselage. CVR was in normal condition and there was not any sign of damage. The details of installed CVR on TC-JOC (A330-303) aircraft is as follows:

Part No.-980-6032-020

Serial NO.-CVR-02342

Manufactured by Honeywell INTL INC USA

ULB Battery expiry date-01 OCT 2019

Photo of CVR installed on TC-JOC aircraft

1.13.1.1 The CVR records:

- the direct conversion between crew members in cockpit
- all aural warning sound in cockpit
- audio communication received & transmitted
- intercom between crew members
- Announcement transmitted over the passengers if PA reception is selected on third audio control panel.

The last 2 hours recording of CVR- was retained.

1.13.2 Flight Data Recorder:

1.31.2.1 The details of flight data recorder installed on TC-JOC (A330-303) aircraft are as follow:-

Model Number: HFR5 FDR

Part Number: 980-4750-001

Serial Number: 02695

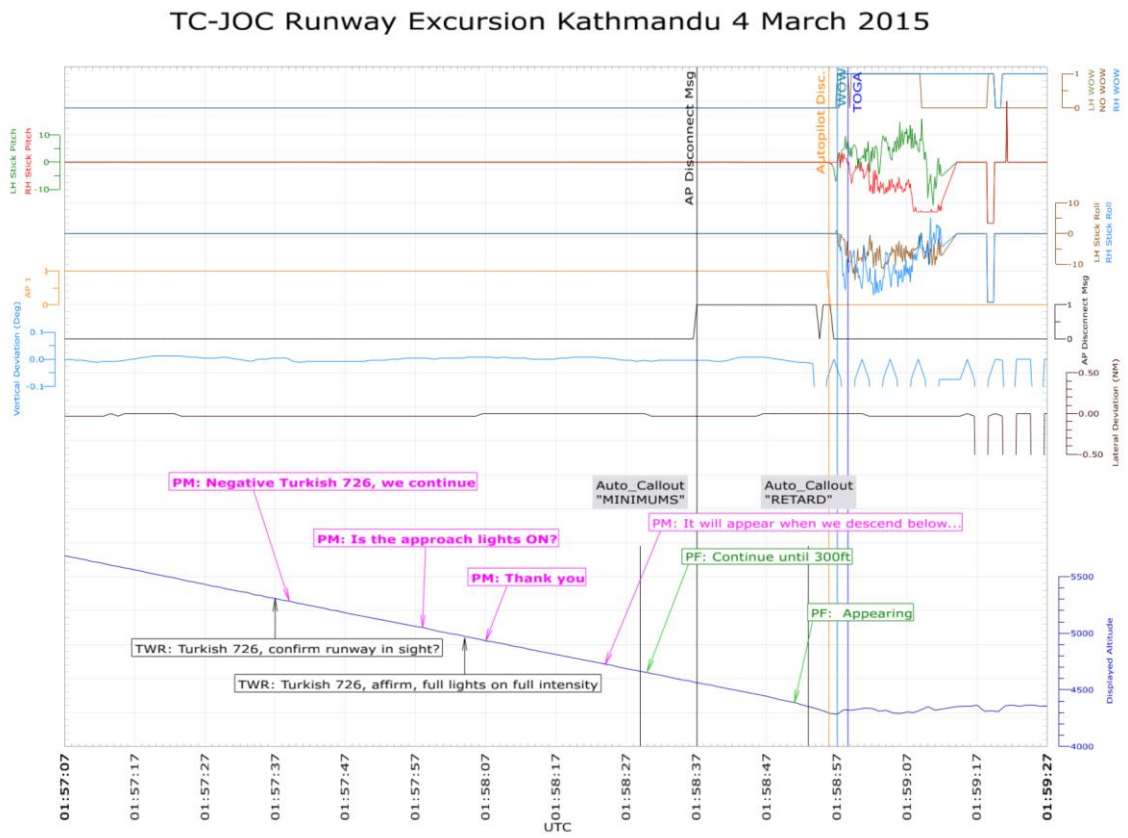
Manufacture by: Honeywell INTL INC USA

ULB Battery expiry Date: 01 DEC 2019

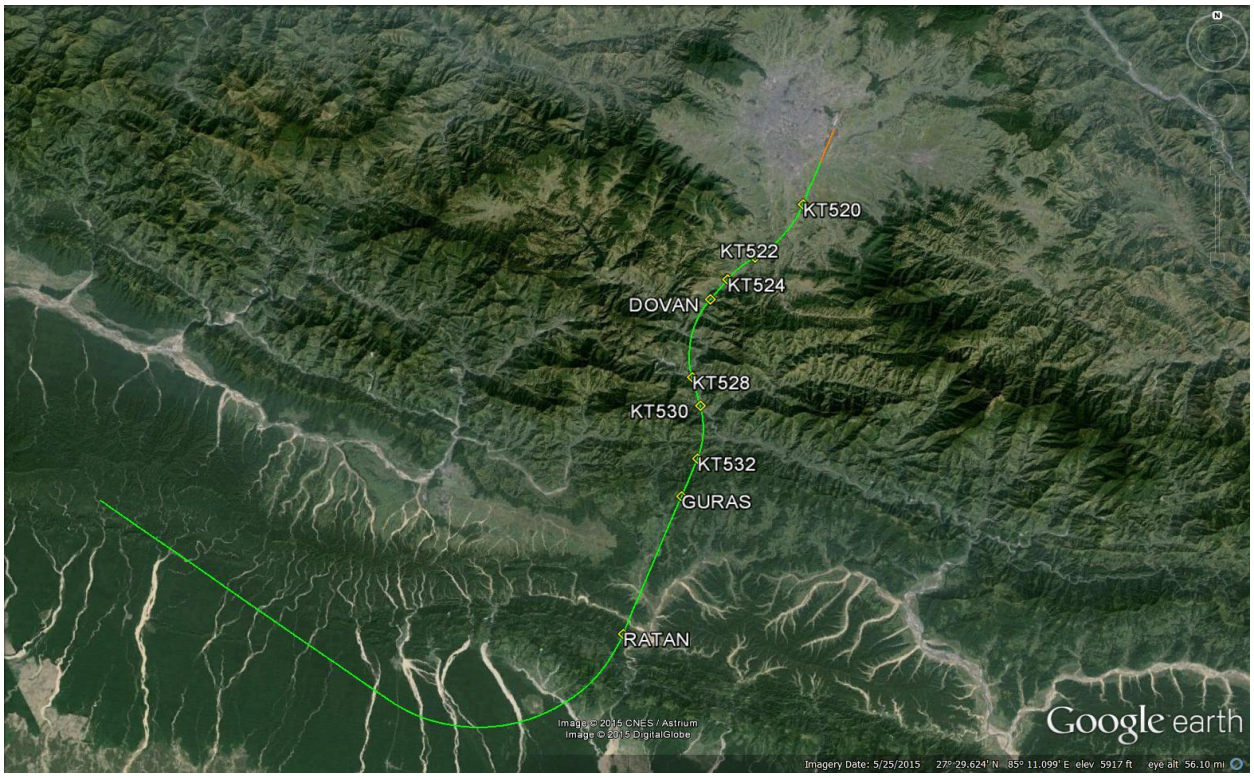
The recording quality of the - DFDR data was of good quality. The FDR contained 26 hours and 45 minutes of flight time. The FDR had 1469 parameters in the data frame file.

1.13.2.2 The FDR was installed on the aft section of the fuselage. The ULB was also attached to the FDR. The last 25 hours data was stored in the FDR. When the FDR was removed, it was in good condition and there was no any sign of damage and fire.

Photo of FDR in stalled on TC-JOC aircraft



Analysis chart of FDR Data



Picture showing the accuracy of the navigation based on FDR data

1.14 Wreckage and Impact Information

Initial touchdown of the right landing gear was 21.6 meters left from the runway centre line while the left landing gear was 32.1 meters left from runway centre line which was on unpaved field (grass field). The grass field was soft due to rain on previous day and night. The initial aircraft rollout after touchdown was with the right hand and nose landing gears on the paved runway and left landing gear on unpaved soft grass field. The maximum vertical acceleration recorded on the flight data recorder at touchdown was approximately 2.7G, so it was hard landing. The aircraft pitch at touchdown was 1.8 º nose up.

Due to the soft and muddy grass field, the left landing gear dug into the grass field and the aircraft veered toward the left. Initial touchdown mark of wheels and grass field dug by left landing gear is shown below.

Initial touchdown points of Left and Nose landing Gears

Initial touchdown point of left landing gear

Initial touchdown point of Nose landing gear.

Aircraft Final position in the Grass area between Taxiway C and D

The nose landing gear entered the grass field at 683.5 meter from the threshold of Runway 02 and right landing gear entered the grass field at 872.5 m from the runway threshold. While crossing the taxiway "D" the nose landing gear collapsed and the forward part of the fuselage started dragging on the grass field. Both engines touched on the ground. The aircraft halted at the position in-between taxiway "D" & "C". There was substantial damage to the aircraft and engines. The passengers and crew were safely evacuated using emergency evacuation system of aircraft with the assistance of fire and rescue team. Fire did not occur on the aircraft.

Aircraft halted position

1.15 Medical and pathological information

Blood samples of both pilots were taken after the accident and were tested. The results of all tests for drugs and alcohol were negative. There were no significant injuries to passengers.

1.16 Fire

Fire did not occur at the time of accident.

1.17 Survival aspects

The accident was non-fatal. All the passengers and crew were safe.

1.17.1 Rescue operations

The Airport fire watch tower was watching and monitoring the approaching aircraft. The aircraft was not visible by the watch tower because of moving fog. At 01:59 hrs it heard an unusual sound and accordingly alerted the fire crew & informed Kathmandu Tower as well. Kathmandu Tower made calls to the aircraft but there was no response. After a few seconds the pilot asked for fire and medical assistance. The command vehicle proceeded towards the runway 02 while in contact with Kathmandu Ground and saw the aircraft on soft grass in between taxiway D and C. Extinguishing agent (water) was discharged. There was fuel leakage from the left engine and hence blanketing it through the foam was done. Discharging through diffuser branch pipe on fog mode was also done after observing smokes from both the engines. 800 liters of foam and about 30000 liters of water were used by three fire vehicles.

At 02:00 hrs when Kathmandu Tower asked if the aircraft had landed. The aircraft requested medical and fire assistance giving its position at the end of the runway. At 02:03 hrs the aircraft requested for bridge and stairs to open the door and vacate passengers instead of evacuation. The fire and rescue team used the ladder in the fire vehicle to open the left cabin door and requested the cabin attendant as well as to pilot through Kathmandu Tower to deploy the evacuation slides.

At 02:10 hrs the evacuation signal was given to evacuate the passengers.

1.18 Tests and research

NA

1.19 Organizational and management information

Turkish Airlines is the national flag carrier airline of Turkey, headquartered at the Turkish Airlines General Management Building on the grounds of Ataturk Airport in Yesilkoy, Bakırkoy, Istanbul. As of February 2015, it operates scheduled services to 261 destinations in Europe, Asia, Africa, and the Americas, making it the fourth in the world by number of destinations. Istanbul Ataturk Airport is the main base of the company. It has been a member of the Star Alliance network since 1 April 2008.

1.20 Additional Information

1.20.1 FMS Navigation database for RNP AR Approach

The Approach flown that day by TK726 in KTM was the RNAV (RNP) RWY02 approach (Non Precision Approach).

This approach is a RNP-AR (0.3) Approach Procedure designed in accordance with the criteria as stipulated in the ICAO PANS-OPS (DOC 8168) Vol. II and ICAO RNP AR Manual (DOC 9905). AIRAC AIP Supplement (ref. S011/12 from 03 May 2012) of the Aeronautical Information Service (AIS) of the Civil Aviation Authority of NEPAL (CAAN) provides the way this approach should be coded in the FMS NAV Data Base. See below the extract of the Approach Coding Table:

W/P ID	P/T	TD	CRS (°) mag	DIST NM	ALT FT	SPD kt	FPA	RNP	RADIUS NM	ARC CTR ID
RATAN (IAF)	IF				AA 10500	230		0.3		
GURAS	TF			6,994				0.3		
KT532 (IF)	TF			1,900				0.3		
KT530 (FAF)	RF	L	022°	2,500	AT 8700	170		0.3	3,9	KTC21
KT528	TF			1,376			-2,8°	0.3		
DOVAN	RF	R	345°	3,840			-2,8°	0.3	4	KTC22
KT524	TF			1,200			-2,8°	0.3		
KT522	RF	R	040°	1,605			-2,8°	0.3	4,5	KTC23
KT520	RF	L	060°	3,320			-2,8°	0.3	4,9	KTC24
RW02 (MAPT)	TF			3,075	AA 4370		-2,8°	0.3		

As mentioned by this Approach Coding Table, the last point of the approach procedure is the MAPT of the RWY02 which is, in that case, at the threshold of the RWY02. This document provides also the coordinates of the RWY02 Threshold published at that time .

RW02	VN	CONV	27°41'02.0070"N	085°21'12.2150"E

On 01 January 2015, due to planned runway extension work the AIS CAAN published an AIRAC AIP supplement S001/15 for the enforcement of existing threshold to be displaced by 120m towards North from runway 02 and existing PAPI/PALS to be decommissioned among other matters to be effective from the 05 February 2015.

The coordinates of the displaced threshold given in this AIP Sup was: 27°41’06”N 085°21’13”E.
The prevailing coordinates of the threshold was: 27°41’02.007’’N 085°21’12.215’’E.

However, it appears that the coordinates of the displaced threshold were not on the runway centreline, but offset from about 26m on the left of the runway centreline. Below plot shows comparison between previous runway threshold coordinates with AIP supplement's based on Google Earth.

Another AIRAC AIP supplement S002/15 was issued on 29 Jan 2015 replacing the AIRAC AIP Sup S001/15 to correct some errors, but the coordinates of the runway threshold 02 and the effectivity date (i.e. 05 February 2015) were unchanged.

A NOTAM A0012 was issued at 0823 on 04 Feb 2015 to cancel the AIRAC AIP Sup S002/15 from 04 Feb 2015 at 2359 to 05 Feb 2015 at 2359. Then, a NOTAM A0013 was issued at 1014 on 04 February 2015 to cancel the AIRAC AIP Sup S002/15 from 05 Feb 2015 at 2359 till 04 March 2015 at 2359 (This NOTAM was published after the AIRAC cycle cut-off date). The FMS Nav DB providers updated the RWY02 THR coordinates as per AIP Supplement S002/15 and the NOTAM A0013 cancelling the AIP Supplement was not taken into account for the AIRAC cycle 04-2015 from 05FEB15 to 04MAR15.

Therefore, the RNAV (RNP) RWY02 approach coded in the FMS NAV Database applicable at the time of the event took into account the wrong RWY02 threshold.

It can be also observed that the error was not corrected on the next AIRAC cycle 05- 2015 as mentioned in the LIDO charts applicable on 06 MAR 2015 (AIRAC cycle 05-2015).

Another NOTAM A0028 was issued at 0857 on 1st March 2015 to cancel the AIRAC AIP Sup 002/15 from 4th March 2015 at 2359 to 3rd April at 2359. Finally on 01 April 2015, an AIP Supplement was issued cancelling the AIP supplement S002/15 which was eventually never implemented. This means that the threshold of RWY02 was never officially and physically displaced but the NAV Database were modified.

A report on calculation of threshold co-ordinate for AIRAC AIP Supplement was received from CAAN, which stated that software WGS-84 calculator downloaded from http:/www.mrsoft.ft/ohj02en.htm was used in calculation, for which origin and destination

co- ordinates from ANNEX 1 of AIP Nepal were used. The screen print of software is shown as below:

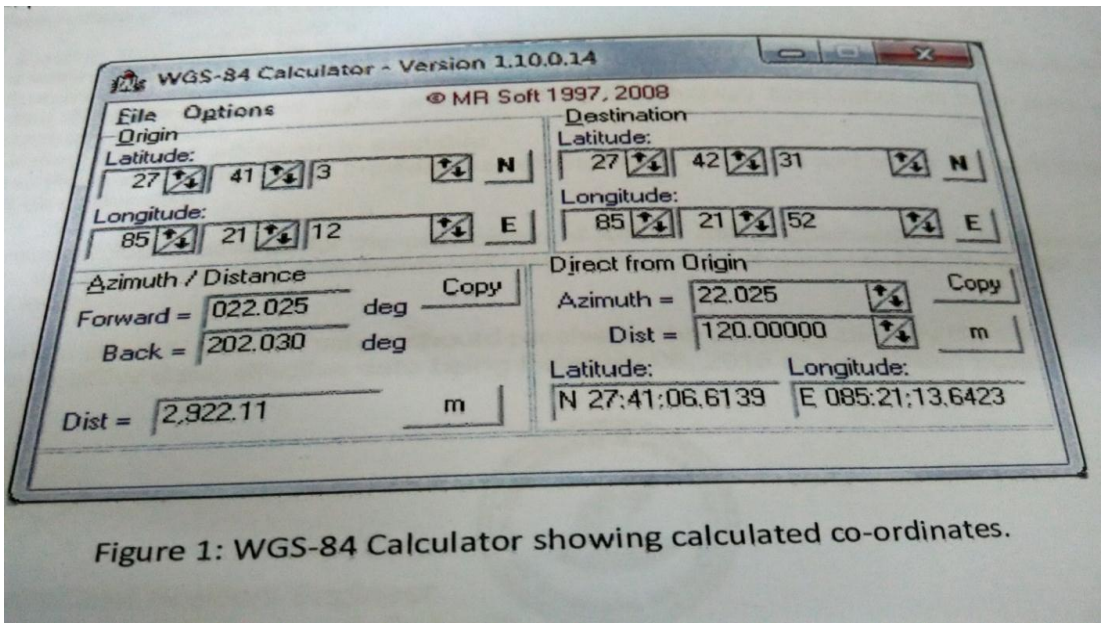


Figure 1: WGS-84 Calculator showing calculated co-ordinates.

As per the version of airline the runway coordinates for Kathmandu Airport as published by the CAAN in AIP SUP 01/2015 were given with a lower resolution compared to the runway coordinates published to 1/1000th of an arc second, whereas the coordinates in the supplement were in degrees, minutes and seconds. Bearing/Distance calculations showed that these published coordinates were not exactly lined up, but the published RW02 coordinates were slightly off to the left.

Then, a NOTAM A0013 was issued on 04 February 2015 to cancel the AIRAC AIP Sup S002 /15 till 04 March 2015 (this NOTAM was published after the AIRAC cycle cut-off date). The FMS Nav DB providers updated the RWY02 THR coordinates as per AIP Supplement S002/15 and the NOTAM A0013 cancelling the AIP Supplement was not taken into account for the AIRAC cycle 04-2015 from 05 FEB 2015 to 04 MAR 2015.

Therefore, the RNAV (RNP) RWY02 approach coded in the FMS NAV Database applicable at the time of the event took into account the wrong RWY02 threshold.

It can be also observed that the error was not corrected on the next AIRAC cycle 05-2015 as mentioned in the KTM JEPPESEN charts applicable on 06 MAR 2015
(AIRAC cycle 05-2015)

On March 2, 2015 i.e. two days before the accident the crews of the Turkish flight to Kathmandu reported through RNP AR MONITORING FORM that all the NAV. accuracy and deviation parameter were perfectly correct at MINIMUM but the real aircraft position was high (PAPI 4 whites) and left offset.

Validation

The FCOM PRO-SUP-22-30 "NAVIGATION DATABASE VALIDATION" reflects the requirements of the EASA AMC 20-26 - Airworthiness Approval and Operational Criteria for RNP Authorisation Required (RNP AR) Operations in terms of NAV Database validation, and mentioned the following:

RNAV(RNP) APPROACHES

To fly an RNAV(RNP) procedure (departure, approach, missed approach), the procedure stored in the Navigation Database must be both:

- produced by an approved supplier compliant with ED76/DO200A requirements, and
- validated and approved by the Operator.

1.20.2 STANDARD OPERATING PROCEDURES

According to FCOM PRO-NOR-SOP-18-C "APPROACH USING FINAL APP GUIDANCE FOR RNAV (RNP)" applicable at the time of the event, at minimum the flight crew should apply the following procedure:

AT ENTERED MINIMUM

MINIMUM.....MONITOR or ANNOUNCE

Below minimum, the visual references must be the primary reference until landing.

■ **If visual references are sufficient:**

CONTINUE.....ANNOUNCE

AP.....OFF

- *At minimum -50 ft, if the AP is still engaged, the message DISCONNECT AP FOR LDG pulses on the FMA to remind the flight crew that automatic landing is not available.*

FD.....OFF

- *The PF orders the PM to set both FDs off.*

TRK FPA.....SELECT

RUNWAY TRACK.....CHECK/SET

- *If needed, the PF orders the PM to set the runway track.*

■ **If visual references are not sufficient:**

GO AROUND.....ANNOUNCE

- *Initiate a go around.*

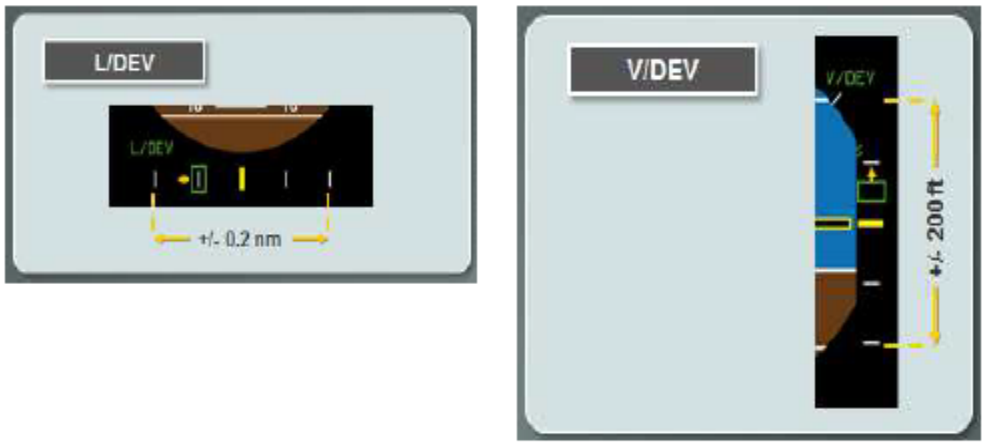
1.18.3 System Review:

FINAL APP MODE

The FINAL APP Mode is a fully managed (Vertical & Lateral) mode used in particular to fly RNAV (RNP-AR) approaches. The flight crew flies this type of approach with the following information on PFD:

Picture given as example (not representative of the event)

The L/DEV and V/DEV shows the deviation of the aircraft trajectory from the FMS trajectory coded in the NAV Database. The scales of these indications are the following:



Note: According to DFDR, the L/DEV and V/DEV information was displayed on both PFDs during the approach (Ref. DFDR parameters "CLATDEVD", "CVERTDEVD" for the captain's PFD and "FLATDEVD" and "FVERTDEVD" for the F/O's PFD).

As the Auto land is not authorized on Non-Precision Approach, the amber message "DISCONNECT AP FOR LDG" is displayed on the PFD if the AP remains engaged below MDA-50ft.

Picture given as example (not representative of the event)

This message pulses on the FMA during 9s then get steady to remind the flight crew that automatic landing is not available.

Note: According to DFDR, the FMA message "DISCONNECT AP FOR LDG" (DFDR parameter "APDISCLDG") was well displayed below MDA-50ft (i.e. 4600ft).

In accordance with the LIMITATIONS Chapter of the Aircraft Flight Manual (AFM), the minimum height for use of the AP for Non Precision Approaches is Minima.

2. Analysis

2.1 Operational analysis

During the interview after the accident for post flight incident report the pilots stated that they were visual with the approach lights of the runway at the Decision Altitude and continued the approach below the DA. According to the PF, during the final approach he momentarily lost visual contact with the runway but before he initiated a missed approach the runway became visual again and he decided to land. However from the following it appears as though there is a high probability that the visibility requirements were below that needed to continue the approach to land.

2.1.1 Weather information analysis

2.1.1.1 CCTV information about weather

The CCTV footage showed that at 01:58 hrs when the aircraft was approaching and landing during second approach, the visibility was almost zero. This visibility was much worse than the visibility when the aircraft was executing go-around at 01:22 hrs during first approach.

2.1.1.2 Witness information about weather:

The aircraft taxing on the parallel taxiway in between taxiway C and D for runway 02 for mountain flight reported that at time 01:58 hrs the visibility was almost zero. Similarly the army guard at the post near threshold runway 02 also reported the same visibility.

Based on the information available from different sources the weather at the time of accident was almost zero visibility. From this information it is concluded that the aircraft continued its approach below MDH without the proper visual reference contrary to the standard and procedure of RNAV (RNP) approach.

2.1.1.3 Cockpit resource management

When the "MINIMUM" auto-call out was annunciated at 01:58:30 hrs the PF responded "continue until 300 ft" which may imply that he was not visual with the approach lights at the decision altitude and wanted to continue below the decision altitude with the expectation of getting visual. Although the Captain stated in his report as well as in his statement that he was visual with the approach lights at decision altitude. Had he established visual contact with approach lights at decision altitude, the response to the "MINIMUM" auto-call out would have been "visual and continue" in accordance with SOP. The PM, whose duty is to look out of the cockpit for the approach lights and runway while the PF flies the approach on instruments, also did not call out "visual".

With regards to the amended threshold coordinate information uploaded on the aircraft, at the DA the aircraft would have still been in a position to visually identify the runway if the required visibility was present. The aircraft descent below the DA, towards the amended runway threshold coordinates, the approach lights and the runway would have been offset to the right of the aircraft nose. Had the flight crew been visual with the runway they should have noticed this offset. The aircraft remained coupled to the autopilot and there was no attempt by the flight crew to correct the flight path of the aircraft.

Approximately 5 seconds before touchdown the PF states "appearing" which was the first mention of the runway being visual.

2.1.1.4 Human Factors

It was the first flight of the Captain and third flight but first RNAV RNP Approach of the Co-pilot to Kathmandu airport. The scheduled arrival time of Turkish Airline is 01:10 hrs. On this day the aircraft arrived at Parsa waypoint approximately 44 minutes ahead of schedule. Kathmandu Airport as well as the communication facilities had not opened yet. The aircraft established contact with Kathmandu Approach only at 00:17 hrs. The aircraft was holding over Parsa at FL270 on the control of Varanasi. At that time visibility was 100m and airport was closed. The aircraft, with two men crew, after flying nearly 5 hours 30 minutes required nearly 50 minutes of holding for weather improvement before attempting the first approach and nearly 15 minutes for the missed approach pattern at the destination airport before the second approach. The Flight crew might have been fatigued and discouraged from diverting to the alternate.

Most of the time there is less visibility during early hours at Kathmandu airport. Turkish Airlines Safety Department had also advised to change the scheduled arrival time.

At 01:29:35 hrs, after first missed approach, a cabin attendant talked to the Captain in the Cockpit that if they diverted to Delhi, there would be a big burden. The Captain told that weather was getting better and they could land here. At 01:30 hrs the First Officer told to the Captain that RNP Approach would bring them directly to runway. These conversations of the crews might indicate a fixation to land at Kathmandu. Four seconds before the "MINIMUMS" auto-callout, the PM stated "it will appear when we descend below…" which may have encouraged the PF to descend below the MDA even if the runway or approach lights were not visual. The PM did not question the Captain when a non-normal response to the "MINIMUMS" auto-callout was made.

2.2. FMS database for RNP AR Approach

The cancellation of PIB through NOTAM was briefed to the flight crews of the aircraft. But the aircraft navigation Database remained the same i.e. to be displaced

threshold coordinates were uploaded on FMGS NAV Data base of the aircraft. To be displaced threshold coordinates for runway 02 of Kathmandu as published by the CAAN in AIP SUP 01/2015 were given with a lower resolution compared to the runway coordinates published to 1/1000th of an arc second, whereas the coordinates in the supplement were degrees, minutes and seconds. Bearing/Distance calculations showed that these published coordinates were not exactly lined up, but the published RW02 coordinates were slightly off to the left.

The airline and flight crew were unaware of these facts. Had the airline and flight crews were aware of this fact, the airline would have taken remedial measures in order to release the aircraft.

The aircraft had been operating to Kathmandu with the amended runway threshold coordinates from 5th February to the date of the accident. When visual contact is made with the runway or approach lights, the flight would have conducted with required visual reference below the decision height and autopilot disengaged at the decision altitude. By flying with required visual reference and autopilot disengaged, the flight crew would have lined the aircraft up with the runway centerline.

In this accident, since there appears to be no required visual reference to continue the approach below the decision altitude the aircraft should have executed a missed approach . Had there been the required visual reference the pilot has every opportunity to align the aircraft with the runway regardless of the coordinates entered into the PMGS NAV database. This type of approach is not designed to be flown on auto-pilot all the way to the threshold.

On March 2, 2015 i.e. two days before the accident the crews of the flight to Kathmandu reported through RNP AR MONITORING FORM that all the NAV. accuracy and deviation parameter were perfectly correct at MINIMUM but the real aircraft position was high (PAPI 4 whites) and left offset. Had the airline received and processed this feedback timely . The airline would have known the wrong data uploading on FMGS NAV Data base and take remedial measures.

The commission collected the LIDO chart from the aircraft. The chart was based on to be displaced threshold coordinates. According to the valid LIDO chart at the date of the event required visibility minima was 1500 m. The crews were briefed at the dispatch that they used 900 m visibility minima because of the cancellation of planned displacement.

The airline as well as service provider took some remedial measures such as suspending the RNAV (RNP) approach and publishing LIDO chart NOTAM immediately after the accident.

3. Conclusions

3.1 Findings

3.1.1 The crews possessed the licenses and ratings required to undertake the flight and medically fit.

3.1.2 The aircraft was airworthy and serviceable for the flight.

3.1.3 The FDR and CVR were in good condition with good quality recording.

3.1.4 The crews were operating within the airline flight time and duty time limitation.

3.1.5 The aircraft weight and balance were within operational limits.

3.1.6 The aircraft had taken off from Istanbul without any known technical problems.

3.1.7 The coordinates as published in AIP SUP 01 and 02 /2015 were given with a lower resolution.

3.1.8 Proposed displacement of runway 02 threshold coordinates published in AIP SUP were retained on FMGS NAV database of the aircraft although cancelled through NOTAM .

3.1.9 On March 2, 2015 i.e. two days before the accident, the crews of the flight to Kathmandu reported through RNP AR MONITORING FORM that all the NAV. accuracy and deviation parameter were perfectly correct at MINIMUM but the real aircraft position was high (PAPI 4 whites) and left offset.

3.1.10 The airlines as well as crews were unaware of the fact that wrong threshold coordinates were uploaded on FMGS NAV data base of the aircraft.

3.1.11 The flight crew was unable to get ATIS information on the published frequency because ATIS was not operating. ATIS status was also not included in the Daily Facilities Status check list reporting form of TIA Kathmandu .

3.1.12 Turkish Airlines Safety Department advised to change the scheduled arrival time at Kathmandu Airport

3.1.13 It was the first flight of the Captain to Kathmandu airport and third flight but first RNAV (RNP) approach of the Copilot.

3.1.14 Both approaches were flown with the auto-pilots coupled.

3.1.15 Crew comments on the CVR during approach could be an indication that they (crews) were tempted to continue to descend below the decision height despite lack of adequate visual reference condition contrary to State published Standard Instrument Arrival and company Standard Operating procedures with the expectation of getting visual contact with the ground.

3.1.16 The flight crew were not visual with the runway or approach light at MDA.

3.1.17 The MET Office did not disseminate SPECI representing deterioration in visibility according to Annex 3.

3.1.18 The Approach Control and the Kathmandu Tower did not update the aircraft with its observation representing a sudden deterioration in visibility condition due to moving fog.

3.1.19 The Air Traffic Control Officers are not provided with refresher training at regular interval.

3.1.20 CAAN did not take into account for the AIRAC cycle 04-2015 from 05 Feb 2015 to 04 March 2015 while cancelling AIP supplement.

3.1.21 The auto-pilots remained coupled to the aircraft until 14ft AGL when it was disconnected and a flare was attempted.

3.1.22 The crews were not fully following the standard procedure of KTM RNAV (RNP) Approach and company Standard Operating procedures.

3.1.23 The aircraft was substantially damaged but there was no injury to passengers and crew.

3.1.24 The aircraft touched down to the left of the runway centerline with the left hand main gear off the paved runway surface.

3.1.25 The aircraft came to a stop on the grass area between Runway 02 and the parallel taxiway north of runway exit Taxiway D

3.1.26 LIDO did not pick up on the NOTAM at the next AIRAC update.

3.2 Causal Factor

The probable cause of this accident is the decision of the flight crew to continue approach and landing below the minima with inadequate visual reference and not to perform a missed approach in accordance to the published approach procedure.

3.2.1 Contributory Factors

Other contributing factors of the accident are probable fixation of the flight crew to land at Kathmandu, and the deterioration of weather conditions that resulted in fog over the airport reducing the visibility below the required minima.

4. Safety Recommendations

The Commission has determined that following safety recommendation should be implemented for the advancement of flight safety.

4.1 The operator should review the pilot qualification requirements to operate to and from TIA, Kathmandu.

4.2 The operators must ensure that the crew strictly adheres to the Standard State Instrument Arrival procedures and Airlines Standard Operating Procedures.

4.3 The operator must ensure that the correct navigation data are uploaded on FMGS NAV database of the aircraft.

4.4 The operator should have a system in place to act efficiently and effectively with full understanding of its gravity upon receiving the information of operational significance such as NOTAM and feedback of the crew etc.

4.5 The operator should establish a system of verifying the quality of charts prepared by the service provider.

4.6 The operator should establish a system of checking the validity of FMS database.

4.7 The operator should review its Kathmandu RNP AR Company visibility minima keeping in view of its own requirements over and above of State published visibility minima.

4.8 The operator should review its crew composition requirements to and from Kathmandu airport keeping in view of the flying time and time zone etc.

4.9 The operator should ensure that the crew strictly follows the safety related procedures and cockpit discipline.

4.10 CAAN should review its requirement in AIP regarding crew qualification before they are authorized to operate to and from Kathmandu airport.

4.11 CAAN must ensure that there exists an effective and efficient coordination between aeronautical information services and aerodrome authorities.

4.12 CAAN must ensure that raw aeronautical information/data are provided by the aerodrome authorities taking into account of its accuracy and integrity requirements for aeronautical data as specified by ICAO Annex 15 and its Aeronautical Information Service Manual.

4.13 CAAN must ensure that there exists a proper planning for works to be accomplished before disseminating such information through Aeronautical Information Services with full understanding of its gravity.

4.14 MET Office must ensure that it disseminate the SPECI representing deterioration in visibility in accordance with the ICAO Annex 3.

4.15 MET Office should have a system of providing MET observation immediately after the accident.

4.16 CAAN must ensure that Air Traffic Controllers on duty at Kathmandu Tower are vigilant and weather information representing deterioration in visibility minima are provided through them to the aircraft immediately.

4.17 CAAN should provide refresher training to all Air Traffic Controllers at regular interval.

4.18 CAAN should include ATIS status check in its Daily Facilities Status check list reporting form of TIA Kathmandu .

4.19 CAAN should restore ATIS Communication facility immediately.

4.20 CAAN should keep track of the AIRAC update cycle while cancelling AIP supplement.

4.21 LIDO should put in place a more robust system to check NOTAMs and act accordingly .

5 Safety Actions:

5.1 The Commission was informed by the Turkish Authority that the following safety actions were initiated:

5.1.1 A decision was made to establish a unit within Turkish Airlines to quality control of charts prepared by service provider,

5.1.2 A new procedure was under preparation to check validity of FMS database for RNP AR approaches,

5.1.3 Kathmandu RNP AR company visibility minima was increased to 1800 m from 900 m.

5.1.4 A memo mentioning AP self-disconnection conditions during a managed non precision approaches to A330 fleet pilots was sent by Flight Operation Department

5.1.5 Flight crew is augmented to three pilots for Kathmandu flight and

5.1.6 Scheduled landing time for winter period was changed.

LIST OF ABBREVIATIONS

Abbreviations:	Definitions:
A/C	**Aircraft**
AMSL	**Above Mean Sea level**

ACARS	**Aircraft communication Addressing And Reporting**
AIP	**Aerodrome Information Publication**
AIS	**Aeronautical Information Service**
AIRAC	**Aeronautical Information Regulation and Control**
AFM	**Aircraft Flight Manual**
AMSL	**Above Mean Sea level**
ALT	**Altitude**
AP	**Auto Pilot**
APV	**Approach Procedure with Vertical guidance**
APCH	**Approach (Route)**
APP	**Approach (ATS Unit)**
AR	**Authorization Required**
ATC	**Air Traffic Controller**
BKN	**Broken**
CAAN	**Civil Aviation Authority of Nepal**
CAPT.	**Captain**
CAR	**Civil Aviation Regulation**
CVR	**Cockpit Voice Recorder**
CRM	**Cockpit Resource Management**
CG	**Center of Gravity**
CPL	**Commercial Pilot License**
DH	**Decision Height**

DME	**Distance Measuring Equipment**
FDR	**Flight Data Recorder**
FMC	**Flight Management Computer**
FMS	**Flight Management System**
FMGS	**Flight Management Guidance System**
G	**Gravity**
GPS	**Global Positioning System**
IFR	**Instrument Flight Rules**
ICAO	**International Civil Aviation Organization**
METAR	**Meteorology Aerodrome Report**
MDA/H	**Minimum Decision Altitude/ Height**
MTOW	**Maximum Takeoff weight**
MLW	**Maximum Landing Weight**
MZFW	**Maximum Zero Fuel Weight**
NAVAID	**Navigation Aid**
NOTAM	**Notice to Air Man**
PAPI	**Precision Approach Path Indicator**
PF	**Pilot Flying**
PIB	**Pre Flight Information Bulletin**
PM	**Pilot Monitoring**
PNF	**Pilot Not Flying**
QNH	**Altimeter setting of the station with reference to Mean Sea Level**
RNP	**Required Navigation Procedure**

RNAV	**Radio Navigation**
Rwy	**Runway**
RVR	**Runway Visual Range**
SOP	**Standard Operating Procedure**
SPECI	**Special Report Amending a Metar**
STAR	**Standard terminal Arrival Route**
TIA	**Tribhuvan International Airport**
UTC	**Universal Coordinated Time**
VMC	**Visual Meteorological Condition**
VOR	**Very High Frequency Omni range**
Wt	**Weight**
Wx	**Weather**