



Islamic Republic of IRAN

Civil Aviation Organization

Aircraft Accident Investigation Board (AAIB)

Accident Investigation Final Report



State File Number: 950330EPMOF
Type of Occurrence: Accident
Date of Occurrence: June 19th 2016
Place of Occurrence: Khark Island Airport
Aircraft Type: BAe146-300
Registration: EP-MOF
Operator: Mahan Airlines

Aircraft Accident

Investigation Board (AAIB)

Date of Issue: 20 Apr 2017

**ISLAMIC REPUBLIC OF IRAN
CIVIL AVIATION ORGANIZATION**



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Basic Information

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Place of occurrence: Khark Island Airport, Islamic republic of Iran

Aircraft Model: BAe146-300

Registration: EP-MOF

Operator: Mahan Air

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Mehrabad International Airport

Tehran/Iran

PBO: 13445-1795

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Foreword:

According to Aircraft Accident Investigation Act of Civil Aviation Organization of the Islamic Republic of Iran, accident investigation shall be conducted separately from any judicial, administrative disposition, administrative lawsuit proceedings associated with civil or criminal liability.

Base on Annex 13 to the Convention on International Civil Aviation, Chapter 3, Paragraph 3.1, and Chapter 5, Paragraph 5.4.1; it is stipulated and recommended as follows;

The sole objective of the investigation of an incident or accident shall be the prevention of incidents and accidents. It is not the purpose of this activity to apportion blame or liability.

Abbreviations:

AMOC	Aircraft Maintenance organization Certificate
AOC	Air operator Certificate
APP	Approach
ATC	Air Traffic Control
ATPL	Air Transport Pilot License
CAMOC	Continuing Airworthiness Management Organization Certificate
CAO	Civil Aviation Organization
CPL	Commercial Pilot License
IAS	Indicated Air Speed
KHG	Khark Island Airport
LH	Left Hand
LMT	Local Mean Time
MET	Meteorological
NM	Nautical Mile
NW	North west
QAR	Quick Access Recorder
RH	right Hand
RWY	Runway
SE	South East
SOP	Standard Operating Procedure
SSFDR	Solid State FDR
UTC	Universal Time Coordinated
VSI	Vertical Speed Indicated

Synopsis:

On June 19, 2016 Mahan Air scheduled aircraft BAe 146-300 with registration EP-MOF for scheduled passenger flight from Tehran to Shiraz-Ahwaz-Khark-Ahwaz-Shiraz-Tehran. After changing cockpit crew in the Ahwaz airport, on the 3.th flight, Aircraft with Flight No; IRM 4525 was scheduled to fly from Ahwaz Intl. Airport to Khark Island Airport. The aircraft was serving flight with 2 cockpit crew, 2 augment Cockpit crew, 5 cabin crew, one flight mechanic, carrying 79 passengers to the destination airport (KHG).No unusual occurrences were noticed during departure, en-route and descent.

After landing the aircraft had runway excursion 13 from the end of RWY and stopped in soils area before airport fence. Then emergency evacuation was done by crew and support of airport rescue team.

No injuries or fatalities were found as sequence of this accident but aircraft sustained major damages to underneath of the aircraft fuselage.

There were not any" Dangerous Goods" on board.

The investigation was conducted with IRI CAO Aircraft Accident Investigation Board as State of Occurrence. Based on Annex 13, notification was sent to UK Aircraft Accident Investigation Board (AAIB) as State of Design /Manufacture and related Accredited Representative was introduced to investigation team. In this respect, no advisers or technical supports from Manufacturer were attended.

The main cause of this accident was "wrong decision making by the pilot " to land in short RWY at destination with tailwind situation for the flight. However the technical failure of "Antiskid System" on "RH Landing Gear " was a latent condition as a contributive factor of this accident.

Finally, the aircraft was beyond repair and written off in khark Island located in the South of IR of Iran.

1. Factual information:

1.1 History of flight:

On June 19, 2016, Mahan Air flight IRM 4525 was a scheduled passenger flight which took off from Ahwaz Airport at 1257 LMT (0827 UTC) to destination and landed at Khark Island Airport at 1335 LMT (0905 UTC).

After delivery of the flight from BUZ approach to Khark tower, the flight was cleared to land on RWY 31 via visual approach. At 10 NM on final the pilot has asked weather information of the destination so, the captain requested to perform a visual approach for RWY 13. Finally the pilot in command accomplished an un-stabilized approach and landed on the runway after passing long distance of the Runway.

a) After landing at N 21 15 10.8 E050 19 51.9 location

Regarding to the length of the runway (7,657 feet) the aircraft overran the end of runway and made runway excursion on runway 13 and came to rest on the unpaved surface after 54 meters past the runway end. The nose landing gear strut has broken and collapsed.

The captain instructed the cabin crew to evacuate the aircraft.

No unusual occurrences were noticed during departure, en-route and descent.

The aircraft wreckage was displaced to the airport parking area for more investigation by Aircraft Accident Investigation Bureau (AAIB).

1.2 Injuries to persons:

No injuries and or fatalities were occurred.

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor/None	10	79	

1.3 Damage to aircraft:

The nose landing gear collapsed and damaged the cabin floor seriously through the electronic compartment.

Since the aircraft was substantially damaged, the aircraft operator dismantled aircraft components after investigating of accident in order to remove and disposition the wreckage from Khark Island Airport.

1.4 Other Damages: None

1.5 .Personnel information:

Flying Pilot/ Pilot in Command :

Male, 46 years old, Iranian Nationality

Airline Transport Pilot License, ATPL 2093 from Iran CAO

Airline Transport Pilot License, validity October 05, 2016.

Type rating: BAe146-300, Avro Jet RJ100

Proficiency check validity, July 08, 2016.

Medical examination validity July 04, 2016.

Total flying hours 5,494 hours,

Current type as a captain 1,270 hours.

Pilot non flying :

Male, 28 years old, Iranian Nationality

Commercial Pilot License (CPL) No. 4170, from Iran CAO

Type Rating : BAe146-300 , Avro Jet RJ100

License validity September 02, 2016,

Proficiency check validity, November 26, 2016,

Medical examination validity July 27, 2016,

Total flying hours 300 hours,

Current type as a first officer 110 hours.

1.6 Aircraft information :

BAe146-300. MSN; E3149

Registration Mark : EP-MOF

Aircraft landing weight: 38 tons.

CG: within limits.

Fuel used: Jet A1.

Aircraft was under property and operation of Mahan Airlines

Aircraft was under valid AOC and maintained in Mahan Airlines maintenance facilities which holds approved AMOC as well as CAMOC.

Aircraft was released from service with valid Certificate of Airworthiness issued by CAO.IRI

The review of recent records of aircraft did not show any significant malfunctions.

1.7 Meteorological information:

The available International METAR in the flight bag which was supported by the airline dispatch was:

METAR OIBQ 190700Z 30014KT CAVOK 32/26 Q1003=

METAR OIBQ 190800Z 30012KT CAVOK 33/26 Q1003=

METAR OIBQ 190900Z 30016KT CAVOK 34/25 Q1003=

The review of ATC communication shows that the reported weather condition to the flight differs from METAR. Also in statement interview of the pilot, he reported big difference amount in the wind value between tower report and his normal sense. So the investigation team decided to research about wind values for the flights in the Khark Island Airport. So the observation of other three flights comparing with International METAR and

local "Meteorology Office Report " (MET) and actual wind observed by available "Digital Wind Indicator " in the ATC tower are shown as below:

Accident time

Flight	Type	Time	METAR	MET	TWR Actual	A/C Actual
IRM.4525	BAe	<u>09:05</u>	300/16	300/16	300/10	-

Wind Calibration Test in Khark on 20 Jun 2016

Flight	Type	Time	METAR	MET	TWR Actual	A/C Actual
IRG.2504	F100	02:44	320/12	320/16	330/8	330/9
IRG.2503	F100	05:16	300/10	300/10	300/8	300/9
IRG.2533	F100	<u>08:12</u>	290/14	290/14	310/10	290/16

The research helped the investigation team to know more about the real situation of the flight. The position of wind indicator sensor for ATC tower is located at the ATC tower building approximately in the Middle of Khark aerodrome. Two edges of the airport are located in the coast location of the Khark Island near to the Persian Gulf water. So the value of the wind may differ from the value of Indicated wind observed by the ATC man in the control tower. This difference is observed more in the middle of the day caused by sunlight effect on the ground and the water. This geographical phenomenon causes tailwind for flight inbounds RWY 13 and headwind for the flight inbounds the RWY 31. The conclusion of the research shows that at the time of the accident, the reported wind value by MET was more valuable than reported wind by ATC tower so the actual tailwind for the flight was more than 10 knots.

1.8 Aids to navigation:

No problems with any navigation system of the aircraft were reported. At the time of accident, Validation of the Navigational aids for the Airport (DVOR/DME, NDB) was expired but evidences of the flights showed that all system were working normally and was not effective on this accident.

1.9 Communications:

No technical communications problems were reported by the flight crew or the air traffic controllers who handled the accident flight. Khark Information 129.0 and 122.1 VHF were operational and in the normal condition.

Bushehr APP Communications with Flight:

TIME(UTC)	STATION	CONTEXT
08:48:52	PILOT	BUSHEHR APPROACH, GOOD TIME ,IRM4525
08:48:57	CONTROLLER	IRM4525, BUSHEHR APPROACH,GOOD TIME
08:49:00	PILOT	RELEASE BY TEHRAN, REQUEST DESCEND TO TRAFFIC ALTITUDE KHARK ISLAND FOR LEFT DOWNWIND RUNWAY 31
08:49:10	CONTROLLER	IRM4525 REPORT POSITION?
08:49:23	PILOT	54 DME INBOUND OF KHARK
08:49:23	CONTROLLER	IRM4525, EXPECT NDB APPROACH FOR RUNWAY 31 KHARK ISLAND VIA IBKUG 1E ARRIVAL ROUTE ,NO DELAY EXPECTED ,TRANSITION LEVEL 55.DESCEND FL40 REPORT PASSING IBKUG.
08:48:47	PILOT	BUSHEHR IRM4525 BE ADVISED SIR AFTER MAHSHAHR WE ARE PROCEEDING DIRECT TOWARD KHARK AND IF POSSIBLE REQUEST DESCEND TO TRAFFIC ALTITUDE LEFT DOWNWIND RUNWAY 31
08:50:09	CONTROLLER	IRM4525 STANDBY
08:50:09	PILOT	ROGER IRM4525
08:50:38	CONTROLLER	IRM4525 REPORT LEVEL
08:50:50	PILOT	146 DESCENDING FOR 4000 FT
08:50:53	CONTROLLER	IRM4525 ROGER MAINTAIN 4000 FT REPORT 20 MILES TO KHARK ISLAND
08:51:00	PILOT	MAINTAIN 4000 FT AND CALL YOU BACK 20 MILES INBOUND OF KHARK IRM4525
08:52:23	PILOT	REQUEST LATEST WEATHER OF KHARK IRM4535
08:52:30	CONTROLLER	RUNWAY IN USE 31 WIND 300 DEGRES 16 KNOTS CAVOK TEMP34 DEWPOINT 25 QNH1003 H.
08:52:40	PILOT	ROGER 1003 IRM4525 THANK YOU,
08:55:00	PILOT	BUSHEHR APPROACH IRM4525 POSITION 20 NM INBOUND KHARK ISLAND

08:55:11	CONTROLLER	IRM4525 CLEARED VISUALL APPROACH FOR RUNWAY 31 KHARK ISLAND,DESCEND TRAFFIC ALTITUD ON QNH,REPORT RIGHT DOWNWIND RUNWAY 31
08:55:20	PILOT	DOWN TO TRAFFIC ALTITUD REQUEST IF POSSIBLE LEFT DOWNWIND
08:55:28	CONTROLLER	ROGER REPORT LEFT DOWNWIND RUNWAY 31 KHARK ISLAND
08:55:37	PILOT	THANK YOU CALL YOU BACK LEFT DOWNWIND RUNWAY 31 IRM4525
08:56:05	CONTROLLER	IRM4525 CONTACT KHARK INFORMATION 122.1 HAPPY LANDING.
08:56:10	PILOT	CONTACT KHARK122.1IRM4525 THANK YOU

KHG Airport ATC tower Communication with flight

Time	Station	context
08:42	Pilot	Khark Information IRM4525
“	TWR	IRM4525 Khark, Good Time
:	Pilot	Maintaining FL170 Not Released By Tehran 90DME Inbound Your Station Request Field Information
08:43	TWR	RWY 31 Wind 310/12 Kt CAVOK Temperature 33 Dew Point 26 QNH 1003 HP
08:56	Pilot	Khark Information Good Time Again IRM4525
“	TWR	IRM4525 KHG Information Good Time
“	Pilot	Now released by Bushehr Approaching 3100 Descending Traffic Altitude Proceeding Left Down Wind RWY31
08:57	TWR	IRM4525 Continue Descend To Traffic Altitude on QNH 1003 Report Left Downwind RWY 31 Khark Island
08:58	Pilot	Wind Check Please IRM 4525
“	TWR	IRM 4525 300 Degrees /10 kt
“	Pilot	Ok Copied Request RWY 13
“	TWR	Approved Clear to Land or Report Final
“	Pilot	Cleared to Land RWY 13 IRM 4525

1.10 Aerodrome information:

This accident was happened in Khark Island airport, field category of the airport is G according to Iranian ATC regulation.

This airport is operated by Iranian Oil company .Fire Fighting services available (commensurate with BAe146 aircraft category).

Runway length is 7,657 feet (2,334 meters).

Airport elevation is 29 feet.

Runway 13 elevation is 21 feet.

Runway 31 elevation is 29 feet.

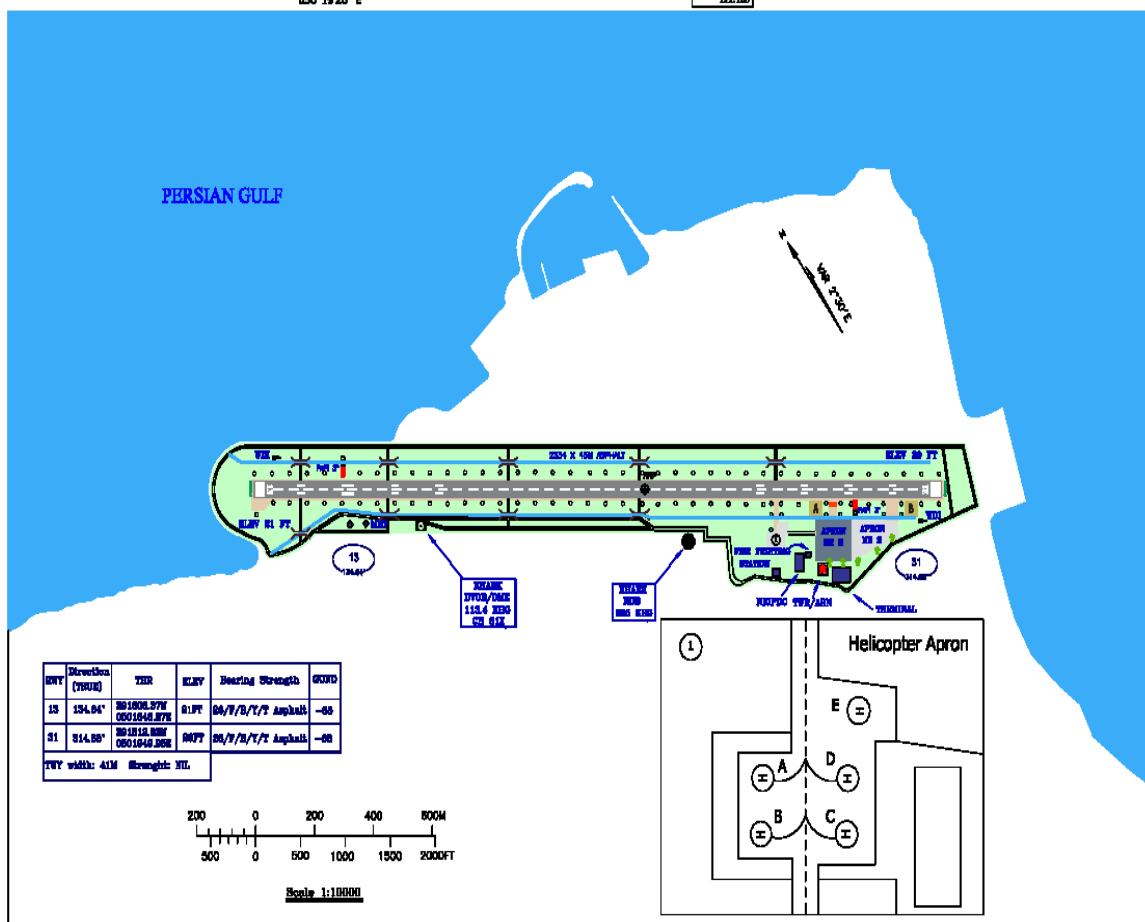
Due to some ground obstacles near the airport, only VFR flight are authorized for this airport but it was not published in Iranian AIP.

Designations RWY NR	TRUE BRG	Dimensions of RWY (M)	Strength(PCN) and surface of RWY and SWY	THR coordinates Geoid undulation
1	2	3	4	5
13	134.64°GEO	2334 x 45	26/F/B/Y/T Asphalt	291605.37N 0501848.27E GUND -68FT
31	314.65°GEO	2334 x 45	26/F/B/Y/T Asphalt	291512.22N 0501949.95E GUND -68FT
Slope of RWY - SWY	SWY dimensions (M)	CWY dimensions (M)	Strip dimensions (M)	OFZ
7	8	9	10	11
0.1 %	NIL	NIL	NIL	NIL
0.1 %	NIL	NIL	NIL	NIL

OIBQ AD 2.13 DECLARED DISTANCES

RWY Designator	TORA (M)	TODA (M)	ASDA (M)	LDA (M)	Remarks
1	2	3	4	5	6
13	1930	2334	2334	1934	NIL
31	1934	2334	2334	1930	NIL

AIP
ISLAMIC REPUBLIC OF IRAN
AERODROME CHART - ICAO
28°15'37" N
050°19'26" E
AD ELEV 29 FT
OIBQ 129.000
122.100
ADZ OIBQ ADC
WEP 23 JUN 16
KHARK ISLAND/KHARK



CIVIL AVIATION ORGANIZATION

CHARTS New ADZ

ATAC ADZT 3/16

1.11 Flight Recorders:

This aircraft has been equipped with SSFDR and SSCVR. Both recorders were picked up from relatively undamaged compartment of aircraft in a good condition and presented to laboratory in order to download /analysis. The whole analysis processes of the flight recorders were done at Tehran.

FDR / QAR analysis:

The following is a sequence of events based on FDR data.

Note: Time references are based on recorded UTC time of the FDR.

QAR data is down loaded and analyzed as follows:

At 2,465 feet R.ALT, VSI 1,080 Ft/m descending, IAS 225 knots, pitch attitude 1.7° nose up, airbrakes retracted (IN).

At 2,280 feet, VSI 540 feet descending, IAS 222 knots, pitch attitude 2° nose up, airbrakes extended (OUT).

At 2,140 feet, VSI 1,068 Ft/m descending, IAS 209 knots, pitch attitude 2° nose up, flaps extended.

At 2,045 feet, VSI zero, IAS 183 knots, pitch attitude 0.3°, airbrake retracted (IN).

At 1,510 feet, VSI 1,260 Ft/m descending, IAS 164 knots, pitch attitude 5.7° nose down.

At 1,000 feet, VSI 1,080 Ft/m descending, IAS 150, pitch attitude 7.4° .

At 500 feet, VSI 888 Ft/m descending, IAS 136 knots, pitch attitude 6.2°, full flaps.

At 400 feet, VSI 1,248 Ft/m descending, IAS 139 knots, pitch attitude 6°.

At 300 feet, VSI 900 Ft/m descending, IAS 141 knots, pitch attitude 6.5°, airbrakes IN, full flaps.

At 210 feet, VSI 1,068 Ft/m descending, IAS 139 knots, pitch attitude 6.8°, airbrake OUT up to aircraft touchdown, full flaps.

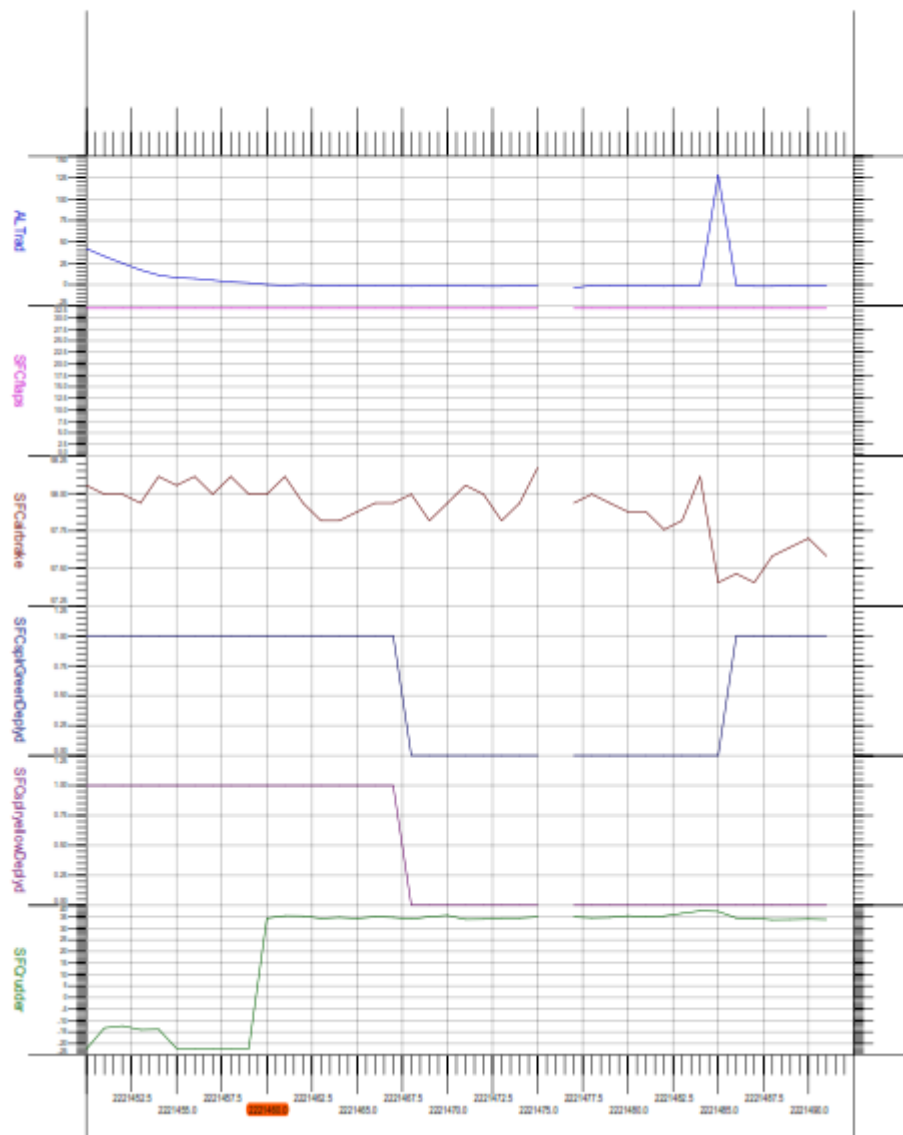
At 105 feet, VSI 720 Ft/m descending, IAS 145 knots, pitch attitude 6.2°, N₁ RPM 61%, 61%, 64% & 60% in normal sequence.

At 42 feet, VSI 888 Ft/m descending, IAS 140 knots, pitch attitude 4.8°, aircraft flare is started probably, touchdown occurs in next 10 seconds.

At 7 feet L, VSI 900 Ft/m descending, IAS 138 knots, pitch attitude 3.8°, N₁ RPM 64%, 62%, 64% & 58% in normal sequence.

At Touchdown, due to an un-stabilized approach (high target speed, altitude higher than normal glide path), touchdown occurs after passing long distance from beginning of RWY 13 optimistically with IAS 121 knots, N₁ RPM 34%, 38%, 36% & 34% in normal sequence. The vertical acceleration of touch down was 1.07 in the normal value.

Spoilers had opened on IAS 112 after 7 seconds



Note:

Spoilers Extension: FCOM, Chap.11, Vol.1, Topic 8, Flight Controls, Lift Spoilers:

- **Page 5:** Remembering that a main wheel has been on the ground in the previous 10 second, ensures that yellow spoilers will be deployed.
- **Page 6:** The green spoiler logic considers the aircraft to be if both main wheels have been on the ground for 1.5 seconds and more after deployment of yellow spoilers. The green spoilers are delayed for 1.5 seconds.

Page 21: The squat switches sense that the aircraft has landed but the airbrake/spoiler lever has not been selected to LIFT SPLR within 6 seconds of touchdown

CVR Analysis:

The CVR downloading was accomplished successfully, which contains about two hour audio files with good quality. These files consist of whole flight of the accident and ground time of the aircraft in Ahwaz airport at end of previous flight. The findings of the CVR are as following items:

- The flight has delay in the departure from Mehrabad Airport (THR) due to high traffic load of this airport and cockpit crew has focused on this subject.
- 1st, 2nd flights were done by other augmented pilots and there are changed in Ahwaz airport.
- The cockpit crew has not sensed any malfunctions of aircraft systems while landing and taking off in Ahwaz airport.
- The pilot has asked ATC direct route to save time against delay of flight, and requested direct visual approach/landing on RWY 13 with this purpose.
- The pilot was pilot flying and copilot was monitoring the flight.
- The copilot has focused on high speed approach and related sufficient warning to the pilot, however they have used airbrake to reduce speed in approach phase.

1.12 Wreckage and impact information:

Aircraft body didn't breaks apart, but aircraft lower part of nose section sustained substantially damages.

Aircraft overran the end of runway and after 54 meters (170 feet) beyond the threshold came to a rest following nose landing gear brake and collapse as a result of passing over the rough surface.

The visual inspection was made on the aircraft wreckage and the Runway with following results:

- There was not any deflection on the airframe and control surfaces.
- The pitot tubes were in normal condition..., the covers were not installed and no blockage line was seen.
- There was sign of Skidding on the RH landing gear tires but normal situation was observed on LH landing gears.
- Touchdown occurred about 685meters (2,245 feet) beyond the beginning of RWY 13.
- The sign of tough brake applying was seen on asphalt surface on the ground at the end of RWY which shows the attempt of the pilot to stop the aircraft.
- Signs of anti-skid failure were clear on the remarks of RH landing gear tires on the asphalt surface at the end of RWY 13.



Signs of anti-skid failure



Overrun location and signs of nose impact

1.13 Medical and Pathological Information:

The test for the presence of alcohol and drugs in the flight for both pilots, was performed at Khark Island and the results were satisfactory with no comments (Negative).

The research about crew and their medical documentation in CAO.IRI didn't show any illegal behaviors or medical problems since previous time.

1.14 Fire:

There was no sign of fire on the aircraft wreckage as consequence of accident.

1.15 Survival aspects:

When the aircraft stopped, the emergency evacuation was requested by the pilot. All passengers and cabin crew evacuated the aircraft safely /successfully with cooperation of rescue team of the airport.

Due to cockpit entrance door damage, cockpit crew left the aircraft through the windows by scape ropes.

1.16 Test and Research:

- *Flight simulation research:*

The flight simulation of this accident was done in the simulator facilities of the Mahan Air in the Kerman airport. The situation of the flight with same characteristics of the airport was simulated in this BAe simulator with different scenarios on the aircraft. These scenarios included: *landing with tailwind in normal touch down, long flare, missed RWY distance, Anti-skid Failure, spoiler failure, etc.* The investigation team reached this point of view that when the *Anti-skid* failure is occurring, at least 30% increase of the landing distance of the aircraft was observed. AAIB made investigation on different wind and direction condition in simulator and found following results:

BAe Simulator test on 12 Jul 2016

RWY	wind	Flare distance	Anti- skid	outcome
13	300/30	Normal	On	Normal
13	300/30	Normal	Off	Normal
13	300/30	Long	<u>off</u>	<u>Over run</u>
13	300/20	Normal	On	Normal
13	300/20	Normal	Off	Normal
13	300/20	Long	<u>off</u>	<u>Over run</u>
13	300/15	Normal	On	Normal
13	300/15	Long	Off	Normal
13	300/15	Long	<u>off</u>	<u>Over run</u>
30	300/15	Normal	On	Normal
30	300/15	Long	Off	Normal

- ***Test of RH braking system:***

The effected main landing gear brake assembly including Brake ASSY, anti-skid electric control box and related sensors was undergone shop testing;

The following brake assemblies were examined and the pressure test results were normal with no deficiencies.

3 Brake ASSY: (P/N: AHA2332-2, S/N: RR168)

#4 Brake ASSY: (P/N: AHA 2331-2, S/N: NIL)

The following main wheel Anti-Skid Sensors were examined but the test on #3 sensor was not satisfactory:

3Anti-Skid sensor: (P/N : AHM8091, S/N : ISS20DA50)

4Anti-Skid sensor: (P/N : AHM8091, S/N : ISS20DA24)

The following main wheel Anti-Skid control box was examined at maintenance base at the Tehran but the #3 Anti-skid sensor test was not satisfactory:

Anti- Skid control box: (P/N: AE 20612 M, S/N: 0063)

The conclusion of the test indicates the failure of Anti-skid System on the right main Landing gear.

1.17 Organizational Information:

Mahan Air is an Iranian private airline that offers passenger and cargo services, including domestic and international flights. The company's corporate office is in Mahan Air Tower, Azadegan St., Karaj Highway, Tehran. This Airline operates a fleet of more wide body airplanes, consisting of Airbus 300s, 310s; Boeing 747s and BAe-146s.

1.18 Additional information:

Cockpit and Cabin Crew Reports:

Captain's comments :

According to captain statements, he briefed his first officer as follows; if weather conditions in destination permit, continuing visually and perform landing on RWY 13. In case of strong wind existing, makes a traffic pattern and lands on RWY 31.

Regarding to weather reported by Bushehr Approach, 300°-310°/16 knots, he decided to perform a visual approach and landing on RWY 31, so he reviewed and briefs his first officer.

By completing descent checklist, he leaves FL 170 and starts descending at 65 NM to destination for a visual approach RWY 31 via left downwind.

Khark Island tower instructs fight 4525 to descend to 4,000 feet up to 20 NM, for visual approach RWY 31.

At approximately 10 NM, the flight requested last weather so the wind reported 300°/10 knots by Khark Island tower.

Regarding to reported wind velocity and probably decreasing to below 10 knots (in captain's mind) and according to Flight Crew Operational Manual (FCOM) and Operations Manual (OM), he decides to land on RWY 13.

Due to flight configuration; aircraft speed was exactly in normal limits and insignificant differences between aircraft and RWY 13 headings. It should be noticed that landing on RWY 13 was requested within aircraft weight of 38 tons (38,000 kg), V_{REF} 119 knots and approach speed 129 knots (target speed).

At 500 ft. MSL, landing checklist completed and go around procedure reviewed.

Regarding to an exact stabilized approach; approach speed was in normal limit, a normal landing performs in touchdown zone vicinity between 700 to 1,000 feet of beginning of RWY 13 as it was done previously.

At beginning of landing, he uses spoilers, applies brakes as mentioned in SOP and receives first officer's confirmation of throttles idle, spoilers yellow over green, brake pressure good.

He notices the aircraft speed is not decelerating as an usual and regarding to shortening of runway, he applies maximum brakes, even expecting tires blowing out to stop the aircraft prior to end of the runway, but the aircraft excurses the runway, nose gear fall in a hole and collapses, results in stopping of aircraft 20 to 30 meters far from the end of runway.

first officer's report comments :

As stated by pilot in command after departing Ahwaz airport, flight 4525 is cleared to climb to FL 170 and continue via SITA plan route by Tehran Controller, but captain decides to continue via Mahshahr.

5 minutes prior to contacting with Bushehr Radar, Khark Island airport weather received via Khark information, as follows; CAVOK, wind 300°/16 knots.

Regarding to weather conditions, captain decides to perform a visual approach for RWY 31 via left downwind.

By contacting Bushehr Radar, the same weather conditions reported.

Flight 4525 cleared for VOR DME-1 RWY 31 at Khark Island by Bushehr Radar, but visual approach requested due to captain's decision, thereafter flight instructed to descend to 4,000 feet up to 20 NM.

At 20 NM and 5,000 feet, the flight 4525 cleared to descend to traffic pattern altitude and contacting Khark Island airport by Bushehr Radar.

Wind conditions, 300°/16 knots reported by Khark Information.

Flight 4525 cleared for right hand downwind by Khark Information. But Left downwind RWY 31 is requested due to captain's decision.

Due to aircraft landing weight of 38 tons (38,000 kg), V_{REF} is computed 119 knots.

At 10 NM, wind check requested, which reported 300°/10 knots.

Regarding to captain's reasons and experiences, he decided to continue and land on RWY 13.

Aircraft configured and respective checklists performed.

At approximately 300 feet MSL, he notices the aircraft speed was accelerated to 145 knots and informed the captain.

Captain responded by standard callout "Auto Brake Out".

Captain tried to correct the airspeed and immediately briefed the missed approach procedure (continuing for overhead and waiting for next instruction).

The aircraft landed around the touchdown zone, approximately 1,000 feet beyond the threshold of RWY 13.

After landing, spoilers extended brakes applied by captain, but the airspeed not decreased as much as enough in my mind.

Ground idle and spoiler yellow over green noticed, but not enough time for callout.

I tried to apply the brakes and after a few seconds later full brakes applied but it wasn't useful, the aircraft excurses the runway and stops after suffering a hard impact.

Senior purser's comments:

Aircraft landing has been performed normally.

After landing, brakes are applied several times (2 to 3 times).

In a short period of time, the event has been happened quickly.

Cabin floor just too close to L1 jump seat and near to cockpit crew door has been raised up, due to impact of nose landing gear strut which has been broken after runway excursion.

Just after the aircraft came to the rest, evacuation was announced by captain's callout "Evacuation from left side".

All 79 passengers, cockpit and cabin crew have been evacuated successfully.

Evacuation has been accomplished in less than one minute.

No body injured.

Eye witnesses:

The ground staff working around the apron, saying; the aircraft landed approximately 400 meters (1,310 feet) beyond the threshold of RWY 13.

1.19 Useful or Effective Investigation Techniques:

The standard and normal techniques for accident investigation were applied.

2. Analysis:

The flight scenario:

The aircraft took off from Ahwaz airport at 1257 LMT (0827 UTC) and continues to destination via flight plan route (NW to SE) and landed at Khark Island airport at 1335 LMT (0905 UTC).

At approximately 65 NM to destination and 5 minutes prior to contacting Bushehr Radar, first officer contacted Khark Island information and requested weather conditions which reported CAVOK, wind 300°/16 knots.

Captain decided to continue for visual approach, left downwind RWY 31 and briefed his first officer to have short time landing.

By the time of contacting Bushehr Radar, the weather reported the same as mentioned previously and the flight was cleared for VOR DME-1 RWY 31 at Khark Island. First officer requested visual approach RWY 31 as previous coordination by the pilot in command as flying pilot.

The flight, IRM 4525 was cleared for visual approach and also descending to 4,000 feet up to 20 NM to destination.

At 20 NM and passing through 5,000 feet, the flight 4525 was cleared to traffic pattern altitude and delivered from Bushehr Radar (approach).

By the time of contacting Khark Island information, weather conditions reported CAVOK, wind 300°/16 knots and the flight 4525 has been directed to proceed for Right downwind RWY 31.

First officer requested joining left downwind RWY 31 for visual approach and landing.

At 10 NM, wind direction and velocity reported 300°/10 knots by Khark Island information.

Regarding to tailwind limitation 15 knots mentioned in FCOM and Operations Manual (OM), the captain changed his mind immediately and decided to land on RWY 13.

First officer was directed by captain to request visual approach for RWY 13, which has been approved by Khark Island information.

The cockpit crew continued for Rwy 13, configured the aircraft for landing and completed the landing checklist with aircraft weight approximately 38 tons (38,000 kg), approach speed (target speed) 129 knots and V_{REF} 119 knots.

At 300 feet MSL, first officer noticed airspeed has been accelerating to 145 knots and made a standard callout “**airspeed 145 knots**”.

Note:

Regarding to FDR analyzing, airspeed at 300 feet MSL is 141 knots, at 190 feet MSL is 146 knots and at 105 feet MSL is 145 knots.

The captain prepared himself and his first officer to perform a landing on RWY 31, but he changed his mind at 10 miles on final approach (at the last portion of flight) and decided to land on RWY 13 as purpose of short time landing while reported wind was 300°/10 knots.

The captain accomplished an un-stabilized high-speed approach (approach speed accelerated to 145 knots at approximately 300 feet MSL on final).

While the first officer called out airspeed 145 knots, instead of performing a go-around, the captain called out “Auto Brake Out”, and just briefed his first officer about the first portion of go-around procedure.

From 10 NM on final approach up to aircraft touchdown, neither wind reported by Khark Island Information nor requested by cockpit crew (neither captain nor first officer).

Regarding to wind conditions (300°/10 knots) which reported at 10 miles on final, just 2 choices remained for landing, either RWY 13 (the worst one) and or RWY 31 (the best one), and the captain preferred to land on RWY 13. According to Meteorological factual information, much tailwind was estimated for this flight.

With relevant tailwind and geographical characters of Khark Island, the aircraft speed has increased unfortunately. Captain made “**airbrake out**” and tried to decrease the airspeed.

The aircraft crossed the threshold of RWY 13 and landed at approximately 685 meters (2,247 feet) beyond the beginning of the RWY 13.

❖ *According to aircraft flight manual performance chart regarding present wind speed and its direction the required runway length for safe landing was 1570 meters.*

The available RWY length was 2334 meters which was suitable for normal landing but missing 685 meters and failure of antiskid system made landing for this flight to the critical condition.

The Landing, FCOM, Vol.3, P.1, Chap.4, Topic 9, Normal Operation & Handling:

- *Page 12: Do not prolong the flare; a better stopping distance is achieved by touching down a little faster rather than floating down the runway, especially with a tailwind.*
- *Page 12: If the speed at the threshold is greater than VREF + 14 knots, a go around must be carried out because of the risk of landing nose wheel first.*
- *Page 12: Beware of tailwind landings: high ground speeds quickly use up the available landing distance.*

Note

According to OM, page 116 (8.Landing), do not prolong the flare; a better stopping distance is achieved by touching down a little fast rather than by floating down the runway especially with tail wind.

Note

If there is a need to make a short field landing, during the final stage of the approach extend the airbrakes and reduce the speed to cross the threshold at VREF 33 at a height of 50 feet. Aim to touchdown in the first 500 feet of the runway. Do not allow the aircraft to float. Select ground idle, deploy lift spoilers and commence maximum wheel braking.

As the approach to runway threshold was at 80 feet therefore the aircraft lost 700 feet from runway threshold and then touched down and had landing.

As pilots efforts to decrease aircraft speed but due to anti-skid failure the distance of landing was increased therefore aircraft run over the runway 13, finally stopped after passing 54 meters out of the RWY asphalt area.

Table 6.1		Landing Distance Required (m)						RJ100AM1A	
Flap 33°	Zero Slope		Runway State: Dry				Manual Landing		
Pressure Altitude (ft)	Weight (kg)	Tailwind (kt)			Headwind (kt)				
		15	10	5	0	10	20	30	40
Sea Level	28 000	1 270	1 160	1 050	950	890	830	780	730
	29 000	1 300	1 180	1 070	970	910	850	790	740
	30 000	1 330	1 210	1 100	990	930	870	810	760
	31 000	1 360	1 240	1 120	1 010	950	890	830	780
	32 000	1 390	1 270	1 150	1 030	970	910	850	800
	33 000	1 420	1 300	1 170	1 060	990	930	870	810
	34 000	1 460	1 330	1 200	1 080	1 020	950	890	830
	35 000	1 490	1 360	1 230	1 110	1 040	980	910	860
	36 000	1 530	1 390	1 260	1 140	1 070	1 000	940	880
	37 000	1 570	1 430	1 300	1 170	1 100	1 030	960	900
	38 000	1 610	1 470	1 330	1 200	1 130	1 050	990	920
	39 000	1 650	1 510	1 370	1 230	1 160	1 080	1 010	950
	40 000	1 700	1 550	1 400	1 260	1 190	1 110	1 040	970
	41 000	1 740	1 590	1 440	1 300	1 220	1 140	1 070	1 000
	42 000	1 790	1 630	1 480	1 330	1 250	1 170	1 100	1 030
	43 000	1 840	1 680	1 520	1 370	1 290	1 210	1 130	1 060
	44 000	1 890	1 730	1 560	1 410	1 320	1 240	1 160	1 080
	45 000	1 940	1 770	1 600	1 440	1 360	1 280	1 190	1 110
2 000	28 000	1 330	1 210	1 100	990	930	870	810	760
	29 000	1 360	1 240	1 120	1 010	950	890	830	780
	30 000	1 390	1 260	1 140	1 030	970	900	850	790
	31 000	1 420	1 290	1 170	1 050	990	930	870	810
	32 000	1 450	1 320	1 200	1 080	1 010	950	890	830
	33 000	1 480	1 350	1 220	1 100	1 040	970	910	850
	34 000	1 520	1 380	1 250	1 130	1 060	990	930	870
	35 000	1 560	1 420	1 290	1 160	1 090	1 020	950	890
	36 000	1 600	1 460	1 320	1 190	1 120	1 040	980	920
	37 000	1 640	1 490	1 350	1 220	1 150	1 070	1 000	940
	38 000	1 680	1 530	1 390	1 250	1 180	1 100	1 030	960
	39 000	1 730	1 580	1 430	1 280	1 210	1 130	1 060	990
	40 000	1 770	1 620	1 470	1 320	1 240	1 160	1 090	1 020
	41 000	1 820	1 660	1 510	1 360	1 280	1 200	1 120	1 050
	42 000	1 870	1 710	1 550	1 390	1 310	1 230	1 150	1 080
	43 000	1 930	1 760	1 590	1 430	1 350	1 260	1 180	1 110
	44 000	1 980	1 810	1 640	1 470	1 390	1 300	1 220	1 140
	45 000	2 040	1 860	1 680	1 520	1 430	1 340	1 250	1 170

Calculating runway distance missing and landing roll distance available:

Regarding to unavailable data to find out runway distance missing and landing roll distance available for the **no wind conditions**, following methods are used as follows:

Note 2: Counter is calculated in seconds.

Runway distance missing:

Counter (Seconds)	Time (Seconds)	Altitude AGL (feet)	IAS (Knots)
2221450	0	42 _(Note)	140.1
2221451	1	33	142.3
2221452	2	25	138.9
2221453	3	17	129.9
2221454	4	11	138.0
2221455	5	8	133.9
2221456	6	7	138.2
2221457	7	5	132.0
2221458	8	3	130.7
2221459	9	2	128.2
2221460	10	Touchdown	121.0
Total Elapsed Time: 10sec.		Sum of IAS: 1333.1 knots	

Note

Altitude (42 AGL feet) is computed into RWY 13 elevation.

Note

Normally crossing runway threshold occurs at 50 feet.

Note

Crossing RWY 13 threshold is happened higher than 42 feet AGL.

Total elapsed time: 10 seconds from **42 feet AGL** up to **touchdown point**.

Sum of IAS: 1333.1 knots from **42 feet AGL** up to **touchdown point**.

1333.1 knots / 10 = 133.31 average IAS in one hour (3600 seconds).

Distance travelled in 10 seconds (Simple Equation):

Average IAS (133.31 knots) * 10 seconds / 3600 seconds = 0.370305 NM.

0.370305 * 1852 meters * 3.2808 feet = 2247.348 feet(685M), runway length missing.

7657 feet (Runway length) – 2247 = 5410 feet, remaining runway available.

Runway distance available:

Counter (Seconds)	Time (Seconds)	IAS (Knots)
2221460	Touchdown point	121.0
2221461	1	122.9
2221462	2	121.8
2221463	3	121.5
2221464	4	98.8
2221465	5	121.0
2221466	6	119.7
2221467	7	112.9
2221468	8	116.4
2221469	9	110.2
2221470	10	106.3
2221471	11	109.3
2221472	12	106.7
2221473	13	104.2
2221474	14	96.3
2221475	15	91.5
2221476	16	82.5
2221477	17	74.2
2221478	18	70.7
2221479	19	67.7
2221480	20	60.2
2221481	21	57.2
2221482	22	52.8
2221483	23	51.2
2221484	Runway excursion	50.5
Total Elapsed Time: 24 sec.		Sum of IAS: 2347.5 knots a

Sum of IAS = 2347 knots from **touchdown point** up to **runway excursion**.

2347 knots / 24 = 97.81 knots, average IAS in one hour (3600 seconds).

Distance travelled in 24 seconds from **touchdown point** up to **runway excursion (Simple Equation):**

Average IAS (97.81 knots) * 24 seconds / 3600 seconds = 0.652NM.

0.652 NM * 1852 meters * 3.2808 feet = 3691 feet, travelled runway length.

7657 feet (Runway length) – 3691= 3966 feet, runway length missing.

Results:

Regarding to captain's report, first officer's report, and the eye witness's orally reports, the result of calculating and comparing all these information tells us; the captain misses minimum 2,247 feet of runway distance available and runway distance available for landing would be 5,410 feet (Landing roll distance was observed).

Technical Investigation:

1. Methodology:

The evaluation is based on data extracted from Quick Access Recorder (QAR) of Aircraft.

A comparison is done for 2 other landing which was performed normally at Khark airport by the very aircraft. In order to simulate the approach, a reverse motion is calculated consisted with QAR records. The first uncommon severe G-shock made by an impact to a puddle is considered as the 0 point for the calculation.

2. Engineering analysis:

The aircraft examination revealed no defects that could show lift spoilers that it was not deploying .

2.1. Lift Spoiler Deployment:

In comparison to lift spoiler deployment time of 2 sample normal flights, in this landing was respectively 3 and 4 minutes of later deployment is observed in FDR records. In addition to that, 8 seconds of spoiler deployments seems to be later than limits mentioned in operation manual of the aircraft.

2.2. Landing roll deceleration Rate:

To examine the performance of run out deceleration systems, the period between touch down and reach point to 50 knot is studied. Table 1 illustrates speed decreasing of MOF during 3 flights in this period.

Apparent delayed touchdown was happened during crash flight. As it is shown by diagram, the aircraft touched the runway almost 8 seconds later than two other normal landings of itself. Therefore, a part of Landing Distance Available (LDA) was missed. Due to relatively short length of Khark runway, it could be a very effective factor to restrict safe landing assurance.

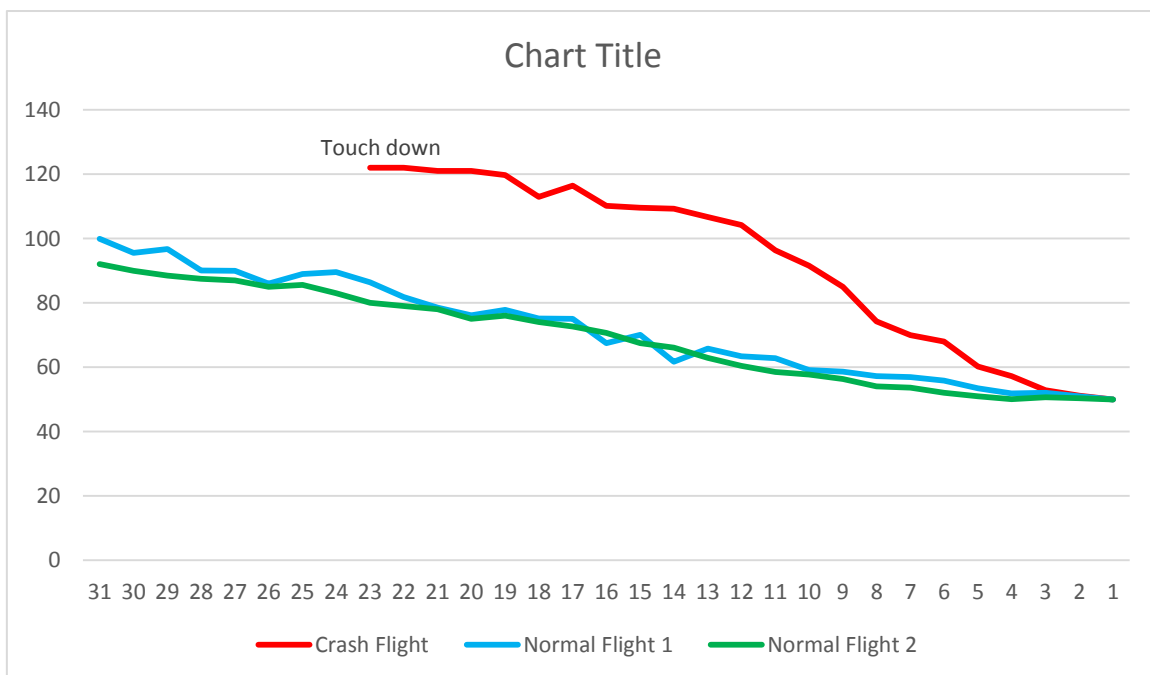


Figure 1. Deceleration Comparison of 3 flights

2.3. Elevator position during the landing roll:

It was not possible to determine the control column position by analysis of the aircraft's recorded pitch attitude. However, as the aircraft's attitude after touchdown peaked at -2° , 2° lower than that recorded on the two previous landings at Khark, and was sustained below this value for some 26 seconds, it is possible that a forward position of the control column could have been a contributing factor to this. The manufacturer has advised that any excessive forward movement of the control column during the landing roll will contribute to a reduction of the aircraft's weight applied to its main landing gear wheels, and hence delay the full effectiveness of the wheel brakes.

3. Performance Analysis:

3.1. Missed runway by touch delay:

In order to estimate length missed because of touch down delay, 8 second delay period before touch is studied. According to indicated airspeed and the distance in which the aircraft had traveled over the runway is calculated.

First, timely table of aircraft air speed during these 8 seconds is presented and relative distance passed in each second is calculated.

So in comparison to 2 other landings the pilot had missed 548 meters more of LDA (Table 1).

3.2. Maximum ground rolling distance:

Based on reports, at least 10 knots of tail wind was flowing at landing phase. This tail wind reduces Indicated Air Speed (IAS) value. It means that ground speed of aircraft was at least 10 knots more than IAS. However, in this study we will ignore tail wind to gain a reliable result as Maximum ground rolling distance in landing.

	Touch(1)	2	3	4	5	6	7	8
IAS (knots/H)	128.2	130.7	132	138	133	138	129	138
Passed Distance (Meters)	66	67	68	71	68	71	66	71
Total	548 meters of missed distance over the runway							

Table 1. Difference of crash touch down point to 2 sample flights

3. Conclusions:

3.1 Findings:

- The cockpit crew was certified to fly with the aircraft.
- Aircraft certification was according to IRI CAO regulations.
- The captain decides to make a landing on RWY 13 while the wind is reported 300°/10 knots. The evidences show that real wind was more.
- The last wind information which is reported to the cockpit crew was 10 NM on final and thereafter, never the wind was reported by Khark Island information nor requested by cockpit crew before touch down.
- Since the Khark Island ATS airport did not give clearances regarding approach and landing (category of airport is G), the captain was responsible of his flight safety.
- Despite tailwind, deceleration rate of the aircraft do not support assumption of possible failure in airbrake and brake system. Also, QAR shows deployment of lift spoilers.
- A un- stabilized approach was performed.
- Long distance of runway was passed at the time of touch down.
- The pilot used high brake effectivity to stop the aircraft but the failure of anti-skid on RH landing gear increased distance of landing.
- Four predominant factors were identified; high approach speed, short runway length, landing with a tailwind component and Anti-skid failure.

3.2 main Cause:

The main cause of this accident is wrong behavior of the pilot which described as:

- Decision to make a landing on short field RWY 13 with tailwind.
- Un stabilized landing against on normal flight profile
- Weak, obviously, CRM in cockpit.
- Poor judgment and not accomplishing a go around while performing a un-stabilized approach.
- Improper calculating of landing speed without focusing on the tailwind component

3.3 Contributing factors:

- Anti-skid failures of RH landing gear causing prolong landing distance.
- Instantaneous variable wind condition on aerodrome traffic pattern.
- Late activating of airbrakes and spoilers (especially airbrakes) with tailwind cause to increase the landing roll distance.

3.4 Other found deficiencies:

- **Route Check;** No cockpit crew's Route Check in their training file.
- **Jeppesen Manual;** No updated airport layout chart in Jeppesen manual at the time of accident.
- **SOP Manual;** SOP Manual not updated and maximum tailwind not mentioned in it.
- Clearway does not exist for Khark Island Airport

4. Safety recommendations:

- Civil aviation Authority of IR Iran should make a process for harmonizing all the Iranian airports supervision and standard Publication of airport information in Iranian AIP.
- The manufacturer should investigate the possibility of improvement in the Cockpit for Anti-skid failure, which the cockpit crew can be warned about failure of the related system.
- Amount of tailwind (**15 knots**) mentioned in FCOM, should decrease to **10 knots** as a safety factor in the short field RWY and be written in Operations Manual (**OM**) as well as (**SOP**) considering **CAO** approval.
- All pilots shall review the intended destination airports as required in Aeronautical Information Publication (AIP) during briefing in dispatch office.
- Flight Operation Department of airlines identify those airports which may have possible insufficient / variable wind condition and notifies all pilots as a safety concern.