

Occurrence Investigation Report
Runway Excursion
Aircraft Overran the Runway during Landing
Solitaire Air
Boeing 737-300 JY-SOA
King Hussein Airport, Aqaba, Jordan
RYW 6888
AMM-AQJ
17September 2017

OBJECTIVE

This investigation has been performed in accordance with Jordan Civil Aviation Law No. (41), 2007, Article 33, and in conformity with ICAO Annex 13. The format of this report is adapted from the Final Report Format as laid down in Chapter 201.85 in CARC Part 2201, Aircraft Accident Investigation Manual.

An investigation was performed based on CARC CEO letter 31/01/508/3756, dated 17/09/2017, since the subject Aircraft had encountered a Runway Excursion in Aqaba Airport and stopped approximately 890 feet in the unpaved area.

The sole objective of this investigation is to prevent the recurrence of similar incidents in future. It is not the purpose of this investigation to assert blame or liability.

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TERMINOLOGY

AAID	CARC Aircraft Accident Investigation Department
ACMI	Aircraft – Crew – Maintenance and Insurance (wet lease)
AIB	Kingdom of Saudi Arabia – Aviation Investigation Bureau
AIP	Aeronautical Information Publication
AGL	Above Ground Level
AMM	Queen Alia International Airport (ICAO Code OJAI)
AQB	a VOR station near AQJ
AQC	NDB station near AQJ
AQJ	King Hussein International Airport (ICAO Code OJAQ)
ASDA	Accelerate Stop Distance Available
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot License
CARC	Jordan Civil Aviation Regulatory Commission
CEO	Chief Executive Officer
CMP	Customized Maintenance Program
CPL	Commercial Pilot License
CRM	Crew Resource Management
CSN	Cycles Since New
CSO	Cycles Since Last Overhaul
CVR	Cockpit Voice Recorder
dba	doing business as
DWC	Al Maktoum International Airport (ICAO Code OMDW)
ELP	English Language Proficiency
ETA	Estimated Time of Arrival
FCOM	Flight Crew Operations Manual
FDR	Flight Data Recorder
FDM	Flight Data Monitoring
FDP	Flight Duty Period
FT	Feet (dimension)
GPWS	Ground Proximity Warning System
HFAC	Human Factors Analysis and Classification
ICAO	International Civil Aviation Organization
IIC	Investigator in Charge
ILS	Instrument Landing System
IR	Instrument Rating
JCAR OPS 1	Jordan Civil Aviation Regulation governing – Commercial Air Transportation - Airplane
LDA	Landing Distance Available
LH	Left Hand Side
LSV	Last Shop Visit
LT	Local Time
M	Meter (dimension)
MAC	Mean Aerodynamic Chord
MLG	Main Landing Gear
NDB	Non Directional Beacon (a type of radio navigation system)

NLG	Nose Landing Gear
NM	Nautical Miles
NOTAM	Notification to Airmen
NTSB	National Transportation Safety Board
OCC	Operations Control Center
OM-A	Operations Manual Part A, GENERAL/BASIC, provides policies and operations procedures
OM-B	Operations Manual Part B, TYPE SPECIFIC, provides aircraft limitations and SOP
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PM	Pilot Monitoring
QAR	Quick Access Recorder
OFZ	Obstacle Free Zone
QNH	Altitude Above Mean Sea Level based on Local Station Pressure
QRH	Quick Reference Handbook
RFF	Rescue and Fire Fighting
RH	Right Hand Side
RWY	Runway
RYW	Royal Wings (call sign designator)
SAW	Sabiha Gökçen International Airport (ICAO Code LTFJ)
SMS	Safety Management System
SN	Serial Number
SSH	Sharm El Sheikh International Airport (ICAO Code HESH)
SWY	Stopway
SOP	Standard Operating Procedures
TODA	Takeoff Distance Available
TORA	Takeoff Run Available
TSN	Time Since New
V _{REF}	Landing Reference Speed at a point 50 feet above the landing threshold
VNAN	Vertical Navigation
VOR	Very High Frequency (VHF) Omni-Directional Range (a type of radio navigation system)

Whenever the following words are mentioned in this Report with first Capital letter, they shall mean the following:

(Aircraft)- the Aircraft involved in this serious incident;

(Investigation)- the investigation into the circumstance of this serious incident;

(Incident)- this investigated serious incident;

(Captain)- the Pilot in Command of the incident flight;

(Copilot)- the Copilot of the incident flight;

(Controller)- the air traffic Controller officer that was communicating with the Aircraft;

(Report)- this serious incident Final Report.

(Flight safety documents) - A set of interrelated documentation established by the operator, compiling and organizing information necessary for flight and ground operations, and

comprising, as a minimum, the operations manual and the operator's maintenance control manual

(Operations manual) - A manual containing procedures, instructions and guidance for use by operational personnel in the execution of their duties.

(Flight Duty Period): is any time during which a person operates in an aircraft as a member of its crew. The FDP starts when the crew member is required by an operator to report for a flight or a series of flights; it finishes at the end of the last flight on which he/she is an operating crew member. Flight Duty Period begins 60 minutes prior to the flight departure and ends 30 minutes after flight arrival.

(Findings)- are statements of all significant conditions, events or circumstances in this Incident. The findings are significant steps in this Incident sequence but they are not always causal or indicate deficiencies.

(Causes)- are actions, omissions, events, conditions, or a combination thereof, which led to this Incident.

(Contributing factors)- are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the accident or incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

Notes

Unless otherwise mentioned ,all times in this Final Report are UTC time (Local time + 3 hours).
Photos and figures used in this Final Report are taken from different sources and are adjusted for the sole purpose to improve the clarity of the Report.

Aircraft Operator: Solitaire Air (dba – FlyJordan)

Category of the Occurrence: Aircraft Serious Incident

Aircraft Type: Boeing 737-300

Registration: JY-SOA

Location of Accident: King Hussein Airport, Aqaba, Jordan

Date and Time: 17 September 2017 at 8:35 am

SYNOPSIS

On 17 September 2017, the Jordanian Airline Fly Jordan Solitaire Air, “Boeing 737-300, JY-SOA”, departed from Queen Alia International Airport (OJAI) to King Hussein Airport (OJAQ) at 04: 47:58 UTC with flight number RYW6888 Amman - Aqaba - Dubai, on behalf of Royal Wings Company on a Wet Lease bases (ACMI). The flight departed OJAI with a delay of 47 minutes from the scheduled departure time due to late boarding of passengers.

the Copilot was the pilot flying and the Captain was the pilot monitoring until the controls were transferred to the Captain before touchdown as the Copilot was unable to land the Aircraft on the runway.

During cruise the crew realized that the delay before departure will negatively affect their duty time and consequently asked for straight approach on runway 19 to save time. The ATC Controller informed the crew that the wind is varying with speeds between 10 - 12 knots and another traffic was expected to depart runway 01 within short time. The Captain of the flight accepted the prevailing wind condition at runway 19, however, no agreement was made yet to land runway 19.

At 35 miles from AQB VOR the ATC contacted the crew and asked them if they there are able to maintain their speed to continue landing on runway 19, the crew accepted and continued to a straight in approach.

During final and after dropping the landing gear, the Aircraft was not configured to the correct landing configuration, the flaps were set to configuration one at height of 650 ft AGL, multiple GPWS aural warning were triggered but disregarded by the crew. the high speed approach was not corrected by the crew efficiently and the aircraft continued to landing runway. the Aircraft passed the threshold at 115 ft radio altitude at flaps 5 and continued along the runway to the point when the flaps were selected to 30 at 90 ft radio altitude.

The Aircraft floated over the runway and pilot flying was unable to land it. The Captain took the controls over and managed to put the Aircraft on the runway but with relatively higher than normal speed. The Aircraft touched down at 7400 ft beyond the runway threshold. The airplane came to a stop 10,600 feet beyond the runway threshold (600 feet inside the soft area), and around 200 feet right of the extended runway centerline.

A notification was passed to CARC investigation department immediately from AQJ airport and an investigation was performed based on CARC CEO letter 31/01/508/3756, dated 17/09/2017, since the occurrence is categorized as a serious incident.

INVESTIGATION PROCESS

The Aircraft Accident Investigation Department (AAID) /Jordan Civil Aviation Regulatory Commission (CARC) was notified that a Solitaire Air (Fly Jordan) Boeing 737-300 ,JY-SOA had encountered a runway excursion.

The occurrence was classified as a Serious Incident in accordance with ICAO Annex 13 and the AAID opened an investigation File (SER/002/2017).

The investigator-in-charge (IIC) was appointed by the chief commissioner. and per Annex 13 the state of manufacture that is United States National Transportation Safety Board (NTSB) was notified and assigned an accredited representative to the investigation.

The Aircraft recorders, Digital Flight Data Recorder (DFDR) and Cockpit Voice Recorder (CVR) were downloaded in the Kingdom of Saudi Arabia Investigation Bureau facility , Aviation Investigation Bureau (AIB) and data for the Incident flight was sent to the NTSB for in-depth analysis. The Flight Crewmembers were Interviewed by the Investigation Committee and all post holders of Solitaire Air and Royal Wings were interviewed as the Aircraft was on a Wet Lease operation. Alcohol and drug test was made for the operating crew.

The information contained in this Final Report is derived from the factual information gathered during the investigation of the Incident.

The following factors are believed to be the main causal factors of the occurrence:

1. *A delay on ground OJAI for 47 minutes influenced crew decision to land on RUNWAY 19 at OJAQ to save time.*
2. *The straight in, unstabilized approach was the main result of the aircraft high energy status for the consecutive phases out from 1000 ft down to the touchdown point.*
3. *The higher than allowed tailwind component which indicates 11 knots on runway 19.*
4. *Incorrect landing configuration was a contributing factor for aircraft high speed and explain pilot flying inability to control the prolonged float of the Aircraft and to roll it out.*
5. *The pilot monitoring (Captain) was aware of the tailwind, however he accepted the prevailing conditions without discussing the operational limitations of the Aircraft with the pilot flying.*
6. *Crew inaction to discontinue the unstabilized approach and execute a go around helped in the developed situation.*
7. *Crew poor situational awareness and lack of coordination.*
8. *Deliberate Disregard of the aural warnings without correcting the Aircraft attitude.*
9. *Crew resource management (CRM) was not evident during the approach phase of flight. The pilot flying did not carry out the proper approach and landing checklist.*
10. *Deviating from standard operating procedures required to conduct a safe landing and as outlined in the aircraft operations manuals.*
11. *Not recognizing the two critical elements, namely fixation and complacency that affected pilots decision to land the aircraft while the approach was not meeting the criteria of stabilized approach.*
12. *Negative organizational factors were evidenced in terms of operational pressure that was exerted by the management of Solitaire air.*
13. *Noncompliance to state regulations regarding the proper training of crews as the CRM training was not completed in a correct way for the PIC.*
14. *Inability to identify the threats and manage the errors encountered during the approach and landing phases . Threat and error management was not evident during the flight.*

1 FACTUAL INFORMATION

1.1 HISTORY OF THE FLIGHT

On 17 September 2017, the Jordanian Airline FlyJordan - Solitaire Air "Boeing 737-300, JY-SOA" departed from Queen Alia International Airport (OJAI) to King Hussein Airport (OJAJ) at 04:47:58 with flight number RYW6888 Amman - Aqaba - Dubai, on behalf of Royal Wings Company on a Wet Lease bases (ACMI). With a delay of flight scheduled according to the "Flight Plan" about 47 minutes.

There were 126 persons onboard the Aircraft consisting of two Flight Crewmembers and 4 Cabin Crew. The flight crew consisted of the Commander and the Copilot. The Commander was the pilot monitoring (PM) and the Copilot was the pilot flying (PF).

At 04:44:00 clearance for taxi after pushback and engine start was requested by the crew. The air traffic controller gave clearance to the pilot of the Airplane for taxi to the Runway in use RWY 26R.

During the Aircraft taxi the CVR reflect the checklist performed by the Flight Crew and received a call from air traffic controller requested Flight Crew to speed up the taxi in order to allow the Aircraft departure as another aircraft was expected to land.

At 04:45:12 the Captain informed by chief of Cabin Crew that Cabin secured and Captain instructed them to be seated for takeoff.

At 04:45:55 the Captain informed the air traffic controller that Royal Wings 6888 ready for departure.

After takeoff At 04:47:04 the ATC clearance was given to Flight Crew: Royal Wings 6888 to maintain Runway heading until passing 5000feet and the read back done by the Captain.

At 04:48:24 After establishing contact with Amman radar frequency 128.9, the flight was cleared to FL180 and to maintain RWY heading. And Auto pilot engaged at 04:48:50

At 04:49:35 the takeoff check list was completed.

At 04:49:52 the flight RYW 6888 was cleared to proceed BAKIR point and the read back confirmed by the Captain.

At 04:50:23 the Captain established a call with OCC and reported the departure and estimated arrival times with the total number of passengers on board.

At 04:55:10,(08 minutes after departure) Flight RYW6888 has established radio contact with Aqaba approach and advised that estimated time of arrival (ETA) will be at 05:20 UTC.

Landing information was copied by the crew at 04:55:50 UTC with a wind report 010/11 and eight kilometers haze weather, QNH1012, temperature twenty six and dew point seventeen and the RWY in use 01.

The crew were discussing the planned RWY in use and elected to as for RWY 19 with a straight in approach instead of inbound procedure to RWY 01.

Shortly after, The flight has been released to Aqaba approach and has established full radio contact with Aqaba approach, while maintaining FL180

The flight crew has reported a release to Aqaba approach (from Amman approach) at time 04:59:00 while maintaining FL180 and asked for the possibility to use RWY for landing if traffic permit.

Aqaba ATC has confirmed the wind speed to the flight crew and reported a variable wind of ten to twelve knots and reported that an expected flight will depart runway 01 within 15 minutes.

The flight crew acknowledged and accepted the prevailing condition on runway 19 and confirmed proceeding to BAKIR with a clearance to descent to 8000 feet. The controller told the flying crew of the incident flight that he will check the possibility to grant them a permission to land runway 19.

The controller did not report to the flying crew of the incident flight that they can use runway 19 until after 7 minutes from crew request. meanwhile the Flight crew came to agree to prepare for a landing on Runway 01 and the COPILOT. transferred the control to the Captain in order to enter the data for landing runway 01.

At 05:06:04 and at about 35 N.M from AQB Aqaba approach asked the crew if they can maintain high speed to give them a permission to land runway 19, the Captain confirmed that while Aircraft altitude at that time was FL160.

At 05:06:33 Aqaba has cleared the flying crew to descent to 7000 feet and proceed to AQC.

At 05:06:37 Aqaba approach has cleared RYW6888 for a straight in approach to runway 19.

Aqaba approach asked about flight position advising confirmed AQC and replied by the Crew affirmative and confirming the straight in approach for runway 19.

After that the Copilot. transferred control to the Captain in order to enter the new approach data for the selected runway,

The Copilot. reported that the ILS at runway 19 is Inoperative, the Captain advised him to keep VNAV. Then the Copilot. Took the control again. the crew reported at AQC point and established on final.

At 05:10:00 The flight crew has confirmed establishing the final approach to the ATC controller who in turn asked the crew to change to tower frequency 118.1MHZ.

Tower frequency was established assuring that the aircraft is in sight and confirming that runway 19 is in use for landing while the wind is 10 to 12 knots.

At approximately 1600 feet radio altitude ATC contacted the crew and subsequently cleared them to land. During the remainder of the approach, the GPWS was activated several times due high rate of descent and incorrect landing configuration, the Captain told the copilot to reduce speed, disregard the aural warnings and to continue the landing

The Aircraft passed the threshold at 115 ft radio altitude at flaps 5 and continued along the runway to the point when the flaps was selected to 30 at 90 ft radio altitude.

The aircraft has touchdown the runway at time 05:12:43 UTC around 7400 feet beyond RWY 19 threshold; (2650) feet prior to the end of the paved surface of RWY 0, and went off the runway few seconds after landing the aircraft stopped at 890 feet beyond the end of runway 01 threshold. [Figure 1.1](#) (represent the ground track of the aircraft along the runway and the final position)

No passengers or crew were injured, Passengers were advised to remain seated until disembarked

The RFF team at AQJ reported to the site and transported the passengers to the terminal by buses.

The Incident scene was secured by airport management unit the arrival of CARC investigators. The necessary medical examinations for drugs and alcohol was made to the incident flight crew after a request by the investigation committee. The runway was closed as the aircraft was

obstructing the safe operation of the runway and affecting runway instruments performance and safety to other operations and for that purpose, an announcement in the form of a NOTAM was issued for the closure of the airport to 13:00 UTC. The NOTAM was amended two times and closing the runway has extended to 04:00 on Monday 18/9/2017 until the aircraft was removed.

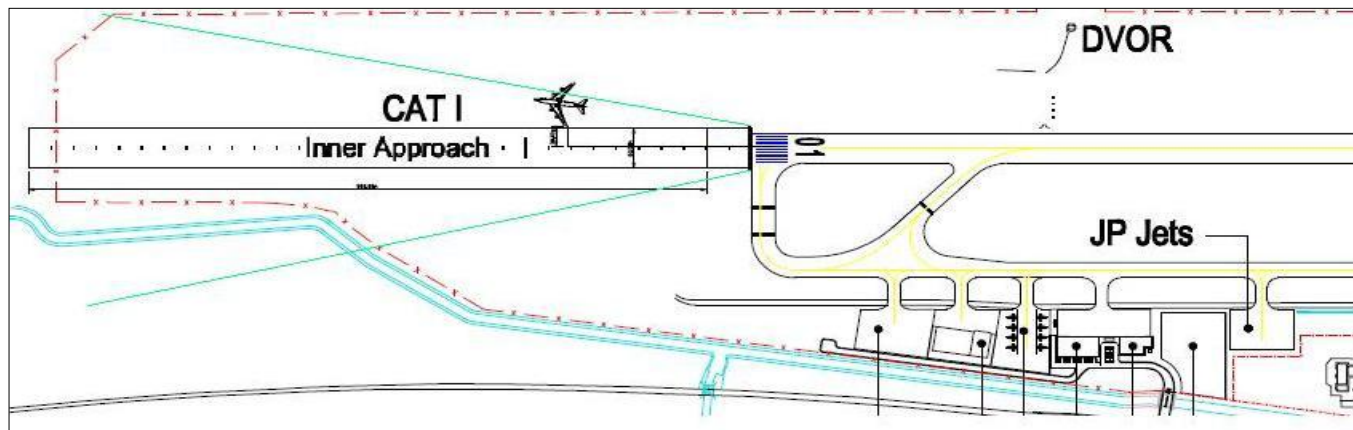


Figure 1.1

At 3:30 am on Monday 18/9/2017, the Airplane was transferred to the maintenance tarmac and a NOTAM declaring the runway availability was issued after making the necessary inspections for the Runway by the ground operations at the airport.

[Figure 1.2](#) below shows the aircraft at its final position while disembarking the passengers



Figure 1.2

1.2 INJURIES

There were no reported injuries among the passengers or crew

Injuries	Flight Crew	Cabin Crew	Passengers	Total Onboard	Others
Fatal	0	0	0	0	0
Serious	0	0	0	0	0
Minor	0	0	0	0	0
None	2	4	126	132	0
Total	2	4	126	132	0

1.3 DAMAGE TO AIRCRAFT

Aircraft sustained substantial damage while moving over uneven and unpaved surface and was grounded for necessary repairs and maintenance.

also No. 2 engine S/No. 860151 had ingested some sand due to the very close proximity to the ground and the dust generated while the aircraft was rolling on the ground. Some leakage and damage were sustained by the R/H Main Landing Gear damper which Boeing company recommended changing it, Minor damages to the lower structure of the aircraft were observed which had to be evaluated by Solitaires approved AMO (JORAMCO) and repaired as required. Solitaire Air were ordered to consult the Boeing Company regarding the damages sustained by the aircraft and take all necessary repairs as required.

The following damage was reported by the approved maintenance organisation contracted to the operator after an extensive assessment

I. AIR FRAME AND AIRCRAFT SKIN DAMAGE:

1. Under wing input fairing leading edge damaged.
2. Left outer flap inner jack screw was damaged;
3. RH pack access door with dent at external surface AFT side area, with dent.
4. RH fuselage skin external surface between STA 344/ 360. Found with dent.
5. LH fuselage skin external surface between STA 440/ 500. Found with 3 each dents between 9/ 10 o'clock position.
6. LH wing leading edge inboard flap (2nd flap nose) edge with crack.
7. LH wing lower surface inboard FWD panel torn out.
8. LH wing flap fairing #2 at AFT lower surface with damage and crack (read 40 mm in length).
9. LH and RH fixed wings LE with scratches.
10. LH and RH INB & O/B flaps trailing edge lower surfaces with dents.
11. RH spoilers #7 and 8 with dents.
12. RH slats #4, 5 & 6 leading edge with scratches.
13. RH wing upper surface FWD of spoiler #5 with dents.
14. RH pylon upper surface MID panel with 2 each screws missing.
15. RH and LH wings Inboard AFT flaps trailing edges upper surfaces with dents.
16. LH wing FWD of spoiler #4 with 1 each dent.

II. AIRCRAFT POWER PLANT:

1. severe damage to No. 1 Engine S/No. 860172 due to the impact with approach lights the damage was observed in the following:
 - a) damage to the outer fan blades, as illustrated in [figure 1.3](#).
 - b) sever damage to the inlet nose cowling, as illustrated in [figure 1.4](#)
 - c) Borescope found out of limit findings at the majority of stages 1-9 along with massive solid sand build ups at HPT, Combustion Chamber, and Shroud and NGV.
 - d) Air inlet cowl, fan blades, thrust reverser and blocker doors and fan cowl found with impact and damage.
 - e) Solid sand buildup on both engines as illustrated in [figure 1.5](#) and [figure 1.6](#)
2. No severe damages were reported on Engine No. 2.

Nevertheless, solitaire air elected to drop both engine as the number of cycles available for Engine No. 2 was limited and both were sent to overhaul shop.



Figure 1.3



Figure 1.4



Figure 1.5



Figure 1.6

III. LANDING GEAR:

1. All MLG wheels and tires with damage. (tires at the incident scene illustrated in [figures 1.7](#) of the LH MLG and [figure 1.8](#) of RH MLG)
2. LH MLG damper apex joint pin slight out of position, as illustrated in [figure 1.9](#)
3. RH MLG damper with body leaking and dent.
4. All MLG wheels bearings noisy with roughness.
5. Brakes #1, 2 and 3 with scratches at lower side.
6. Wheel #1 outer bearing outer seal torn out
7. All brakes are dirty with accumulated sand and small stones between the brakes discs.
8. LH and RH MLG shock strut outer surfaces with scratches and nicks
9. LH and RH MLG lower lateral axle areas with scratches.
10. LH MLG damper apex joint pin out of position.
11. RH MLG damper/ upper torsion link with body leaking and dent as illustrated in [figure 1.10](#)
12. LH MLG speed transducer harness not secure due to attachment clamp broken.
13. LH MLG tier #2 speed transducer shaft hard to rotate.
14. NLG LH outboard axle position with 2 areas with chrome detachments (in the following places):
 - a. at 12 o'clock position with L=5.2 mm; w= 4.1mm
 - b. at 12 o'clock – 3 o'clock position with L= 25.8; w (max) = 2.6 mm
15. NLG LH wheel hub with damage.
16. NLG LH and RH tire with damage.
17. NLG LH and RH axle spacers with wear.

All landing gears were replaced after a one off flight exemption to AMM as the landing gears were due to replacement according to company CMP



Figure 1.7



Figure 1.8

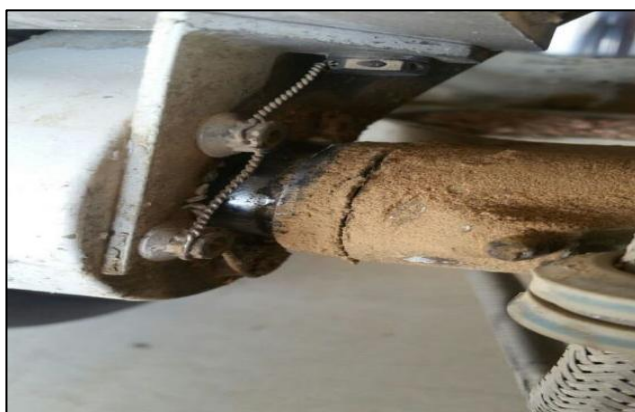


Figure 1.9

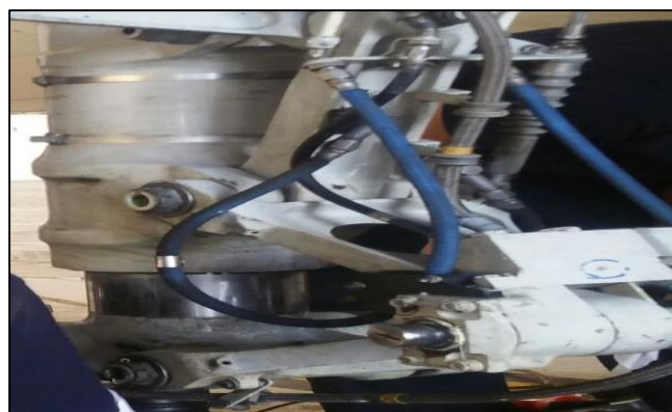


Figure 1.10

IV. CABIN AND INTERIOR

1. Cabin ceiling panels between seats #19 and 23 LH & RH sides with minor cracks at lower corners.
2. Cabin ceiling panels between seats 9 and 11 and at seat #19, found slight out of position.

1.4 OTHER DAMAGES

Three of the approach lights located in RWY 01 threshold were damaged in addition to one metal sewer cover in addition to one concrete sewer cover .

1.5 PERSONAL INFORMATION

1.5.1 FLIGHT CREW INFORMATION

	PIC	COPILLOT
Age	43	29
Certificate Type	ATPL / B 737	ATPL / B737
Valid to	7 April 2018	17 Oct 2019
Medical Class	Class 1	Class 1
Valid to	31 Sep 2018	21 May 2019
ELP	Level 5	Level 4
Valid to	1 October 2019	Nov 2017
Total Hours	7102:45 Hours	1662 Hours
Total on Type	6973: 45 Hours	1469 Hours

	PIC	COPILLOT
Total as PIC on Type	3223: 45 Hours	N/A
Total Hours last 30 days	74	76 Hours
Total Last 72 hours	6:35 Hours	0
Total last 24 Hours	0	0

The PIC has graduated from the Royal Jordanian Air Academy on 6 Sep1999 and obtained a CPL / IR license, then obtained the type rating on B737 in one of the Jordanian airlines. The PIC occupied management positions in flight operations in his previous company. He joined Solitaire air on 1 May 2017 and he was accepted by CARC as hold Flight Operations PH for Solitaire air in addition to his duties as a captain on line. The training records of the PIC shows that he made the required conversion course in accordance to JCAR OPS1 regulations. However, during the course of investigation and the oversight activity carried out by CARC Flight Operations Inspectors that one of the courses required in the conversion was not completed properly as the course instructor who was the accountable manager for Solitaire air falsified the training record of the PIC and signed the related attendance sheet while the PIC was attending another course.

The copilot of the incident flight graduated from the Middle East Aviation Academy in 2009 where he obtained his CPL / IR license. He started his career in airlines since April 2010 to August 2010 where he worked in Ground Operations then on 8 April 2012 till 14 August 2012 he was flying as a First Officer Assistant until he obtained his B737-300 Type rating. He Joined Solitaire Air on 22 June 2017 and flew as a copilot with an ATPL license. No observation were made on the copilot raining and conversion requirements.

1.5.2 AIR TRAFFIC CONTROLLER INFORMATION

The air traffic controller responsible for handling the incident flight, held a valid license issued by the CARC. In addition, he had several years of experience at this control tower and had completed the required competency checks and training.

1.6 AIRCRAFT INFORMATION

1.6.1 GENERAL INFORMATION

Manufacturer	The Boeing Company
Type	B737-300
Nationality and Registration	Jordan, JY-SOA
Aircraft Serial Number	29338
Year of manufacture	1999
Power plant (Engines)	Two CFM56 3C1 turbofan engines
Configuration	Passenger
Total airframe hours	29697:4 at 17 September 2017
Total airframe cycles	26622 at 17 September 2017
Last Weighing Report	07 May 2015
Center of Gravity	16.43 % MAC
Certificate of Registration	No. 584 date of Initial Issue 22/12/2015. Date of Re-Issue 12/10/2016
Certificate of Airworthiness	First issue 22/12/2015. Expiry 21/12/2017
Airworthiness Review Certificate	Renewed 21/12/2016. Expiry 21/12/2017

1.6.2 ENGINES INFORMATION

Engines type	Position	Date of Installation	S/N	LSV Date	TSN	CSN	CSO	TSO
CFM56-3C1	#1	4-Nov-2011	860172	21-Jun-2011	30794.4	27519	2538	2908.4
CFM56-3C1	#2	4-Nov-2011	860151	17-Jul-2011	30185.4	27193	2538	2908.4

1.6.3 AIRCRAFT DESCRIPTION

The B737 is a twin-engine Aircraft of conventional two wheel landing gear. The main wheels are numbered from 1-4, from left to right across the Aircraft. The systems used for retardation during the landing ground roll are ground spoilers fitted to the wings; engine thrust reversers and wheel brakes. The ground spoilers are normally set to deploy automatically on landing in order to reduce residual lift from the wings during the subsequent ground roll and thus improve the effectiveness of the wheel brakes. Thrust reversers are selected manually.

1.6.3.1 GROUND PROXIMITY WARNING SYSTEM

The aircraft manufacturer describes the EGPWS system installed on B737 aeroplanes as a system that provides alerts for potentially hazardous flight conditions involving imminent impact with the ground.

In addition to providing the protection of GPWS, the EGPWS monitors terrain proximity using an internal worldwide terrain database. Proximate terrain data show on the navigation display. If there is a potential terrain conflict, alerts are provided based on estimated time to impact. These alerts are "Look-ahead terrain alerts".

the EGPWS provides alerts based on radio altitude and combinations of barometric altitude, airspeed, glide slope deviation, and airplane configuration.

The alerts are for:

- Excessive descent rate
- Excessive terrain closure rate
- Altitude loss after takeoff or go-around
- Unsafe terrain clearance when not in the landing configuration
- Excessive deviation below an ILS glide slope
- These alerts are "radio altitude based alerts"

Ground proximity alarms are given by voice aural alerts accompanied by a visual annunciation on the altitude indicators and/or illumination of panel lights.

More information related to the EGPWS aural warnings that were identified during the course of investigation are discussed in the analysis part of this report.

1.6.3.2 AIRCRAFT WEIGHT

Before the flight the crew received details of the passenger load; The commander signed a trim sheet indicating that the Aircraft was loaded so as to operate at all times within its approved Centre of Gravity (CG) envelope. The signed load sheet indicated that the landing weight of the Aircraft would be 48995 kg.

The Maximum Certified Landing Weight for this Aircraft is 51,709 kg.

1.6.3.3 AIRCRAFT OPERATIONAL PROCEDURE

The operational procedures during all flight phases are described and detailed in multiple operational documents, the most used document is the aircraft FCOM. During the investigation the FCOM of the aircraft was found to be not customized to the aircraft MSN, this finding is introduced in organizational and management information part of this report. However, and as the standards operating procedures may not vary significantly unless the AOC Holder or the state of operator may request changes to such procedures to be reflected in the FCOM and other operations manuals such as OM-A, OM-B, etc.

The FCTM, produced by the Aircraft manufacturer, describes standard operating procedures and provides information about Aircraft performance in various phases of flight, In relation to the appropriate operational procedures to all phases of the flight.

Additionally and according to the Boeing FCOM the operational procedures required to be exercised by the pilots in the approach and landing phases are outlined in the following subsections.

1.6.3.4 AIRCRAFT APPROACH PROCEDURE

The Approach Procedure is normally started at transition level. The Approach Procedure is to be completed before:

- The initial approach fix, or
- The start of radar vectors to the final approach course, or
- The start of a visual approach

The Boeing brings pilots attention to the fact that In spite of visual contact established early during approach, visual approach is one of most complicated time critical type of instrument approaches. And a full attention as well as understanding and proper application of principles stated below is mandatory.

- Visual approach clearance and separation:
 1. Clearance for visual approach could be given when the pilot reports at any time during instrument approach that the meteorological conditions are such that allows visual reference without interruption to complete entire visual approach and landing. Visual contact with the runway could be requested by ATS controller in addition;
 2. The controller provides separation during approach unless pilot reported the preceding traffic inside and is cleared to maintain own separation.
- Main rules that shall be followed:
 1. The entire instrument approach procedure shall be executed unless the clearance for a visual approach is received;
 2. Descending below MSA aeroplane shall not be flown below three degrees prolonged glide path;
 3. Approach shall be stabilized not later than at 500 ft RA.
 4. Instrument approach facilities (such as an ILS, VOR, DME, NDB etc.) as back up for the visual approach should be used, if available;
 5. Use full automation and switch off the FD/AP/AT to complete the final part of visual approach manually when established on final;
 6. Plan to intercept inbound course not closer than 5NM from threshold (1 500 ft AGL) to be stabilized at 500 ft RA.

7. Vertical profile (recommended)
 8. Descent in clean configuration to level off at MSA in a distance of at least 2NM before the final descent point and speed not above 210Kts;
 9. Establish flaps 5 / speed 180 Kts configuration before the final descent on desired glide path is initiated (Use speedbrakes and/or early landing gear extension, if required);
 10. Ensure Landing gear is down not later than 1 500 ft AGL;
 11. Ensure landing flaps are set not later than 1 000 ft AGL.
 12. Crew co-ordination
- Within the limitations / recommendations above the pilots are free to choose the way in which the particular visual approach will be completed. Concerning the methods and profile to execute particular visual approach:
 1. It is PF obligation to brief PM about it;
 2. It is responsibility of the Commander to accept it;
 3. It is responsibility of PM to assist PF in execution of it.
 - Non-ILS Instrument Approaches (Non-precision):
Non-ILS (Non-precision) approaches includes the following:
 1. VOR approach.
 2. NDB approach.
 3. LOC or similar approaches.

Non-ILS approaches are normally flown using LVL CH or V/S pitch modes. Recommended roll mode is invariably HDG SEL but LNAV may be applicable for certain segments leading to the approach phase.

The traditional method of flying a non-ILS approach involves setting a vertical speed on final approach, leveling off at step-down altitudes (if applicable) and at MDA, followed by a transition to a visual final approach segment and landing. This traditional method involves changing the flight path at low altitudes and is different to the standard method of flying ILS approaches. It may often require a higher level of skill, judgment and training than the typical ILS approach.

Automatic flight is the preferred method for flying non-ILS approaches. Automatic flight minimizes flight crew workload and facilitates monitoring the procedure and flight path. During non-ILS approaches, autopilot use allows better course and vertical path tracking accuracy, reduces the probability of inadvertent deviations below the vertical path, and is therefore recommended up until suitable visual reference is established on final approach.

Manually flying non-ILS approaches in IMC conditions increases workload and does not take advantage of the significant increases in efficiency and protection provided by the automatic systems. However, to maintain flight crew proficiency, pilots may elect to use the flight director without the autopilot when in VMC conditions.

Upon arrival at MDA or any time thereafter, if any of the above requirements are not met, PF must immediately execute the missed approach procedure.

When suitable visual reference is established, PF has to maintain the descent path to the flare and do not descend below the visual glide path.

Note: Descent rates of greater than 1000 fpm should be avoided.

The recommended landing approach path is approximately $2\frac{1}{2}^{\circ}$ to 3° . Once the final approach is established, the aeroplane configuration remains fixed and only small adjustments to the glide path, approach speed and trim are necessary.

Adjusting thrust is to be slowly using small increments. Sudden large thrust changes make aeroplane control more difficult and are indicative of an unstable approach. No large changes should be necessary except when performing a go-around. Large thrust changes are not required when extending landing gear or flaps on downwind and base leg. A thrust increase may be required when stabilizing on speed on final approach.

Go-around is the only way to discontinue unsuccessful approach.

Go-around shall be initiated whenever pilot is not ensured that continuation of approach and landing is safe. The following shall be considered:

- Approach ban rules, if weather below Minimum;
- A/C is not stabilized at 1 000 ft / 500 ft Radio Altitude;
- Visual contact is not established at DA/DH;
- Visual contact is lost below DA/DH;
- A/C position/movement relative to runway cannot guarantee safe landing;
- There are obstacles in the air or on the runway.

Go-around could be initiated by either pilot and at any moment during approach and landing.

Go-around initiation after touchdown should be used as absolutely “last escape” option and shall not be considered if the reversers have already been applied.

Flight crew shall plan landings with the correct speed and touchdown on the touchdown aiming point markings that are located at a distance from the threshold of:

300 m with the LDA less than 2200m

400 m with the LDA 2200m and more.

NOTE: When “Long landing” is approved by ATS controller and accepted by Commander for operational reasons the touchdown in any case shall be completed within the touchdown zone (900m from runway threshold).

The max command (target) speed should not exceed the lower of $V_{REF} + 20$ Kts or maximum landing flap placard speed minus 5 Kts.

The target speed to be set on MCP normally is $V_{REF} + 5$ knots. The aim is to cross threshold at V_{REF} and touchdown about 300-400m into the runway at V_{REF} minus 5 knots.

If the A/T is disengaged, or is planned to be disengaged prior to landing, add the following to the reference speed V_{REF} to use as command speed:

- $\frac{1}{2}$ of the reported steady headwind component
- Full gust increment above the steady wind.
- The gust correction should be maintained to touchdown while the steady headwind correction should be bled off as the aeroplane approaches touchdown.

The Boeing emphasize on flying the airplane onto the runway at the desired touchdown point and at the desired airspeed and not over-rotate or trim the airplane during the flare or prolong the flare with the aim to make a “soft” landing. A smooth touchdown is not the criteria for a safe landing.

Prolonged flare coupled with misjudged height above the runway may cause the aft body contact or runway excursion. Touchdown shall be executed within touchdown zone markings.

Floating above the runway before touchdown must be avoided because it uses a large portion of the available runway. The airplane should be landed as near the normal touchdown point as possible. Deceleration rate on the runway is approximately three times greater than in the air.

Height of the airplane over the runway threshold also has a significant effect on total landing distance. For example, on a 3° glide path, passing over the runway threshold at 100 feet altitude rather than 50 feet could increase the total landing distance by approximately 950 feet. This is due to the length of runway used up before the airplane actually touches down.

Glide path angle also affects total landing distance. As the approach path becomes flatter, even while maintaining proper height over the end of the runway, total landing distance is increased.

[Figure 1.11](#) shows typical increase in landing distance due to improper landing techniques compared to the proper (baseline) condition. These data are based on dry runway, sea level, standard day conditions with landing weights up to the maximum landing weight. Data exclude wet or contamination effects. When increased landing distance is shown as a range, it reflects variations in airplane weight and model variants (if applicable). These calculations are intended for training discussion purposes only.

737-300 - 737-500

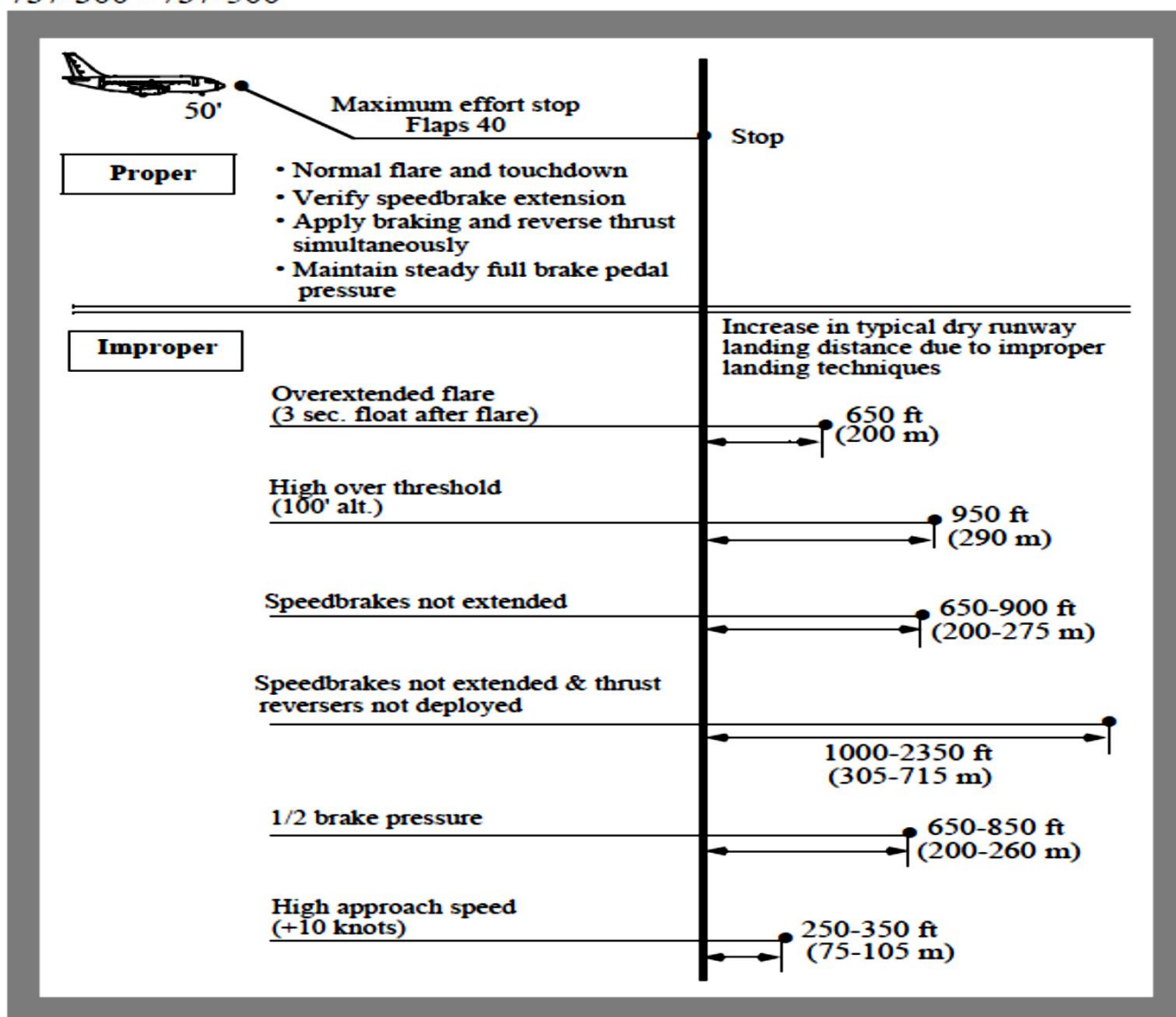


Figure 1.11

1.6.4 AIRCRAFT MAINTENANCE DATA

The last "A" check performed on the aircraft was on 26/08/2017 at JORAMCO-Jordan, The Technical Log Book (TLB) was checked back to 11/09/2017 and no Defects or any Maintenance related to the landing gears or the brake system were recorded.

The aircraft Mass and Balance was carried out on 07/05/2015 and the center of gravity was within the limits specified by the aircraft manufacturer (16.43 % MAC), the next Mass and Balance will be 07/05/2019.

The aircraft was certified, equipped and maintained in accordance with existing regulations and approved procedures.

The aircraft had a valid Certificate of airworthiness and had been maintained in compliance with the regulations. And the maintenance record indicated that the aircraft was equipped and maintained in accordance with existing regulations and approved procedures.

The aircraft was airworthy when dispatched for the flight.

The mass and center of gravity of the aircraft were within the prescribed limits.

There was no evidence of any defect or malfunction in the aircraft that could have contributed to the incident

1.7 METROLOGICAL INFORMATION

The landing forecast weather information received by the crew from ATC Approach at AQJ was indicating a surface wind from 010° at 11 kts. Surface visibility was 8 km and local QNH was 1,012hPa, temperature was 26°C, dew point 17°C.

The reported wind was showing a tail wind component of 11 kts. The operational limitation to the B737-300 as indicated in the AFM is maximum of 10 kts tail wind in both takeoff and landing phases.

1.8 AIDS TO NAVIGATION

RWY 01/19 is equipped with an automatic landing system (ILS) from both directions and with a lighting system of the center of the Runway as well as a visual landing system Precision Approach Path Indicator (PAPI).

1.9 COMMUNICATIONS

All communication between ATS and the crew were recorded by ground-based automatic voice recording equipment for the duration of the flight. The quality of the ground-based automatic voice recording and the aircraft transmission was with good quality.

A transcript to the communication between the crew of the incident flight and ground station shows that the crew requested the use of RWY 19 from the ATC AQJ approach who reported a varying wind between 10 to 12 kts. The PIC of the incident flight accepted the condition.

The transcript is found in [subsection 1.11.2](#).

1.10 AERODROME INFORMATION

OJAQ was re-licensed as of January 2017 for a period of two years as per the requirements of the Civil Aviation Regulatory Authority (JCAR Part 139). King Hussein International Airport / Aqaba consists of one Runway 01/19, equipped with an automatic landing system (ILS) from both directions and with the lighting of the center of the Runway as well as a visual landing system Precision Approach Path Indicator (PAPI). [Figure 1.12](#) illustrate AQJ layout and information. The preventive maintenance of these systems is carried out according to the requirements of national legislation. Aerial examination of these systems every six months and the last aerial examination in April 2017.

The length of the Runway is 3000 m according to national and international specifications. The following table shows these specifications.

RWY Declared distances				
RWY	TORA	TODA	ASDA	LDA
Designator	(M)	(M)	(M)	(M)
01	3000	3000	3195	3000
19	3000	3000	3060	3000

The runway physical characteristics is as following

SWY Dimensions (M)	CWY Dimensions (M)	Strip Dimensions (M)	OFZ
60x45	NIL	3375x300	900x300

The airport was in use prior to the incident. A previous aircraft landed on RWY 01 and there was no report from the pilot of the Airplane having any technical breakdowns. However the incident flight crew stated that the ILS on RWY 19 was inoperative and for that reason the approach was continued as visual. The incident flight operating crew did not report to the tower that the ILS was down and did not request a clearance for the visual approach from the controller.

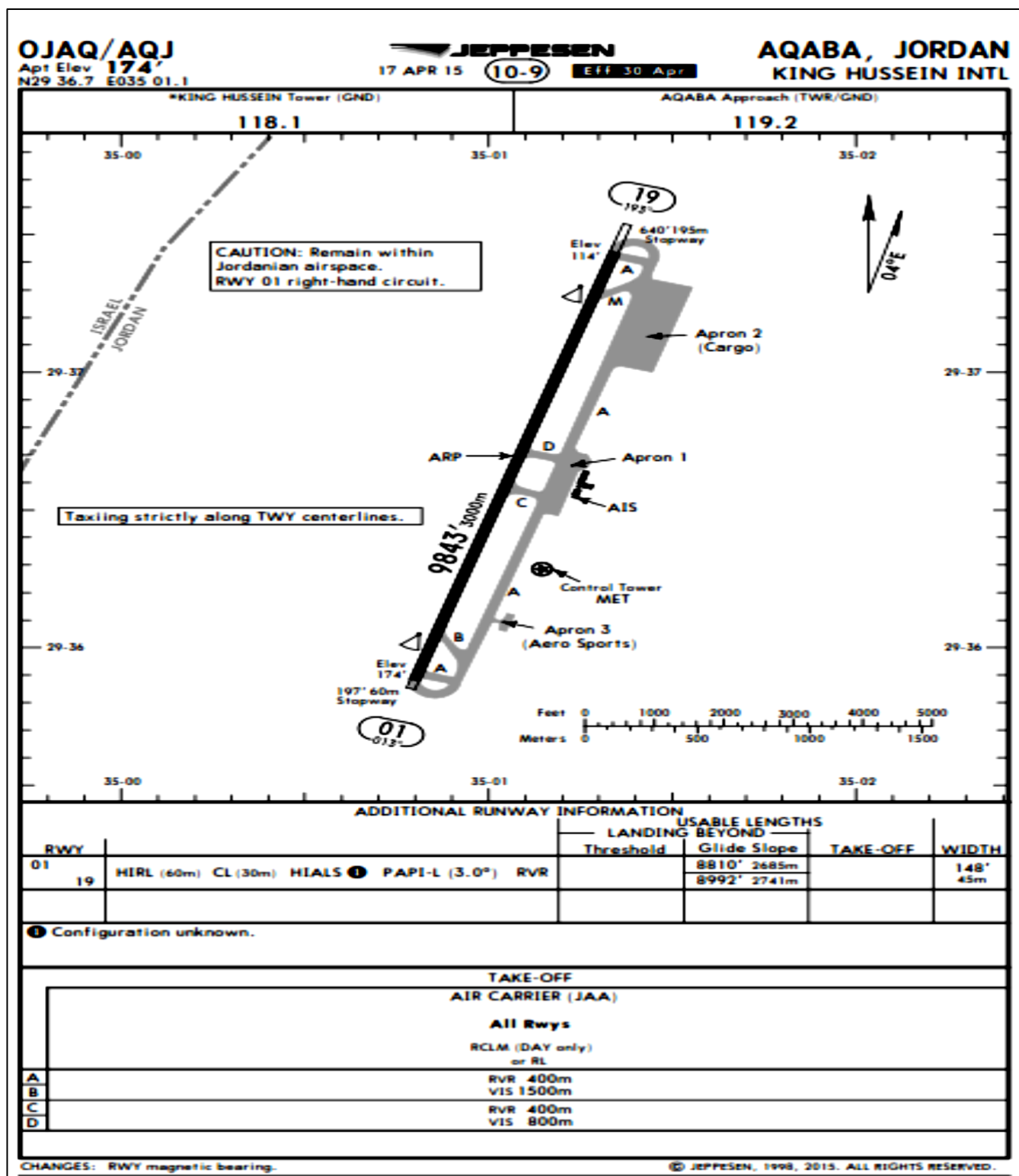


Figure 1.12

Figure 1.13 illustrate the instrument approach procedure to RWY 19

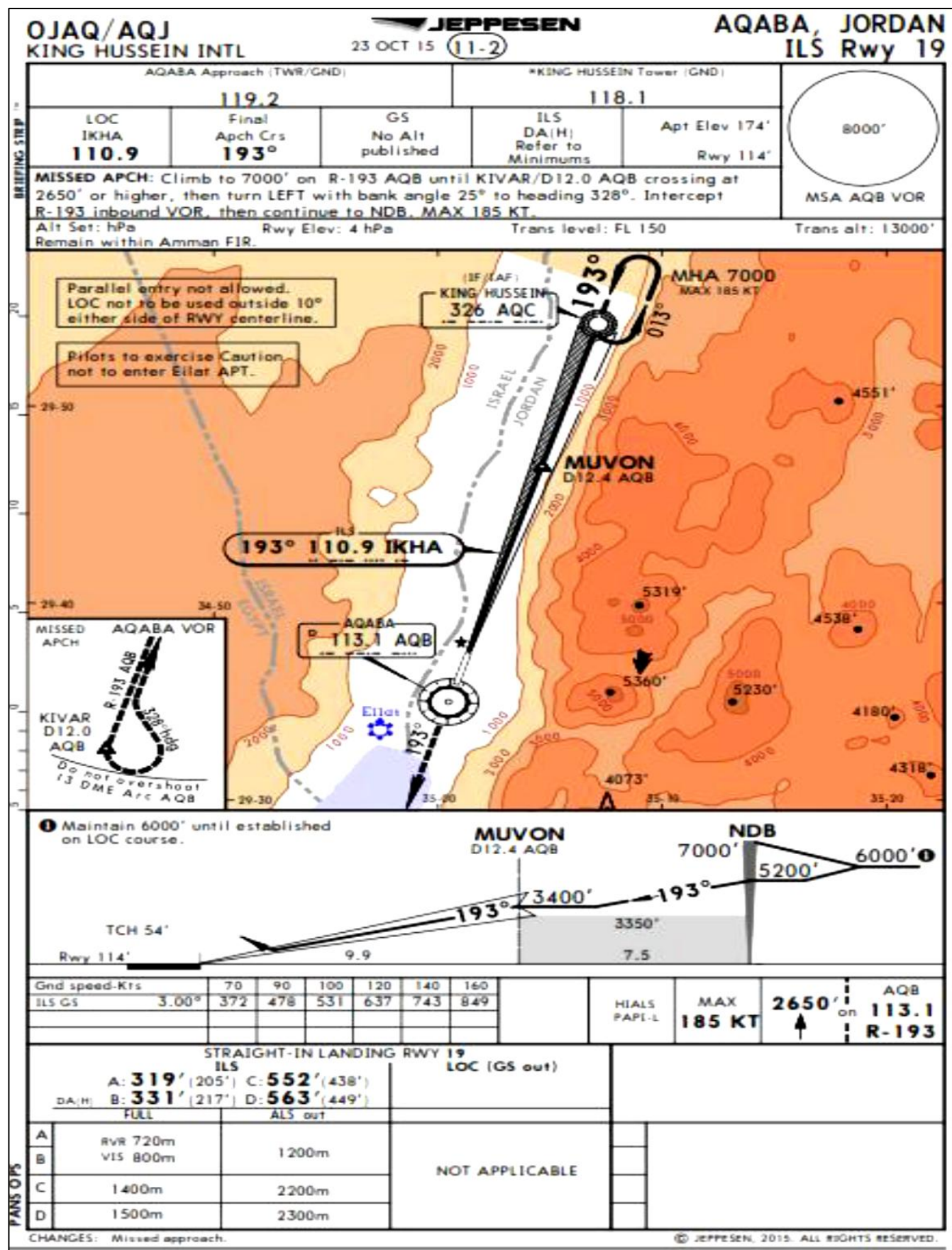


Figure 1.13

1.11 FLIGHT RECORDERS

The aircraft was fitted with a solid-state Cockpit Voice Recorder (CVR), Allied Signal, Part Number 980-6022-001, Serial Number 1008, and a solid-state memory Flight Data Recorder, Allied Signal, Part Number 980-4700-042, and Serial Number 6690. Both recorders were removed and sent for analysis by the CARC to the (AIB) in Saudi Arabia. Additionally, the flight data was sent to NTSB for in depth analysis. The results of flight data readouts is detailed in the Analysis section. [Figure 1.14](#) shows the identification plate of both DFDR and CVR units.



Figure 1.14

1.11.1 THE SIGNIFICANT DATA RETRIEVED FROM THE DFDR ON APPROACH AND LANDING

1.11.1.1 DFDR DATA ANALYSIS

Time history plots of the pertinent longitudinal and lateral-directional parameters are attached as Figures 1.15 through 1.18. [Figures 1.15](#) and [1.16](#) focus on the approach, and Figures 1.17 and 1.18 focus on the touchdown and rollout. In addition to an evaluation of the FDR recorded parameters provided to Boeing, a kinematic analysis was conducted on the provided FDR data, to correct inherent inconsistencies often present in recorded data. Such inconsistencies may be due to sample rate differences, multiple independent data sources, and the presence of instrumentation biases. The kinematic analysis utilized integrated acceleration data to ensure basic inertial parameters such as altitude, ground speed, and drift angle are compatible and comparable. The analysis' output is a kinematically consistent set of data with acceleration biases removed, allowing calculations of wind data and other parameters information.

The FDR data show the airplane configured with flaps up and gear down ([Figure 1.15](#)). The speedbrake handle was extended to 43 degrees (maximum speedbrake handle deflection is 48 degrees). As a result, the flight spoilers were deflected to approximately 32 degrees (not plotted). Note that the expected spoiler deflection at flight detent is 26 degrees, and maximum deflection is 40 degrees.

The autopilot was engaged in level change (LVL CHG) and lateral navigation (LNAV) modes ([Figures 1.15](#) and [1.16](#)). The autothrottle was engaged, and the throttle levers were at idle.

The airplane was descending through 4350 feet pressure altitude on approach to Runway 19 (verified by latitude/longitude data [not shown] and magnetic heading) at Aqaba. The airplane was at a computed airspeed of 266 knots, and the calculated sink rate (negative vertical speed) was approximately 4240 feet per minute (fpm) ([Figure 1.15](#)). The calculated wind components indicate a tailwind of around 12 knots relative to the runway and a negligible

crosswind ([Figure 1.16](#)). The calculated winds were consistent with those recorded on the FDR. Around time 2362 seconds the tailwind increased to approximately 16 knots, where it remained fairly steady until touchdown.

The computed airspeed was steadily decreasing, and at time 2399 seconds the autopilot and autothrottle disconnected as the airplane descended through 1215 feet radio altitude ([Figure 1.15](#)). The cause of the autopilot and autothrottle disconnects could not be definitively determined from the available data. Following autopilot disengagement there was a notable increase in the magnitude of control column fluctuations, resulting in normal load factor variations of +/- 0.2 g's. At time 2407 seconds the flight mode annunciator (FMA) pitch mode transitioned from LVL CHG to altitude acquire (ALT ACQ).

The data indicate the occurrence of a Ground Proximity Warning System (GPWS) activation at time 2409 seconds ([Figure 1.15](#)). Note that the FDR combines multiple alerts into general warning and caution discretes, and does not record all of the individual alerts. The flaps began to extend to flaps 1 at time 2417 seconds (650 feet radio altitude), and from flaps 1 to flaps 2 shortly afterward at time 2425 seconds (460 feet radio altitude). Only the trailing edge flap deflections were recorded on the FDR, the flap handle position was not recorded.

At time 2435 seconds the GPWS was activated again, along with the *TOO LOW TERRAIN* discrete. Immediately afterwards, at time 2436 seconds (220 feet radio altitude), the flaps began to extend from flaps 2 to flaps 5.

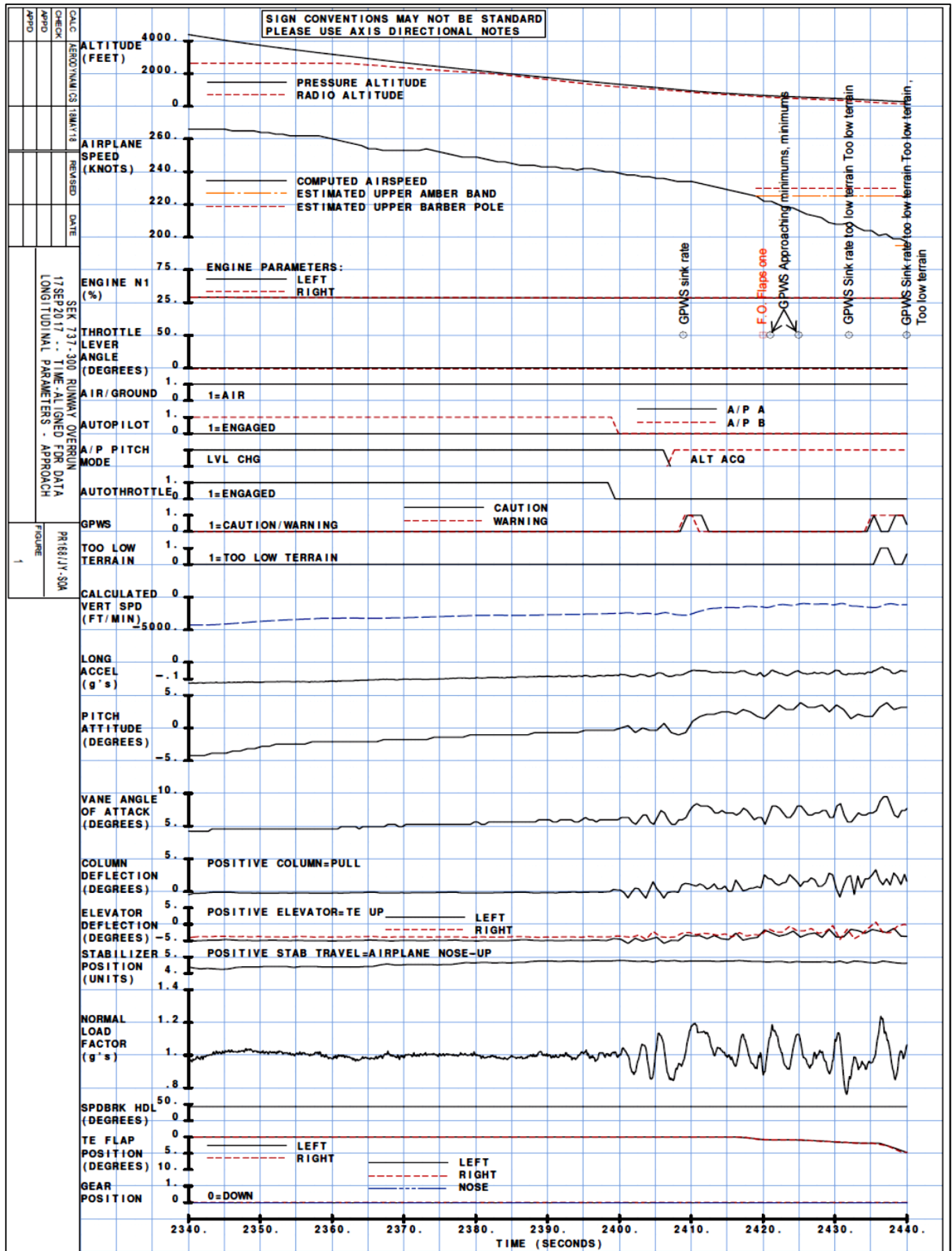


Figure 1.15

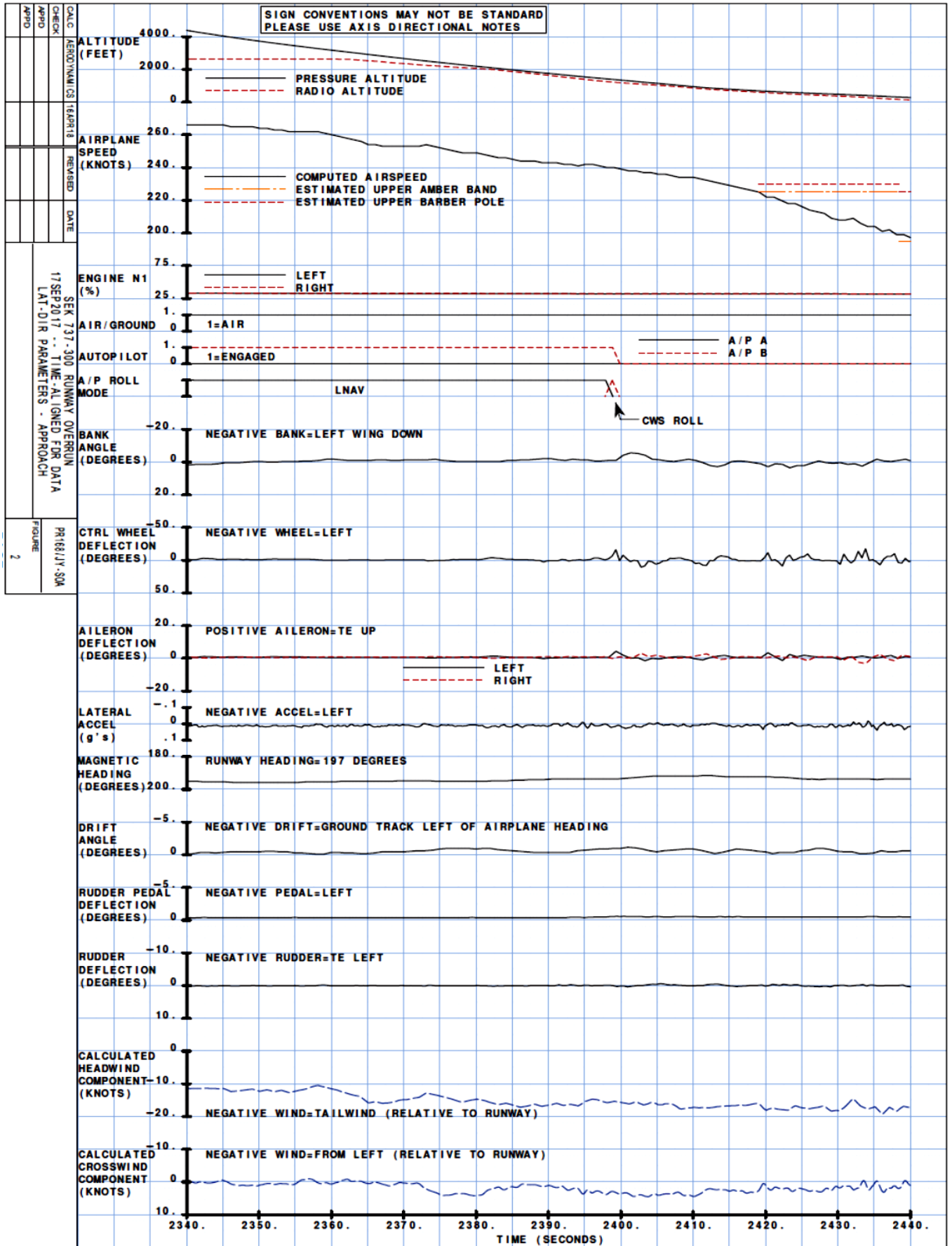


Figure 1.16

At time 2442 seconds (90 feet radio altitude) the flaps began to extend from flaps 5 towards flaps 30 ([Figure 1.17](#)). The speedbrake handle was also retracted at this time. As the flaps extended, the calculated sink rate began to decrease, until stabilizing at approximately 0 fpm at time 2448 seconds (25 feet radio altitude). The airplane then proceeded to float down the runway, with the radio altitude and computed airspeed gradually decreasing. The airplane descended through 20 feet radio altitude at time 2450 seconds. The flaps remained in transition until they arrived at flaps 30 at time 2452 seconds, by which time the pitch attitude had decreased to approximately 0 degrees. Beginning at time 2454 seconds (16 feet radio altitude), numerous momentary airplane nose-up control column inputs were recorded.

The airplane descended through 10 feet radio altitude at time 2457 seconds. There was no discernable flare, and the pitch attitude remained relatively constant at approximately 0 degrees until touchdown.

The airplane touched down at time 2463 seconds, as evidenced by a decrease in longitudinal acceleration, in combination with the transition of the AIR/GROUND discrete to GROUND([Figure 1.17](#)). The landing reference speed (VREF) was not recorded; however, at flaps 30 and a weight of approximately 108,000 pounds (not shown), VREF would have been approximately 133 knots. Touchdown occurred at a computed airspeed of 158 knots(VREF+25), at a groundspeed of 176 knots, and with a maximum normal load factor of 1.5g's. Note that the airplane did not exceed the flap placard speed (identified by the upper barber pole), the landing gear operation speed, or the landing gear extended speed at any point during the approach (Figures [1.15](#) and [1.17](#)).

Promptly after touchdown the thrust reversers deployed, the speedbrake handle extended, and brake pressure was applied ([Figure 1.17](#)). At time 2466 seconds, 3 seconds after touchdown, the flaps began to extend from flaps 30 to flaps 40. The commanded brake pressures had increased to the maximum of 3000 pounds per square inch (PSI) by time 2469 seconds, and by time 2473 seconds the engine N1s had stabilized at 80%, which is approximately equivalent to detent 2 reverse thrust. The airplane likely departed the paved surface around time 2477 seconds at a groundspeed of 50 knots, as evidenced by an increase in the perturbations in normal load factor, and a decrease in magnitude of longitudinal acceleration. Right control wheel and right pedal were also commanded at this time ([Figure 1.18](#)). The thrust reversers were stowed at time 2484 seconds at 25 knots ground speed, and the airplane came to a rest at time 2491 seconds (not plotted).

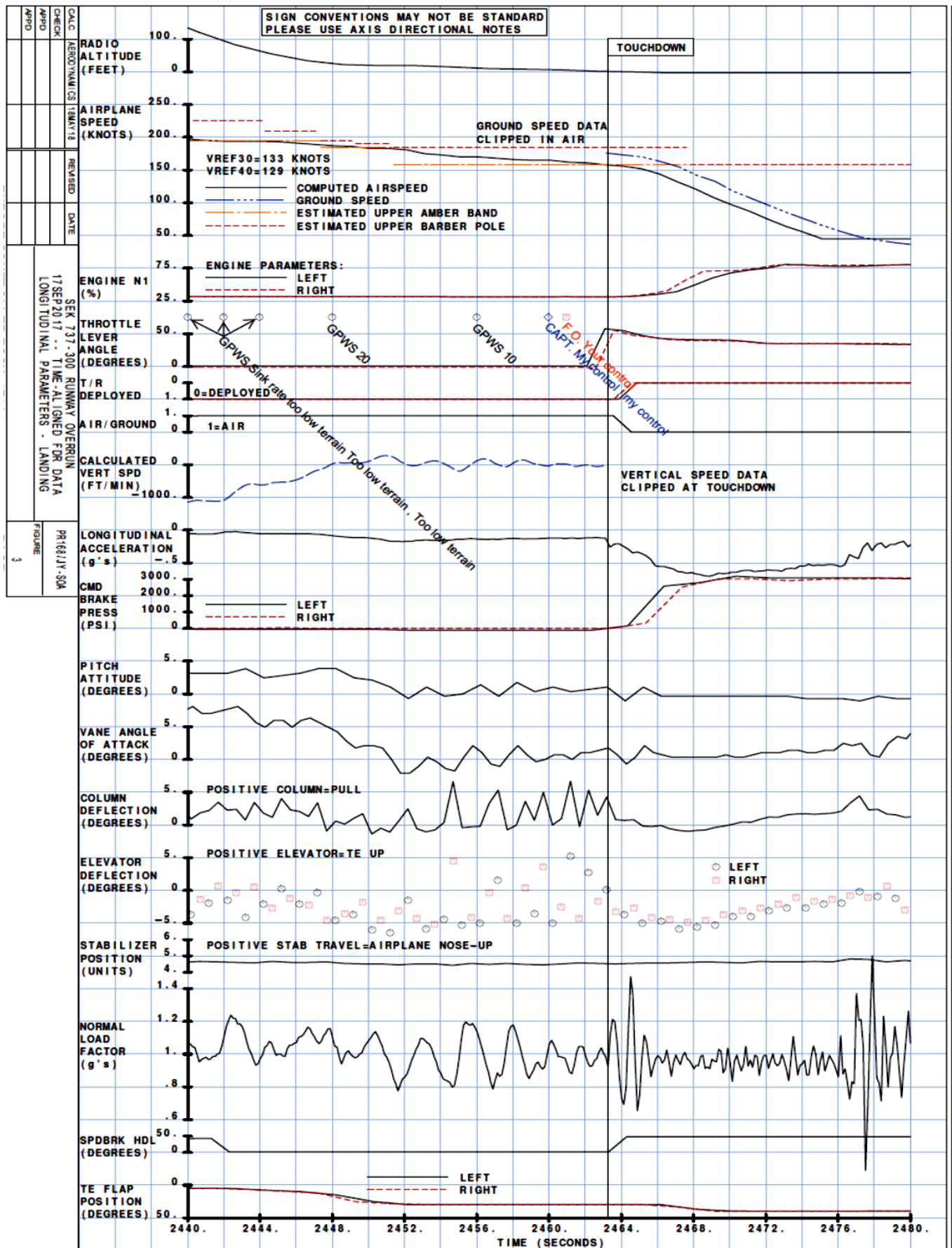


Figure 1.17

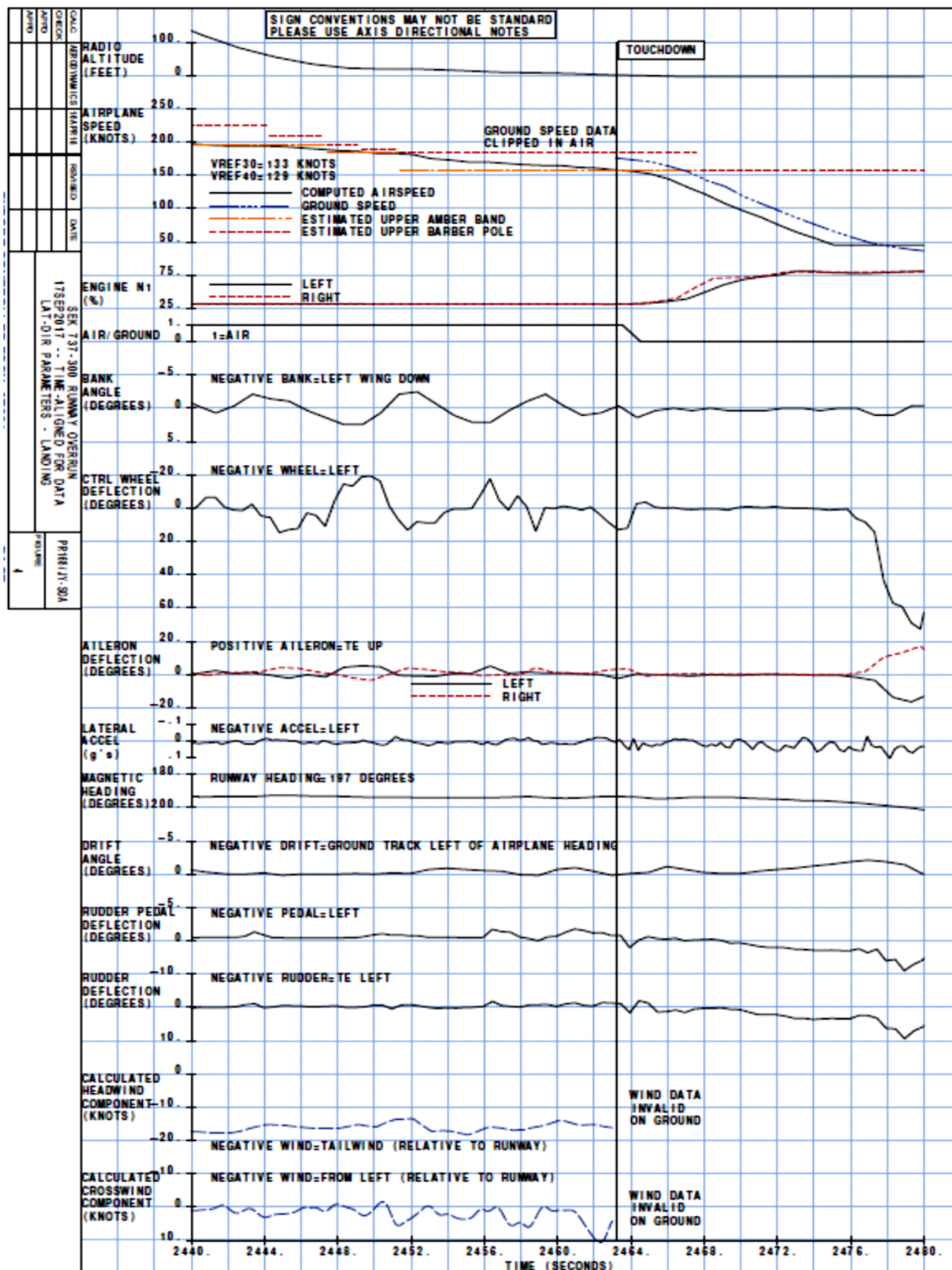


Figure 1.18

1.11.1.2 GROUND TRACK ANALYSIS

A ground track was generated to show the airplane's path during the end of the approach and the landing rollout ([Figure 1.19](#)). Longitudinal and lateral distances were calculated using a combination of inertial data (ground speed, drift angle, heading) and airport information (runway and pavement dimensions). As a final airplane location was unavailable, the distances were referenced to the runway longitudinally by aligning the change in normal load factor and longitudinal acceleration characteristics with the end of the paved surface.

Additionally, the distances were referenced to the runway laterally by aligning the touchdown and beginning of the rollout with the runway centerline. The assumptions relied on to generate this ground track are potential sources of error. The calculated ground track is representative; however, the absolute position may be inexact. In order to validate this calculation, the airplane's final position would be required.

The ground track analysis results indicate the airplane crossed the threshold at approximately 115 feet radio altitude and with a computed airspeed of around 195 knots (VREF+62) [not plotted]. The airplane touched down around 7400 feet beyond the runway threshold (2650 feet prior to the end of the paved surface) [[Figure 1.19](#)]. The commanded brake pressures had reached the maximum of 3000 PSI around 1040 feet prior to the end of the paved surface, and the engine N1 stabilized at 80% around 490 feet prior to the end. As the airplane neared the end of the pavement, it began to deviate right of the centerline. The airplane came to a stop 10,600 feet beyond the runway threshold (600 feet beyond the end of the paved surface), and around 200 feet right of the extended runway centerline.

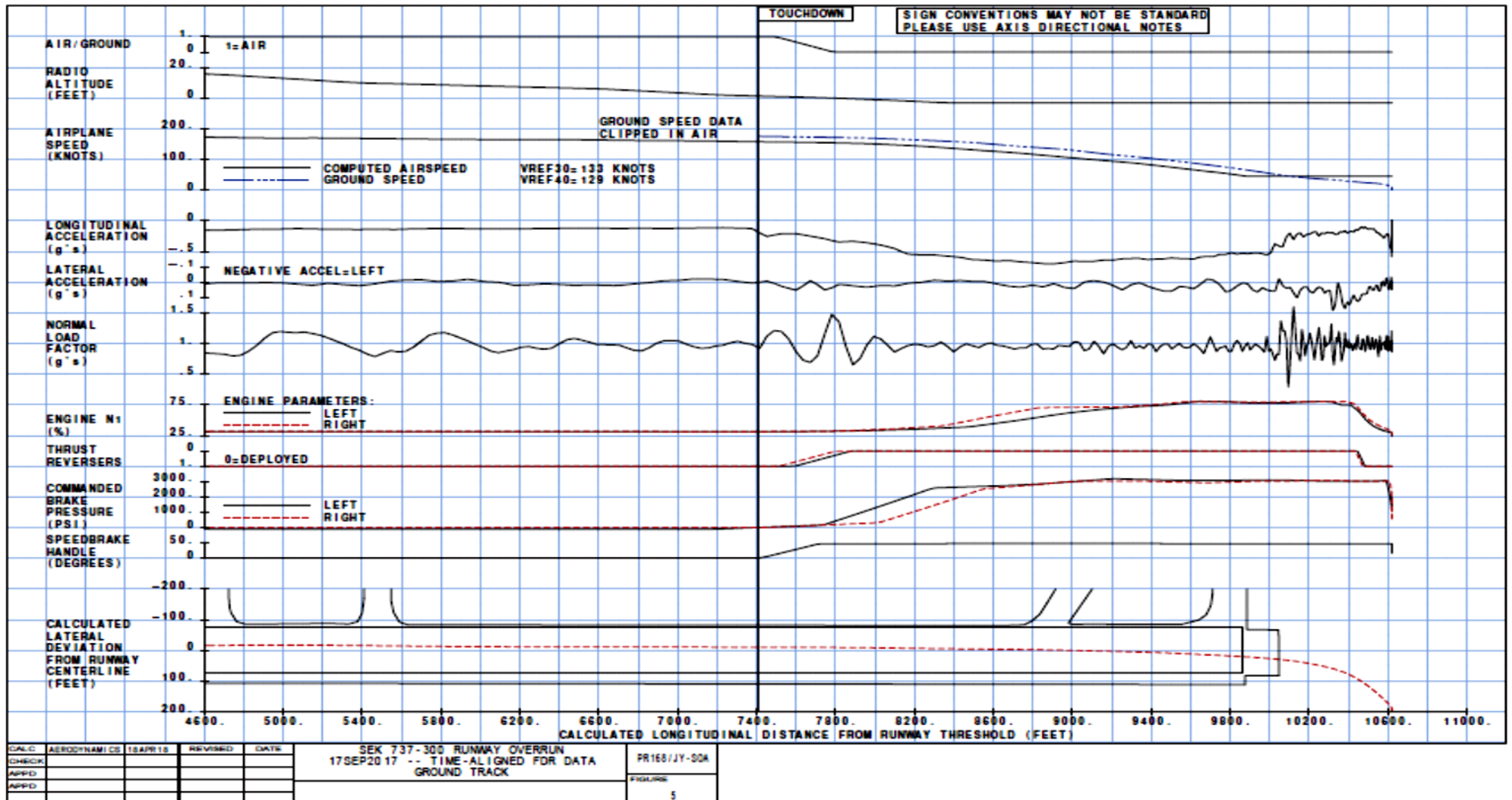


Figure 1.19

1.11.2 COCKPIT VOICE RECORDER

The CARC provided a partially translated transcript of the cockpit voice recorder (CVR) which is related to the incident most critical phases to the NTSB, including the GMT time of some of the communications. The communications relevant to the subject event are reproduced below.

Aligning GMT times between the transcript and FDR data allowed for CVR statements to be referenced at the appropriate times on Figures [1.15](#) and [1.17](#).

The transcript indicates the crew discussed their choice of runway around 7 minutes prior to top of descent:

Source	GMT Time	Transcript
Captain	04:57:05	What do you want, would you like straight or inbound
First Officer		We will ask for 19

Around 2 minutes later the crew request Runway 19:

Source	GMT Time	Transcript
Captain	04:59:00	Aqaba App. Royal wings six triple eight released by Amman maintaining 180
ATC Approach		Thank you sir pilot discretion descend eight thousand 1012 give me call when leaving 180
Captain		Copy that eight thousand 1012 will call you when leaving flight level 180 royal wings six triple eight and is there any chance for runway one niner if traffic permit

Approximately 2 minutes after top of descent, at a pressure altitude of around 15,000 feet, ATC advised the crew to maintain high speed:

Source	GMT Time	Transcript
ATC Approach	05:06:04	Royal wings six triple eight how many miles to AQB now sir
Captain	05:06:30	We are 35 miles in bound to AQB
ATC		Able to keep up speed to have runway one Niner
Captain		Affirmative sir
ATC Approach		Yes sir maintain high speed and descent 7000 report AQC
Captain		Descend 7000 and confirm aa can we proceed to AQC
ATC Approach		I do confirm AQC after AQC you are cleared for straight in one niner

During descent, the crew discussed that the runway 19 ILS was inoperative:

Source	GMT Time	Transcript
First Officer		ILS 19 193 193 1109 ILS minima 552 (ILS inoperative)
Captain		(inoperative keep on VNAV.)

At approximately 1600 feet radio altitude ATC contacted the crew and subsequently cleared them to land. During the remainder of the approach, the GPWS was activated several times:

Source	GMT Time	Transcript
ATC tower	05:11:27	RYW 6888 do you read
Captain		Loud and clear sir establish on final runway ... one niner
ATC tower		In sight sir cleared to land one nine wind 010 12 knots
Captain		Cleared to land runway one nine RYW 6888
Captain		Keep on keep on
GPWS		Sink rate,
Captain		No problem
GPWS		Sink rate
Captain		Leave it leave it you fly
Captain		Reduce your speed little
First Officer	05:11:00	Flaps one
GPWS	05:12:01 05:12:05	Approaching minimums, minimums
Captain		Continue continue , go down go down
GPWS	05:12:12	Sink rate too low terrain too low terrain
Captain		Continue
GPWS	05:12:20 05:12:22 05:12:24	Sink rate too low terrain too low terrain, too low terrain
GPWS	05:12:28	20
GPWS	05:12:36	10
Captain	05:12:40	My control , my control
First Officer	05:12:41	Your control

The transcript indicates that 8 seconds elapsed between the GPWS callouts of '20' and '10', which is in agreement with the FDR data, and indicative of prolonged float prior to touchdown.

1.12 WRECKAGE AND IMPACT INFORMATION

The aircraft stopped approximately 600 feet in the unpaved area after RWY 01 threshold, the final position of the aircraft is illustrated in [Figure 1.1](#). Previously introduce in [subsection 1.1](#).

Several damages were reported by maintenance of the solitaire air and detailed in [section 1.3](#).

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

The captain of the flight stated that he reported sick after a flight to Sharm El Sheikh on 5/9/2017, during the flight the captain felt unwell and upon arrival to SSH he reported to crew scheduling at AMM that he was unable to continue the upcoming flights to SAW. The management of solitaire air was unsatisfied with captain sickness and he was accused for not considering the company interests in continuing the flow under the operations pressure at that period of time. and, the company managed to send another crew to handle the other flights instead of the captain of the incident flight. However, CARCs Aviation medicine doctor

examined the medicines that the captain took to medicate the reported sickness and found no relations between the incident and the medicines used, specially that the incident took place after 12 days from the date he started the usage of the medicine and after taking 3 days as a sick leave. The captain of the flight also stated that on 15 Sep 2017 he was operating a four sectors flight before the incident flight and arrived from it at midnight and until he reached his house it was approaching 2:30 am LT. the captain added that he slept at 4:30 am till 3:00 pm at which he received a phone call from company crew scheduling informing him that he has to report to a flight at 2:00 am next day 17 Sep 2017 (the incident flight). The captain stated that he could not sleep after the call. The aviation medicine doctor analyzed that the captain has to act against the natural body clock to modify his sleeping disorder. At the time of the departure the captain of the incident flight had been awake for 11 hours before the departure.

1.14 FIRE

Not Relevant

1.15 SURVIVALS ASPECT

According to the Captain, no passengers or crew were injured and ordered to keep their seats until the landing ladder was brought. The RFF came to the plane's site and helped the passengers to get off and transported them to the passenger terminal area by buses.

1.16 TESTS AND RESEARCHS

No tests or researches were made

1.17 ORGANIZATIONAL AND MANAGEMENT INFORMATION

The investigation team has outlined the factual aspects as found in operations and management departments of the operator on the date of incident and analyzed particularly the actions or inactions which could have acted as precursors to the incident. In the following section an attempt has been made to give systematically the identified active and latent failures within the functions of various departments which, is found relevant to the incident. The approach is based on Human Factors principals which helps to investigate and analyse human factors aspects. Additionally, the analysis is based on SMS functions and James Reason's model of accident causation [figure 1.20](#). The aim is not to attribute blame but is to understand the underlying causal factors that lead to this incident

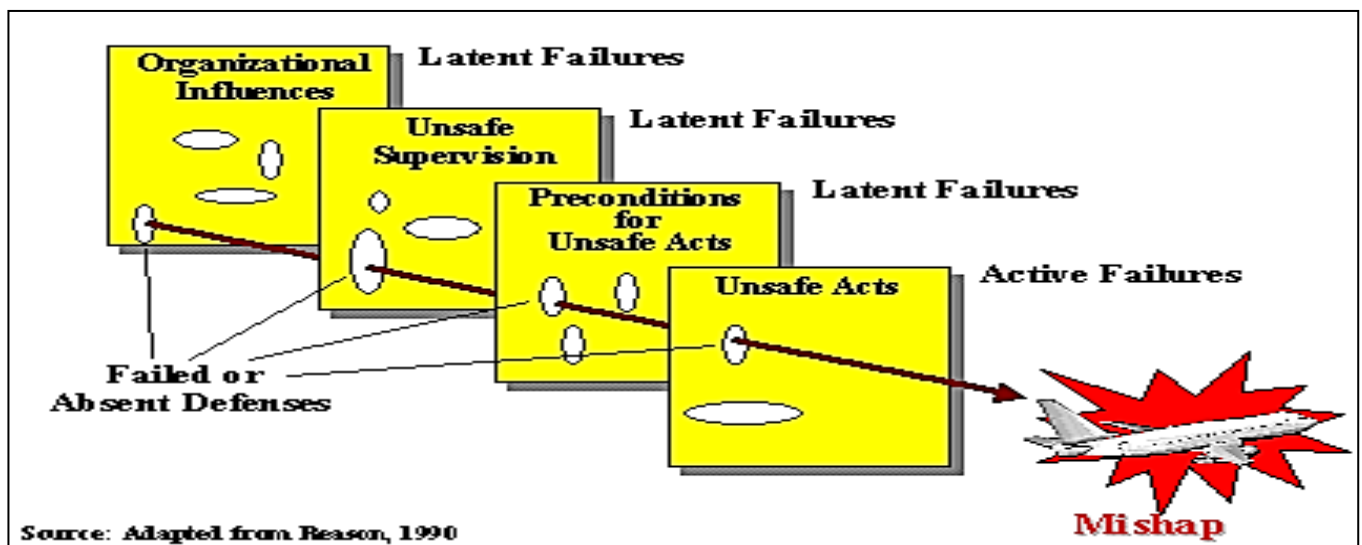


Figure 1.20

1.17.1 BRIEF HISTORY OF SOLITAIRE AIR

Solitaire Air, is a Jordanian charter carrier, doing business as Fly Jordan and based at Queen Alia International Airport. Solitaire air launched service operations on 09-Jan-2016, with an Amman-Sharm El Sheikh service. Currently Solitaire air is providing charter services into multiple regional airports most of it for tourism purposes and holiday packages. The fleet of solitaire air consists of two B737-300 airplanes, both registered in Jordan and hold a valid certificates.

In June 2017 Solitaire air wet leased the incident aircraft to Royal Wings (a Jordanian AOC Holder). The aircraft was leased to operate charter flights from AMM to DWC and BEY through AQJ airport in addition to other direct charter flights from AMM to multiple destinations on behalf of Royal Wings. All operated flights used RW flight codes and flight numbers. However, Solitaire air and according to the contract was responsible for the operational control of the aircraft and the operating crew.

1.17.2 ORGANIZATIONAL STRUCTURE

since Solitaire air is an approved AOC holder company, it was regulated under the terms and conditions of an operator certificate as stipulated in JCAR OPS1.175 and related regulations that require the operator to assign an accountable manager and nominated PHs, acceptable to the CARC, who are responsible for the management and supervision in order to conduct a safe operations. [Figure 1.21](#) illustrates Solitaire air organization chart at the time of the incident.

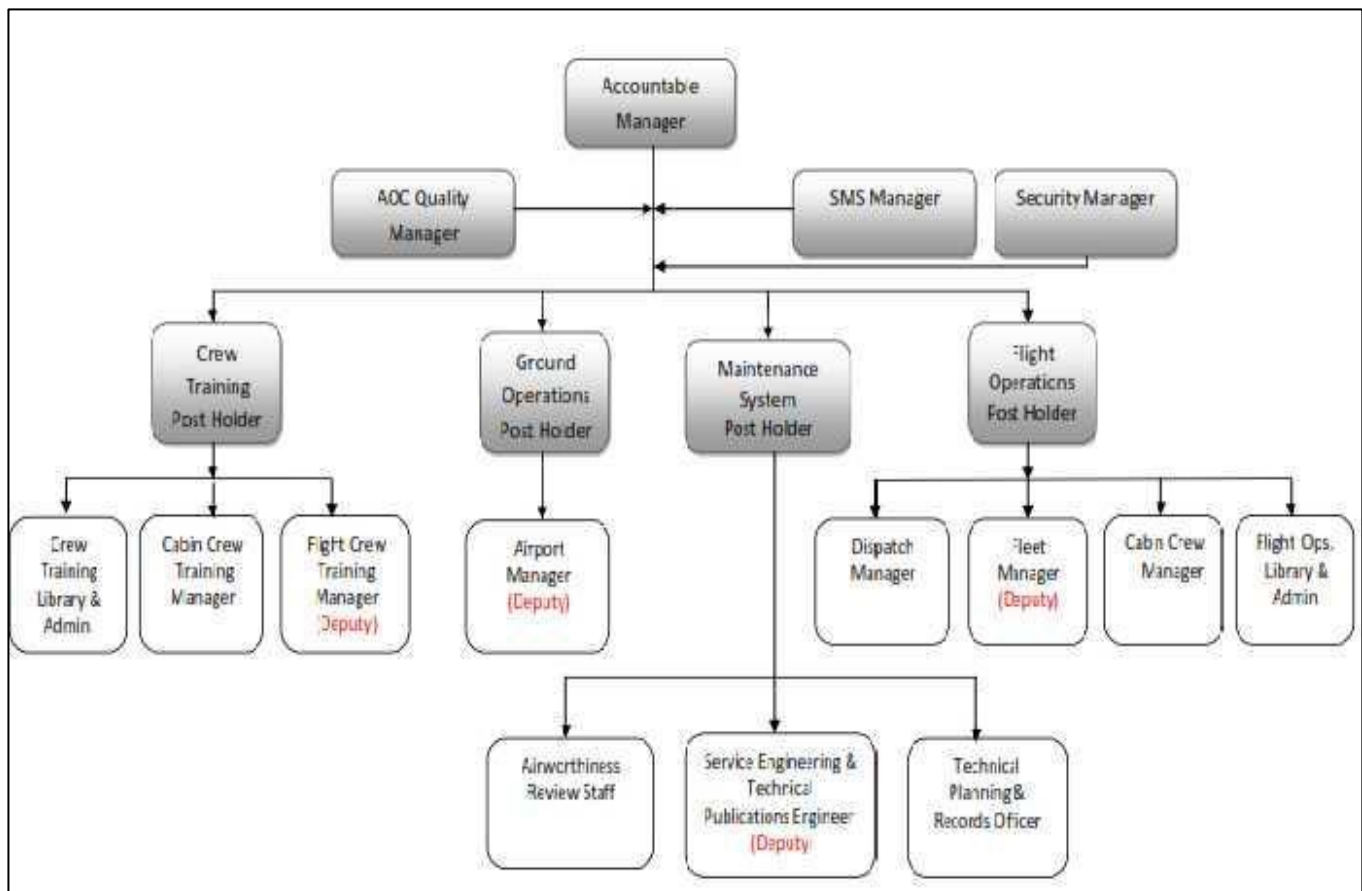


Figure 1.21

1.17.3 TERMS OF ACCOUNTABILITY

The captain of the incident flight joined Solitaire air on 1 May 2017 and was accepted by CARC to hold a Flight Operations Post Holder position on 27 May 2017. At the time of the occurrence the captain of the incident flight was fulfilling the position of Flight Operations PH who reports directly to the Accountable Manager. The Accountable Manager had previously held both positions as an Accountable Manager and Flight Operations PH in addition to holding a TRE authorization, but in Dec 2016, a warning was made to the Accountable manager as a result of an investigation made by CARC flight operations standards directorate after a runway incursion occurrence in which it was found by CARC inspectors that operational control in terms of pilots duty time exceedances were not observed by him in his capacity as a Flight Operations PH and an accountable manager to the organization, and in case these violations are not corrected and managed he may jeopardize his acceptances granted by CARC and as a result they may be revoked. Another decision was made by CARC against the Accountable Manager in April 2017 in which his TRE authorization was suspended after a report received from the Crew Training PH of Solitaire air concerning document falsification made by the Accountable Manager in his capacity as an authorized TRE. The Approved Flight Training Organization contracted by Solitaire Air raised this issue and informed the crew training PH who in turn reported that to CARC. The Crew Training PH submitted his resignation from Solitaire air shortly after this decision.

The accountable Manager of Solitaire air made a press release on 20 Sep 2017 in response to the incident and condemned the ATS controller as being guilty for giving a request to the flying crew of the incident flight to land under the prevailing condition of gusting winds on RWY 19. The CARC did not accept the statement made by the accountable manager as this statement violated JCAR regulation of accident investigation and as it may result in affecting the investigation key decisions. The CARC called for a meeting with Solitaire owner and management board to discuss the impact of the press release along with some critical safety concerns that were found during the initial investigation phase and a decision was made to revoke the Accountable Manager acceptance that was given to him by CARC for not assuming his responsibilities in his position in addition to the accumulated violation he made as discussed in the paragraph above.

After this incident, and during the ongoing investigation, the CARC was informed that a previous occurrence took place on 2 Sep 2017 (two weeks prior to the incident under investigation) in which the accountable manager and in his capacity as a captain was piloting a flight from AMM to SAW and made multiple violations to Civil Aviation Law and CARC regulations. The occurrence of 2 Sep 2017 was not reported on due time and officially by Solitaire air to CARC although it falls under mandatory reporting scheme as required by JCAR OPS1. The former accountable manager was called for an interview to show cause of the deviations reported against him. The investigation revealed that the violations made were deliberately and accordingly; CARC board of commissioners took a disciplinary action to suspend the former Accountable manager license as a pilot on B737 for a period of 6 months.

1.17.4 FLIGHT SAFETY DOCUMENTS AND OPERATIONS MANUALS

Additionally, and within the context of this investigation the Captain of the incident flight stated that on his first flight with Solitaire air on 16 June 2017 that required an evaluation by an authorized TRE who at that time was former accountable manager noticed that the onboard aircraft flight safety documents represented in the FCOM and QRH were not customized for the specific aircraft MSN and tail mark and also noticed that these documents belong to the previous AOC holder he was working with before joining Solitaire air in addition to another QRH document that belongs to another operator. The former accountable manager argued the

Captain of the incident flight that the documents is a solitaire air property and all of them were accepted by CARC before carrying them onboard. An internal investigation made by solitaire air on 14/ Jan 2018 revealed that the former Accountable Manager was the one who brought the flight safety documents to the company and there is no evidence that he made any arrangement to obtain such documents through The Boeing Commercial Airplane, Commercial Aviation Services Organization or any approved or known flight safety document provider.

In this context, the certification process of an AOC holder requires that flight safety documents shall be accepted by CARC and used as a reference and a guidance material to develop operations manuals that need CARC approval in accordance with JCAR OPS 1 subpart P.

During the course of investigation it was found that the flight safety documents carried onboard the incident flight were sealed with CARC stamp although they were not customized specifically for the airplanes operated by solitaire air and listed in their operations specification document. Hence, an internal investigation was made in order to explore the means used in FOSD to review and accept the flight safety documents of solitaire air and other operators during the initial certification, variation or renewal processes. The internal investigation concluded that none of the inspectors responsible for solitaire air certification had reviewed the provided flight safety documents and did not review or notice the control number of the documents that shows the operator identification nor reviewed the model identification section that clearly identify the airplanes covered with such document. [Figures 1.22](#) and [1.23](#) illustrate an example of a B737 FCOM model identification table page and document number identification page.

737 Flight Crew Operations Manual

Preface

Chapter 0

Model Identification

Section 1

General

The airplanes listed in the table below are covered in the Flight Crew Operations Manual (FCOM). The table information is used to distinguish data peculiar to one or more, but not all of the airplanes. Where data applies to all airplanes listed, no reference is made to individual airplanes.

Airplane number is supplied by the operator. Registry number is supplied by the national regulatory agency. Serial and tabulation number are supplied by Boeing.

Airplane Number	Registry Number	Serial Number	Tab Number	Model Miscellaneous Data
1	XX - XXX	nnnnnnnn	XXnnnn	737-33V

Figure 1.22

Page Identification

Each page is identified by a customer document number and a page date. The customer document number is composed of the general 737 FCOM number, D6-27370-, and is followed by the customer identification. The page date is the date of publication of the manual or the most recent revision date.

Example Page Identification

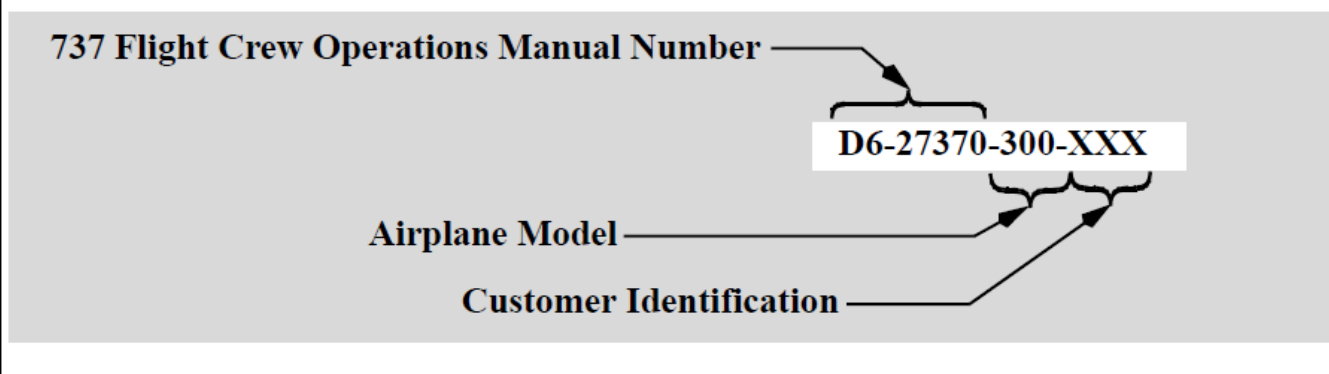


Figure 1.23

1.17.5 FLIGHT DUTY PERIOD

Solitaire air operations manual OM-A, and in accordance to JCAR OPS 1 Subpart Q defines the flight duty period (FDP) as any time during which a person operates in an aircraft as a member of its crew. The FDP starts when the crew member is required by an operator to report for a flight or a series of flights; it finishes at the end of the last flight on which he/she is an operating crew member. Flight Duty Period begins 60 minutes prior to the flight departure and ends 30 minutes after flight arrival. Additionally, the JCAR OPS 1 limit the maximum daily FDP to 13 hours and These 13 hours will be reduced by 30 minutes for each sector from the third sector onwards with a maximum total reduction of two hours.

The flight duty period planned for this specific flight to DWC was 11:30 hrs and the maximum FDP is 12:00 hours, which shows a legal duty time planning. However, and after a realistic calculation for this flight that include passengers disembarkation/embarkation in AQJ for immigration administrative purposes with also considering the fact that the briefing office of solitaire air is located in the city of Amman in which the adherence to the 60 minutes before the flight is not guaranteed and more time would be required before the departure of the flight as conditioned in FDP definition. The calculation was based on previous flights and crew statements who flew this flight previously and showed that the total FDP would normally exceed 13 hours.

The regulations provisioned in OPS 1 gives an exemption to operators as the maximum daily FDP can be extended to an extra one hour provided that number of extensions do not exceed two in any seven consecutive days.

The captain of the incident flight in his capacity as flight operations PH highlighted the issue previously with his management and supported that with correspondences made earlier to the incident, however, all responses made by the management of solitaire air were verbal and it put the conduct of this operation as a priority.

Although this finding did not contribute directly to this specific incident flight; but the investigation team put a concern over the robustness of the operational control, flight planning and crew scheduling preparation and conduct, which again shows symptoms of latent condition that affected the incident flight crew in addition to other crew performance and their ability to conduct safe operation.

1.17.6 FLIGHT CREW TRAINING

During the course of investigation it was evidenced that the captain of the incident flight did not receive the required CRM course during his conversion training. JCAR OPS 1 Subpart N and Solitaire air operations manual clearly define the requirements for Elements of CRM course to be integrated into the conversion course.

The investigation team found an attendance sheet for a CRM session signed by the CRM instructor (the former accountable manager) listing the captain of the incident flight name, however another attendance sheet for another course conducted in the same also listed the captain of the incident flight name in that other attendance sheet. The captain of the incident flight was questioned regarding this issue and he informed the investigation committee that he did not attend the CRM course and that was due to the fact that the operational demand and the shortage of crews was prevailing the situation and the former accountable manager (who was the CRM instructor for solitaire air) elected to not conduct the CRM session to the captain of the incident flight and signed the training document which is believed to be another mishap in the operational control of the company, and a misuse of the privileges and authorities granted by the CARC to the former accountable manager. In addition to the limited role of compliance and safety management functions in solitaire air that created unsafe supervision latent condition.

1.17.7 SAFETY MANAGEMENT SYSTEM

Solitaire air has developed a SMS as required by JCAR OPS 1 Subpart C and JCAR PART 19 that serves as a regulation and a guidance for the establishment of SMS for AOC holders. The operator SMS manual has been approved and the SMS manager was accepted by CARC. The SMS main objective is to manage safety issues and is required to monitor the organisation safety performance through safety reports, inspections, training, hazard analysis, etc. and based on these reports, risk analysis is performed and mitigation actions are taken.

After the incident, CARC inspectors had evaluated the SMS in solitaire air and found that the organisation progress in implementing SMS is still in phase one that is described by CARC inspectors as being behind the required position on implementation phased approach plan.

An effective and mature SMS in an organisation would help in capturing operational hazards and managing them in a systematic way to reduce the likelihood and impact of similar incidents in future. This objective shall be supported by the organisation management by the development of safety policies, procedures, training and safety risk assessments and in order to monitor the effectiveness of it the SMS shall be facilitated with tools such as flight data monitoring and reporting systems in addition to the results of the safety assurance activities.

The flight data monitoring is mandated by JCAR OPS 1 subpart B, as being an element of Accident Prevention and Flight Safety Program. It is the proactive use of digital flight data from routine operations to improve aviation safety.

The incident aircraft is equipped with flight data recorders as described in [section 1.11](#), however, these recorders were not utilized as a source of reliable information that enable the SMS in solitaire air to identify the operational risks such as unstabilized approaches.

1.18 ADDITIONAL INFORMATION ABOUT THIS REPORT

The investigation team has used the Human Factors Analysis and Classification System as a tool that helps in the development of analysis and conclusion and to assist in investigating operator processes, training and prevention efforts. It is heavily connected to accident causation model introduced in [section 1.17](#). HFAC framework aims to systematically identify active and latent failures within an organisation that having developed until it reached in an adverse event. The goal of HFACS is not to attribute blame; it is to understand the underlying causal factors that lead to occurrences. And to have a clear picture for this system the following subsections will describe the HFAC framework and elements as they were used in the analysis section.

1.18.1 HFAC FRAMEWORK

The HFACS framework describes human error at each of four levels of failure:

1. unsafe acts of operators(e.g., aircrew),
2. preconditions for unsafe acts,
3. unsafe supervision, and
4. organisational influences.

Within each level of HFACS, causal categories were developed that identify the active and latent failures that occur. In theory, at least one failure will occur at each level leading to an adverse event. If at any time leading up to the adverse event, one of the failures is corrected, the adverse event will be prevented. [Figure 1.24](#) illustrates the HFAC framework.

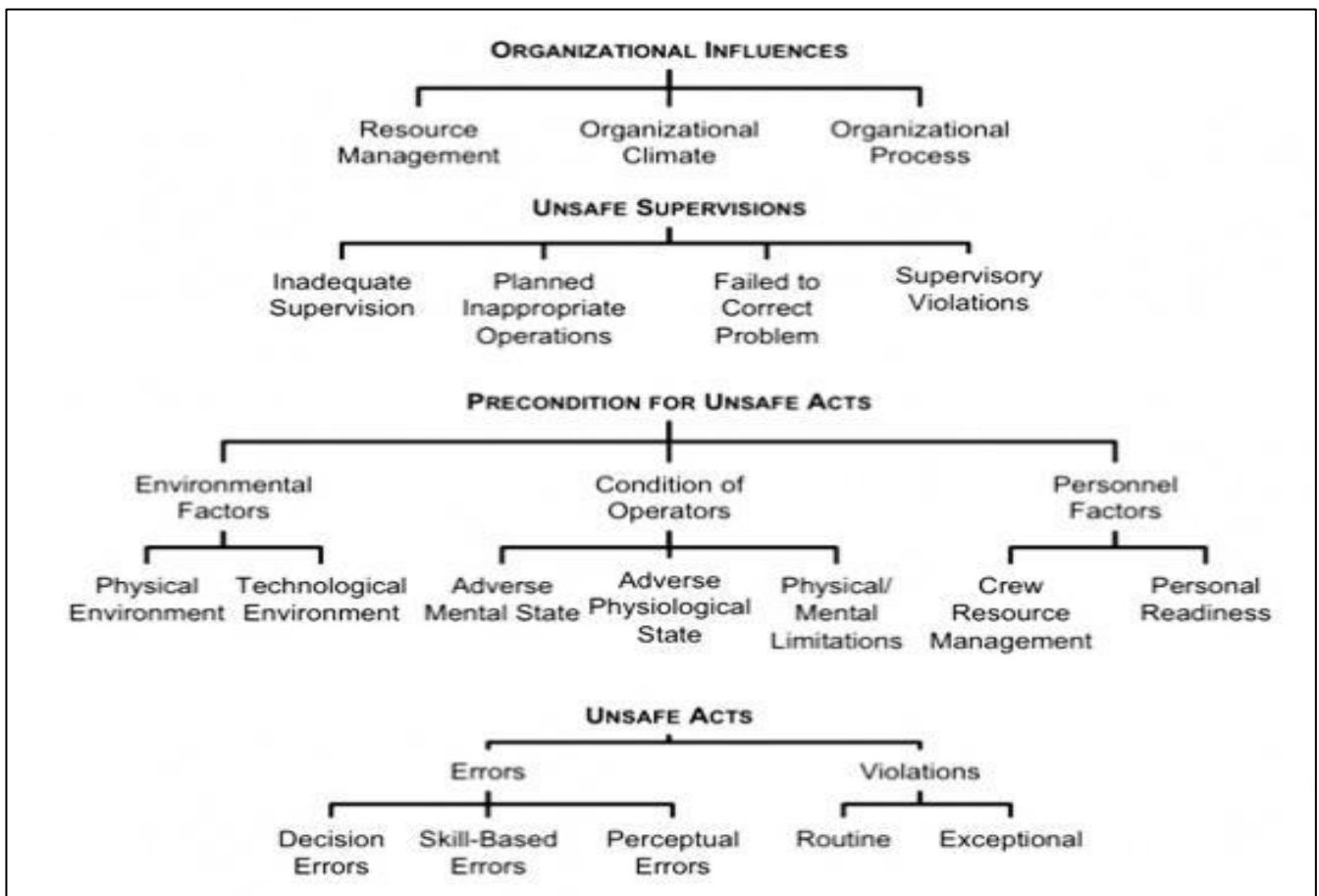


Figure 1.24

1.18.2 HFAC FRAMEWORK LEVELS AND TAXONOMY

1.18.2.1 LEVEL 1 UNSAFE ACTS

The Unsafe Acts level is divided into two categories - errors and violations - and these two categories are then divided into subcategories. Errors are unintentional behaviors, while violations are a willful disregard of the rules and regulations.

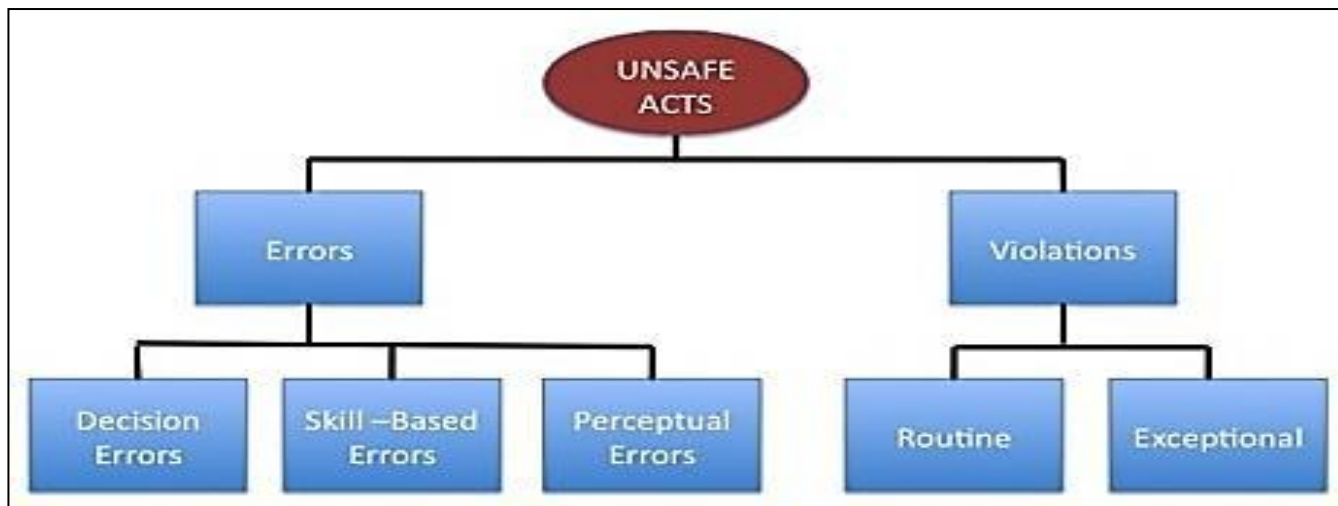


Figure 1.25

Errors

Skill-Based Errors: Errors which occur in the operator's execution of a routine, highly practiced task relating to procedure, training or proficiency and result in an unsafe a situation (e.g., fail to prioritize attention, checklist error, negative habit).

Decision Errors: Errors which occur when the behaviors or actions of the operators proceed as intended yet the chosen plan proves inadequate to achieve the desired end-state and results in an unsafe situation (e.g., exceeded ability, rule-based error, inappropriate procedure).

Perceptual Errors: Errors which occur when an operator's sensory input is degraded and a decision is made based upon faulty information.

Violations

Routine Violations: Violations which are a habitual action on the part of the operator and are tolerated by the governing authority.

Exceptional Violations: Violations which are an isolated departure from authority, neither typical of the individual nor condoned by management.

1.18.2.2 LEVEL 2 PRECONDITIONS FOR UNSAFE ACTS

The Preconditions for Unsafe Acts level is divided into three categories - environmental factors, condition of operators, and personnel factors - and these two categories are then divided into subcategories. Environmental factors refer to the physical and technological factors that affect practices, conditions and actions of individual and result in human error or an unsafe situation. Condition of operators refer to the adverse mental state, adverse physiological state, and physical/mental limitations factors that affect practices, conditions or actions of individuals and result in human error or an unsafe situation. Personnel factors refer to the crew resource management or Team Resource Management and personal readiness factors that affect practices, conditions or actions of individuals, and result in human error or an unsafe situation.

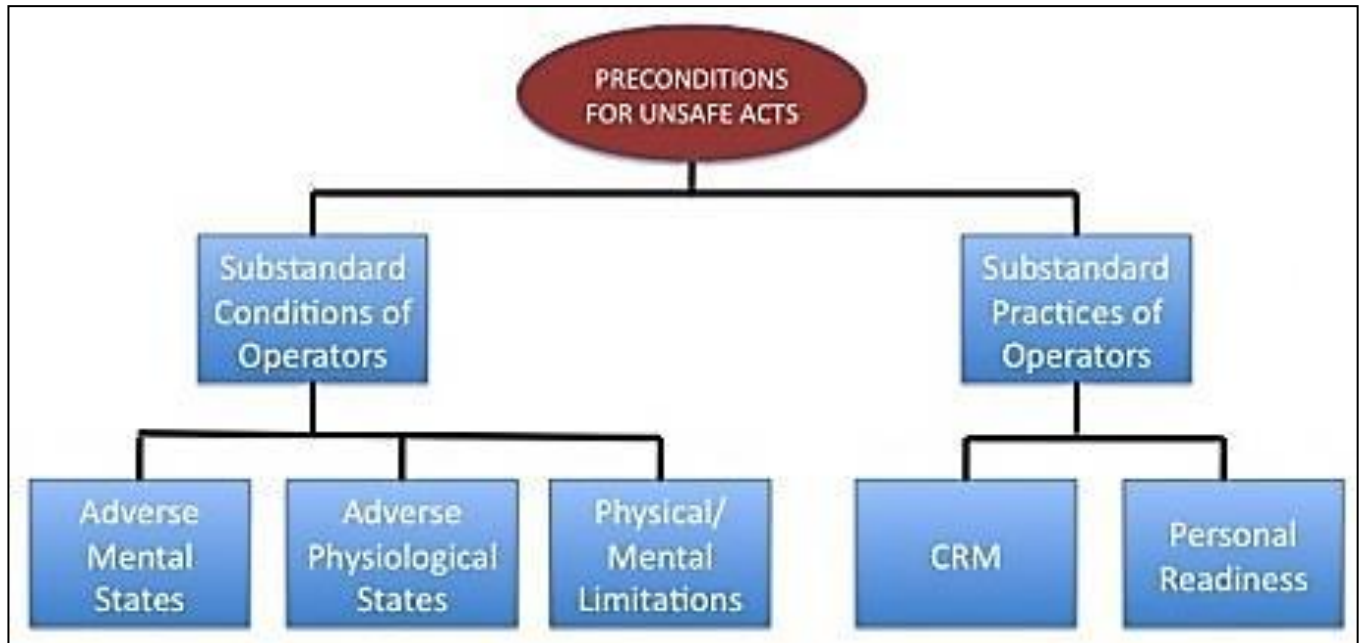


Figure 1.26

Environmental Factors

Physical Environment: Refers to factors that include both the operational setting (e.g., weather, altitude, terrain) and the ambient environment (e.g., heat, vibration, lighting, toxins).

Technological Environment: Refers to factors that include a variety of design and automation issues including the design of equipment and controls, display/interface characteristics, checklist layouts, task factors and automation.

Condition of Operators

Adverse Mental State: Refers to factors that include those mental conditions that affect performance (e.g., stress, mental fatigue, motivation).

Adverse Physiological State: Refers to factors that include those medical or physiological conditions that affect performance (e.g. medical illness, physical fatigue, hypoxia).

Physical/Mental Limitation: Refers to when an operator lacks the physical or mental capabilities to cope with a situation, and this affects performance (e.g., visual limitations, insufficient reaction time).

Personnel Factors

Crew Resource Management: Refers to factors that include communication, coordination, planning, and teamwork issues.

Personal Readiness: Refers to off-duty activities required to perform optimally on the job such as adhering to crew rest requirements, alcohol restrictions, and other off-duty mandates.

1.18.2.3 LEVEL 3 UNSAFE SUPERVISION

The Unsafe Supervision level is divided into four categories as illustrated in [figure 1.27](#)



Figure 1.27

Inadequate Supervision: The role of any supervisor is to provide their staff with the opportunity to succeed, and they must provide guidance, training, leadership, oversight, or incentives to ensure the task is performed safely and efficiently.

Plan Inappropriate Operation: Refers to those operations that can be acceptable and different during emergencies, but unacceptable during normal operation (e.g., risk management, crew pairing, operational tempo).

Fail to Correct Known Problem: Refers to those instances when deficiencies are known to the supervisor, yet are allowed to continue unabated (e.g., report unsafe tendencies, initiate corrective action, correct a safety hazard).

Supervisory Violation: Refers to those instances when existing rules and regulations are willfully disregarded by supervisors (e.g., enforcement of rules and regulations, authorized unnecessary hazard, inadequate documentation).

1.18.2.4 LEVEL 3 ORGANISATIONAL INFLUENCES

The Organisational Influences level is divided into three categories. as illustrated in [figure 1.28](#)



Figure 1.28

Resource Management: Refers to the organisational-level decision-making regarding the allocation and maintenance of organisational assets (e.g., human resources, monetary/budget resources, equipment/facility recourse).

Organisational Climate: Refers to the working atmosphere within the organisation (e.g., structure, policies, culture).

Operational Process: Refers to organisational decisions and rules that govern the everyday activities within an organisation (e.g., operations, procedures, oversight).

1.19 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES

None

2 ANALYSIS

2.1 ACTIVE FALIURES

By analyzing the significant data retrieved from the Flight Data Recorders on approach and landing, it was found that 2 minutes before the top of descent, the captain asked the co-pilot about the runway he would like to use and the copilot answered that they would ask for RWY 19. Both pilots knew that the delay at AMM for 45 minutes would affected the duty time limitations rules and that was the reason for asking the controller the possibility to use RWY 19 to save time. The condition to have a permission to land RWY 19 was to maintain high speed as another aircraft was preparing for departure. The captain of the incident flight accepted RWY 19 although the prevailing wind condition was exceeding the aircraft operational limitations. A chain of multiple errors took place right from the top of descent. The copilot set up the FMS for RWY 19 and tuned the ILS frequency. Both pilots confirmed the ILS frequency not working, and the captain told the copilot to keep on VNAN and to continue the approach. Since they selected RWY 19, the crew did not make the required checklists properly. The Auto Pilot was disconnected as the airplane descended through 1215 feet radio altitude.

Boeing's 737 CL Flight Crew Training Manual includes the Flight Safety Foundation's published criteria for flying a stabilized approach. These criteria recommend that a go around should be initiated if the approach becomes unstabilized under 1000 feet above the ground for instrument meteorological conditions and under 500 feet for visual meteorological conditions.

As the airplane descended below 500 feet radio altitude the computed airspeed was 218 knots ($V_{REF}+85$) and decreasing. The airplane was configured at flaps 1 with the speedbrakes extended, and the calculated sink rate was approximately 1200 fpm. As such, the approach did not adhere to several of the recommended stabilized approach criteria. These criteria are summarized below:

- the airplane should be at approach speed. Deviations of +10 knots to -5 knots are acceptable if the airspeed is trending toward approach speed
- the airplane is in the correct landing configuration
- sink rate is no greater than 1,000 fpm; if an approach requires a sink rate greater than 1,000 fpm, a special briefing should be conducted

In addition, Boeing's 737 CL Flight Crew Training Manual specifies that as the airplane crosses the runway threshold it should be:

- stabilized on approach airspeed to within +10 knots until arresting descent rate at flare
- positioned to make a normal landing in the touchdown zone (the first 3,000 feet or first third of the runway, whichever is less)

As multiple aspects of the stabilized approach criteria were exceeded, a go-around would have been warranted.

The FDR data also indicate the occurrence of several GPWS cautions and warnings, including the alert “TOO LOW TERRAIN”. The CVR confirms the occurrence of “TOO LOW TERRAIN”, and also identifies the occurrence of the “SINK RATE” aural alert. Boeing’s Flight Crew Operations Manual provides the following descriptions regarding the conditions that will trigger the GPWS:

SINK RATE – *Excessive descent rate*

TOO LOW TERRAIN – *Unsafe terrain clearance at high airspeed with landing gear not down or flaps not in landing position*

Analysis of the data indicate that the runway overrun occurred due to the airplane touching down an estimated 7400 feet beyond the runway threshold (2650 feet prior to the end of the paved surface) at a computed airspeed of 158 knots ($V_{REF}+25$). Despite prompt use of deceleration devices upon touchdown, the airplane overran the runway, coming to a stop around 600 feet beyond the end of the paved surface.

The casual tone in the cockpit was evident with inadequate briefing and not following the SOP properly. The copilot had possibly been affected by this casual atmosphere in the cockpit. It was evident that there was lack of CRM and crew coordination, as both pilots had been aware of incorrect parameters and unstabilized approach. However, after the GPWS aural warnings and instantaneously, the captain was showing a steep trans-cockpit authority gradient that had resulted in the captain overruling the decision to continue the approach and disregard the aural warning without considering the multiple deviations of being at high speed and with an excessive sink rate in addition to the incorrect landing configuration of the flight controls. Both pilots continued the faulty approach and landing, possibly due to incorrect assessment of their ability to restrain the high energetic aircraft and this could be attributed to their determination to land the aircraft within the first attempt to compensate the lost time as a result of the delay at origin airport, and this is also an indication of complacency, which is one of the critical elements of the situational awareness. The roles in cockpit were not followed correctly, the copilot who was flying the aircraft was not assertive against the captain intentions and continuation calls even after the GPWS warnings that gave them a clear indication of the unstabilized situation they were encountering. The situation had clearly indicated ineffective CRM skills and resulted in the incorrect decision of the eventful landing.

CRM is an effective method to use all available resources to achieve a safe and efficient flight. Specific issues such as leadership, assertiveness, decision-making, delegation and acceptance, as well as crew interaction and communication constitute the basic element of CRM. The prime objective of CRM training is to produce an atmosphere of sound leadership by the Captain and team work by both crew. CRM fosters participation by subordinates by encouraging Captain to be receptive to their inputs or suggestions. There is need to encourage requisite assertiveness in subordinate crew when they express their concerns. Interpersonal communications, skills and healthy relationship improves the environment for an effective and conducive cockpit environment

According to the HFAC model, the investigation team has classified the following unsafe acts:

- Skill based error that was represented by crew failure to conduct the appropriate checklists and briefings after changing the landing runway. In addition to not taking the required measures by informing the tower that the ILS system was not captured upon establishing final. That was also evidenced in crew failure to prioritize attention to flaps extension schedule when their attention was majorly concentrated on the recovery

actions made to correct the attitude of the aircraft after the GPWS warnings, these errors are believed to be attributed to complacency

- Decision based error that was evidenced by crew decision to continue the unstabilized approach because of the rule based pressure of being late on departure and the expected flight duty exceedances.

2.2 LATENT FALIURES

2.2.1 PRECONDITIONS FOR UNSAFE ACTS

The captain of the flight also stated that on 15 Sep 2017 he was operating a four sectors flight before the incident flight and arrived from it at midnight and until he reached his house it was approaching 2:30 am LT. the captain added that he slept at 4:30 am till 3:00 pm at which he received a phone call from company crew scheduling informing him that he has to report to a flight at 2:00 am next day 17 Sep 2017 (the incident flight). The captain stated that he could not sleep after the call. The aviation medicine doctor analyzed that the captain has to act against the natural body clock to modify his sleeping disorder. At the time of the departure the captain of the incident flight had been awake for 11 hours before the departure. Personal readiness of the captain was not observed as he did not manage his off duty activities and rest requirements. The captain of the incident flight did not make an optimum use of the opportunity for rest provided. The investigation committee concluded that the personnel readiness of the captain was not observed as he was not able to manage his off-duty and rest time before the commencement of that flight, in addition to what has been discussed earlier in **subsection 1.13** regarding the captain physical status after using the medicines and acting against his natural body clock. Hence, it is believed that the captain personnel readiness was not utilized properly to ensure that he is able to perform his duties optimally.

Additionally; the CRM conversion training that should be provided by the operator for crew when changing operators is well defined by regulations and shall emphasize in depth on areas related to the organisation safety culture, SOPs, organisational factors and the importance of reporting. these requirements are outlined in OPS 1 Subpart Q with CRM requirements summarized as in the following table

Core Elements (a)	Initial CRM Training (b)	Operator's conversion course when changing type (c)	Operator's conversion course when changing operator (d)	Command course (e)	Recurrent Training (f)
Human error and reliability, error chain, error prevention and detection	In depth	In depth	Overview	Overview	Overview
Company safety culture, Sops, organizational factors		Not required	In depth	In depth	
Stress, stress management, fatigue & vigilance			Not required		
Information acquisition and processing situation awareness, workload management		Overview			
Decision making			Overview		
Communication and coordination inside and outside the cockpit					
Leadership and team behavior synergy					
Automation, philosophy of the use of automation (if relevant to the type)		As required	In depth	In depth	
Specific type-related differences	Not required				
Case based studies	In depth	In depth	In depth	In depth	As appropriate

The CRM course required for the captain when he joined solitaire air was not conducted as discussed earlier in [1.17.6](#) Flight Crew Training subsection, and this believed to be attributed to the insufficient and ineffective CRM skills shown by the crew during the incident flight.

2.2.2 UNSAFE SUPERVISION

Within the course of investigation it was evidenced that there was no adequate planning for this operation in terms of operational risk assessments and duty time planning. The lease operation was not introduced to flight operations department according to the captain of the incident flight who was the flight operations post holder at the time of the incident. Planning of such operations requires an operational assessments to identify the organisation limitations and preparedness in order to conduct a safe operation. That was not exercised systematically by the solitaire air departments.

The unsafe supervision was also evident when the management of the operator did not react with the identified deficiencies reported by the captain of the incident flight regarding safety related issues, such as the flight safety manuals that were found not relevant for the operated airplanes as in [1.17.4](#) and the duty time issues described in [1.17.5](#). these unsolved problems created an atmosphere in the company in which reporting is believed to be discouraged in contrary to the safety policy of the company, and that in turn created mistrust problems between the operating crew and their management.

Accountable managers and nominated post holders should take a leading role in developing an active safety culture within their organisation, so that SMS becomes an integral part of the management and work practices of the organization. Senior management commitment is crucial and this needs to be demonstrated on a regular basis. The investigation committee found that the safety culture in solitaire air was impaired with the company management attitude that was prioritizing the commercial and production interests over the safety requirements.

Safety Culture is the way safety is perceived, valued and prioritized in an organisation. It reflects the real commitment to safety at all levels in the organisation. It can have a direct impact on safe performance. If safety culture is not considered and evaluated properly in an organisation then workarounds, cutting corners, or making unsafe decisions or judgments will be the result, especially when there is a small perceived risk rather than an obvious danger.

During CARCs investigation and the following oversight activities conducted on solitaire air as discussed in [1.17.7](#) it was found that the under-reporting of hazards is evidenced in the company, the finding was discussed with different personnel working in solitaire air and found that this impairment in reporting culture was due to fears of recrimination or adding hardship to them from their management; and in some occasion risks may be under estimated because they came to believe that doing so, is what they are supposed to do.

The investigation committee has classified these findings as failure of solitaire air management to correct known problems by not developing corrective actions in response to the limited amount of available safety reports. Additionally, the investigation revealed that the management of the company was showing a pattern of supervisory violations as discussed earlier in this report.

3 CONCLUSIONS

3.1 GENERAL

From the evidences available, the following findings, causes and contributing factors were made with respect to this Incident:

3.1.1 FINDINGS

3.1.1.1 FINDINGS RELEVANT TO THE AIRCRAFT

- a) The aircraft was certified, equipped, and maintained in accordance with the existing requirements of the Jordan Civil Aviation Regulations.
- b) The aircraft was airworthy prior to Incident. There was no evidence of any defect or malfunction in the aircraft that could have contributed to the Incident

3.1.1.2 FINDINGS RELEVANT TO THE FLIGHT CREW

- a) The crew had valid license and medical certificate. There was no evidence of crew incapacitation.
- b) The PIC in this flight acted as PM and Copilot acted as PF;
- c) The PIC accepted to land RWY19, while setup was made to land RWY01, according to this data, the arrival time was expected 05:20 UTC. The aircraft ALT was 15200 feet at GS of 378 knots;
- d) The PIC took over the control second time during the flight ,when he accepted to change landing RWY from RWY01 to RWY19;
- e) Copilot setup FMS for RWY19 and turned ILS frequency 110.9 at time 05:07:23UTC at ALT 12500 with IAS was 305knots and GS 362knots, were both pilots confirmed that ILS frequency inoperative;
- f) The flight crew did not conduct descent checklist, approach checklist and landing checklist they changed the landing runway from RWY01 to RWY19;
- g) The sink rate of descent recorded vary and up to 4240 feet per minute and below 500 feet radio altitude the sink rate was approximately 1200 fpm ;
- h) There were several GPWS warning of ' SINK RATE, TOO LOW TERRAIN' activated during approach and landing Phase ,were ignored by flight crew ;
- i) The aircraft touched down at a computed airspeed of 158 knots ($V_{REF}+25$), at groundspeed of 176 knots; exceeding the SOP limitations set by aircraft manufacturer.

3.1.1.3 FINDINGS RELEVANT TO THE AIRCRAFT OPERATIONS

- a) The wind conditions in which the pilot landed the aircraft were outside the limits detailed in the Flight Manual and the Operations Manual.
- b) The continuation of the landing with airspeed above the calculated threshold speed resulted in touchdown beyond the normal touchdown point.

3.1.1.4 FINDINGS RELEVANT TO THE AIRCRAFT OPERATOR

- a) The crew Resource management training arranged by the operator did not promote robust flight deck communication.
- b) The flight duty period planned for this specific flight to DWC was 11:30 hrs and the maximum FDP is 12:00 hours, which shows a legal duty time planning; however; the planning was not realistically reflected on the actual and real conduct of the flights.

- c) The onboard aircraft flight safety documents represented in the FCOM and QRH were not customized for the specific aircraft MSN and tail registration
- d) The operation was not assessed properly in a way that the management of the organisation would be able to capture the hazards encountered or the deviation from regulations, standards and rules.
- e) The company was not providing sufficiently the required crew resource and threat error management courses that helps in the effective use of all available resources for flight crew personnel to assure a safe and efficient operation, reducing error, avoiding stress and increasing efficiency.
- f) The solitaire air management responsibility in developing and maintain the required standards of safety and quality management systems were not effectively observed in which it altered the organisational safety culture.
- g) The Flight Data Monitoring was not utilized properly as a tool that support an effective monitoring of the flights conducted by the company.

3.2 CAUSES

The cause of this Incident was Flight Crew failure to discontinue the Unstabilized Approach and their persistence in continuing with the landing despite 8 numbers of warning from EGWPS

3.3 CONTRIBUTING FACTORS

The following factors are believed to be the main causal factors of the occurrence:

- a) The delay on ground OJAI for 47 minutes influenced crew decision to land on RWY19 at OJAQ to save time.
- b) The straight in, unstabilized approach was the main result of the Aircraft high energy for the consecutive phases out from 1000 ft down to the touchdown point.
- c) The higher than allowed tailwind component that recorded an average of 16 knots during final approach and landing phases.
- d) Incorrect landing configuration was a contributing factor for Aircraft high speed and explain pilot flying inability to control the prolonged float of the Aircraft and the ability to roll it out.
- e) The pilot monitoring (Captain) was aware of the tailwind, however he accepted the prevailing conditions without discussing the operational limitations of the Aircraft with the pilot flying.
- f) Crew inaction to discontinue the unstabilized approach and make a go around helped in the developed situation.
- g) Crew poor situational awareness and lack of coordination.
- h) Deliberate Disregard of the aural warnings without correcting the Aircraft attitude.
- i) Lack of cockpit management (CRM) for task sharing and decision making. Crew resource management (CRM) was not evident during the approach phase of flight
- j) Failure of the airline to provide its pilots with clear and consistent guidance and training regarding company policies and procedures related to stabilization criteria and the necessary actions to be followed including the conduct of go around.
- k) inability to recognize the two critical elements, namely fixation and complacency that affected pilot decision to land the aircraft while the approach was not meeting the stabilization criteria
- l) Negative organizational factors were evidenced in terms of operational pressure that was exerted by the management of Solitaire air.
- m) Inadequate risk management by the operator as the repeated reports of duty time exceedances were not known or observed by the operational safety management

- n) Noncompliance to state regulations regarding the proper training of crews was found a contributing factor as the PIC CRM conversion training was not completed in a correct way.
- o) Non availability of customized flight safety documents (FCOM, FCTM and QRH) which includes the manufacture recommended standard operating procedures.

4 RECOMMENDATIONS

4.1 SOLITAIRE AIR

It is recommended that solitaire air:

1. review the crew resource management and threat error management training and refreshers for all flight crew and incorporate the threat and error management on both classrooms and simulator sessions.
2. Emphasize on go around maneuvers whenever required and specially when the approach is found unstabilized on both instrument and visual metrological conditions and encouraging company pilots to report unstabilized approaches whenever they happen.
3. Provide copilots with necessary training related to assertiveness.
4. Review the reporting policy and monitor the effectiveness implementation of it in terms maintaining the confidentiality of the reporters and developing the required management follow ups and controlling measures. The Operator should have a sound and effective non-punitive safety reporting system that shall be implemented throughout the organization in all areas where operations are conducted.
5. Review the safety management system in the company and provide the staff with the required effective SMS training, by emphasizing on the methods required to create a safety culture within the organisation
6. Review crew duty time rules in a way that a more realistic duty time calculations is to be considered, including the factors that may affect the compliance to CARC regulations.
7. Develop a more effective flight data monitoring that enables the management to address the hazards encountered during the ongoing operations and helps in providing corrective actions proactively through trends analysis of the captured operational deviations. This can be made by more frequent data download and analysis.
8. Conduct a more frequent co-ordination meetings between various operational departments to discuss the challenges encountered and provide ongoing follow ups for the corrective actions required.
9. Provide the required arrangements to maintain the consistency of operations and flight safety documents (FCOM, QRH, FCTM, etc.) in order to provide the operating crew with the correct and customized SOPs.

4.2 CARC

1. It is recommended that the Flight Standards Directorate increase surveillance of AOC holders with emphasis on the actions of flight crew and their adherence to SOPs by conducting more frequent flight deck observations.
2. It is recommended that Flight Standards Directorate review the operators flight safety documents to ensure that they are customized to the types and registrations of airplanes operated by each operator.
3. It is recommended that CARC inspectors evaluate the accountable manager and post holders in terms of their responsibilities and authorities to ensure that they are able to demonstrate a commitment to the management of safety and a sound knowledge of safety management system principles and practices within the organisation for which they are responsible including, in particular, knowledge of their own role.