



# **The Aircraft Accident Investigation Board of the Islamic Republic of Iran**

## **Flight PS752 Accident Investigation**

# **Final Report**



## **In the Name of God**

### **Crash of Ukraine International Airlines Flight PS752**

AAIB File Number:	A981018URPSR
Type of Occurrence:	Accident
Date of Occurrence:	Jan. 08, 2020
Place of Occurrence:	Near IKA Airport (OIIE) - I.R of Iran
Aircraft Type:	B737-800
Registration:	UR-PSR
Date of Issue:	Mar. 15, 2021



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## Abbreviations and Definitions

AAIB	Aircraft Accidents Investigation Board of I.R.Iran
ACC	Area Control Unit
ACCREP	Accredited Representative
ADS-B	Automatic Dependent Surveillance–Broadcast
ADU	Air Defense Unit
AMO	Approved Maintenance Organization
Annex 13	Annex 13 to the Convention on International Civil Aviation
ANSP	Air Navigation Service Provider
APP	Approach Control Unit
APU	Auxiliary Power Unit
ATCO	Air Traffic Control Officer
BEA	Bureau d’Enquête et d’Analyse pour la Sécurité de l’Aviation Civile
CAM	Cockpit Area Microphone
CAMO	Continuing Airworthiness Management Organization
CAOIRI	Civil Aviation Organization of the Islamic Republic of Iran
CCTV	Closed-Circuit Television
CMOCC	Civil- Military Operational Coordination Center
CSMU	Crash-Survivable Memory Unit
CVR	Cockpit Voice Recorder
EASA	European Union Aviation Safety Agency

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ELT	Emergency Locator Transmitter
EUROCAE	European Organisation for Civil Aviation Equipment
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FCOM	Flight Crew Operating Manual
FDR	Flight Data Recorder
FL	Flight Level
FMS	Flight Management System
FOD	Foreign Object Debris
FS	Frequency Spacing
GND	Ground Movement Control unit
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IDG	Integrated Drive Generator
IFR	Instrument Flight Rules
IKA	Imam Khomeini International Airport
LS	Load Sheet
NTSB	National Transportation Safety Board
PA	Passenger Address system
PSR	Primary Surveillance Radar
QAR	Quick Access Recorder
RSL	Radio Station License

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SID	Standard Instrument Departure
SSCVR	Solid-State Cockpit Voice Recorder
SSFDR	Solid State Flight Data Recorder
SSR	Secondary Surveillance Radar
STC	Supplemental Type Certificate
TC	Type Certificate
TI	Trip Information
TMA	Terminal Maneuvering Area
TWR	Air Traffic Control Tower
UIA	Ukraine International Airlines
WPS	Words Per Second

## Special Foreword To English Edition

This is a courtesy translation by the AAIB of the Islamic Republic of Iran of the Final Report on the PS752 accident investigation.

As accurate as the translation may be, the original text in Farsi is the work of reference.

## Foreword

Flight PS752 departing from Imam Khomeini International Airport for Kyiv crashed shortly after takeoff. 176 people lost their lives in this accident and their next of kin suffered profound grief.

Two major questions following any air accident were raised: what was the cause of the accident and how can similar accidents be prevented?

Aircraft Accident Investigation Board of I.R.Iran instituted the accident investigation in accordance with the international regulations laid down in Annex 13 to Convention on International Civil Aviation.

This report contains facts, analyses and conclusions as a result of the investigation. Based on them, the recommendations which can serve to prevent similar accidents are made to different parties.

Although the prevention of accidents cannot be 100 percent guaranteed in aviation, there are always areas to be improved to minimize the probability of such occurrences. The lessons learned from this accident are used to make recommendations to related parties. It is for those parties to decide what action to take.

The accident-related preliminaries are provided in Section 1 of this report and the factual information is explained in Section 2. The Management of Potentially Hazardous Activities to civil aviation in general and, in particular, regarding this accident is elaborated on in Section 3. Section 4 reviews similar accidents and Section 5 makes an analysis of the issues provided in the preceding Sections. Conclusions, including the Findings, the cause of accident and other contributing factors are stated in Section 6, and finally the Safety Actions Taken by Iran and Safety Recommendations to the States managing airspace, to States overseeing the airlines activities, to ICAO and to the EUROCAE are listed in Section 7.



## Summary

On January 08, 2020, Ukraine International Airlines (UIA) Flight PS752 departing from Imam Khomeini International Airport for Kyiv crashed shortly after takeoff.

Under the Islamic Republic of Iran Regulations and as per Annex 13, the accident investigation team was formed, who collected and analyzed data, made conclusions and safety recommendations with the aim of preventing similar accidents.

The accident aircraft was misidentified by the air defense unit in the suburbs of Tehran and, consequently, two missiles were launched toward it. The operation of aircraft had not imposed any error to the air defense unit.

The cause of the accident was the detonation of the missile.

All 176 people on board lost their lives.

The airworthy Boeing 737-800 operated by qualified crew of Ukraine International Airlines was under control of Iranian air traffic control and the takeoff clearance was issued after coordination with military sector.

The air defense forces were on a higher level of alertness at the time of the accident.

According to the analyses conducted by the investigation team, safety recommendations are made to enhance the process of distribution and gathering information, risk assessment, and implementation of measures when potentially hazardous military activities may put the civil aviation safety at risk, to prevent similar accidents.

## 1. Introduction

### 1.1. Accident Investigation Institution

Following the accident involving a Boeing 737-800, UR-PSR operated by Ukraine International Airlines on January 08, 2020, near Tehran, Iran's Vice Minister of Roads and Urban Development and the president of Civil Aviation Organization designated the investigator-in-charge for this accident. The accident investigation team was formed afterwards.

The accident investigation was carried out to implement the Civil Aviation Accidents and Incidents Investigation Bylaw, adopted by Iran's Cabinet of Ministers on August 21, 2011.

This investigation was done in compliance with the provisions of Annex 13 to the Chicago Convention, whose Standards and Recommended Practices were applied accordingly.

### 1.2. The Objective and Scope of the Accident Investigation

The investigation was carried out to determine the root causes of the flight PS752 accident on January 08, 2020, so that similar events in the future could be prevented accordingly.

The provisions of Annex 13 do not approve of conducting an accident investigation with the aim of apportioning blame or liability and the sole objective of this investigation is the prevention of accidents and incidents.

This prevention can only be realized through identifying the details of events and providing recommendations to implement the necessary improvements for eliminating the roots of such events.

As for this accident, the interference of military activity with civil aviation operations resulted in an accident.

The team addressed three areas in their investigation: military, civil and the area of their cooperation and interactions; however, the identification of the root causes and the provision of recommendations are confined solely to the civil area and its cooperation scope with the military one

In order that the investigation team could independently identify the events, announced by the military authorities, and compare it with other data available and reciprocally verify them, some military operational events, which resulted in the launching of the missiles at the aircraft, were identified.

It was necessary to become aware of such events in the military sector so that the impact of civil operations and practices on the military occurrence could be investigated. The investigation scope and areas probed in civil and military areas are illustrated in Figure 1.

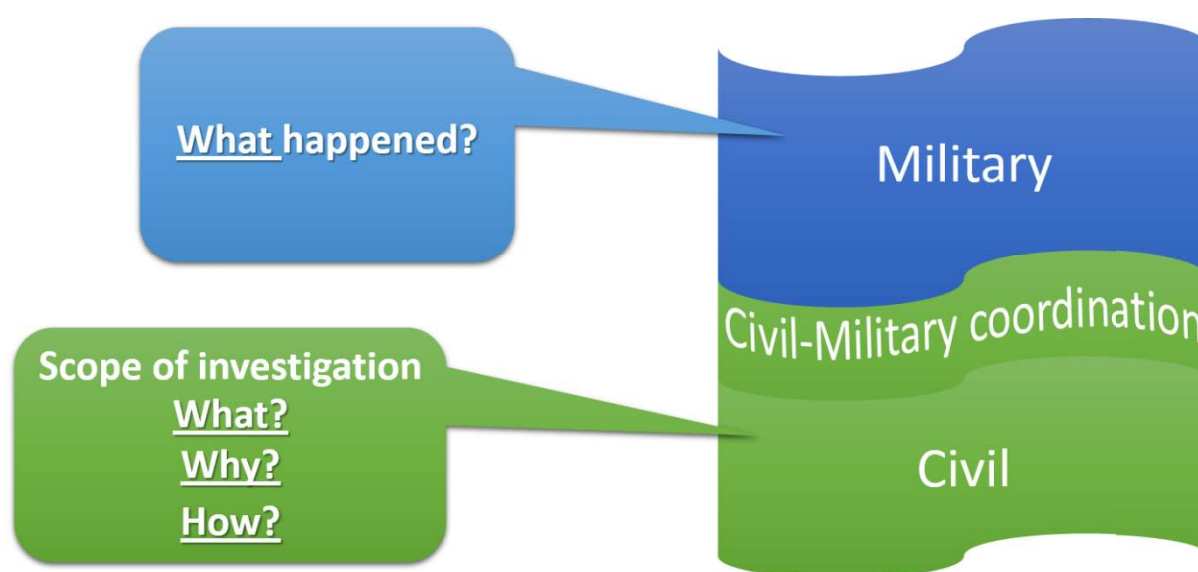


Figure 1- Scope of the investigation

After I.R. Iran General Staff of the Armed Forces publicly announced their air defense system had targeted flight PS752 mistakenly, Iran Armed Forces Judicial Organization commenced judicial proceedings into the accident by order of the Iranian head of the Judiciary.

The accident investigation subject to Annex 13 and judicial proceedings are independent of one another. Nevertheless, given the coordination required in data gathering or recording evidence, joint cooperation was performed in accordance with the standards contained in Annex 13. The investigation team used the results of a simulation performed by the judicial systems, where the required data for judicial investigation was obtained through deploying the defense systems in similar positions and

conducting similar flights and validated some of the findings already gained.

### **1.3. Investigation Methodology and Participating Parties**

The investigation into this accident can be categorized into three general stages:

First, it was initiated upon the accident notification. Under the Air Accident Investigation Regulations, the eleven expert groups were then formed. However, due to the signs of fire and explosion on the aircraft wreckage, the images and videos showing the aircraft being targeted or hit by missile, and the observations of ATC men as well as a passing flight pilot, another group was formed to specifically investigate the explosives.

The initial evidence confirmed that the fire had broken out in the aircraft before crashing into the ground. The analysis convinced the investigation team that the explosion is the probable cause of fire. Having made some analyses, the team focused on three scenarios:

- Explosion in the aircraft due to technical issues
- Explosion in the aircraft due to the presence of 'dangerous goods' inside the aircraft
- Explosion due to unlawful interference from the inside of the aircraft
- The aircraft being targeted by terrorists acts
- The aircraft being targeted by military forces

While the team was gathering facts, on January 11, 2020, i.e. 3 days after the accident, the I.R. Iran General Staff of the Armed Forces announced publicly that its air defense system had fired missiles at flight PS752 due to human error.

The AAIB and the accident investigation team had been made aware of this targeting hours before the announcement of the statement at about 18:30 on January 10, 2020.

At this point, the Accident Investigation Team revised their approach. Given that a significant amount of information was made available from official military and judicial sources, they shifted their focus on identifying other findings and comparing them with the information received from the military sector, to simply ensure that the only cause of the crash had been the defense system's missile launch and identifying the underlying factors.

Once the facts on the missile firing were collected and confirmed, the collection for risk assessment, analysis and preparing safety recommendations was performed.

The following States participated in the investigation by appointing and introducing their accredited representative(s):

- Ukraine (as the State of Registry and State of the Operator)
- The U.S. ( as the State of Design and State of Manufacture of aircraft)
- France (as the State of Design and Manufacture of the aircraft engines as well as State providing information and assistance for readout of flight recorders)

There were passengers of different nationalities, and some with multiple nationalities registered while purchasing tickets, reception, boarding and crossing the border. Hence, Canada, the United Kingdom, Sweden, Germany and Afghanistan as the States having special interest in the accident by virtue of fatalities to their citizens, were invited to introduce their experts to enjoy their entitlement according to Standard 5-27 to Annex 13, all of which did so but Afghanistan.

The Canadian and Ukrainian representatives visited the accident site. One day following the crash, a full delegation from Ukraine was authorized to access the crash.

Given the nature of the accident and the need for full coordination of the interested States, the ICAO was also invited to appoint a team of advisors to observe the process and lend their support, where necessary. The ICAO was accordingly kept abreast of the investigation via their representative.

In accordance with paragraph 6.3 of Annex 13, the AAIB sent the draft final report to the accredited representatives of the states participating in the investigation, inviting their significant and substantiated comments. In addition, the draft final report were sent to ICAO representative to receive their advisory comments and UK expert to receive their comments about sections related to information provided by UK.

#### **1.4. Previous Reports**

After the accident occurred, the first Preliminary Report containing the initial information related to the accident was published on Jan. 08, 2020.

The second Preliminary Report was published on Jan. 20, 2020, when some supplementary information, such as the recorded radio communication and radar data had been obtained.

A Factual Report was released in June 2020, setting out the details on the missile launch by the air defense unit.

Having read out the flight recorders, the relevant report was also released in July 2020, considering the expectations of the victims' families to become aware of the content obtained in the flight recorders read-out.

Given that the Final Accident Investigation Report had not been released on the first anniversary of the flight PS752 accident, the investigation team published an Interim Statement pursuant to Section 6.6 of Annex 13 to the Convention on International Civil Aviation, providing a brief overview of the progress of the investigation.

#### **1.5. Other Investigations**

Under Article 172 of the Constitution of the Islamic Republic of Iran, military courts are established to investigate offenses germane to the military or disciplinary duties of members of the armed forces.

After I.R. Iran General Staff of the Armed Forces publicly announced the air defense unit had fired missiles at PS752 because of human error, the head of Iran's Judiciary assigned the Armed Forces Judicial Organization of I.R.Iran to institute judicial proceedings into the accident.

This type of investigation is carried out within the framework of the Judicial Law of the Armed Forces of the Islamic Republic of Iran, approved by the Parliament of I.R.Iran on May 12, 1985, and the associated regulations, and investigation on errors and violations in military sections fall under their authority.

Coordination between the investigator-in-charge and judicial authorities was conducted pursuant to the standard 5-10 of Annex 13.

### **1.6. Points to Consider in This Report**

The objective of the investigation of an accident subject to Annex 13 to the Chicago Convention shall be the identification of the root causes and prevention of similar incidents and accidents by determining the corrective measures required and implementing them accordingly. This type of investigation is not conducted with the aim of apportioning blame or liability. Such issues are obviously important and will be addressed by other authorities through their investigations, in an accident investigation conducted with the aim of improving safety, but if the process is diverted to simply apportioning blame or liability, safety goals will be put at risk for two major reasons:

First, individuals involved in an accident would naturally be led to defending themselves, hence reducing their cooperation in identifying the factors having contributed to it. Even worse, some would consider concealing issues concerning their responsibilities in case of occurrence of an error leading to an accident, so that they can escape blame or avoid liability, and, resort to hiding such sensitive issues rather than reporting voluntarily and cooperating to eliminate the areas of concern.

Second, if the factors contributing to an accident are not well determined and eliminated, the identification of the liable individuals and eliminating them from the system in place will not entail the prevention of similar occurrences. On the contrary, the very factors leading such liable individuals to commit the error, causing the accident, will still be lurking for others; hence, similar accidents will take place through others' negligence in the same area.



This report never blames the entities who are named in this report and has no adversarial position with them. The investigation team did all its efforts to use neutral wording, information, analysis and conclusions to conduct the investigation and preparing the report. No biased or misleading interpretation of this report will be valid.

The dates written in the English version are according to the Gregorian Calendar, and the times according to Tehran Local Time (UTC+3:30), unless specified otherwise.

Considering the different information sources, the key event times, particularly those related to the missile launch and activation had minor differences. The investigation team calibrated the times using available information and techniques; however, the tolerance of direction and distance measurements and the update rate of information resulted in a 2-second uncertainty for the reported time values. Values related to the direction of ADU have a tolerance of  $\pm 2$  degrees. Even so, these tolerances and uncertainties did not affect the conclusions and results.

The details of an accident could be painful and poignant to the victims' families. Stating the contributing factors could also be interpreted as justifying or downplaying them, or making them look inevitable simply. However, it should certainly be borne in mind that elaborating on the causes of an accident is not supposed to mean it was inevitable. More importantly, no analysis and elaboration on such issues will be in any way worthy of comparison neither to the accident victims' lost lives nor to their families' hurt feelings.

The PS752 accident investigation team would hereby genuinely like to extend their heartfelt condolences and sympathies to those having suffered distress and loss as a result of the accident and show great respect for their deep feelings and emotions.



## 2. Factual Information

### 2.1. Flight History

On Wednesday, January 08, 2020, at 00:53, the inbound flight No. 751 of Ukraine International, Boeing 737-800, UR-PSR, en route to Tehran Imam Khomeini INTL. Airport from Kyiv Boryspyl INTL. Airport was cleared for landing, and after four minutes landed on the IKA runway. After disembarking 58 passengers and refueling, the flight crew went on to check into the hotel located at IKA.

From 01:16 to 01:38, the aircraft was refueled with 9510 kg (11800 liters) of fuel. Once the total weight of the cargo received from passengers (310 packages weighing 6794 kg) was determined, in order to comply with the maximum takeoff weight allowed for aircraft, 82 packages in 2094 kg in weight, were separated by Airport Service Company, that is, they were not loaded. Initially, 78 packages of the passengers' luggage were not loaded first, then due to the large volume of passengers' hand luggage, the flight attendants passed some of them on to the Airport Service Company personnel to be placed in the aircraft cargo. After that, 4 packages belonging to the passengers were removed from the aft cargo door, where the hand luggage was placed.

At 04:35, the flight crew embarked on the aircraft. After checking the aircraft and cabin, boarding was announced at 04:45, and passengers started to board the plane.

Based on the available documents, 167 passengers proceeded to the Airport Services Co. counter at the airport terminal, all of whom went on board. Only one of the passengers who received the boarding pass online the night before the flight, due to the delay in arriving in Tehran from another city did not go to the airport in person, and therefore had been removed from the list of passengers provided by the UIA.

At 05:13, the pilot made his first radio contact with the IKA's control tower ground unit and requested the initial clearance for flying, which was issued by the controller subsequently.

At 05:48, all the aircraft documents required to start the flight operations were filled out, and all the doors were then closed at 05:49.

The flight was initially scheduled for 05:15, and based on the flight coordinator's report form, the reason given for its delay was the aircraft being overweight and the decision not to load the passengers' luggage for reducing the aircraft weight.

At 05:51 the pilot notified his position at the airport parking, declared his readiness to exit the parking and start up the aircraft. The IKA tower asked him to wait for receiving the clearance since they wanted to make the coordination required with other relevant units.

At 05:52, the IKA tower made the necessary coordination with the Mehrabad approach unit, who contacted Tehran ACC asking for clearance. Accordingly, the controller in ACC made coordination on Ukrainian flight clearance with the CMOCC. The clearance was issued by the CMOCC.

At 05:54, the Mehrabad approach unit, received the FL260 clearance for the flight AUI752 from ACC, and forwarded it to IKA via the telecommunication system.

Flight no. 752 was detached from the A1 Jet Bridge and at about 05:55 started to leave its parking position, NO 116 on the right, by a pushback truck.

Following that, at 05:55 the ground controller cleared the AUI752 flight for startup and exiting the parking, which was read back by the pilot.

At 06:12, the aircraft took off from the Runway 29 Right of IKA and was delivered to the Mehrabad approach unit. The pilot contacted the approach unit, and announced the IKA 1A radar procedure as SID procedure. Next, the Mehrabad approach identified and cleared the flight to climb to FL260. The controller instructed the pilot to turn to the right after 6,000 feet, and continue straight to PAROT.

After it was read back by the pilot, the controller again instructed the pilot to continue to PAROT point once passing the 6000-foot altitude, which was read back by the pilot.

From 06:17 onwards, upon the disappearance of the PS752 information from the radarscope, the controller called the captain repeatedly, but received no response.

According to the data extracted from the surveillance systems and FDR, the aircraft climbed to an altitude of 8,100 feet; thereafter, the label including the call sign and altitude of aircraft disappeared from the radarscope, yet no radio contact indicating unusual conditions was received from the pilot. FDR recording terminated at 06:14:56. This time corresponds to the termination of Secondary Surveillance Radar (SSR) and ADS-B information.

After the mentioned time, the aircraft was still being detected by the Primary Surveillance Radar (PSR), according to which the aircraft veered right and after approximately three minutes of flying, it disappeared from the PSR at 06:18 too.

The aircraft was conducting the flight under the Instrument Flight Rules (IFR) and the accident occurred around half an hour before the sunset.

The aircraft flight path detected by PSR and SSR is illustrated in Figure 2.

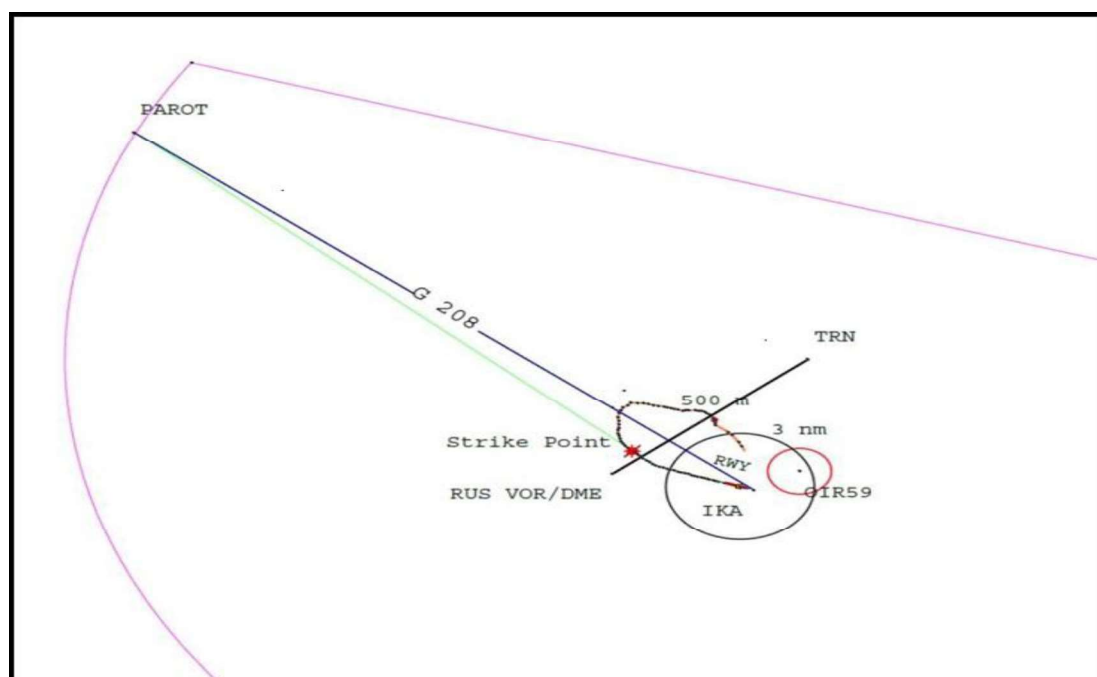


Figure 2- The aircraft flight path detected by PSR and SSR

## 2.2. Injuries to Persons:

All 176 persons on board this flight lost their lives<sup>1</sup> as shown in Table 1.

Table 1- The number and type of injuries to persons

Injuries	Crew	Passenger	Others	Total
Fatal	9	167	0	176
Serious	0	0	0	0
Minor / None	0	0	0	0
Total	9	167	0	176

<sup>1</sup>- One of the passengers on board this aircraft had been pregnant, whose fetus is reported to have been 7 months old. Under the Laws in Iran, the dead fetus is regarded a person; therefore, in judicial investigations, the number of the victims is reported as 177 people.

Two of the passengers who had purchased tickets did not go to the airport, so they were not onboard this aircraft.

### **2.3. Identification of Victims**

At the AAIB's official request, the following was put on the agenda:

- Identification of the victims
- Tests on flight crew bodies
- The cause of deaths
- The analysis of burning and discovery of metal objects in passengers' bodies

Initially, the Iranian Legal Medicine Organization (Forensic Medicine Organization), in cooperation with domestic entities and coordination made with the involved international authorities, created a DNA data bank for the passengers. By judicial authorities' decision, bodies were handed over to the victims' families for burial and afterwards following their DNA sample confirmation. At the request of some States and victims' families, some of the passengers' bodies were transferred to foreign countries for delivery to their families and burial at their desired location.

### **2.4. Damage to Aircraft**

The aircraft was completely destroyed due to crash and ground impact.

### **2.5. Other Damage**

Apart from the damage to the aircraft, the accident caused further damage to public properties, such as a park and playground, and also private gardens and estates.

After losing altitude and passing by a residential area, called Khalajabad, the aircraft initial impact point was with a gazebo in a recreational park, called Lale. The aircraft fuselage, subsequently, impacted the ground, disintegrating completely after passing a football pitch, which in turn damaged the surrounding agricultural farms and gardens. Following the initial impact, other impacts were observed along the track at the accident site, wrecking the fuselage and spreading across the entire track. (Figure 3)





Figure 3- Accident site scheme

## 2.6. Organizational and Managerial Information

Ukraine International Airlines was the aircraft operator.

The company was established in 1992 and is headquartered in Kyiv, Ukraine. Its main station is Boryspyl International Airport.

The company is coded AUI in ICAO and PS in IATA. At the time of the accident, the company owned 45 aircraft, conducting flights to approximately 88 destinations.

The price of the ticket, as well as the flight network of this company, was such that it was considered an economic choice by travelers who flew to or from Tehran to travel to third countries. For example, the crashed flight had only two passengers of Ukrainian nationality, and most of the passengers also intended to travel to other countries.

At the time of the accident, UIA had a valid operating license No. UK 021 issued by the State Aviation Administration of Ukraine (valid from 10/14/2019 to 10/13/2021).

The airline had a valid CAMO approval certificate from State Aviation Administration of Ukraine.

The aircraft airworthiness was managed by UIA CAMO and the last aircraft maintenance service was performed by the contractor MAU technic.

## **2.7. Personnel Information**

### **2.7.1. Pilots**

The flight was being operated by three pilots, comprising a flight instructor, captain and first officer together with six flight attendants. According to the report provided by the UIA, the pilots' information is as follows:

Captain, aged 50, had experience of 11590 hours total flight time, including 4462 hrs on B737 NG and 3966 hrs on B737 CL with 4 takeoffs and 5 landings in IKA.

Copilot, aged 48, had experience of 7633 hrs total flight time, including 266 hrs on B737 CL, 2002 hrs on B737 NG and 1374 hrs of B737 experience before joining UIA with 6 takeoffs and 7 landings in IKA.

Flight instructor, aged 42, had experience of 12052 (9820 B737) hrs total flight time, including 3240 hrs on B737 NG, 6580 hrs on B737 CL and 1075 hrs on Embraer 190 with 13 takeoffs and 14 landings in IKA.

Each of the three flight crewmembers had both valid personal licenses relevant to their duties, and related medical certificates.

### **2.7.2. Mehrabad Approach Radar Controller's Background**

At the time of the accident, the aircraft was being controlled by the Mehrabad approach controller, a forty-one-year-old man with valid air traffic control tower ratings, and Mehrabad Radar Approach with License No. 1073. He holds an English Proficiency Level 4 and medical certification valid up to July 20, 2020.

### **2.7.3. Flight Attendants**

There were two male cabin crew members and four females on the flight. To date, the UIA has not provided information on training, medical

certificate validity, approval for flight security. However, it was revealed that such issues were not relevant to this accident and investigation.

## **2.8. Aircraft Information**

### **2.8.1. Introduction to the Aircraft**

The Boeing B737-8K (WL), serial No. 38124 with manufacture date of June 21, 2016 was operated by Ukraine International Airlines.

The aircraft's type has been certified by the U.S. Federal Aviation Administration (FAA) with TC number A16WE subject to Federal Aviation Regulations (FAR).

The maximum takeoff weight is 72,500 kg (159,835 pounds), and the maximum capacity seating is 189 passengers.

The aircraft was equipped with two CFM56 7B24E, which are certified by Type Certificate Data Sheet no. E000056EN by FAA and E004 by European Aviation Safety Agency (EASA).

The Boeing 737-800 aircraft had a TL 0001 type certificate, the CFM-56 7B24E engine installed on this aircraft had a TD 0038 (TD 0038) type certificate issued by the Ukrainian Civil Aviation Authority.

### **2.8.2. Aircraft Technical Information**

According to the list and documents provided by the State of Registry, the aircraft technical information shows that the aircraft had a valid Airworthiness Certificate. The Airworthiness Review Certificate was valid until Feb. 07, 2020.

The UIA had CAMO and the accident aircraft was included in the scope of CAMO approval.

There were no changes in the aircraft that would make it subject to STC.

According to the Aircraft Flight and Maintenance Log page No.068845, Figure 4, on the flight before the accident, the aircraft departed at 21:41 from Kyiv, Ukraine to IKA, and after flight landing and preparations, no technical defect was reported by the pilot requiring a technical action.



**UIA AIRCRAFT FLIGHT AND MAINTENANCE LOG**  
 PAGE No: 068845  
 A/C REG. No: UR - PSP  
 AFTER FLIGHT No: 0011051  
 DATE OF ISSUE: 22/5/2020

**FLIGHT TIME:** 1:21  
**BLK. OFF:** 13:21  
**TAKE OFF:** 13:21  
**LANDING:** 14:42  
**BLK. ON:** 15:03  
**BLOCK:** 15:03  
**AIR:** 15:03  
**AUTOLAND APCH:**  OK  NOT OK

**FUELING:** 9511 UPLIFT, 12511 TOTAL, -11100 ADJUST, 12400 DEPART  
**TYPE:** 14-1 ORDER(S) No: 00407432

**HYDRAULIC FLUID UPLIFT:**  LTR A/1/L B/2/C STBY/3/R  
**ENGINE OIL UPLIFT:**  LTR 1 2  
**APU OIL UPLIFT:**  LTR  
**DE-ICING:** Type Ratio STARTED

**TIRE SERVICING:**  NIL ADDED (Pressure check/added, psi)  
**SCHEDULED MAINTENANCE / CRS\*:** CHECK SIGN. Auth. No. FINISHED AMO Part-145 Appr. No. 145  
**WEIGHT LIMITATIONS\*\*\*:** STANDARD  ALTERNATE 1 ALTERNATE 2  
**PRE FLIGHT INSPECTION:** CAPTAIN'S ACCEPTANCE CERTIFICATE FROM TO NAME TIME DATE SIGN

**DPS CAT:**  I  II  III  IV  V  VI  
**ETOPS:** MIN  NOT ETOPS  ETOPS VERIF. FLT REQUIRED\*\*

Figure 4- Aircraft flight and maintenance log

The ground handling Co. handled the flight preparations, boarding and loading according to the Trip Information it received from the pilot, including the amount of residual fuel, the maximum takeoff weight (MTOW), the maximum landing weight (MLW), the amount of fuel required to conduct the flight, the flight time and other information on the aircraft defined in the Load Sheet.

According to the aircraft Load Sheet, the maximum allowable weight had been calculated at 72500 kg. Due to the limit on maximum allowable takeoff weight, the ground handling Company did not load 82 pieces of baggage equal to 2094 kg. Ultimately, the aircraft takeoff weight was calculated 72468 kg, which was 32 kg lower than the maximum allowable takeoff weight. After boarding and loading, the pilot finally approved the Load Sheet.

According to the report provided by the ground handling Co., each male passenger’s weight was considered 88 and a female 70 kg taking their hand luggage into account, and the excessive packages inside the cabin

were transferred to the aircraft aft cargo, where some were removed. Ultimately, 82 packages were not loaded.

Based on the information obtained from the ground handling Company, it was found that the flight crew brought delivered some luggage onboard to the handling Co. The ground handling personnel were then unloaded some of the passengers' luggage and cargo from the cargo section to comply with the maximum allowable weight.

The pilot had chosen the Odessa airport (ICAO CODE: UKOO) as the alternate airport and made fuel-related calculations accordingly.

### 2.8.3.Aircraft Systems

A large number of systems have been installed on aircraft, the analysis of each is based on the recorded data parameters.

According to the information obtained out of the FDR read-out, no system failure was recorded till 06:14:56, after which no conclusion can be made on them due to termination of the recording.

Navigation Systems:

The accident aircraft navigation systems include the following:

1. The Flight Management System (FMS) which includes:
  - Flight Management Computer System (FMCS)
  - Autopilot/Flight Director System (AFDS)
  - Auto throttle (A/T)
  - Inertial Reference System (IRS); 2 independent systems
  - Global Positioning System (GPS); 2 receivers
2. Two VOR- Receivers
3. Two ILS Receivers
4. Two Marker Beacon Indications
5. Two ADF Receivers
6. Two DME Transceivers

In addition to the above items, the aircraft is equipped with two ATC transponder devices, one of which can only be active at one time while the other can be used as a backup.

On the flight resulting in the accident, according to the data found from the SSR radar, no defect could be observed in receiving signals from ATC transponder, from the beginning to the moment the flight reached the altitude of 8100 feet. Nevertheless, from 06:14:56, when the aircraft had been climbing at an altitude of 8,100 feet and the ground speed of 276 Kt (according to the FDR), ATC transponder signal was interrupted, and this situation continued until the aircraft crashed to the ground. (At 06:18:23)

#### Communication Systems:

According to its Radio Station License, the aircraft had three VHF communication systems, manufactured by Honeywell Co., functioning in the frequency band 118-136.992 with a Frequency Spacing of 8.33 kHz.

The pilots made their last communication with Mehrabad Approach Unit at 06:13:23. The CVR read-out indicates that up until the end of recording at 06:15:15, the flight crew had not been attempting to establish communication; therefore, no comment can be given on the performance of communication system after last recorded communication.

#### Other Systems

The flight recorders read-out and analysis revealed that until 06:14:56, when the recording was continuing, all the systems had normal performance. After the mentioned time, given the end of the FDR recording and transponder messages stopped being received, the warning sound as well as the unusual condition in the cabin, it is highly probable that several electrical buses failed. Considering the objective evidence indicating the fire outbreak and its intensification in the aircraft, the cascading damage to other systems is likely (refer to sections 2.13 and 2.15).

## **2.9. Meteorological Information**

Upon receipt of the accident notification, Iran Meteorological Organization was enquired about the overall situation of IKA's weather, as per the following:

### **2.9.1. IKA METAR (OIIE)**

OIIE 080330Z 28006KT CAVOK M01/ M04 Q1021

OIIE 080300Z 27006KT CAVOK M01/ M04 Q1021

OIIE 080230Z 28008KT CAVOK M02/ M04 Q1021

There were no operational considerations regarding weather conditions for the flight.

## **2.10. Aids to Navigation**

Investigations indicated that the required navigational aids related to the flight had been operational and in good condition.

## **2.11. Communications**

### **2.11.1. Radio Communications**

The review of the radio communications is based on the information received from Iran ANSP.

### **2.11.2. Iran Aseman Airline's Flight Conversation during Approach**

Few minutes before the accident (ground impact), flight No. 3768 of Iran Aseman airlines from Shiraz Airport, approaching to land at Mehrabad Airport, asked Mehrabad ATC about any unusual activity in the region. After landing, the pilot contacted AAIB, and her report was reviewed as a witness by the investigation team.

The transcript of this communication is given in Table 2.

**Note:** The audio file of this radio communication was released through the media. However, the sequence and content of the released file are different from those of the original one.

Table 2- Transcript of communications between Tehran radar and IRC3768 flight

Speaker	Time	Transcriptions of the Communications
AUI752	06:12:57	Radar good morning AUI752....on course IKIA 1 A
RDR		Good morning AUI752, radar identified on departure climb FL260, crossing 6000 feet turn right PAROT
AUI752		Next PAROT climbing 260 AUI752 information all received, thank you
RDR		Welcome after 6000 to PAROT
AUI752		After 6000 to PAROT AUI752
IRC3768	06:16:25	Approach from Aseman 3768
RDR		You have GPS failure?
IRC3768		No sir, is the area approximately on heading 320 active now?
RDR		320? Area? No. ... how many miles away? Where?
IRC3768		A series of flares ...like that of a missile ... Is there anything like this over there?
RDR		How many miles away? Where?
IRC3768		Well, can't tell how many miles away exactly. But I think it is in Payam vicinity; Karaj whereabouts
RDR		Ummm...We have not been informed of that. No idea.
IRC3768		Now we can see its flare from here.
RDR		What's it like? What does this light look like?

IRC3768		It is the flare of a missile, perhaps
RDR		It's not, by any chance, approaching east, is it?
IRC3768		No, no; it just emerged from there. I mean it was something like this
RDR		We have not received any report on this. Be cautious anyway!
IRC3768		Yes, thanks.
RDR	06:17:50	AUI752 radar, AUI752 radar
RDR	06:18:08	AUI752 Mehrabad radar
RDR	06:18:26	AUI752 radar, AUI752 Mehrabad radar
RDR	06:19:00	AUI752 Mehrabad radar, do you read
RDR	06:19:34	AUI752 radar
RDR	06:19:48	AUI752 Mehrabad radar, AUI752 Mehrabad radar do you read
RDR	06:20:35	IRC3768 9000 QNH1020 cleared approach
IRC3768		OK 9000 feet cleared approach
RDR		3768! Can't you see anything else?
IRC3768		It was an explosion sir; we saw a huge light over there. I wonder what it was really!
RDR		Thanks.
IRC3768		Confirm that everything is normal for us!
RDR		Yes, I don't think it would cause you any problem.
IRC3768		God willing. Thanks.

*Note: The blank time cell shows that the communication was made immediately after the previous one.*

**2.12. Aerodrome Information:****2.12.1. General Information on IKA**

Imam Khomeini International Airport is located in the south of Tehran and is the main international airport in Iran. By 2015, it had been operated by Iran Airports and Air Navigation Company, and since the end of 2015, it has changed into Imam Khomeini Airport City Company with the approval of Iran's government. The Company operates the airport independently but air navigation services in this airport are provided by Iran Airport and Air Navigation Company through a contract.

The air traffic control service is provided at IKA by two GND and TWR units in the control tower, and since the IKA is located in Tehran TMA, the APP service is provided through the relevant unit at Mehrabad Airport. According to the operational agreements, just after takeoff from the runway the flight will be delivered to the controller of the approach unit of Mehrabad Airport.

At this airport, three companies, namely Homa, Saman and Hamrah Kooshkish provide ground-handling services, and Saman Co. provided ground-handling services to the accident flight.

**2.12.2. IKA CCTV Information**

Considering the importance of security issues related to the accident aircraft, all information of the aircraft at the airport parking and the ground handling procedures recorded by CCTVs for the flight were reviewed, from the aircraft arrival time to its parking and exit time. Different individuals' access to the aircraft in addition to the provided ground service to the aircraft were checked in the CCTV footage of the aircraft parking stand close to the airport Jetway. Various services provided to the aircraft are as follows:

*Table 3- Key events recorded by IKA CCTVs*

Time	Events
01:02:50	The aircraft parked at the stand close to the Jetway



<b>01:07:22</b>	The refueling vehicle arrived
<b>01:10:00</b>	The Jetway was connected to the aircraft for passenger disembarkation
<b>01:16:35</b>	Start of refueling
<b>01:20:35</b>	The end of cargo unloading, the conveyor belt was detached.
<b>01:38:23</b>	The end of refueling.
<b>01:45:32</b>	The Jetway disconnected from the aircraft after crew left the aircraft and the cabin door was locked
<b>03:58:00</b>	Re-connection of the Jetway
<b>04:01:03</b>	The luggage was carried beside the aircraft.
<b>04:20:20</b>	The conveyor belt was connected to the aircraft.
<b>04:24:30</b>	The start of luggage loading
<b>04:41:30</b>	Connection of towbar to the nose landing gear.
<b>04:49:35</b>	End of forward cargo loading
<b>05:27:26</b>	The cargo pallets were carried away from the aircraft.
<b>05:38:07</b>	Some luggage was unloaded from the aft cargo.
<b>05:39:28</b>	The remaining hand luggage was loaded to the aft cargo.
<b>05:41:35</b>	The conveyor belt was detached from the aft cargo.
<b>05:50:25</b>	Jetway disconnection
<b>05:50:50</b>	Connection of tow car.
<b>05:55:00</b>	Start of pushback
<b>06:06:40</b>	The aircraft started taxiing and moved towards the runway.



The airport CCTV shows that except for the individuals responsible, no one else had access to the aircraft and engines, nor was any technical action performed on the aircraft.

## **2.13. Flight Path, Impact Point and Wreckage Information**

### **2.13.1. Flight Path**

Based on the submitted flight plan, the route considered to fly from Tehran to Kyiv was as follows:

OIIE → PAROT → ASPOK → BUDED → TBZ → DASIS → ERZ → KUGOS →

DIGAM → ETNIL → MIMKO → KONIP

The PS752 planned flight path is illustrated in Figure 5.

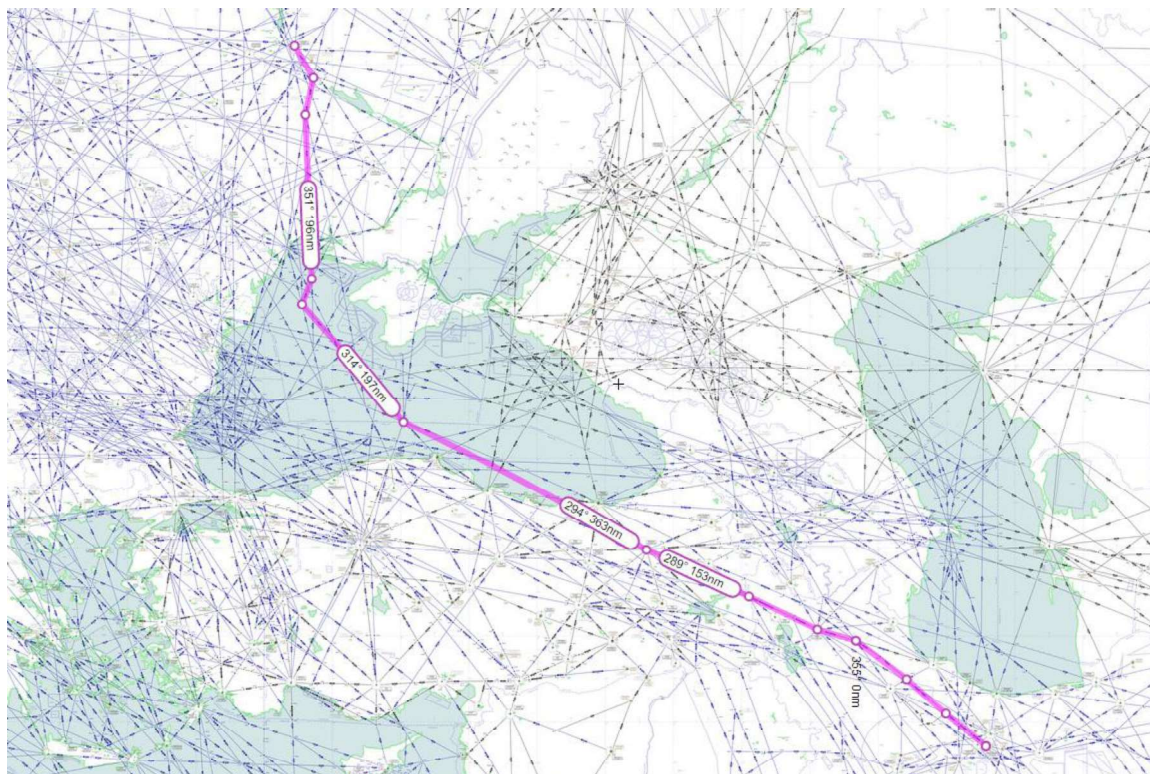


Figure 5- The planned flight path for PS752 according to the flight plan

After takeoff, the aircraft continued flying on the planned path, but at position  $35^{\circ}29'29.79''\text{N}$   $50^{\circ}57'13.43''\text{E}$ , the ATC transponder signals and FDR recording terminated, shortly afterwards the aircraft began turning to the right and losing height<sup>2</sup>. While already on fire (based on observations of eyewitnesses and recorded videos), the aircraft crashed into the ground at position  $35^{\circ}33'45.63''\text{N}$   $51^{\circ}6'11.21''\text{E}$  and exploded. Figure 6 depicts the flight trajectory.

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<sup>2</sup> - Losing the height was observed by eyewitnesses.

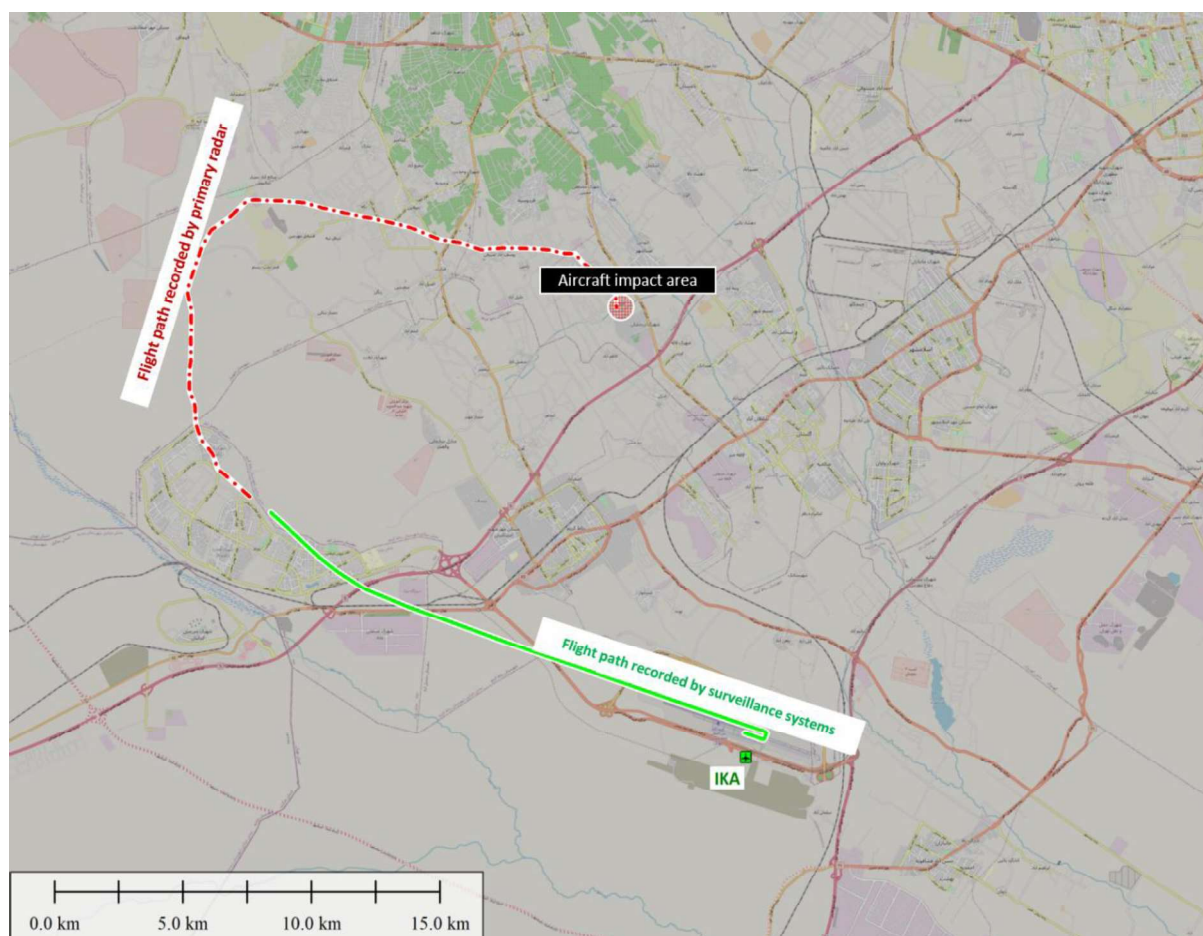


Figure 6- Flight PS752 trajectory

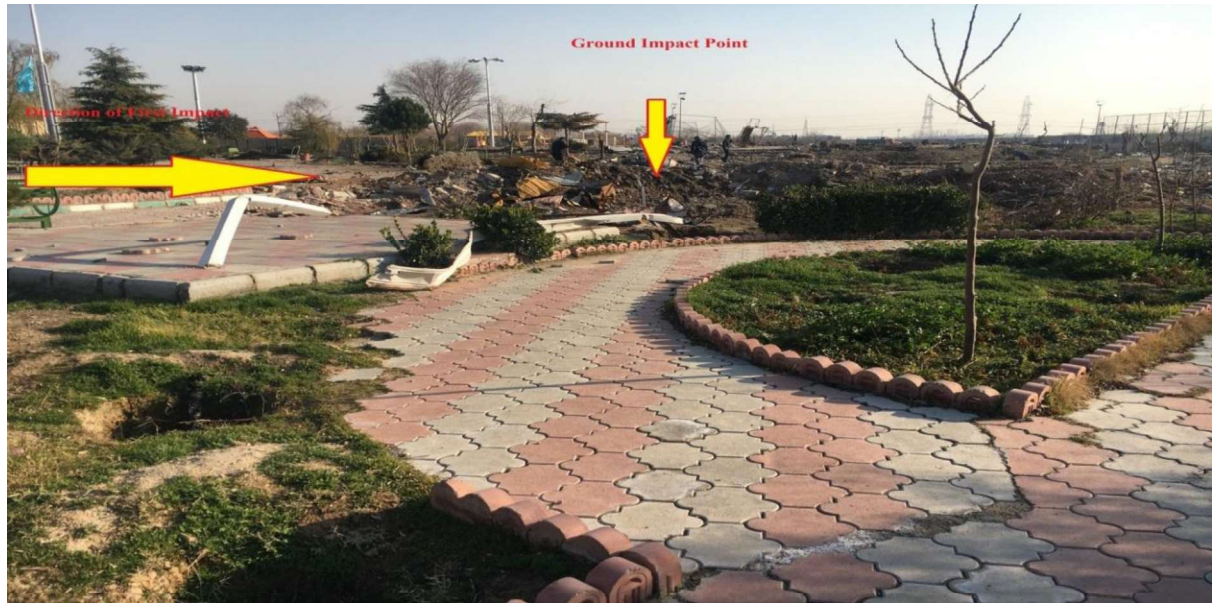
### 2.13.2. Impact Information

Shortly after the transponder stopped transmitting signals, the aircraft heading was changed to the right and after turning, headed toward the airport. The aircraft lost its altitude gradually and after passing by Khalaj Abad residential area impacted a gazebo roof in a recreation park with the position  $35^{\circ}33'45.4''\text{N}51^{\circ}06'11.3''\text{E}$  and then hit the ground (Figure 7).

The impact with the ground created a large hole in the park, then the fuselage distanced from the ground and went on to a soccer pitch, hit its fences, passed by a water canal, again hit walls of private gardens and disintegrated completely as shown in Figure 8. The evidence and pieces gathered from the aircraft at the main accident site showed that the aircraft still maintained its relative integrity before impacting the ground. Interviews with eyewitnesses along the flight path confirmed this as well.



Due to the vast area of the accident site, it is presumed that the locals accessed it during the minutes after the accident until the arrival of Law Enforcement Officers there. With the arrival of the investigation team, the necessary coordination with the district local authorities was done to preserve the accident site for locating the aircraft parts, to perform general analysis and sampling.



*Figure 7- The first ground impact of the aircraft*



Figure 8- An overview of the aircraft parts distribution

By the end of the search operation for bodies, the arrangements were made for the ambulances to transfer the bodies to Tehran's Legal and Forensic Medicine Organization. Due to the vast area of the crash site, filled with the aircraft parts, and the impossibility of long-term protection, the wreckage parts were collected and transferred to a safe place at IKA, where they were separated and laid out by the relevant experts.

While flying past a village called Boke near Shahriar, some skin pieces belonging to the aircraft wing back end surfaces (Figure 9) were detached and found on the ground at position  $35^{\circ}35'55''\text{N}$ ,  $50^{\circ}59'00''\text{E}$ . Some small pieces and a piece of the air conditioning system (Figure 10) were found at position  $35^{\circ}35'53''\text{N}$ ,  $50^{\circ}59'43''\text{E}$ , about 10 kilometers before the crash site, which was collected by the locals in residential complexes and delivered to the respective rural council.



*Figure 9- Part of the aircraft wing*



*Figure 10- A part of air conditioner found on ground before crash site*

The flight track on ground was searched, and no other reports on finding any other pieces were received and the rest of aircraft pieces at the crash site were collected finally. The found pieces before the crash site were handed over to the investigation team and transferred to the AAIB.

### 2.13.3. Findings Obtained from the Crash Site

The outer skin of the left wing had signs of burning. There was no sign of fire at the place where the piece was found and the vegetation surrounding



it was undamaged. This showed the burn on the wing had occurred before the crash into the ground. The inner walls of the wing indicated that the fire had not broken out into the aircraft fuel tank. (Figure 11)



*Figure 11- The aircraft left wing at the crash site*

Some parts of the right wing together with the winglet indicated that the fire had not broken out into the right side of it (Figure 12).



*Figure 12- The aircraft right winglet*

Smoke and burn were observed on the ground close to the Auxiliary Power Unit (APU) (Figure 13).



*Figure 13- Auxiliary Power Unit*

#### 2.13.4. Aircraft Wreckage

Evidence shows serious damage to the lower part of the aircraft nose, especially the lower half of the cockpit. As for the upper half (upper body) found at the site, however, even the cockpit windows were still in their own place in the relevant frame (5 out of 6 total), though a lot of heat had spread into them from inside.

Of the main four exit doors of the aircraft, three cabin doors were found at the accident site, which were transported to the wreckage piece layout location.

The upper part of the aircraft had sustained less damage than the lower part.

The passenger cabin equipment was completely shattered, which was barely identifiable. The two wings of the aircraft were connected to the fuselage until ground impact, and as for the winglet, it was detached from the wing without any damage, or signs of destruction at its location, which is available at the layout site.

At the rear of the aircraft, there is an APU connected to the empennage end part, which was found with the horizontal structure and connected to



it at the accident site, indicating the integrity of the end part on ground impact.

The vertical fin at the rear of the aircraft had been entirely detached from the lower part, which was found at the accident main site.

Life vests, seat covers, plates, and the rest of passengers' clothes were on the spot without any signs of burns. The fire extinguishers did not show any signs of fire either, indicating that the fire has not spread completely.

The wing roots and the upper section of the fuselage, equipped with two emergency exit doors, still existed in their place, confirming the relative structural integrity of the fuselage and wings at the moment of ground impact.

The main burn signs were seen in the front left side of the plane and in the connection of the left-wing with the fuselage. In the upper surfaces of the wing, there were more signs of fire than the lower part.

The rear end of the aircraft suffered less damage before hitting the ground.

No traces of fire were found in the passengers' luggage.

The ceiling of the passenger cabin in front of the plane, between the cockpit door and the front cargo, caught fire. Most of the damage seems to have been caused from fire in electronic compartment towards the above, and the avionics equipment was largely destroyed.

The traces of a serious fire can be observed inside the cockpit (Figure 14).

The traces of fire and smoke on the cockpit outer skin mark two situations: before and after the ground impact. In fact, it revealed that the fuselage had caught fire before the ground impact.



*Figure 14 - Closer view of the cockpit*

An ID card related to instructor pilot was found at the crash site without any signs of burns (Figure 15).



Figure 15- Instructor pilot's ID card

A large number of ruptured holes were seen on the aircraft fuselage, which varied in terms of size, shape and direction in opening, though they were of two different types. One, which was fewer, shows the thick smoke towards outside of the fuselage (Figure 16, Figure 17, Figure 18 and Figure 19), and in the other, with a higher number, only ruptured holes could be observed (Figure 20 & Figure 21).

On the cabin ceiling along the electronic compartment, a few holes and traces could be seen, caused by a small object impact from inside to outside. The thick track of smoke coming out of the holes indicates they had been caused before the ground impact, out of which smoke had been coming out while the aircraft was flying.

Laboratory results from the sample smoke layers around the holes show that the chemical base of the smoke was carbon, in which no traces of explosives were found.



*Figure 16- Hole in the fuselage with a trace of a different color of smoke*



*Figure 17- Hole on the fuselage near the cabin with a trace of different color of smoke*





*Figure 18- Hole on the fuselage near the cockpit and exhaust fumes*



*Figure 19- Closer view of the hole on the fuselage near the cockpit and burn signs in the hole area*





*Figure 20- Crack with an outward hole in the skin of the structure near the cockpit*



*Figure 21- Holes and cracks on vertical stabilizer*

In the central part of the aircraft, below and to the left between the fuselage and the wing, the traces of burns could be seen in the vicinity of the cabin air-conditioning system, which was the installation point of pre-cooling part found before the crash site near Jandaq village. There was

another heat exchanger found at the crash site, on which molten aluminum was observed, indicating a severe fire in this part.



*Figure 22- The second heat exchanger found at the accident site and its installation point on the fuselage*

Two aircraft engines were found at the accident site, which were totally destroyed (Figure 23). The damage observed on the rotating parts shows that the engines were working. The evidence revealed no explosion or severe fire on the engines and it seemed that most of the damage had been caused by deforming due to ground impact.





*Figure 23- The two aircraft engines*

#### **2.14. Medical and Pathological Information**

It could not be determined if the occupants of the aircraft were injured prior to impact, or if they received fatal injuries as a result of the impact.

Toxicological samples related to crew were sent to a laboratory, where no drug or toxin was observed.

The investigation team requested the pathologist if he could detect the existence of metal objects in the bodies. It was decided if metal parts were observed in the autopsy process, they had to be reported, and samples had to be handed over to the investigation team for analysis. Forensic experts could not finally discover any metal parts in the corpse tissues of the passengers on board.

DNA tests were needed to identify the bodies, so a blood sample was taken at the official request of the Iranian Legal Forensic Medicine Organization with at an international level. At the same time, the CAO IRI went on to send DNA samples via the official representatives of the States involved in the accident investigation. Thereby, the DNA samples of the deceased were determined and collected in a data bank at Kahrizak Forensic Medicine Center. Afterwards, the bodies were prepared for delivery to the



victims' families, and the necessary arrangements were made to transfer them to their own desired cities.

### **2.15. Fire Breakout and Extinguishing**

The evidence from the aircraft wreckage and the videos and images obtained suggested the occurrence of a fire in parts of the aircraft before the ground impact.

The fire was observable in the front cabin and on its left side.

Fuselage evidence suggested that some holes were made in it. Afterwards, with the occurrence of a fire in the front cabin, the traces of thick smoke coming out of the created holes on the fuselage appeared which were quite different from those of the fires on other exterior parts of the aircraft.

Because of the spreading of the aircraft fuel upon impact with the ground barriers, fire engulfed the crash site, which was extinguished by the fire department in the area.

### **2.16. Search and Rescue**

Under the Emergency Response Procedure and Air Accident Regulations, upon communication failure with the flight PS752, the Rescue Coordination Committee (RCC) was immediately formed in Tehran ACC, and the necessary notifications were subsequently sent to the relevant authorities.

The AAIB notified the Crisis Committees of Iran's Ministry of Roads and Urban Development and Ministry of Health. Emergency Operations Center (EOC) of the Ministry of Health confirmed the accident and fire at the accident site, and then it ordered the dispatch of forces of both Relief and Rescue Organization and the fire department from Shahriar. Finally, it was announced that all the passengers had, most probably, died.

A Crisis Management Team was at the same time formed, led by the governor of Shahriar.

Following the Emergency Response Plan of IKA, the relevant committee was formed at this airport, which was attended by the representative of the UIA and the CAO IRI.

Initially, helicopters of the Red Crescent and Emergency were dispatched to the site from Tehran.

The necessary arrangements were simultaneously made to send the required forces from state and military organs to the area, all of whose capacities were used to manage the crash site.

No Emergency Locator Transmitter (ELT) signal was received from the crash site.

After the Red Crescent Organization of Iran collected the bodies and announced the search completion, numerous ambulances transported the bodies to Kahrizak Forensic Medicine Center.

## **2.17. Tests and Examinations**

### **2.17.1. The Aircraft Fuel Examination**

No aircraft fuel was found at the crash site for test. Given the importance of such an issue, the refueling vehicle having provided fuel to the aircraft, operated by the refueling company at IKA, was released from operation to be investigated. The fuel in the truck tank was sent to a laboratory for sampling. The test results showed that the fuel met the standards and its quality did not produce any effect on the accident, as shown in Figure 24.

DATE: 16/Feb/2020		FORM NO: QC-FO-04-01		
PROPERTY	TEST METHOD		SPECIFICATION LIMITS	Owj-co
	ASTM	IP		RB-206
				RESULT
APPEARANCE			C&B	<b>C&amp;B</b>
DENSITY AT 15°C	4052	365	0.775-0.840 gr/ml min-max	<b>0.8001</b>
SAYBOLT COLOUR	156			<b>29</b>
DISTILLATION	86	123	-	-
I.B.P.			REP. °C	<b>156</b>
10% Recovered %VOL			205°C max	<b>173</b>
50% " %VOL			REP. °C	<b>196</b>
90% " %VOL			REP. °C	<b>237</b>
F.B.P.			300°C max	<b>269</b>
R/L %VOL			1.5ml/1.5ml max	<b>0.5/0.5</b>
EXISTENT GUM mg/100ml		540	7 max	<b>0.4</b>
MICRO SEPARO METER			70 min	<b>99</b>
FLASH POINT		170	38°C min	<b>49</b>
COPPER CORROSION 2hrs @ 100°C	130	154	NO.1 STRIP max	<b>1A</b>
FREEZING POINT	2386	16	- 47°C max	<b>&lt;55</b>
CONDUCTIVITY	2624	274	50-600 pS/m min-max	<b>115</b>

Figure 24- Aircraft fuel test result

### 2.17.2. Investigation into the operation of the Aircraft's ELT

Although the global statistics are indicative of the ELT failure in numerous air accidents, it still came under the investigation team's scrutiny. This device is used only to determine the crash location in search and rescue process and has neither an impact on its occurrence nor is considered a contributing factor in this regard. Even so, the reason for its signal transmission failure was investigated.

The accident aircraft ELT should have sent signals in two frequencies, 121.5 MHz and 406 MHz.

The former is intended to locally receive accident warning, no relevant report on which was received, though. As for the 406 MHz signal, the global satellites did not receive such a signal either.

The investigation team came across an automatic ELT and two survival ones at the accident site.

The automatic ELT had been activated due to the impact severity, yet as its signal-transmitting antenna to satellites was detached, the

international satellites did not succeed in locating the crash site. To assess the aircraft ELT performance, the survival ELTs were activated at laboratory<sup>3</sup>, but no information was received from the satellite. Due to the damage inflicted on the antennas of the two ELT devices, a new antenna was installed and activated on them. The warning was received this time in the frequency 121.5 MHZ in the local station, but again no information was received from Cospas-Sarsat. Hence, the ELT manufacture company was contacted to provide the necessary explanation. Thanks to the cooperation offered by the French ACCREP and the ECA Group (ELTA group), it became clear that the internal structures of survival ELT might have been damaged by the severity of the impact. Following this conclusion, no deeper analysis was performed..

### 2.17.3. Test for Metal Object Existence in Passenger Seats

As some holes were observed in the passenger seat pads (Figure 25), they were collected from the accident site to find the FODs possibly penetrating into them due to explosion. Then, using the X-ray scanners, the initial detection of FOD was made, and the observable cases were transferred to the AAIB. Having cut their pads, the metal pieces were extracted and sent to a metallurgical laboratory to be assessed and compared with the missile shrapnel alloy.

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<sup>3</sup> - Both survival ELTs were found with the switch on the OFF position.



Figure 25- One of the remaining passenger seats with holes in it

The facilities of the Atomic Energy Organization of Iran and a metallurgical research center were used to perform analysis and tests on such small metal pieces.



Figure 26- Metal objects found in the passenger seats

The results obtained from the X-ray fluorescence (XRF) spectrometry revealed the existence of two different metal types in the objects found in the passenger seat pads, which are related to the aircraft alloys, not the tungsten (missile shrapnel substance), as shown in Table 4.

Table 4- Results of X-ray fluorescence (XRF) spectrometry on the two samples found in the passenger seat pads

Substance		Sample 1		Sample 2	
Element	Symbol	Unit (%)	Estimate of error (% ±)	Unit (%)	Estimate of error (% ±)
Aluminum	AL	99.09	0.04	71.9	2.40
Barium	Ba	0.465	0.025	0	-
Iron	Fe	0.464	0.049	1.21	0.23
Molybdenum	Mo	0	-	0.071	0.016
Niobium	Nb	0	-	0.192	0.023
Titanium	Ti	0	-	26.49	2.48
Tungsten	W	0	-	0.055	0.046
Zirconium	Zr	0	-	0.035	0.007

#### 2.17.4. Explosive and Weapon Test

At the request of the investigator-in-charge and coordination with the relevant authorities, an expert group was formed to examine the unusual cases such as explosives. Having done sampling and tests at the crash site, the possibility of damaging radiation, including laser and electromagnetic radiation (radioactive) strike was ruled out. Further investigation into the aircraft wreckage to detect presence of explosives on the fuselage was made subject to conducting further research and sending samples to a reputable laboratory.

The aircraft pieces and remnants were investigated in a suitable site where they had been separated by examining their apparent signs with cameras and then laid out next to one another on the ground. After that, the burn



signs, explosion, and traces of any suspicious materials on the pieces were first detected using portable devices and trained dogs.

In the investigations performed, neither of the aircraft engines showed any suspicious signs being indicative of fire or explosion in the sky.

It was confirmed that there were cracks and holes caused by shrapnel strike by blaze and the remaining smoke on the aircraft fuselage, which were outward-bound. Likewise, the test result of traces caused by smoke and burn due to explosives from aliphatic (PETN, HMX, RDX, C<sub>4</sub>) was confirmed.

The parts detected to have been contaminated with explosives were sent to laboratory, the detected areas of which were sampled there.

Based on the results yielded through GC/Mass chemical analysis, the existence of Trinitrotoluene (TNT) explosives with a chemical formula C<sub>7</sub>H<sub>5</sub>N<sub>3</sub>O<sub>6</sub> was confirmed in the aircraft wing skin, which was found before the crash site. (Figure 27)



*Figure 27- The wing piece found before the accident site*

Gas chromatography–mass spectrometry; GC-MS of this piece can be seen in Figure 28.

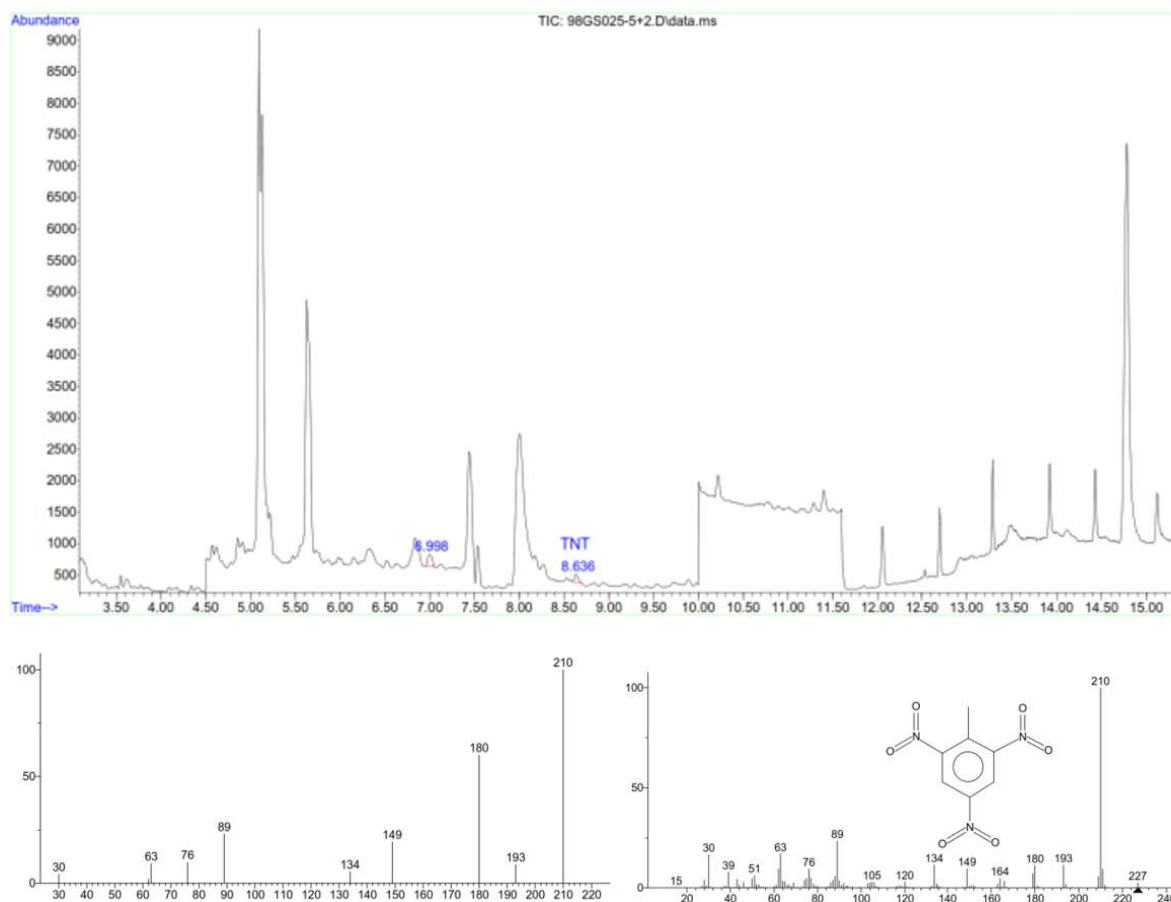


Figure 28- Gas chromatography–mass spectrometry; GC-MS, of aircraft wing skin piece

By sampling the air conditioning system and the two ELT pieces of the aircraft (Figure 29) and performing gas-chromatographic-mass spectrometry on each of the parts, the presence of negligible amounts of Dinitrotoluene (DNT) with the chemical formula  $C_7H_6N_2O_4$  was proven.

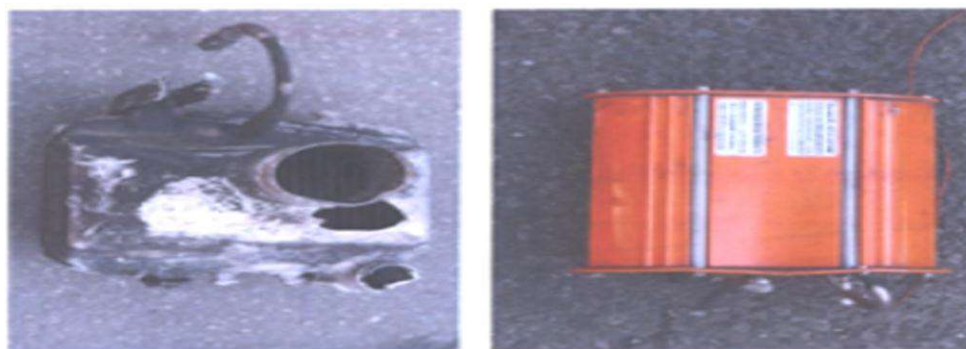


Figure 29- Pieces on which the explosive test was done



The GC/Mass chemical analysis spectrum of the above samples can be seen in Figure 30.

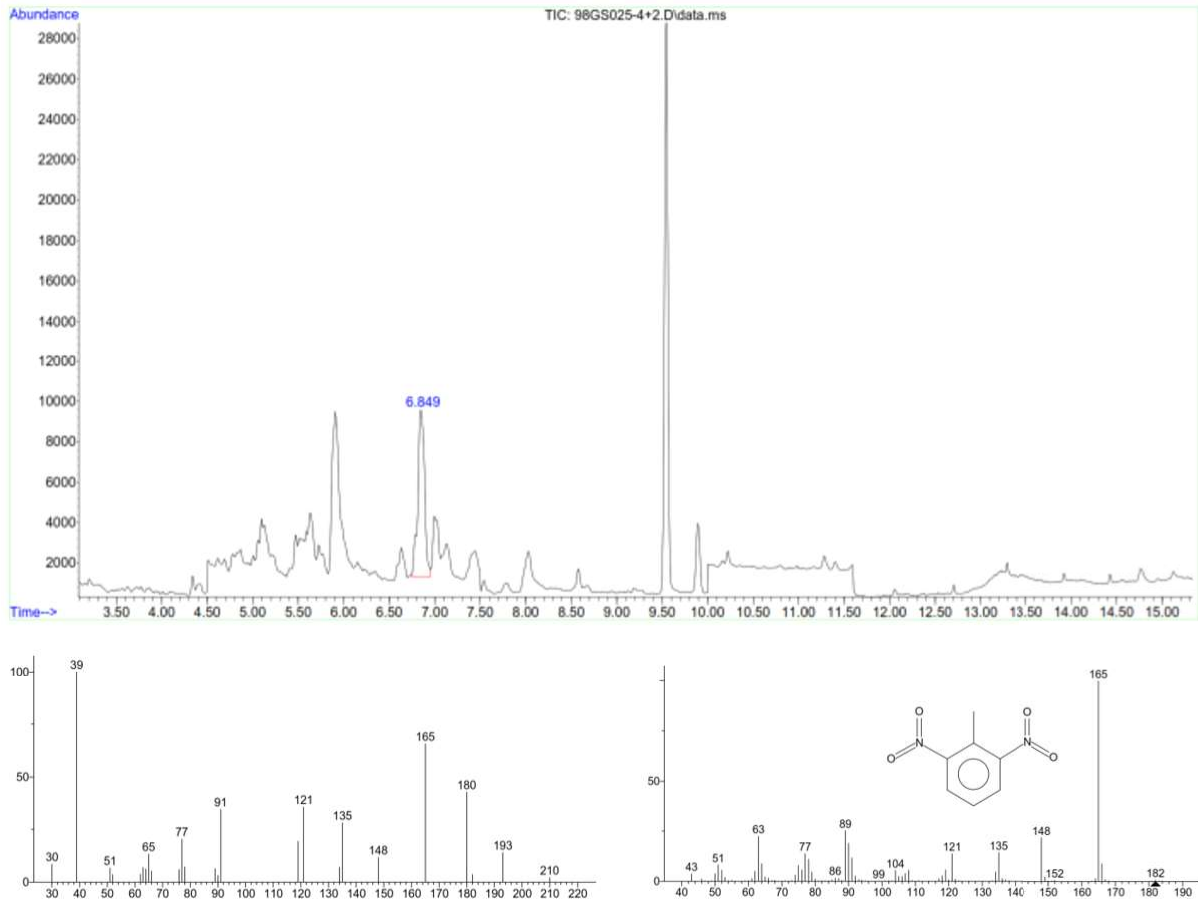


Figure 30- The GC-MS of the ELT and heat exchanger

According to the spectrometry obtained from the interior part of the aircraft cabin window (as shown in Figure 31), the presence of explosive Trinitrotoluene (TNT) was detected (Figure 32).



Figure 31- The interior of part of the aircraft cabin window pieces on which the explosive test was done

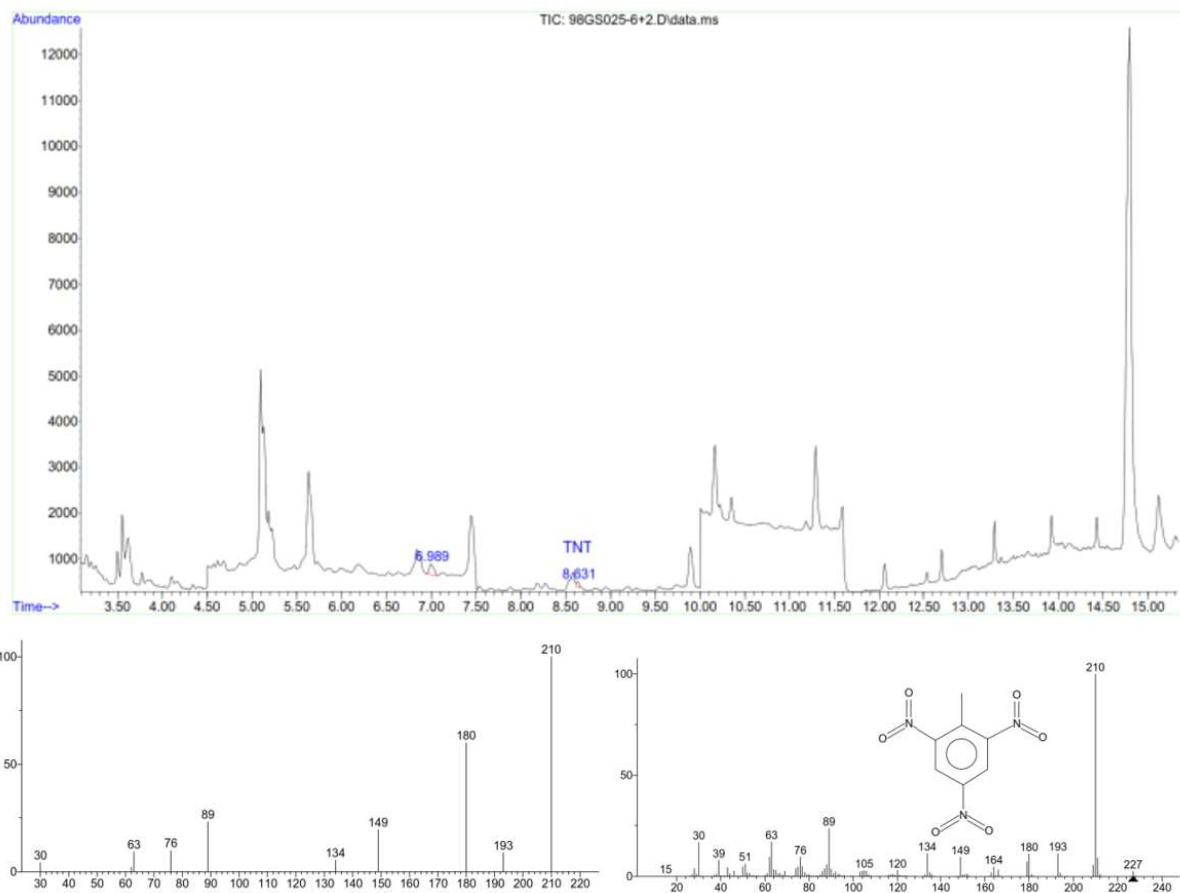
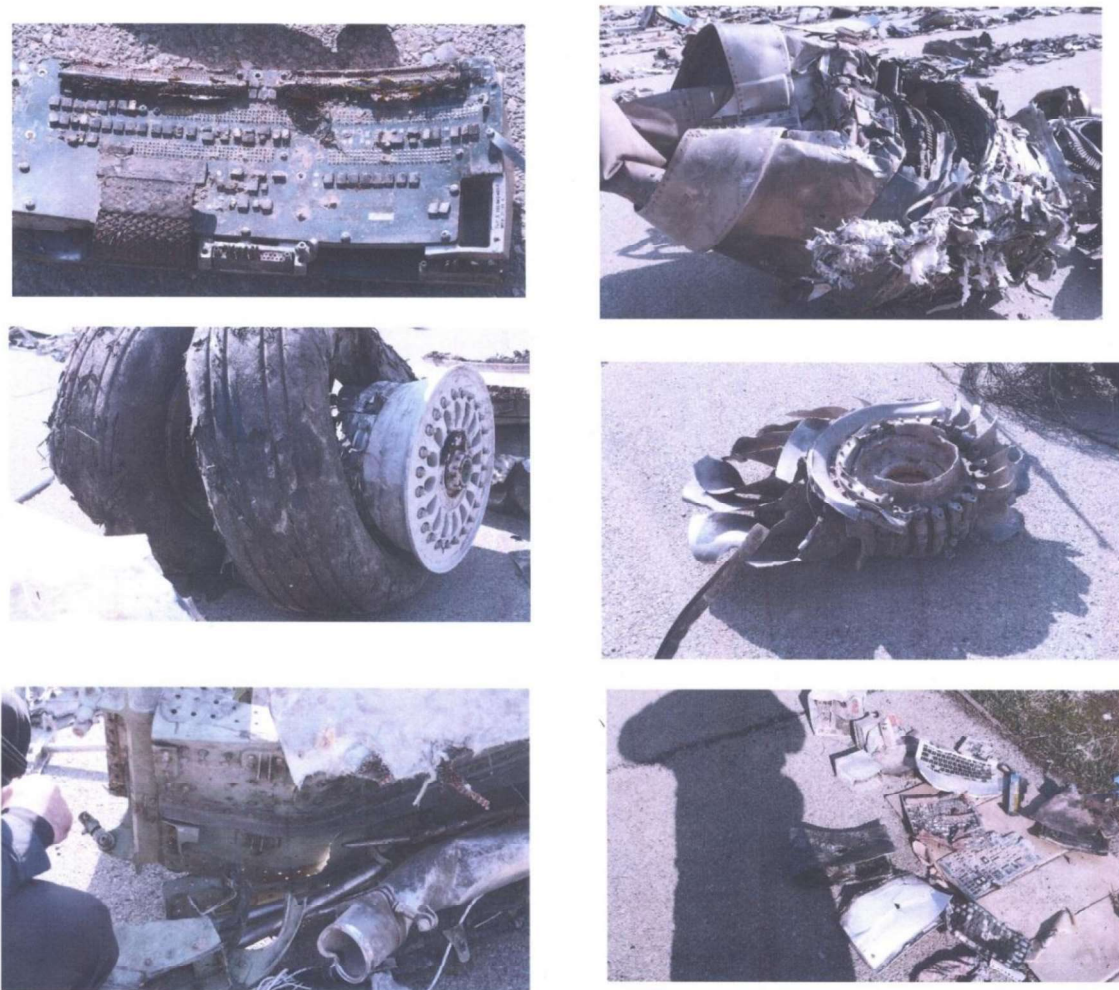


Figure 32- The GC/Mass test result from the interior of part of the aircraft cabin window Pieces

The results of the sample analysis taken from the inside of the upper skin of the aircraft engine showed the presence of (DNT) Dinitrotoluene contamination.

It should be noted that no explosive contamination was observed in the samples taken from the engines and other aircraft pieces or the objects inside the passenger cabin (Figure 33).



*Figure 33 -Some of the aircraft parts free from explosives*

As the DNT presence in the remaining evidence of the explosion or fire did not match the expected explosives type from missile, and the fact it was likely such evidence had been caused by the byproduct of other substances, the test results were provided to the State of Design and Manufacturer to investigate the DNT origin found in them.

The NTSB and Boeing's chemistry and flammability experts reviewed the test results and announced that some materials in commercial aircraft, such as fuel and epoxy containing aromatic, may produce DNT during thermal degradation, but in large quantities, this substance is not common.

Following the release of the videos and images showing the firing of two missiles at the aircraft, their authenticity was begun to be checked.

Surveys were then conducted at the accident site on January 10, 2020 through which the authenticity of the videos, which were shot from Bidkane and Parand, was verified. Gaining access to CCTV footage recorded by the organizations near the areas supported the hypothesis that the aircraft had been fired by missile.

## 2.18. Flight Recorders

### 2.18.1. Technical Specifications

The aircraft was equipped with Solid State Flight Data Recorder (SSFDR) technology with P/N 980-4750-003 that recorded more than 1200 parameters, Solid State Cockpit Voice Recorder (SSCVR) with P/N 980-6032-003 capable of recording the last two hours of flight audio channels, and a Quick Access Recorder (QAR). The FDR and CVR are manufactured by Honeywell Incorporation (Figure 34).

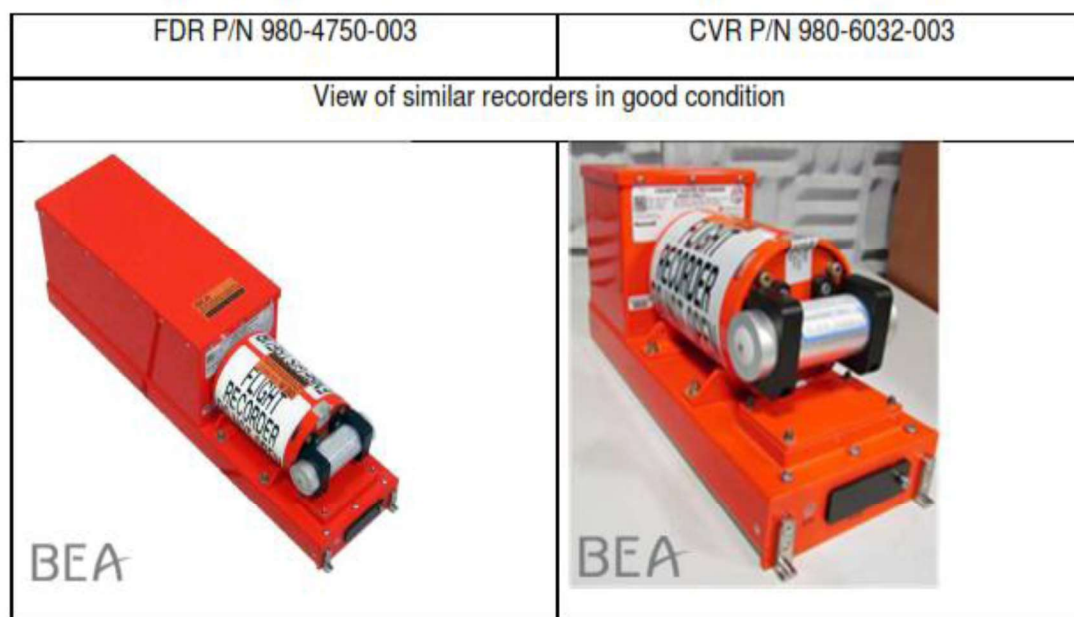


Figure 34- Flight Recorders similar to those installed on the accident aircraft, photo by BEA

### 2.18.2. The Discovery of the Flight Recorders and Their Condition

The QAR was not found at the accident site, but the FDR and CVR were, both of which displayed physical damage on them.



Damage to CVR had been more serious, whose main memory (CSMU) was detached due to the impact severity. The condition of these recorders indicated that the CVR and FDR had not been exposed to the fire in the aircraft, and after the ground impact, they were damaged or exposed to fire. (Figure 35 and Figure 36)



Figure 35- FDR physical appearance after the crash



Figure 36- CVR physical appearance after the crash

### 2.18.3. Readout of Flight Recorders

On January 09, 2020, the visual condition of flight recorders was checked with the presence of Ukrainian delegation at the CAOIRI Aircraft Accident Investigation Board (AAIB).

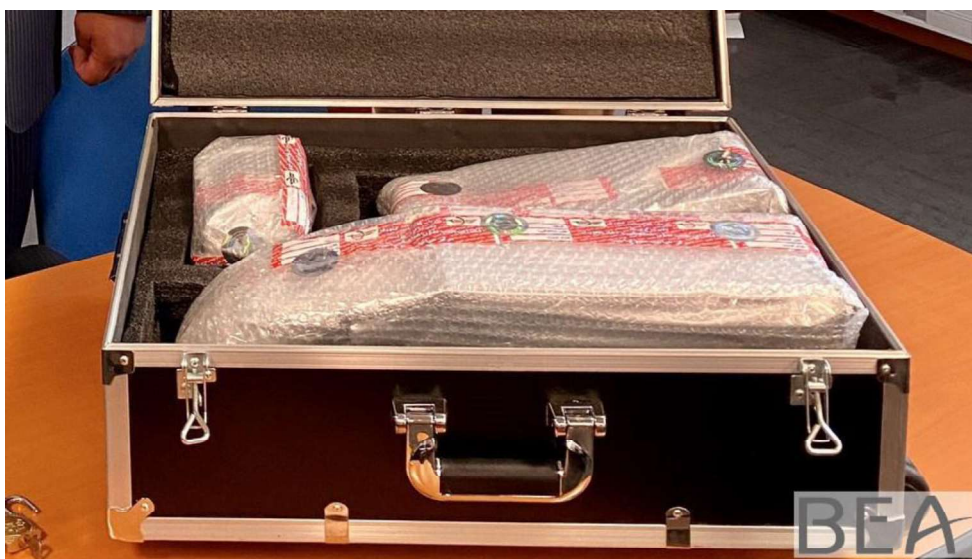
Having considered Iran's capacity in this area, the investigation team reached the conclusion that restoring the data of the two devices with the facilities and experience at hand would involve a degree of risk or missing them, which was considered unacceptable due the inherent sensitivity of the issue.

The investigation team did not ultimately succeed in obtaining the facilities and resources required to read out the recorders. Despite the fact a list of them had been provided to the team and necessary financial resources were offered for purchase, the required equipment could not still be provided due simply to the U.S. sanctions imposed on Iran as well as the direct and indirect suppliers' concern about penalties.

An Iranian team was sent to Ukraine. They assessed Ukrainian facilities needed for recorders readout. At the same time, Ukraine hosted joint meetings between experts from Iran, Canada and France to decide on further cooperation. Seeing the specialized reports presented by the members in meetings held, the investigation team decided to use a laboratory with more experience and facilities to reduce the risk of losing the data of flight recorders during the recovery process.

Initial agreements were made with the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) of France to perform the read-out.

Following the outbreak of the COVID-19 pandemic and consulting with representatives of other States whose participation in the read-out process was necessary, the read-out was postponed due to travel restrictions as well as those of the French laboratory. In the end, once the issues were resolved and coordination was made, the read-out was performed from July 20 to 24, 2020 at BEA laboratory.



*Figure 37- Flight recorders transferred to BEA*

The disassembling of the flight recorders and downloading the data was performed under the control and supervision of the accident investigator-in-charge using the BEA facilities and experts.

The representatives of the U.S. as the State of Design and Manufacture, Ukraine as the State of Registry and Operator, and France as the State providing service and technical advice participated in the process.

The experts of Canada, U.K. and Sweden, as the States having special interest in the accident by virtue of fatalities to their citizens, observed the process to stay informed accordingly.

A representative from the International Civil Aviation Organization (ICAO) participated in this undertaking to observe and facilitate collaboration among the States involved.

Considering the fact some of the crew members' conversations were made in Russian and some others in Ukrainian, the representatives of Ukraine translated such conversations, heard on the Cockpit Voice Recorders (CVR), into English.

The data on both aircraft flight recorders was retrieved without any technical problems and then converted into analyzable information. (Figure 38 and Figure 39)



Figure 38- CVR memory card read-out at BEA laboratory using donor-chassis- Photo: BEA



Figure 39- FDR memory card read-out at BEA laboratory using donor-chassis - Photo: BEA



#### 2.18.4. Flight Recorder Read-Out Results

Four audio channels recorded in the CVR were read out, including those related to the captain, first officer, Passenger Address system (PA), and Cockpit Area Microphone (CAM).

The overall quality of all of audio channels were understandable enough.

Using audio analyzing software, the investigation team listened to the audio files at BEA laboratory. Considering the flight crew's nationality, the ACCREP of Ukraine, together with a pilot from the UIA, accompanied the investigation team to analyze and transcribe the data.

Only, the captain's voice had been recorded in his channel, and it was clear that the other two crew members were not using their active microphones to make conversations inside the cockpit, yet the good quality of CAM channel made it possible to comprehend their conversations without difficulty.

Recording of the last flight started at 05:56:18.949, at the time of engine start up and start of pushback.

The recording had ended at 06:15:15.

A strong and short impulse, similar to a detonation is recorded at 06:14:55.865.

Immediately after sound of detonation, an aural tone consistent with the Altitude Alert C-Chord was present, which continued until the end of the recording.

A drop of frequencies began 2.445s before the end of CVR recording.

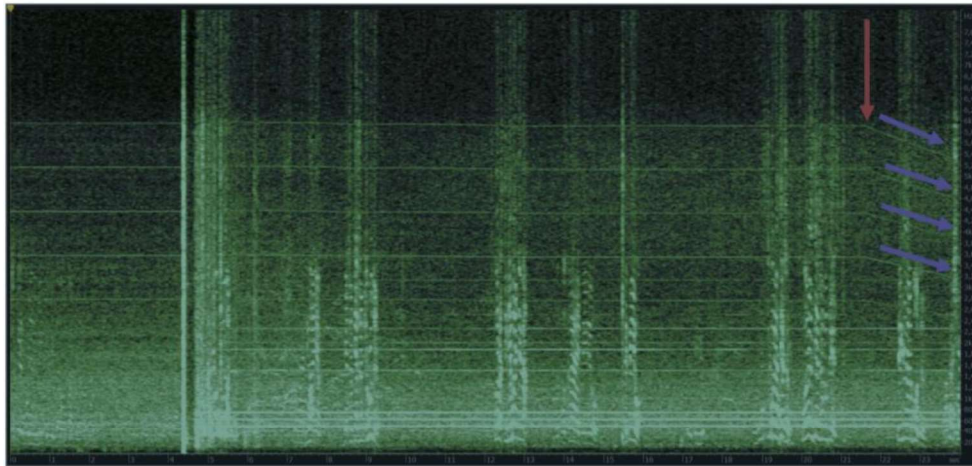


Figure 40- Drop of frequencies recorded in CVR. Photo:BEA

After the sound of impulse, conversations from all three cockpit crews were audible.

The flight crew became aware of the unusual conditions after the impulse sound and immediately started to take necessary actions to control the situation and operation of the aircraft in that condition.

At 06:15:05, the instructor pilot instructed to turn on the Auxiliary Power Unit (APU), and a second later, a sound consistent with a switch was heard, which may have been the APU switch.

At 06:15:13, the instructor pilot stated that engines were running.

By filtering the sound recorded in the CAM channel, some voices were barely audible from the passenger cabin upon hearing the detonation sound for three seconds, which shows that passengers noticed the unusual event. After almost 11 seconds, some voices were again heard from the passenger cabin.

The transcript of the conversations carried out from the time the aircraft started from the runway is given in Table 5.

Table 5- The CVR transcript

Time	Speaker	Transcript	Remarks
05:56:18		PS752 recording starts	
06:11:39	Captain	Full take-off thrust	
06:11:41	First officer	Ninety-one-point three set normal	
06:11:49	First officer	Eighty knots	
06:11:50	Captain	check	
06:12:09	First officer	V one	
06:12:12	First officer	Rotate	
06:12:21	First officer	Positive rate	
06:12:22	Captain	Gear up	
06:12:26	First officer	(*)	
06:12:27	Captain	check	
06:12:29	Captain	Easy easy don't pull	Russian
06:12:32	Captain	It is not helping you Just this	Russian
06:12:35	Captain	I haven't ability to pull simultaneously you and plane	Russian
06:12:35	Instructor pilot	(Ground) speed	
06:12:37			Trim moving
06:12:38	First officer	Let's do it	Russian
06:12:42			Trim moving
06:12:48	Captain	Report he said change	Russian

06:12:49	First officer	Yes yes	Russian
06:12:55	First officer	Radar good morning AU1752 .... on board on course IKA 1 A	
06:13:00			Trim moving
06:13:01	Mehrabad Approach	Good morning AU1752 radar identified on departure climb flight level 260 crossing 6000 feet turn right PAROT	
06:13:13	First officer	Next PAROT climbing 260 AU1752 information all received, thank you	
06:13:16	Instructor pilot	After six thousand	
06:13:18	Mehrabad Approach	Welcome, after 6000 to PAROT	
06:13:21	Captain	After 6000	
06:13:24	Captain	Flaps up	
06:13:25	First officer	Flaps up speed check flaps up	
06:13:27	Captain	Five thousand PAROT active point	
06:13:29	First Officer	yes	Russian
06:13:30	Instructor pilot	Now the second six thousand he said	Russian
06:13:31	Captain	yes	In Russian
06:13:32			Trim moving
06:13:34	Captain	Six thousand	
06:13:40	Instructor pilot	(*)	

06:13:43	Instructor pilot	Unknown: two six zero speed	Russian
06:13:48	Captain	Just connect it easily	Russian
06:13:49	First officer	What?	In Russian
06:13:50	First officer	Flaps up no light	
<b>06:13:52</b>	Captain	Check after take-off Check list	
06:14:06	First officer	Six thousand PAROT active point	
06:14:08	Captain	Six thousand execute check	
06:14:09	First officer	L-NAV available	
06:14:14	Captain	After take-off?	
06:14:15	First officer	Now executing	In Russian
06:14:18	First officer	Engine bleeds ON packs	
06:14:22	First officer	Auto pressurization normal landing gear up and off flaps up no light after take-off check list completed	
06:14:28	Captain	Ha Ha	
06:14:40	First officer	Unknown: what is the light?	In Russian
06:14:43	Captain	GPS right invalid	
06:14:45	First officer	Yes I see	In Russian
06:14:50	Captain	And left invalid	In Russian
06:14:51	Instructor pilot	Un known: now will flight like....	In Russian
06:14:56			Noise similar to detonation



06:14:56			C-Chord alarm until the end of the recording
06:14:56	Instructor pilot	(...)	In Russian: strong feeling about bad event
06:14:58	Captain	(Breathing) what is this?	In Russian
06:14:59	Instructor pilot	Caution keeping keeping the thrust levers	In Russian
06:15:03	Instructor pilot	Speeds with caution	In Russian
06:15:05	Instructor pilot	Start A P U	In Russian
06:15:06			switch sound
06:15:07	First officer	A P U	
06:15:08	First officer	A P U	
06:15:10	Captain	(*)	In Russian
06:15:10	Instructor pilot	Keep the speed here	In Russian
06:15:11	Instructor pilot	Keep speed here	In Russian
06:15:13	Instructor pilot	Engines are running	In Russian
06:15:15	Captain	(*)	In Russian
02:45:15		<b>END OF RECORDING</b>	

(...); *Word or group of words with no bearing on the flight*

(\*); *Word or group of words not understood*

At 05:13, the captain made his first radio contact with the ground unit of IKA control tower. This conversation was recorded by the airport systems. The recording of the radio communication in the accident flight CVR started at 05:56:18 and the flight was cleared for startup and pushback at 05:55. Hence, there exist no information on the cabin and preflight checks and the probable briefing about the situation and decision-making in the recorded audios.

The FDR had recorded approximately 54 hours (193,242 seconds) of data in 54 areas at a 512 WPS.

The raw data was decoded using data frame provided by the aircraft manufacturer. The accident flight was the last flight recorded on the recorder.

There were 86 bytes with a value of zero at the end of the data file. Data recording is made using four-second frames, each with four one-second sub-frame. The last complete recorded sub-frame was number 2 and the last incomplete sub-frame was number 3. In this last sub-frame, the last valid word recorded was the word 320, and the words recorded after the word 321 were invalid due to inconsistencies with the physical values and hence were not recorded correctly.

An investigation into the last data recorded showed that all the values underwent their own normal changes with no indication of recording any abnormal ones like in altitude, speed, acceleration, etc.

The last recorded values of some important parameters are shown in Table 6.

Table 6- Last recorded values of some important parameters; time column corresponds to the time of recording

	Parameter	Value	Time
1	L Eng. N2 Tachometer	95.5 %	06:14:55
2	R Eng. N2 Tachometer	95.47 %	06:14:52
3	L Eng. N1 Tachometer	91.21 %	06:14:54
4	R Eng. N1 Tachometer	91.09 %	06:14:54
5	Present Position Long.	50.953 deg.	06:14:56
6	Present Position Lat.	35.491 deg.	06:14:56
7	Angle of Attack - L	1.23 deg.	06:14:56
8	Angle of Attack - R	1.05 deg.	06:14:56
9	Radio Height - L	4378 FT	06:14:56
10	Radio Height - R	4382 FT	06:14:56
11	Capt. Display Pitch Att.	9.66 deg.(UP)	06:14:56
12	Capt. Display Roll Att.	2.28 deg.(RT)	06:14:56
13	Vertical Acceleration	0.97 g(UP)	06:14:56
14	Capt. Display Heading	306.86 deg.	06:14:56
15	Longitudinal Acceleration	0.17 g(FWD)	06:14:56
16	Altitude(1013.25mB)	7947 FT	06:14:56
17	Computed Airspeed	250.12 KT	06:14:56
18	Lateral Acceleration	0.00 g(RT)	06:14:56

## **2.19. Launching Missile at the Aircraft**

Following the crash, numerous videos were released in the cyberspace and media showing the launching of missiles at the aircraft. The investigation team investigated the authenticity of videos and inquired the security and military authorities on firing missiles toward the aircraft.

On Jan. 09, 2020, the investigation team reached the conclusion that some of the videos released corresponded to the time and location of the crash. However, there was still no conclusion about the origin of the launched missile, the type, number and effect on the aircraft.

One of the most important evidence was a video which had been recorded in a construction work area showing the missile flight and explosion. The investigation team processed the images and identified the location of the camera. After comparison and matching of calculated point with aerial images, a team of experts were deployed to the same area and by filming in the same position and direction, the validity of the original video was confirmed.

In the afternoon of Friday Jan. 10, 2020, the person who had managed to record the second missile firing was identified by securities. The investigation team had interview with him and found out he was the caretaker of a construction site who could record the flight and second missile with his cell phone after he saw the first missile launch.

This video was a key source for defining the accurate times and positions of key events related to missile launch and matching non-calibrated information with accurate ones like the aircraft path and radar information.

On the evening of Friday Jan. 10, 2020, the Civil Aviation Organization of Iran and AAIB were made aware of the missile launch by Air Defense of the country, and the Armed Forces of I.R. Iran stated that they would announce the event.

In the early morning of Saturday, Jan. 12, 2020, the I.R. Iran General Staff of the Armed Forces released a formal statement about firing missile toward the accident aircraft.

The investigation team received the information related to the missile launch from the Armed Forces.

The declared information was then assessed through the team's independent observations, including the videos, recorded sounds, relevant photos and reports, interviews with some people and review of judicial proceeding documents. The correspondence between such observations and military-related findings, such as the time and location of the recorded events, radar data, and flight recorders was also checked.

Given the error of the time mentioned in the Factual Report published in July 2020, the event times were corrected using the information obtained from the recorder read-out.

#### 2.19.1. Launching

The information in this section was provided by military authorities. The investigation team was able to see evidence that confirmed it.

At 04:54, on January 08 2020, one of the air defense units of Tehran was locally relocated for the last time in order of 100 meters according to tactics of mobile ADUs. This relocation clearly caused a change in the ADU's heading and therefore the ADU suffered an error of 105 degrees due to operators' failure in conducting north realignment properly. The ADU remained on standby mode until 06:07 and after this time, the ADU was set at operation mode. As such, while the Ukrainian aircraft was flying, the direction of objects and targets detected by this unit was being observed with an increase of 105 degrees by the operator.

At about 06:14, the air defense system operator detected a target at his azimuth of 250 degrees flying on a 56-degree course. At the same time, after takeoff, the PS 752 was flying towards the defense system from a 143-degree azimuth. The aircraft was taking a 309-degree course.

At 06:14:19, the operator announced the specifications of the detected target over the communication network of the relevant Coordination Center. The message was not relayed to the Center. In fact, it had not been recorded in the recorded messages of the Coordination Center.



Without receiving a response (command) from the Coordination Center, the operator came to the conclusion that the observed target was a threat and fired a missile at it at 06:14:39.

The system recorded the activation of the missile proximity fuse at 06:14:57.

After the first missile radio fuse was activated, the air defense system radar still locked on the target and kept detecting and tracking it.

Having observed the continuity of the detected target trajectory, the second missile was fired at the aircraft by the ADU crew at 06:15:09.

At 06:15:22, the last communication between the second missile and the defense system was recorded in a place close to the aircraft route. After that, the defense system showed a message indicating the strike had failed, with the aircraft clearing from the radar lock-on after some time.

Figure 41 depicts the trajectory and true location of the aircraft, wrong detected position and locations related to the activation of the missiles.

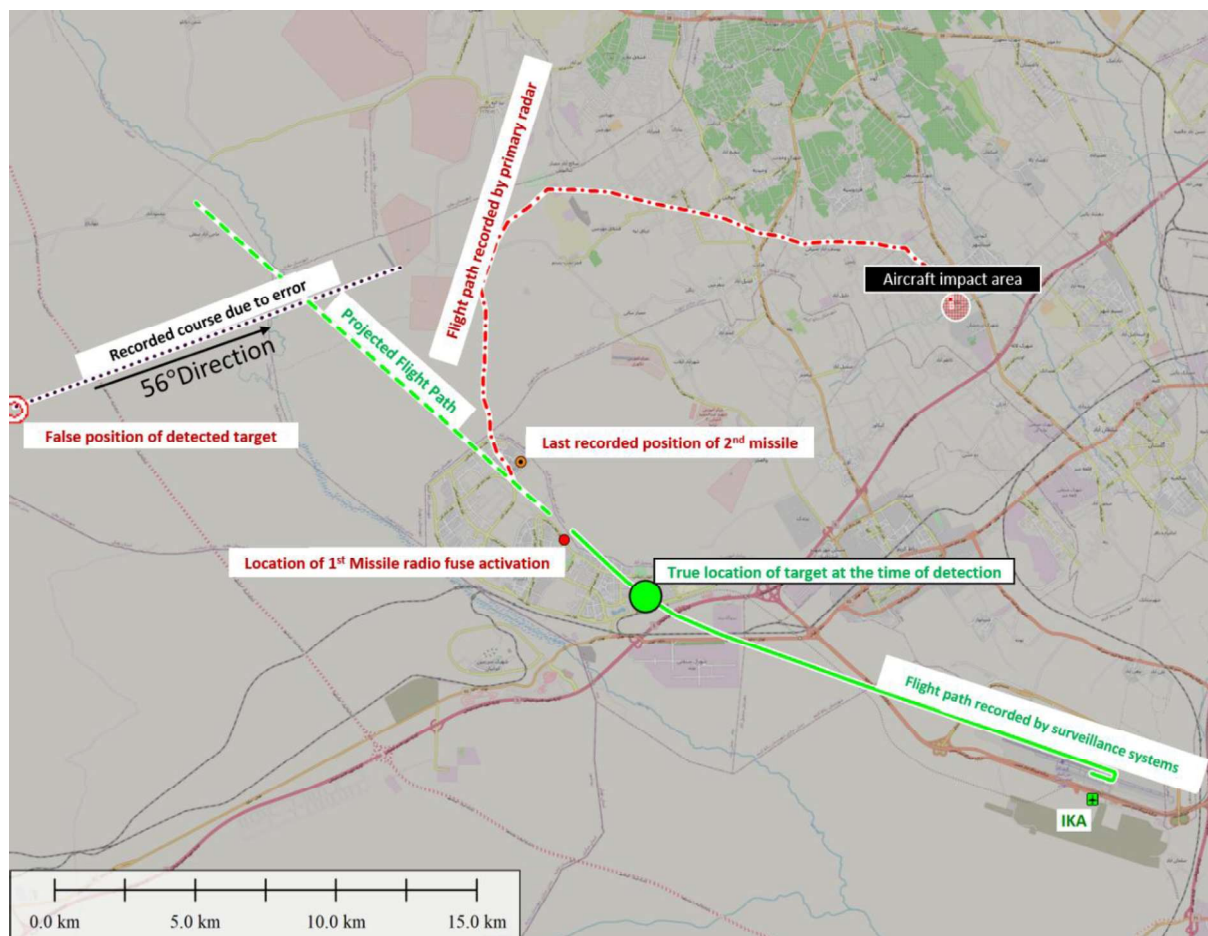


Figure 41- The location of key events in missile launch

### 2.19.2. Missile Information

The missiles targeting the aircraft were launched from TOR M1 air defense unit.

The M1 Tour system, known in NATO designation as the SA-15 Gauntlet, is a short-range air defense system in which the vehicle's radar and missile launcher system are integrated. The range of this system is about 12 km.

This unit is equipped with radar guided missiles with proximity fuses, while approaching the target the warhead containing shrapnel is detonated throwing about 2500 to 3000 pieces of shrapnel 2.4×7.8×7.8 mm dimension, weighing 2.4 gr of tungsten metal at a speed of about 1,800 m/s.

Missile length is 2898 mm, 167 kg in weight and its warhead 14 kg.

The explosives in the missile are of COMP-B type in which 50 percent of RDX% and 40% of TNT is used.

### 3. The Management of Potentially Hazardous Military Activities to Civil Aviation

#### 3.1.1. States' and Operators' Responsibilities<sup>4</sup>

Every State has complete and exclusive sovereignty over the airspace above its territory<sup>5</sup>, and no aircraft may be operated over an airspace except with the permission of the State managing that airspace<sup>6</sup>. Each State has the authority to limit the operation over the airspace managed by them<sup>7</sup>.

On the other hand, the States have oversight on the safety of airlines for which they have issued certificates and may impose restrictions on their activities in accordance with the laws and regulations they enact.

Further, airlines are inherently responsible for the safety of their operation and shall ensure the safety of the routes in which they conduct flights<sup>8</sup>.

One of the factors potentially hazardous to flight safety is military activities. Therefore, the States managing the airspace, the ones that have oversight on the airline activities as well as the airlines themselves shall gather information related to military activity hazards, conduct relevant risk assessment and adopt mitigating measures to maintain the associated risk within acceptable levels.

As can be seen in Figure 42, the State managing the airspace may impose restrictions over its own airspace, which can include the prohibition on entry into certain geographical areas, limitations on some routes, flight altitude and some of the normal procedures.

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<sup>4</sup> - Responsibilities arising from Convention on International Civil Aviation.

<sup>5</sup> - Article 1- Convention on International Civil Aviation

<sup>6</sup> - Article 6- Convention on International Civil Aviation

<sup>7</sup> - Article 9- Convention on International Civil Aviation

<sup>8</sup> - Annex 6 to Convention on International Civil Aviation, part I, 4.1.

Naturally, the State can impose restrictions on the operations of operators certified by them, beyond those done by the State managing the airspace.

The airline shall comply with the restrictions imposed by the State managing the airspace and those of the one that has certified their operation. However, they may consider more operation-related restrictions in that airspace in order to ensure their desired level of safety.

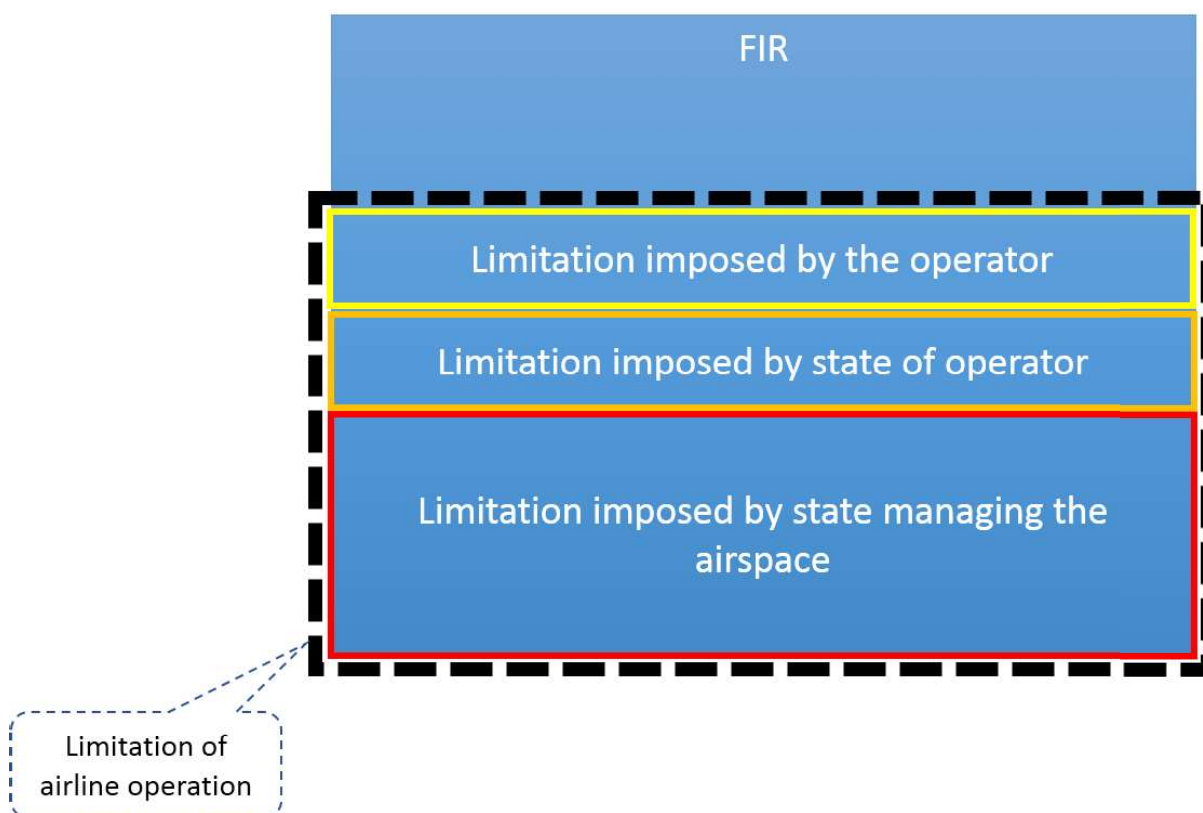


Figure 42- Dimensions of limitations in an airspace from different responsible parties

Taking the very approach, the parties having responsibility for the means to the safe use of flight routes include:

- The State managing the airspace
- The airline using the airspace
- The State issuing certificate for the operation of an airline

Hence, this section deals with the means to perform such a responsibility towards the threats of military activities in Iran as the State managing the



airspace, Ukraine as the State of the Operator of the UIA and the very airline itself.

### **3.2. Background and Structure of Civil-Military Coordination in Iran**

The States' airspace is a place for conducting civil air transport operations as well as military aviation ones.

Further, the airspace of States forms an important and sensitive part of their sphere of sovereignty, and they carry out regular oversight and measures to exercise their sovereignty over the sky from the perspective of military security. As a result, the airspace has always been a place for joint military and civilian operations. This inherent commonality is a ground for expanding the results of actions to one another, from either party.

On the one hand, civil aviation operations may disrupt the military security of the States or be exploited for hostile purposes, and on the other hand, military actions and arrangements can interfere with commercial air activities in this common space due to the errors, threats and shortcomings in the military sector. Therefore, in all aviation-related activities, it is essential to take account of the considerations of the other sector and the way they affect one another, not to mention their coordination method.

The ICAO has developed the standards, recommended practices and guidelines on civil-military coordination in the aviation sector, as well as risk management of military operation potentially hazardous to civil aviation.

The Middle East is a region that is particularly sensitive in terms of the effects of military action on civil aviation for a variety of reasons, including hostility between states, instability due to the presence of insurgent and terrorist groups, and the widespread presence of trans-regional military forces. In the meantime, the continuity of air transport is a necessity for countries, and in Iran, in addition to what is initiated by ICAO, experienced measures and structures have been established to make this

coordination to maintain the continuous and regular air transportation in various conditions that will be described below.

### 3.2.1. Background of Civil-Military Coordination

On September 22, 1980, with the all-out Iraqi air strike on Iran, a war broke out that lasted for eight years until 1988. During this long war, civil-military coordination was made for commercial flights to be conducted, and the management of Iran's airspace was inherently carried out through the continuous interaction of the military and civilian sectors. Iraq attacked Kuwait on August 1, 1990, as a result of which, on January 17, 1991, the launch of a large-scale air strike by the United States and its allies on Iraq exposed Iran's western borders to a tense air zone military region. This inevitably entailed the civil-military coordination specifically to ensure flight safety and security.

For 12 years, from March 1990 to March 2002, the United States and its allies established two no-fly zones, North and South, over Iraq (Figure 43).



Figure 43- Two no-fly zones in Iraq adjacent to Iran

In the east of Iran, Afghanistan, which suffered from internal tensions, has been embroiled in the US-led war since 2001, which lasted until 2014, after 13 years of continuous conflict and the handover of Afghan security-related responsibilities to the country.

Since 2002, with the start of the Second Persian Gulf War, the U.S. and its allies have invaded Iraq, and the war officially ended in August 2010, but American forces and their bases are still present in this country.

In June 2014, the ISIS group began its strong presence in Iraq by attacking and controlling the city of Mosul, raising tensions over aviation security concerns on Iran's western border.

This tense regional atmosphere, having existed for such a long time, has led to the domestic formation of measures of civil-military coordination in Iranian aviation based on objective needs as well as a long-standing structure in this area in the field of risk analysis as well as precautionary and preventive measures.

Due to the widespread presence of American forces in the south of the Persian Gulf and the expansion of their forces in the western and eastern neighbors of Iran (Figure 44), such measures are constantly practiced and implemented in the border areas of Iran.

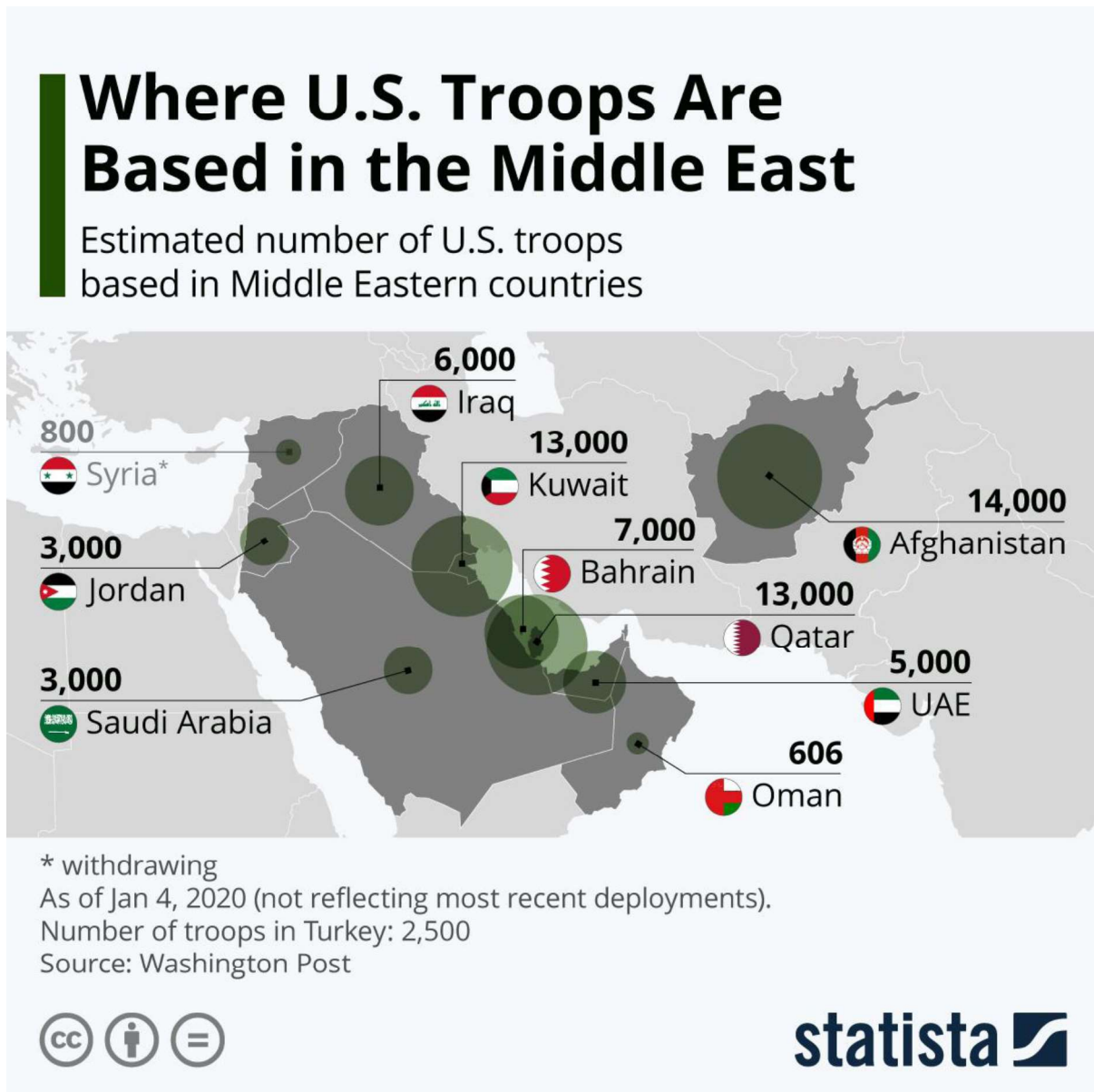


Figure 44- U.S. military bases around Iran – source: Washington Post

### 3.2.2. Structure of Civil-Military Coordination

Civil-military aviation coordination in Iran is carried out at three levels: strategic, tactical and operational.

At the strategic level, the Secretariat of the Supreme National Security Council determines the manner of cooperation and responsibility of each sector by determining the general requirements and communicating the necessary policies, and the relevant sectors, including the Civil Aviation

Organization, ANSP and armed forces plan and monitor the effective implementation of these policies.

At the tactical level, specific procedures are defined for the implementation of strategies, which are implemented operationally and usually in the form of actions of air traffic control units and representatives of the air defense sector. A significant number of such measures apply to the management of the country's airspace, and there is also a section related to the flight operations of Iranian airlines in the airspace outside Iran, which is implemented in cooperation between airlines and the CAOIRI in the context of Security manuals and airlines Safety Management System.

At an operational level, since the war between Iran and Iraq, a structure part of Iran's air defense has been assigned to make coordination with the airspace management with the aim of ensuring the security of the airports and flights against possible enemy attacks besides separating commercial flights from anonymous and hostile flights. This hierarchical structure makes coordination between the air defense sector and the civil flights at an operational level.

Figure 45 demonstrates Iran's civil-military operational coordination structure at the time of PS752 accident.

The civil-military operational coordination center (CMOCC) is located in the Tehran ACC. This center communicates all civilian flights information to the military sector, and this information exchange is used to identify civilian flights in the military network. Also, the military flight-related information is provided to the civil airspace management sector to enable integrated air traffic management. CMOCC is in direct contact with State Air Defense Operation Center (SADOC).

In the military sector, Air Defense Sectors have been established, each of which is responsible for an area of the country's airspace. In addition to communicating with the CMOCC, these centers communicate with some airports through the Air Defense Coordinators.



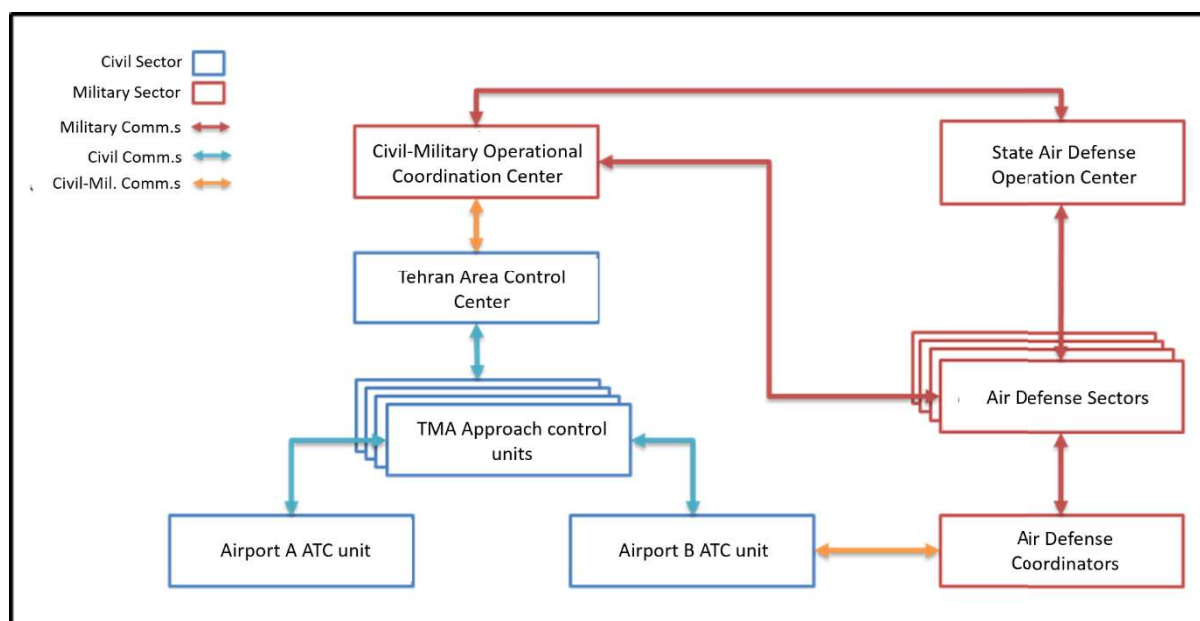


Figure 45- Civil-military Coordination Structure in Iran

The TMA Approach control units are in contact with both the Tehran ACC and air traffic control units of the airports within that area, and depending on the necessity, there would be an air defense coordinator in some airports.

The military units are in contact with one another. Apart from the military communications, the CMOCC and air defense coordinators are both in contact with the civilian sector. Such communications are of three types of voice, message data and radar data.

The issued flight permits, which are exchanged on the aeronautical telecommunications network between the air traffic control units, are also provided to the CMOCC through the network.

CMOCC, which is located in the Tehran ACC, has access to information from the surveillance radars of the civilian sector.

### 3.3. Airspace Risk<sup>9</sup> Management for Civil Aviation in Iran

The information in this section is obtained by review of public and classified regulations, official inquiries, interview with individuals and

<sup>9</sup> - Here, a combination of safety and security risk arising from potential military hazardous activities

review of evidence and records and the investigation team was able to independently validate them.

Typically, security and intelligence organizations collect and analyze overt and covert information related to national security.

These agencies are located in different sectors of the country, including military and civilian. There is a structure in the form of the Supreme National Security Council and its secretariat which plays a role in coordinating and integrating issues.

If the information or the results obtained through their analysis have something to do with the aviation security of the country, and the issue falls completely within the duties and responsibilities of a governmental body, it will be transferred to the civilian sector. If the dimensions of the issue fall beyond the functions of the given body, relevant measures will be taken using the capacity of the Supreme National Security Council.

Every military, security or intelligence organization enjoys some autonomy to make specific decisions in urgent situations.

Security risk analysis and assessment are classified into two areas: Iranian airspace and the airspace of foreign areas to which Iranian companies fly.

Risk analysis and management is performed at three levels: strategic, tactical and operational.

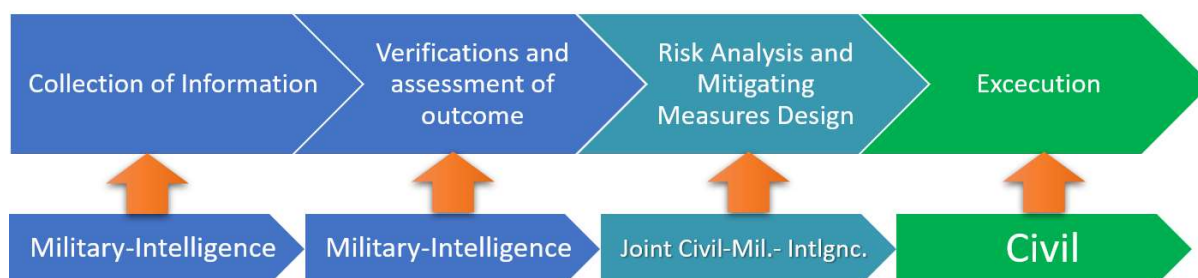
At the strategic and tactical levels, the CAOIRI and the ANSP are involved in decision-making in interaction with the civil and military security and intelligence sectors. At the operational level, decisions are made and implemented at the level of air traffic control units and in interaction with the representative of the air defense sector, relevant to predefined strategies and tactics. Of course, these operational measures are continuously analyzed, and based on the feedback obtained from the operations, the strategic and tactical plans are reviewed.

As is common for all military forces, sometimes the nature of threats and their alertness condition is at such a level which necessitates designing

actions that are highly classified and of which the civilian sector should not be made aware before they are implemented.

In such circumstances, the relevant military sector designs the measures necessary to maintain the safety and security of civil aviation by using the already obtained information of the type and structure of civil aviation operations, and finally notifies the civilian sector at the appropriate time at the operational level about the pre-defined measures. The relevant units in the civilian sector determine the method of implementation of the measures that are in accordance with the requirements of civil aviation.

The structure of data collection, risk analysis and implementation of measures are shown in Figure 46.



*Figure 46- Structure of data collection, risk analysis and implementation of measures related to the management of potentially hazardous military activities to civil aviation operations*

Figure 46 shows where each process -monitoring and data collection, validating and analyzing their consequences, risk assessment and designing corrective measures and implementing measures- is carried out. Data is collected, verified and analyzed outside of civil aviation and by the military or security departments of the country. Depending on the urgency and classification of the issue, risk assessment and compensatory measures are designed in joint military-civilian cooperation, but the urgency and classification may be such that the informed departments act directly in this step and ultimately the civilian sector implements the measures. Obviously, if a portion of the mitigating measures are designed for the military side, their implementation will be the task of the relevant military sector.

### **3.4. Iran Airspace Risk Assessment at the Time of the Accident**

#### **3.4.1. Prevailing Conditions**

When Major General Qassem Soleimani, one of the top commanders of the Armed Forces of the Islamic Republic of Iran, was on an official trip to Iraq, he was targeted at Baghdad airport in a U.S. drone strike on January 3, 2020, where he and a number of his entourage, including a senior commander of the Iraqi counter terrorism force, lost their lives.

The United States claimed responsibility for the operation. The Iraqi government announced the operation had been carried out without their permission or knowledge.

Iran strongly condemned the assassination and officially declared it a clear example of state terrorism, the responsibility for the consequences of which would rest entirely with the U.S. regime. Iranian officials also vowed they would exact revenge on the U.S. action appropriately.

In the morning of Wednesday, Jan. 08, 2020, at 02:00, in response to the U.S. action, the Armed Forces of the Islamic Republic of Iran started a missile attack on the Al Assad base in Iraq, where the U.S. forces were based; the attack was ended in at 02:05.

Considering the possibility of the conflict escalation through the American counterattack by its military forces in the region, the relevant defensive units, including the air defense sector was placed on a higher level of alertness.

#### **3.4.2. Risk Assessment and Planned Measures**

The accident investigation team was provided with information on the measures taken by the military sector.

The investigation team realized that although different and specific definitions, techniques, tools, forms and diagrams are used for risk management in the military sector, they are substantially consistent with the aviation risk management literature.

The identification of Generic Hazards, the determination of Specific Hazards, and the type of operations combinable with hazards are among the components used in the military sector.

The investigation team reviewed the documents and records related to the risk management method in the military sector and given the complexity of these part of evidence, the key aspects and outcomes are described in a coherent manner with conventional risk management literature.

In a situation where the possibility of military move against Iran and its interests was growing, the players whose activity or readiness was potentially hazardous to civil aviation were taken into account along with their intentions.

The unintentional targeting was classified into two general probabilities:

- **Misidentification:** When a commercial aircraft could be identified and targeted as a hostile target.
- **Accidental strike (Mistargeting):** When during a conflict with a hostile target, a commercial aircraft is damaged as a result of military actions related to the conflict with another target.

Due to the very high sensitivity of commercial flights in the event of a conflict, it was decided in case of an air attack, all commercial flights, including transit flights in addition to the inbound and outbound ones to Iran's airports, would be stopped. Then, depending on the severity and location of the conflict, a decision should be made and announced regarding the continuation of the aircraft operation. Nevertheless, given that in the event of a conflict, it would not have been possible to immediately stop the aircraft already on their flight paths, the routes more likely to interfere with the enemy military operations in that situation would be gradually cleared of air traffic independently and with no regard to the conflict initiation, with no new flights being directed to these routes.

The three parties below were considered to have had the possibility to perform military activity in Iran's airspace:

- Iranian defense forces



- Possible attacking forces
- Terrorist groups

Terrorist groups have a history of intervention in aviation in Iran, which was limited to hijacking. According to the collected information, the probability of their attack on passenger aircraft was considered quite low considering the extent of their ability and presence in Iran, not to mention the equipment available to them.

Regarding the possible attacking forces, two dimensions, namely intention and type of commercial aircraft operation were analyzed.

According to the analysis, the probability of an intentional attack on commercial aircraft by foreign forces was determined to be low, but the unintentional damage to commercial aircraft was considered probable due to misidentification or mistargeting in the event of a conflict.

Commercial aircraft departing from joint civil-military airports would be at higher risk of misidentification and mistargeting by enemy, and the risk of being misidentified by commercial aircraft departing from commercial airports had been determined to be lower. In order to minimize the risk of misidentification by defense forces, it was decided to identify and track all commercial flights from the beginning so that in the event of a conflict, the military forces would be able to take immediate action thanks to their full knowing of directing flights to safe areas.

In addition, the probability of the attack to joint civil-military airports was considered very high in case of an attack to Iran's airports, and the probability of attack to civil airports was determined low. The probability of attack to IKA was assessed as very low.

The risk of accidental targeting of aircraft entering Iraq from Iran was assessed as high, and the probability of accidental damage to transit aircraft in the area between Iran and Iraq border could not be ruled out.

It was impossible to reduce the risk of targeting the commercial aircraft crossing the Iran and Iraq border to an acceptable level; hence it was

necessary to stop the traffic exchange between airspace control centers of Iran and Iraq.

In the event of a conflict, Iran's western airspace was deemed unsafe and therefore it was necessary to stop flights from four parallel routes in the west of Tehran FIR. Given that in the event of a conflict, there would not have been enough time to clear and direct the aircraft of such routes to the safe ones, the gradual evacuation of routes from transit flights and denying clearance for new traffics in these routes was considered as a preventive measure.

Also, to clear the flights, the risk of the airport and the flight path on which the aircraft would continue flying would have to be considered in an integrated manner, and the risk governing the aircraft flight would be the highest risk.

A summary of the Risk Management Model posed by the generic hazard of a possible enemy air strike for civil air transport is given in Table 7.

*Table 7- A summary of the Risk Management Model posed by the generic hazard of a possible enemy air strike*

<b>Generic Hazard</b>	<b>Enemy Attack</b>		
Type of operation	Area	Level of Risk	Mitigating Measure
Overflights	Tehran-Baghdad Exchange points	Very high	Stop the exchange
	West of Iran	High	Gradual evacuation
	Remaining FIR	Probable	Rerouting to safe areas in case of conflict
Departures	Joint Airports	High	Flight permission only if no attack is predicted
	Civil Domestic Airports	Probable	Flight permission only if no attack is predicted
	Civil International Airports	Negligible	Flight permission only in white alert level

*Note: This table is prepared by the investigation team for a coherent presentation*

About the conditions resulting from level of alertness of Iran's defense forces, the following considerations were taken into account:

- As previously military forces had used the commercial aircraft cover, and the hostile aircraft had conducted flight near commercial aircraft to enter the Iranian airspace, besides the high probability of using Iraqi airspace for a possible attack, flights entering from the Iraqi airspace to Iran could have endangered the security and been identified as a threat consequently. Or they could have been accidentally damaged through an air defense operation. Suspending the exchange of civil flights between Tehran and Baghdad airspace

would have removed such a concern. The risk associated with these flights was calculated high.

- Preventive measure: stop the air traffic exchange between Iran and Iraq airspace despite no air strike
- In the event of a conflict, it was likely that the defense system would misidentify the aircraft leaving the country's airports as a hostile aircraft. The risk associated with these flights was calculated to be very low.
- Preventive measure: before issuing a clearance to start up aircraft engine, air traffic control units would have to coordinate with the air defense sector through the Tehran ACC. The air defense sector would not allow the engine startup if an air attack was launched.
- In the absence of an air strike report, the start of flights to low-risk areas would be unimpeded once identified in the defense network.
- In the event of a conflict, it was likely that the domestic defense system would misidentify the aircraft crossing Iran's airports as a hostile aircraft. Or they could have been accidentally damaged through an air defense operation. The risk associated with these flights was calculated to be very high.
- Preventive measure: Iran's western fly zones, including routes of UT430, M317/L319, UL223 and UT331 would be at high risk and there would not be enough time to direct them to safer areas if an air strike began. So, clear air traffic flow in these areas and clear traffic only after issuing an air defense permit.

A summary of the Risk Management Model posed by the generic hazard of a possible enemy air strike for civil air transport is given in Table 8.

Table 8- A summary of the Risk Management Model posed by the generic hazard of alertness and operation of defense forces (This table is prepared by the investigation team for a coherent presentation)

Generic Hazard		Alertness and operation of defense forces				
Type of operation	Area	Alertness Level	Type of hazard	Level of risk	Mitigating measure	Residual risk
Overflights	Tehran-Baghdad FIRs Exchange points	Surveillance	Misidentification	Very High	Stop the exchange	Acceptable
			Mistargeting	Negligible	NIL	Acceptable
		Conflict	Misidentification	Very High	Stop the exchange	Acceptable
			Mistargeting	Very High	Stop the exchange	Acceptable
	West of FIR	Surveillance	Misidentification	High	Gradual evacuation and no new flights	Acceptable
			Mistargeting	Negligible	NIL	Acceptable
		Conflict	Misidentification	Very High	Stop the operation	Acceptable
			Mistargeting	High	Stop the operation	Acceptable
Departures	Joint Airports	Surveillance	Misidentification	Low	Flight permission if it is ensured enemy is not ready for attack	Acceptable
			Mistargeting	Negligible	NIL	Acceptable
		Conflict	Misidentification	Probable	Stop the operation	Acceptable
			Mistargeting	Very High	Stop the operation	Acceptable
	Civil Airports	Surveillance	Misidentification	Low	Flight permission after coordination with defense unit in white alert condition	Acceptable



			Mistargeting	Negligible	NIL	Acceptable
	Conflict		Misidentification	Probable	Stop operation	the Acceptable
			Mistargeting	high	Stop operation	the Acceptable

### 3.4.3. Implementation of the Measures

At the time of the accident, the CMOCC had notified the three following preventive measures to the Tehran ACC chief on duty during an urgent coordination meeting minutes after attack to Al Asad base:

- 1- The evacuation of four parallel routes in the west of the country
- 2- The ban on traffic exchange between Tehran and Baghdad FIR
- 3- Coordination with the air defense sector prior to issuing a startup approval for departure flights.

Civil- Military coordination at the time of flight PS752 is illustrated in Figure 47. In this figure, the communication lines between IKA ATC unit, Mehrabad approach unit, Tehran ACC and CMOCC are shown.

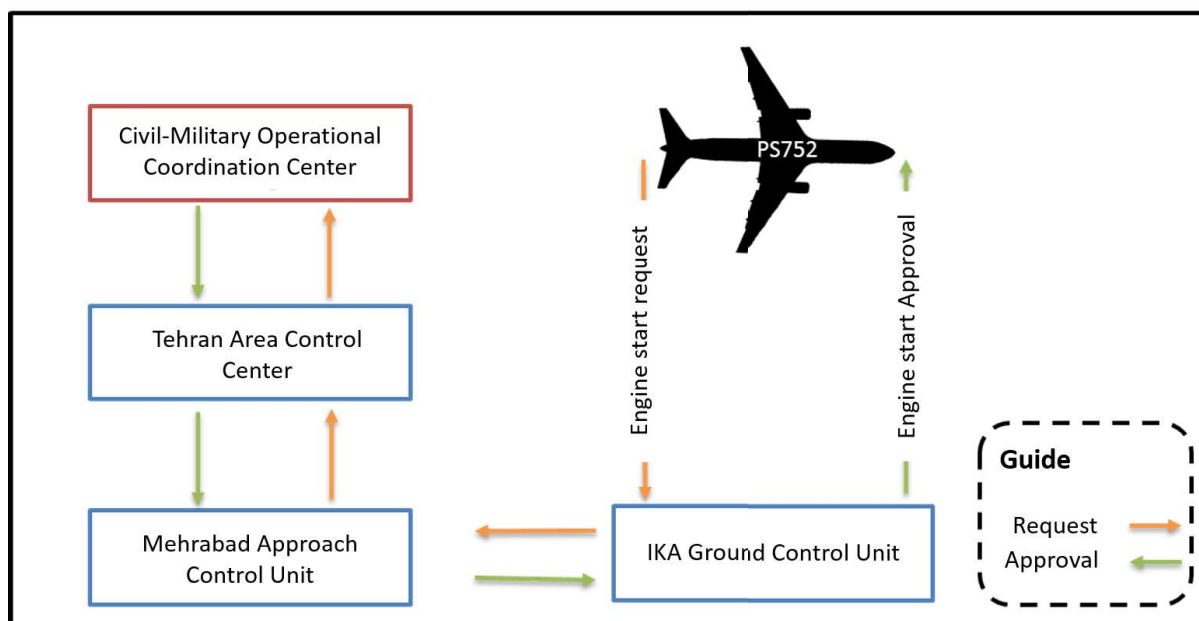


Figure 47- Civil-Military coordination structure at the operational level at the time of the accident

Investigations showed that the measures adopted had been notified to the civil sector based on the planned schedule.

As for PS752, according to the prevailing conditions, the plan was to notify the flight specifications to the defense sector and make coordination with them before issuing clearance for engine startup.

Review of evidence regarding flight PS752 showed that the plan had been implemented and the air traffic control had issued the clearance for engine startup after making coordination with the air defense sector.

Also, the flight PS752 plan had been sent to the military sector, and the CMOCC had been receiving the civil surveillance radar information including the very flight specifications. Considering the location and time of the PS752 takeoff as well as its trajectory to leave Iran FIR, which was not in the limited areas in west of FIR (Figure 48), the measures envisaged in the risk reduction program from this perspective had also been implemented according to the plan.

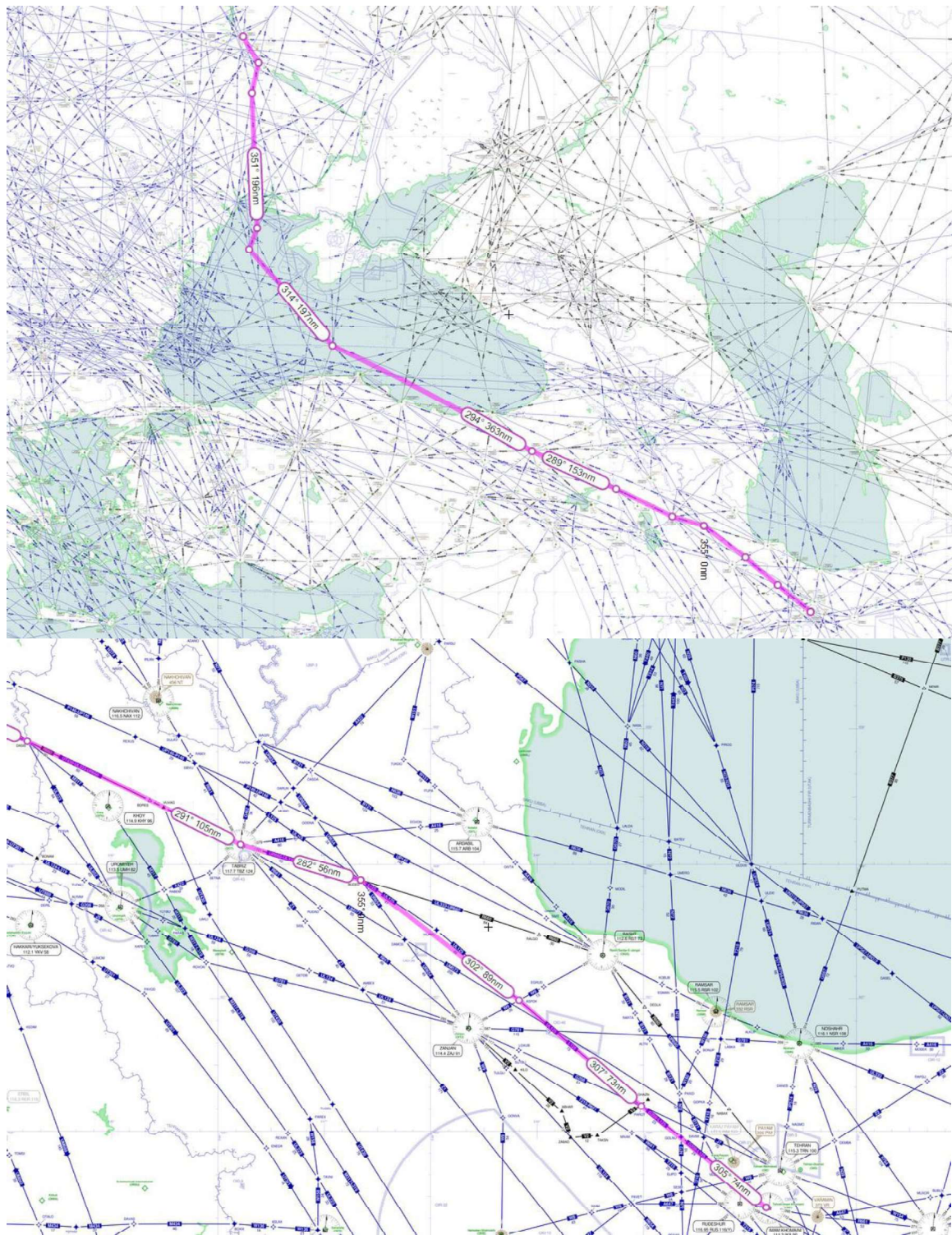


Figure 48- PS752 planned route



The planned measure to clear the four parallel routes in the west of the country had been carried out. The radar observations showed that at the time of the accident, the clearance of four parallel routes No. UT430, M317/L319, UL223 and UT 331 of the transit traffic in the west of Tehran FIR near Iraqi border (Figure 49) had been carried out and there was no flight in this area.

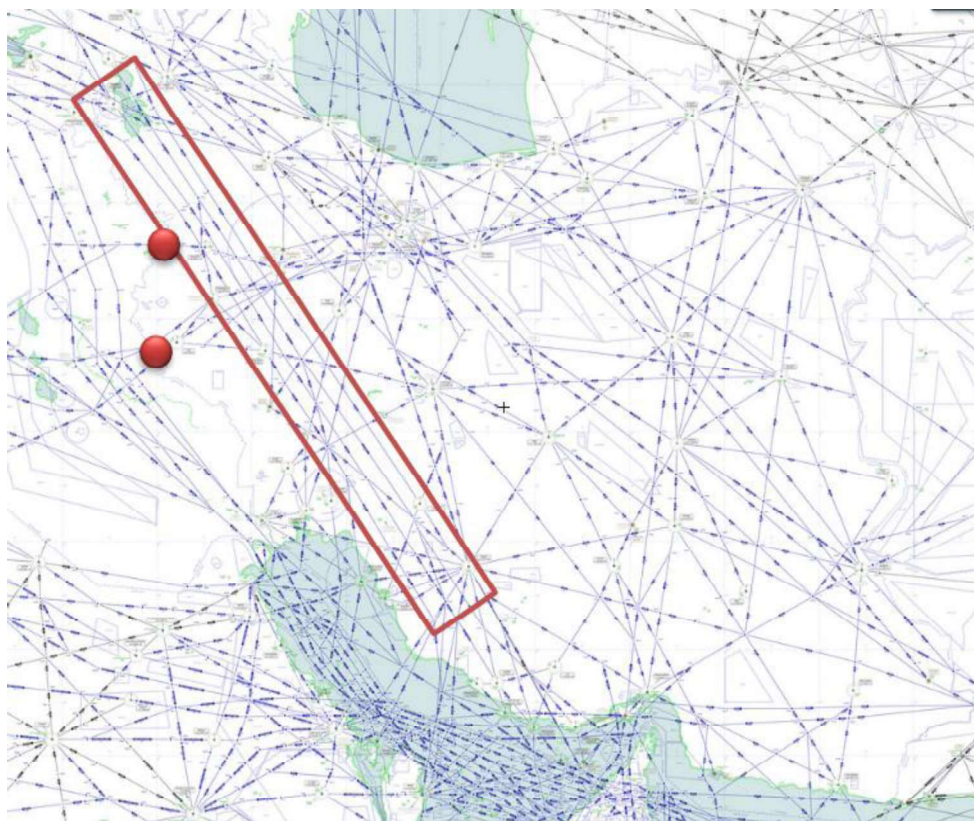


Figure 49- The scope of Iran west routes and exchange points between Tehran and Baghdad FIRs

The observable flight information on these routes corresponds to the one recorded on Internet sources (Figure 50).

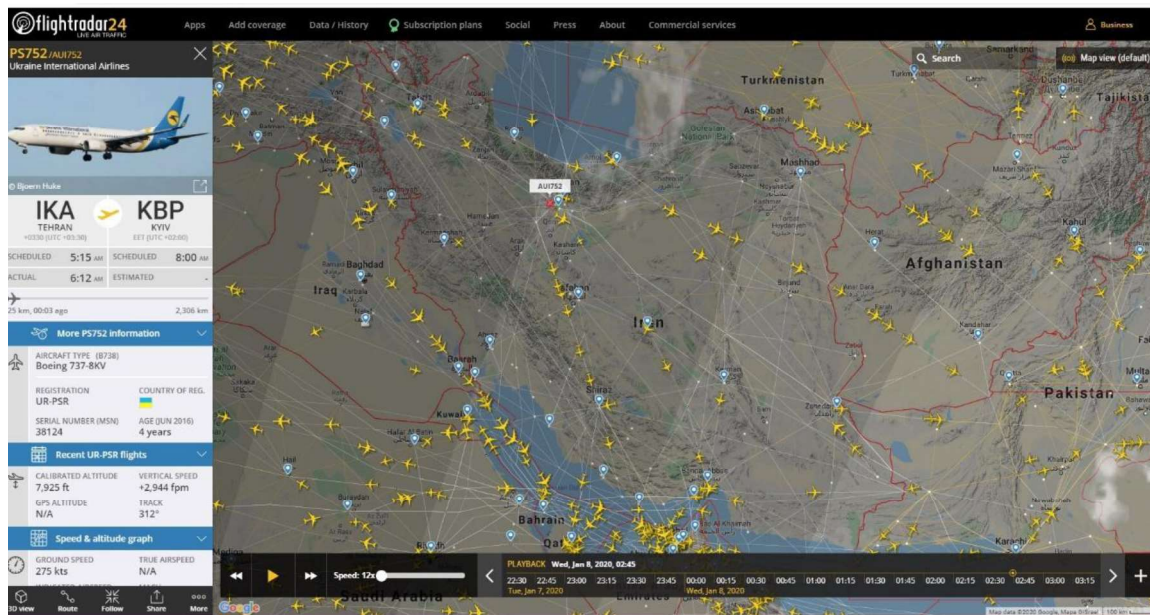


Figure 50- Transit flights status in the west of Iran FIR at PS752 takeoff time (source: FlightRadar24)

For evacuation of routes, at the first the inbound flights were routed to other routes operationally. Considering the rise in the workload together with the conditions persistence, NOTAM No. A0087/20 (Figure 51) was issued hours after the accident at 10:27 on Jan. 08, 2020, whereby new air traffic route scheme was announced.



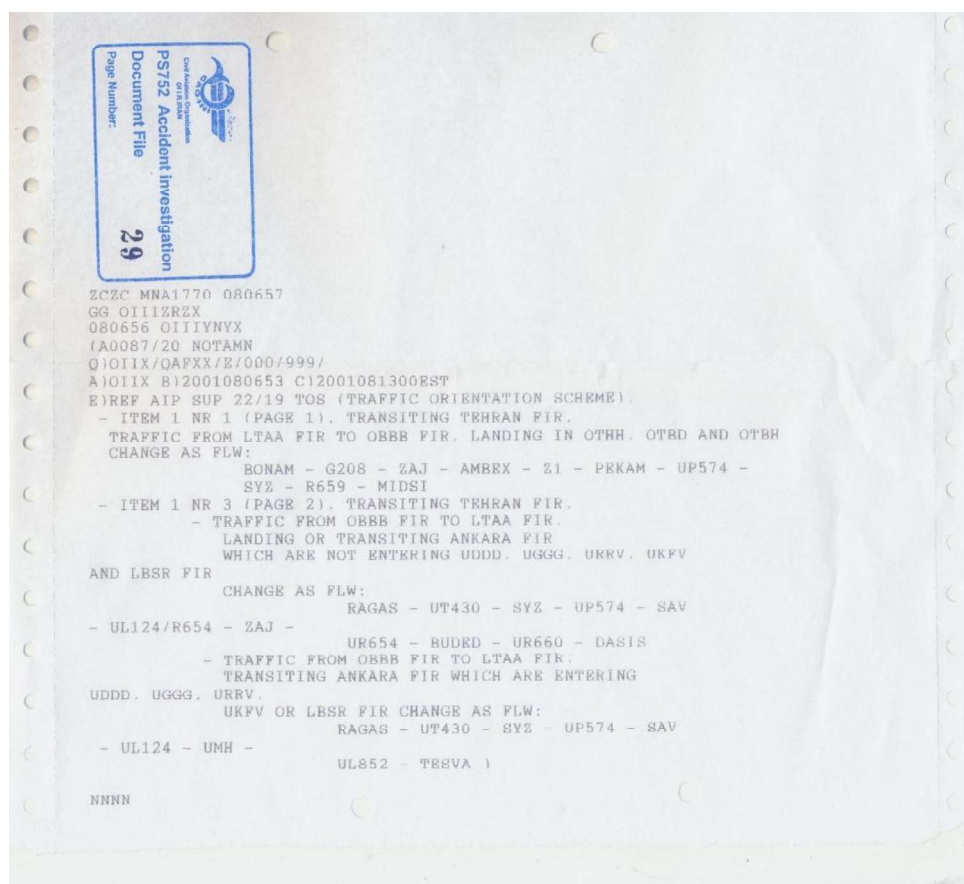


Figure 51- NOTAM issued for change in route scheme

As the air traffic exchange between Tehran and Baghdad FIR had been stopped, four exit flights from IKA to Iraq had been canceled according to the Table 9. The inquiry into the airlines subject to this cancellation showed that IKA did not issue any clearance for the flights to destinations bound for Iraq. Such a restriction had been announced via NOTAM A0086/20 at 09:23 (Figure 52) too.

Enquiry from Turkish airlines showed that the cancellation of flight 899 to Istanbul Sabiha airport was due to the closure of destination airport according to NOTAM A0116/20 and was not a result based on the risk assessment or the situation. On the same basis, the Pegasus flight number 513 to Istanbul Sabiha airport had been cancelled.

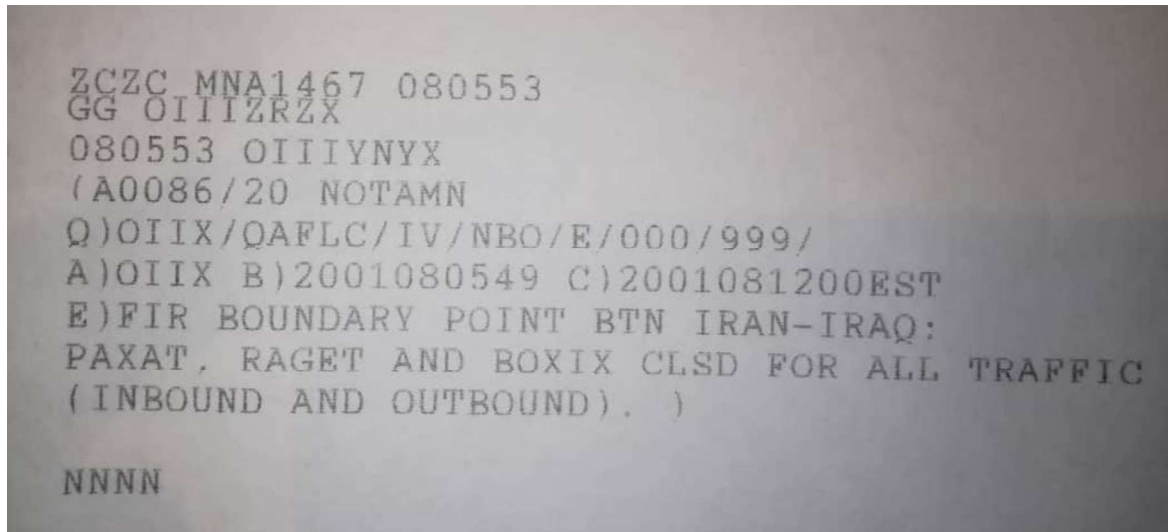


Figure 52- NOTAM issued following the suspension of traffic exchange between Tehran and Baghdad FIR

It was also observed that at 04:11 Iraq ACC requested their counterpart in Iran to accept the entry of British Airways fight BAW124 into the Iranian airspace. This was, however, denied due to the restriction imposed on the traffic exchange between the two countries -Iran and Iraq (Figure 53). Such a negative response was in line with the planned preventive measures.

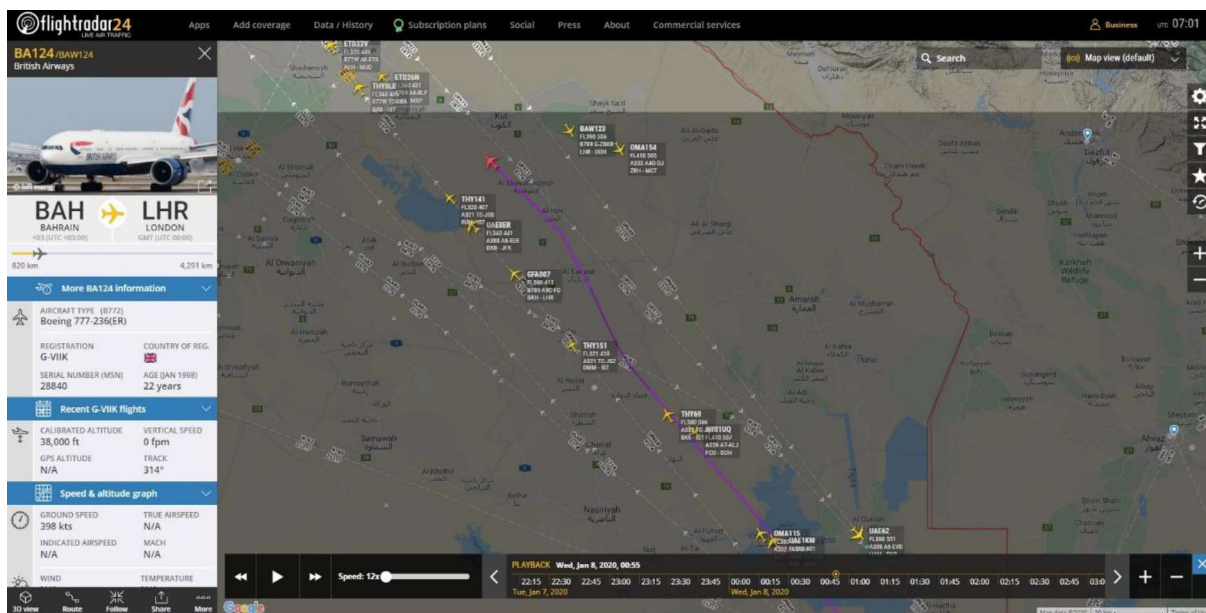


Figure 53- BAW124 whose entry into the Iranian airspace was denied due to the suspension of traffic exchange between Tehran and Baghdad FIR

Table 9 displays the flight schedule of IKA on the day of the accident. Flight 6650 of Ata Airlines, scheduled for 06:00 local time, and Flights No. 5062 and 5042 of Mahan Airlines, scheduled for 06:30 local time, all

to Najaf in Iraq, were canceled due to the traffic exchange suspension between Tehran and Baghdad FIR.

Table 9- IKA departure schedule in morning on the day of the accident

Airlines	Flight Number	Destination	Scheduled Time	Actual Flight Time
Azerbaijan Airlines AHY	9006	Baku UBBB	01:25	01:37
Lufthansa DLH	601	Frankfurt EDDF	02:25	02:43
Mahan IRM	1138	Denizli Cardak LTA	02:30	Cancelled
Turkish Airlines THY	875	Istanbul LTFM	03:00	03:35
Austrian Airlines AUA	872	Vienne LOWW	03:45	04:23
Pegasus Airlines PGT	513	Istanbul – Sabiha LTFJ	04:20	Cancelled
Aeroflot Airline AFL	543	Moscow- Sheremetyevo UUEE	04:30	04:32
Qatar Airways QTR	491	Doha OTHH	04:45	05:00
Turkish Airlines THY	873	Istanbul LTFM	04:45	05:07
Qatar Airways QTR	8408	Hong Kong VHHH	05:15	05:39
Atlas Global KKK	1185	Istanbul LTFM	05:15	05:17
Ukraine International AUI	752	Kiev UKBB	05:15	06:11
Ata Air TBZ	6650	Najaf ORNI	06:00	Cancelled
Turkish Airlines THY	899	Istanbul- Sabiha LTFJ	06:20	Cancelled
Mahan IRM	5062	Najaf- ORNI	06:30	Cancelled
Mahan IRM	5042	Najaf ORNI	06:30	Cancelled

### 3.5. Risk Management in the Airline and the State of the Operators

According to the information provided by the Ukraine International Airlines, *"the safety risk assessment is carried out by UIA airlines in compliance with the Law of Ukraine On the State Aviation Security Program of Civil Aviation"* of March 21, 2017.

*The risk assessment in UIA is in accordance with the Annexes to ICAO Chicago Convention: Annex 17 "Security" and Annex 19 "Safety Management" ICAO Doc 8973 "Aviation Security Manual", ICAO Doc 10084 "Risk Assessment Manual for Civil Aircraft Operations Over or Near Conflict Zones", ICAO Doc 10108 "Aviation Security Global Risk Context Statement" and IATA "Operational Safety Audit Standards Manual.*

*UAI airlines had performed the assessment of the safety risk assessment for the flight PS 752 on the ground of the following analysis of the information.*

*There had been requested NOTAMs of the whole route, and, in particular, those ones from the Civil Aviation Authority of Iran, from the State Aviation Service of Ukraine, as well as from the civil aviation authorities of the countries through which the respected route had been scheduled (OIIE PARO2L PAROT UL125 BUDED UR660 ERZ UL851 KUGOS M860 DIGAM ETNIL M435 MIMKO T219 KONIP B246 CY CY1F UKBB), Conflict Zones Information Bulletin (CZIB's) published on EASA web-site<sup>10</sup> had been analyzed, the information related to the respected region risk assessment, which was placed on the site<sup>11</sup> of the State Aviation Service of Ukraine, had been reviewed , there had been considered the world map of risk zones on the web site <https://www.controlrisks.com/riskmap/maps>.*

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<sup>10</sup>- <https://easa.europa.eu/domains/air-operations/czibs>

<sup>11</sup> -<https://avia.gov.ua/bezpeka-aviatsiyi/aviatsijna-bezpeka/otsinka-zagroz-ta-ryzykiv-aviatsijnij-bezpetsi/>

*UIA believes that any information having been promulgated by 07.01.20 and the morning of 08.01.2020 did not indicate a presence of threats for PS752 civil flight safety, which was performed by the aircraft with Ukrainian registration from Tehran civil airport being completely opened for civil aviation flights and it did not contain any limitations or warnings as for the opportunity of such a flight performance.*

*There did not exist any prohibitions and limitations for the use of Iran's airspace en route of PS 752 flight imposed by any governmental and/or international organizations, being competent to introduce such prohibitions. Besides that, there had not been sent any warnings or specific flight performance conditions by the ATS, from military bodies, from airport Imam Khomeini (or the Ukraine's authorities) to the Airlines or to the air crew of PS 752 flight.*

*Other air carriers, including Iranian and foreign ones, had performed flights on the same day to/from Imam Khomeini airport till PS752 accident."*

The operation of UIA showed that no restriction had been imposed on operation of flight PS752 from UIA or State of Ukraine.

One of the sources that could have helped the understanding of the status of the crew's perception of the conditions and possible decision-making about restrictions or measures at operational level was the conversations of the flight crew inside the cockpit. Standard operating procedures at UIA did not require the crew to manually turn on the CVR before engine start and the voices related to the briefing time before takeoff and cabin check and preparation were not recorded. The voices recorded afterwards did not indicate any condition of the airspace, concerns and possible precaution or a decision-making related to the condition.

The investigation activities shows that no other airlines who had departure flight from IKA in the day of accident, imposed restrictions on their operation on the basis of the flight route safety risk assessment results



### 3.6. The availability of Information and the Level of Access to Them

The provision of adequate and timely information is essential for the proper performance of the responsibilities of the various parties in managing the risk of operations in an airspace from the perspective of potentially hazardous military activities.

Although States use overt and classified information to assess the situation, when the situation is changing rapidly, the timely dissemination of information plays an important role in assisting different parties in taking the necessary measures.

The news on the missile attack on Al Asad airbase on Jan.08, 2020 was publicly announced after a few minutes following the attack.

In an official statement released in the very hours , the U.S. Department of Defense confirmed the attack to the American Forces in Iraq and announced, “It is clear that these missiles were launched from Iran.”<sup>12</sup>

The news of this statement was also published in the mass media. It could be accessed at least at 03:11 on January 08,<sup>13</sup>.

The Islamic Republic of Iran Armed Forces released an official statement regarding the missile operation, which was covered by Iranian news agencies<sup>14</sup> at around 02:40 on January 08, 2020 Tehran time and published in the international mass media shortly.

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<sup>12</sup>- <https://www.defense.gov/Newsroom/Releases/Release/Article/2052103/dod-statement-on-iranian-ballistic-missile-attacks-in-iraq/>

<sup>13</sup> - <https://www.usatoday.com/story/news/world/2020/01/07/iran-state-tv-tehran-fires-iraqi-base-housing-us-troops-ain-assad/2837693001/>

<sup>14</sup> - Irna news agency- Jnuary08 2020, 02:41 Tehran local time- news code 83625435

<https://www.irna.ir/news/83625435/%D8%A7%D9%86%D8%AA%D9%82%D8%A7%D9%85-%D8%B3%D8%AE%D8%AA-%D8%A8%D8%A7-%D8%B4%D9%84%DB%8C%DA%A9-%D8%AF%D9%87%D9%87%D8%A7-%D9%85%D9%88%D8%B4%DA%A9-%D8%A8%D9%87-%D9%BE%D8%A7%DB%8C%DA%AF%D8%A7%D9%87-%D8%A2%D9%85%D8%B1%DB%8C%DA%A9%D8%A7%DB%8C%DB%8C-%D8%B9%DB%8C%D9%86-%D8%A7%D9%84%D8%A7%D8%B3%D8%AF>

At 03:15 on the 8th of January, the Federal Aviation Administration (FAA) of the U.S. issued the following NOTAM number A0001/20 prohibiting conducting flights in Baghdad FIR for the persons and operators already described under its oversight:

A0001/20 NOTAMN

Q) KICZ/QRDLP/IV/NBO/AE/000/999/

A) KICZ

B) 2001072345

C) PERM

E) SECURITY..UNITED STATES OF AMERICA PROHIBITION AGAINST CERTAIN FLIGHTS IN THE BAGHDAD FLIGHT INFORMATION REGION (FIR) (ORBB). THOSE PERSONS DESCRIBED IN PARAGRAPH A (APPLICABILITY) BELOW ARE PROHIBITED FROM OPERATING IN THE BAGHDAD FLIGHT INFORMATION REGION (FIR) (ORBS) DUE TO HEIGHTENED MILITARY ACTIVITIES AND INCREASED POLITICAL TENSIONS IN THE MIDDLE EAST, WHICH PRESENT AN INADVERTENT RISK TO U.S. CIVIL AVIATION OPERATIONS DUE TO THE POTENTIAL FOR MISCALCULATION OR MIS-IDENTIFICATION.

A. APPLICABILITY. THIS NOTAM APPLIES TO: ALL U.S. AIR CARRIERS AND COMMERCIAL OPERATORS; ALL PERSONS EXERCISING THE PRIVILEGES OF AN COMMERCIAL OPERATORS; ALL PERSONS EXERCISING THE PRIVILEGES OF AN AIRMAN CERTIFICATE ISSUED BY THE FAA, EXCEPT SUCH PERSONS OPERATING U.S.-REGISTERED AIRCRAFT FOR A FOREIGN AIR CARRIER; AND ALL OPERATORS OF AIRCRAFT REGISTERED IN THE UNITED STATES, EXCEPT WHERE THE OPERATOR OF SUCH AIRCRAFT IS A FOREIGN AIR CARRIER.

B. PERMITTED OPERATIONS. THIS NOTAM DOES NOT PROHIBIT PERSONS DESCRIBED IN PARAGRAPH A (APPLICABILITY) FROM CONDUCTING FLIGHT OPERATIONS IN THE BAGHDAD FIR (ORBB) WHEN SUCH OPERATIONS ARE AUTHORIZED EITHER BY ANOTHER AGENCY OF THE UNITED STATES GOVERNMENT WITH THE APPROVAL OF THE FAA OR BY A DEVIATION, EXEMPTION, OR OTHER AUTHORIZATION ISSUED BY THE FAA ADMINISTRATOR. OPERATORS MUST CALL THE FAA WASHINGTON OPERATIONS CENTER AT 202-267-3333 TO INITIATE COORDINATION FOR FAA AUTHORIZATION TO CONDUCT OPERATIONS. C. EMERGENCY SITUATIONS. IN AN EMERGENCY THAT REQUIRES IMMEDIATE DECISION AND ACTION FOR THE SAFETY OF THE FLIGHT, THE PILOT IN COMMAND OF AN AIRCRAFT MAY DEVIATE FROM THIS NOTAM TO THE EXTENT REQUIRED BY THAT EMERGENCY. THIS NOTAM IS AN EMERGENCY ORDER ISSUED UNDER 49 USC 40113(A), 44701(A)(5), AND 46105(C). ADDITIONAL INFORMATION IS PROVIDED AT:

[HTTPS://WWW.FAA.GOV/AIR\\_TRAFFIC/PUBLICATION](https://www.faa.gov/air_traffic/publication)

F) SFC

G) UNL END

At 00:10 on the 8th of January, the Federal Aviation Administration (FAA) of the U.S. issued the following NOTAM number A0002/20 prohibiting conducting flights in Baghdad FIR for the persons and operators already described under its oversight.

A0002/20 NOTAMN

Q) KICZ/QRDLP/////

A) KICZ

B) 2001080010

C) PERM

E) SECURITY..UNITED STATES OF AMERICA PROHIBITION AGAINST CERTAIN FLIGHTS IN THE TEHRAN FLIGHT INFORMATION REGION (FIR) (01IX). THOSE PERSONS DESCRIBED IN PARAGRAPH A (APPLICABILITY) BELOW ARE PROHIBITED FROM OPERATING IN THE TEHRAN FLIGHT INFORMATION REGION (FIR) (01IX) DUE TO HEIGHTENED MILITARY ACTIVITIES AND INCREASED POLITICAL TENSIONS IN THE MIDDLE EAST, WHICH PRESENT AN INADVERTENT RISK TO U.S. CIVIL AVIATION OPERATIONS DUE TO THE POTENTIAL FOR MISCALCULATION OR MIS-IDENTIFICATION.

A. APPLICABILITY. THIS NOTAM APPLIES TO: ALL U.S. AIR CARRIERS AND COMMERCIAL OPERATORS; ALL PERSONS EXERCISING THE PRIVILEGES OF AN AIRMAN CERTIFICATE ISSUED BY THE FAA, EXCEPT SUCH PERSONS OPERATING U.S.-REGISTERED AIRCRAFT FOR A FOREIGN AIR CARRIER; AND ALL OPERATORS OF AIRCRAFT REGISTERED IN THE UNITED STATES, EXCEPT WHERE THE OPERATOR OF SUCH AIRCRAFT IS A FOREIGN AIR CARRIER.

B. PERMITTED OPERATIONS. THIS NOTAM DOES NOT PROHIBIT PERSONS DESCRIBED IN PARAGRAPH A (APPLICABILITY) FROM CONDUCTING FLIGHT OPERATIONS IN THE ABOVE-NAMED AREA WHEN SUCH OPERATIONS ARE AUTHORIZED EITHER BY ANOTHER AGENCY OF THE UNITED STATES GOVERNMENT OR BY A DEVIATION, EXEMPTION, OR OTHER AUTHORIZATION ISSUED BY THE FAA ADMINISTRATOR. OPERATORS MUST CALL THE FAA WASHINGTON OPERATIONS CENTER AT 202-267-3333 TO INITIATE COORDINATION FOR FAA

AUTHORIZATION TO CONDUCT OPERATIONS. C. EMERGENCY SITUATIONS. IN AN EMERGENCY THAT REQUIRES IMMEDIATE DECISION AND ACTION FOR THE SAFETY OF THE FLIGHT, THE PILOT IN COMMAND OF AN AIRCRAFT MAY DEVIATE FROM THIS NOTAM TO THE EXTENT REQUIRED BY THAT EMERGENCY. THIS NOTAM IS AN EMERGENCY ORDER ISSUED UNDER 49 USC 40113(A), 44701(A)(5), AND 46105(C). ADDITIONAL INFORMATION IS PROVIDED AT: [HTTP://WWW.FAA.GOV/AIR\\_TRAFFIC/PUBLICA](HTTP://WWW.FAA.GOV/AIR_TRAFFIC/PUBLICA)

F) SFC

G) UNL

END

Further, according to the information provided by British Airways through UK Expert, this airline had been made aware of the Iranian missile attack on the American base at 03:25 on Jan. 08, 2020, so even before receiving the formal FAA NOTAM, it had already put in place processes to stop operations entering the Baghdad and Tehran FIR, and to leave those FIRs as soon as possible if already in them, but focusing initially on the Iraqi airspace. The request of BAW124 flight for entering Tehran FIR was the result of the risk assessment at the time, but the airline was focused on securing the preference to operate through Saudi airspace.

The States' information and actions taken by them were not necessarily limited to the above-mentioned. Nevertheless, since the investigation team had dealt with the availability of the information to the States and operators about the conditions to plan and take necessary measures, such cases are simply presented as existing examples.

## 4. Review of Similar Accidents

Many civilian aircraft accidents caused by military activities have been recorded so far.

Although such accidents are different in terms of the aircraft type, being commercial or non-commercial, the cause and nature of the attacks, the accident type and severity, they all had commonalities in that they were all the aircraft engaged in civilian transport, were not a military threat and occurred as a result of armed activities outside the aircraft.

In various sources, there exist several cases of accidents suspected to have occurred by downing through armed activities, yet they have never been officially confirmed.

It is obvious that due to the consequences, the official acknowledgment of a civilian aircraft shoot-down is extremely hard and unappealing. More importantly, if the shoot-down has been intentional, there will be a natural general tendency for states to conceal matters, not to mention their great reluctance to declare that the accident has occurred due simply to the unsafe airspace under control their control. As a result, it could be concluded it is highly likely that there exist accidents of such nature and yet never been declared.

In the following, reference will be made to official similar accidents to commercial aircraft. Considering of the overall similarities and differences of such accidents, along with the PS752 one's, can help prevent similar events.

Following any aircraft accident caused by military activity, there is a change in the approach and level of attention to this threat at the national and international levels. A review of such changes shows that the processes resulting from MH17 accident can be considered a turning point in the development of theoretical foundations of safety in this area while staying focused on such issues and continuous follow-up of improvements.



#### **4.1. Korean Airlines Flight No. 007**

On September 01, 1983, Korean Airlines Flight 007, a Boeing 747 with registration number HL-7442, was scheduled to fly from New York to Seoul via Anchorage, Alaska. It was shot down by a Soviet Union's interceptor airliner en route from Anchorage to Seoul. All 269 people on board the aircraft, including 246 passengers and 23 crew members, lost their lives in the accident. The crash came after the Korean aircraft entered a Soviet-controlled prohibited zone due to a navigation error and the military forces identified it as a threat.

#### **4.2. Flight No. 655 of the Islamic Republic of Iran Airlines (IranAir)**

On July 03, 1988, Flight 655, Airbus A300B2-203 of the Islamic Republic of Iran Airlines with the EP-IBU registration mark, departed from Bandar Abbas Airport, Iran, to Dubai in the United Arab Emirates at 06:47. While it was on a planned route and altitude, climbing from an altitude of 12,000 to 14,000 feet, it was hit by two surface-to-air missiles fired from a U.S warship and crashed near Qeshm Island at 06:54:43. All the 16 crew members together with the 274 passengers onboard were lost their lives.

#### **4.3. Flight No. 1812 of Siberia Airlines**

On October 04, 2001, Siberian Airlines, Flight 1812 was hit by a surface-to-air missile on a flight from Tel Aviv to Novosibirsk using a Tu-154 aircraft registered RA-85693. At the time of the flight, military exercises were underway in the area, and the aircraft was shot down by one of the rockets fired over the Black Sea. All 66 passengers and 12 crew members aboard were killed in the crash.

#### **4.4. Malaysia Airlines Flight No. 17**

On July 17, 2014, a Boeing 777 of Malaysia Airlines with the registration mark 9M-MRD was flying from Amsterdam to Kuala Lumpur with MH17 flight number over eastern Ukraine, where military disputes were raging. It was hit in the air by missile and crashed. All 298 occupants, including 283 passengers and 15 crew members onboard the aircraft were killed.

#### **4.5. 2020 African Express Airway accident**

On 4 May 2020, an Embraer-120 aircraft of African Express Airways with the registration mark 5Y-AXO, originated a flight from Baidoa to Berdale in Somalia. The aircraft was hit by 23 mm shells (ZU-23) emanating from Sector 3 AMISOM (African Union Mission to Somalia) forces. 04 crewmembers and 2 airline staff were killed in the crash.

## 5. Analysis

### 5.1. Missiles Function

The times provided by the military sector on the first missile launch and detonation, along with the location of the warhead fuse activation, corresponded to the time and location of the strike heard on the CVR, the termination of FDR recording and termination of the ATC transponder of the aircraft.

The investigation conducted showed that the TNT explosives found on the outer layers of the fuselage were similar to the aliphatic compounds used in the missile launched at the aircraft, and that the small amount of DNT observed could be a by-product of the thermal degradation of the aircraft conventional substances like fuel and epoxy. The DNT could be a small amount of aliphatic explosives impurities with lower quality nitrite.

The explosives found on the remaining parts of the aircraft had to do with the missile function. In fact, no explosives of an unknown origin were found in the tests and analyses.

The tests conducted on other small pieces found on the passenger seat pads revealed that none were of the missile shrapnel material, but rather the ones used in manufacturing the aircraft, and that they had spread out all across due to the explosion caused by ground impact.

Due to the termination of FDR and CVR recording before the probable time of activation of the second missile, no conclusion could be made on the effect of the second missile based on the flight recorders data.

The recorded data in ADU shows that the second missile failed and was not successful.

The video which had been recorded in a construction work area showing the missile flight and explosion supports the conclusion that the 2<sup>nd</sup> missile exploded near the aircraft.

The investigation team analyzed the last recorded position of the two missiles, which is most likely the position of the detonation. The recorded data shows that the last position of the first missile was located about 400

meters south of the aircraft track, and the last position of second missile was located about 500 meters north of the aircraft track. Since the first missile affected the aircraft, the calibration of data related to the missiles position was proven necessary. The main source of this error is the error of ADU north heading calculation, which had been determined 105 degrees. After the direction recalibration of ADU in order to align the last recorded position of the first missile to aircraft track, the locations are shifted 400 meters northward, and hence the last location of the second missile differs 900 meters from the aircraft track and in this case the missile had no chance to affect the aircraft.

Considering all the above analysis, due to the residual uncertainty of information and analysis related to second missile detonation, the proven effect of the first missile, the proven launch of second missile and the fact that for prevention of similar accidents, this information is enough, the investigation team concluded that making the conclusion about the detonation and effect of the second missile is not reliable and does not affect the outcome of this investigation.

## **5.2. Aircraft Technical and Operational Conditions**

Aircraft technical and operational functions had been normal by the missile strike.

The technical condition and operation of the aircraft systems did not play a role in creating errors for the operator of the ADU or strengthening the context of error.

In the judicial proceedings, in a similar environment, a simulation was run to investigate how the error had been formed and how the missile was launched. All the processes in the military, civil sector, and the cooperation between them were made just as the events occurring on the day of the accident, based on the records made in all sectors using a BOEING 737 flying twice from IKA on a flight trajectory similar to that of PS752. The accident investigation team participated in the simulation to observe the events taking place in the civil and joint cooperation sectors.

Two ADUs were placed at the location of the launching ADU. The north alignment error like the launching system was repeated in one system,

considered as the main one, while in the other, as the reference one, the north alignment error was corrected.

The simulation also indicated that the aircraft flight operation did not play a role in the occurrence of the error made by the air defense unit operator. In the two times of simulation, the reference unit operators detected the aircraft from the IKA direction (Figure 54), while the main unit operators detected it approaching from the western area (Figure 55).



Figure 54- The target direction in the reference ADU in the simulation with correct North alignment





Figure 55- The target direction in the ADU in the simulation with repeated north alignment error

After the detonation of the first missile in the proximity of the aircraft, the ATC transponder and FDR recording terminated simultaneously due to damage to the aircraft. The aircraft sustained cascading damage, as a result of which, after about 16.5 seconds, the rotation frequency of one of the generators (Electrical power supply - IDG) started to decrease, causing a reduction in frequency of recorded audios in CVR and termination of recording after 2.5 seconds.

As civil aircraft are not designed and manufactured in a way to be missile resistant, the analysis of the way the missile affect the aircraft systems is pointless to safety enhancement goals. In addition to this, the severity of the damage caused by aircraft impact to the ground and the resulted explosion does not make such an analysis practicable.

### 5.3. CVR Turn-on

The first radio communication of PS752 with the IKA ground control unit was made at 05:13:11 and recorded in the aeronautical communications systems. The CVR of the accident aircraft started recording at 05:56:18 and the flight received the clearance for engine startup and pushback at 05:55. According to the recorded voice, it can be said that the CVR was turned on automatically after the first engine was switched on.

Given the fact the flight crew had already been present at the cockpit for some time, listening to their conversations before takeoff could have helped understand if they had been made aware of Iran's missile attack to the U.S. base in Iraq, or if they had ever talked about or made any decision regarding the conditions at the time.

The ICAO standard for the start of voice recording is set out in Annex 6 to the International Civil Aviation Convention. According to the text in Section 3.1, Part 1 of Appendix 8 (Aircraft Operations), 10<sup>th</sup> edition, Amendment 41, the CVR shall start to record prior to the aeroplane moving under its own power and record continuously until the termination of the flight when the aeroplane is no longer capable of moving under its own power. In addition, depending on the availability of electrical power, the CVR shall start to record as early as possible during the cockpit checks prior to engine start at the beginning of the flight until the cockpit checks immediately following the engine shutdown at the end of the flight.

Although the second sentence of Section 3.1 of Appendix 6 sets out the start of voice recording when the cockpit checks are performed, the condition for the existence of electrical power complicates the effective implementation of this action, making it unattended.

The civil aviation authorities have similar instructions in national regulations in this respect too, sufficing to state the same text in Annex 6. In approving the Operation Manuals of the airlines, the review of procedure related to CVR switch during cockpit checks and the clarification of the meaning of "the availability of electrical power" by the airlines are not taken very seriously either.

Studies show that some airlines typically do not set specific requirements for the time to turn on the CVR and simply follow the usual manufacturer's instructions provided on the Flight Crew Operating Manual (FCOM).

It has been observed that in the FCOM of some aircraft manufacturers, the CVR switch is put on the ON mode at the beginning of the cockpit check/briefing.

The FCOM of the Boeing 737-800 series, compiled by Boeing, states the CVR switch mode "as required". Such a requirement must be specified by the airline, taking into account their policies and national regulations and the conditions of the electrical power supply, not to mention other factors.

Even though the recording and analysis of such conversations did not pose a serious challenge to the investigation of this accident, the investigation team concluded that the transparency of the regulations in this area, in such a way that it ensures the recording of the cockpit voices during checks, technical and operational conversations, and decision making, will be beneficial for safety studies related to cockpit conversations. At the very least, it seems that recording radio calls from inside the cockpit, conversations about performing the necessary checklist items and those on deciding whether to initiate, continue or end a flight operation are some of the matters that shall be recorded in the cockpit.

#### **5.4. Operational Conditions of the Flight Crew, and the Aircraft**

The flight crew held the necessary qualifications to conduct the flight.

Both the flight crew performance and the aircraft flight operation were normal, not playing any role in inducing the error for the ADU operator, nor contributing to it.

After takeoff, the aircraft had been continuing to fly on the expected trajectory at an appropriate altitude and speed until hit by the missile.

The flight delay had been caused by unloading some cargo to reach the aircraft total weight appropriate for flight.

## 5.5. Risk Assessment

### 5.5.1. Risk Assessment by the State Managing the Airspace

As the missile attack on Al Asad base had been planned in Iran, there was enough time and information at hand to predict the situation and assess the risk for civil flights in Iranian airspace.

Due to the information classification, the risk assessment had been done before, and the mitigating measures had been planned to reduce the risk to civil aircraft.

The civil sector had been notified of such measures, which were thoroughly performed accordingly.

Eventually, the actual risk for the “misidentification of civil aircraft departing from an international civil airport following the defense system’s initial identification” exceeded the risk level predicted, making the planned measures for this type of operation concerning the PS752 ineffective, due to the materialization of an unforeseen chain of events.

At the time, other flights had taken off from IKA, though a misidentification causing a missile launch at them never occurred.

Considering that the pattern of error making and the materialization of its consequences follow the famous patterns of the chain of events or Swiss Cheese Model, it is concluded that the presence of grounds for errors is not equivalent to the occurrence of final event. In other words, it is only in special and rare conditions that the entire chains necessary for the accident to occur are formed, while in other cases, by breaking one of the links in the chain or the effective performance of one of the anticipated defense layers, the existing latent condition would become unlikely to be materialized.

In order to realize what happened in military side, investigate the role of civil aviation operation in this event, and provide an answer into how the existing error caused an accident for this certain flight, the investigation team still submitted a request for investigating the measures and events leading to the missile launch in addition to the actions having been planned to prevent it. The military sector and the judicial authority

responsible for this accident provided the information required to the investigation team accordingly.

The investigation team found that the operating military unit was not basically responsible for monitoring the targets; it was just obliged to perform the actions planned within the command hierarchy only if a target was assigned to them from the command center.

Following a tactical relocation, the relevant ADU failed to adjust the system direction out of human error, causing the operator to observe the target flying west from IKA as a target approaching Tehran from the southwest at a relatively low altitude.

The target specifications were announced to the command center, but the message was never relayed. Without receiving a go-ahead or response from the command center, he came to identify the target as a hostile one and fired missile at the aircraft against the procedure planned.

The chain of events observed by the investigation team leading to firing missile at PS752 is illustrated in Figure 56.



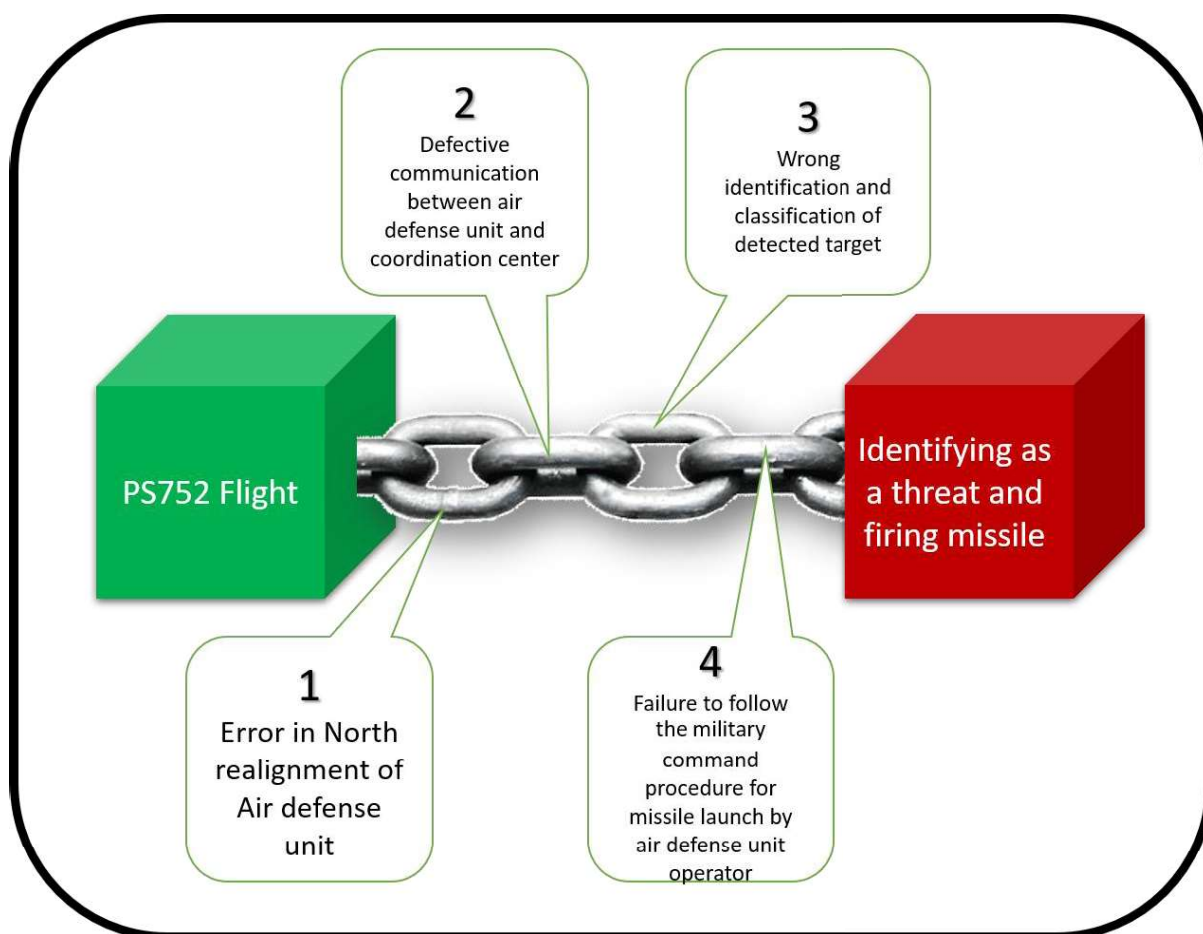


Figure 56- The chain of events leading to firing missile at PS752

The existence of this threat and the possibility of such chains being formed had not been predicted, and had not been considered in the calculations of the risk associated with misidentification.

The chain leading to the accident demonstrates the extent to which the hazards resulting from human performance are serious with a far-reaching consequence. It shows how much the ignoring the contribution and the possibility of complex combinations of rare events, could affect the accuracy and efficiency of risk management.

If normal condition with no conflicts or the possibility of that is considered at one extreme end, and on the other hand, a major military conflict at another extreme end, there would be a spectrum in between, where a series of measures must be taken to ensure the safety of civil aviation, from no operational restriction to the suspension of any civil operation depending on the very conditions.

In vast geographical areas, due to differences in the amount of risk in various parts of an area, the set of measures governing one area may vary from those governing another one.

To reduce the probability of hazards for civil sector, military forces normally implement measures to minimize overall organizational errors and their associated consequences, as well as eliminating the contributing factors. All these analyses would form the basis for the development of operational procedures. Considerations related to human errors and their tolerability, the classification and definition of various conditions, such as normal, different levels of alertness, conflict and requirements of the operating environment, hardware, procedures, command hierarchy, human performance, among others are taken into account in developing the operational procedures.

Once all the considerations and executive measures have been implemented, there will be a level of residual risk that must be commensurate with the operational context. The more operations, the higher the probability of an error, and the need for the contributing factor to be reduced to such an extent that the residual risk is maintained at an acceptable level.

During the conditions when the PS752 accident happened, the risk of commercial aircraft being accidentally struck while trying to target the hostile aircraft was estimated to have been negligible before the start of a military operation. Nonetheless, given the fact the Iranian air space is always monitored independently of a military attack, the risk of misidentification is also considered at all time, which was higher in the alertness conditions at that time.

It can finally be concluded that the risk assessment conducted was not commensurate with the real conditions at the time, and an unpredicted chain of events was materialized at the end.

The investigation team requested the authorities who had done the risk assessment to repeat the assessment considering the information gathered after the accident. The result of such assessment was similar to the previous one, and again, clearance for PS752 to conduct the flight was

evaluated to be safe and coordination with air defense before startup approval was evaluated to be enough to eliminate the possibility of misidentification.

The investigation team found that in the conducted risk assessment, only the steady state of conditions had been considered. In other words, only the elements of hazards raised from the alertness of the military forces had been taken into account, but no element representing the rapid transition from one alertness level to another had been stipulated in calculations.

The investigation team identified three states for any change between the two hazard levels. The first state is the initial state of the system. After the change of condition to the next hazard level, due to the occurrence of a change in conditions which is initially unknown in terms of the extent, duration and dimensions, the system enters a transient condition. When the new condition remains stable and the elements of system, including humans get used to the new condition, the system enters into the next steady state level.

This is while entities who had conducted the risk assessment considered only the three following levels of hazards and defined and implemented the related safety measures.

The first level was the initial condition. It was predicted that after the missile attack on Al Asad airbase, the system would enter the second level, namely the alertness condition. In case of a counterattack, the conflict condition as the third level had been predicted with strict safety measures including the no-fly zone.

Transient condition is applicable to all systems. Each level of conditions has its own hazards and any change in condition includes special hazards related to the nature of change. At the time period close to the change, the change hazards must be added to hazards related to the new condition until the system enters steady state and the hazards related to change disappear.

During the investigation, some studies were done to determine the characteristics of transient condition.

The time period and level of hazards associated with transient condition are related to the range of change and the components of the system, and defining the characteristics of transient condition would not be accurate and real at this step. However, from the human factors perspective, it seems that the transient condition period must last longer than the working hours of the personnel who were working in the system at the time of transition. The personnel who work in each section of the system are less affected by the change of condition, at least in terms of situational awareness, if they start their work shift after that change, and obviously, if the change happens during their work shift, they are more affected by this change.

In PS752 accident case, taking into account that the prevailing conditions rapidly changed at about 02:00, it is likely that at the time of the accident, the transition time was not finished yet and this transient condition contributed to human errors and the existing hazards within the whole system.

An illustration of this concept is shown in Figure 57.

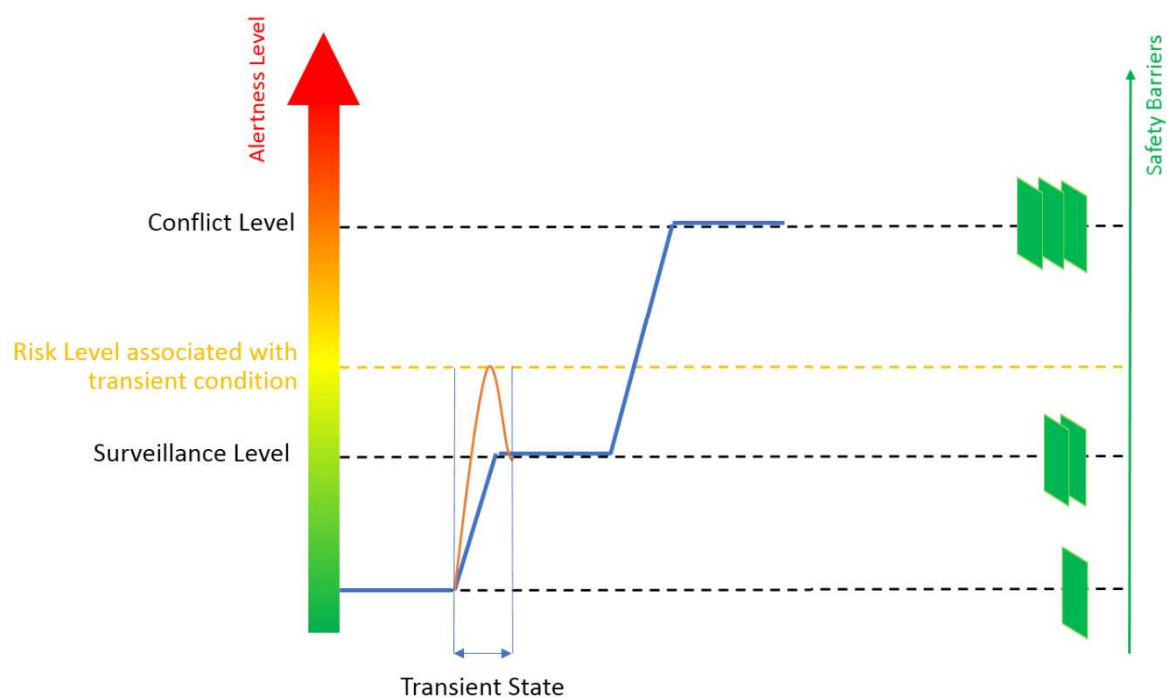


Figure 57- Alertness levels and risk in transient condition

### 5.5.2. The Airline's and the State of the Operator's Risk Assessment

In PS752 accident condition, it was found that some airlines had performed a risk assessments in a short period of time and implemented various measures to the point of suspension of their flight operations in some areas.

It was also found that some States quickly set and announced restrictions on the activities of airlines under their oversight.

However, some had not taken any clear action on the situation, and others had not made any assessment of the situation at a pace commensurate with that changing trend.

As for PS752, no restriction whatsoever had been imposed neither by Ukraine nor the UIA.

Figure 58 illustrates the risk assessment flowchart for the operators provided in ICAO DOC10084. The first step of assessment is collecting information, whose source could be the published aeronautical information, the special information provided to the operators by the States, special information network -where the States and operators participate-, aerodromes as well as open source information.

the collection of relevant information is a vital step in the success of risk assessment, because if the information is not available or is not collected properly and in a timely manner, the risk assessment process can not be initiated.

The speed of information collection and the vastness of its sources become far more important during the conditions like those in PS752 accident, when the changes were very rapid and in the order of few hours than when they do over a longer period of time, about a few days.

The conditions changed at such a pace and time that the exclusive sources for the provision of aviation-related information useful for the airlines did not publish any new information, but the open and public sources had released the news on the attack to Al Asad base hours before, and official



authorities in the States issued statements and notifications about that event.

The investigation reveals that such information sources was not considered in the risk assessment by the operators who had departure schedule from IKA..

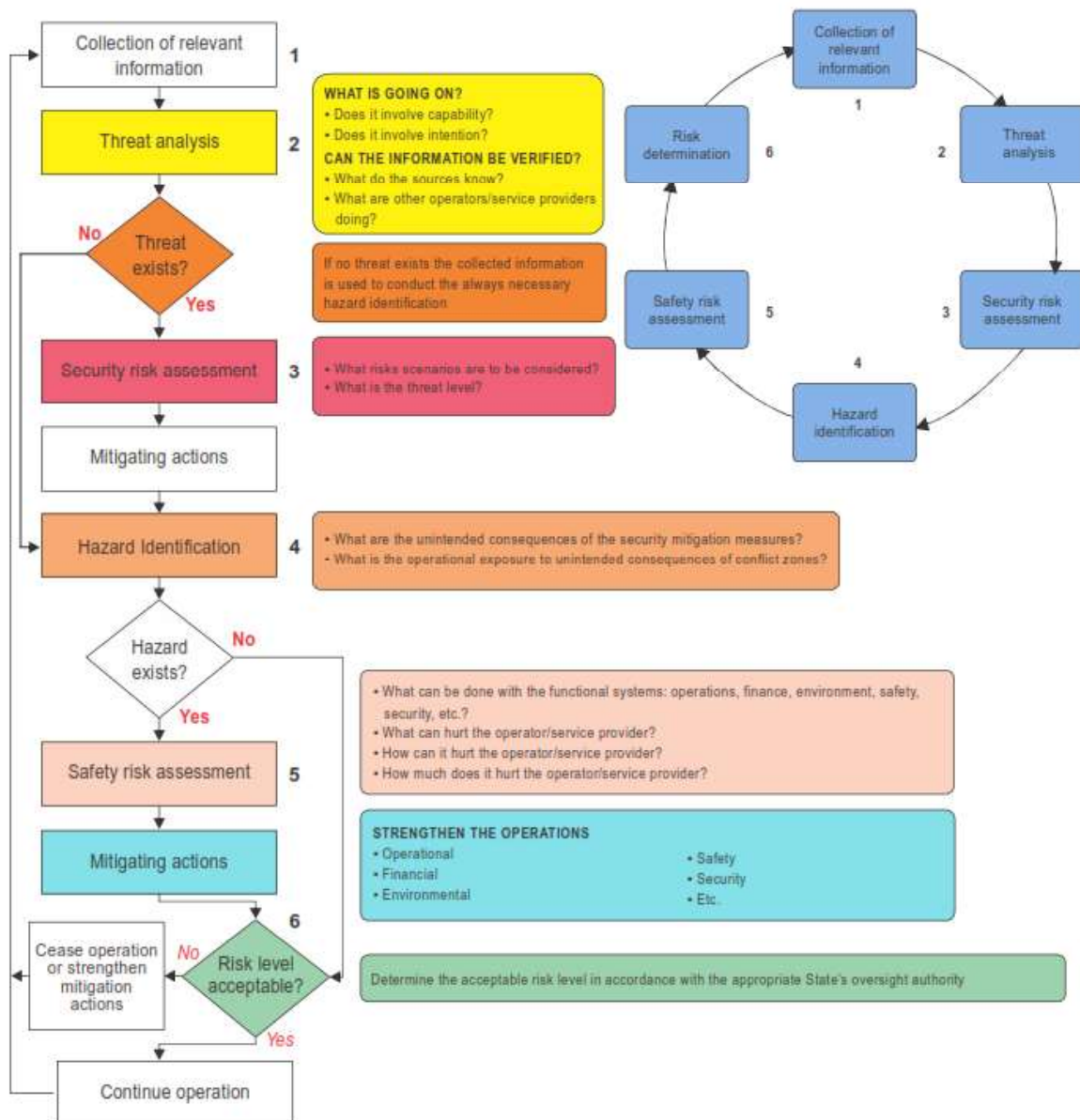


Figure 58- flow chart of the risk assessment cycle for operators and service provider

It is observed that the airlines and operators tend to consider the NOTAMs issued in the form of “conflict zones” bulletins as an information source to initiate the risk assessment process.

This is while such bulletins or notifications, like NOTAMs, normally contain prohibition and restriction made through a risk assessment process, obtained on the basis of some initial information.

That is, such notifications and bulletins are some information-bound mandates. Although their content can be utilized as information to initiate another process, the very initial information leading to the issuance of those notifications must be collected and analyzed by operators.

#### **5.6. Availability of Information for Risk Assessment**

The change in the military condition was public and widely reported in the media. At around 02:40 Jan. 08 2020, the official authorities of the U.S. and Iran had announced the strike against the Al Asad airbase in Iraq. Actually, the open source information about this issue was available to States and various airlines to conduct an assessment of the situation.

Apart from the tensions having existed in the Middle East for many years, the U.S. had declared a drone strike against one of the Iranian top commanders at Baghdad airport, following which Iran announced revenge would definitely be taken. As such, there had, certainly, been adequate information to pay more heed to the condition in the region and possible hazards at the time.

Iran ANSP had implemented changes in the way air traffic flow was managed, based on already planned measures for mitigating the risk to civil aviation from military alertness but the related NOTAMs had issued hours after the accident.

At first, due to limited traffic demand, the management of traffic flow was practicable with operational technics. By the increase in traffic volume, NOTAMs were issued to change the traffic flow scheme.

The investigation team investigated the reasons for time difference between the execution of measures and issuance of NOTAMs.

Operationally, all the planned measures were implemented promptly, but the ANSP assumed that based on definitions and criteria for issuance of NOTAM in ICAO Annex 15, NOTAM is an operational tool for people involved in air navigation, and the workload and predicted traffic was in such a way that the operational techniques were enough to manage the demand. As a result, it was assumed that issuance of NOTAM was not necessary for management of air traffic at that time.

The issuance of NOTAMs, in addition to the operational benefits associated with air navigation and air traffic flow management, can be used as a significant source of information about changing conditions in a flight zone to analyze the flight risk. Taking this into account, if there is a change in the way airspace is managed for military or security reasons at any time, NOTAMs will prove effective. In other words, apart from direct operational application of NOTAMs, they can be used as a source of information for assessment of risk for operations even outside of the scope of that NOTAM.

It should be noted that the planned limitations were implemented, and within the very limitations and considering the planned route, the initiation of Flight PS752 was assumed to be safe. The existence of NOTAMs would not impose any limitations on flight PS752, but it was possible that by receiving such NOTAMs, which did not affect the flight route, a process of risk assessment was initiated by departing airlines from IKA.

#### **5.7. Effective Implementation of Standards and Measures**

Various standards and measures have been envisaged and set by ICAO for safe management in PS752-like conditions.

Thanks to the investigation conducted into the MH17 accident, and following up on the implementation of its recommendations, greater attention has been paid to the development of necessary regulations and structures and their effective implementation.

On the other hand, the implementation of such new requirements in States and the establishment of national regulations for airlines to manage

flight risk in a situation, where potentially hazardous military activities are occurring, have been inconsistently conducted.

It can be understood that the effective implementation of safety oversight elements in States regarding the requirements developed by ICAO for years are applied by them in a tangible and daily manner, yet still needs to be improved (Figure 59).

**EI by Audit Area**

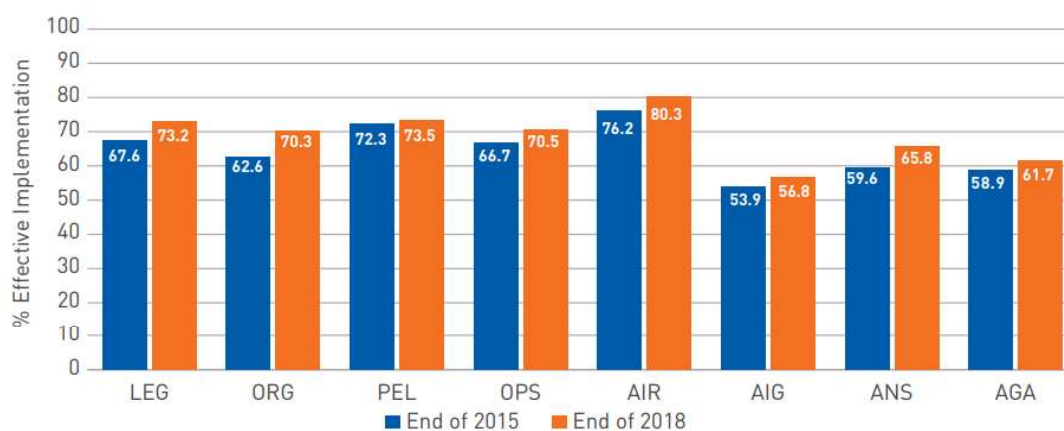


Figure 59- Effective implementation of the safety oversight elements in the world in various areas - ICAO Safety Report

As a result, given their newness, the status of implementation of measures in the field of aviation activity in areas where potentially hazardous military activities are underway cannot be better than that of traditional aviation standards, hence monitoring their effective implementation in States and assisting them to do so as for these patterns is essential.

Since conditions vary from one area to another, it is necessary to have a regional approach to assist and monitor the implementation of such measures, taking into account the conditions and priorities of each region.

## 5.8. Similar Accidents

### 5.8.1. Transparency and Speed in the Announcement of Events

Transparency and acknowledgment of events leading to similar accidents have always been an important challenge.

As far as civil aviation safety is concerned, reporting errors and their associated details are always encouraged. There are a variety of tools to do so, which in turn will promote safety. In accidents, where an aircraft has been targeted by weapons, some of the factors involved in its occurrence fall outside the context of civil aviation and the procedures governing it, so the implementation of common measures in civil aviation to encourage reporting without apportioning blame is seriously challenged.

Further, to discover and prove the reality, a vast number of resources are wasted simply due to secrecy, confidentiality or denial of the event, not to mention the harm caused to the precious data and time to enhance safety.

A review on the previous similar accidents indicate that operating military or para-military forces did not admit their role in the accidents openly, putting the blame on other parties and trying to downplay their own role in such occurrences.

In the meantime, PS752 was one of the accident cases where the operating military forces publicly announced their role in it within a short time period. Providing the accident investigation team with access to the details allowed them to focus on the underlying factors besides the corrective and preventive measures instead of wasting resources to discover the reality behind the event.

#### 5.8.2. The Proportion of Military Threats in Civil Aviation Safety

Figure 60 indicates the results of a review on the number of fatalities in air accidents of aircraft above 5700 kg from 2008 to September 2020, in terms of three important safety factors, including Runway Safety, Controlled Flight into Terrain and Loss of Control, Other Factors, and Hazardous Military Activities for Civil Aviation. The data of this graph is obtained from ICAO<sup>15</sup> reports while fatalities of MH17 and PS752 accidents are added as a new risk factor.

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<sup>15</sup> - <https://www.icao.int/safety/iStars/Pages/Accident-Statistics.aspx>



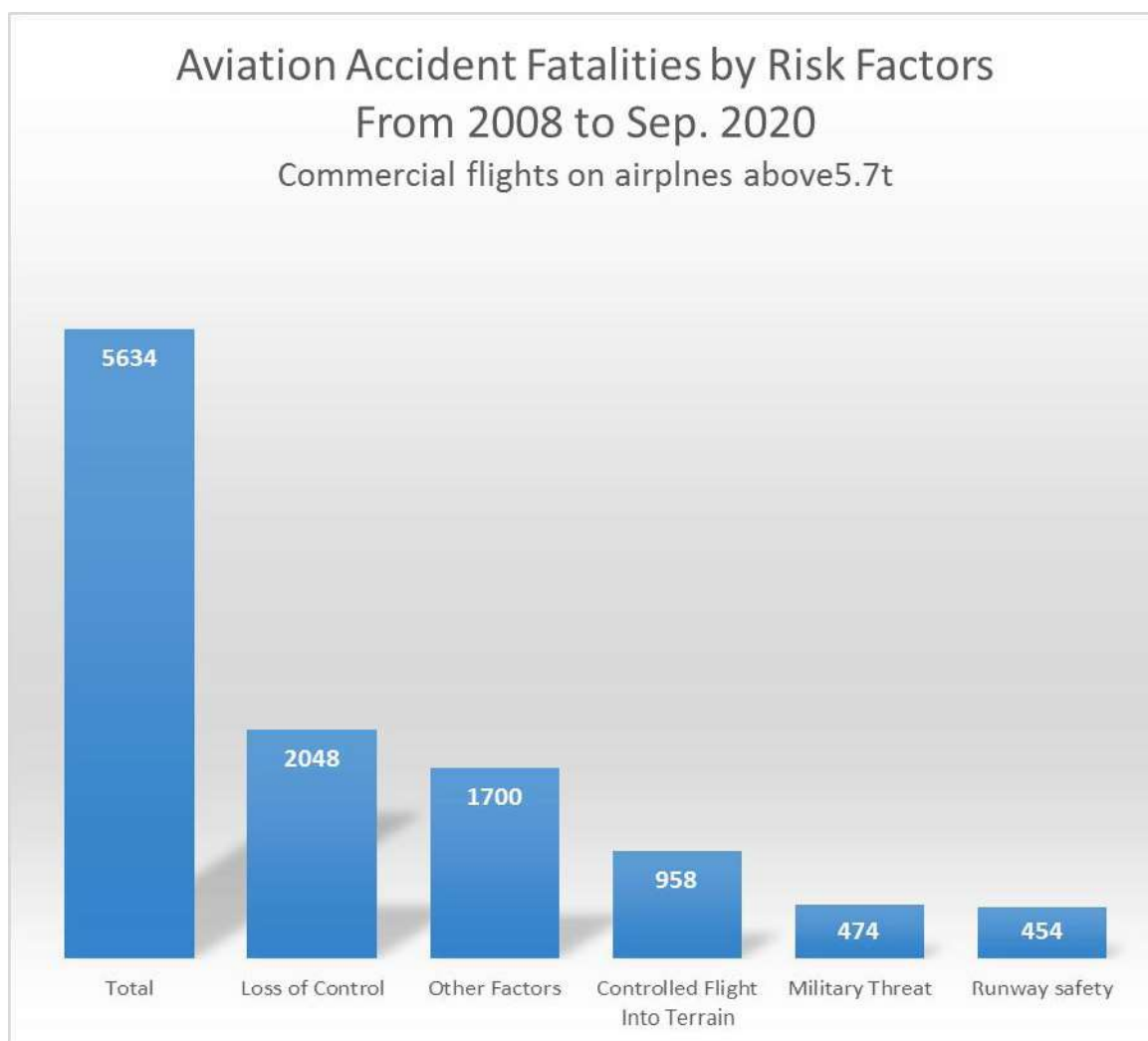


Figure 60- Aviation Accident Fatalities by Risk Factors

Despite being considered a very rare occurrence, targeting a civil aircraft by weapons has claimed more lives than the events resulting from runway safety on commercial flights with aircraft above 5,700 kg since 2008. Of course, the nature of military threats is completely different from other types of threats, and in terms of safety analysis, their probability are lower but have a higher severity of consequences.

A key challenge for mitigating such a risk factor would entail access to data, reconsidering the strategies and procedures at international, regional and national levels.

The fact is following the aircraft crashes of 1983 in Korean airlines, 1988 Iran Air, 2014 MH17 in Ukraine, the global approach to this hazard has undergone fundamental changes. Such crashes have, in effect, paved the

way for a reconsideration of the issue at hand and the development of mechanisms leading to improvement.

Proven safety lessons show that for any fatal accident, there are a significant number of near-miss cases. Such cases are always an effective tool to seize the opportunity to correct and improve performance before an unfortunate event occurs. Nevertheless, in the case of hazardous military activities for civil aviation, only the statistics revealed following a fatal accident are citable and analyzable. Misidentification, wrong unnecessary interception, increased alertness due to an authorized civil aviation operation and failed firings are among the cases that have not been probed and analyzed just because they passed off well. This is while these are the very events and untapped conditions which will provide the ground for unfortunate and deadly occurrences. In other words, the mentioned crashes are only the visible part of an iceberg whose bigger portion is hidden. (Figure 61)

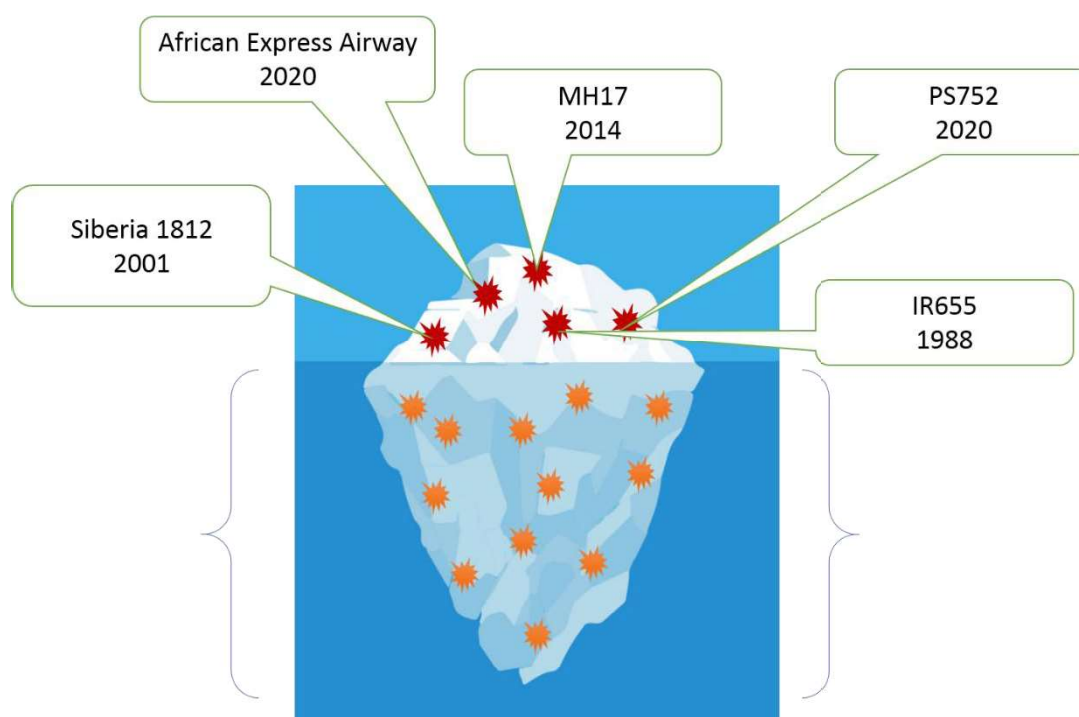


Figure 61- The announced air accidents; Iceberg Model and the abundance of near-miss events

Although in recent years, especially after the MH17 accident, much attention has been continuously paid to aviation safety against military

activities, it can be said that, in comparison with other safety factors, there is still no reporting and data-driven improvement, which causes significant revisions and improvements to be considered only after a fatal accident.

The Iceberg Model suggests that this hazard might occur quite often in different parts of the world, and that the investigated accidents are only signs of hidden conditions in the international air transport.

There is a significant correlation between such events and geographical areas and political conditions. Naturally, the type of hazards in these areas varies from one to another. In some areas, in line with their aim to pose security threats, militant groups' activities are more distinct, seeing commercial aircraft suitable targets for demonstrating their power and dominance therein. In others, however, the presence of criminal groups armed with dangerous weapons to commercial aircraft is more worrying. There are military threats between countries in some regions, and in other conditions, trans-regional military forces are present in third countries.

This altogether suggests that the assessment and evaluation of conditions must be continuous and contextual, geographical and time-dependent, and that only when the integrated mechanisms have different information sources can they produce different outcomes that prove effective for that area and situation. This requires the establishment of a statistical system and much more data than the announced accidents.

A significant proportion of this data is now provided by monitoring threat and tension levels. Since military systems are a large and important component of this set, it has to be determined that the available risk in their system, created by a wide assortment through organizations, hardware, software, manpower and environmental conditions have still remained in balance with the civil aviation operation level after analyzing the conditions and adopting the defensive layers pertinent to the very condition. It is possible to assess this balance in the military sector, which possesses its own performance information, analytically, but the part of the threat related to the performance of another military force cannot be properly analyzed. Nor does the civil sector have accurate information about the level of tolerable error in the military one.

## 6. Conclusions

### 6.1. Findings

1. At 06:12, on January 08, 2020, Flight PS752 operated by UIA, an airworthy Boeing 737 registered UR-PSR, along with qualified flight crew, took off from IKA runway and crashed at 06:18 near the airport.
2. The aircraft was misidentified as a hostile target by an air defense unit; two missiles were fired at PS752.
3. At 06:14:56, the warhead of first launched missile detonated in the proximity of the aircraft and, almost simultaneously, the aircraft transponders stopped transmitting radio signals, together with the termination of the FDR recording.
4. The missile detonation near the aircraft caused damage to the aircraft systems, after which the cascading damage was observable.
5. After the detonation of the first missile, the three cockpit crew members were all still alive. They appeared to have sustained no physical injuries and were just involved in managing the situation.
6. At 06:15:09, the second missile was launched towards the aircraft by the air defense unit. It is likely that this missile did not affect the aircraft, yet it is not possible to comment on this explosion and its impact with acceptable certainty.
7. The aircraft had maintained its structural integrity by the time it crashed into the ground and exploded at 06:18:23 in Khalajabad near Shahriar, the southwest of Tehran.
8. The automatic ELT had been activated, and due to the impact severity its signal-transmitting antenna to satellites was detached; the international satellites did not succeed in locating the crash site.
9. According to the ELT manufacturer the internal structures of survival ELTs are unable to withstand impacts, thereby their internal systems might have been damaged due to the impact severity.
10. Neither the aircraft technical and operational condition, nor its flight path and altitude contributed to the misidentification.
11. Within the airspace management, the information based risk assessment had been conducted, and various mitigations had been

- devised to provide civil aviation safety for the threats caused by potentially hazardous military activities.
12. In the risk management, only the stable conditions was considered, not the transient conditions.
  13. Civil-Military coordination was done according to the planned program and the considered mitigation measures for reduce the risk of misidentification and mistargeting of civil aircrafts was implemented in both civil and military sectors.
  14. The risk management was not effective due to occurrence of an error, which had not been previously predicted.
  15. The UIA and the State overseeing it had not imposed restrictions or prohibitions on the flight PS752.
  16. No airline with departure schedule from IKA in the day of accident imposed restriction on their flights on the basis of risk assessment of flight route safety.
  17. The process of information collection from open and public sources in airlines, which forms the basis of risk assessment in potentially hazardous military activities scope, has not yet tuned into a procedure, at least not for the times when changes occur so rapidly. Even though some airlines and States had imposed restrictions using open and public information, none of the airlines whose flights departed from IKA had made any change in their flights on the basis of a risk assessment.

## **6.2. Accident Causes and Contributing Factors**

### **6.2.1. Cause of the Accident**

The air defense's launching two surface-to-air missiles at the flight PS752, UR-PSR aircraft, the detonation of the first missile warhead in proximity of the aircraft caused damage to the aircraft systems, and the intensification of damage led the aircraft to crash into the ground and explode instantly.



### 6.2.2. Other Contributing Factors

- The mitigating measures and defense layers in risk management proved to be ineffective due to the occurrence of an unanticipated error in threat identifications, and ultimately failed to protect the flight safety against the threats caused by the alertness of defense forces.

## 7. Safety Actions Taken and Safety Recommendations

### 7.1. Safety Actions Taken

- The NOTAM procedure was revised by Iran Airports & Air Navigation Company (ANSP) to promptly issue NOTAM about any change in Tehran FIR airspace management that results from the outcome of a conducted security risk assessment or military instructions.
- In order to provide even further access for the users outside of the aviation communication networks, the "Airspace Safety and Security Warning" section was created on the Iran Aeronautical information Management (AIM) website as a repository to announce security NOTAMs regarding airspace. This website has been launched since December 03, 2020, which was notified to users via AIC 2-20 and ICAO in a separate letter.
- The concept of transient risks was added to the risk assessment procedures of Civil and Military organizations responsible for safety and security of Tehran FIR.

In the amended procedures, an additional risk called "adaption risk" has been added to available risks for each change in level of threats to civil aviation. The specification of the nature and duration of related safety measures shall be defined during each risk assessment task. For each change in existing situation, an adaption period has been considered, where "adaption risk" and related safety layers shall be applicable during that period.

- CAO.IRI ATM/ANS safety oversight manual was amended to include oversight activities of the risk management of potentially hazardous military activities. The ANSP is mandated to perform periodic airspace security management exercise.
- Iran Military authorities informed AAIB that based on their investigation results, adequate corrective actions have been implemented for prevention of events which caused misidentification of flight PS752.

## 7.2. Safety Recommendations

### 7.2.1. To the States Managing the Airspace:

- Promptly issue NOTAMs regarding any limitation or any change on the provision of services followed by the change in civil-military coordination status in short term, even if the issuance of such NOTAMs appear to have no effect neither the airlines flight operations nor the services provided by the State managing the airspace operationally.
- Since during transition from a level of military alertness to a higher one, the risk of whole system is affected by the nature of transition apart from the new conditions, in risk assessment of potentially hazardous military activities to civil aircrafts, in case the types of changes in military alertness conditions or its associated reason has not been frequently experienced before, consider the risk of the misidentification or mistargeting at times closer to transition more cautiously than stable conditions.
- Conduct oversight on effective implementation of the measures adopted for the risk management of potentially hazardous military activities and perform periodic exercises for risk assessment based on different types of probable conditions; apply the results obtained from the monitoring and exercises to identify the hidden threats and enhance the risk management accordingly.

### 7.2.2. To the States Overseeing the Airlines:

- Conduct oversight on effective implementation of the measures adopted for the risk management of potentially hazardous military activities and perform periodic exercises for risk assessment based on different types of probable conditions; apply the results obtained from the monitoring and exercises to identify the hidden threats and enhance the risk management accordingly.

- Ensure that the airlines are able to quickly apply the open and public information issued by non-aviation sources in their processes of risk assessment.

### 7.2.3. To ICAO:

- Revise the Standards related to the issuance of NOTAMs in such a way that air navigation service providers promptly issue the NOTAMs in case of any change or restriction imposed in the provision of services due to potentially hazardous military activities or civil-military cooperation considerations independently of the operational application, in a format that these NOTAMs could indicate that the change has been made due to security or military considerations.
- Develop a framework necessary for gathering information on the near-miss accidents and events caused by targeting a civil aircraft, including the provision of definitions and examples, the method of information collection, reporting and sharing. Such database should allow for the revision of relevant standards and guidelines, as appropriate, based on information submitted by States at national, regional and international levels.
- Considering that the initiatives and measures established to minimize the risks caused by potentially hazardous military activities are newer compared to other traditional safety measures, develop and/or amend related Universal Safety Oversight Audit Programme (USOAP) and Universal Security Audit Programme (USAP) protocol questions as necessary, and prioritize the assessment of those States that should have implemented such measures due to potentially hazardous military activities in their airspace.
- Support and encourage States to improve the efficiency of risk assessment of civil aircraft operations over or near conflict zones, and civil-military coordination with due consideration of the regional priorities and models.
- Given that more clarity of the regulations relating to switching on the CVR, in such a way that it ensures the recording of the

cockpit voices during checks, technical and operational conversations, and decision making, would be beneficial for safety and safety studies related to cockpit conversations., ICAO should revise and clarify the provisions in Annex 6 — Operation of Aircraft and associated guidance material related to switching on the Cockpit voice recorder (CVR).

- Given that information gathering is a key step to conduct flight risk assessment in potentially hazardous military conditions, review and enhance the available guidance material, such as the Risk Assessment Manual for Civil Aircraft Operations Over or Near Conflict Zones, Doc 10084, to provide further assistance to States and aircraft operators on the nature and method of gathering initial information, including its difference with NOTAMs issued. .
- Study the effects of stable and transient conditions in risk assessment, determine the threat level specifications in transient conditions and update the provisions and associated guidance material addressing civil aircraft operating over or near conflict zones accordingly.
- The prevention of accidents would only be achieved through identification of the root causes, issuance of safety recommendations and implementation of the necessary corrective measures. It was challenging to investigate the actions and their root causes within the military sector; thus, the investigation team requested the investigation of the events leading to the missile launch and the corrective actions planned to prevent recurrences. The relevant military sector provided the information required accordingly. This convinced the investigation team of the importance of establishing well-advanced agreements on investigation cooperation with the military authorities.

Recognizing the need for timely cooperation during investigations of occurrences involving the military, ICAO should develop or expand guidance material (e.g. MOU) addressing cooperation and coordination between States' accident investigation authorities and the military authorities.



#### 7.2.4. To the EUROCAE:

- The EUROCAE ED-62B Minimum Operational Performance Specification for Aircraft Emergency Locator Transmitters provide specifications for the design and manufacture of emergency locating transmitters. The problem with the antenna hardware connections failing between the ELT unit and the ELT antenna is known to the aviation industry. To improve this situation, the ED-62B specification need to be assessed and revised.

It is recommended that EUROCAE revisit the EUROCAE ED-62B Minimum Operational Performance Specification for Aircraft Emergency Locator Transmitters to assess if the specification adequately addresses the design of the hardware connecting the automatic ELT unit to the ELT antenna.

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Appendix B- Consultation





## **CVR and FDR data extraction and preliminary analysis**

The data of flight recorders of UR-PSR aircraft was extracted in BEA laboratory and preliminary analysis was done by facilities and experts of BEA under supervision of Investigator In Charge (IIC).

The IIC requested BEA to prepare a report on CVR and FDR data extraction and preliminary analysis for public release.

This technical report is provided in Appendix A to PS752 Accident Investigation Final Report.

# Technical document

**CVR and FDR data extraction and preliminary analysis**

**Public release**

Accident on **8th January 2020**  
near **Teheran (Islamic Republic of Iran)**  
to the **BOEING - 737 - 800**  
registered **UR-PSR**  
operated by **Ukraine International Airlines**

# Foreword

*This document and the photographs and technical information contained herein are subject to the laws relating to communication and confidentiality embodied in European Regulation 996 of 20 October 2010.*

*The conclusions of this document are based on the work undertaken by the BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile). They should not be used to prejudge the final conclusions of the safety investigation.*

*Note: Following the request of the Investigator In Charge, this document is released to the public. The information of traceability (fingerprint of the files for instance) was removed from this version to ease the reading. A version including the information of traceability was delivered to all the members of the investigation team at the end of the readout process.*

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# ***Glossary***



<b>CSMU</b>	Crash Survivable Memory Unit
<b>CVR</b>	Cockpit Voice Recorder
<b>FDR</b>	Flight Data Recorder
<b>RTV</b>	Room Temperature Vulcanizing

## 1 - EQUIPEMENT EXAMINED

The aircraft UR-PSR was equipped with a FDR and a CVR. The IIC from the AAIB Iran brought both recorders to the BEA facilities on 20<sup>th</sup> July 2020.



This document describes the readout of the two recorders identified here after.

	CVR	FDR
		
<b>Manufacturer</b>	Honeywell	Honeywell
<b>Part number</b>	980-6032-003	980-4750-003
<b>Serial number</b>	CVR 04699	04893

## 2 - WORK PERFORMED

### 2.1. CVR

#### 2.1.1. Opening

The CVR was visually inspected. The CSMU was not connected to the chassis. The CSMU showed some traces of impact but no evidence of fire. The ULB beacon was still attached to the CSMU. The flex cable was found torn off.





Figure 1: CSMU and flex cable

The screws attaching the beacon to the CSMU were removed.



Figure 2: Beacon separated from the CSMU

The CSMU was opened by removing the screws and hold down latches to extract the memory board.



Figure 3: Extraction of the memory board from the protected module

The memory board is protected by a RTV silicon. This protection was removed to allow visual inspection of the board. The damaged flex cable was removed from the memory board.



Figure 4: CVR memory board

The memory board was visually inspected under magnification. It was in good condition. The temperature indicator color showed that the memory board was not exposed to heat.

### 2.1.2. Electrical checks

The memory board was connected to the Honeywell HFR5 BEA adapter and electrical checks were performed. The values were consistent with the expected ones.

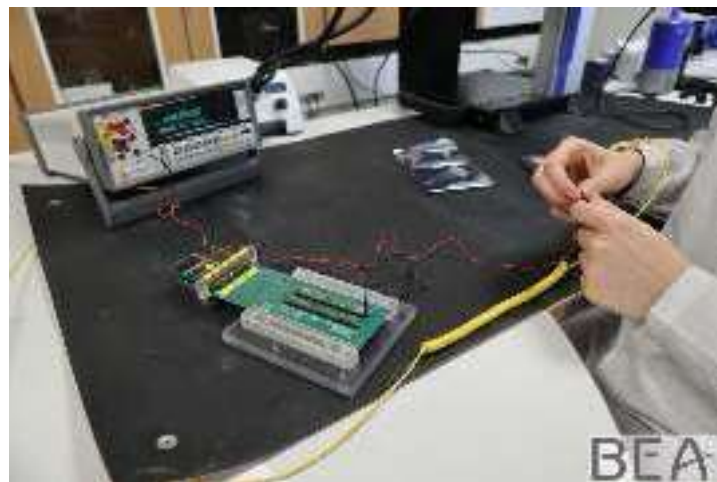


Figure 5: CVR electrical checks

### 2.1.3. Data extraction

The memory board was connected to the BEA Honeywell HFR5-V chassis (P/N 980-6032-001). The data was downloaded twice. The first download was done with the manufacturer software DLDR and the second with the manufacturer software Playback-32.

The raw files recovered with DLDR were reconstructed into one file with CHIPS software. The output file from Playback-32 was already a reconstructed raw file (DLU).



Figure 6: readout of the memory board on BEA HFR5-V chassis

In both cases, the raw file was decompressed using the official manufacturer software Playback-32.

The DLU files are:

- **Playback-32 file:** HFR5CVR-07202020140128\_playback32\_download.dlu
- **CHIPS file (from DLDR chips images):** reconstruction.dlu

The decompression generated 4 audio .wav files:

- Narrow band (8 kHz):
  - hfr5cvr-07202020140128\_playback32\_download-1P.wav containing public address microphone recording, with a duration of 2 h 10 min 34 s
  - hfr5cvr-07202020140128\_playback32\_download-2P.wav containing first officer microphone recording, with a duration of 2 h 10 min 34 s
  - hfr5cvr-07202020140128\_playback32\_download-3P.wav containing captain microphone recording, with a duration of 2 h 10 min 34 s
- Wide band (16 kHz):
  - hfr5cvr-07202020140128\_playback32\_download-4P.wav containing Cockpit Ambiance Microphone recording, with a duration of 3 h 12 min 2 s

*Issue encountered:* Wide band from DLDR download is not usable. Some audio blocks are not at the correct place.

## 2.2. FDR

### 2.2.1. Opening

The FDR was visually inspected. The CSMU was still attached to the chassis. The flex cable was partially linked to the chassis. There were traces of fire and soot. The chassis was bent.



*Figure 7: FDR chassis and CSMU*

The screws attaching the beacon to the CSMU were removed.



*Figure 8: beacon separated from the FDR CSMU*

The screws of the flex cable cover were removed. The CSMU connector was disconnected from the chassis interface. The screws attaching the CSMU to the chassis were removed, two out of 4 were found loose. The CSMU was separated from the chassis.





Figure 9: Separation of the FDR CSMU from the chassis

The CSMU was opened by removing the screws and hold down latches to extract the memory board. One side of the flex cable was found torn off.



Figure 10: Extraction of the memory board from the protected module

The memory board is protected by a RTV silicon. This protection was removed to allow visual inspection of the board. The flex cable was removed from the memory board.



Figure 11: FDR memory board

The memory board was visually inspected under magnification. It was in good condition. The temperature indicator color showed that the memory board was not exposed to heat.

### 2.2.2. Electrical checks

The memory board was connected to the Honeywell HFR5 BEA adapter and electrical checks were performed. The values were consistent with the expected ones.

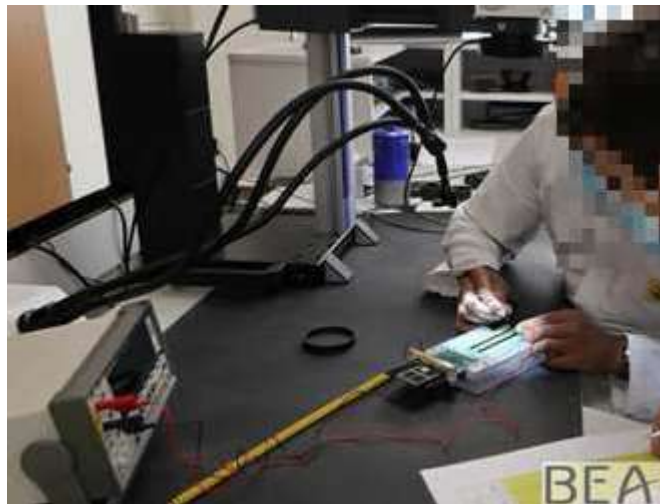


Figure 12: FDR electrical checks

### 2.2.3. Data extraction

The memory board was connected to the BEA Honeywell HFR5-D chassis (P/N 980-4750-009).

The data was downloaded three times. The first download was done with the manufacturer software Playback-32 (with an issue), the second with the manufacturer software DLDR and the third one with Playback-32 (with no issue).

The raw files recovered with DLDR were reconstructed into one file with CHIPS software. The output file from Playback-32 was already a reconstructed raw file (DLU).



Figure 13: readout of the memory board on BEA HFR5-D chassis

The DLU files are:

- **Playback-32 first download:** UR-PSR\_FDR\_HFR5FDR-07202020180423.dlu
- **DLDR file reconstructed with CHIPS:** reconstruction.dlu
- **Playback-32 second download:** UR-PSR\_FDR\_HFR5FDR-07202020185258.dlu



## 3 - RESULTS

### 3.1. CVR analysis

The flight accident was recorded on the audio data. A preliminary transcription was generated and is provided in a document named BEA2020-0170\_Preliminary\_Transcript\_and\_WandCO-V1.0.3.pdf.

#### 3.1.1. Listening sessions

Listening of the four audio files was carried out using an audio editing software.

- Overall quality of recording was good
- The four audio files were listened using an audio editing software.
- Only Captain speeches were present on narrow band, the other two crew members obviously not using their hotmikes.
- The good quality of CAM Channel recording allowed a good understanding of their speeches.
- The four tracks end at UTC time 02h45mn15.509s
- The flight recording began at 02h26mn18.949s UTC
- A strong and short impulse, similar to a detonation is recorded at 02h44mn55.865s UTC
- Immediately after a C-Chord alarm relative to Altitude Alert is present on the recording until the end of the CVR at 02h45mn15.509s UTC
- A drop of frequencies possibly linked to the electrical power supply began 2.445s before the end of CVR recording, these frequencies will be further analyzed

#### 3.1.2. Filtering

The Cam channel was filtered for the duration of the flight of the event (limitation of the background noise).

### 3.2. FDR analysis

The Arinc 717 FDR uncompressed file was synchronised with the BEA FDR analysis software (Lea 6.0.0). The file contained a total of approx. 54 hours (193,242 seconds) of synchronized data (RBS, Teledyne) in 54 areas, recorded at 512 wps.

The raw data were decoded using the aircraft manufacturer's dataframe referenced 737-7 in the document *D226A101-2H.pdf*. A set of plots of validated parameters is available in the Appendix.

The accident flight was the last flight on the recording.

#### 3.2.1. Synchronisation and UTC time

The UTC time was obtained from the decoding of the following FDR parameters:

- Time UTC Hours
- Time UTC Minutes
- Time UTC Seconds

The FDR parameters were synchronized with the CVR audio using the VHF keying and the noise at lift off.

#### 3.2.2. Last recorded second

When the recording is not stopped through the normal aircraft power off sequence, which is the case during an accident, it is not uncommon to have an incomplete subframe at the end of the recording.

The recordings inside the FDR is made by frames of four seconds, that is four subframes of one second each. In order to synchronize the data that are recorded in the flow, each subframe starts with a synchronization word. Those synchronization words are predefined for all recorders.

The analysis software by default does not consider the last incomplete subframe as there could be invalid values recorded, due to abrupt end of recording.

The investigation team requested to look at the last incomplete subframe to identify potential variations of parameters at the end of the flight.

There are 86 bytes of 0 values at the end of the raw FDR file (.dlu). The last incomplete subframe was identified plotting the SYNC WORD parameter recorded in the FDR.

The last complete subframe was the number 2, and the last incomplete subframe was the number 3 as the last SYNC WORD value was 2631 (in decimal) corresponding the A47 in hexadecimal, the synchronization word for subframe 3.

The readout of data was forced up to word 330 in the .dlu file with the BEA analysis software. In the plot below, the raw values of word 320 to 330, defined only on subframe 3, bits 1 to 12, are varying. However, the decoded value of the vertical acceleration, recorded on word 322 on all subframes is invalid. Also, the decoded value of the ELEVATOR L recorded on word 324 is invalid.

This meant that the bytes taken after word 321 are invalid as they do not correspond to physical values (even if there are not at 0). This conclusion was shared with the NTSB. NTSB agreed with this conclusion.

All values recorded in the FDR raw file after word 321 of subframe 3, which is the last subframe (incomplete due to end of recording) recorded, are invalid and should not be considered.

In this document, the FDR analysis stops at the word 321, dated at 02:44:56.125 UTC.

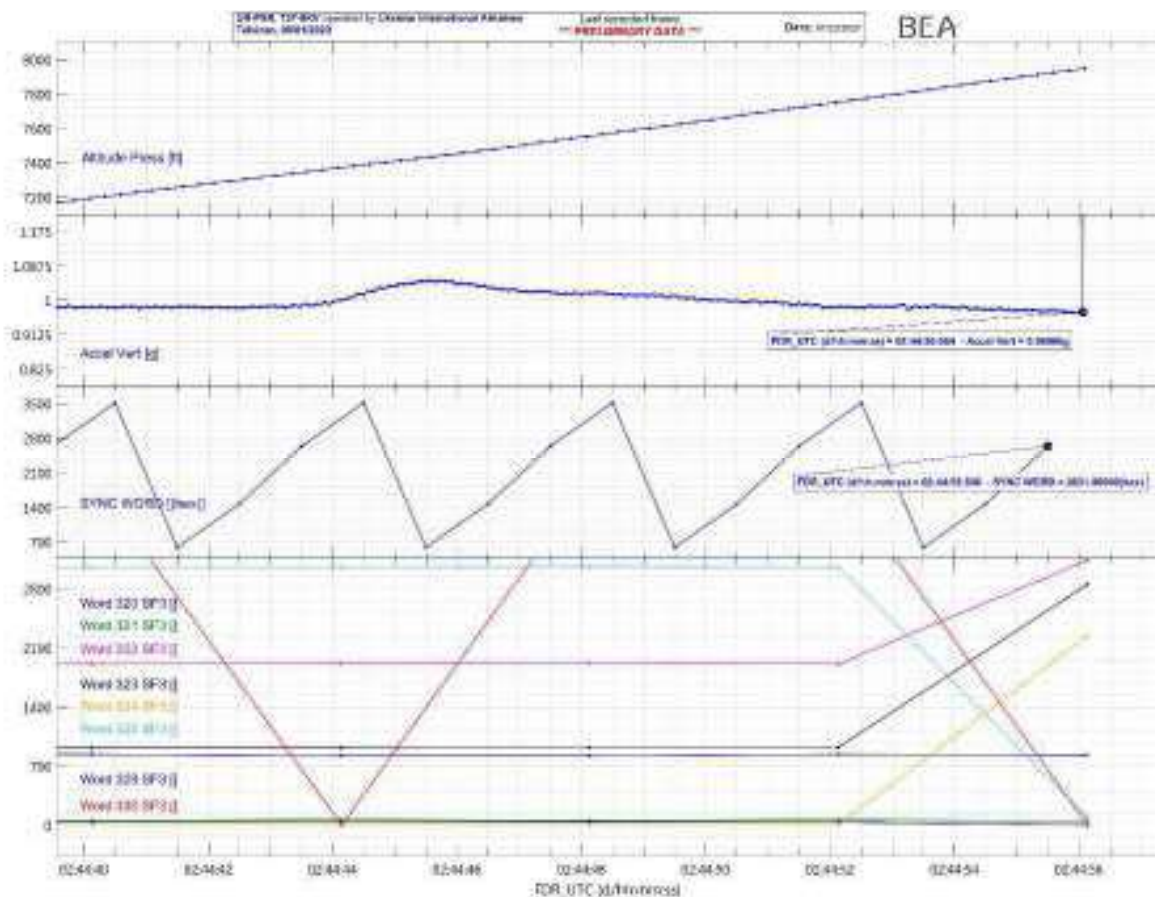


Figure 14: Plots of the last recorded words in the FDR file

### 3.3. History of the flight

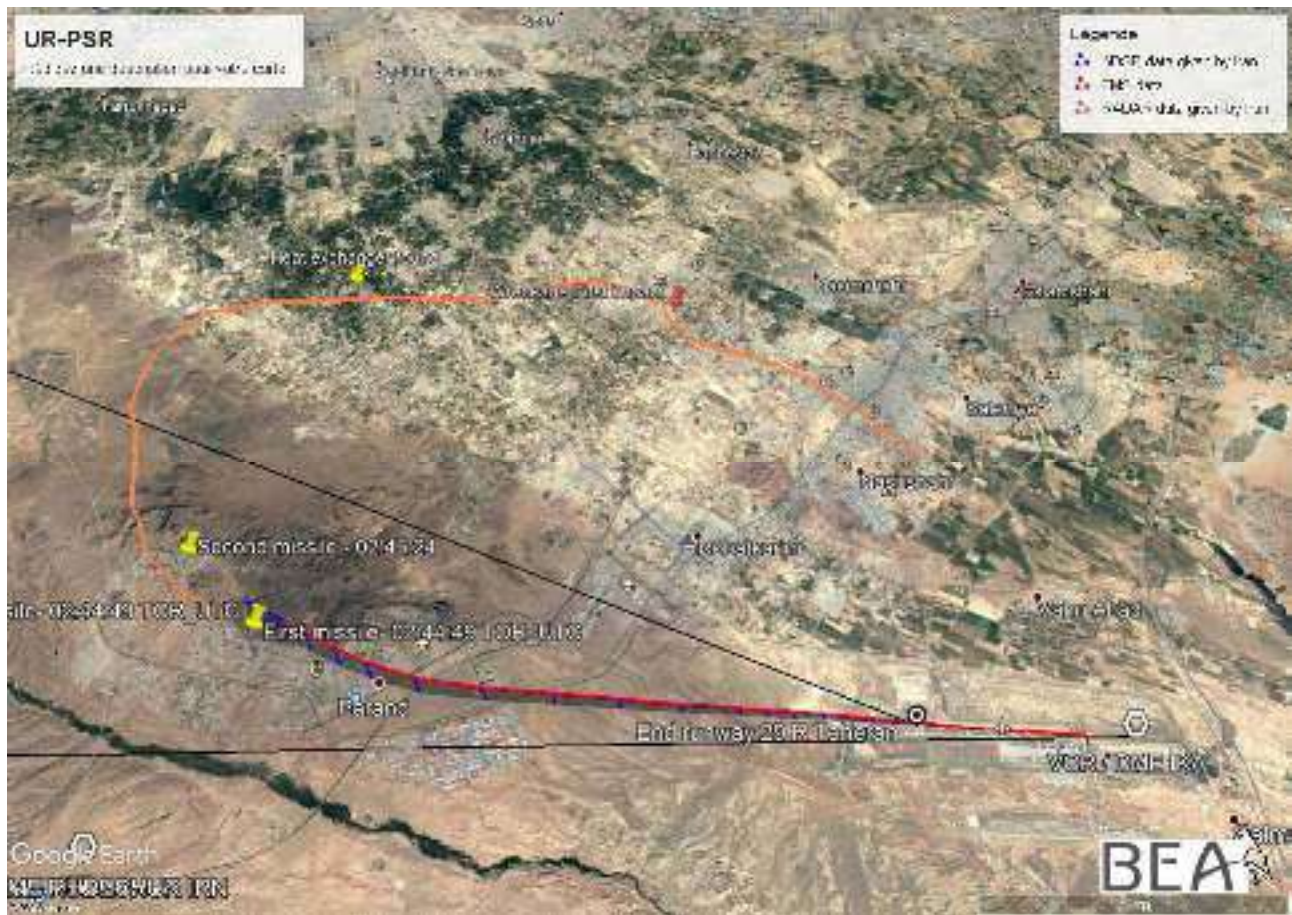
The history of the flight presented in **APPENDIX 2** was produced using mainly the FDR data. It was completed with relevant information extracted from CVR preliminary listening.

### 3.4. FDR plots

Several parameter plots were generated and are presented in **APPENDIX 3**.

### 3.5. 3D track

A Google Earth track file (in KML format) was produced using the FMS latitude and longitude recorded in the FDR (red curve), from take-off until the end of the FDR recording. The trajectory has been completed by Radar position (orange curve) and ADSB information (blue curve) provided by IIC.



# Appendices

## Appendix 1: Software versions

Name	Version
Windows 10	1903
GBE driver interface	998-3360-520
Playback32	1.3.0.0 998-3414-515
HFR5 utility	v512
Chips	998-3419-501
DLDR	22/03/2011 02:55

## Appendix 2: History of the flight

UTC Time	Baro Altitude (ft)	CAS (kt)	Computed Vz (fpm)	Guidance mode	Relevant parameter information	Engine information	Comments	Comments CVR
02:26:18								Start of accident flight in the CVR recording
02:26:55	3232	-	-	-	-	Left engine start	Start of accident flight in the FDR recording	
02:27:21	3232	-	-	-	-	End of push back from 116R		
02:41:34	3232	-	-	-	-	Alignment on runway 29R		
02:41:37		-	-	TOGA engaged	-	Both engines increased to 91% N1		
02:41:41								F/O announces 91,3% N1
02:41:49								F/O announces 80kt
02:42:09								F/O announces V1
02:42:13	3264	154	-	-	CAS reached V1=154 kt and Vr=154 kt	Both engines at 91,75% N1		
								F/O announces "rotate"
02:42:15	3264	157	-	-	CAS reached V2 = 157 kt	Both engines at 91,75% N1		
02:42:19	3264	171	192	-	Lift Off	-		
02:43:22								Capt announces "gear up"
02:43:24	3296	183	720	-	Landing gears retracted	-		

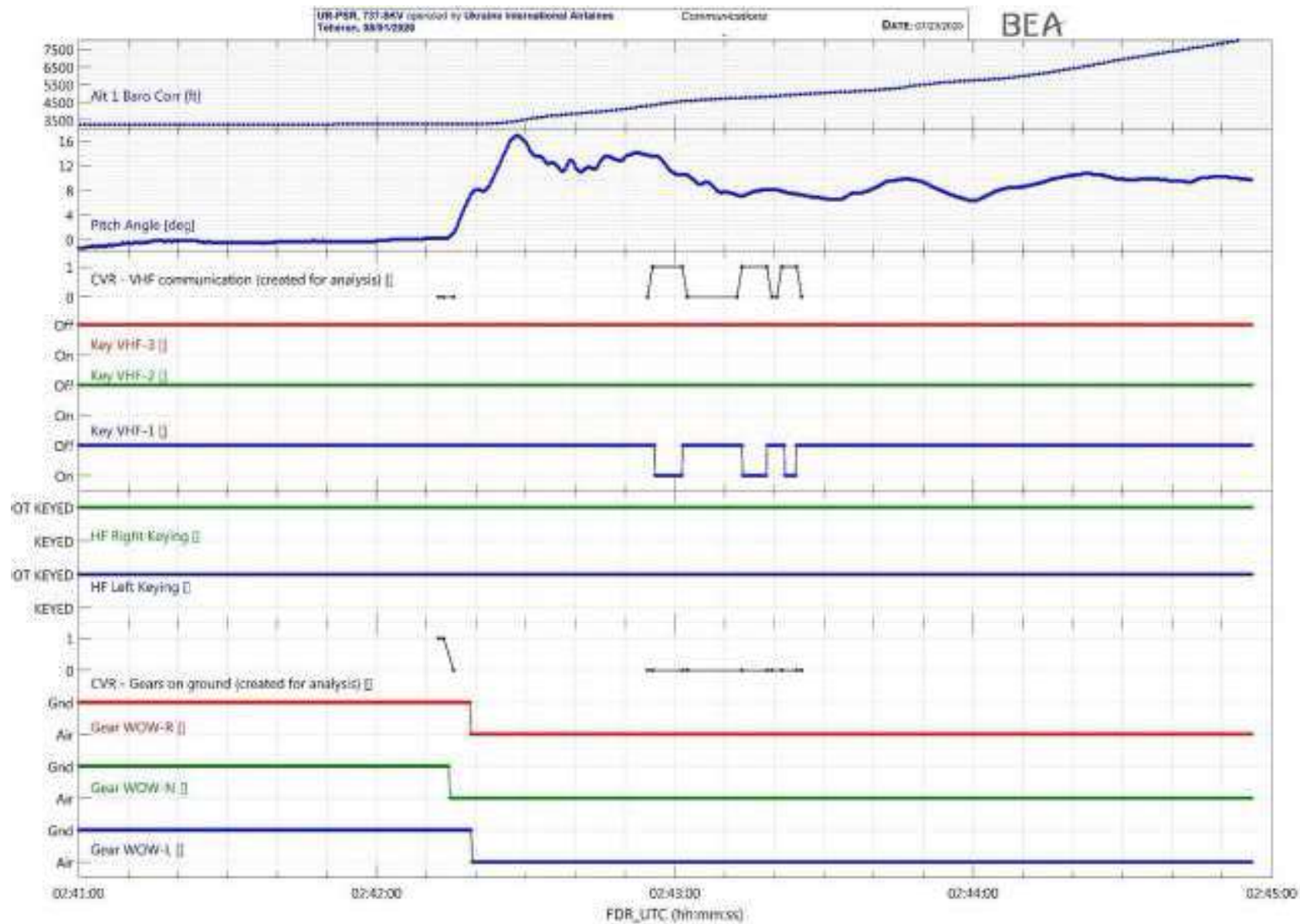


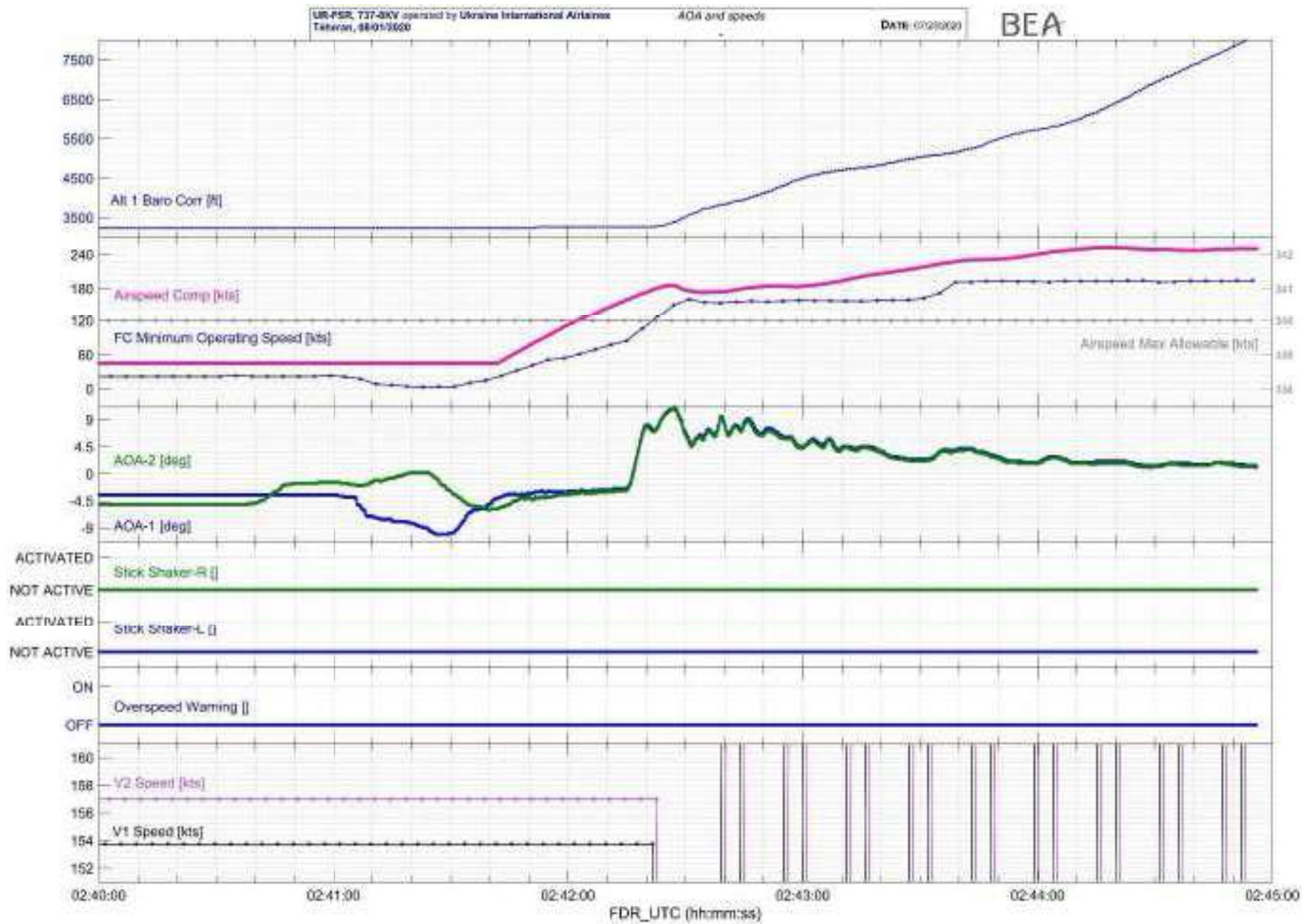
02:42:26	3340	186	1619	LNAV mode engaged at 60 ft radio altitude	-	-		
02:42:35	3744	173,5	1760	VNAV Speed mode engaged and TOGA disengaged	-	-		
02:42:51	4149	185	2216	AT N1 Mode engaged	-	-		
02:42:56 To 02:43:01	4352	184	2400	-	Communication from cockpit to ATC (VHF1)	-		
02:43:11	4736	195	720	AP ON and CMD A selected	-	-		
02:43:17 to 02:43:18	4736	199	640	-	Communication from cockpit to ATC (VHF1)	-		
02:43:22 to 02:43:24	4896	208	1200		Communication from cockpit to ATC (VHF1)	-		
02:44:01	6560	251	928	-	Vertical speed increases from 928 up to 3200	-		
02:44:15	6144	251	2464	-	Heading change from 284° to 307° during 25 seconds	-		
02:44:55								Strong and short impulse, similar to the sound of a detonation, recorded on CAM track

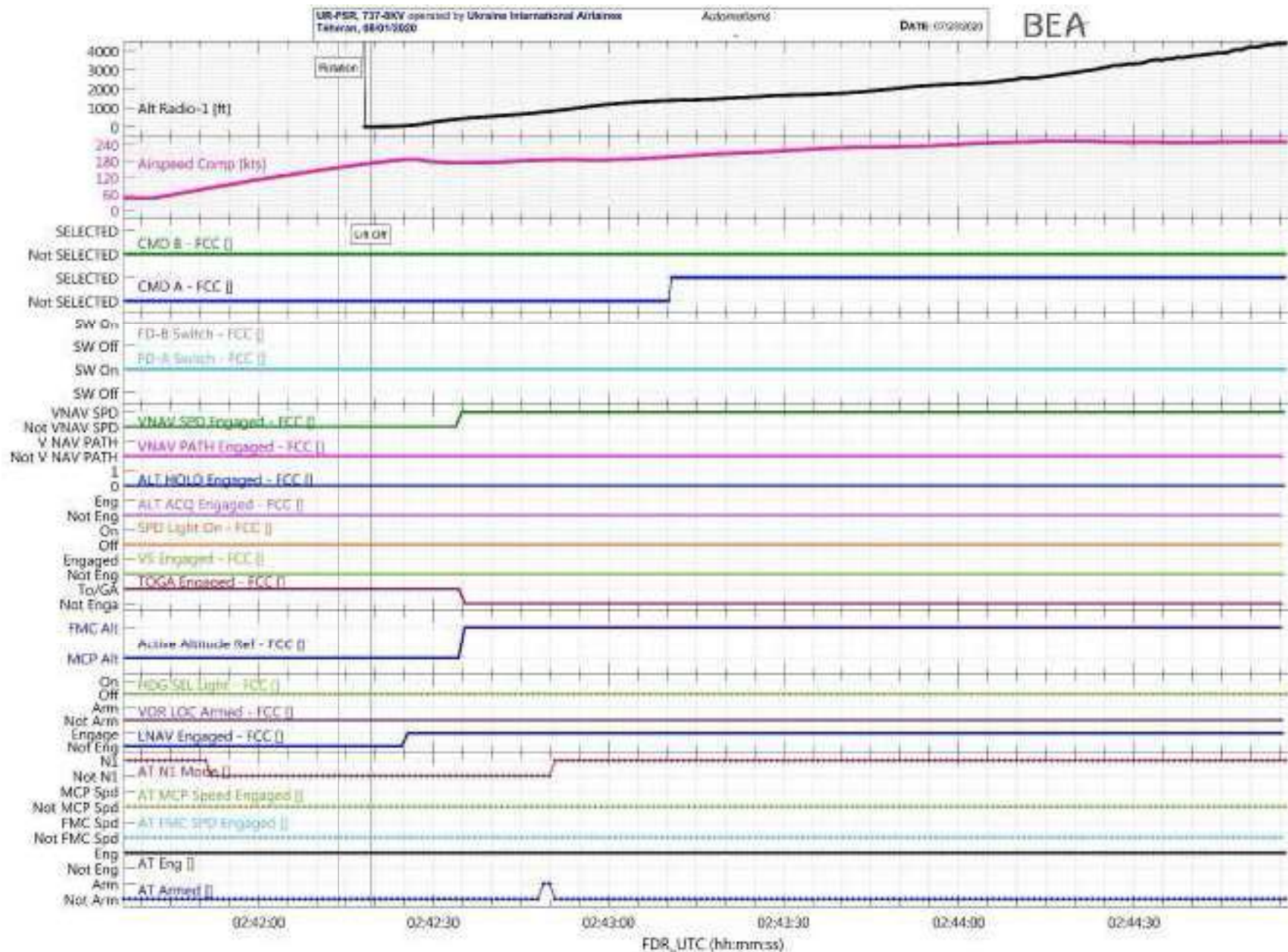


02:44:55								C-Chord alarm recorded until the end of the recording
02:44:56.125	Last recorded value : 8096	Last recorded value : 250	Last recorded value : 2928	-	End of the FDR recording. Last incomplete subframe taken up to word 321	-		
02:45:05								Instructor speech: "Start A P U"
02:45:06								Switch sound
02:45:13								Instructor speech: "Engines are running"
02:45:15								End of CVR recording

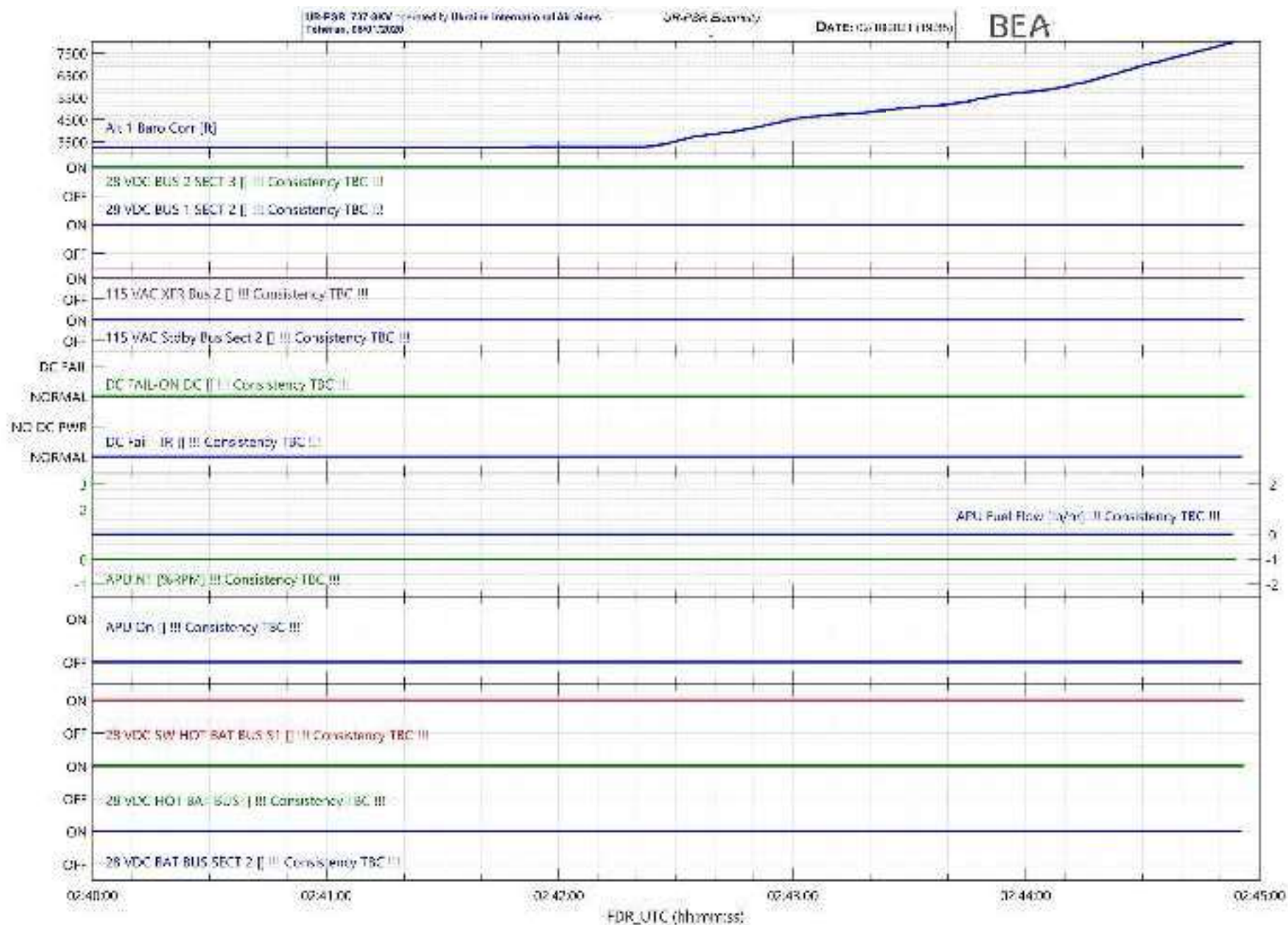
### Appendix 3: Plots

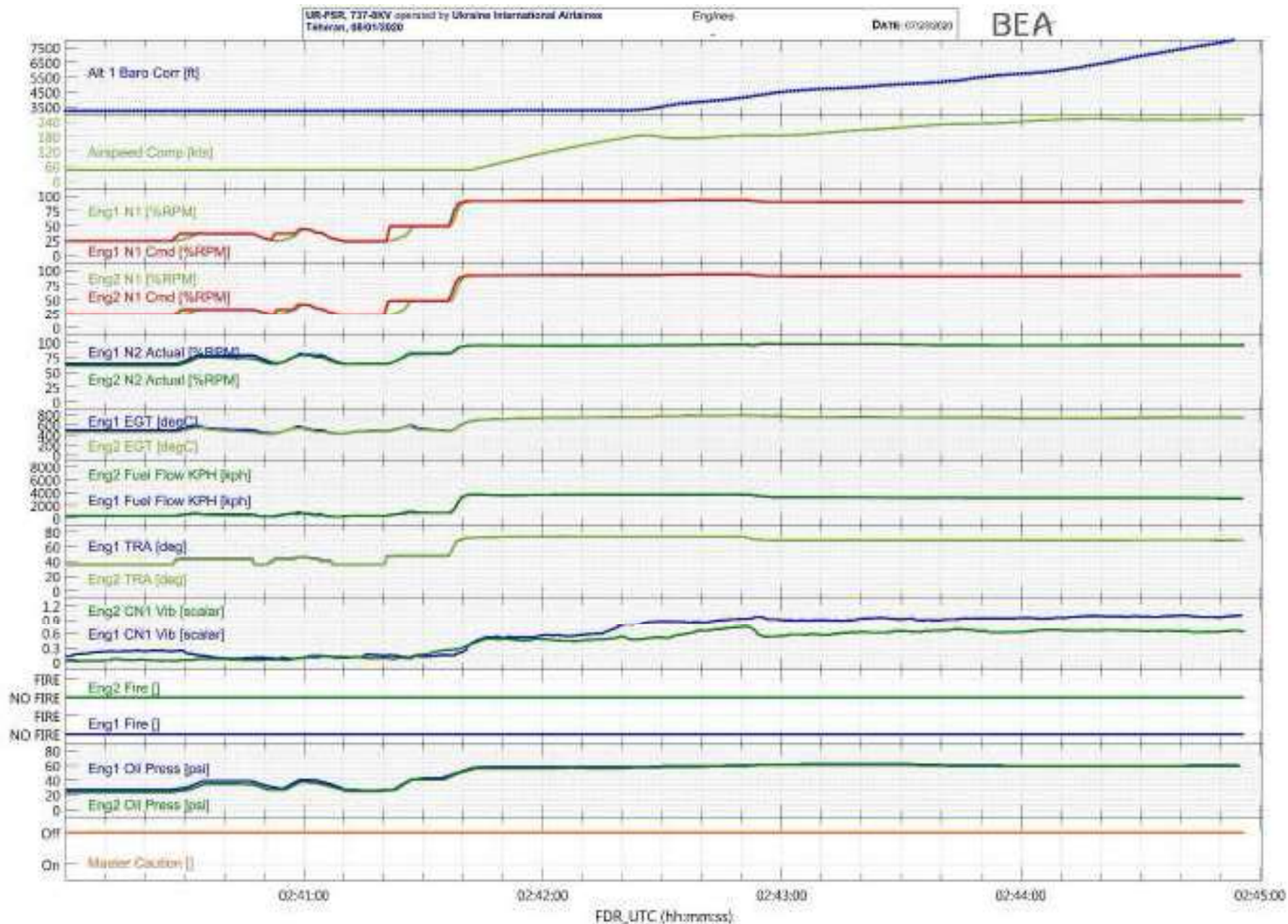




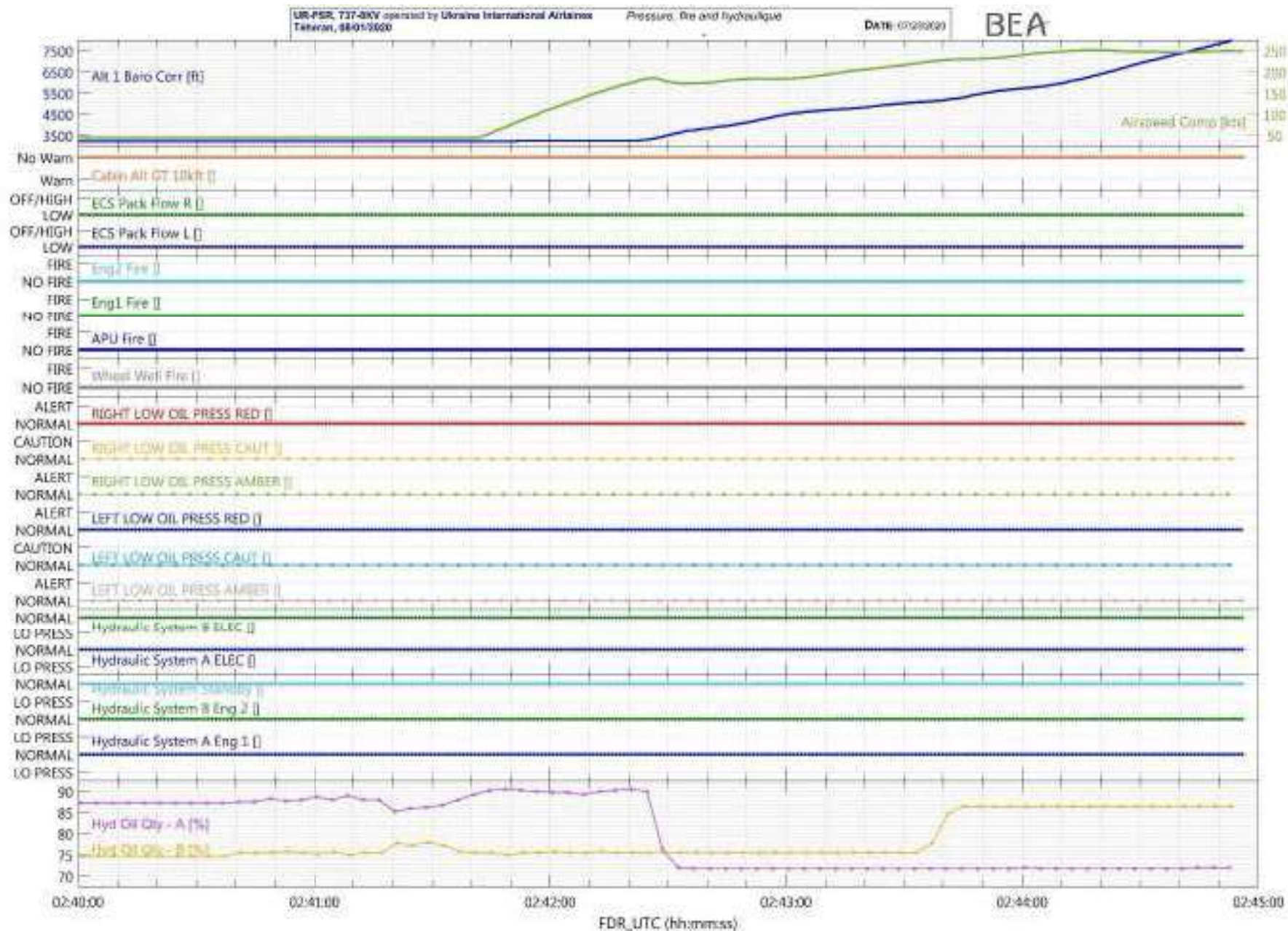


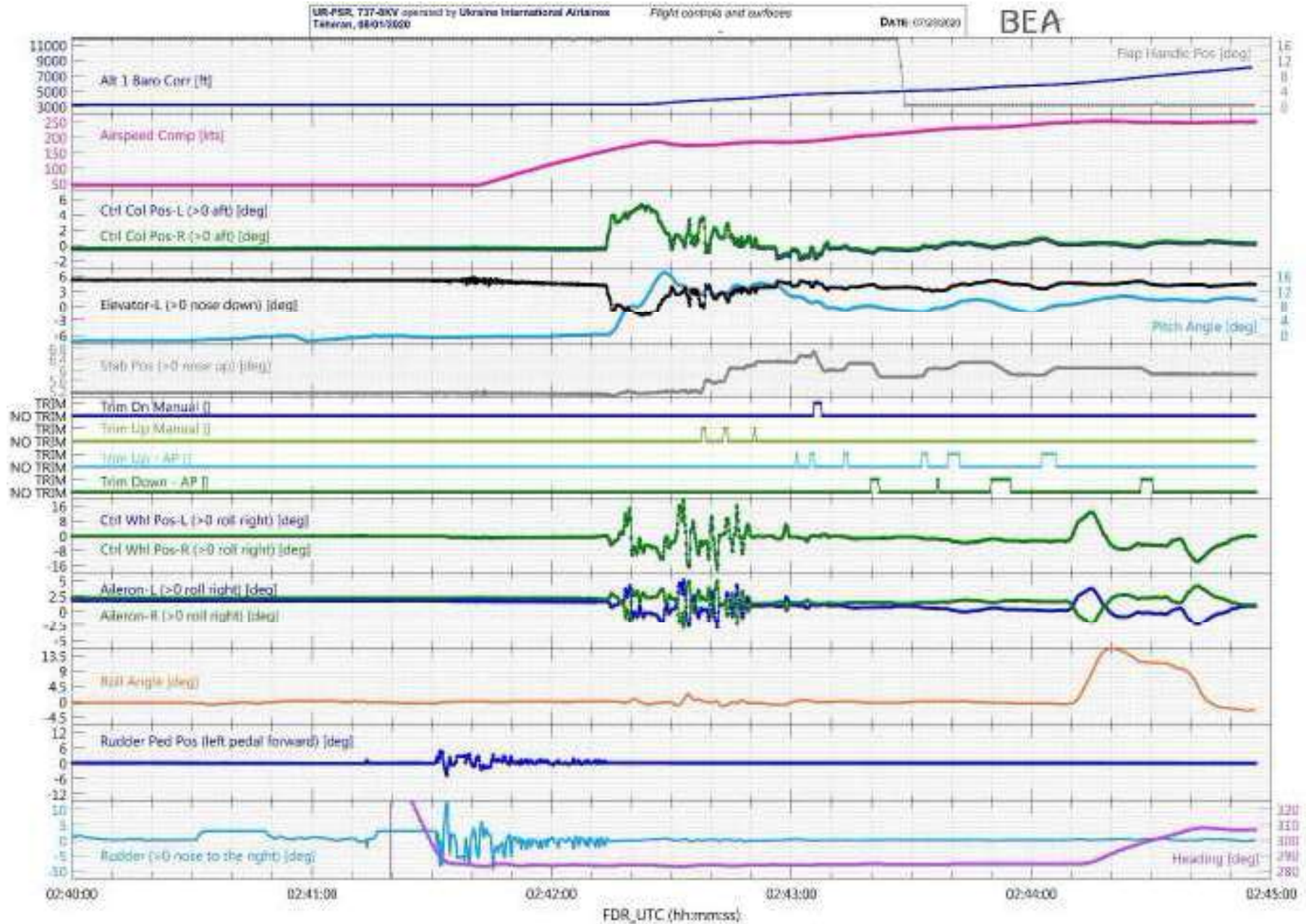




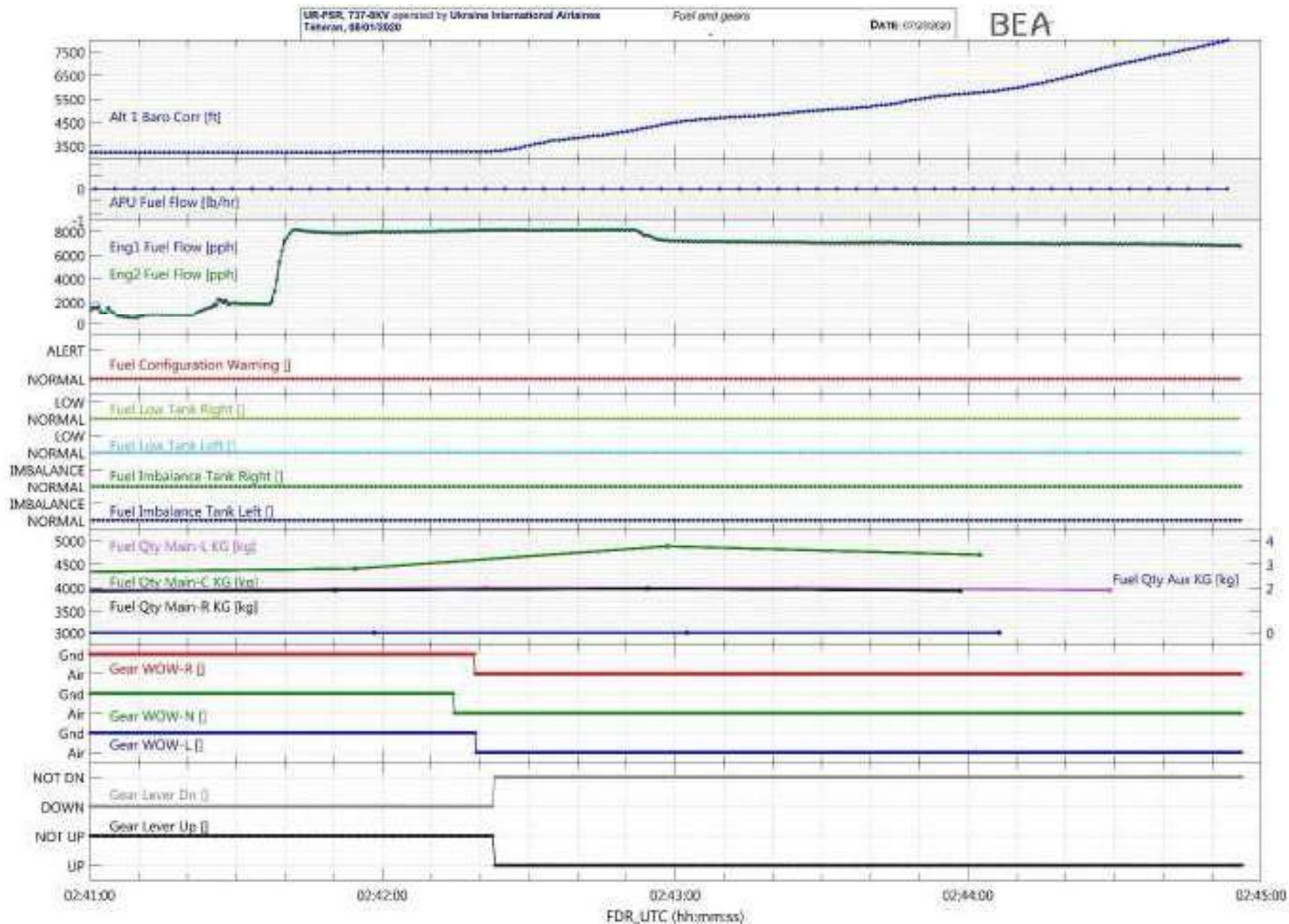


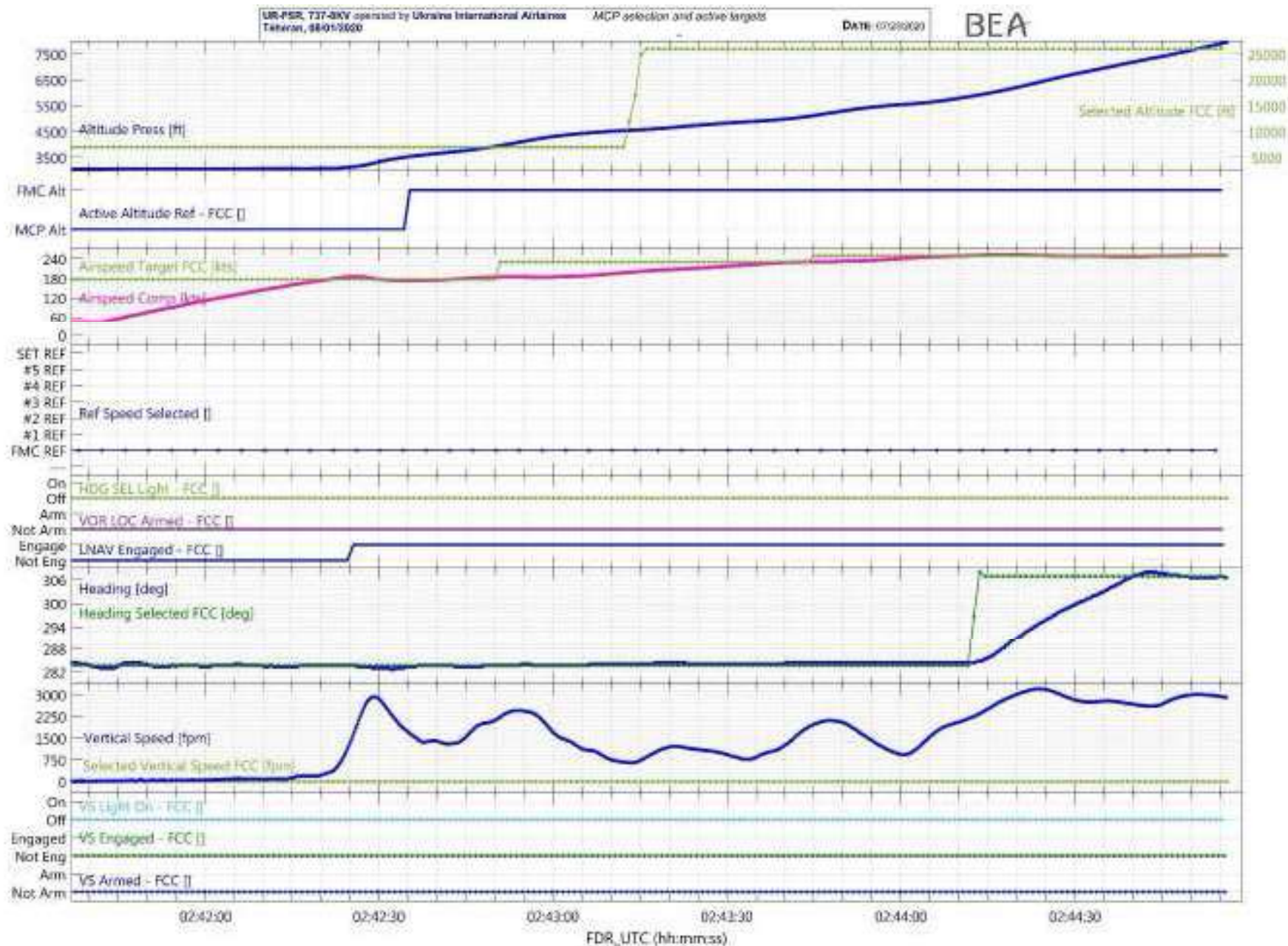




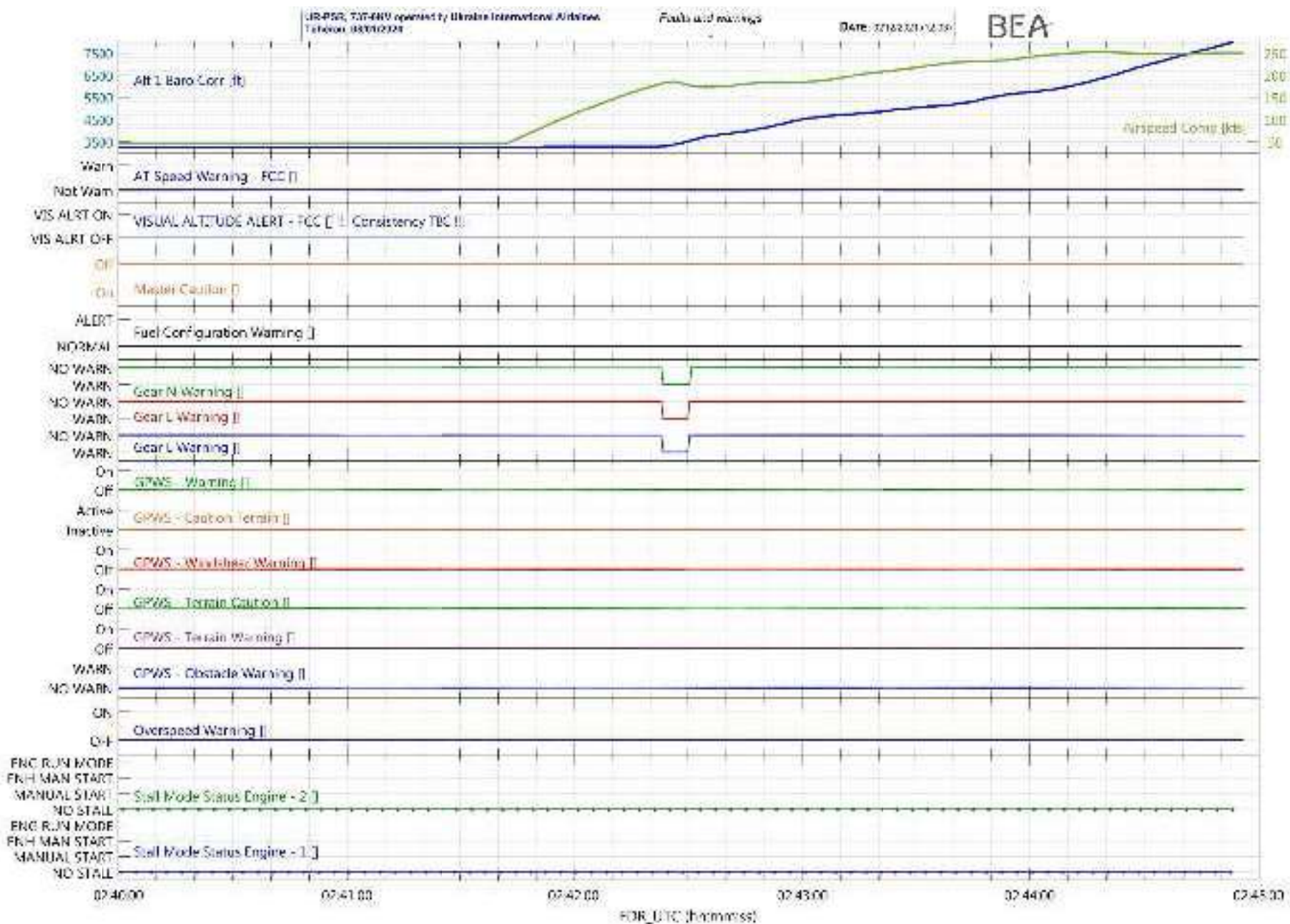














# BEA

Bureau d'Enquêtes et d'Analyses  
pour la sécurité de l'aviation civile

## مشاوره

مطابق با ضمیمه ۱۳ ایکائو، پیش نویس گزارش نهایی بررسی سانحه برای طرف‌های مرتبط ارسال و از آنها درخواست شد تا نظرات خود را ارسال نمایند.

پیش نویس گزارش نهایی برای طرف‌های زیر ارسال شد:

کشور	سازمان
کشور محل رویداد- ایران	• سازمان هواپیمایی کشوری
کشور محل ثبت و کشور محل بهره‌برداری هواپیما- اکراین	• NBAAI • UIA
کشور طراح و کشور سازنده (هواپیما)- آمریکا	• NTSB • Boeing
کشور طراح و کشور سازنده (موتور) و کشور ارائه دهنده اطلاعات، امکانات و متخصصان- فرانسه	• BEA • Safran Aircraft Engines • EASA
کشور ارائه دهنده اطلاعات- انگلستان	• AAIB
سایر	• ایکائو

نظرات ارسال شده به دفتر بررسی سوانح به شکل زیر در نظر گرفته شدند:

- تمامی نظراتی که دفتر بررسی سانحه آن‌ها را در راستای هدف بررسی ارزیابی کرد و باعث بهبود دقت، نتایج ایمنی و موثر بودن گزارش می‌شدند در گزارش نهایی استفاده شدند و گزارش به شکلی اصلاح شد که آن نظرات را منعکس نماید.
- نظراتی که در گزارش نهایی استفاده نشدند، در یک جدول در ضمیمه ب گزارش به همراه دلایل دفتر بررسی سانحه برای نپذیرفتن آن‌ها آورده شدند.

نکته: نهاد بررسی سوانح هوایی اکراین درخواست کرده بود که ضمائم که به همراه نقطه نظارت خود اریال کرده بودند به گزارش ضمیمه شوند. ضمیمه A و ضمیمه B نظرات اکراین در این بخش و پس از جدول نظرات درج شده‌اند.

در خصوص ضمیمه B ارائه شده توسط اکراین، باید توجه داشت که در گزارش نهایی، اطلاعاتی هوانوردی آمریکا تنها برای بحث در خصوص در دسترس بودن اطلاعات برای تحلیل‌های منتهی به تصمیم آورده شده و به معنی این نبوده که این اطلاعاتی برای شرکت اکراینی محدودیت زا بوده است. تفاوت بین اطلاعاتی هوانوردی و اطلاعات پایه، همواره باید در نظر گرفته شود و به همین دلیل توصیه‌های ایمنی در گزارش با هدف رفع چنین سوء برداشتی از مفاهیم ارائه شده‌اند.



## Consultation

In accordance with ICAO Annex 13, the draft Final Report is submitted to the parties involved, inviting their comments.

The draft Final Report was submitted to the following parties:

State	Organization
State of Occurrence- I.R.Iran	<ul style="list-style-type: none"> <li>• CAO.IRI</li> </ul>
State of Operator and State of Registry- Ukraine	<ul style="list-style-type: none"> <li>• NBAAI</li> <li>• UIA</li> </ul>
State of Design and State of Manufacture (aeroplane)- USA	<ul style="list-style-type: none"> <li>• NTSB</li> <li>• Boeing</li> </ul>
State of Design and State of Manufacture (engines) and State Provided Information, Facilities and Experts- France	<ul style="list-style-type: none"> <li>• BEA</li> <li>• Safran Aircraft Engines</li> <li>• EASA</li> </ul>
State Provided Information- UK	<ul style="list-style-type: none"> <li>• AAIB</li> </ul>
Other	<ul style="list-style-type: none"> <li>• ICAO</li> </ul>

The comments provided to AAIB have been considered in the following manner:

- The comments which AAIB found consistent with the goal of the investigation or the ones which could enhance the accuracy, safety results and effectiveness of the report were adopted in the final report, and the report was amended to include them accordingly. These comments are not listed in Appendix B of the report.
- The comments not adopted have been listed in a table in Appendix B of the report with counter arguments.

This table contains the literal text of the comments, plus the sections they apply to, the parties who provided them and the AAIB's response.

*Note: Ukraine NBAAI asked the AAIB to append the annexes to its comment to the final report. Annex A and Annex B to Ukraine NBAAI are brought here after the table of comments.*

*Regarding annex B of the mentioned comments, it should be noted again that AAIB provided the US NOTAMs just to discuss the availability of information in open and public sources and it does not mean that US NOTAMs imposed any restrictions on UIA operation. The difference between NOTAM and information should be always considered and safety recommendations are provided to eliminate such misunderstanding.*



Number	State / Organization	Page	Section / Paragraph	Text to be corrected	Argument	Suggestion	IRAN AAIB Response
1.	Ukraine/ NBAAI	10	Summary, subparagraph 3 and 4	<p>The accident aircraft was misidentified by the air defense unit in the suburbs of Tehran and, consequently, two missiles were launched toward it.</p> <p>The cause of the accident was the activation of missile and the operation of aircraft had not imposed any error to the air defense unit</p>	<p><b>Comment:</b></p> <p>The Draft Final does not describe or summarize the factual findings of the Technical Investigation but instead contains a conclusion about the erroneous identification of the Aircraft by the Air Defense Unit. However, the Draft Final Report does not contain any evidence with respect to the Air Defense Unit's attempts, if any, to identify the Aircraft. the cause of the accident is the attack by the Air Defense Unit on the Aircraft not the activation of the missile as stated in the Draft Final Report.</p> <p>The main, not only, factor explored in the Draft Final Report is human error and it ignores the systemic failure on the part of the State controlling the airspace in which the Aviation Accident occurred, Iran.</p> <p>The aircraft fatal accident occurred as a result of its being shot by two anti-aircraft guided missiles launched by an air defense unit based in the suburbs of Tehran.</p> <p><b>Justification:</b></p> <p>The Draft Final Report does not provide solid conclusions about causes of accident.</p> <p>Among reasons for the shooting can be viewed:</p> <ul style="list-style-type: none"> <li>- lack of control over the functioning of the air defense control system of the Islamic Republic of Iran;</li> <li>- non-observance by the relevant officials of their duties during the preparation and the conduct of combat operations on anti-aircraft weapons;</li> <li>- lack of control over the activities of anti-aircraft units by the command;</li> <li>- errors in the identification of the aircraft of flight PS752, and the acquiring it by the anti-aircraft system as a dangerous target;</li> <li>- intentional shooting down of a civil aircraft, etc.</li> </ul> <p>Therefore, act of unlawful interference has been committed against flight PS752. At the same time, requirements of paragraph 5.11 Annex 13 have not been met.</p>	<p>Continue the investigation in order to establish all causes and factors that led to the accident.</p>	<p>The investigation is complete and all causes and factors in the scope of safety of civil aviation are covered. Proper safety recommendations are provided for prevention of similar accident.</p>
2.	Ukraine/ NBAAI	11	Paragraph 1.1, subparagraph 3	<p>This investigation was done in compliance with the provisions of Annex 13 to the Chicago Convention, whose Standards and Recommended Practices were applied accordingly. .</p>	<p><b>Comment:</b></p> <p>The statement that an investigation was carried out in accordance with ICAO Annex 13 is incorrect and, certainly not accurate. For example, the accident scene and all the evidence were not preserved, the on-board recorders were not decoded at the first opportunity and the decoding thereof was</p>	<p>Continue the investigation as it is incomplete and lacks analysis of all important data necessary to establish all causes and factors that led to the accident. Subparagraph amend as</p>	<p>The investigation is complete and all causes and factors in the scope of safety of civil aviation are covered. Proper safety recommendations are provided for prevention of similar accident.</p>



Number	State / Organization	Page	Section / Paragraph	Text to be corrected	Argument	Suggestion	IRAN AAIB Response
					<p>unreasonably delayed for more than 6 months, the transcripts of the on-board recorders were not transferred to the members of the Accident Investigation Board, there are no originals of the transcripts of ATC and CVR records, and some of the transcripts presented in the Draft Final Report have been edited and, accordingly, do not correspond to the original records.</p> <p>Many of the so called facts indicated in the Draft Final Report are incorrect and farfetched and do not correspond with the evidence available, the sources of those facts are not referenced.</p> <p>Moreover, the Draft Final Report does not fully comply with "Appendix 1. Form of the final report" of Annex 13, in particular the title does not contain the manufacturer, national and registration marks of the aircraft; the synopsis does not contain an information regarding the fact of reporting of aviation incident to the national and foreign authorities; investigation authority for aviation accidents investigation and the accredited representative of Ukraine</p> <p><b>Justification:</b>                      During investigation IRI deviated from provisions of Annex 13, in particular, Ukraine was not given an opportunity to fully exercise their rights and participate in all aspects of investigation, such as meetings related to analysis, findings, causes, contributing factors and safety recommendations, as it indicated by Paragraph 5.25 (h) and Paragraph 6.8.1 Annex 13.                      CVR&amp;FDR data, information regarding flight safety measures that were taken because of military activities potentially dangerous for the civil aircraft operation according Doc 9554, concerning organization and function of civil-military coordination, was not provided to Ukraine at the accredited representative request, as indicated by Paragraph 5.25 (d) Annex 13.                      The investigation was conducted by Iranian Civil Aviation Authority which contradicts with Paragraph 3.2 Annex 13.                      During work on the IRI territory, Ukraine's experts were not provided access to familiarize themselves with all investigation materials.                      By the time of Ukrainian delegation arrival to the accident site, the territory where aircraft crashed was cleaned from wreckage.                      Iranian side actions did not allow Ukrainian experts to exercise their rights as indicated by Article 26 Chicago Convention to arrange thorough</p>	<p>follows: "Ukraine considers, that during investigation Islamic Republic of Iran did not comply with provisions of Annex 13 to Chicago Conventions"</p>	<p>ICAO Annex 13 recommendation 6.1 states that: "Recommendation.— The format of the Final Report in Appendix 1 should be used. However, it may be adapted to the circumstances of the accident or incident."                      The format of this report is in compliance of ICAO Annex 13.</p>





Number	State / Organization	Page	Section / Paragraph	Text to be corrected	Argument	Suggestion	IRAN AAIB Response
					examination of accident site and aircraft wreckage, which contrary to the requirements of Paragraph 3.3 Annex 13. Thus, the factual conclusions set out in the Draft Final Report fail to correspond to the actual circumstances of the Aviation Accident, there are convincing confirmations of improper collection and examination of evidence, and therefore it is impossible to conclude that the investigation was carried out in accordance with Annex 13.		
3.	Ukraine/ NBAAI	11	Paragraph 1.2, subparagraph 1	"The investigation was carried out to determine the root causes of the PS752 flight accident on January 08, 2020, so that the similar events in the future could be prevented accordingly"	<b>Comment:</b> The Technical Investigation Regarding the military's interference with civil air transportation is not transparent. Accordingly, and without more, the Technical Investigation was not carried out properly.  <b>Justification:</b> It is not supported by evidence and is limited by reference to secrecy.	This subparagraph needs to be modified or removed.	Causes and factors in the scope of safety of civil aviation are covered. Proper safety recommendations are provided for prevention of similar accident.
4.	Ukraine/ NBAAI	11	Paragraph 1.2, subparagraph 5	The team addressed three areas in their investigation: military, civil and the area of their cooperation and interactions; however, the identification of the root causes and the provision of recommendations are confined solely to the civil area and its cooperation scope with the military one. Addressing the root causes of events within the military area and making improvements in it falls out of the mandate of Annex 13.	<b>Comment:</b> During investigation analysis of all relevant information has not been done. Investigation authority must recommend any preventive measures for flight safety level increasing. Failure to provide recommendations to the military will prevent the requirements of Paragraph 3.1 Annex 13 from being met and could not address the threats and prevent accidents in the future. This phrase indicates the lack of an effective mechanism for the control and influence of the civilian authorities of the Islamic Republic of Iran on the actions of the military authorities in the matters of flight safety in Iranian airspace. It is not clear what is meant by the scheme portrayed in Figure1 what is its significance to the Technical Investigation. Further, the Draft Final Report does not provide any assessment pursuant to the scheme set out in Figure 1. Why in the military area of the scheme are there no questions like Why? and How?  <b>Justification:</b> Paragraph 3.1 Annex 13, Subparagraph (a) Paragraph 5.4 Annex 13, Paragraph 6.8 Annex 13, Paragraph 1.3.1, part IV Doc 9756, Paragraph 5.13 Annex 13, Paragraph 10.9 Doc 9962 Despite the fact that the Draft Final Report refers to the identification of some events of military activity	Continue the investigation as it is incomplete and lacks analysis of all important data, or amend the Final Report in line with the factual information.	The safety of civil aviation should not rely on military proceedings, but civil aviation shall be aware of military threats to avoid them simply. Military systems including human sources, hardware and procedures are not controlled nor certified or overseen by civil aviation. All areas in the scope of civil aviation safety are covered in the investigation.

Number	State / Organization	Page	Section / Paragraph	Text to be corrected	Argument	Suggestion	IRAN AAIB Response
					which resulted in missiles being launched into the Aircraft, the investigation of the true causes of the Aviation Accident was not properly or fully conducted. In the absence of a proper organization of interaction between the military authorities and the authority conducting the investigation, the conclusions about the preconditions and the causes of the flight PS752 fatal accident are questionable.		
5.	Ukraine/ NBAAI	13	Paragraph 1.3, subparagraph 3	The initial evidence confirmed that the fire had broken out in the aircraft before crashing into the ground. The analysis convinced the investigation team that the explosion is the probable cause of fire. Having made some analyses, the team focused on three scenarios: - Explosion in the aircraft due to technical issues - Explosion in the aircraft due to the presence of dangerous goods inside the aircraft - Explosion due to unlawful interference from the inside of the aircraft - The aircraft being targeted by terrorists acts - The aircraft being targeted by military forces	<b>Comment:</b> The technical investigation methodology described in this subparagraph of the Draft Final Report does not correspond the factual circumstances.  <b>Justification:</b> From the very beginning, after the Aviation Accident, the Iranian side announced only its version of the technical failure of the Aircraft. By January 11, 2020, other possible causes of the Aviation Accident were ignored by Iran and were not even considered; none of which is reflected in the Draft Final Report. The Draft Final Report lacks evidence and information on the study of the listed causes of the Aviation Accident. The question whether a terrorist act could have been the cause of the aviation accident remains open. Moreover, the version officially announced by the Iranian side on January 11, 2020, that the aircraft was downed by missiles, indicates that other versions of the aviation accident were not considered.	Bring the Draft Final Report to the factual circumstances and address the question whether a terrorist act could have been the cause of the aviation accident.	The cause of accident is described in the report on the basis of facts and analysis provided. The aircraft was targeted mistakenly by military forces.
6.	Ukraine/ NBAAI	15	Paragraph 1.4 subparagraph 4	having read out the flight recorders, in July 2020, the relevant report was also released ... »	<b>Comment:</b> The Draft Final Report does not contain any justification for delaying and postponing of the process of decoding of the on-board recorders. The Draft Final Report contains a number of inconsistencies and contradictions with previous reports, including the Factual Report.  <b>Justification:</b> Appendix D to Annex 13 1.3.1 Chapters 1 DOC 9756 Part IV	Supplement the Final Report with justifications for delaying and postponing of the process of decoding of the on-board recorders. To remove inconsistencies with previous reports.	The process of decoding the flight recorders are described at 2.18. The factual report is about the available information at the time of that report and Final Report is the final one. However, there are no major difference between information in both reports.
7.	Ukraine/ NBAAI	16	Paragraph 1.6, subparagraph 2 and 3	« First, individuals involved in an accident would naturally be led to defending themselves, hence reducing their cooperation in identifying the factors having contributed to it. Even worse, some would consider concealing issues concerning their responsibilities in case of occurrence of an error	<b>Comment:</b> Investigation must not refuse reporting only as it could become purpose to apportion blame or liability. Failure to adhere to established policies must be clearly indicated if they are related to the occurrence. Absence of analysis circumstances and reasons for military personnel failure to fulfill their duties, in the Draft Final Report can tell that investigation	Delete the both subparagraph 2 and 3 and amend paragraph 1.6 with the following: "Investigation authority must not refuse reporting only as statements of reasons could become purpose to apportion blame or liability. Deviations from	This paragraph explains the logic behind the ICAO Annex 13 standard 3.1, because it will help some readers, including the family of victims who may not be familiar with safety promotion concepts to understand the objective of the investigation subject to Annex 13.



Number	State / Organization	Page	Section / Paragraph	Text to be corrected	Argument	Suggestion	IRAN AAIB Response
				<p>leading to an accident, so that they can escape blame or avoid liability, and, resort to hiding such sensitive issues rather than reporting voluntarily and cooperating to eliminate the areas of concern.</p> <p>Second, if the factors contributing to an accident are not well determined and eliminated, the identification of the liable individuals and eliminating them from the system in place will not entail the prevention of similar occurrences. On the contrary, the very factors leading such liable individuals to commit the error, causing the accident, will still be lurking for others; hence, similar accidents will take place through others' negligence in the same area.</p> <p>»</p>	<p>is not finalized, and conclusions regarding identification error are perfunctory.</p> <p><b>Justification:</b> Paragraph 3.2.7; 5.2.1, part IV Doc 9756</p>	<p>established norms of compliance with policies and procedures must be clearly indicated if they are related to the accident. The norm nature and deviation role from it must be described in detail, for explanation of such deviation effect for flight safety. Analysis should explain reasons resulting in deviation which created a threat resulted in act of unlawful interference “</p>	
8.	Ukraine/ NBAAI	18	Paragraph 2.1	Whole paragraph	<p><b>Comment:</b> Provides only partial information and does not contain data on preparation for departure, including the process of aircraft towing.</p> <p>Our understanding is the information that “IKA tower asked him to wait for receiving the clearance since they wanted to make the coordination required with other relevant units” and “The controller instructed the pilot to turn to right after 6,000 feet, and continue straight to PAROT. After it was read back by the pilot, the controller again instructed the pilot to continue to PAROT point once passing the 6000-foot altitude, which was read back by the pilot flying” is not exact and should be verified against the original record. Ukrainian Side cannot verify it as we do not have the original recordings.</p> <p>Figure 2” The aircraft flight path detected by PSR and SSR” is unverified evidence that tries to confirm the absence of a second missile shot, which, in turn, clearly contradicts the evidence contained in the CVR, FDR records as well as on the traces of shrapnel from the missile explosion on fuselage fragments.</p> <p><b>Justification:</b> There is no clear statement in the Draft Final Report that permission was granted to UIA by the Iranian military sector to operate the flight, which</p>	<p>Verify and present the information in accordance with the original ATC and CVR records. Add a clear statement that permission to operate the flight was granted to UIA by the Iranian military sector.</p>	<p>The information is driven from ATC recording and CVR download. Refer to 2.18.3.</p>

Number	State / Organization	Page	Section / Paragraph	Text to be corrected	Argument	Suggestion	IRAN AAIB Response
					has to be confirmed by ATC records and Factual report.		
9.	Ukraine/ NBAAI	22	Paragraph 2.4 subparagraph 1	«The aircraft was completely destroyed due to crash and ground impact »	<p><b>Comment:</b> The findings that the damage to the aircraft was the complete destruction of the Aircraft resulted from the crash and hitting the ground are disingenuous and false as the evidence is the Aircraft was damaged as a result of being struck by missiles shot by the Iranian Air Defense Unit. The Aircraft was destroyed because of the intervention of the Iranian military sector.</p> <p><b>Justification:</b> DOC 9756 part IV</p>	Subparagraph needs to be amended as follows: « The PS752 aircraft was shot down by two ground-to-air missiles launched from the Tor-M1 anti-aircraft missile system which was located in the Tehran area and accomplishing missions as assigned by the Iranian Air Defense Forces deployed in this area. The launching at the aircraft resulted in cascading failures of the onboard systems, which led to its downing and a complete destruction from the impact with ground»	The paragraph uses technical wording about the condition of aircraft after the crash and the investigation is not done for apportion blame or liability. Refer to Annex 13 standards 3.1, 5.4.1, appendix 2, recommendation in section 6.
10.	Ukraine/ NBAAI	29	Paragraph 2.10	“Investigations indicate that the required navigational aids related to the flight had been operational and in good condition”	<p><b>Comment:</b> There is no information regarding the investigation of the GPS failure causes, which directly contradict the statement in this paragraph.</p> <p><b>Justification:</b> The CVR-transcript mentioned on page 72 of the Draft Final Report, indicates that the both left and he right GPS was “invalid”.</p>	Continue the investigation as it is incomplete and lacks analysis of all important data, or amend the Final Report in line with the factual information.	The aircraft was flying in planned route with no deviation from the expected trajectory and altitude. No navigation problem was contributed to misidentification of aircraft.
11.	Ukraine/ NBAAI	29	Paragraph 2.11.2	Whole paragraph	<p><b>Comment:</b> When asked by the Iranian crew, which was performing the above mentioned flight, about the outbreaks on course 320, the dispatcher replied that he was not informed. This shows that the military did not have any interaction with the ATM services of the Iranian airport, which in turn explains why the Iranian side did not provide relevant information to users of Iranian airspace for risk analysis and decision-making. Moreover, in our opinion, the part of the transcript of the communications between the ATC controller and the Aircraft crew that is disclosed in the Draft Final Report is false and misleading (pages 30, 31 of the Draft Final Report), there is no timeline of communications, and therefore the transcripts of the original recordings of the communications should be reproduced in their entirety. The transcript of the communications between the ATC controller and the Iran Aseman Airlines’ aircraft: The Iranian airline</p>	Continue the investigation as it is incomplete and lacks analysis of all important data, or amend the Final Report in line with the factual information.	This table is factual information and is provided to answer the questions raised after release of the incorrect audio file in medias.



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					<p>indicates that there were no problems, warnings, or tension in the region of Flight PS 752. Further communications indicate that the pilot of the Iran Aseman Airlines aircraft saw the launch of missiles and the explosion of the Aircraft. This information did not tacking into consideration by ATC controller.</p> <p><b>Justification:</b> Paragraphs 2.18.1, 2.18.3, 2.18.3.1, 2.19.1, 2.19.2 of Chapter 2 of Annex 11.</p>		
12.	Ukraine/ NBAAI	32	Paragraph 2.12.2	In terms of aviation security at the airport.	<p><b>Comment:</b> Information is presented in biased manner. Multiple violations of ICAO requirements as to the aviation security measures were discovered in the Imam Khomeini Airport by the Ukrainian investigation team. There is no evidence of IKA CCTV information, the original recordings and full transcripts of the recording were not provided to the members of the Ukrainian investigation team, so Ukraine cannot verify this information.</p> <p><b>Justification:</b> Doc 8973</p>	Continue the investigation as it is incomplete and lacks analysis of all important data, or amend the Final Report in line with the factual information.	The AAIB as the state constituted the investigation had verified the information in report.
13.	Ukraine/ NBAAI	34	Paragraph 2.13, 2.15	Whole paragraphs	<p><b>Comment:</b> Presented data is inaccurate, or not evidenced</p> <p><b>Justification:</b> The information on the measures to preserve evidence at the crash site is incorrect, since the Iranian side failed to ensure that, without the consent of the members of the relevant Accident Investigation Authorities, the evidence was moved and carelessly accumulated, its safety and security was not ensured. Most of the parts of the Aircraft, of great evidentiary value, were missing (for example, the lower and front parts of the Aircraft fuselage, damaged by missile fragments, doors, antennas, passenger seats, etc.). The information on the time of arrival of law enforcement agencies at the scene, the situation at the scene after their arrival and the measures taken to restrict the access of third parties are not displayed in any way. The most important evidence of the missile hitting is not presented; instead the Draft Final Report emphasizes impact of fire and smoke, without analyzing the cause of their occurrence.</p>	The information contained in this clause requires verification and re-analysis to reflect the actual circumstances of the Aviation Accident and needs to be included in the Final Report.	All information here are based on provided evidences and verified by AAIB.
14.	Ukraine/ NBAAI	51	Paragraph 2.16, subparagraph 5	« Initially, helicopters of the Red Crescent and Emergency were dispatched to the site from Tehran »	<p><b>Comment:</b> The information does not have any details about the time of departure, the number of helicopters,</p>	Add information about the time of departure, number of helicopters, crew	This proposal has nothing to do with the investigation the requested data has no effect on the conclusion, because due to the severity of the



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					the composition of the crews, the place of landing, the measures taken, etc. <b>Justification:</b> Para 3.2.3 of DOC 9756 Part IV	composition, landing place, performed measures, etc.	accident, all occupants had lost their lives and rescue operation had no effect on the outcome.
15.	Ukraine/ NBAAI	53	Paragraph 2.17.3 Subparagraph 1	<p>“As some holes were observed in the passenger seat pads (Figure 25), they were collected from the accident site to find the FODs possibly penetrating into them due to explosion. Then, using the X-ray scanners, the initial detection of FOD was made, and the observable cases were transferred to the AAIB. Having cut their pads, the metal pieces were extracted and sent to a metallurgical laboratory to be assessed and compared with the missile shrapnel alloy.</p>	<p><b>Comment:</b> The paragraph does not indicate the number of seat pads that were found and from which related metal samples were extracted. The given results of test are only concerns of two seized samples, which actually showed similarities with aircraft metal alloy, not missile one.</p> <p><b>Justification:</b> It is impossible to confirm or deny the facts relating to the metal objects in the Aircraft’s passenger seats as all the seats were removed from the crash site by the time the members of the Accident Investigation Team representatives of Ukraine arrived. Only one seat of flight attendant was found by representatives of Ukrainian team. At the same time, samples of a metal alloy were found exactly in seats that according to paragraph 5.10 Annex 13, may have force of physical evidence. Appendix 1 to Annex 13 Paragraph 1.3.1 of Chapter 1 of DOC 9756 Part IV</p>	<p>Paragraph 2.17.3, first subparagraph - indicate the exact number of seat pads that were found and supplement text as follows: « They were collected form the accident site before the Ukrainian experts arrival»</p> <p>Continue the investigation as it is incomplete and lacks analysis of all important data, or amend the Final Report in line with the factual information</p>	The focus of this paragraph is on the explosive detection analysis, the results are proven and are supported by other evidences. It does not explain the search operation.
16.	Ukraine/ NBAAI	56	Paragraph 2.17.4, Subparagraph 3	<p>« It was confirmed that there were cracks and holes caused by shrapnel strike by blaze and the remaining smoke on the aircraft fuselage.</p> <p>Likewise, the test result of traces caused by smoke and burn due to explosives from aliphatic (PETN, HMX, RDX, C4) was confirmed.»:</p>	<p><b>Comment:</b> Draft Final Report do not contain the images which have clearly identified incoming holes, being explained by the impact of striking elements (shrapnel) of the combat staffing of the anti-aircraft guided missile « TOR M1 » No other information on the nature of the shrapnel, its physical properties and its belonging to the specific type of missile is provided. Moreover, the mentioned list of the explosive substances found, which are: PETN, Octogen (HMX), Hexogen (RDX), C-4 (C4), indicates about a list of all possible usual explosives, used in missile weapons. This means, that either study of the fuselage damage has not been conducted at all, or the obtained results were erroneous, because the warhead of the anti-air and Hexogen. Paragraphs 2.14 and 2.17.3 also do not provide information on the nature of the striking elements (shrapnel) that could be used to determine the type of anti-aircraft guided missiles that hit the flight PS 752.</p> <p><b>Justification:</b> Paragraph 1.3.1 of Chapter 1 of DOC</p>	<p>Draft Final Report should be supplemented with information regarding nature of the missile’s striking elements. Identify the type of the anti-aircraft guided missiles that made impact on PS 752 flight and their striking elements. Continue the investigation as it is incomplete and lacks analysis of all important data, or amend the Final Report in line with the factual information.</p>	Since the fact that the aircraft was targeted by two missiles and at least one of the caused damage to aircraft, more details are not needed to prove this fact.



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					9756 Part IV		
17.	Ukraine/ NBAAI	57	Paragraph 2.17.4, subparagraph 8	« By sampling the air conditioning system and the two ELT pieces of the aircraft (Figure 29) and performing gas-chromatographic-mass spectrometry on each of the parts, the presence of negligible amounts of Dinitrotoluene (DNT) with the chemical formula C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub> was proven» and subparagraph 11 “The results of the sample analysis taken from the inside of the upper skin of the aircraft engine showed the presence of (DNT) Dinitrotoluene contamination.”	<b>Comment:</b> In the air conditioning system, two elements of ELT and internal side of the engine cowling, a small amount of DNT has been found.  <b>Justification:</b> Such conclusion can be considered as false or incomplete because this substance could be present as small admixture to TNT (Trinitrotoluene) as a result of either poor quality of production or long-term preservation. The absence of Trinitrotoluene (TNT) in the conducted examinations indicates erroneous and poorly conducted study because the major substance, i.e., Trinitrotoluene (TNT) has not been found.	Continue the investigation as it is incomplete and lacks analysis of all important data	This comment is not supported with the information and analysis of AAIB and the result of consultation with the State of design and manufacture.
18.	Ukraine/ NBAAI	58	Paragraph 2.17.4, subparagraph 10	“According to the spectrometry obtained from the interior part of the aircraft cabin window (as shown in Figure 31), the presence of more explosive Trinitrotoluene (TNT) was detected.”	<b>Comment:</b> Trinitrotoluene (TNT) was found on the interior part of the aircraft cabin window with absence of this substance on all other examined parts, items, located in the aircraft cabin. As it is mentioned in Paragraph 2.17.4, subparagraph 12: «It should be noted that no explosive contamination was observed in the samples taken from the engines and other aircraft pieces or the objects inside the passenger cabin»  <b>Justification:</b> This constitutes grave mistakes made by the expert during research of the chemical elements, which were identified in the exterior and interior parts of the aircraft.	Continue the investigation as it is incomplete	This sample confirms the data related to explosion of missile, and is enough for the related analysis.
19.	Ukraine/ NBAAI	60	Paragraph 2.17.4, subparagraph 15	«Following the release of the videos and images showing the firing of two missiles at the aircraft, their authenticity was begun to be checked. Surveys were then conducted at the accident site on January 10, 2020 through which the authenticity of the videos, which were shot from Bidkane and Parand, was verified. Gaining access to CCTV footage recorded by the organizations near the areas supported the hypothesis that the aircraft had been fired by missile.»	<b>Comment:</b> Proceeding from the analysis of the materials described in paragraphs 2.14-2.17 of the Actual Report (objective information, physical evidence) it is not clear whether the aircraft the was or was not hit by one or two anti-aircraft guided missiles of the anti-aircraft missile system « TOR M1» There are no sufficient evidences such as, but not limited to videos and images of the anti-aircraft launch itself in the Draft Final Report, to which there are references and on the basis of which the conclusion was made in the Draft Final Report.  <b>Justification:</b> The Accident Investigation Team concluded that the aircraft was hit by anti-aircraft guided missiles of the Tor-M1 anti-aircraft missile system solely on the basis of the statement by the Iranian military	Continue the investigation as it is incomplete and did not investigate all versions, which led to an accident.	The investigation is complete and the report is clear in this regard.

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					leadership. Other versions of the event had not been considered.		
20.	Ukraine/ NBAAI	62	Paragraph 2.18.3.	Whole paragraph	<p><b>Comment:</b> It was indicated that there was no technical capability in Iran to complete readout of the CVR and FDR, mentioned in Second Preliminary Report dated 20.01.2020. Iranian side unreasonably delayed the decoding of the flight recorders for more than 6 months after the Aviation Accident. According to the results of the reading of the CVR, the recording started at 2:26:18 (engine start time) and the end of the recording was at 2:45:15. Importantly, the transcript of the recordings set out in the Draft Final Report at Table 5 reveals only the communications from 2:41:39 and fails to disclose the transcript of the recording from 2:26:18 to 2:41:39, which is 15 minutes long, and contains information important for the Technical Investigation. These 15 minutes of the CVR transcript are not included in the Draft Final Report. Thus notwithstanding these 15 minutes contain important information of the communications between the crew members immediately before the Aircraft take off and evidence there was no unusual situation before departure and no worries of the crew. Given the, unfounded allege facts, innuendo, conclusions and recommendations in the Draft Final Report on this issue (see for ex. paragraphs 5.3 and 7.2), the omission of this relevant portion of the transcript of the CVR appears to be intentional.</p> <p><b>Justification:</b> Half year slowness with solving this issue does not meet the requirements of ICAO standards. In addition, voice information data obtained as a result of readout of black boxes Paragraphs 5.7, 5.8, Attachment D Annex 13 was never transmitted to the Ukrainian side. No evidence of an absence of a cockpit and pre-flight check, discussion of the situation and decision-making were provided to Ukraine. However, the answers to these questions are in the CVR recording, confirming that all pre-flight checks were carried out by the crew, the crew had no doubts about the safety of the flight and the decision to operate Flight PS 752 was made accordingly.</p>	<p>The Final Report needs to be brought in line with the factual information. The transcript of the CVR recording needs to be produced in its entirety and, as set out in paragraph 2.18 of the Draft Final Report, the transcript needs to be corrected and reflect the actual and original transcript Also, it is necessary to supplement the decoding of the last words of the crew, which, in our understanding, can be identified.</p>	<p>The complete audio file was analyzed in BEA with BEA facilities and experts and since several crew conversation was Russian/ Ukrainian, NBAAI ACCREP and advisor provided the translation which is brought in this table. All conversations were listened and analyzed and since the conversations before start of takeoff are just about normal ground operation of personal dialogues, the investigation team decided to provide the transcript from that time. The Ukrainian delegation declared during the readout sessions in BEA that the last incomplete word could be translated as: Retu... in English, but at the end the incomplete word was not identified. However, considering the texture and time of recording interruption, the investigation team decided to put the last word as Unknown to prevent incorrect understanding.</p>
21.	Ukraine/ NBAAI	75	Paragraph 2.19.1	Whole paragraph	<p><b>Comment:</b> The information in this paragraph does not show chronological sequence of events related to</p>	<p>Continue the investigation as it is incomplete and did</p>	<p>More details added to report. Some other details are already available in report.</p>



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					<p>military coordination, other major events which could provide the key answers for the investigation.</p> <p>Information about time of combat readiness level change, which led to changes in conditions of civil-military coordination as it is mentioned in factual report dated 11.07.2020, is missing;</p> <p>Time of the Air Defense Unit redeployment which fired missiles is also not mentioned. Time at which target was acquired by the operator differs by at least 4 seconds from that specified in paragraph 8 of the factual report (02:43:56), although the Draft Final Report provided the 2 seconds time correction.</p> <p>Besides, the Draft Final Report does not show what exact technical characteristics of the target the ADU operator provided to the coordination center.</p> <p>The Draft Final Report does not contain information on the reasons why there was no communication between the ADU operator and the coordination center and when this communication was lost.</p> <p>Additionally, it is required to check the hypothesis about continuity of target trajectory, which was the reason of the second missile launch.</p> <p>This paragraph 2.19.1 does not reflect the fact that at approximately 02:46:11 a fire broke out on the aircraft, which was intensifying (information from the factual report). No information is given about sources used to determine time when the fire started.</p> <p><b>Justification:</b> 1.3.1 Chapters 1 DOC 9756 Part IV This is one of the key questions to check the version of erroneous aircraft identification. It is not possible to make any conclusions as to completeness of conducted investigation without absence of these characteristics. The Investigation team has no other options than to take the statements submitted to it by the military management authorities, for granted. Thus, the only one version of the events that caused the accident of PS752 was considered. The mentioned data should be provided from the ADU data recorder.</p>	<p>not investigate all versions, which led to an accident.</p> <p>This paragraph should be supplemented with:</p> <ul style="list-style-type: none"> <li>- the time of redeployment of one of Tehran's air defense units;</li> <li>- explanation for the movement of the Air Defense Unit and the failure to correctly calibrate the compass;</li> <li>- which other objects (if any) were detected by the Air Defense Unit before and after PS 752 accident;</li> <li>- what technical characteristics of the target were detected by the Air Defense Unit operator (velocity, altitude, direction, etc.);</li> <li>- how the target was to be identified;</li> <li>- for what reasons the Air Defense Unit operator's message about the technical characteristics of the detected target was not transferred to the Coordination Center;</li> <li>- what communication channel was used for communication between the Air Defense Unit operator and the Coordination Center and for what reason alternative communication channels were not used;</li> <li>- for what reason there's no operator's message in the records of the Coordination Center;</li> <li>- on the basis of what data the Air Defense Unit operator concluded that the target was hostile, did the operator have the</li> </ul>	<p>Enhancement of military communication systems are not in the scope of this investigation.</p>



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						right/orders/discretion to launch the missile, and what was the procedure itself for identifying the target and launching the missile; - how the launch of the second missile was carried out: automatically or did the Air Defense Unit operator manually performed it; - how communication was lost and exact links where it was lost; - time of target acquisition should be additionally clarified; - time when the fire broke out on the aircraft.	
22.	Ukraine/ NBAAI	75	Paragraph 2.19.1, subparagraph 2	« After the relocation of one of the air defense units of Tehran, clearly causing a change in its heading, it suffered an error of 107 degrees due to failure in conducting north realignment properly. As such, while the Ukrainian aircraft was flying, the direction of objects and targets detected by this unit was being observed with an increase of 107 degrees by the operator.»	<p><b>Comment:</b>                      The action described by this statement, in accordance with the terminology adopted among experts, is called "Alignment of an air defense weapon, or orographic reference".                      An alignment of an anti-aircraft weapon is a mandatory and an integral element of the preliminary preparation of firing of any anti-aircraft weapon, which is caused by the specifics of the operation of such weapons.                      The physical essence of this procedure is the coordination of the direction of the vertical line from the center up on the circular survey screen (commander's display) of the combat vehicle with the azimuthal direction to the North, which is the beginning of the azimuth angle in the coordinate system of the target acquiring station of the combat vehicle.                      The alignment of anti-aircraft weapons consists of a certain sequence of actions of combat service team (crew), namely:                      - the direction to the north magnetic pole is determined (for this purpose the tool has a standard optical device);                      - the direction of the longitudinal axis of the anti-aircraft vehicle relative to the direction to the north is determined;                      - the determined angle (azimuth) is corrected in accordance with the angle of magnetic inclination and the angle of convergence of the meridians, the result is called the « the directional angle »:</p>	Continue the investigation as it is incomplete and did not investigate the ADU operator's actions from the moment of his arrival at the position to the moment of the missile launch.	As it is stated in several arts of report, civil aviation should be able to avoid the hazards of military activities and alertness by means of proper information sharing, coordination and risk analysis. It was proven that two missiles were fired toward the aircraft. The reason behind this mistake does not change the important conclusion that the civil aircraft crashed as a result of military hazard.





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					<p>- the directional angle is introduced by the maintenance of the anti- aircraft vehicle into the navigation, topography and orientation (ANTO) equipment of the combat vehicle « TOR M1 » After that, this angle is automatically considered by the equipment of the combat vehicle during the air reconnaissance, acceptance of target designation, an analysis of the aerospace environment, direct preparation for launching, and so on. As a rule, this element of combat operation takes up to 3 minutes.</p> <p>The result of all operations of preparation for a combat operation (firing) shall be controlled by the commander of the anti-aircraft unit (in this case, the commander of the anti-aircraft missile battery) with the help of automated controls and the voice report of the chief of the combat anti-aircraft service.</p> <p><b>Justification:</b> A non-compliance with the measures of topographic reference and of the alignment, or in the terminology of the Draft Final gross violation (erroneous actions) of the personnel of the service team (crew) of the anti-aircraft vehicle.</p>		
23.	Ukraine/ NBAAI	75	Paragraph 2.19.1, subparagraph 4	«At 02:44:19, the operator notified the specifications of the detected target to the relevant Coordination Center via the communication network. The message was not relayed to the Center. In fact, it had not been recorded in the recorded messages of the Coordination Center.»	<p><b>Comment:</b> Interaction procedure between Anti- air Missile Complex operator and Coordination Center is not described. Such phrase is not clear and may indicate Coordination Center operator failure to notify about target observed on monitor. Upon a target acquisition to track it by the guidance station (GS) of vehicle «TOR M1», the combat service team had to determine the coordinates and the parameters of the target (azimuth, angle, distance to it, as well as the target speed, its altitude and the course parameter) using digital scoreboards of the equipment. At the same time, the analysis of these data had to show that the speed of the target, its angle and the altitude could not meet the performances of a dangerous target. Thus, a failure to perform this action by the service team, had led to an incorrect assessment of the aerospace situation and to the wrong decision to launch. One of the mandatory elements of the air defense system is the communication and control subsystem. Its organization and the maintenance of its continuous and uninterrupted functioning is one of the responsibilities of the military authorities (headquarters) at all levels. Checking the readiness</p>	It is necessary to provide records of Operator's notification report or describe content of this notification report according the data from the ADU. Need to specify what operator notified after destroying the target and what did the Coordination Center answer. It could reveal reasons for shooting decision that urged operator to fire. Supplement the Final Report with actual data on the malfunction of the control system (communication) of the Air Defense Unit, which launched the anti-aircraft missiles towards the flight PS 752	This is a safety investigation subject to ICAO Annex 13. The reason behind this action is provided according to verified evidences. The investigation team could listen to the audio track recorded in ADU that the operator announces the location of target as 250 degrees which is 105 degrees different from the actual azimuth.



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					of communications is also one of the elements of the preliminary preparation of launching, and in its absence, combat operations shall be carried out only by a separate order.		
24.	Ukraine/ NBAAI	76	Paragraph 2.19.1, subparagraph 5	«receiving a response (command) from the Center, the operator came to the conclusion that the observed target was a threat and fired a missile at it at 2:44:39»	<p>The analysis of the Draft Final Report does not allow to determine which procedure was used by the combat service team of the anti- aircraft weapon in the conditions of a loss of the communication with the Coordination Center (or a commander, a senior commander).</p> <p><b>Justification:</b> Paragraph 1.3.1, 2.2.7, 3.2.3, 5.1.1, 5.2.1, part IV Doc 9756. The analysis of the text of the Draft Final Report does not allow to determine how the communication with the combat vehicle was organized, the number of communication channels and other parameters of the control system. There is also no data on the functioning of the control system (communication) of anti-aircraft means, the time parameters and the causes of the communication failure.</p>	Continue the investigation as it is incomplete and did not investigate all versions, which led to an accident.	Refer to above explanation about completion of investigation and the scope and concept of safety improvement.
25.	Ukraine/ NBAAI	76	Paragraph 2.19.1, subparagraph 8	«Having observed the continuity of the detected target trajectory, the second missile was fired at the aircraft by the defense system at 02:45:09. At 02:45:22, the last communication between the missile and the defense system was recorded in a place close to the aircraft route. After that, the defense system showed a message indicating the strike had failed, with the aircraft clearing from the radar lock-on after some time.»	<p><b>Comment:</b> An anti-aircraft guided missile of an anti-aircraft missile system « TOR M1 » can break up the communication with the defense system (i.e., a combat vehicle that guides it towards the target) in the following cases: - hitting the target; - missing the target; - a technical malfunction of a missile or a combat vehicle equipment. In cases of a missile missing or a malfunction, to prevent unauthorized damage to other targets (objects), the missile enters into a self-destruction mode, which ends with its self-destruction in 23 + 3 seconds. In the event of a malfunction of the equipment of the combat vehicle, the missile is not guided at the target, and a few seconds flies along a ballistic trajectory to the ground, while the warhead does not activate. In the described case, when the missile was guided and launched towards the target area (see Draft Final Report, paragraph 5.1 The description of the missile functionality, p. 120, its flight duration is approximately 13 seconds) it is indicated that the second missile was targeted and most likely hit the aircraft as well.</p>	Phrase « After that the defense system showed a message indicating the strike had failed » should be removed. Continue the investigation as it is incomplete and did not investigate the influence of the second missile on the accident.	These information are provided by military and judicial authorities and are verified by investigation team. As described before, for the safety objectives, firing the missiles toward the civil aircraft is a safety failure and effect of the second one is not important for safety prevention. As described in analysis, the videos support the conclusion that the 2 <sup>nd</sup> missile affected the aircraft, but location data supports the conclusion that the missile was failed. At the end, the investigation team provided the safety recommendation as if the aircraft was hit by more than one missile.



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					<p><b>Justification:</b> The information that the second clearing from the radar lock-on after the actual circumstances of the Aviation Accident, CVR recordings. In addition, no information is provided about the time when the transmission of the Squawk code signal was stopped and needs to be checked through the ADU data verification.</p>		
26.	Ukraine/ NBAAI	77	Paragraph 2.19.2, subparagraph 3	«This unit is equipped with radar guided missiles with proximity fuses, while approaching the target the warhead containing shrapnel is detonated throwing about 2500 to 3000 pieces of shrapnel 2.4x7.8x7.8 mm dimension, weighing 2.4 gr Of tungsten metal at a speed of about 1,800 m/s.»	<p><b>Comment:</b> The Tor-M1 combat vehicle guides missiles at the target using a radar telecontrol. At a distance of 120 meters from the target, a command from the combat vehicle is transmitted to the missile to turn on the radio detonator (a non-contact radar sensor of the target). It is activated and it initiates the detonation of the missile's warhead, so that the target at this time would be at a distance of not more than 12 meters from the missile.</p> <p><b>Justification:</b> It is impossible to deny or to confirm the presence of striking elements of the missile in the form of tungsten shrapnel, because the Draft Final Report does not specify the specific type of the anti aircraft guided missile that was fired at the flight PS 752. The same applies to the quantitative and qualitative characteristics of the explosives in the missile combat charge. Combined analysis of paragraphs 2.14, 2.17.3 and 2.19 gives reason to believe that investigation specifically bypasses the fact of identifying the missile as an instrument of the crime.</p>	It is necessary to include in the Final Report detailed data on the type and technical performances of anti-aircraft guided missiles, which were launched at the flight PS 752.	Refer to above comments.
27.	Ukraine/ NBAAI	79	Paragraph 3.1.1, subparagraph 4	« One of the factors potentially hazardous to flight safety is military activities. Therefore, the States managing the airspace, the ones that have oversight on the airline activities as well as the airlines themselves shall gather information related to military activity hazards, conduct relevant risk assessment and adopt mitigating measures to maintain the associated risk within acceptable levels. »	<p><b>Comment:</b> The main responsibility for flight safety and aviation security rests with the State that exercises control over the airspace, which are the sovereignty over its airspace. Iran, as a State which holds exclusive sovereignty with respect to the airspace over its territory, violated ICAO standards and did not secure the safety of civil aviation in its airspace, by failing to make the necessary and appropriate assessment of the level and nature of threat to civil aviation within its territory and the airspace over it, by not providing information regarding the potential hazards/threats for the safe civil air operations, did not determine that it was necessary to avoid flying in the airspace, did not introduce any restrictions on flights, did not issue NOTAMS containing the necessary information,</p>	Subparagraph to be supplemented with the following text: « Responsibility for beginning of coordination process lies on a State, which armed forces participate in a conflict. As of 08.01.2020 Iran was a part of conflict and must notify its own ANSP and other States about known hazards. Lack of information did not allow ANSP to conduct risk assessment and notify UIA operator Add to the Final Report a statement that the	This comment is not neutral and technical. Refer to Annex 13 standard 3.1.



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					<p>recommendations and measures to ensure safety in the circumstances.</p> <p>Iran was not only a State, which operates airspace, but also the party to a conflict. On 8th of January 2020 Iran possessed all necessary information to evaluate the risks, had an obligation to notify other States about hazards and had to implement the necessary and appropriate security measures to properly and adequately safeguard the operation of civil aircraft.</p> <p><b>Justification:</b> Article 3bis, 9, 37 to Chicago Convention Paragraph 2.19.1 Annex 11 to Chicago Convention Annex 17 to Chicago Convention, (paragraphs 2.1.1., 2.1.2, 2.1.3 (a) (b), 3.1.3, 2.2.1, 2.3., 4.3.6 Paragraph 3.1.3, 3.1.6., 3.1.8 Doc 10084 Paragraph 10.1, 10.2 Doc 9554 Paragraph 9.1.1.5 of ICAO Doc 8973</p>	<p>Islamic Republic of Iran has not complied with the basics tenants of the ICAO regime, in particular, the standards as per Annexes 11, 17 to the Chicago Convention, Doc 10084, Doc 8973, Doc 9554</p>	
28.	Ukraine/ NBAAI	80	Paragraph 3.1.1, subparagraph 8	<p>«Taking the very approach, the parties having responsibility for the means to the safe use of flight routes include:</p> <ul style="list-style-type: none"> <li>• The State managing the airspace</li> <li>• The airline using the airspace</li> <li>• The State issuing certificate for an airline operations.</li> </ul> <p>Hence, this section deals with the means to perform such a responsibility towards the threats of military activities in Iran as the State managing the airspace, Ukraine as the State of the operator of the UIA and the very airline itself.»</p>	<p><b>Comment:</b> Not all parties, responsible for coordination with the military and safe use of flight routes are listed. In mentioned. Absence of ANSP assessment on influencing the occurrence could indicate that investigation is not finalized. The Draft Final Report confuses the hierarchy of the relevant parties' obligations for the means to the safe use of flight routes.</p> <p><b>Justification:</b> Paragraph 2.18.1, 2.18.3, 2.18.3.1, 2.18.3.2, 2.19.1, 2.19.2, 2.19.2.1, 2.19.3, Annex 11, Paragraph 1.1.4, 2.4.3, 3.3, 3.8.4, 4.3.2, Doc 10084, Paragraph 3.1.1, 3.2, 3.2.1, 3.6, 3.9, 3.10, 4.2, 5, 6.5, 10.6 Doc 9554.</p>	<p>After the phrase «•The State managing the airspace » include additional item: «•Air Navigation Service Provider» Continue the investigation as one that is not complete since it did not investigate all the circumstances of the occurrence.</p> <p>Amend the Final Report in order to reflect airspace restrictions applied by different responsible parties in the proper sequence (Figure 41- "Dimensions of limitations in an airspace from different responsible parties") and in descending order from highest priority to lowest, as follows:</p> <ul style="list-style-type: none"> <li>- the State controlling the airspace;</li> <li>- the State of the Operator;</li> <li>- Operator.</li> </ul>	<p>This classification is in accordance with ICAO doc 10084. Same classification is used in several safety discussions including MH17 accident investigation report.</p>
29.	Ukraine/ NBAAI	81	Paragraph 3.2	whole paragraph	<p><b>Comment:</b> Contained provisions are difficult to be attributed to civil-military coordination, in particular foreign relations with Iran, USA, Afghanistan, etc. The provided structure of civil-military coordination and communication between links do not describe the link where communication was lost and the causes of this loss.</p>	<p>Subparagraphs about foreign relations of Iran and some historical events should be excluded.</p> <p>Instead supplement the paragraph with answers to the dismissed questions on links and communication</p>	<p>This section describes the existing condition in Iran and region in terms of military alertness and is provided to explain the necessity of civil-military coordination in such special context.</p>



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					<p>The Draft Final Report states that military units have communication with each other, and CMOCC coordinators and air defense coordinators with the civilian sector, and there are three types of communication: voice, messages, and radar. However, there is no evidence of such communications, and therefore it is impossible to establish exactly how the coordination between the civil and military sectors took place, and what mistakes were made in this Coordination</p> <p><b>Justification:</b> The description and Figure 44 at paragraph 3.2.1 are not consistent with and confused by that set out in at Paragraph 3.4.3 and Figure 46. Moreover, Paragraph 3.2 of the Draft Final Report does not correspond to the Factual Report.</p>	on civil-military coordination.	
30.	Ukraine/ NBAAI	82	Paragraph 3.2.1	"Structure of Civil-Military Coordination	<p><b>Comment:</b> The given text determines the organization and the procedure of civil-military interaction in normal conditions. No data on changes in the sequence of such interaction in non-standard conditions (for example, in the conditions of the increased combat readiness of forces and the means of air defense of a sector or the state) are described. This par. 3.2.1 occurs twice in the Draft Final Report</p> <p><b>Justification:</b> Current information is not enough to analyze the peculiarities of the functioning of civil-military interaction in the specific conditions as of January 8, 2020.</p>	Add to the Final Report the structure and procedure for the functioning of civil military cooperation in non-standard (crisis) situations. Adjust paragraph numbering.	The structure of civil-military coordination in Iran is the same in normal and non-standard situations. During the heightened military awareness, the inputs of the system are different not the structure of the system. The paragraph numbering is corrected.
31.	Ukraine/ NBAAI	85	Paragraph 3.2.2, Subparagraph 6	"The Civil-Military Operational Coordination Center (CMOCC) is located in the Tehran ACC. This center communicates all civilian flights information to the military sector, and this information exchange is used to identify civilian flights in the military network. Also, the military flight-related information is provided to the civil airspace management sector to enable integrated air traffic management. CMOCC is in direct contact with State Air Defense Operation Center (SADOC)": subparagraph 9: [...] The military units are in contact with one another. Apart from the military	<p><b>Comment:</b> Despite the fact that the Draft Final Report states the identification of the aircraft as a threat that led to the launch of two missiles by the air defense system, the conclusions of the investigation do not contain any specific final statements about violations in the civil-military system of the ATM in the Islamic Republic of Iran, which directly led to the accident.</p> <p><b>Justification:</b> paragraph 3.2.3 DOC 9756 Part IV</p>	Continue the investigation as it is incomplete and did not investigate all important circumstances of the accident.	All errors and violations ended to this accident are addressed. Refer to ICAO Annex 13 standard 3.1.





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				communications, the CMOCC and air defense coordinators are both in contact with the civilian sector. Such communications are of three types of voice, message data and radar data. The issued flight permits, which are exchanged on the aeronautical telecommunications network between the air traffic control units, are also provided to the CMOCC through the network. CMOCC, which is located in the Tehran ACC, has access to information from the surveillance radars of the civilian sector.			
32.	Ukraine/ NBAAI	87	Paragraph 3.3, subparagraph 9	«As is common for all military forces, sometimes the nature of threats and their alertness condition is at such a level which necessitates designing actions that are highly classified and of which the civilian sector should not be made aware before they are implemented.»	<p><b>Comment:</b> Ukraine considers such approach as contradictory to Chicago Convention principles related to aircraft flight safety.</p> <p><b>Justification:</b> Article 3bis, 37 Chicago Convention, Paragraph 2.19.1, 2.19.2 Annex 11</p>	Subparagraph to be supplemented with the following text: «A system with a possibility when ATS authorities would not be aware about planned activity would always contain risk. In case when information was not provided to civil ATS authorities, the Iranian airspace should have been closed	The report clearly explains how and when the civil sector became aware about the conditions and safety measures.
33.	Ukraine/ NBAAI	101	Paragraph 3.4.3, subparagraph 10	«As the air traffic exchange between Tehran and Baghdad FIR had been stopped, four exit flights from IKA to Iraq had been canceled according to the Table 9. The inquiry into the airlines subject to this cancellation showed that IKA did not issue any clearance for the flights to destinations bound for Iraq. Such a restriction had been announced via NOTAM A0086/20 (Figure 51) too.»	<p><b>Comment:</b> Information in the Draft Final Report indicates that before the downing of Ukrainian aircraft none of the measures were taken to inform about threats in Iran's airspace All NOTAMs by Iran were issued after Ukrainian aircraft was downed. The NOTAM A0086/20: - activity and does not contain information about hazards (Figure 51 – "NOTAM issued following the suspension of traffic exchange between Tehran and Baghdad FIR" and information on the British Airways Flight BAW124, set out at pgs. 106 and 113 of the Draft Final Report a) cannot be considered as an evidence of Iran's implementation of preventive measures, since these events occurred after the downing of the Aircraft and b) regarding pg. 113 of the Draft Final Report, are simply incorrect, misleading and irrelevant). -and does not indicate how and when the preventive measures described in the text were supposed to be implemented.</p>	Subparagraph to be supplemented with the following text: « NOTAM information about flight routes closing was issued by Iran only after 3 to 4 hours after the downing of PS752 flight. Issued NOTAMs did not describe military activity, did not contain information about threats in Iranian airspace and did not allow operators and operator states to properly assess risks related to operations in Iran's airspace. Considering that the failure of the air defense system management system of the state (a sector) occurred namely on the tactical level, it is necessary to supplement the Final Report with relevant materials otherwise it is	It was an important point in the investigation; hence a complete explanation and analysis are provided in 5.6.5.6. Availability of Information for Risk Assessment.



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					<p>The information presented in Figure 46 and Figure 51 of the Draft Final Report has nothing to do with and is irrelevant to assessing the causes of the Aviation Accident.</p> <p><b>Justification:</b> Paragraph 5.1.1, 6.3.2.2, 6.3.2.3 Annex 15, Paragraph 3.8.3, 4.3.2 Doc 10084, Paragraph 4.1, 4.2, 4.7, 10.3 Doc 9554 Paragraphs 2.19.3, 2.19.4, 2.19.3.1 of Annex 11</p> <p>The information set out in Clause 3.4.3 of the Draft Final Report and Figure 46 Military coordination structure at the operational level at the time of the accident” cannot be verified since no evidence of this information was provided to the Ukraine investigation team. The functioning of the coordination system (control) on the tactical level (the level of the anti-aircraft unit - anti-aircraft means, or an air defense unit) has not been studied.</p> <p>However, the ATC recording does confirm that the Iranian military cleared Flight PS752 for takeoff, which we understand was the CMOCC. The wording of Clause 3.4.3 while stating that the “the plan had been implemented” requires clearer language and that reflects what is on the ATC recording: The Iranian Military/Air Defense by way of the Iranian Civil-Military Operational Coordination Center (CMOCC) cleared Flight PS752 for take off.</p> <p>Figure 51 – “Notam issued following the suspension of traffic exchange between Baghdad and Tehran FIR” and information on the British Airways Flight BAW124, set out at pgs. 106 and 113 of the Draft Final Report a) cannot be considered evidence of Iran’s implementation of preventive measures, since these events occurred after the downing of the Aircraft and b) regarding pg. 113 of the Draft Final Report, are simply incorrect, misleading and irrelevant.</p> <p>The same applies to Table 9 – “IKA departure schedule in morning on the day of the accident”. The cancellations of Ata Airlines Flight 6650, Mahan Airlines Flights 5062 and 5042 occurred following the downing of the Aircraft. Turkish Airlines Flight 899 and Pegasus Airlines Flight 513 were canceled, as indicated in the Draft Final Report at pg. 105, as a result of the closure of their respective flights destination airport. There is no evidence that any of the airlines operating flights</p>	<p>impossible to exclude the fact of intentional downing of the PS752 flight with missiles. Remove from the Final Report reference to all events occurred after the downing of the Aircraft, such as cancellation by the airlines of their flights, as they cannot be considered evidence of Iran’s implementation of any preventive measures.</p> <p>On the other hand, supplement the Final Report with the information on flights performed, both before and after the downing of the Aircraft, or transit flights over Iranian airspace. Such information similarly evidences that there were no airlines that cancelled or changed their operations to/from IKA as result of a risk assessment conducted in the morning of 08.01.2020 or at all before the downing of the Aircraft; and a number of airlines operated over Iranian airspace the morning of 08.01.2020 prior to the downing of the Aircraft. Such information should be properly considered and included in the Final Report. The wording of paragraph 3.4.3, while stating that the “the plan had been implemented” requires clear language that reflects what is on the ATC recording: The Iranian Military/Air Defense by way of the Iranian Civil-Military Operational Coordination Center (CMOCC) cleared Flight PS752 for take off. »</p>	

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					to / from IKA canceled a flight as a result of a risk assessment conducted in the morning of 01.08.2020 or at all before the downing of the Aircraft.		
34.	Ukraine/ NBAAI	104	Paragraph 3.5	"Risk Management in Ukraine and Ukraine International Airlines"	<p><b>Comment:</b> Ukrainian and UJA airline risk assessments are represented in the Draft Final Report, but no risk assessment by Iranian ANSP is presented. It is unclear whether ANSP conducted risk assessment for civilian aircraft. This indicated that investigation is not can be accomplished. Comments and remarks on risk assessment by Ukraine and Ukrainian air carrier contained in Annex 1 "Risk Assessment" It should also be noted that the conclusion that the crew did not turn on the CVR before starting the engines is unreliable and likely incorrect, since according to certain configurations of the Boeing 737- 800 there are no such switches and the CVR recording starts automatically after starting the engines. As noted above, the Draft Final Report omits 15 minutes of the transcript of the CVR recording, the very portion of the CVR transcript of the communications from the time of the engines startup, which contains important information about the crew's communications pre-flight answers open questions of the Draft Final Report and directly addresses the conclusions and recommendations of the Draft Final Report on this issue</p> <p><b>Justification:</b> Subparagraph (b) Paragraph 4.2 Attachment C to Annex 11 Paragraph 2.4.3,3.3,4.3.2 Doc 10084 Annex 1 "Risk Assessment"</p>	<p>It is necessary to investigate whether ANSP assessed risk for civilian aircraft operations in the conditions of military activity and supplement the Draft Final Report with the following Chapter: "Risk Assessment by ANSP" Supplement the Final Report with correct information on the Ukrainian and UJA airline risk assessments contained in Annex 1 to this document. Continue the investigation as it is incomplete and did not investigate all the circumstances of the occurrence.</p>	<p>The information in this section are exactly quoted from Ukraine ACCREP letter, however some wordings were revised and the risk assessment of other departing airlines from IKA is explained.</p>
35.	Ukraine/ NBAAI	106	Paragraph 3.6.	"Availability of information and the Level of Access to them"	<p><b>Comment:</b> US NOTAM was irrelevant to PS 752 flight and was not designated to TEHRAN FIR. The timing of the news of the missile attacks is incorrect. The information provided in the Draft Final Report on the termination of flights due to the risk assessment specified in both paragraph 3.4.3 and paragraph 3.6 of the Draft Final Report is not based on evidence, is contradictory and irrelevant.</p> <p><b>Justification:</b> Comments and remarks as per Annex 2 "US NOTAM" Paragraph 3.6 of the Draft Final Report contains not evidenced information on the termination of</p>	<p>Amend the Final Report with Ukraine comments as provided hereof.  Delete all references to the US NOTAM as completely irrelevant.</p>	<p>This section was checked again. The information are correct and are reviewed by other relevant states.</p>



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					flights by British Airways in Baghdad and Tehran FIR and that the request for Flight BAW124 to enter Tehran FIR was the result of a risk assessment, since it contradicts not only the information set out in Paragraph 3.4.3 of the Draft Final Report but also the real circumstances of the case. In particular, British Airways Flight BAW124 was stopped on January 7 not due to a risk assessment, but because British Airways was denied access to Iranian airspace from Iraqi airspace due to restrictions on air traffic between Iran and Iraq. Moreover, British Airways stopped operating flights to Tehran (IKA) back in 2018.		
36.	Ukraine/ NBAAI	114	Paragraph 5.1	« ...Considering all the above analyses, due to the residual uncertainty of information and analysis related to second missile detonation, the proven effect of the first missile, the proven launch of second missile and the fact that for prevention of similar accidents, this information is enough, the investigation team concluded that making the conclusion about the detonation and effect of the second missile is not reliable and does not affect the outcome of this investigation.»	<p><b>Comment:</b> The information that the second missile failed and fired unsuccessfully according to the Air Defense Unit recordings is unsupported by any evidence. Ukraine disagree that effect of the second missile is not reliable and does not affect the outcome of this investigation.</p> <p>It follows that the study of the ADU recording is of great importance, since it has to be analyzed why and in accordance with which procedure, if any, it was decided by the operator of the Air Defense Unit to fire the second missile.</p> <p>Despite this categorical statement that the second missile did not hit the plane, paragraph 6, sub-clause 6.1 of the Draft Final Report states the probability of the plane not being hit by the second missile, which already puts under question the objectivity and unambiguous conclusions of the Iranian side.</p> <p>Information about the collision with the ground (paragraphs 2.13.1 and 2.13.2 of paragraph 2.13 "Flight Path, Impact Point and Wreckage Information" of section 2 "Factual information") indicates that "...After takeoff, the aircraft continued flying on the planned path, but at position [...] the signals of the ATC transponder and FDR recording stopped, soon after that the plane began to turn to the right and lose altitude. Already being on fire, the accidented into the ground at the point [...] and exploded. Shortly after the transponder stopped transmitting signals, the aircraft heading was changed to the right and after turning, headed toward the airport"</p> <p>According to the conclusions of the Draft Final Report, almost 4 minutes after the explosion of the warhead of the first launched missile in the immediate vicinity of the aircraft, "the aircraft retained its structural integrity until it collided with</p>	Continue the investigation in order to establish all facts related to the second missile and its affect for the accident and support the Draft Final Report with the relevant evidences.	A Paragraph was added to this section about the evidence that supports the effect of 2 <sup>nd</sup> missile on aircraft. As described before, for the safety objectives, firing the missiles toward the civil aircraft is a safety failure and effect of the second one is not important for safety prevention. As described in analysis, the videos support the conclusion that the 2nd missile affected the aircraft, but location data supports the conclusion that the missile was failed. At the end, the investigation team provided the safety recommendation as if the aircraft was hit by more than one missile.



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					<p>the ground, the three cockpit crew members were all still alive. They appeared to have sustained no physical injuries and were just involved in managing the situation".</p> <p>The direct impact on the aircraft of the second missile in sub-paragraph 6.2.1 of paragraph 6.2 "Accident Causes and Contributing Factors" is not mentioned at all.</p> <p><b>Justification:</b> Paragraph 1.3.1 of Chapter 1 of DOC 9756 Part IV The transcripts of the Air Defense Unit recordings were not provided to the Ukrainian investigation team.</p> <p>In contrast, the available evidence (FDR and CVR recordings, traces of missiles on various parts of the fuselage, etc.) indicates that the first Aircraft. The CVR continued to record for another 19 seconds, according to which the crew members continued to control the Aircraft, the engines continued to work, and accordingly the crew decided to return the Aircraft to the airport (IKA). Only the second missile strike to the Aircraft resulted in termination of the CVR recording and which turned out to be fatal for the Aircraft. Despite the above evidence, the Draft Final Report indicates that the second missile strike did not affect the results of the investigation's study. At the same time, the second missile strike could actually have destroyed the Aircraft.</p>		
37.	Ukraine/ NBAAI	113	Paragraph 5.1	«missiles function»	<p><b>Comment:</b> The text of this paragraph is focused only on the analysis of one version of the accident, namely on the impact of one anti-aircraft guided missile.</p> <p><b>Justification:</b> The calculation results given on page 120 are unacceptable.</p>	Revise these parts of the Draft Final Report, to finalize this section in accordance with the actual evidence.	The calculations was done with no presumption about number of missiles impacts but the fact that the 1 <sup>st</sup> missile caused damage to aircraft cannot be ignored.
38.	Ukraine/ NBAAI	114	Paragraph 5.2, subparagraphs 4-6	«Two ADUs were placed at the location of the launching ADU. The north alignment error like the launching system was repeated in one system, considered as the main one, while in the other, as the reference one, the north alignment error was corrected. The simulation also indicated that the aircraft flight operation did not paly a role in the occurrence of the error made by the air defense unit operator.	<p><b>Comment:</b> The text describes the results of a practical experiment (modeling launching conditions) which was conducted during the investigation. Information about the simulation of the situation to investigate the cause of the error and the launch of missiles cannot be either support or denied by Ukraine In addition, the investigation of the issue of the missiles launch must be carried out along with the decoding of the ADU recordings, to which the members of the Ukraine investigation team still do not have access.</p>	<p>The simulation of the cause of the error and the launch of missiles needs to be supported by any factual evidences.</p> <p>The results of the simulation (modeling) and their analysis needs to be presented in Section 2 Actual information, paragraph 2.19.1.</p>	The simulation was done by judicial authorities and not by AAIB, because the reason of such error should be identified and rectified by relevant authorities. Since it was important for AAIB to observe the effect of civil operation in misidentification, the investigation team observed the simulation and received relevant information. This simulation confirmed the analysis and conclusion of AAIB that no technical and operational aspects of PS752 contributed in this accident.



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				In the two times of simulation, the reference unit operators detected the aircraft from the IKA direction (Figure 53), while the main unit operators detected it approaching from the western area (Figure 54). After the detonation of the first missile in the proximity of the aircraft, the ATC transponder and FDR recording terminated simultaneously due to damage to the aircraft. The aircraft sustained cascading damage, as a result of which, after about 16.5 seconds, the rotation frequency of one of the generators (Electrical power supply - IDG) started to decrease, causing a reduction in frequency of recorded audios in CVR and termination of recording after 2.5 seconds »	<b>Justification:</b> Information about the simulation of the situation to investigate the cause of the error and the launch of missiles is not supported by any evidence.		
39.	Ukraine/ NBAAI	116	Paragraph 5.3	Whole paragraph	<b>Comment:</b> The conclusion that some airlines usually do not set requirements for CVR turn-on time and simply follow the usual manufacturer's instructions (FCOM), and on the need to turn on the CVR is incorrect. It should be noted once again that the Draft Final Report omits the transcript of 15 minutes of CVR recording from the start of the engines, which contains important information on communications between the crew members immediately before the Aircraft take off and evidences there was no unusual situation before departure and no worries on the part of the crew, no conversations about missile attacks. <b>Justification:</b> According to certain configurations of the Boeing 737-800 there are no CVR switches and CVR recording starts automatically after engine start.	The Draft Final Report needs to be amended with Ukraine comments on requirements for CVR turn-on time. The transcript of 15 minutes of CVR recording from the start of the engines should be included into the Final Report.	This analysis resulted to safety recommendation to ICAO and not the airline. The related recommendation is reviewed by ICAO and updated as their suggestions.
40.	Ukraine/ NBAAI	119	Paragraph 5.5	«Risk Assessment»	<b>Comment:</b> Paragraph 5.5 describes the process of risk assessment by a State controlling the airspace, Operator and State of Operator. Information about risk assessment by ANSP is absent. Absence of risk analysis by ANSP does not allow to make an objective conclusion as to the role of ANSP in the occurrence. <b>Justification:</b> Paragraph 1.3.1, part IV Doc 9756	Continue the investigation as it is incomplete and did not investigate whether ANSP assessed risks related to operations of civilian aircrafts in the conditions of military activity. Supplement Paragraph 5.5 with new paragraph 5.5.3 « ANSP risk assessment ».	Here, the state means ANSP, Regulator, Military authorities and all concerned parties within the state.



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41.	Ukraine/ NBAAI	119	Paragraph 5.5.1, subparagraph 2	Due to the information classification, the risk assessment had been done before, and the mitigating measures had been planned to reduce the risk to civil aircraft. The fact of misidentification of the target, occurrence of an unpredictable chain of events, etc. is mentioned again.	<p><b>Comment:</b> The text of this paragraph, as well as the whole Draft Final Report, does not specify at all who had performed the risk assessment in Iran and how these risks had been taken into account in the activities of Specific Civil Sector Officials.</p> <p><b>Justification:</b> The Draft Final Report lacks information what officials and how the risk assessment was carried out for civilian aircrafts. Conclusions about higher factual risk over predictable level of risk and realization of cheese model is premature until the version about intentional aircraft downing is excluded.</p>	<p>Amend the Final Report with information about who performed the risk assessment and in what way these risks were taken into account by exact civil sector officials in their work.</p> <p>Correction of the contents of this paragraph should be performed with consideration of absent data as to civil-military coordination, mostly its implementation on tactical level; determination of the causes of communication loss and its links, other important information.</p>	<p>These information are provided in 3.4. The mentioned communication loss is within military sector, not civil- military communication.</p>
42.	Ukraine/ NBAAI	120	Paragraph 5.5.1, subparagraph 8	«The investigation team found that the operating military unit was not basically responsible for monitoring the targets; it was just obliged to perform the actions planned within the command hierarchy only if a target was assigned to them from the command. ».	<p><b>Comment:</b> As it is mentioned in the Draft Final Report, investigation found that ADU operator did not monitor the airspace, but only executed instructions given by a command center. Ukraine considers that missile launch into Ukrainian aircraft is a gross violation of the instructions or execution of improper command from the command center to down the target.</p> <p><b>Justification:</b> Paragraph 1.3.1, part IV Doc 9756 The Investigation team determines that launching towards an air target was possible only through a direct order from the Air Defense Command Center. Ukraine considers that command center relevant instruction to the ADU operator to track PS752 flight should be investigated. In the same Draft Final Report (Section 2 Actual Information, paragraph 2.19.1, subparagraph 5 (see number 10)), no information is provided on the functioning of the air defense control system of the state (a sector). Therefore, the conclusion made by the Investigation team in this subparagraph is unconfirmed.</p>	<p>Continue the investigation as it is incomplete and did not investigate the role of the command center in launching the missile.</p>	<p>The interactions between ADU and its command center is given in the report. It was within military sector. Refer to ICAO Annex 13 standard 3.1.</p>
43.	Ukraine/ NBAAI	127	Paragraph 5.6, subparagraphs 1, 2	Apart from the tensions having existed in the Middle East for many years, the U.S. had declared a drone strike against one of the Iranian top commanders at Baghdad airport, following which Iran announced revenge, would definitely be taken.	<p><b>Comment:</b> Ukraine and UIA performed risk assessment using many sources of information. At the same time, it does not change the fact that Iran failed to provide UIA and Ukraine with necessary information, which could influence their risk assessment.</p>	<p>Amend the Final Report with the statement that despite the change in the military condition that was public and widely reported in the media, Iran failed to evaluate threats for flight safety, and</p>	<p>The actions of state managing the airspace and results of risk assessments are provided in report. This section does not contain the conclusion. The conclusions are in chapter 6.</p>



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				As such, there had, certainly, been adequate information to pay more heed to the condition in the region and possible hazards at the time »	Despite the fact that Iran had information about threats for flight safety, no measures were taken to close the airspace. Measures related to closing of the airspace were taken only after the aircraft was downed. Prior to the downing of UIA aircraft Iran's airspace level of risk remained unacceptable.  <b>Justification:</b> Annex 1 "Risk Assessment" and Annex 2 "US NOTAM"	no measures were taken to close the airspace».	
44.	Ukraine/ NBAAI	134	Paragraph 6.1, subparagraph 2	"The aircraft was misidentified as a hostile target by an air defense unit ... "	<b>Comment:</b> There is no research or evidence to support the conclusion that the Aircraft was mistakenly identified by the Air Defense Unit, nor is there evidence that Iran was attempting to identify the Aircraft, properly or at all.  <b>Justification:</b> Iran obviously failed to adhere to paragraphs 2.1.1 and 2.1.2 of the Annex 17 to Chicago convention. The Draft Final Report fails to comply with paragraph 1.1.2 of the ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of the Annex 13 to Chicago convention.	Continue the investigation as it is incomplete and did not investigate the attempts (if any) of identification by Air Defense Unit of the Aircraft.	Refer to Annex 13 standard 3.1.
45.	Ukraine/ NBAAI	134	Paragraph 6.1, subparagraph 3	"At 02:04:57, the warhead of the first launched missile detonated in the proximity of the aircraft and, almost simultaneously the aircraft transponders stopped transmitting the radio signals, together with termination of the FDR recording.	<b>Comment:</b> The information is confusing and irrelevant to the Conclusions of the Draft Final Report, since it does not confirm or deny the fact that the destruction of the Aircraft was caused by the missile.  <b>Justification:</b> The Draft Final Report fails to comply with the ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of the Annex 13 to Chicago convention.	The finding should be amended to state that that the destruction of the Aircraft was caused by the missile launched by the Air Defense Unit.	Firing the missiles are addressed in finding 2. Here the effect of 1 <sup>st</sup> missile is addressed.
46.	Ukraine/ NBAAI	134	Paragraph 6.1, subparagraph 4	"The missile detonation near the aircraft caused damage to the aircraft systems, after which the cascading damage was observable"	<b>Comment:</b> The finding is irrelevant to the Conclusions of the Draft Final Report, and is confusing, inaccurate and not supported by the available evidence.  <b>Justification:</b> The Draft Final Report fails to comply with ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of Annex 13.	The finding should be deleted.	The finding is relevant to provided facts and is on the basis of analysis of verified information. Refer to 2.18.4.
47.	Ukraine/ NBAAI	134	Paragraph 6.1, subparagraph 5	"After the detonation of the first missile, the three cockpit crew members were all still alive. They appeared to have sustained no	<b>Comment:</b> The finding is irrelevant to the Conclusions of the Draft Final Report, confusing, inaccurate and not supported by the available evidence. This	The finding should be deleted.	The finding is relevant to provided facts and is on the basis of analysis of verified information. Refer to 2.18.4.

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				physical injuries and were just involved in managing the situation."	information is merely a description of the facts, but not the conclusion.  <b>Justification:</b> The Draft Final Report fails to comply with ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of Annex 13 to Chicago convention.		
48.	Ukraine/ NBAAI	134	Paragraph 6.1, subparagraph 6	"At 02:45:09, the second missile was launched towards the aircraft by the air defense unit. It is likely that this missile did not affect the aircraft, yet it is not possible to comment on this explosion and its impact with acceptable certainty."	<b>Comment:</b> The finding that the second missile did not affect the aircraft is in the manifest contradiction with the available evidence and the circumstances of the Aviation Accident.  <b>Justification:</b> The Draft Final Report fails to comply with ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of Annex 13 to Chicago convention.	The finding should be deleted.	The finding is relevant to provided facts and is on the basis of analysis of verified information. Refer to 5.1.
49.	Ukraine/ NBAAI	134	Paragraph 6.1, subparagraph 9	"Within the airspace management, the information based risk assessment had been conducted, and various mitigation had been devised to provide the civil aviation safety for the threats caused by the potential hazardous military activities"	<b>Comment:</b> There is no evidence that a risk assessment has been carried out in relation to airspace management by the relevant authorities/persons from the Iranian side, the Ukrainian investigation team were not aware that any such risk assessment had ever been conducted.  <b>Justification:</b> The Draft Final Report fails to comply with ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of Annex 13 to Chicago convention.	The finding should be deleted.	The finding is relevant to provided facts and is on the basis of analysis of verified information. Refer to 3.4.
50.	Ukraine/ NBAAI	134	Paragraph 6.1, subparagraph 10	"In the risk management, only the stable conditions we considered, not the transient conditions".	<b>Comment:</b> The finding that only stable conditions were taken into account in Iranian risk management witnesses Iran's inability to duly control its own airspace or, attempts to justify its actions.  <b>Justification:</b> The Draft Final Report fails to comply with ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of Annex 13 to Chicago convention.	The Final Report should conclude that Iran was not able to duly control its own airspace	Refer to ICAO Annex 13 standard 3.3. Report amended to correct the typo.
51.	Ukraine/ NBAAI	134	Paragraph 6.1, subparagraph 11	«Civil-Military coordination was done according to the planned program, and the considered mitigation measures for aimed at reduce reducing the risk of misidentification and mistargeting of civil aircrafts was were	<b>Comment:</b> There is no evidence that Civil- Military coordination was properly conducted; and, it is not specified what measures, if any, were taken to reduce the risks of misidentification of civil aircraft and what their result was.  <b>Justification:</b>	This finding should be deleted.	The finding is relevant to provided facts and is on the basis of analysis of verified information. Refer to 5.5.1.



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				implemented in both civil and military sectors.	The Draft Final Report fails to comply with ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of Annex 13 to Chicago convention.		
52.	Ukraine/ NBAAI	135	Paragraph 6.1, subparagraph 12	" The risk management was not effective due to occurrence of the error which had not been previously predicted"	<b>Comment:</b> This finding is misleading, inaccurate and is not supported by the available evidence. It is not clear what was exactly the error which could not have been predicted by the risk management system  <b>Justification:</b> The Draft Final Report fails to comply with ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of Annex 13 to Chicago convention.	This finding should be deleted.	The finding is relevant to provided facts and is on the basis of analysis of verified information. Refer to 2.19 & 5.2.
53.	Ukraine/ NBAAI	135	Paragraph 6.1, subparagraph 14	" ... Even though some airlines and States had imposed restrictions using open and public information, none of the airlines whose flights departed from IKA had made any change in their flights on the basis of a risk assessment.	<b>Comment:</b> There is no evidence of imposition by some airlines and states of restrictions on flights to Iran. This conclusion is used by the Iranian side simply to level its own guilt in shooting down the Aircraft and creating a threat to civil aviation.  <b>Justification:</b> The Draft Final Report fails to comply with ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of Annex 13 to Chicago convention.	This language should be deleted.	This finding is given based on facts. Refer to 3.6. Refer to ICAO Annex 13 standard 3.1. The objective of this investigation was not to blame parties or identify the level of their guilt. This comment and language is not neutral nor technical.
54.	Ukraine/ NBAAI	135	Paragraph 6.2, subparagraph 6.2.1	"The air defense's launching two surface-to-air missiles at the flight PS752, UR-PSR aircraft, the detonation of the first missile warhead in proximity of the aircraft caused damage to the aircraft systems, and the intensification of damage led the aircraft to crash into the ground and explode instantly."	<b>Comment:</b> This finding is misleading and inaccurate. It does not contain any reference to the fatal impact on the aircraft of the second missile launched by the Iranian air defense unit.  <b>Justification:</b> The Draft Final Report fails to comply with ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of Annex 13 to Chicago convention.	The finding should be amended to correctly reflect the set of facts namely launch of two missiles and impact of the launch of both missiles on the aircraft.	Again, launch of two missiles is addressed in finding 2 and there is no need to repeat it in other findings.
55.	Ukraine/ NBAAI	138	Paragraph 7.2	Whole paragraph	<b>Comment:</b> The following recommendations should be added to the Final Report since they address the crucial deficiencies in the safety management system of the State bearing responsibility for the airspace revealed in course of investigation.  <b>Justification:</b> ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and Annex 13 to Chicago convention.	Recommendations to States bearing responsibility for the airspace: - Develop clear State regulations related to timely airspace closure or its usage restriction; - Develop clear State regulations related to timely provision of information to the interested States and operators as to possible risks for flight safety	The recommendations are results of findings and facts and are not supported by them.

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						<p>in military or potential military conflict zones;</p> <ul style="list-style-type: none"> <li>- Implement clear coordination between civil and military authorities, which would provide flight safety in airspace for civil aircraft;</li> <li>- Provide redundant communication channels in all military units whose activity is influential to the civil aircraft flight safety;</li> <li>- Develop and implement clear procedures as to evidence custody related to an accident;</li> <li>- Establish an independent national civil aircraft accidents and incidents investigation authority.</li> </ul>	
56.	Ukraine/ NBAAI	138	Paragraph 7.2.2.	<p>“Conduct oversight on effective implementation of the measures adopted for the risk management of potentially hazardous military activities and perform periodic exercises for risk assessment based on different types of probable conditions; apply the results obtained from the monitoring and exercises to identify the hidden threats and enhance the risk management accordingly.</p> <p>-Ensure that the airlines are able to quickly apply the open and public information issued by non-aviation sources in their processes of risk assessment”.</p>	<p><b>Comment:</b> The primary goal of recommendations is to address deficiencies in the safety management system, which might have contributed to the accident.</p> <p>In this particular case it is obvious that the accident was caused by the failure of Iran to manage and control its airspace and control its military, and Ukrainian airline operator neither could reasonably foresee the launch of two missiles, nor avoid their impact to the aircraft. The assumption therefore is that this particular recommendation is inserted into the Draft Final Report with the only purpose to cover and justify the fatal failure of the Iranian authorities to comply with the principles and basic requirements of Chicago convention.</p> <p><b>Justification:</b> The Draft Final Report fails to comply with ICAO DOC 9756 (Manual of Aircraft Accident and Incident Investigation) and paragraph 5.1.1 of the Annex 13 to Chicago convention.</p>	<p>Delete the said recommendations.</p>	<p>This is recommendation and the states have the right to accept it or not.</p>
57.	Ukraine/ NBAAI			<p>General comment about “The human and organizational factors behind the decision to fire missiles.”</p>	<p>The report contains very limited if any information regarding the underlying factors behind the ADU operator’s decision to fire the missiles. These factors potentially include human factors (such as situational awareness, training, perception, stress, authority gradient, etc.), technical factors (such as equipment errors, radar limitations, communications equipment failures), and</p>	<p>The investigation report should be amended to include factual information and analysis of the decision-making process that resulted in the ADU operator firing the missiles</p>	<p>The safety of civil aviation should not rely on military proceedings, but civil aviation shall be aware of military threats to avoid them simply.</p> <p>Military systems including human sources, hardware and procedures are not controlled, nor certified or overseen by civil aviation.</p>



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					organizational factors (such as training, procedures, risk analysis, etc.).  Without this information, the risk of the reoccurrence of such a similar action cannot be fully understood, and the resulting future risk analyses that evaluate the probability of this occurring will be inaccurate and ineffective.		
58.	Ukraine/ NBAAI			The general comment about “The factors behind the decision to keep the airspace open.”	The report contains some information related to the state’s decision to keep the airspace open following the military escalation (albeit with restrictions), but does not discuss whether the state’s actions met the requirements of the international standards, and more specifically, why the information on the known hazard was not shared.  Without this information, the report cannot make recommendations as to what should be done to prevent this specific situation from occurring again, nor help outside states learn from the event and make improvements of their own.	The report should be amended to include information regarding why information was not shared, and likely propose actions to prevent reoccurrences.	If the “known hazard” refers to Military alertness, AAIB believes that sharing the information should be improved and there is information, analyses and recommendations on that. If the “known hazard” refers to a hazard within the military system regarding misidentification of aircraft in those circumstances, this hazard in the military system was unidentified before this accident.
59.	Ukraine/ NBAAI			The general comment about “The decision by many airlines and specifically, UIA, to operate during the conflict.”	The report suggests that the airline operator made no risk assessment regarding its operation into Iran. This does not appear to be accurate. The operator has stated that it did complete a risk assessment, but this assessment was based on information provided from official sources, and therefore lacked information on the risk which should have been published by the state that was aware of the hazard, as outlined by ICAO Annex 15.  Additionally, the report does not thoroughly describe what information the operator knew, and when they knew it, nor evaluate the standards which detail how these risk assessments should be done.  Without a more thorough examination of this topic, operators will not be able to improve their own risk analysis processes, and similar events could reoccur.	The report should be amended to include more thorough information regarding the airline operator’s knowledge of the hazard, the timing and reliability of information received, and an assessment of the standards relating to air operator’s risk analysis processes.	This is a valid consideration. The official information received from UIA was limited to what is mentioned in the report. The airline believes that due to lack of official information they could not conclude that conducting the flight would be unsafe. AAIB believes that even it was difficult for the airlines to collect public information; the airlines should be able to pay more attention to information from public sources, and has provided recommendations in that regard to the ICAO.
60.	Ukraine/ NBAAI			The general comment about “The independence of the Aircraft Accident Investigation Board.”	The report presents significant information that suggests that the AAIB is not “independent from State aviation authorities and other entities that could interfere with the conduct or objectivity of an investigation” as required by Annex 13.  Some of these details include: 1. The organizational structure of the AAIB within the CAO.	Suggest that the report clarify the current dependence of the AAIB, and the national laws and restrictions which would prevent independence, and possibly limit the scope of the investigation, or challenge its objectivity.	The investigation was instituted on the basis of Civil Aviation Accidents and Incidents Investigation Bylaw, adopted by Iran’s Cabinet of Ministers on August 21, 2011. This bylaw defines the questions raised in this respect and could be accessed on: <a href="https://rc.mallis.ir/fa/law/show/807963">https://rc.mallis.ir/fa/law/show/807963</a>

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					<p>2. The appointment of a CAO staff member as the investigator-in-charge.</p> <p>3. The stated lack of access to military information, and the reliance on information provided.</p> <p>4. The narrowing of the investigation scope, to eliminate examination of the military process.</p> <p>5. The participation of the AAIB in the judicial investigation.</p> <p>Under Annex 13, the sole purpose of safety investigations is to prevent accidents and incidents. To achieve this objective, investigation authorities must remain independent from national and foreign entities that could interfere with the conduct or objectivity of their investigations. Investigation authorities therefore have a fundamental responsibility to uphold this independence to remain unimpeded from undue pressures, and to preserve the integrity, transparency, credibility, and impartiality of all investigations.</p> <p>When this independence is challenged, the effectiveness of the investigation reports produced, and the recommendations found within, are greatly reduced.</p>	<p>With this transparent explanation, the report may be better received, and the credibility of its findings and Recommendations significantly improved.</p>	<p>AAIB is functionally independent from other organizations and in this case is completely independent from ANSP and Military sections.</p> <p>The assignment of IIC by president of CAO is a procedural act to start the investigation and after assignment, the IIC has independence and his/her independency is supported by regulation.</p> <p>Sometimes, the nature of accident and the related challenges are so that the expertise of CAO personnel should be used for management of the investigation and national and international coordination. In such cases the independence of IIC is controlled by "Management of conflict of interest" manual and the outcome of the investigation.</p>
61.	Ukraine/ NBAAI	11	Section 1.1	Iran's Vice Minister of Roads and Urban Development and the president of Civil Aviation Organization designated the investigator-in-charge for this accident.	This statement appears to suggest a lack of independence from the regulator, or other government departments.	Clarify how independence was assured	<p>AAIB is functionally independent from other organizations and in this case is completely independent from ANSP and Military sections.</p> <p>Sometimes, the nature of accident and the related challenges are so that the expertise of CAO personnel should be used for management of the investigation and national and international coordination. In such cases the independence of IIC is controlled by "Management of conflict of interest" manual and the outcome of the investigation.</p> <p>The assignment of IIC by president of CAO is a procedural act to start the investigation and after assignment, the IIC has independence and his/her independency is supported by regulation.</p>
62.	Ukraine/ NBAAI	11	Section 1.1	This investigation was done in compliance with the provisions of Annex 13 to the Chicago Convention, whose Standards and	There were some issues that weren't exactly in keeping with Annex 13, such as the preservation of the crash site, and the delay in recorder download.	Suggest clarify or explain these deviations.	Articles 19 and 20 of Civil Aviation Accidents and Incidents Investigation Bylaw, adopted by Iran's Cabinet of Ministers on August 21, 2011 defines



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				Recommended Practices were applied accordingly.			preservation of crash site and AAIB believes that even though the crash site was in a middle of residential area, the preservation activities were acceptable. The process for readout of flight recorders is described in 2.18.3.
63.	Ukraine/ NBAAI	16	Section 1.6	Second, if the factors contributing to an accident are not well determined and eliminated, the identification of the liable individuals and eliminating them from the system in place will not entail the prevention of similar occurrences. On the contrary, the very factors leading such liable individuals to commit the error, causing the accident, will still be lurking for others; hence, similar accidents will take place through others' negligence in the same area.	Although this is stated, and accurate, it doesn't seem in this case that this guidance is being followed. It is our understanding from reviewing information from media sources that the individuals involved have been removed, and punished as part of the military/judicial investigation, and that they have been 'blamed' and accused of 'negligence', two things that are specifically prohibited under Annex 13.	Suggest remove or clarify that other organizations may investigate for other purposes.	This explanation falls in the scope of Annex 13 safety investigation. Military disciplinary measures and judicial proceedings follow their own regulations and are independent from safety investigation.
64.	Ukraine/ NBAAI	29 29 66	Section 2.10 Section 2.11.2 Section 2.18.4	Investigations indicate that the required navigational aids related to the flight had been operational and in good condition.  And RDR – You have GPS failure?  And 02:44:43 Captain – GPS right invalid	There are significant indications of a GPS outage of some degree.  A GPS outage could have been a result of many factors, some of which could possibly be related directly to the event.  This issue needs to be examined and discussed.	Suggest to include all of the information regarding GPS outages in this section, and consider its potential in relation to the event.	The aircraft was flying in planned route with no deviation from the expected trajectory and altitude. No navigation problem was contributed to misidentification of aircraft.
65.	Ukraine/ NBAAI	38	2.13.2	Due to the vast area of the crash site, filled with the aircraft parts, and the impossibility of a long- term protection, the wreckage parts were collected and transferred to a safe place at IKA, where they were separated and laid out by the relevant experts.	This issue, and whether or not this procedure followed Annex 13, is debatable, and without further explanation this action will likely be viewed negatively.	Suggest adding more information regarding how and why the decision was made to do this, and why this decision made sense at the time, to the person/group who made it	In 2.13.2, first paragraph describes the condition.
66.	Ukraine/ NBAAI	75	2.19.1	After the relocation of one of the air defense units of Tehran, clearly causing a change in its heading, it suffered an error of 107 degrees due to failure in conducting north realignment properly.	As this issue is key to the whole investigation, it needs to be explained, in significant detail.	Suggest to explain in a comprehensive manner, how such an error occurred.	The AAIB could observe the evidences showing the misalignment of ADU. The AAIB continued its investigation and ensured that the cause of this error was not induced from civil aviation operation and after that, AAIB concluded that no improvement in civil side could be suggested to prevent north misalignment of military vehicles. AAIB focused on measures to avoid civil aviation from similar hazards in military system and hence, although



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							information related to this event is provided in AAIB Factual report, focusing on that in final report cannot help civil aviation.
67.	Ukraine/ NBAAI	75	2.19.1	At 02:44:19, the operator notified the specifications of the detected target to the relevant Coordination Center via the communication network.	This does not appear to be accurate. It is our understanding, from reading other information contained in the report, that the operator DID NOT communicate the target to the Coordination Center.	Suggest clarifying how or why this communication, if it was attempted, was not successful.	The report amended accordingly. The reason falls within the military communication system and identifying the reason of this failure is out of the scope of this investigation.
68.	Ukraine/ NBAAI	89	Section 3.4.1	Considering the possibility of the conflict escalation through the American counterattack by its military forces in the region, the relevant defensive units, including the air defense sector was placed on a higher level of alertness.	It is not clear in the report what the 'level of alertness' was. The report speaks of 'conflict' and 'surveillance' but does not define when each threshold is reached.  The described risk analysis describes different risk levels depending on whether or not a 'conflict' is underway, but it is not clear whether or not a conflict was underway in this case.  Table 8 seems to suggest that the alertness level was 'surveillance', and this is the only level that would permit departures from IKA.	Suggest clarifying.	3.4.1 only describes the prevailing conditions and details of level of alertness, including the level at the time of accident is described in 3.4.2. The report is clear in this regard.
69.	Ukraine/ NBAAI	89	Section 3.4.2	In the event of a conflict, it was likely that the defense system would misidentify the aircraft leaving the country's airports as a hostile aircraft. The risk associated with these flights was calculated to be very low.	This states that it was 'likely' that defense would misidentify a departing aircraft from its own airports, but however the risk was very low? This doesn't appear to be accurate.	Suggest to verify / correct.	In normal condition, the departure flights receive clearance for takeoff from ATC and the information will transfer to military sector. In alertness level, in case of any failure in transferring the information, it could be likely that a civil aircraft be identified as unknown and then a threat. The mitigation was to receive clearance from defense in advance to eliminate this probability.
70.	Ukraine/ NBAAI	114	Section 5.1	the investigation team concluded that making the conclusion about the detonation and effect of the second missile is not reliable and does not affect the outcome of this investigation.	It is known from the CVR recordings that the crew survived the first missile impact and there is no evidence to suggest the aircraft was out of control before the second detonation. It is very possible that the crew may have been in full control of the aircraft until the second missile hit.  Given the time between the firing of the two missiles, the reason for the firing of the second missile without attempting communication with central control should also be described, and discussed.  The second missile may in fact have been the missile that caused the aircraft to crash.	Suggest to amend the report to include explanation of the decision process for the second missile firing, and a more accurate estimation of the proximity to the aircraft	Misidentification of civil aircraft and firing missile toward it is the main finding. Even firing one missile is enough to dramatically endanger the safety of civil aircrafts and the decision process for firing the second missile and its effect will not change this fact. It is proven that the first missile had effect on aircraft and the aircraft was hit by missile. So, the fact is the plane was hit by the missile. The conclusion and recommendation of report are so that to cover the probable effect of second missile.

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71.	Ukraine/ NBAAI	116	Section 5.2	after about 16.5 seconds, the rotation frequency of one of the generators (Electrical power supply - IDG) started to decrease, causing a reduction in frequency of recorded audios in CVR and termination of recording after 2.5 seconds.	<p>This does not appear to have been discussed before.</p> <p>If the CVR stopped recording when the IDG's spooled down, this possibly means that both the engines shut down at this time as well. If so, this is a very important detail.</p> <p>Also, this concept raises the concern that this CVR didn't have an independent power supply. If it did (as is required for new types since 2013), the investigation would have had audio until the aircraft hit the ground, greatly aiding the investigation.</p>	Suggest to revise the report to include this information.	This section of report is based on analysis and conclusions provided by BEA and NTSB and their point of view as involved states is valid for AAIB
72.	Ukraine/ NBAAI	119	Section 5.5.1	Risk Assessment by the State Managing the Airspace As the missile attack on Al Asad base had been planned in Iran, there was enough time and information at hand to predict the situation and assess the risk for civil flights in Iranian airspace	<p>This section does not describe the organizational structure outlining which persons or positions are tasked with the actions or decisions related to the risk assessment.</p> <p>Without this information, it is very difficult to understand the processes, and for the reader to understand why the process was not effective.</p>	Suggest revising this section to include more thorough information regarding the organizational factors behind the risk assessment decision-making process.	3.3 and 3.4 describe these details and the report is clear.
73.	Ukraine/ NBAAI	120	Section 5.5.1	The target specifications were communicated to the command center, but the message was never relayed.	It is not clear why the message was not relayed, and why the communication was defective. This defective communication is a main contributing factor that likely has a significant effect on the ADU operator's decision making	Suggest to amend the report to include significant information to explain why the communication were ineffective.	The reason falls within the military communication system and identifying the reason of this failure is out of the scope of this investigation.
74.	Ukraine/ NBAAI	122	Section 5.5.1	In fact, it was beyond the scope of this investigation to investigate the actions and their root causes within the military sector.	Although the state of occurrence has stated that this is beyond the scope of the investigation, without this information being examined, the risk assessments that occur in the civilian sector will never be able to accurate forecast risk related to military activity.	Suggest amending the report to include additional information to describe the misalignment, ineffective communication, and decision-making process to fire without authorization.	The method of improving safety and enhancement of risk assessments is to have a better avoidance from military threats and to identify the hidden risks in military systems. These goals can be achieved by considering the transient risks and data mining of near miss events and are addressed in report. The wording was amended.
75.	Ukraine/ NBAAI	122	Section 5.5.1	The result of such assessment was similar to the previous one, and again, clearance for PS752 to conduct the flight was evaluated to be safe and coordination with air defense before startup approval was evaluated to be enough to eliminate the possibility of misidentification.	The statement says that this exact same sequence of events can happen again tomorrow, with the same results. This is obviously not acceptable.	Suggest the report be amended to clearly identify the steps that have been, or will be taken to ensure that future risk assessment do not reach the same conclusion.	The report has been amended and safety actions are listed in report. The statement says that this exact same sequence of events could happen again, with the same results and identified the weakness of existing approach and found out that the risk assessment was failed because the transient risks were not taken into account. The safety recommendation and safety actions are effective in preventing similar occurrence.
76.	Ukraine/ NBAAI	119	Section 5.5.1	*General comment on complete section.	This section presents a lot of human factors and risk assessment theory, but does not provide any references or academic sources where the	Suggest amending the report to include references for the presented theories.	These theories are based on deep analysis during the investigation and are recommendations. AAIB believes that



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					concepts are grounded. The significantly reduces the veracity of the claims.		there is a need for reviewing the existing approaches and to define the details of mentioned ideas and defining the characteristics of transient condition would not be accurate and real at this step as mentioned in report.
77.	Ukraine/ NBAAI	125	Section 5.5.2	As for PS752, no restriction whatsoever had been imposed neither by Ukraine nor the UIA.	There was no official information on which to base this risk assessment, and some guidance suggests that basing these assessments on media information can be ineffective.	Suggest amending the report to consider this fact.	Section 5.5.2 (typo in addressing this comment) The same idea is presented in report and since the availability of information is a critical item in risk assessment, chapter 5.6 is dedicated for this topic.
78.	Ukraine/ NBAAI	122	Section 5.5.1	The conditions changed at such a pace and time that the exclusive sources for the provision of aviation-related information useful for the airlines did not publish any new information.	The explanation needs to be expanded. The Civil air traffic services were aware of the hazard before PS752 departed, as they were aware of restrictions; however, they did not issue a NOTAM as would be required by ICAO.	Revise the report to clearly explain the decision-making process that result in the AIS/ANS not issuing a NOTAM to inform operators of the known hazard.	Section 5.5.2 (typo in addressing this comment) This section talks about awareness of airlines, no the ANSP.
79.	Ukraine/ NBAAI	127	Section 5.6	As such, there had, certainly, been adequate information to pay more heed to the condition in the region and possible hazards at the time.	This suggests that the airline operator should have paid more attention, yet the state of occurrences itself evaluated the threat as low. So, in fact the assertion is that the operator (with limited information) should know better than the country (that has all of the information).	Revise the report to remove the assignment of blame, and reconsider the decision-making process in each case, for both airline operator and state of occurrence.	The report does not assert that the airline should know better than the airspace manager. It simply states the conditions existing in the region for several days and all parties involved (not just the airline) could have had much more focus on any signs of military threat to civil aviation. As stated in report, the ANSP was aware of this condition and the reason for failure in risk assessment is described in the report.
80.	Ukraine/ NBAAI	128	Section 5.6	Operationally, all the planned measures were implemented promptly, but the ANSP assumed that based on definitions and criteria for issuance of NOTAM in ICAO Annex 15, NOTAM is an operational tool for people involved in air navigation.	This is not accurate. The definition of NOTAM in Annex 15 says: A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.	Suggest to revise the analysis to examine the ANSP's misunderstanding of the definition and purpose of a NOTAM.	This section does not confirm the assumption of ANSP about NOTAM, but rather it simply explains the reason behind this action. Safety recommendations to the state to prevent such misunderstanding and to ICAO to enhance the definition are issued.
81.	Ukraine/ NBAAI	135	Section 6.	12.The risk management was not effective due to occurrence of an error which had not been previously predicted.	This finding is the only one which mentions the 'error' at the ADU operator level. This error is fundamental to the cause of the crash, and should be described in the findings (and cause) section.	Suggest revising to include significantly more information regarding the ADU operational error and decision- making process.	Information relating to north alignment error is included in the body of report and there is no need to repeat the information and analysis in this section.
82.	Ukraine/ NBAAI	139	Section 7.2.3	To ICAO: Revise the Standards related to the issuance of NOTAMs in such a way that air navigation service providers promptly issue the NOTAMs in case of any change or restriction imposed in the provision of services due to potentially	<b>Comment:</b> The report does not discuss the current requirements for the issuance of NOTAMs, and show where, in the AAIB's opinion, these standards are inadequate.	Suggest to include information in the report to support the AAIB's assertion that these current standards are inadequate. Or, alternatively, explain in thorough detail, the decision-	This recommendation is reviewed by ICAO and AAIB received their comment about that. The recommendation will be issued according to ICAO's comment.





Number	State / Organization	Page	Section / Paragraph	Text to be corrected	Argument	Suggestion	IRAN AAIB Response
				hazardous military activities or civil-military cooperation considerations independently of the operational application, in a format that these NOTAMs could indicate that the change has been made due to security or military considerations.	On our review of these standards, they seem to already include this requirement.  Annex 15 6.3.2.3 - A NOTAM shall be originated and issued concerning the following information:  m) presence of hazards not otherwise promulgated, which affect air navigation (including obstacles, military exercises and operations, intentional and unintentional radio frequency interferences, rocket launches, displays, fireworks, sky lanterns, rocket debris, races and major parachuting events);  n) conflict zones which affect air navigation (to include information that is as specific as possible regarding the nature and extent of threats of that conflict and its consequences for civil aviation);	making process that resulted in the required NOTAMs not being issued.	
83.	Ukraine/ NBAAI	139	Section 7.2	Develop a framework necessary for gathering information on the near-miss accidents and events caused by targeting a civil aircraft, including the provision of definitions and examples, the method of information collection, reporting, sharing, continuous revision of approaches, standards and guidelines on the basis of the analysis conducted on such information at national, regional and international levels.	As discussed in this report, for the numerous reasons presented, this goal is almost certainly not attainable, so stating it as a recommendation distracts from the other recommendations.	Suggest remove.	This recommendation is reviewed by ICAO and AAIB received their comment about that. The recommendation will be issued according to ICAO's comment.
84.	Ukraine/ NBAAI	138	Section 7.2.2	Conduct oversight on effective implementation of the measures adopted for the risk management of potentially hazardous military activities.	The recommendation addresses the 'new measures' adopted, but the report does not state at any point what these 'new measures' are, or whether they would have been effective in this case.	Suggest revising report to include comprehensive information regarding the new measures (see MH17 report), and the potential effectiveness	This recommendation is reviewed by ICAO and AAIB received their comment about that. The recommendation will be issued according to ICAO's comment.
85.	Ukraine/ NBAAI		General	*Timeline	The report would benefit significantly from a table with an event timeline, with all events listed in one table.  This would help ensure the sequence is clear, and not open to misinterpretation.	Suggest to include.	Good suggestion, but definition of "all events" or "key events" is not clear and providing a set of events in a table might be considered as the investigation team decided which event was more important.
86.	Ukraine/ NBAAI	19	Section 2.1	and after four minutes landed on the IKA runway.	This says it landed at 21:27, but the logbook says 21:28	Suggest to amend.	Here, the difference is in order of seconds and the difference is the result of rounding the time and this difference does not affect the report.



Number	State / Organization	Page	Section / Paragraph	Text to be corrected	Argument	Suggestion	IRAN AAIB Response
87.	Ukraine/ NBAAI	50	Section 2.16	Under the Emergency Response Procedure and Air Accident Regulations, upon communication failure with the PS752 flight, the Rescue Coordination Committee (RCC) was immediately formed in Tehran ACC, and the necessary notifications were subsequently sent to the relevant authorities.	It would be helpful to include the time of the various events within this sequence to better understand when each of these steps occurred.	Suggest to amend.	Prefer to keep the existing structure.
88.	Ukraine/ NBAAI	76	Section 2.19.1	The system recorded the activation of the missile proximity fuse at 02:44:57.	This time is one second off other associated times	Suggest synchronize time with other events.	This is a fact that was recorded in ADU, however the uncertainty of directions and times related to missile is explained in 1.6.
89.	Ukraine/ NBAAI	106	Section 3.6	The news on the missile attack on Al Asad airbase on Jan.08, 2020 (Tehran local time) was publicly announced after a few minutes following the attack.	No time stated.	Suggest to amend.	The times are described after this paragraph.
90.	Ukraine/ NBAAI	106	Section 3.6	In an official statement released in the very hours	Not clear what 'in the very hours' means.	Suggest to clarify	The statement of US DOD is accessible on web archive. News websites covered that statement and the time of published news is accessible at least from 03:11 Tehran local time. Refer to footnote 13.
91.	Ukraine/ NBAAI	106	Section 3.6	The news of this statement was also published in the mass media. It could be accessed at least at 20:41 on January 08, 2020 Tehran time, equal to 02:11 on January 07, 2020 UTC11.	This report says the missiles were launched at Iraq between 2230-2235 (understood to be UTC?) This is 0200- 0205 local time. It is difficult to believe it 'could be accessed' at 2041, (six minutes after it occurred). Also, it seems that in the statement, UTC and Local are reversed. 20:41 Local is not 02:11 UTC.	Suggest to amend.	The report amended for using a single time reference. The news is accessible on webpage from 02:40 local time, i.e about 35 minutes after the attack. Refer to footnote 14. The link was added to footnote.
92.	Ukraine/ NBAAI	106	Section 3.6	The Islamic Republic of Iran Armed Forces released an official statement regarding the missile operation, which was covered by Iranian news agencies at around 02:40 on January 08, 2020 Tehran time and published in the international mass media shortly.	Verify accuracy. This says that the armed forces made a public statement at 2:40 am in the morning, 35 minutes after the missile operation. If true, suggest some sort of reference to verify that this occurred.	Suggest to verify / clarify.	The news is accessible on webpage from 02:40 local time, i.e about 35 minutes after the attack. Refer to footnote 14. The link was added to footnote.
93.	Ukraine/ NBAAI	11	Section 1.2	As for this accident, the interference of a military activity with civil aviation operations resulted in an accident.	This conclusion is out of place in this section, as no support information has yet been discussed.	Suggest amending to place conclusions at the end.	This is introduction of report and includes general information and should not be considered as a conclusion.
94.	Ukraine/ NBAAI	24	Section 2.7.1	Captain, aged 50, had experience of 8428 hours total flight time, including 4462hrs on B737 NG and 3966hrs on B737 CL with almost 35hrs flight time to Tehran. Copilot, aged 48, had experience of 3642 hrs total flight time, including	These details state that the Captain and Copilot had never flown any other aircraft than Boeing 737 variants, i.e., no training aircraft or other types. Similarly, it says the flight instructor has never flown anything other than commercial jets.	Suggest clarify / correct.	It states "including" and does not mean just.



Number	State / Organization	Page	Section / Paragraph	Text to be corrected	Argument	Suggestion	IRAN AAIB Response
				266 hrs on B737 CL, 2002 hrs on B737 NG and 1374 hrs of B737 experience before joining UI with almost 48 hrs flight time to Tehran. Flight instructor, aged 42, had experience of 10895 (9820 B737) hrs total flight time, including 3240 hrs on B737 NG, 6580 hrs on B737 CL and 1075 hrs on EM 190 with almost 55 hrs flight time to Tehran			
95.	Ukraine/ NBAAI	38	Section 2.13.2	While flying past a village called Boke near Shahriar, some skin pieces belonging to the aircraft wing back end surfaces (Figure 9) were detached and found on ground at position N 35 35 55, E50 59.	This location is 2.5 km off of the path shown in figure 8.	Suggest to verify / clarify.	This location is correct.
96.	Ukraine/ NBAAI	57	Section 2.17.4	By sampling the air conditioning system and the two ELT pieces of the aircraft	It is not clear why the ELT's were sampled for DNT.	Suggest to clarify.	Several parts were sampled. Some of them as random selection of different sections of aircraft.
97.	Ukraine/ NBAAI	62	Section 2.18.2	The condition of these recorders indicated that the CVR and FDR had not been exposed to the fire in the aircraft	It is not clear how it was determined that the FDR did not receive fire damage while in flight.	Suggest to clarify.	The signs of fire on pieces was similar to the surrounding area in crash site which were not exposed to in flight fire.
98.	Ukraine/ NBAAI	68	Section 2.18.4	02:42:29 captain Easy easy don't pull 02:42:30 captain It is not helping you Just this 02:42:35 captain I haven't ability to pull simultaneously you and plane	These statements make it unclear who is 'pilot flying' and who is 'pilot monitoring', and what they are pulling on.	Suggest to clarify.	It is before the detonation and is not an important point, considering the normal condition at that time.
99.	Ukraine/ NBAAI			Editorial comment about "references"	The report frequently speaks with authority, alluding to international standards, national laws and policies, risk assessment methodology and human factors theory, however does not provide actual reference for these topics. Without providing specific references an investigation report can appear to be unsupported and the safety recommendations contained within to be considered as unresearched statements of opinion.	Ensure that any concept, theory, policy, procedure, standard or regulation, that is present in the report, is supported by a footnote containing the appropriate reference material.	The mentioned concepts are basic and fundamental concepts in aviation safety and are well-known. Adding references for these well-known concepts or approaches was not considered to be necessary, because they are self-explaining.
100.	Ukraine/ NBAAI			Editorial comment about "ICAO format"	This report differs significantly from ICAO format recommended by Annex 13 (Appendix 1), most noticeably in the sectional organization within the body.  The recommended format being: 1. Factual information 2. Analysis 3. Conclusions 4. Safety recommendations/safety action taken	Suggest to amend the report to conform to the format recommended by Annex 13.	ICAO Annex 13 recommendation 6.1 states that: " Recommendation.— The format of the Final Report in Appendix 1 should be used. However, it may be adapted to the circumstances of the accident or incident." The format of this report is in compliance of ICAO Annex 13. And is tailored to the circumstances of this accident. The MH17 investigation report format was also taken into



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					Differing from the well-established standard can cause reports to be difficult to read, especially for those that are familiar with the usual presentation. Additionally, the standard has been improved extensively throughout the years to help ensure that investigation reports that follow this format are successful at achieving their goal, that is to prevent future accidents by ensuring the contained conclusions, recommendations, supporting factual information and analysis, are clearly understood.		account as one of the best practices for similar accidents.

## RISK ASSESSMENT

According to Annex 17 to the Chicago Convention (3.1.3) both Ukraine and Islamic Republic of Iran shall keep under constant review the level and nature of threat to civil aviation within its sovereign territory and airspace above it.

Thus, as it mentioned, Iran, not Ukraine, as it prescribed in para. 3.1.2 DOC 10084, has the exclusive sovereignty of the airspace over its territory; the over flight in sovereign airspace can only be conducted solemnly in accordance with authorization of Iran. Ukraine has the analog rights concerning its territory and the airspace over it. As a result, Ukraine did not oblige to do such risk assessment over the territory of other sovereigns.

Iran, not Ukraine, can also prohibit or restrict use of the airspace over its sovereign territory, fully or partially, for reasons of military necessity or public safety, but no State (including Iran) can compel another State (Ukraine) to do so (para. 3.1.2 DOC 10084).

The investigation concludes that UIA had not initiated a risk assessment. We entirely disagree with these conclusions based on the following.

UIA implements and exercises, and did in the circumstances of Flight PS752, its assessments of risks and hazards based on the applicable international and domestic regulations and standards as well as the internal producers implemented by the airline. In particular

in accordance with the requirements of ICAO Annex 17 (Security) to the Chicago Convention, Doc 8973/11 (2019), Aviation Security Manual, Doc 10108, Aviation Security Global Risk Context Statement, Doc 10084, Risk Assessment Manual for Civil Aircraft Operations Over or Near Conflict Zones, Doc 10084, the Law of Ukraine no. 651965-VIII On State Programme for Aviation Safety of Civil Aviation dated March 29, 2017, Guidelines for assessing the safety threat to civil aviation of Ukraine, approved by the Order No390 issued by the Ministry of Transport and Communications of Ukraine dated May 11, 2007, Aviation Security Risk Management Programs No. 00 of Ukraine International Airlines JSC dated November 8, 2019.

Risk assessment is based on the information, facts and statistics received from the designated civil aviation authority, aviation security sections of airports, other state authorities, and individuals. Risk assessment methodology consists of three main pillars:

- analysis of potential threats, including probability and implications;
- assessment of residual risk;
- providing recommendations for further risk assessment and mitigation.

Threats and Risks Assessment to Aviation Security is performed by the UIA's team of aviation security through identification of the following factors:

- threat directed at a specific object, means and methods of a potential attack;
- threat probability;
- implications and scope of likely impact;
- assessment of efficiency of the existing security measures within the established scenarios of threat mitigation;
- remaining vulnerability – the level of vulnerability that remains after the threat mitigation measures are taken;
- assessment of the risk remaining upon the successful attack on the facility, which enables making decision on its acceptability from the risk management standpoint.

Starting from the operation of the KBP-IKA-KBP (Kyiv - Tehran – Kyiv) route in 2014, in accordance with the threats and risks assessment performed, UIA introduced certain risk mitigating procedures: monitoring over the security situation in the region and following information about any emergency incidents on a permanent basis. In addition, the crewmembers were interviewed on any military suspicious activity at the airport or on the territory near the airport on a random basis by security officers of the airline. The technical

hatches of the aircraft, accessible from the ground without using equipment, had to be checked and sealed for each flight.

In June 2019, after the events related to the shooting down of the U.S. military's remotely piloted aircraft systems by Iranian military forces, UIA's security threats and risks assessment for the KBP-IKA-KBP route was performed again and the decision to interview the crews on an ongoing rather than random basis was taken, as well, the permanent the monitoring of the military and political situation in the region became more intense.

After events on the night of January 3, 2020, which caused the increase of tension between the United States and Iran, UIA was following very closely the situation and performed its risk assessments considering these new circumstances.

While performing the risk assessment, UIA considered various sources of information and analyzed different indicators that could have notified that there was an increase of risk for the performance of the flights to Imam Khomeini International Airport (IKA). In particular, the monitoring and assessment of security threats revealed that IKA (which has a civil purpose only), to which the airline operated flights, was functioning in a normal operation mode. The general security situation in at IKA was steady. According to information received from crewmembers during the interview after flights on the KBP-IKA-KBP route during the period from 03.01.2020 to 06.01.2020, there was no suspicious military activity, armed persons, or military equipment detected directly at the airport or at the surrounding area. The distance from IKA(Tehran), Iran to Baghdad, Iraq is approximately 695 km.

All flights to IKA were performed in accordance with the then current NOTAM requirements, applicable to the route, of both the aviation authorities of Ukraine and authorities of other countries, including the Islamic Republic of Iran, as well as EASA Bulletins. There were no restrictions on flights to the Islamic Republic of Iran, including IKA. The situation related to the events of January 3, 2020 was continuously monitored and assessed.

Information on security was monitored both throughout the Islamic Republic of Iran and near IKA on the basis of available official information resources in the field of civil aviation, including collections of aeronautical information, notices for airmen (NOTAMs), Advisory Circulars with aeronautical information of Conflict Zone Information Bulletins (CZIB). Existing media sources were also used to monitor the situation.

To increase the level of aircraft safety, all the service hatches (panels) of the aircraft were checked during the preparation of the aircraft for departure on the KBP - IKA route and sealed in accordance with the sealing scheme. After sealing, the aircraft technician handed over the completed diagram to the co-pilot to be used during the inspection of seals on service hatches before departure from IKA.

On January 6, 2020, a threat and risk assessment was performed by the aviation security of UIA:

#### **Threats and Risks to Aviation Security Matrix KBP-IKA-KBP as of 06.01.2020**

#	Threat Type	Probability level	Level of implications	Level of vulnerability	RISK CATEGOR Y	Risk acceptance criteria
1	Use of MANPADS, SAMs	Middle –Low	High	Middle	<b>Middle – Low</b>	Acceptable
2	Use of unmanned aircraft system (UAS)	Middle –Low	Middle – High	Middle – High	<b>Middle – Low</b>	Acceptable

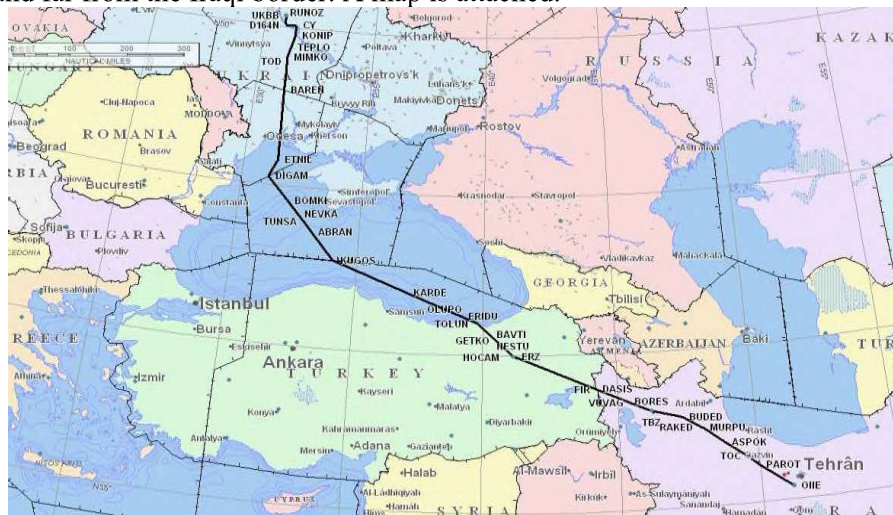
In addition, the scheduled flights to IKA were not altered by other carriers, such as: Azerbaijan Airlines, Qatar Airways, Lufthansa, Austrian Airlines, AtlasGlobal, Aeroflot, Iran Air, Iran Airtour, Mahan Airlines, Turkish Airlines and Emirates.



On January 08, 2020, at the time of Iran's missile attack on US military bases in Iraq, the Aircraft (UR-PSR) and the crew of UIA's Aircraft operated as Flight PS752 were already in Tehran. Once the first references to Iran's missile attacks on bases housing US forces in Iraq appeared on the Internet, UIA decided to continue monitoring the situation with the missile attacks until the scheduled departure of the Flight in order to apply additional security measures, if necessary.

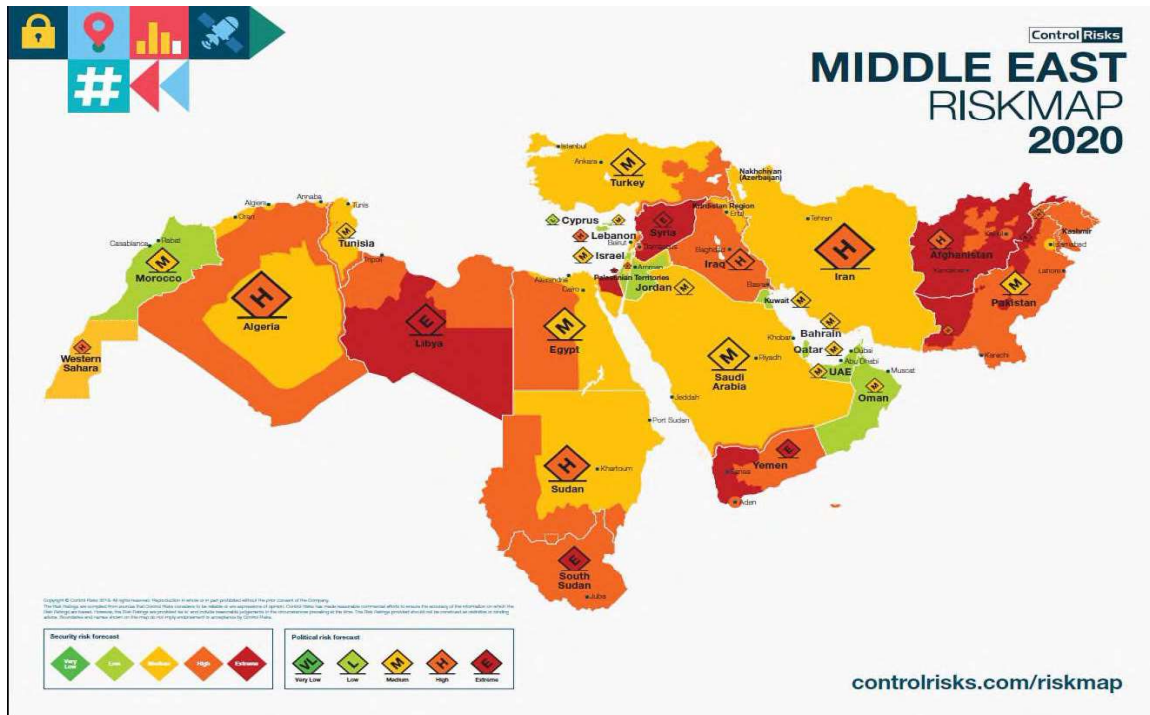
During the entire stay of the Aircraft at IKA and its crew members in Tehran, and until the actual departure of the Flight, no new missile attacks were reported, by either Iran or the United States. According to information obtained from the open source Flightradar24, other foreign airlines continued to operate in Iranian airspace, i.e., Iranian airspace was open for flights and, at the time of the actual departure of the Flight, there were no restrictions prohibiting flights by Ukrainian airlines in Iranian airspace. There was no information on any bans on flights in the airspace over Tehran from the Iranian Operations Controller of Operations Control Center. Iranian aviation authorities did not ban flights in the airspace over Iran. There was no information that would give grounds to UIA not to operate a flight on the route, Tehran - Kyiv.

While in its risk assessment UIA considered that: during Iran's missile attack on US military bases, ballistic missiles might have been used which are in service with Iran, the range of which is from 300 to 750 km, meaning that the missile launches most likely took place from near the Iraqi border, and possibly from an Iranian military base in Kermanshah province, which is about 420 km away from Tehran and 430 km from the Al Asad Air Base in Iraq. The distance between Tehran and the US military base Al-Assad in Iraq as well as between Tehran and the US military base in Erbil, Iraq, which were hit by missiles, is approximately 840 km and 670 km, respectively. The routes of UIA flights to / from IKA did not pass through Iraqi airspace or close to the Iran-Iraqi border. After taking off from IKA, the UIA route was northwest toward Turkey and far from the Iraqi border. A map is attached.



Moreover, UIA assessed that in the event the US decided to respond and attack Iran, noting that Iran's missile attack January 8, 2020 did not cause any fatalities and struck only US military bases, the probability that the US would in its responses strike purely civilian targets, and specifically an open international civil airport located in the capital city of Iran, and risk civilian casualties, was extremely low.

While assessing the threats and risks to aviation security during flights to / from Tehran, UIA also relied on the information from the website <https://www.controlrisks.com>, which posted a map of security risks in the Middle East (<https://www.controlrisks.com/riskmap-2020-special-edition/maps>). The map is attached.



In addition, in the process of assessing the threat of the use of MANPADS or SAMs, UIA considered the possible incorrect (erroneous) identification of a passenger aircraft of civil aviation as a military aircraft. Having analyzed the information that UIA's Aircraft was equipped with on board transmitters (transponders) and considered the necessity to get clearance from Iranian ATC for the Flight's take-off from IKA (UIA also understood that in such a highly military controlled State as Iran the military sector should and would be aware of all clearances for the operation of the civil aircrafts by Iranian civil authorities, included ATC), it was concluded that any risk was reduced to a minimum.

On January 8, 2020, a threat and risk assessment was performed by the aviation security of UIA:

#### Threats and Risks to Aviation Security Matrix KBP-IKA-KBP as of 08.01.2020

#	Threat Type	Probability level	Level of implications	Level of vulnerability	RISK CATEGOR Y	Risk acceptance criteria
1	Use of MANPADS, SAMs	Middle	High	Middle	Middle	Acceptable
2	Use of unmanned aircraft system (UAS)	Middle –Low	Middle – High	Middle – High	Middle – Low	Acceptable

The risk acceptance criteria for flights to/from IKA was "Acceptable" and it was decided to continue with the implemented measures for risks reduction and to monitor the security situation, which had developed against the background of aggravated military-political relations between the United States and Iran.

In light of the fact that (1) there was no ban on UIA's operation of Flight PS752 as of 8 January 2020 neither from the CAO of Iran nor from the CAA of Ukraine, nor the aviation authority of any other State (please refer to our explanations about the FAA NOTAM) or any other official sources; (2) other carriers did not cease their operations from/to IKA, as of the scheduled departure time of Flight PS752, or that of their transit flights over the territory of Iran; (3) UIA did not possess any specific intelligence data that could give grounds for a more broader risk assessment; and, (4) neither safety nor security alerts were made by the crew of Flight PS752 that would give grounds to reassess the risk, UIA's own assessment of threats and risks to aviation security identified risk acceptance criteria for flights from IKA on 8th of January as "Acceptable" and there were no reasons or grounds to implement any restrictions for the operation of Flight PS752 to Kiev.

**US NOTAM**

**1. THE US NOTAM WAS IRRELEVANT TO PS 752 FLIGHT**

In line with Chapter 1 of Annex 15 (Aeronautical Information Services) to the Chicago Convention, a NOTAM (Notice to Airmen) is a notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.,

At the same time, Chapter 1 of Annex 15 to the Chicago Convention states that the pre-flight information bulletin that is used by operators for flight preparation is a presentation of current NOTAM information of operational significance, prepared prior to flight.

The indicated Chapter 1 determines that Prohibited area is an airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited.

Standard 5.1.1 of Annex 15 states that a NOTAM shall be originated and issued promptly whenever the information to be distributed is of a temporary nature and of short duration or when operationally significant permanent changes, or temporary changes of long duration are made at short notice, except for extensive text and/or graphics.

A NOTAM shall be originated and issued concerning the presence of hazards which affect air navigation (including obstacles, military exercises, displays, races and major parachuting events outside promulgated sites) (Standard 5.1.1.1 of Annex 15).

At least seven days' advance notice shall be given of the activation of established danger, restricted or prohibited areas and of activities requiring temporary airspace restrictions other than for emergency operations (Standard 5.1.1.4 of Annex 15).

In line with Standard 5.2.9 of Annex 15 each NOTAM shall be as brief as possible and so compiled that its meaning is clear without the need to refer to another document.

There are several requirements for NOTAM distributions provided by paragraph 5.3 of Annex 15 to the Chicago Convention:

- NOTAM shall be distributed based on a request.
- International exchange of NOTAM shall take place only as mutually agreed between the international NOTAM offices concerned.
- These exchanges of NOTAM between international NOTAM offices shall, as far as practicable, be limited to the requirements of the receiving States concerned by means of separate series providing for at least international and domestic flights.

On the 8<sup>th</sup> of January, 2020 at 00:10 UTC time the Federal Aviation Administration of the USA (the FAA) issued NOTAM KICZ A0002/20 prohibiting all U.S. air carriers and commercial operators; all persons exercising the privileges of an airman certificate issued by the FAA, except such persons operating U.S.-registered aircraft for a foreign air carrier; and all operators of aircraft registered in the United States, except where the operator of such aircraft is a foreign air carrier, from operating in the Tehran Flight Information Region (FIR) due to heightened military activities and increased political tensions in the middle east, which present an inadvertent risk to U.S. civil aviation operations due to the potential for miscalculation or mis-identification.

The said NOTAM states that it does not prohibit persons listed in paragraph A (Applicability) from conducting flight operations in the above-named area when such operations are authorized either by another

agency of the United States Government with the approval of the FAA or by a deviation, exemption, or other authorization issued by the FAA administrator.

It clearly means that FAA's NOTAM was not applicable to UIA and should not be used as an official document imposing any restrictions for the operations of Flight PS752.

## 2. US NOTAM WAS NOT DESIGNATED TO TEHRAN FIR

Chapter 6 of ICAO Doc 8126 (Aeronautical Information Services Manual) specifies some crucial requirements that are applicable to NOTAM, one of which is Naming of locations, requiring that location indicators included in the text of NOTAM must be those contained in Location Indicators (ICAO Doc 7910), and curtailed forms of these indicators must not be used. In NOTAM containing information concerning a location that has not been assigned an ICAO location indicator, the name of the location must be given in plain language, spelled in conformity with local usage and transliterated when necessary into the Latin alphabet. NOTAM information coding based on document ICAO Doc 8126 and the ICAO NOTAM Code together with significations/uniform abbreviated phraseology and ICAO Abbreviations are determined in the ICAO Doc 8400.

It is important to point out that Appendix A to Chapter 6 of ICAO Doc 8126 (Aeronautical Information Services Manual) stipulates that item A) of a NOTAM must insert the location indicator as contained in ICAO Doc 7910 (Location Indicators) of the aerodrome or FIR in which the facility, airspace, or condition being reported on is located.

The Standard 5.2.11 of the Annex 15 states that a NOTAM containing permanent or temporary information of long duration shall carry appropriate AIP or AIP Supplement references.

The FAA NOTAM does not include the location indicator of the aerodrome or FIR in which the facility, airspace, or condition being reported on is located. Instead of this, the item A) of the NOTAM contains a code «KICZ» that does not relate to any location indicator and, therefore, would not have come to the attention of any non US airline operators using Iranian airspace.

Moreover, since item C) of the NOTAM marked as «PERM» or permanent information, it must carry appropriate AIP or AIP Supplement references.

**080007 KDZZNAXX**  
**(A0002/20 NOTAMN**  
**Q) KICZ/QRDLP/////**  
**A) KICZ**  
**B) 2001080010**  
**C) PERM**  
**E) SECURITY..UNITED STATES OF AMERICA PROHIBITION**  
**AGAINST CERTAIN**  
**FLIGHTS IN THE TEHRAN FLIGHT INFORMATION REGION (FIR)**  
**(OIX).**

In order to summarize, the FAA NOTAM was not designated to Tehran Flight Information Region location and was not included to aeronautical information provided by States concerned for the pre-flight planning purposes at IKA essential for the safety, regularity and efficiency of air navigation, since it does not relate to the route stages of Flight PS752 and as such should not and could not have been included in the Flight Briefing Package for Flight PS752, provided by Jeppesen (the flight planning software used by UIA) or any other alternative flight planning systems, as the same common principles and codes are used by other software providers for flight planning and dispatchers.

**List of flights that departed from Tehran before/after the crash of Flight PS752  
and flights over Iran's airspace on the 8<sup>th</sup> of January, 2020  
(source: [www.flightradar24.com](http://www.flightradar24.com))**

*Tehran time is +3:30 UTC*

The following flights departed from Tehran (IKA) on the morning of the 8<sup>th</sup> of January, 2020 before the crash of Flight PS752:

<b>Flight</b>	<b>Airline</b>	<b>From</b>	<b>To</b>	<b>Departure time, UTC</b>
J29006	Azerbaijan Airlines	Tehran	Baku	2020-01-07 22:06:55
LH601	Lufthansa	Tehran	Frankfurt	2020-01-07 23:12:30
TK875	Turkish Airlines	Tehran	Istanbul	2020-01-08 00:05:15
OS872	Austrian Airlines	Tehran	Vienna	2020-01-08 00:53:37
SU513	Aeroflot	Tehran	Moscow	2020-01-08 01:01:29
QR491	Qatar Airways	Tehran	Doha	2020-01-08 01:31:28
TK873	Turkish Airlines	Tehran	Istanbul	2020-01-08 01:37:28
KK1185	AtlasGlobal	Tehran	Istanbul	2020-01-08 01:47:16
QR8408	Qatar Airways	Tehran	Hong Kong	2020-01-08 02:09:39
PS752	Ukraine International Airlines	Tehran	Kyiv	2020-01-08 02:42:19

The following flights departed from Tehran (IKA) on the 8<sup>th</sup> of January, 2020 after the crash of Flight PS752:

<b>Flight</b>	<b>Airline</b>	<b>From</b>	<b>To</b>	<b>Departure time, UTC</b>
PS752	Ukraine International Airlines	Tehran	Kyiv	2020-01-08 2:42
IR721	IranAir	Tehran	Frankfurt	2020-01-08 4:18

IR717	IranAir	Tehran	Vienna	2020-01-08 4:22
B99700	IranAirtour	Tehran	Istanbul	2020-01-08 4:44
W561	Mahan Airlines	Tehran	Dubai	2020-01-08 4:48
TK879	Turkish Airlines	Tehran	Istanbul	2020-01-08 4:53
IR713	IranAir	Tehran	Stockholm	2020-01-08 5:10
W5116	Mahan Airlines	Tehran	Istanbul	2020-01-08 5:37
IR715	IranAir	Tehran	Ankara	2020-01-08 6:24
EK972	Emirates	Tehran	Dubai	2020-01-08 7:51

The following airlines operated flights over Iran's airspace within 02:40 – 06:40 UTC on the 8<sup>th</sup> of January, 2020 (without any changes to their scheduled routes):

- 1 UAE – Emirates
- 2 QTR-Qatar
- 3 FDB – Fly Dubai
- 4 THY- Turkish
- 5 DHL- DHL International (cargo)
- 6 ABY – Air Arabia
- 7 AIC – Air India