THE DOWNING OF UKRAINE INTERNATIONAL AIRLINES FLIGHT 752

FACTUAL ANALYSIS

FORENSIC EXAMINATION AND ASSESSMENT TEAM

JUNE 24, 2021

Government of Canada Gouvernement du Canada

Canada

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Analyse des faits

DEDICATED TO THE MEMORY
OF THOSE WHO LOST THEIR LIVES
ON FLIGHT **PS752**

LIVES LOST

Flight PS752 Passenger List

Abaspourqadi, Mohammad
Abbasnezhad, Mojtaba
Abtahiforoushani, Seyedmehran
Aghabali, Iman
Agha Miri, Maryam*
Ahmadi, Motahereh
Ahmadi, Muh Sen
Ahmadi, Rahmtin*
Ahmadi, Sekinhe
Ahmady, Mitra
Amirliravi, Mahsa*
Arasteh, Fareed
Arbabbahrami, Arshia
Arsalani, Evin*
Asadi Lari, Mohammadhossein*
Asadi Lari, Zeynab*
Ashrafi Habibabadi, Amir
Attar, Mahmood
Azadian, Roja
Azhdari, Ghanimat
Badiei Ardestani, Mehraban
Bashiri, Samira
Beiruti, Mohammad Am
Borghei, Negar*
Choupannejad, Shekoufeh*
Dadashnejad, Delaram
Daneshmand Mojgan*
Dhirani, Asgar*
Djavadi Asll, Hamid Reza*
Djavadi Asll, Kian*
Ebnoddin Hamidi, Ardalan*
Ebnoddin Hamidi, Kamyar*
Ebrahim, Niloufar
Ebrahimi-khoei, Behnaz*
Eghbali Bazoft, Shahrokh*
Eghbali Bazoft, Shah*
Eghbalian, Parisa*
Elyasi, Mohammad Mah
Emami, Sayedmahdi
Emami, Sophie*
Eshaghian Dorcheh, Mehdi
Esmaeilion, Reera*
Esnaashary Esfahani, Mansour
Faghihi, Sharieh*
Falsafi, Faezeh*
Falsafi, Faraz*
Farzaneh, Aida
Feghahati, Shakiba*
Foroutan, Marzieh
Ghaderpanah, Iman*
Ghaderpanah, Parinaz*
Ghafouri Azar, Siavash*
Ghandchi, Daniel*
Ghandchi, Dorsa*
Ghasemi Ariani, Milad
Ghasemi Dastjerdi, Fatemeh
Ghassemi, Amirhossein
Ghassemi, Kiana
Ghavi, Mandieh
Ghavi, Masoumeh
Gholami, Farideh
Ghorbani, Bahabadi A
Golbabapour, Suzan*
Gorji, Pouneh
Haghjoo, Saharnaz*
Haj Esfandiari, Bahareh*
Hajiaghavand, Sadaf*
Haji Ghassemi, Mahdieh*
Hamzeei, Sara*
Hasanisadi, Zahra
Hashemi, Shahrazad*
Hassannezhad, Parsa
Hatefi Mostaghim, Sahan
Hayatdavoudi, Hadis
Jadidi, Elsa*
Jadidi, Pedran
Jamshidi, Shadi*
Jebelli, Mohammaddam
Kadkhoda Zaden, Mohammaddam
Kadkhodazadeh Kashani, Saeed
Karami Moghadam, Bahareh*
Katebi, Rahimen
Kaveh, Azaden
Kazerani, Fatemeh*
Khadem, Forough*
Kobiuk, Olga
Lindberg, Emil
Lindberg, Erik
Lindberg, Raheleh
Lindberg, Mikael

LIVES LOST

Flight PS752 Passenger List

Madani, Firouzeh*
Maghsoudlouestarabadi, Siavash
Maghsoudlouesterabadi, Paria
Mahmoodi, Fatemeh
Malakhova, Olena
Malek, Maryam
Maleki, Dizaje Fereshteh*
Mamani, Sara*
Mianji, Mohammadjavad
Moeini, Mohammad*
Moghaddam, Rosstin*
Mohammadi, Mehdi
Molani, Hiva*
Molani, Kurdia*
Moradi, Amir*
Morattab, Arvin
Moshrefrazavimoghaddam, Soheila*
Mousavi, Daria*
Mousavi, Dorina*
Mousavi Bafrooei, Seyed-pedram*
Nabiyi, Elnaz
Naderi, Farzaneh*
Naghibi, Zahra
Naghib, Lahouti Mehr
Nahavandi, Milad
Niazi, Arnica*
Niazi, Arsam*
Niknam, Farhad*
Norouzi, Alireza
Nourian, Ghazal
Oladi, Alma
Omidbakhsh, Roja
Ovaysi, Amir Hossein*
Ovaysi, Asal*
Pasavand, Fatemeh*
Pey, Ali Javaheri*
Pourghaderi, Ayesheh*
Pourjam, Mansour*
Pourshabanoshibi, Naser*
Pourzarabi, Arash
Raana, Shahab
Rahimi, Jiwan*
Rahimi, Razgar
Rahmanifar, Nasim
Razzaghi Khamsi, Niloofar*
Rezai, Mahdi
Rezae, Hossain
Saadat, Saba*
Saadat, Sara*
Saadat, Zeinolabedin
Saati, Kasra*
Sadeghi, Alvand*
Sadeghi, Anisa*
Sadeghi, Mir Mohammad Mahdi*
Sadeghi, Sahand*
Sadighi, Neda*
Sadr, Niloufar*
Sadr, Seyednoojan*
Saeedinia, Amirhosse
Safar Poor, Pegah
Saket, Mohammadhossein*
Salahi, Moh Sen*
Saleheh, Mohammad
Saraeian, Sajedeh
Setareh Kokab, Hamid
Shadkhoo, Sheyda*
Shaterpour, Khiaban
Soltani, Paniz
Tahmasebi, Khademasa
Tajik, Mahdi
Tajik, Shahram
Tarbhai, Afifa*
Tarbhai, Alina*
Toghian, Darya*
Zarei, Arad*
Zibaie, Maya*
Zokaei, Sam*

Flight PS752 Pilots:
Gaponenko, Volodymyr Ivanovych
Khomenko, Serhii Anatoliiovych
Naumkin, Oleksii Yevhenovych

Flight PS752 Flight Attendants:
Lykhno, Denys Mykhailovych
Matkov, Ihor Valeriiovych
Mykytiuk, Mariia Mykhailivna
Ovcharuk, Valeriia Yevheniivna
Solohub, Yuliia Mykolaivna
Statnik, Kateryna Olehivna

* Indicates Canadians and Permanent Residents

MESSAGE FROM THE PRIME MINISTER TO THE FAMILIES

JUSTIN TRUDEAU

June 2021

In the aftermath of the downing of Ukraine International Airlines Flight 752, Canadian intelligence officials presented me with information demonstrating that an Iranian surface-to-air missile was responsible.We announced that fact to the world, and Iran was forced to concede it.

Now, our intelligence experts have again brought forward information about the downing of this flight, and again the conclusion is clear: Through their decisions, actions and omissions, Iranian civilian and military authorities bear full and complete responsibility. Flight PS752 was shot down due to their recklessness, incompetence, and wanton disregard for human life.

Canadians will always remember January 8, 2020, and the devastating news that the people aboard Flight PS752 would not be coming home. We continue to mourn the 176 precious lives lost, including 55 Canadian citizens, 30 permanent residents, and 53 others with ties to Canada.

I have been privileged to meet many of the passengers' families and loved ones. They live with unfathomable grief.

From the beginning, we have tried to make their heartbreak a fraction easier to bear. Canadian officials have notably provided emergency consular assistance, counselling, financial support, and immigration services, such as the new pathway to permanent residence for victims' family members announced in recent weeks. There have also been commemorative measures, including a scholarship fund in the victims' memory and the designation of January 8 as a National Day of Remembrance for Victims of Air Disasters.

At the same time, the families also live with the pain of unanswered questions. Since those first terrible hours, our Government has been determined to uncover and share as much information as possible about what happened. This effort began when we confronted Iran on January 9, 2020, with the truth that it had shot the plane down. It continued in December with the publication of Special Advisor Ralph Goodale's report, which posed vital questions for Iran to answer. It continues now with this expert report by Canada's Forensic Examination and Assessment Team. And it will not stop until Iran provides a complete and verifiable accounting of events.

Let us be clear: The Forensic Team has analyzed the information at its disposal, from public sources and classified intelligence, with professionalism and skill, but only Iran has full access to the evidence, crash site, and witnesses. The onus is on Iran to provide definitive answers about all aspects of this tragedy.

According to the Forensic Team's report, Iranian authorities positioned anti-aircraft systems on high alert near a civilian airport, without implementing basic protections like closing Tehran's airspace or notifying airlines. All planes flying into or out of Tehran's airport that night were at risk, including the four that took off immediately before PS752: Qatar Airways Flight QR491, Turkish Airlines Flight TK873, Atlas Global Flight KK1185, and Qatar Airways Flight QR8408. In fact, the totality of available information leads the Forensic Team to conclude that Iran tracked multiple targets but could not differentiate between passenger aircraft and legitimate threats.

The report demonstrates that Iran's official account of events is disingenuous, misleading and superficial, and intentionally ignores key factors. The downing cannot be conveniently blamed on a few junior personnel. Senior regime officials made the decisions that led to this tragedy, and the world must not allow them to hide with impunity behind a handful of low-ranking scapegoats.

The families and loved ones of the victims deserve a full explanation of Iran's dangerous and deliberate choice to keep its airspace open, and a full accounting of the Iranian military's training and command and control procedures for anti-aircraft operations. Iran must also account for the cover-up that followed the downing of Flight PS752, including bulldozing the crash site before investigators arrived.

Iran owes these answers to the victims' loved ones so they can have a measure of closure. And Iran owes these answers to the world, because without them, no country, airline or passenger can have confidence in the safety of Iranian airspace.

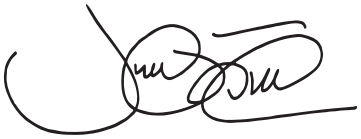
While we continue to press Iran for these answers, Canada will work closely with our partners in the International Coordination and Response Group to pursue reparations in accordance with international law. This includes a complete accounting of the events that led to the downing, along with concrete assurances of non-repetition. As well, Canada will demand just compensation for the harm caused to the victims, their families and the affected states.

Canada will negotiate reparations with eyes wide open. Should negotiations with Iran not result in an acceptable outcome for Canada on behalf of the families, we will pursue all available options, including recourse to the International Court of Justice.

Canada will also continue working with international partners to improve investigative protocols for shoot-down situations, and to advance the Safer Skies Initiative to better protect passengers from the risk of flying in or near conflict zones. To this end, funding in Budget 2021 will allow Transport Canada to make permanent Canada's Conflict Zone Information Office, which fills a global need by monitoring emerging conflicts and issuing alerts to civilian aircraft. In addition, we are endeavouring to build consensus at the International Civil Aviation Organization (ICAO) to strengthen the Annex 13 framework to ensure greater investigative scrutiny, independence, and impartiality when civilian aircraft are shot down. Canadian representatives have already raised these matters with ICAO's Council President and Secretary General.

While we cannot return those aboard Flight PS752 to their loved ones, or replace the contributions they would have made to their communities, to Canada, and to the world, we do this important work in their name.

I thank Jeff Yaworski and the Forensic Examination and Assessment Team for their report. It is one more step in the long and difficult journey toward truth and accountability.
Canada will not relent, and Canada will not forget.



Prime Minister Justin Trudeau
Ottawa, ON

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FOREWORD

JEFF YAWORSKI

June 2021

On January 8, 2020, the Islamic Republic of Iran's Islamic Revolutionary Guard Corps (IRGC) shot down Ukraine International Airlines Flight 752 shortly after it took off from Imam Khomeini International Airport in Tehran.

In the fall of 2020, significant questions remained surrounding the circumstances and causes of the tragedy. In October 2020, the Honourable François-Philippe Champagne, the then Minister of Foreign Affairs, announced the formation of a Canadian Forensic Examination and Assessment Team (Forensic Team), on the recommendation of the Honourable Ralph Goodale, Special Advisor for the Government of Canada's (GoC) ongoing response to the downing of Flight PS752. This initiative was part of the GoC's commitment to hold Iran to account and seek justice for the victims, their families and their loved ones.

The Forensic Team consists of public servants from several federal departments and agencies with relevant knowledge and skill sets, including those with expertise on military equipment and operations. The team was tasked with analyzing every available piece of information, evidence, and intelligence on the Flight PS752 disaster to advise the GoC on its credibility and probative value. The development of this factual analysis and the findings in this report draw upon an extensive body of information collected by the GoC and our allied partners, including classified information.

This report also contains the results of some excellent investigative journalism, significant contributions from academic publications, as well as contributions from Iranian citizens who posted images, videos and other relevant material to social media sites. Endnotes have been included attributing these contributions to the original authors wherever possible and as appropriate. Finally, it references official Iranian reports on the downing of Flight PS752 including a thorough analysis of Iran's Final Report issued on March 15, 2021. Nothing in Iran's official reports was taken at face value.

The Forensic Team also benefitted from discussions with and material provided by several family members of the victims of Flight PS752. Without all of these contributions, we would have been unable to shed light on the facts as we know them. It is my hope that our work will help the families in some little way on their difficult journey to reconciling their unimaginable grief.

The lives lost and potential never met of the 55 Canadians, 30 permanent residents and the other passengers and crew of Flight PS752, 176 victims in total, should never be forgotten.

I want to emphasize that only Iran has full access to the evidence, the crash site, witnesses, and those ultimately responsible. It therefore remains incumbent upon Iran to provide a full and credible accounting of

the events so that the families and loved ones of the victims may finally know the truth about what happened to Flight PS752. Iran must also provide assurances to the international community that this tragic event will never happen again.

I want to express my gratitude to Vincent Rigby, National Security and Intelligence Advisor to the Prime Minister, and the Honourable Ralph Goodale for their direction and guidance. I also want to include my special thanks and appreciation for the hard work and dedication of Steven Shragge, Meaghan Campbell, Beth Champoux, Richard Davidson, Rana Abi-Nader, and the Intelligence Assessment Secretariat of the Privy Council Office.

Jeff Yaworski
Head, Forensic Examination and Assessment Team
Ottawa, ON

Executive Summary

The Forensic Examination and Assessment Team (Forensic Team) developed this all source factual analysis as part of the Government of Canada's commitment to uncovering how and why Ukraine International Airlines Flight 752 was shot down near Tehran on January 8, 2020.

To date, Iran has presented an incomplete account of events and failed to outline all relevant actions by military and civilian authorities that likely contributed to the shoot-down. On March 15, 2021, Iran's Aircraft Accident Investigation Board (AAIB) issued its Accident Investigation Report (Final Report). It falls well short of providing a credible explanation of how and why an Iranian Islamic Revolutionary Guard Corps (IRGC) surface-to-air missile (SAM) downed Flight PS752.

The Forensic Team's report draws upon an extensive body of information to deliver an account of the factual sequence of events that led to the tragedy. It also examines the full range of human and organizational factors that likely contributed to the downing and presents analysis that either substantiates, questions, or dispels Iran's assertions. The findings and conclusions in this report are based on a comprehensive analysis of the reports produced by the AAIB and other publicly available information, and have been validated by consulting information collected by the Government of Canada, including classified information.

Forensic Team Analysis

Iran's Final Report concludes that missile damage to Flight PS752 was the primary cause of the downing. It claims that the SAM operator made a series of unanticipated errors that contributed to the downing, including the misidentification of Flight PS752 as a hostile target and the resulting launch of missiles.

Based on the information available, it seems evident that the SAM operator's actions played a key role in the downing of Flight PS752; however, the Forensic Team concludes that his actions and the resulting tragedy could and should have been avoided. But for a number of fundamental deficiencies in planning, mitigating risk, and decision making, Flight PS752 would not have been targeted by the SAM operator.

Iran's explanation to date, including its Final Report, is evasive and presents a highly selective explanation of events. Its claims are not substantiated with evidence. Iran's account lacks context and fails to address the full breadth of causes and contributing factors that led to the downing.

Subject to further legal analysis, the Forensic Team's assessment is that Iran's Final Report fails to meet the standards and recommended practices set out in Annex 13 to the Chicago Convention as a result of these shortcomings.

The Forensic Team's analysis shows that Iranian civilian and military authorities – through their actions and omissions – directly put Flight PS752 and other civilian aircraft in danger by creating conditions in which a SAM operator could launch missiles at them and by failing to take adequate preventative measures to reduce this high risk.

The Forensic Team identified the following key findings on the causes and contributing factors that led to the downing of Flight PS752:

Key Finding 1: Iran Failed to Take Measures to Ensure the Safety of its Airspace and to Notify Airlines of the Risks

First, Iranian authorities had the opportunity and responsibility to put in place a plan to ensure the safety of its airspace following the Iranian attack on US positions in Iraq and the expectation of a counterstrike. The Forensic Team assesses that this would have been discussed at a high level. Iran positioned anti-aircraft systems on high alert directly adjacent to an international airport, and despite these proximate military threats, the decision was made not to close the airspace over Tehran. Information suggests that senior Iranian civilian and military decision makers prioritized defence over the safety of civilian air traffic.

Iran contends that its decision to keep its airspace open and its corresponding airspace management decisions were justified and based on sound risk assessment. Iran's risk assessment, as presented in the Final Report, failed to address contradictory information suggesting that risk levels were much higher. Iran's air defences represented a clear and present danger. Its military was on high alert and tasked with monitoring airspace where multiple civilian aircraft would be present. Iran implemented a single mitigation measure that required military pre-authorization for flights before take-off from Imam Khomeini International Airport (IKA). Iran's determination that the risk was "low," the decision to keep its airspace open over Tehran, and the implementation of only one preventative measure were all flawed decisions. It is the Forensic Team's assessment that this fell short of internationally recognized standards in place to ensure airspace safety.

Furthermore, Iran did not provide official notification of the increased risk to airlines and pilots before Flight PS752 departed or adequately explain why this basic measure was not implemented. Iranian military authorities were the only ones who were aware of the recent military activities and high alert resulting from Iran's launch of missiles into Iraq. Only they knew that SAM units had been deployed in proximity to an international airport. Despite having knowledge of International Civil Aviation Organization guidance from 2018 with respect to "conflict zones," Iran chose not to notify airlines of this danger. This lack of pertinent threat-related information deprived airlines (such as Ukraine International Airlines) of the full and up-to-date picture of conditions necessary to determine whether it was safe to fly.

Key Finding 2: Surface-to-Air Missile Operator's Sequence of Events

Second, information analyzed by the Forensic Team indicates that the IRGC SAM unit operator made a series of decisions that resulted in the downing of Flight PS752. The Forensic Team assessed it is likely the SAM operator failed to align the direction indication system of the SAM unit properly or correct the misalignment over the six hours the unit was deployed and operational. However, such an action on its own should not have resulted in the shoot-down.

Information available to the Forensic Team, including the SAM unit's technical specifications, is consistent with a misalignment. Based on expert analysis of this type of weapon, such a misalignment would have resulted in the inaccurate representation of potential hostile threats on the SAM operator's radar. A misalignment of 105 degrees would likely have resulted in Flight PS752 appearing to approach the SAM operator from the southwest (Iraq) rather than the true direction from IKA, which was in the southeast.

While the act of shooting the missiles was a deliberate and intended action, the information available to the Forensic Team indicates the IRGC SAM unit operator likely misidentified Flight PS752 as a hostile target. A properly functioning command and control system, procedures, and effective training are meant to prevent this outcome; however, Iran has not provided any substantive information on these important factors. Iran's incomplete explanation of the events and the absence of supporting evidence undermines the credibility of its assertion that the SAM operator's actions were the sole cause of the downing.

With respect to Iran's claim that the IRGC SAM operator fired upon Flight PS752 without the necessary approval from its command and control, there is no information that the Forensic Team is aware of that would contradict this assertion. While it is likely that authority to fire on aerial targets was delegated to lower levels of Iran's military than usual given high alert levels, it is very unlikely the SAM operator would have been authorized to launch missiles without approval from his command.

However, given the number and sequence of events known to the Forensic Team, Iran has not provided sufficient information or explanations to account for the broader questions this raises. Important questions about the proficiency of the IRGC SAM operator who downed Flight PS752, including the adequacy of his training, the target validation process, and the supervision of SAM operators under such circumstances, remain unanswered.

Key Finding 3: Command and Control Failures

Finally, while Iran recognized that risk levels exceeded expectations and planned mitigations failed to prevent the downing of Flight PS752, Iran's Final Report and other public statements from senior Iranian military leaders focus exclusively on the SAM operator's decisions. Iran's account refuses to analyze the full range of deficiencies in the military sector that played a major role in the downing. Iran's military command and control over the SAM unit failed. If it were functioning properly, the shoot-down would not have occurred.

The Forensic Team determined that the SAM unit's immediate command and control should have identified a SAM-unit misalignment as significant as the 105 degrees reported by Iranian authorities. Standard military procedure would dictate that the SAM unit would not operate in isolation but as part of an integrated air defence structure to enhance situational awareness and decision making. Iran's Final Report states that SAM units were required to engage their command and control to distinguish hostile targets from commercial aircraft and obtain approval to fire.

Based on Iran's stated protocols, it is reasonable to conclude there were very likely multiple interactions between the operator and his command and control as part of identification procedures for flights that departed IKA before Flight PS752. Given the likely misalignment, previous departing flights would also have likely appeared to be coming from an inaccurate direction (i.e. the southwest). Nine other flights departed IKA before Flight PS752 on January 8, 2020, including eight departures after Iran launched missiles into Iraq. If the operator followed the same procedure that Iran claimed he followed for Flight PS752, the operator would have engaged his command to assist with their identification as hostile targets or commercial aircraft.

The Forensic Team further analyzed Iran's unsubstantiated and questionable claim that the SAM unit was moved at 04:54 Tehran Time (TT) and set to "standby" until five minutes before Flight PS752 took off. The Forensic Team determined it was likely the SAM unit would have been operational immediately after the supposed move, as would be expected under such high threat levels. In fact, the totality of available information leads the Forensic Team to conclude that Iran tracked multiple targets but could not differentiate between passenger aircraft and legitimate threats. Iran ultimately fired two missiles, downing an unidentified target which was later confirmed to be Flight PS752. Four flights departed IKA between 04:54 TT and Flight PS752's departure. As such, even if one accepts Iran's claims about relocation, there were very likely multiple interactions between the SAM unit and its immediate command and control, which should have resulted in the identification of this erroneous tracking and correction of the misalignment – but it did not.

The four flights that took off between 04:54 TT and Flight PS752's departure at 06:12 TT were Qatar Airways Flight QR491, Turkish Airlines Flight TK873, Atlas Global Flight KK1185, and Qatar Airways Flight QR8408. Given their similar flight paths when departing IKA and the Iranian claim that the SAM unit was misaligned when it relocated at 04:54 TT, each of these flights was potentially at significant risk of being misidentified. This should gravely concern every country whose airlines and citizens travelled through IKA that morning. Because of Iran's actions – and failure to act – any of those other flights could have met the same fate as Flight PS752.

Based on this analysis, the Forensic Team concluded it is very likely that the SAM unit's immediate command and control missed numerous opportunities to identify and correct the SAM operator's misalignment, to recognize associated risks during the six hours the SAM unit was likely operational and, most importantly, to take action to remove the operator until the problem could be rectified.

In its description of events, Iran suggests a communications outage between the SAM operator and his command and control occurred and contributed to errors in decision making. According to the Forensic Team's assessment, if disruptions to these communications occurred at any point, there is no evidence that "jamming" or electronic warfare were the cause.

Iranian military officials have suggested that such a communication's outage could potentially be attributable to the saturation or overload of command and control systems. Either communications were not coming through due to system overload (e.g. insufficient bandwidth) or the workload was too high for the SAM unit's immediate command and control to process information as it arrived. This is consistent with the Forensic Team's assessment. However, this raises concerns with regards to capacity inadequacies of Iran's military communication systems. Iran has failed to explain if redundancies or contingencies were in place. Events also suggest that if they were put in place, they were insufficient to mitigate the risk of misidentification.

Conclusion

Given the totality of information available, the Forensic Team concludes that a series of acts and omissions by Iranian civil and military authorities caused a dangerous situation where previously identified risks were underestimated and not taken seriously. These acts and omissions were both in the development and the implementation of plans, systems and procedures. The following decisions created the conditions that allowed the SAM operator to launch missiles at Flight PS752:

- They launched a premeditated attack on US positions in Iraq that they believed, by their own admission, would likely generate a US response.
- They planned how they would likely respond to the anticipated US retaliation.
- They put their air defence on the highest level of alert and likely delegated down to a lower level authority to fire on aerial targets.
- They positioned anti-aircraft systems on high alert in close proximity to an international airport and tasked IRGC personnel with monitoring airspace in which approaching and departing civilian flights would be present.
- They conducted a severely flawed analysis, which determined that the risk of Iranian air defence forces misidentifying a civilian aircraft was "low."
- Based on this analysis and despite these proximate military threats, they decided to keep the airspace over Tehran open; they issued no official warnings to civilian aircraft and they implemented only one measure to prevent misidentification that would have applied to Flight PS752. This measure failed due to foreseeable military inadequacies.

While the decision to keep the airspace open was arguably shared between military and civilian decision makers, the remaining decisions were exclusively made by Iran's military.

The Forensic Team assesses that Iran's official account of events, and specifically its Final Report, is absent a recognition of these deficiencies and the broader context of decision making. Moreover, Iran's account of events to date has been wholly inadequate. While the Forensic Team believes that target misidentification was one of the causes, the Iranian government cannot expect the international community to set aside the other clear, immediate and systemic causes and contributing factors. This report has identified many of these failures and has indicated, where possible, the evidence that supports the Forensic Team's assessment.

The Forensic Team determined Iran has fallen well short of providing a credible explanation of how and why the IRGC downed Flight PS752. While the Forensic Team found no evidence that the downing of Flight PS752 was premeditated, this in no way absolves Iran of its responsibility for the death of 176 innocent people. Iran is ultimately responsible for the actions it took – or failed to take – which led to the shoot-down. Iran's Final Report does not provide any explanation as to why basic preventative measures

were not taken that could have avoided this tragedy. Iran is responsible for failing to protect these civilian lives and for its lack of subsequent transparency. Iran must provide solid evidence to establish the credibility of its account and remove any doubt on the chain of events that led to this tragedy.

Iran's Final Report claims that Iran and the IRGC have instituted unspecified and unsubstantiated actions in response to its investigative findings. Iran has failed to clearly demonstrate what these actions were and what steps need to be taken to address the numerous deficiencies that caused and contributed to the downing of Flight PS752. There is no explanation of how similar shoot-downs might be prevented in the future. Most troubling, Iran has not outlined any concrete actions taken by the Iranian military to address the stated cause of the tragedy – the launching of missiles at a civilian aircraft.

Moving forward, it is of particular importance for the victims' families, Canada, and the international community that Iran provide a transparent and credible explanation of the downing and provide facts to back up its assertions. Without knowing the answers to the many remaining critical questions, the international community cannot conclude that these deficiencies have been resolved. The international community is left to assume that civilian aircraft in Iranian airspace are still at risk, particularly when Iran heightens its defence posture during times of increased tension.

Introduction

On January 8, 2020, the Islamic Republic of Iran's Islamic Revolutionary Guard Corps (IRGC) shot down Ukraine International Airlines (UIA) Flight 752 (Flight PS752) shortly after take-off from Imam Khomeini International Airport (IKA) in Tehran. This tragedy took the lives of 176 passengers and crew, including 55 Canadians, 30 permanent residents and dozens more on their way to Canada. There were nine Ukrainian crewmembers and other nationals from Iran, Sweden, Afghanistan, and the United Kingdom on board Flight PS752.

Since the downing, significant questions have remained surrounding the circumstances and causes of the tragedy. Gaps in knowledge continue to exist, and to date, the Government of the Islamic Republic of Iran (Iran) has been unresponsive to requests by Canada and its international partners to address them.

This Forensic Team report draws upon an extensive body of information to develop this all-source factual analysis and present as complete an unclassified account of events as possible. It outlines the factual sequence of events that led to the tragedy, examines human and organizational factors that most likely contributed to the downing, and presents analysis that either substantiates, questions or dispels Iran's assertions. The findings and conclusions in this report are informed by a comprehensive analysis of the reports produced by Iran's Aircraft Accident Investigation Board (AAIB) and other publicly available information. They have been validated by consulting information collected by the Government of Canada, including classified information.

The pages that follow present the Forensic Team's factual analysis of events related to the downing of Flight PS752 and is intended to complement the Honourable Ralph Goodale's report (*Flight PS752: The Long Road to Transparency, Accountability and Justice*) published on December 15, 2020.

Following the downing of Flight PS752, Canadian law enforcement agencies have received a number of complaints from family members of victims in which they reported being the targets of intimidation and threats. In the interest of public safety, all potential victims of intimidation in Canada have been asked to contact their local police to address any immediate safety concerns. This report, along with Canada's broader response, should be taken as a demonstration that no attempt by Iran to intimidate the family members will end the demands for answers and accountability from Canada and others. (See Annex A for details on the Royal Canadian Mounted Police investigation.)

Key Lines of Inquiry

The Forensic Team's lines of inquiry were focused primarily on assessing the facts relevant to the immediate and systemic causes and contributing factors that led to the downing of Flight PS752.

Annex 13 to the Convention on International Civil Aviation (Chicago Convention) establishes standards and recommended practices for the conduct of international aviation investigations. It includes the requirement to establish an independent investigation body separate from State aviation authorities and other entities that could interfere with the investigation.[1] As the "State of Occurrence," the Islamic Republic of Iran, specifically its AAIB, was the lead investigative body.[2] It is the view of the Forensic Team that the AAIB lacks this required independence due to its incorporation within the Civil Aviation Organization

and the Ministry of Roads and Urban Development – represented in Cabinet by its Minister. The degree to which Iran conducted an independent and impartial investigation in accordance with Annex 13 is, however, outside the purview of this report.

The Transportation Safety Board of Canada (TSB) is Canada's official independent authority responsible for investigating aviation occurrences (including incidents and accidents). Pursuant to Annex 13 to the Chicago Convention, the TSB has no investigative authority over the events surrounding the downing of Flight PS752. Rather, the TSB held "Expert" status in the investigation due to the high number of Canadian fatalities. This status allowed only limited participation and receipt of some information as determined by Iran's AAIB. In February 2021, a TSB Expert assigned to the Flight PS752 safety investigation was appointed by the National Bureau of Air Accidents Investigation of Ukraine as a technical advisor to Ukraine's Accredited Representative. Separate from this bilateral cooperation, the TSB independently reviewed Iran's Final Report and commented, to the extent possible, on its accuracy and completeness or lack thereof. It should be emphasized that the TSB did not provide any information gained from its participation in the AAIB's safety investigation to the Forensic Team, as it was not authorized to do so according to the standards established in Annex 13.

This Forensic Team report is not intended to provide a detailed legal analysis of Iran's compliance with or violation of international obligations or standards relevant to the events surrounding the shoot-down. Nor is it linked in any way to judicial activities or criminal investigations that may be undertaken by the Royal Canadian Mounted Police, Ukrainian authorities or any other investigative body or authority. This report does not purport to provide legal advice or make any conclusions of a legal nature.

The Forensic Team's analysis focuses upon the following:

1. What factors is Iran known to have considered when deciding to keep its airspace open during the heightened state of military alert?
2. Is there information that indicates Iran knew or ought to have known that its military activity presented a significant hazard to civilian aviation taking off and landing in Tehran on or around January 8, 2020?
3. What mitigation measures did Iran put in place to safeguard civilian airlines after making that decision?
4. Was the downing of Flight PS752 a premeditated or planned attack?
5. What information exists with respect to the actions of the surface-to-air missile (SAM) operator that led to the shoot-down and does Iran convincingly explain why he fired upon Flight PS752?
6. Was this an isolated occurrence or indicative of more systemic problems within Iranian military structures? This includes whether evidence exists with respect to acts and omissions by the IRGC's command and control (C2).
7. Has Iran provided information that transparently explains all causes and contributing factors that resulted in the shoot-down of Flight PS752? If not, what is missing?

This report contains a brief overview of increasing regional tensions, a review of the claims made in Iran's Final Report, and a presentation of the facts and essential details critical to understanding the sequence of events on January 8, 2020 in Iran as known to Canada. Finally, this report analyzes the causes and con-

tributing factors that led to the downing of Flight PS752. It considers Iran's claims presented in its various statements and reports and assesses their credibility and completeness by drawing upon the full range of information available to Canada. The report concludes with the Forensic Team's Key Findings. It must be emphasized that only Iran has full access to the evidence, the crash site, witnesses, and those ultimately responsible. It therefore remains incumbent upon Iran to provide a full and credible accounting of the events.

All times referenced in this report are noted in Coordinated Universal Time (UTC) and/or local Tehran Time (TT). Tehran Time is 3 hours and 30 minutes ahead of UTC for all references in this report.

Contextual Information

In the months leading up to January 2020, tensions were increasing in the region. Iran and the United States (US) came to the brink of overt hostilities on three occasions:

- On June 20, 2019, Iran shot down a US Global Hawk drone that it claimed had entered Iranian airspace;

- On September 14, 2019, multiple drones hit Saudi Arabia's oil infrastructure, an act claimed by Iran likely to demonstrate its ability to disrupt oil supplies in response to the US "maximum pressure" campaign; and

- On January 3, 2020, a US drone strike near Baghdad killed IRGC Quds Force (IRGC-QF) commander Major General Qassem Soleimani and Iraqi Popular Mobilization Front Chief of Staff Abu Mahdi al-Muhandis.

Iranian Retaliation

The hours preceding the departure of Flight PS752 from IKA were marked by further escalations in the tensions between Iran and the US. At approximately 02:00 TT on January 8, 2020, Iran fired some 22 ballistic missiles at two Iraqi airbases used by US and Coalition forces, in retaliation for Major General Soleimani's death. One of the targeted airbases was in Irbil where Canadian Forces personnel were present, and the other was at Al Asad Airbase, west of Baghdad.[3]

There is conflicting information available on the duration of this attack. Iran has stated it was concluded approximately five minutes after it began at 02:05 TT on January 8, 2020[4] (22:35 UTC on January 7, 2020), while US sources report it lasted approximately two hours.[5] Irrespective of the duration, the attack represented the first time since the 1990 Gulf War that ballistic missiles were used against US forces in the Middle East. Due to the expectation of a counterattack by the US, Iran relocated mobile surface-to-air missile units to temporary positions around Tehran.[6]

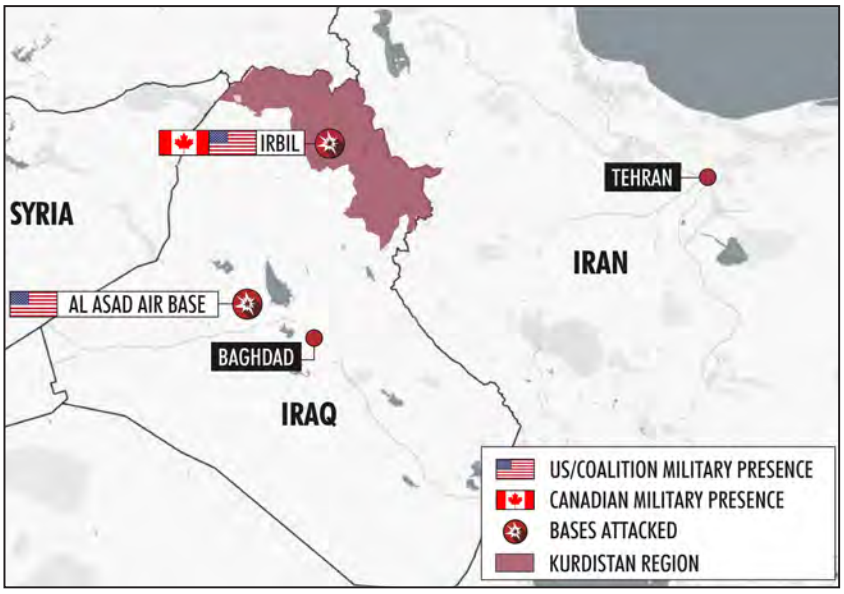

Figure 1: Sites of Iranian Missile Impact in Iraq

Iranian Military on High Alert

As the commander in chief, Iran's Supreme Leader Ayatollah Ali Khamenei had the authority to approve military operations and did so, in January 2020, through the Supreme Council for National Security (SCNS). The SCNS alerts military leadership, who in turn transmit orders through the regular military (Artesh) or the IRGC chains of command (See Annex B for further details on Iranian military structure and defence planning). The IRGC's mission is to defend the regime and its Islamic system of government from any threat, foreign or domestic, and remains the main actor influencing and implementing Iran's security policy.[7] Iran's Ministry of Roads and Urban Development, a civil authority, is responsible for Iran's Civil Aviation Organization, which oversees airports and the air navigation provider.

In anticipation of a military response from the US, Iran had placed its air defence system on a higher level of alertness and deployed SAM units in the vicinity of Tehran's IKA. This was confirmed by the head of the IRGC Aerospace Force, Brigadier General Amir Ali Hajizadeh, when he indicated that on the night of January 7–8, 2020, IRGC forces were at the highest level of alert and SAM units were relocated "to prepare for war."[8] Iran's Final Report also indicated that Iran's military was put on high alert immediately after it fired these missiles.[9] In this environment of heightened tensions, the only measure that Iran's military implemented to protect civil aviation in Tehran was to assume greater procedural control over civilian flight operations, consisting of military approval for flight clearances.[10]

Flight PS752 departed Imam Khomeini Airport in Tehran a little over four hours after Iran launched missiles into Iraq.

As Iran was anticipating an American counterstrike, Iranian air defence forces were likely operating under rules of engagement that allowed for delegated authorities.[11] During periods of heightened threat, most militaries will delegate approvals to engage hostile targets to lower levels. Iran has indicated, however, that missile release authority was never delegated down to the individual SAM operators. According to Iran's Final Report, the SAM operator accused of having launched the missiles at Flight PS752 was required by IRGC procedure to contact a Coordination Center to verify targets and receive approval (command) to fire.[12]

Airspace Management and International Issuance of Notices to Airmen

To address the risks to civil aviation as a result of the military being placed on high alert on January 8, 2020 and the positioning or re-positioning of mobile air defence units, Iran's Final Report asserts that three mitigation measures were implemented. Only the third mitigation would have applied to Flight PS752 and its planned operations:

- Evacuation of four parallel airway routes in the west of the country;
- A ban on traffic exchange between the Tehran and Baghdad Flight Information Regions (FIR); and
- Coordination with the air defence sector prior to issuing start-up approval for departing flights.[13]

Iran decided to keep the majority of its airspace open for civilian aircraft and did not share information about the elevated risk with either air carriers or pilots using its airspace during the night and early morning of January 7–8, 2020. It is the Forensic Team's view that this was not consistent with international standards that require issuing such warnings when there are "hazards" to the safety of civilian aviation.

At no time did Iran issue a notice to airmen (NOTAM) or aeronautical information circular (AIC) to civilian airlines for the area around Tehran. NOTAMs and AICs are the most commonly used way for States to convey flight safety information. Given the dangerous situation, the conditions in Iran warranted the issuance of NOTAMs to advise civilian aircraft of ongoing military activities. NOTAMs No. A0086/20 (ban on Iran–Iraq traffic exchange) and A0087/20 (evacuation of four parallel airways), as identified in Iran's Final Report, are irrelevant to the shoot-down as they were not issued until 09:19 TT and 10:23 TT respectively on January 8, 2020 – several hours after the downing of Flight PS752. In fact, in spite of the mitigations Iran claimed to have put in place, with the exception of the four airways in the west, the majority of Iranian airspace remained open for civil aircraft arriving at or departing from Iranian airports, as well as aircraft navigating through Iran without stopping (overflights). (See Annex C for further information on international requirements and NOTAMs.)

It was during this period of elevated risk and heightened Iranian military alert levels that UIA Flight 752 departed from IKA on January 8, 2020 at 02:42 UTC (06:12 TT) and headed northwest towards Parand, Iran. (See Annex D for further information on Flight PS752 aircraft details.)

The Facts:

What Happened on January 8, 2020?

The Downing of Flight PS752

Air Traffic over Tehran on January 8, 2020

Air traffic on January 8, 2020 was normal for the Tehran FIR and IKA. Prior to Flight PS752's departure, 21 flights arrived at IKA the morning of January 8, 2020, from locations in Europe (including Kyiv and London), Asia (including Shanghai and Delhi) and the Middle East (including Najaf and Doha). The last of which was Mahan Flight W570, Delhi to Tehran, at 05:37 TT. (A complete list of arrival and departures is located in Annex E.)

Nine flights departed IKA on January 8, 2020, prior to Flight PS752's departure. The first flight was Azerbaijan Airlines Flight 9006 to Baku, Azerbaijan, at 01:37 TT. The last flight to depart before Flight PS752 was Qatar Airways Flight 8408 at 05:39 TT. The Forensic Team confirmed that Turkish Airlines Flight 899 to Istanbul, Turkey, and two flights destined for Najaf, Iraq – Mahan Airlines Flights 5042 and 5062 – were scheduled to depart before Flight PS752 but were cancelled. While the reason for these cancellations could not be definitively determined by the Forensic Team, the Turkish Airlines flight was likely cancelled due to an earlier closure of the airport in Istanbul. Those with Najaf, Iraq, as a destination were likely impacted by the Iranian airspace closure along the border with Iraq, which began at approximately 05:15 TT on January 8, 2020.[14]

As confirmed in Iran's Final Report, all aircraft systems on Flight PS752 were functioning properly and the flight did not deviate from its pre-approved course. The plane's take-off, ascent to the northwest, speed, altitude, and trajectory were all reported to be normal. Its take-off heading was routine and similar to those of other UIA flight paths for months prior to the shoot-down. Flight PS752's flight path was also similar to that of other carriers that had departures from IKA that morning.[15]

There is no indication that the flight crew did anything out of the ordinary during the take-off and ascent of Flight PS752. Iran's Final Report indicates that the flight was delayed due to extra baggage that was offloaded from the flight,[16] and this was confirmed by UIA.[17] Flight delays for this reason are common in commercial aviation and the Forensic Team found no information suggesting the delay was related to the downing.

The Forensic Team confirmed with Ukrainian authorities that there were two passengers who had booked tickets for Flight PS752 but did not board the aircraft. One passenger failed to arrive at the airport, and the other was not checked in due to personal reasons. The Forensic Team found no information to support the claim that two additional passengers missed the flight. While there have been suggestions that other passengers were removed from the flight in anticipation of an intentional targeting of Flight PS752, the Forensic Team found no information to support this claim or any indication that any passengers were removed from the plane before departure. The Forensic Team has concluded that the events leading to the two passengers not boarding Flight PS752 were unrelated to the downing of the plane.

Based on the above information, UIA Flight 752 and other airlines with flights landing at and departing from IKA were operating as normal on January 8, 2020. A detailed timeline of events relevant to Flight PS752 and its shoot-down follows. Where times are attributed to official Iranian reports, the Forensic Team has not found any information that would question their accuracy.

Detailed Timeline for January 8, 2020

00:01 TT (approximately)
The SAM unit reportedly arrives at its location west of Tehran around midnight on January 8, 2020, according to statements by IRGC Brigadier General Hajizadeh on January 11, 2020.[18]

02:00 TT (approximately)
Iran launches ballistic missiles towards two Iraqi bases hosting US troops.[19]

03:40 TT
The US Federal Aviation Administration (FAA) issues a NOTAM prohibiting US carriers from operating in the Tehran FIR. The NOTAM prohibits US carriers from operating due to "heightened military activities and increased political tensions in the Middle East, which present an inadvertent risk to US Civil Aviation Operations due to the potential for miscalculation or misidentification."[20] This NOTAM affects US air carriers only, and UIA was not on the FAA distribution list.

04:00 TT (approximately)
The Iranian military takes over responsibility for authorizing startup approval for civilian flight departures from IKA.[21]

05:00 TT
Qatar Airways Flight QR491 departs IKA.

05:07 TT
Turkish Airlines Flight TK873 departs IKA.

05:17 TT
Atlas Global Flight KK1185 departs IKA.

05:39 TT
Qatar Airways Flight QR8408 departs IKA.

05:51 TT
Flight PS752 requests authority from IKA Air Traffic Control (ATC) to start aircraft engines.[22]

05:52 TT
The ATC requests military clearance for Flight PS752 via the Tehran Air Coordination Center.[23]

05:54 TT
The clearance request is forwarded to the Civil-Military Operational Coordination Center (CMOCC).[24]

05:55 TT
Flight PS752 is cleared for start-up and pushback.[25]

05:56:18 TT
The cockpit voice recorder (CVR) begins recording at the time of engine start-up.[26]

06:10:20 TT
Flight PS752 receives take-off clearance from IKA ATC.[27]

06:12 TT
Flight PS752 departs IKA after being cleared for take-off by both civilian and military authorities

and becomes airborne with 167 passengers and 9 crew members aboard.[28] UIA confirmed that the departure of Flight PS752 had been delayed to offload passenger luggage in order to meet the maximum take-off mass of 72,500 kg.[29]

06:13:56 TT
The operator of an Iranian SAM system likely misidentifies the commercial passenger jet taking off and ascending from east to west as a cruise missile[30] incoming from west to east.

Iran's AAIB Factual Report dated July 11, 2020 indicates that "the system operator began analyzing the observable information and categorized the detected target as a threat."[31]

06:14:19 TT
Iran's Final Report states that "the operator notified the specifications of the detected target to the relevant Coordination Center via the communications network. The message was not relayed to the Center. In fact, it had not been recorded in the recorded messages of the Coordination Center."[32] The Forensic Team could not confirm that this alleged communication ever took place.

06:14:39 TT
Iran's Final Report indicates that "without receiving any 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 TT."[33]

06:14:56 TT
Iran's Final Report states that, according to the CVR read-out "a strong and short impulse, similar to a detonation is recorded."[34] This sound corresponds to the FDR failure.[35]

Iran's Final Report also indicates that the CVR read-out showed that "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."[36]

06:15:09 TT
A second missile is fired at Flight PS752.[37]

06:15:15 TT
The CVR ends 19 seconds after the failure of the FDR.[38]

06:15:22 TT
Iran's Final Report states that the last communication between the second missile and the defence system was recorded in a place close to the aircraft route. A message was received on the defence system indicating the strike had failed, with the aircraft clearing from the radar lock-on after some time.[39]

06:16:11 TT
A fire breaks out on Flight PS752 and begins intensifying.[40]

06:18:23 TT
Flight PS752 crashes into the ground and explodes in Khalajabad near Shahriar, southwest of Tehran.[41] All passengers and crew perished in the crash.[42]

07:49 TT
Flights are halted for a period of time after the downing of Flight PS752 and resume with an Iran Air Airbus A330 flight, IR 721, departing for Frankfurt, Germany.

Iranian Aseman Airlines Pilot

Credible eyewitness accounts of the shoot-down of Flight PS752 were documented and made available on the Internet. On February 1, 2020, a weekly Ukrainian TV program (TSN.Tyzhden)[43] released a transcript of intercepted communications between the Imam Khomeini Airport tower and a pilot on descent towards the airport aboard Iran's Aseman Airlines Flight EP3768 (flying route: Shiraz to Tehran) at the time of the shoot-down and crash of Flight PS752.[44] In the exchange, the pilot states having seen the airborne missiles. The ATC operator appears surprised by the revelation and actively follows up with the pilot to acquire more information on the evolving incident.

The transcript of this conversation is included in the Iranian Final Report and is not repeated here.[45] It reflects an eyewitness account of the shoot-down of Flight PS752 but also suggests that civilian ATC had no advance knowledge of the Iranian military targeting this aircraft. After receiving this information, the civilian ATC was increasingly frantic in trying to re-establish contact with Flight PS752. EP3768 landed without incident at 06:31 TT. What is omitted from the Iranian Final Report is the fact that this live account of the shoot-down was immediately and readily available to civilian authorities, including Iran's Civil Aviation Organization, and makes Iranian denials in the three days after the shoot-down all the more disconcerting.

Online Postings

Even before Iran acknowledged its culpability for the shoot-down of Flight PS752, a number of credible eyewitnesses, videos, and analysis emerged in the public domain that left little doubt that two surface-to-air missiles were launched in Tehran on the morning of January 8, 2020.[46]

Bellingcat, a collective of international researchers, investigators, and citizen journalists, led the initial open-source investigation into the downing of Flight PS752. When examining the first uncorroborated video of the incident posted on Telegram,[47] Bellingcat used geolocation and publicly available satellite imagery to situate the site of the missile strike over Parand. Bellingcat data was simultaneously corroborated by other open-source information, including analysis of the flight route data and videos obtained by *The New York Times.*

On January 9, 2020, *The New York Time*s published a video (subsequently posted on the Global News website on January 14, 2020) taken by a local resident showing a missile exploding in the sky. In it, a small streaking object (the missile) can be seen detonating near another object (Flight PS752) followed by an explosion.[48] On the same day, *The New York Times* published other videos it had authenticated showing the aircraft falling to the ground as well as video of people walking though the crash site area.[49]

On January 14, 2020, *The New York Times* published security camera footage from the roof of a building near the village of Bidkaneh.[50] This video showed the entire sequence of the two missiles, fired 30 seconds apart, followed by images of an object on fire (Flight PS752) in the sky on a downward trajectory. The video confirmed that the aircraft appears to have turned back towards the airport but crashes before being able to do so. *The New York Times* also published a video from a security camera in a second parking lot, which showed the launch of the second missile, as well as footage from yet another security camera that

Figure 2: Global News – Parking lot camera showing first missile launch

Figure 3: Global News – Parking lot camera showing second missile launch

Figure 4: Global News – Parking lot camera showing aircraft on fire

Figure 5: *The New York Times* – Ground security camera footage recording ground impact of aircraft

showed the bright flashes of the aircraft impacting the ground.[51] These videos were also used by other media outlets including Global News[52] from which we obtained the above images.

Other footage that was authenticated and published by *The New York Times* showed the crash site as emergency workers scoured the area where debris was spread over a 1,500-foot radius around a small park, orchard, and a soccer field. The Forensic Team has no reason to doubt the authenticity of any of the referenced videos. The Global News video was particularly useful as its continuous footage showed the two missiles being launched within approximately 30 seconds of each other and the plane subsequently on a downward trajectory. The timings of these missile launches correspond to the admissions by Iran in its official reports.

Crash Site

Witness accounts of the crash site reported numerous uniformed rescue and emergency workers, officials in military uniforms as well as non-uniformed individuals present. Several bulldozers were also observed at the site by media officials as well as ordinary citizens, who posted the images on social media. Iranian media has published numerous photos that show the removal of aircraft fragments, the pillaging of the area, and bulldozing that occurred within hours of the accident.[53] Some of the original images that were posted

Figure 6: Search and recovery of Flight PS752 crash site – AP Photo/Ebrahim Noroozi via CBC News January 8, 2020.[56]

online have now been removed. According to foreign journalists who arrived at the site on the morning of January 10, 2020, most of the pieces of the aircraft had been removed, and there was no sign of the area being cordoned off by Iranian security officials.[54] The rapid removal of crash debris is consistent with available photographs of the crash site from numerous sources.

Iran's failure to protect the crash site is the source of many questions and concerns. The quick removal of wreckage and disturbance of the crash site prevented Accredited Representatives from effectively examining the site and the aircraft wreckage at its location.[55]

Figure 7: Iranian Students' News Agency via Tom Podolec Aviation (Twitter) - Flight PS752 aircraft wreckage

Figure 8: Zuma/Alamy from *The Guardian* – Image of bulldozer removing aircraft wreckage from crash site, January 9, 2020[57]

Missile Debris

Images of missile debris were photographed by Iranian citizens in the immediate aftermath of the incident, some of which are included herein. Photographs from the crash site on January 8, 2020 have been geolocated to a location near Khalajabad, southwest of Tehran.

The origin of the missile debris photographs could not be independently verified because those who took and posted the images online have not come forward publicly. Bellingcat noted that a missile "fragment" was likely located in a residential area near Parand,[58] which is more than 40 km away from the main crash site near Khalajabad.

Upon examination of all available video, geodata and photographic information, the Forensic Examination and Assessment Team assesses that Ukraine International Airlines Flight 752 was downed by at least one surface-to-air missile fired from an Iranian SA-15 anti-aircraft system. The extent of damage caused by the second missile could not be confirmed.

Image comparisons between the missile debris and known designs of the SA-15 missile demonstrate a high degree of correlation and the debris is likely authentic. The Iranian Flight PS752 Accident Investigation Final Report confirms that the air defence unit that shot down Flight PS752 was an SA-15 Gauntlet (also known as a Tor M1).[59]

Figure 9: T-Intelligence. Unverified photos of debris from missile likely fired at Flight PS752

Figure 10: Weapons Systems.net – An example of an intact Tor M-1/2 9M330 missile

The Iranian Account of Events

Initial Response

Iran's initial response to the incident appeared uncoordinated with various officials and ministries making different public statements. Initial Iranian statements include:

- Ali Abedzadeh, head of Iran's Civil Aviation Organization, told Iran's semi-official news agency (Mehr News) that the Flight PS752 pilot had not contacted the airport control tower to alert it of any problems. Abedzadeh also said that Flight PS752's "black boxes" – the cockpit voice recorder and the flight data recorder – had been found but that they would not be handed over to Boeing or the Americans.[60]

- A spokesman for Iran's Ministry of Roads and Urban Development said on January 8, 2020 that a fire erupted in one of Flight PS752's engines, which caused the aircraft to burst into flames and the pilot to lose control of the aircraft.[61]

- Another Iranian semi-official news agency, the Iranian Students' News Agency said on January 8, 2020 that the Ukrainian airliner crashed due to "technical difficulties."[62]

- Separately, Iran's Disaster Mitigation and Management Organization also said early assessments indicated the cause was a technical issue.[63]

- The Director of Iran's Center for Communication and Information in the Ministry of Roads and Urban Development, Qasem Biniaz, said on January 8, 2020 that "it appeared a fire struck one of its engines. The pilot of the aircraft then lost control of the plane, sending it crashing into the ground."[64] Biniaz denied rumors that the Ukrainian plane was hit by a missile.

- On January 8, 2020, an Iranian Armed Forces spokesman, Brigadier General Abolfazl Shekarchi, rejected Western media reports that a missile had hit the Ukrainian airliner.[65] Describing the reports as part of Americans' "psychological warfare," Shekarchi claimed that such reports were "ridiculous."

- On January 9, 2020, numerous other Iranian officials made statements to state-run media organizations (Fars News and Iran News Network) claiming that the allegations of a missile strike were "psychological warfare" against Iran. This includes Ali Abedzadeh, head of Iran's Civil Aviation Organization, who told reporters that "what is obvious to us and we can say for sure is that no missile has hit the plane."[66]

- In the hours before Iran admitted culpability on January 10, 2020, Ali Abedzadeh told a televised news conference he was "certain that no missiles hit the aircraft" and that Flight PS752 was not shot down. "If they [Western governments] are certain and have the courage, they should share any finding that has scientific and technical backing."[67]

Admission of Responsibility

During the evening of January 10, 2020 in Tehran, in the face of irrefutable evidence put forward by Canada, Iran publicly admitted that its military had shot down the flight as a result of "human error." This admission followed three days of firm denials.

- At that time, President Hassan Rouhani tweeted the following: "Armed Forces' internal investigation has concluded that regrettably missiles fired due to human error caused the horrific crash of the Ukrainian plane & death of 176 innocent people. Investigations continue to identify & prosecute this great tragedy & unforgivable mistake. #PS752." [68]

- Foreign Minister Mohammad Javad Zarif also tweeted the following on January 10, 2020: "A sad day. Preliminary conclusions of internal investigation by Armed Forces: Human error at time of crisis caused by US adventurism led to disaster."[69]

- On January 11, 2020, Brigadier General Amir Ali Hajizadeh, the Islamic Revolutionary Guard Corps aerospace commander, told a televised press conference that "the soldier mistook the aircraft for a cruise missile" and had "10 seconds to decide… to shoot or not shoot and he made the wrong decision".[70] The general said, "Unfortunately, because of the hasty decision of one person, this great disaster happened".[71] Hajizadeh described the morning of January 8, 2020 as a "war situation" where additional defence systems had been deployed around Tehran, including the air defence unit that hit Flight PS752, which arrived at its location (Bidkaneh) west of the capital at around midnight.[72] According to Hajizadeh, Iran's integrated air defence system detected incoming cruise missiles several times and warned all units to be vigilant. He acknowledged that "units were on the highest level of alert, fingers were hovering over buttons to fire".[73] Hajizadeh said that when the air defence unit operator at Bidkaneh tried to contact his superior, there were problems with the communications system..."Whether this was due to a network being clogged up or jamming signals, he cannot establish contact," Brigadier General Hajizadeh said.[74]

- On January 14, 2020, President Hassan Rouhani said that a special court would be set up to probe the downing of the plane and promised his administration would pursue the case "by all means."[75]

Iran initially stated that six Iranian individuals had been charged with certain offences with respect to the destruction of Flight PS752.[76] On June 20, 2020, Iran publicly acknowledged the arrests, stating that three individuals had been released on bail while the other three accused remained in detention.[77] More recent media reporting quoting Iranian military prosecutor Gholam Abbas Torki indicates that 10 officials have been indicted.[78] Torki is quoted as saying, "The indictment of the case of the Ukrainian plane was also issued and a serious and accurate investigation was carried out and indictments were issued for 10 people who were at fault."[79] No information has been made available about who these people are, what they are alleged to have done, or what their degree or level of responsibility is. Iran has not made public the evidence being used against them, the substance of their defence, or the judicial process by which their guilt or innocence is being or will be determined.

Iran's Accident Investigation Pursuant to the Chicago Convention

As the State in which the downing occurred, Iran's Civil Aviation Organization Aircraft and Accident Investigation Board (AAIB) led the Flight PS752 investigation in accordance with Article 26 of the Convention on International Civil Aviation (Chicago Convention) and its Annex 13. The investigation was to be conducted according to the standards and recommended practices of the International Civil Aviation Organization (ICAO) to identify all relevant causes and contributing factors, and to make safety recommendations in order to prevent similar events in the future. Annex 13 investigations are not conducted with the intent to apportion blame or liability.

The AAIB released five accident investigation reports including the most recent Final Report, which was issued on March 15, 2021 and released publicly on March 17, 2021. Despite its many flaws, from an aviation safety perspective, the Final Report represents Iran's latest and most comprehensive account of the sequence of events and causal factors that resulted in the downing of Flight PS752.

In Iran's Final Report, the AAIB acknowledged that the crash was caused by damage to the aircraft from the detonation of the first of two surface-to-air missiles launched from the SAM unit.[80] The report also concluded that mitigation measures (intended to protect civilian flights from potential threats from Iranian defence forces) failed to prevent the downing due to the occurrence of "unanticipated errors in threat identification" by the SAM unit.[81] Iran's Final Report suggested that the misidentification of Flight PS752 as a perceived hostile target, and the subsequent launch of missiles at the flight, resulted from the following sequence of events:[82]

1. The SAM unit was misaligned 105 degrees off north[83] due to "human error," which resulted in the operator observing the detected target direction inaccurately,

2. Defective communication occurred between the SAM unit and the Coordination Center,

3. The SAM operator misidentified Flight PS752 as a hostile target,

4. The SAM operator failed to follow military command procedure for missile launch and fired upon Flight PS752 without approval.

While the airline operator has a role to play in conducting its own risk assessment, Iran's Final Report placed excessive blame on UIA, suggesting that the airline should have been tracking emerging events from the region through social media and subsequently applying mitigation measures to the flight. Their Final Report later acknowledged that no other airlines with departing flights from IKA on the day of the downing imposed restrictions on their own flights on the basis of a risk assessment.[84]

Iran's Final Report also presented an incomplete account of the military sector's role in events, despite the fact that actions by IRGC personnel were central to the downing and military safeguards were most relevant to protecting civilian aircraft against the risk of misidentification and targeting. Disappointingly, the AAIB states that, in its view, the military's actions were outside the scope of its investigation.[85] The report claims that the investigation of military matters were instead within the purview of the Armed Forces of the Islamic Republic of Iran only.[86] The Transportation Safety Board of Canada has stated that it did not agree with Iran's exclusion of the military's role in the shoot-down from its Annex 13 investigation.[87]

Iran's Final Report thus presented a selective account of military activities related to the shoot-down. It focused exclusively on the narrow set of reported actions by the SAM unit and launch of missiles at Flight PS752. It relied heavily on the military's accounting of events. The Final Report incorporated only high-level information on the coordination of military and civil authorities related to airspace management; however, it provided no specific information related to how such coordination influenced events, and it excluded any findings related to military activities that would have been relevant to ensuring civilian flights were not misidentified. Subject to further legal analysis, the Forensic Team's assessment is that Iran's Final Report fails to meet the requirements set out in Annex 13 to ICAO's Chicago Convention as a result of these shortcomings and by failing to thoroughly identify the causes and contributing factors of the shoot-down.

While it seems evident that the SAM operator's actions played a key role in the downing of Flight PS752, based on the information available, the Forensic Team believes that his actions could have been avoided. But for a number of deficiencies in planning, mitigating risk and decision making, Flight PS752 would not have been targeted by the SAM operator. Iran's explanations to date, including through its Final Report, lack context and fail to address the full breadth of causes and contributing factors that led to the downing. Indeed, the analysis below demonstrates that Iranian civilian and military authorities – through both their actions and omissions – directly put Flight PS752 and other civilian aircraft in unnecessary danger by creating the conditions in which a SAM operator could launch missiles at them and by failing to take adequate preventative measures to reduce this high risk.

The Shoot-Down of Flight PS752:

Analysis of Critical Elements and Factors

Iran Failed to Take Measures to Ensure the Safety of its Airspace and to Notify Airlines of the Risks

KEY FINDINGS

- Iran decided to keep the majority of its airspace open to civil aviation notwithstanding the heightened level of military alertness on January 7–8, 2020. Its Final Report provides information related to this decision and their determination that flights from IKA were "low risk." However, it fails to address contradictory information suggesting that risk levels were much higher. The Forensic Team found this determination and Iran's corresponding decision to keep its airspace open over Tehran were flawed and completely fell short of internationally recognized standards to ensure airspace safety

- Iran reported that it planned and successfully implemented mitigation measures to protect flights from the threat of misidentification on the morning of January 8, 2020. The lone mitigation measure that appears to have been implemented for flights departing IKA was a requirement to obtain military approval for take-off. While Iran recognized that risk-levels exceeded expectations and planned mitigations failed to prevent the downing of Flight PS752, its Final Report identifies no specific deficiencies in the decisions or actions of the civil-sector or its coordination with the military sector. Iran has therefore provided insufficient information to explain why the only implemented measure that related to Flight PS752 failed. It has also failed to explain why basic preventative measures that could have avoided this tragedy were not taken.

- The Forensic Team could not locate any official Iranian notifications to air carriers prior to the departure of Flight PS752. Iran did not make reference to having issued a NOTAM or any other information to air carriers regarding the status of ongoing military activities on January 8, 2020. This failure to advise airlines of the clear risks of flying that day likely fell short of expected international standards.

- The Final Report from Iran suggested "transient conditions" and SAM operator errors were not factored into its flawed assessment of risks to civilian aircraft. Iran also indicated the inclusion of such factors would not have changed Iran's determination that Flight PS752 was safe to fly or necessitated additional mitigation measures. As events unfolded, it is clear that conditions were far more dangerous and Iran's judgement was proven wrong.

In the hours preceding the ballistic missile launch on US positions in Iraq, Iran went on high military alert, and the IRGC deployed mobile SAM units in the vicinity of Tehran's IKA.[88] Iran knew that ongoing military tensions, an elevated defence posture, and the deployment of SAM units in the vicinity of an airport serving civil aviation would raise the risk for civil aircraft. Notwithstanding the increased risk to civil aviation and, based on its risk assessment that such a risk was "low," Iran decided to keep this airspace open to civil aircraft while implementing only one mitigation measure.

Iranian decision makers had the benefit of international guidance and recommendations to inform their plan to manage risks to civil aviation from the IRGC's military activities. Recent history demonstrated the level of risk, most notably Malaysia Airlines Flight 17 (MH17) which was shot down over Ukraine in 2014. Iran also had ICAO guidance material available to assist it in managing risks to civil aviation from military activities in conflict zones.[89] Finally, Iran had first-hand knowledge of the risks faced by civil aircraft during times of heightened tension with the downing of Iran Air Flight 655 (IR655) in 1988. The downing of IR655 resulted in the development of ICAO guidance on managing military activities with the potential to be hazardous to civil aircraft operations.

Risk Analysis

Under international law, Iran bears the responsibility for ensuring that civil aviation operations in its airspace are safe, including from military hazards.[90] Standards and recommended practices are set out in annexes to the Chicago Convention to assist member States in this regard.

The Iranian Final Report claimed that Iran's military conducted a thorough risk assessment in advance of its launch of missiles on US positions in Iraq the morning of January 8, 2020,[91] but was silent on any risk assessment conducted by Iran's Civil Aviation Organization or the Air Navigation Service Provider.

The military's risk assessment concluded there was a "low risk" of Iranian defence forces misidentifying civil aircraft (like Flight PS752) departing IKA.[92] Iran claimed its military assessment informed its decision to keep its airspace open over Tehran during this period of heightened tension and noted its identification of mitigation measures to protect airlines. This reportedly included a mitigation measure that required flights departing IKA to obtain military approval before take-off. The Forensic Team has no other source of information to corroborate Iran's claim with respect to the conduct of its risk assessment; however, it is known that Iran did not share information on its risk assessment with UIA in advance of Flight PS752 taking off.

In contrast, Iran's Final Report indicated that the assessment determined there was a "very high" risk of misidentification for flights transiting the Iran-Iraq border and "high risk" for those travelling along four parallel north–south flight corridors in western Iran in proximity to the border.[93] Iran's Final Report indicated that Iranian airspace and departures from Iranian airports would have been stopped "in the event of a conflict."[94]

The Forensic Team examined air traffic within the four airways close to the Iran-Iraq border the morning of January 8, 2020 (UT430, UM317/L319, UL223, and UT301). This analysis determined that ATC stopped using the four airways beginning at approximately 05:15 TT.[95] ATC managed the traffic in these corridors without issuing a NOTAM to notify airlines of the risk, contrary to international guidance.[96]

This airspace closure along the border with Iraq had no effect on Flight PS752, which departed from Tehran's IKA at 06:12 TT and whose flight plan did not include any of these airways. In fact, the majority of airspace remained open for civilian aircraft arriving at or departing from Iranian airports, as well as aircraft navigating through Iran without stopping (overflights). An official NOTAM for this airspace closure was not issued until several hours after Flight PS752 departed.

The Iranian Final Report suggested that airspace near the Iran-Iraq border presented a "high risk" of misidentification and claimed that air traffic was cleared from this area as there would be insufficient time to redirect flights to safety in the event of a retaliatory US air strike.[97] However, they did not restrict traffic in this area until approximately three hours after the missile attack on US bases in Iraq. Furthermore, the timing, location, number of targets, and speed of any US counterstrike resulting from Iran's launch of missiles into Iraq would have been unpredictable. The Forensic Team determined that these factors would have presented similar airspace management challenges for aircraft like Flight PS752 departing IKA and flying through Iranian airspace. Iran's Final Report provided very limited details to substantiate how risk levels were materially different, and the Forensic Team found no information to account for these inconsistencies.

The Forensic Team analyzed conditions such as the heightened state of tensions and the placement of the SAM units on high alert near IKA, and determined that risks to civilian aircraft were not "low." Iran's Final Report failed to account for contradictory information that suggested risk levels specific to Flight PS752 were much higher. Based on the information available, the Forensic Team concludes that Iran's risk assessment and decision to leave the majority of its airspace open was severely flawed. Iran fell well short of internationally recognized standards in place to ensure airspace safety by failing to take adequate preventative measures for such a dangerous situation.

When Iran went on high alert in the hours preceding the ballistic missile launch on US positions in Iraq, defensive preparations included the IRGC deployment of mobile SAM units in the direct flight path of flights arriving at and departing from IKA.[98] These actions strongly suggested that Iran was anticipating an imminent US counterstrike and that military leadership viewed areas in close proximity to IKA as possible targets.

On January 11, 2020, IRGC aerospace commander Brigadier General Amir Ali Hajizadeh indicated that "for more than a week, the region's conditions and the likelihood of conflict [had been] unprecedented since the beginning of the revolution."[99] He described the morning of January 8, 2020 as a "war situation" and stated that Iran's integrated air defence system detected incoming cruise missiles several times and warned all units to be vigilant. He acknowledged that "units were on the highest level of alert, fingers were hovering over buttons to fire."[100]

In public pronouncements, Iran has contended that its experience in safely managing its airspace during the eight year Iran-Iraq war (1980–1988) and during periods of high regional tensions stands as evidence that its decision to keep the skies open over Tehran was justified.[101]

The Forensic Team determined that the conditions in Iran on January 8, 2020 were consistent with a conflict zone as defined by ICAO guidance: "airspace over areas where armed conflict is occurring or is likely to occur between militarized parties, and … airspace over areas where such parties are in a heightened state

of military alert or tension, which might endanger civil aircraft." Iran's air defences were on high alert and presented a clear and present danger to civil aviation. The level of risk was assessed inadequately, and Iran failed to take sufficient measures to safeguard civil aircraft from military hazards.

ICAO standards and recommended practices and guidance emphasize the importance of protecting civilian aircraft in conflict zones. The Dutch investigation into the downing of MH17 also resulted in the identification of a number of recommended practices to help the international community safeguard civil aviation against similar tragedies. These underscored the importance of sound risk assessment, the timely closure or restriction of airspace, and that States provide early and specific information to airlines on potential threats from military activities. The Forensic Team's analysis determined that Iran's management of its airspace was inconsistent with these international standards and recommendations.

Mitigation Measures and Notifications to Airmen

Iran's Final Report claimed that Iran's overall determination of risk was sound and that mitigation measures were identified to achieve an "acceptable level of risk."[102] The Final Report further claimed that Iran's military re-evaluated the risks and incorporated elements that were not included in its initial determination ("transient conditions" and the chain of events that led to firing missiles at Flight PS752). This re-assessment arrived at the same conclusion – Flight PS752 remained safe to fly. The military also determined the plan implemented on January 8, 2020 to protect civil aircraft from misidentification by the IRGC remained valid and indicated no additional mitigation measures would have been required due to the aircraft's routing. Based on the events that unfolded, it is clear that Iran's judgement was proven wrong. It is the Forensic Team's assessment that these determinations and the plan to protect civilian aircraft were severely flawed, as conditions were far more dangerous than Iran suggests.

Iran's plan to mitigate risk included a requirement that flights departing IKA obtain military approval for take-off. By Iran's own admission, the professed goal of requiring advanced approval prior to take-off was to ensure the correct identification of civil flights by the Iranian defence network and avoid targeting civilian aircraft by mistake.[103] The Iranian report further stated that the following actions specific to Flight PS752 were conducted as intended and there were no deficiencies among civilian authorities:

- Submission of Flight PS752's flight plan to the military sector;
- Provision of military clearance to civilian air traffic control for Flight PS752's engine start-up and take-off; and
- Receipt of civil surveillance radar information, including flight specifications for Flight PS752, by the Civil-Military Operational Coordination Center (CMOCC).[104]

Iran claimed that the civil and military sectors coordinated airspace management activities through the CMOCC to ensure the security of airports as well as to distinguish "commercial flights from anonymous and hostile flights."[105] Iran further claimed that the CMOCC was operated by the military and located in the Tehran Area Control Center, a civilian body that is responsible for communicating all civilian flights to the military sector. Iran's Final Report asserted that this structure was operational and functioning properly at the time of Flight PS752's departure.[106]

Iran has not provided any information to substantiate its claim that civil-military coordination, as Iran described in its Final Report, actually occurred in relation to Flight PS752. However, if civilian air traffic controllers did in fact provide flight information to military authorities and coordinated with them prior to issuing start-up clearance for flights,[107] it raises significant questions as to whether or not such critical information was communicated to SAM units and their command structures in the field. If this information was available, it should have allowed the SAM operator and his command to identify Flight PS752 as a civilian aircraft. If such information was not transmitted to IRGC personnel, including the SAM operator, why not? The Forensic Team was unable to find information to answer these important questions, and Iran has not been forthcoming, given its decision to exclude military findings from its Final Report.

As previously indicated, States bear responsibility for ensuring that civil aviation operations in their sovereign airspace are safe; however, air carriers also have a role in deciding when a flight can operate safely. According to ICAO's standards and recommended practices, air carriers should use every reasonable means available to ascertain flight safety prior to the commencement of a flight.[108] Risk assessments are to be conducted prior to take-off and mitigation measures put in place to ensure a safe and secure flight, including when flying though conflict zones. However, according to ICAO standards and guidance, States are responsible for the proper coordination and publication of activities hazardous to civilian aviation arising in their territories. They are the only ones who have access to military planning and risk assessments. ICAO guidance also states that such notifications by national authorities should be issued sufficiently far in advance of any hazard to allow all international civil aircraft to plan their routes clear of such areas.[109]

Without access to such information in a timely manner, air carriers' assessments would naturally be missing a critical element. In Appendix B to the Iranian Final Report, there is a thorough description provided by UIA of the risk assessment that was conducted by the airline prior to Flight PS752's departure.[110]

The US FAA had issued flight restrictions for the Baghdad Flight Information Region prohibiting American carriers from "operating in the region due to heightened military activities and increased political tensions in the Middle East" on January 7, 2020 at 23:50 UTC (03:20 TT 8 January). Shortly thereafter, on January 8, 2020 at 00:10 UTC (03:40 TT) – 2 hours and 32 minutes before the departure of Flight PS752 – the FAA issued a NOTAM prohibiting US carriers from operating in the Tehran Flight Information Region. In a meeting with representatives of the Forensic Team and Transport Canada on October 23, 2020, the Ukraine State Aviation Administration (USAA) indicated that they had not received the US FAA-issued NOTAMs of January 7 and 8, 2020 in order to consider them in their risk assessment for Flight PS752. This is because Ukraine is not part of the FAA's distribution. UIA further confirmed this in Ukraine's statement in response to Iran's Final Report, noting that "The FAA NOTAM … should not and could not have been included in the Flight Briefing Package for Flight PS752…."[111]

The Forensic Team's analysis concludes that UIA and the pilots of Flight PS752 very likely had limited awareness of military activities and associated risks on January 7 and 8, 2020. Interviews with Ukraine Civil Aviation Organization officials and reports in the Ukrainian press suggest that there was advanced knowledge of elevated Iran-US tensions in the region, given the death of Major General Soleimani five days earlier. However, the Forensic Team found no indication that UIA or the pilots of Flight PS752 were aware that risk levels had gone up significantly due to Iran's ongoing military activities near Tehran and

Iran's high-alert condition following the launch of missiles at US forces in Iraq a little over four hours before Flight PS752 took off from IKA. This limited situational awareness would likely have also applied to the other airlines' pilots who departed IKA before Flight PS752. (See Annex E for a list of departures before Flight PS752.)

While Iranian media did begin reporting on the IRGC-announced launch of missiles towards Iraq (referred to as "Operation Shahid Soleimani") early on January 8, 2020 (at 02:27 TT on a Fars News Agency Twitter account[112] and at 03:20 TT on a Mehr News Agency site[113]), Iran did not formally and promptly communicate that the risk environment for civilian aircraft had significantly increased due to military activities. Iran's Final Report stated that UIA requested NOTAMs from the Civil Aviation Authority of Iran. However, UIA indicates that neither the airline nor the crew of Flight PS752 received information or warnings of any kind from Iran's Air Traffic Services, military bodies, or IKA.[114]

The Forensic Team was unable to identify any records of Iranian authorities providing NOTAMs or advisories to airlines before Flight PS752's departure. This lack of pertinent threat-related information deprived airlines such as UIA of the full and up-to-date picture of conditions necessary to determine whether it was safe to fly or if additional measures were required to manage risks. Like failing to close the airspace, this failure to notify airlines of the clear risks of flying that day demonstrates that Iran did not take the reasonable and expected precautions necessary to protect civilian air traffic. This stands in stark contrast to past instances when the Iranian Civil Aviation Organization had issued NOTAMs to advise airspace users of potential risks related to military exercises.[115]

Iran has also provided no information on its decisions to cease and then restart operations from IKA following the downing. It has not clarified if an immediate assessment of the downing took place, whether military hazards to airspace users were identified as part of that assessment, and what, if any, measures were put in place to ensure flights were safe to depart from IKA following the shoot-down.

Iran's Final Report indicated that the Supreme Council for National Security (SCNS) plays a role in coordinating and integrating issues between Iranian security and intelligence organizations, both military and civilian. The importance of the SCNS's role is highlighted with the comment "[I]f the dimensions of the issue fall beyond the functions of the given body, relevant measures will be taken using the capacity of the SCNS."[116] It is very likely the SCNS would have had the final word on issues of strategic importance, like defence plans and decisions related to airspace management.

This concludes the Forensic Team's analysis of the first line of inquiry regarding the measures Iran adopted as a part of its airspace management. The next section contains an analysis of the extent to which SAM operator actions and decisions contributed to the downing.

Surface-to-Air Missile Operator's Sequence of Events

KEY FINDINGS

- While the act of shooting the missiles was a deliberate and intended action, the information available to the Forensic Team indicates the IRGC surface-to-air (SAM) unit operator likely misidentified Flight PS752 as a hostile target.

- The IRGC SAM unit operator took a series of actions and made decisions that resulted in the downing of Flight PS752. The Forensic Team determined it is likely the SAM operator failed to align the direction indication system of the SA-15 unit properly or detect and correct the misalignment during the six hours after it was deployed and likely operational.

- Analysis by the Forensic Team concluded that a misalignment of 105-degrees, when present, would have likely resulted in Flight PS752 appearing to approach the SAM operator from the southwest (Iraq) rather than the true direction from IKA which was from the southeast. However, it is the Forensic Team's assessment that, in the context of military operations, a misalignment of this nature should have been detected.

- Following delays and obfuscation in the days immediately following the downing, especially the numerous misleading pronouncements from Iranian civilian and military officials (including from the IRGC) Iran has now stated that they view the downing of PS752 as a mistake. The Forensic Team has found no information that contradicts the suggestion that the IRGC SAM operator mistook Flight PS752 as a hostile target and fired upon Flight PS752 without receiving the necessary approvals from command and control. The Forensic Team also found no evidence that Iranian officials ordered the shoot-down or that it was premeditated.

- However, given the number and sequence of decisions, acts and omissions known to the Forensic Team, Iran has not provided sufficient information or explanations to account for the broader questions this raises regarding the proficiency of the IRGC SAM operator who downed Flight PS752. These include the adequacy of his training, the target validation process, and the supervision of SAM operators under such circumstances.

- Without a credible and transparent accounting of the facts, including into the causes related to military activities, it is the Forensic Team's assessment that the international aviation community cannot be assured that a similar tragedy will not occur again in the skies over Iran.

Figure 11: SA-15 or Tor-M1 surface-to-air missile delivery system[117]

SA-15 Missile System

The air defence unit that downed Flight PS752 was a Russian-made SA-15 (or Tor-M1) short-range, SAM delivery system.[118] This is a mobile system that includes target acquisition radar, tracking radar, and missiles.[119] Two radars detect and engage manned aircraft, helicopters, missiles, and other precision-guided ammunition.[120] A three- or four-person crew is generally required to operate the system, and it includes a vehicle commander, system operator, and vehicle driver.[121]

The SA-15 has a range of 12 to 16 km, and can fire at targets with an altitude of 6 km. Missiles reach a velocity of up to three times the speed of sound.[122] The missile relies on command guidance from the SA-15's radar tracking system, which transmits instructions to the missile while it is in flight.[123] The warhead is located further down the shaft of the missile and is designed to detonate by proximity and shower its target with shrapnel projectiles.

These missile delivery systems originated in 1986, and there have been a number of updates over the years.[124] The age of Iran's current fleet is uncertain, but Iran is known to have purchased some of its SA-15 units in 2007 from Russia[125] and additional units as recently as 2015.[126] As of 2018, Iran reportedly had 29 SA-15 missile delivery systems.[127]

Forensic Team Finding:
The specifications of this system are consistent with images captured of Flight PS752 debris showing the missile head intact as the proximity warhead is positioned further down the body of the missile.

Given the lethal threat posed by anti-aircraft batteries such as the SA-15, they are typically targeted first by an attacking enemy, which puts the operating crews under intense psychological pressure during times of potential conflict.[128] While the unit is designed to be easy to operate, it requires some training. The Forensic Team has no information on the exact age of the SA-15 equipment that was used or the quality and length of training that the Iranian personnel responsible for the launch of missiles at Flight PS752 received on the use of this system.[129] The Forensic Team did, however, obtain information suggesting that the operator of the SAM system could have been a trainer on the SA-15. If confirmed, this would make their actions and decisions all the more concerning.

According to military experts, SAM units typically operate as part of an integrated air defence structure. Depending on the mission, deployments can include several SA-15s (SAM battery) working in concert to defend targets in a specific area along with a battery command post. The battery command post provides

command and control functions over the SAM units and also often integrates the SAM battery into the broader structures of an air defence system.[130] Iran's Final Report indicated that the SAM operator was required to contact a Coordination Center (also referred to as a "Command Center") to verify targets and receive approval to fire. However, Iran has provided insufficient information that would allow the Forensic Team to conclude definitively if the SA-15 unit that downed Flight PS752 was part of a larger SAM battery. Iran also provided no information to indicate whether the Coordination Center was a battery command post, to identify its specific location, or to detail its role or position within the IRGC's air defence command structure.

Given this lack of clear explanations by Iran, the Forensic Team applies the term "SAM unit's immediate C2" when analyzing IRGC command and control functions. This immediate C2 would be one level up the chain of command from the SAM unit and its operator. Military experts consulted by the Forensic Team indicated that the SAM unit's immediate C2 would have been responsible for overseeing the SAM unit, including any actions by the operator, and would have been integrated into the IRGC's air defence structure to ensure situational awareness.

Iran's Final Report pointed to actions by the SAM operator as the primary cause of the Flight PS752 shoot-down. It claimed an unanticipated chain of events resulted in the SAM operator firing missiles at Flight PS752. It identified errors related to alignment of the SAM unit, defective communication with the Coordination Center, misidentification of Flight PS752 as a threat, and a failure to follow military procedures by firing at Flight PS752 without approval.[131]

The Forensic Team assessed these claims and determined that they provide an incomplete explanation of events. Iran has failed to provide information to convincingly explain how and why each of the alleged errors occurred. Importantly, Iran provided no information that would establish the specific steps the SAM operator did or did not take to determine whether Flight PS752 was a civilian aircraft or a threat. Iran's Final Report also did not recognize the relevance of command and control functions to the operator's purported errors or provide any information on the quality of training or supervision. Despite the significance of these factors as an immediate cause of the shoot-down and an essential element to resolve in preventing similar events in the future, Iran considered them to be out of scope in its Final Report and has presented no information on military actions aside from that of the SAM operator. The Forensic Team identified credible information related to actions taken by the IRGC SAM operator and his command which are outlined in the next section (Command and Control Failures).

Operator Action # 1 – Misalignment

An air defence Transporter, Launcher and Radar such as the SA-15, when in good condition and used properly, should allow the operator to make a distinction between a cruise missile and a large civilian aircraft. The capabilities of individual air defence units are enhanced by integration and regular information exchanges with command and control (C2), as the defence network as a whole would likely have extensive situational awareness.

Missile system experts consulted by the Forensic Team indicated that it was conceivable for the operator to introduce a 105-degree misalignment. However, they further indicated that militaries as advanced as Iran's

should have had specific procedures for operators to follow when setting up their SAM units in-theatre. If the operator failed to follow these procedures, a misalignment could have been introduced.

The SA-15 can be deployed to its battle location under its own power or transported via a trailer depending on defence or logistical considerations. Standard military procedures for such systems would normally require SA-15s to be powered down upon transport by trailer. This could result in a loss of orientation, which would require operator intervention upon start-up to ensure alignment of the inertial navigation system to north. Proper alignment is required to ensure the operator's display accurately depicts the physical direction the SA-15 is pointing. While this scenario is possible, the Forensic Team was unable to identify information confirming this was the source of the misalignment.

The SAM unit reportedly arrived at its location west of Tehran around midnight TT on January 8, 2020 according to statements by IRGC Brigadier General Hajizadeh on January 11, 2020.[132] Iran's Final Report claimed that the SA-15 was relocated 100 metres for tactical reasons at 04:54 TT on January 8, 2020, which introduced the misalignment. Iran also claimed the SAM unit was on "standby mode" until 06:07 TT, five minutes before Flight PS752 departed, at which point it was set to "operation mode."[133] The Forensic Team consulted missile system experts who indicated "standby" and "operational" modes reflect different battle readiness conditions, which typically involve SAM units powering radar systems and target detection capabilities "on" (operational) or "off" (standby). The Forensic Team finds that the Iranian explanation is significantly lacking in credibility given the heightened threat level posture of SAM units at the time. Iran's contention that the system was left on standby or inactive for over an hour is inconsistent with its numerous statements that Iran's air defence forces were on high alert and implies there was a more reduced threat level than the actions of the SAM unit, that is, firing against Flight PS752, would clearly suggest. Iran has provided no additional details on these issues and must provide concrete proof to render such a critical claim believable.

In the event the SAM unit was relocated at 04:54 TT as claimed, it likely would have moved under its own power for such a small distance. Iran's Final Report did not indicate why the system would only be misaligned after the short move, as such systems do not typically require re-calibration of the direction indication system under such conditions. The Forensic Team has determined that Iran must provide additional information on how the misalignment could have been introduced under such circumstances to establish the credibility of such a claim. If the misalignment was introduced through such a move, it raises concerns as to whether the SAM unit's personnel followed or violated relevant IRGC procedures; however Iran has not provided any information to answer such questions.

According to Forensic Team analysis and as demonstrated in Figure 12, the 105-degree misalignment referenced in the Iranian Final Report likely would have resulted in the operator perceiving Flight PS752 as approaching from the southwest (Iraq) rather than the true direction of IKA from the southeast.

However, it is the Forensic Team's assessment that, in the context of military operations, a misalignment of this nature should have been detected. There are also other systems and procedures in place to prevent misidentification, so the misalignment on its own should not have resulted in the launching of missiles against Flight PS752. The operator should have been able to identify Flight PS752 accurately given the SA-15's on-board capabilities and interactions with a properly functioning C2 system.

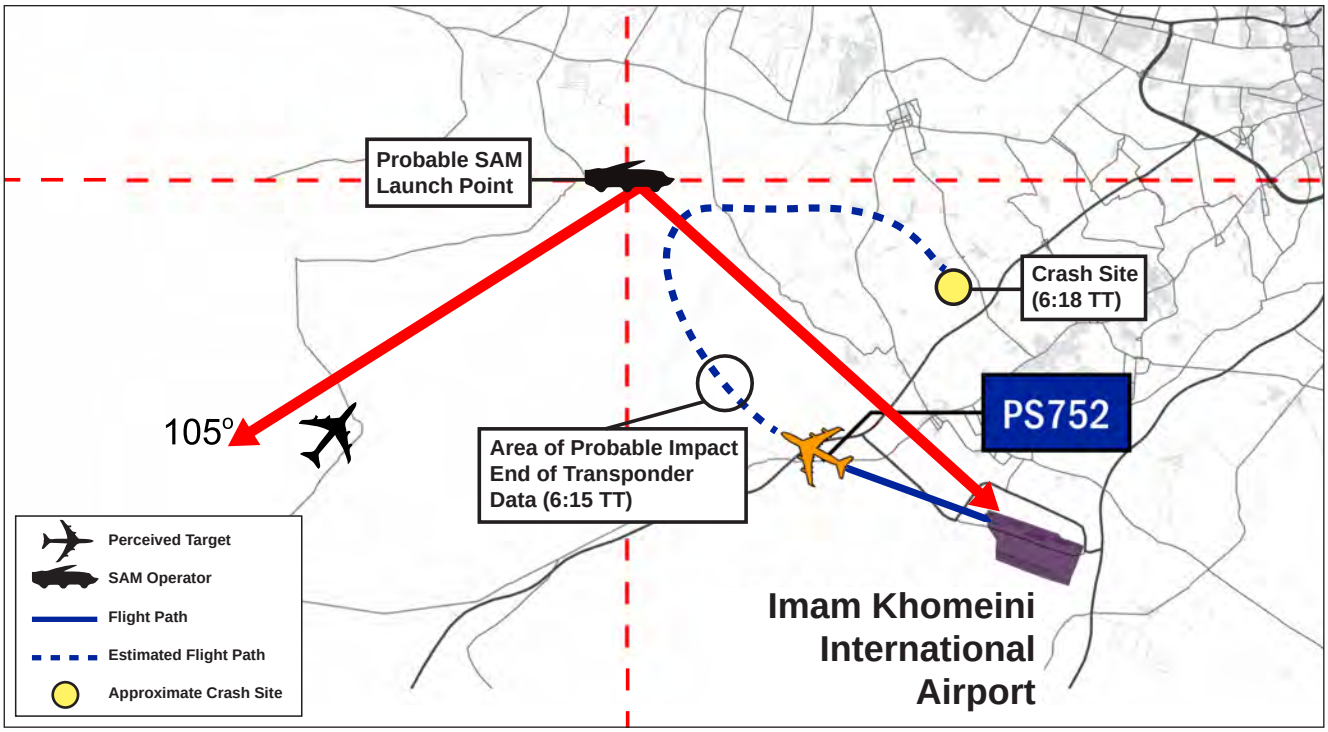

Figure 12: Flight trajectory of Flight PS752 and reported misalignment

Operator Action # 2 – Identification of Flight PS752 as a Hostile Target

According to missile system experts, such a misalignment should have had no effect on the operator's perception of vertical movement of the aircraft or its airspeed (i.e. an airplane climbing versus an incoming cruise missile). It simply would have made the aircraft look like it was coming from another direction to the operator (i.e. southwest versus southeast). The method and precision of the altitude indication system on the SA-15 unit that shot down Flight PS752 is unknown but could have influenced the operator's ability to differentiate between ascending, level, and descending aircraft. Iran has provided no information to describe if or how these factors were considered as part of the SAM operator's target identification process.

Figure 13 shows a typical radar display from a SAM unit. It includes radar "sweeps" across the area that it is facing; as it rotates, the sweep is displayed on the operator's screen and revolves in sync with the radar's scan. Through the system's parameters and algorithms, objects that the radar detects (called "contacts") will be identified as a target on the operator's display when very specific criteria are met. When the Identification Friend-or-Foe (IFF) system interrogates a radar contact, it is displayed on the screen. In this case, its status is unknown as it has not yet been determined as a hostile or friendly contact. Military experts indicated the primary operator screen for such radar systems typically only display an icon for unidentified objects. While radars are often able to report the strength of the return that could provide some indication of relative target size, it is uncertain how accessible or useful this information would have been to the operator of this system to differentiate an airliner from a cruise missile. Iran has provided no information to clarify these considerations or explain how the SAM operator identified and classified Flight PS752 as a threat.

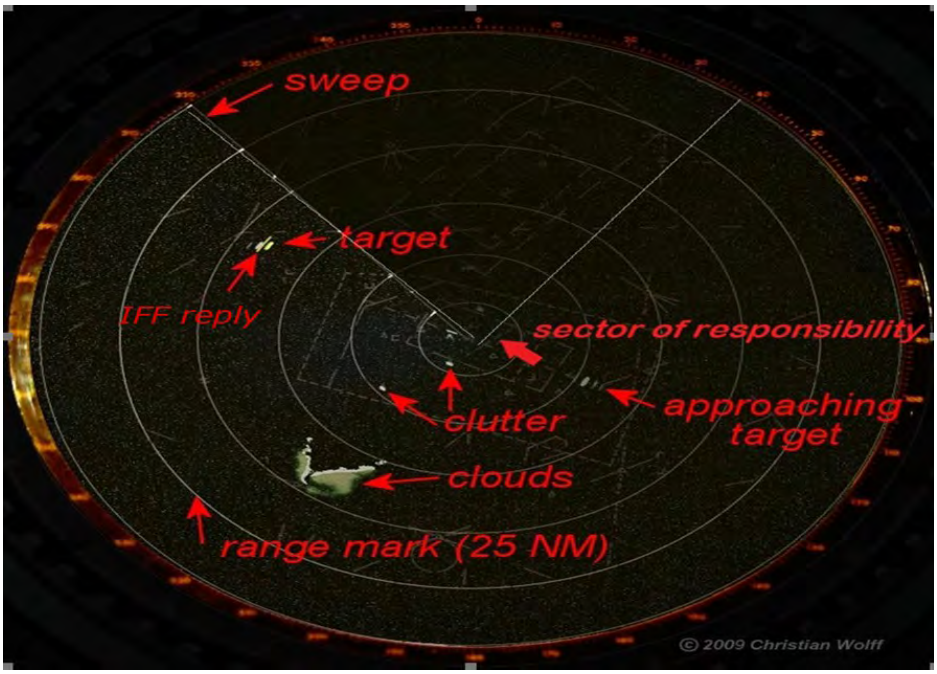

Figure 13: Sample radar display

Range marks, also known as range rings, are circles displayed on the operator screen to provide an approximate range from the radar location. They also assist a radar operator in determining the relative rate at which a radar contact is closing in, or is evading. An approaching target is displayed when a radar contact conforms to the criteria of a target and exhibits movement towards the radar unit. The system is also capable of detecting the altitude of a target and its change while tracking. A radar sector (of responsibility) is the area defined by lines on the operator screen, often appearing as a pie shape from the screen centre that indicates the left and right boundaries of the area that a particular radar unit operator is responsible for monitoring and defending.

If the SA-15 operator was using such an assigned engagement sector on his system, it would likely have been perceived as being focused on an area towards Iraq and not towards Tehran due to the 105-degree misalignment. The Forensic Team consulted experts who have concluded that this may have resulted in the operator becoming fixated on the targets in the assigned engagement sector and not focused on other factors that would have distinguished a commercial aircraft taking off from a target that could have appeared to be approaching Tehran from the direction of Iraq.

Like most air defence systems, certain models of the SA-15 are known to be equipped with IFF systems. Civilian aircraft have transponders that broadcast their status as civilian. SAM unit operators are able to send interrogation signals to potential targets, which would result in an aircraft transmitting its identity to the SAM IFF system as civilian. According to Iran's Final Report, Flight PS752's transponder was functioning properly. Transmissions from it to Air Traffic Control's secondary radar indicated the aircraft was flying at a normal altitude and trajectory until the first missile detonated.[135]

While IFF systems are valuable safety measures, the Forensic Team determined that they do not always work as intended and, even when functioning properly, may not be sufficient on their own to definitively identify an aircraft as hostile or civilian. The Forensic Team consulted military experts, who indicated that Russian IFF systems featured on units such as the SA-15 are potentially incompatible with transponders used to identify civilian airliners such as the Boeing 737-800 (Flight PS752). Civilian airliners like Flight PS752 employ the ICAO-standard L-band interrogations whereas Russian IFF radars are known to interrogate in S-band, meaning the two IFF systems speak different languages.[136]

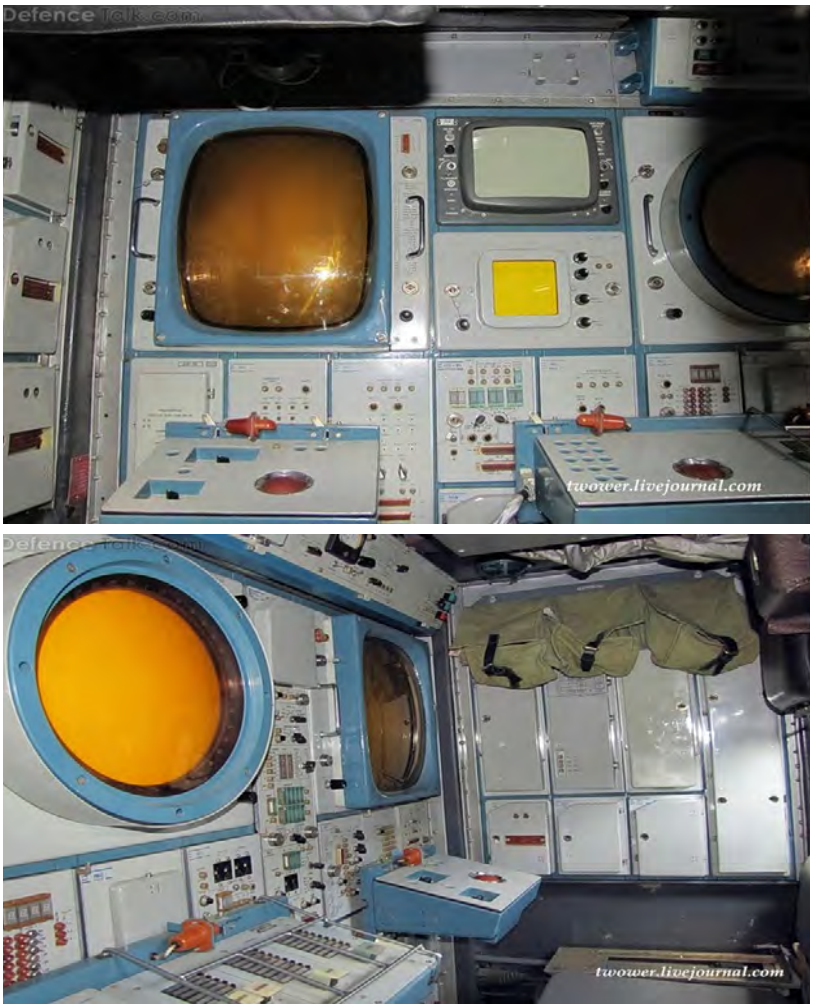

Figure 14: The interior of an SA-15[134]

The Forensic Team was unable to determine if the SAM unit that shot down Flight PS752 had a standard Russian IFF system installed, whether such incompatibility issues were present, and, if not, if the IFF system was functional and activated. Responsible military planning should ensure that SAM units deployed in close proximity to an international airport would be equipped with some means (e.g. IFF, datalink) of differentiating friendly and civilian aircraft to reduce the likelihood of misidentification. Iran has not provided access to the SAM unit's recorders[137] or provided any information in its official reports to clarify if the SAM unit was equipped with such a means of identification and, if so, what role it played in events.

The Forensic Team identified additional measures that could have been relevant to properly identifying Flight PS752 as a civilian aircraft. Military experts consulted by the Forensic Team indicated that some countries with older SAM systems manually mark civilian air-traffic lanes on search radar displays and verify them with their immediate C2 as part of their identification procedures. Also, the SA-15 is known to be equipped with a TV optical tracking system (visual camera capability), which complements its radar systems. If such a system had been used and functional during the time of day (darkness), the operator may have been able to observe the aircraft's flashing anti-collision lights. Military experts advised that ambient lighting associated with a civilian aircraft's proximity to the horizon during take-off could affect the camera's accuracy, which could influence the operator's ability to identify targets and detect such strobe lights at night.

The Forensic Team determined it was unlikely the SAM operator would have been able to perform a direct visual confirmation given that he would have been inside the unit focusing on his instruments. Aside from the claimed attempt to contact the Coordination Center, Iran has provided no concrete information to explain what steps the SAM operator took to confirm the identity of Flight PS752. As such, the Forensic Team was unable to determine if the SAM operator employed any of these measures when misidentifying Flight PS752 as a threat or the degree to which the SAM operator followed or violated IRGC standard operating procedures.

Irrespective of the SAM operator's actions, standard defence procedure would dictate that SAM units operate as part of an integrated structure with steady information exchanges between complementary C2 elements. Based on the information available, the Forensic Team has assessed that the command unit should have known that there was a significant misalignment and notified the SAM operator of the situation.

Furthermore, if a SAM unit is not aligned properly, then there would probably be a mismatch between the targets' directional information received from C2 and the information that is on the display in the misaligned SAM unit. Traditionally, the information would flow between the SAM unit and the immediate C2 through a form of digital data link and/or voice communications relaying headings and target.

The SAM unit arrived at its location west of the capital around midnight TT on January 8, 2020.[138] It was set up and likely operational for over six hours before Flight PS752 was shot down. With nine other flights departing IKA before Flight PS752 on this date, including eight departures after Iran launched missiles into Iraq, there should have been ample opportunity for C2 to detect and correct this misalignment.

Operator Action # 3 – Firing Missiles without Authority

The SA-15 system is effective in conflict zones against short-range threats. The system cannot, however, by itself easily distinguish between airliners, military aircraft, and cruise missiles.[139] According to experts, militaries using these systems typically link them to a broader air defence command system that has better situational awareness of civilian air traffic. In such circumstances, permission is typically required from the air defence C2 before an operator fires a missile at a target.[140]

Aside from Iranian official reports, the Forensic Team was not able to identify any information suggesting the SAM operator requested or received authorization to fire upon Flight PS752. Iranian official reports and public statements also indicate that missile release authority was never delegated to the level of the SA-15 operator and the operator fired without permission.[141]

The Forensic Team consulted military experts, who indicated that it is a common practice for air defence forces to launch two missiles, often one after the other, and then conduct a damage assessment of the target (shoot-shoot-look). In this case, the SAM operator appears to have employed a different approach known as a purposeful re-attack strategy (shoot-look-shoot). That is, the SAM operator fired the second missile at Flight PS752 after observing the first missile failed to destroy its target, as indicated in Iran's Final Report.[142] Iran has provided no information to substantiate these claims or demonstrate whether the decision to fire the second missile was consistent with IRGC procedures.

The Forensic Team has assessed the significance of Iran's purported communications outage between the SA-15 operator and his immediate C2. The veracity of this claim is unknown; however, if it did occur, this would have denied the operator the ability to enhance his situational awareness and receive authority for missile release. It should have also impacted other SA-15 operators, not just the one who shot down Flight PS752. The IRGC aerospace commander pointed to saturation (or communications system overload) as a possible cause of this alleged communications outage rather than to external factors.[143] According to Gholam Abbas Torki, the Military Prosecutor for Tehran, "there were hypotheses on the cyberattack, hacking of the defense system, disruption of the aircraft systems and the defense network, but none of them have been substantiated by any solid reasons."[144] The Forensic Team found no evidence of a cyberattack.

Other Claims

The Forensic Team also analyzed Iran's claims that "the last communication between the second missile and the defence system was recorded in a place close to the aircraft route" and the SA-15 system showed "a message indicating that the second missile strike had failed and the aircraft cleared radar lock-on after some time."[145] Iran's Final Report also stated that investigators were unable to come to a conclusion regarding the detonation and effect of the second missile due to the uncertainty of information and analysis.[146] Missile system experts advised the Forensic Team that once the missile was in flight, the operator likely could have prevented it from hitting the target by discontinuing the radar guidance at any point up until the intercept. The Forensic Team's analysis and statements from Iran suggest that this did not occur. The Forensic Team's analysis of available video of the shoot-down indicates that the second missile does appear to have detonated. Although it is not clear how this detonation would have occurred, missile system experts suggest that it is possible the missile continued on an unguided trajectory and the proximity fuse arm signal was already sent or the missile impacted the aircraft and detonated. The extent of damage caused by the second missile could not be determined.

Knowledge of the SA-15 unit suggests that a three- or four-person crew is generally required to operate the system and includes a vehicle commander, system operator, and vehicle driver.[147] The Iranian Final Report focuses exclusively on SAM operator actions but fails to cover the role of other crew members or how they influenced the chain of events. Why did no other IRGC personnel, either within the unit or at the next level of command, identify the misalignment or ensure that standard procedures were followed when identifying the target as hostile and firing without receiving approval? This raises questions about the responsibility and proficiency of the SAM unit crew in addition to the operator. The Forensic Team was unable to confirm whether or not these issues were an isolated occurrence or indicative of a more systemic problem within Iran's air defence forces. Unfortunately, these are some of the key remaining questions that only Iran can answer.

Military officials within elements of the IRGC – including senior officers – almost certainly knew immediately that Iran was responsible for firing the missiles that brought down Flight PS752. It is unknown, however, who among civilian officials and senior leadership was aware of this fact, as well as when and how the information was managed. The Forensic Team cannot confirm media reports claiming that President Rouhani himself was informed only two days later (on January 10, 2020) by military officials.[148] Brigadier General Hajizadeh did concede at a public press conference that he had been informed that a target had been hit over Tehran but claimed he "had no permission to say anything to anyone" including to civilian officials until the situation was assessed.[149]

On February 9, 2021, CBC News published an article based on an audio recording of a man that their sources identified as Iran's Minister of Foreign Affairs, Javad Zarif. On the Farsi-language recording reviewed by CBC News, the individual identified as Zarif is heard suggesting the downing was accidental – but later says there are a "thousand possibilities" including an intentional act by possible "infiltrators" that he would never be told about.[150] Based on the Forensic Team's assessment of the CBC News reporting and other statements, it is believed that the comments on the possible explanations for the downing of Flight PS752 were of a hypothetical nature when stating that the truth "may never be revealed."

Based on an analysis of the totality of available information,[151] the Forensic Team concludes that while the act of shooting was a deliberate and intended action, it is unlikely the SAM operator knowingly shot down Flight PS752 as a civilian airliner, but rather he likely misidentified it as a hostile target. Despite the series of significant actions taken by the SAM operator, the shoot-down could have been prevented by a properly functioning C2. This is analyzed in the following section.

Command and Control Failures

KEY FINDINGS

- A misalignment of 105-degrees as reported by Iranian authorities should have been obvious to the SAM unit's immediate command and control (C2). Standard military procedure would dictate that the SAM unit would not operate in isolation but as part of an integrated air defence structure to enhance situational awareness and C2 decision making. Iran's SAM units were required to engage their C2 as part of distinguishing hostile targets from commercial aircraft and obtaining approval to fire.

- Based on Iran's stated protocols, it is reasonable to conclude there were very likely multiple interactions with C2 as part of identification procedures for flights that departed IKA before Flight PS752. In fact, the totality of available information leads the Forensic Team to conclude that Iran tracked multiple targets but could not differentiate between passenger aircraft and legitimate threats. Iran ultimately fired two missiles, downing an unidentified target which was later confirmed to be Flight PS752. As such, it is very likely that the SAM unit's immediate C2 missed numerous opportunities to identify this erroneous tracking, correct the SAM operator's misalignment and, most importantly, take action to remove the operator from theatre until the misalignment could be rectified.

- Given the likely misalignment, it is reasonable to conclude that previous departing flights would have also likely appeared to be coming from an inaccurate direction (i.e. the south-west). If the operator followed the same procedure Iran claimed was followed for Flight PS752, the operator would have engaged C2 to assist with their identification as hostile targets or commercial aircraft.

- Iran suggests a communications outage between the SAM operator and C2 occurred and contributed to the errors in decision making. Any communications disruptions should have also impacted other SAM operators, not just the one who shot down Flight PS752. Iran has not indicated this to be the case. If these communications were disrupted at any point, there is no evidence that "jamming" or electronic warfare were the cause.

- As Iranian military officials have suggested, such a communications outage was potentially attributable to C2 systems being saturated or overloaded. This raises the possibility that there were capacity inadequacies amongst Iranian C2 communication systems. If this was the case, either communications were not coming through due to system overload (e.g. insufficient bandwidth) or the workload was too high for the SAM unit's immediate C2 to process information as it arrived.

- While Iran recognized that risk levels exceeded expectations and planned mitigations were insufficient to prevent the downing of Flight PS752, Iran's Final Report focused exclusively on the SAM operator when analyzing potential deficiencies in the military sector. Iran has

provided no substantive information on military actions that would have been relevant to mitigate the known risk of misidentification and that should have prevented the downing of Flight PS752. Its Final Report failed to detail the specific events that occurred including the military's monitoring of civil air traffic, communications of such information to front-line personnel, or the effectiveness of command structure supervision over the SAM unit and operator.

Iran's Final Report intentionally excluded military root causes and provided no analysis to substantiate that IRGC C2 of the SAM unit and its operator was effective or deficient despite their relevance to events. The Forensic Team analyzed all information available and determined that deficiencies by the SAM unit's immediate C2 played a critical role in the shoot-down and the SAM operator's superiors very likely missed numerous opportunities to prevent the downing.

Iran's Final Report indicated civil-military coordination structures were in place on January 8, 2020 to integrate Iran's air traffic management. This reportedly included a military-led civil-military coordination center (CMOCC) whose express task was to transmit all civilian flight information to Iran's air defence sector to support their identification of civilian flights. Iran's Final Report indicated the CMOCC was responsible for communicating with its civilian counterparts and exchanging voice, message, and radar data. Iran indicated that this information was to be passed through its air defence hierarchy, which included a State Air Defense Operation Center, Air Defense Sectors (area responsibility), and Air Defense Coordinators in some airports. Iran has provided no information to situate the SAM unit or its immediate C2 relative to these coordination structures.[152]

Having accurate and timely information on civilian air traffic throughout military coordination and command structures would have been critical to enabling the SAM operator to identify Flight PS752 as civilian. Iran's Final Report indicated that the CMOCC had access to civilian surveillance radar data and flight information for Flight PS752.[153] However, it presents no analysis or facts to demonstrate whether or not Iran's military transmitted such critical information to the SAM unit that shot down Flight PS752 or its immediate command and control. Further transparency from Iran is required to answer this critical question.

As mentioned above, a 105-degree misalignment would likely have consistently skewed the operator's determination of target direction by making targets appear to come from the southwest (from Iraq) rather than the southeast (from Tehran and the airport).

With this misalignment in place, it is conceivable that the operator would have likewise deemed previous departing flights from IKA as "hostile targets" and similarly attempted to report them to his C2. Assuming the SAM unit's immediate C2 had greater situational awareness, as do most upper echelon command centres, they should have had detailed knowledge and accurate positioning for all flights arriving at and departing from IKA. That was, after all, the stated purpose of the only mitigation measure put in place by Iran. As such, C2 should have detected the operator's misidentification during any earlier exchanges of information and stepped in to address them. Iran has not provided any information to explain why the SAM unit's C2 did not recognize this and order the operator to stand down until such time as the problem could be resolved.

The Forensic Team analyzed Iran's unsubstantiated and questionable claim that the SAM unit was misaligned during a 100-metre relocation at 04:54 TT and then allegedly put on standby until 06:07 TT, five minutes before Flight PS752's departure.[154] Missile system experts advised the Forensic Team that if the unit was in fact put into standby mode and doing so required radar systems to be turned off, it would have reduced the ability to identify the misalignment. However, Iran's Final Report provided no information to identify the specific actions that were taken, clarify implications, or substantiate its assertions with facts. Iran must provide concrete proof to clearly render such important claims credible.

The Forensic Team determined it was likely the SAM unit would have been operational immediately after the supposed move, as would be expected under such high threat levels. In fact, the totality of available information leads the Forensic Team to conclude that Iran tracked multiple targets but could not differentiate between passenger aircraft and legitimate threats. Iran ultimately fired two missiles, downing an unidentified target which was later confirmed to be Flight PS752. Four flights departed IKA between 04:54 TT and Flight PS752's departure. As such, even if one accepts Iran's claims about relocation, there were very likely multiple interactions between the SAM unit and its immediate command and control, which should have resulted in the identification of this erroneous tracking and correction of the misalignment – but it did not.

The four flights that took off between 04:54 TT and Flight PS752's departure at 06:12 TT were Qatar Airways Flight QR491, Turkish Airlines Flight TK873, Atlas Global Flight KK1185, and Qatar Airways Flight QR8408. Given their similar flight paths when departing IKA and the Iranian claim that the SAM unit was misaligned when it relocated at 04:54 TT, each of these flights was potentially at significant risk of being misidentified. This should gravely concern every country whose airlines and citizens travelled through IKA that morning. Because of Iran's actions – and failure to act – any of those other flights could have met the same fate as Flight PS752.

The IRGC chain of command has established rules of engagement, which the operator allegedly did not follow. The SAM unit's immediate chain of command did not take action to address the SAM unit operator's procedural errors or challenge erroneous reporting from the operator prior to the shoot-down. Had his C2 done so, the chain of actions leading to the shoot-down would have been broken. This demonstrates obvious deficiencies at the tactical level of command that contributed to creating the conditions in which the SAM operator could make such a faulty decision. The Forensic Team was unable to determine with the information available whether these deficiencies were an isolated occurrence or indicative of a more systemic problem within Iran's military command structures. Nonetheless, the acts and omissions of the SAM unit's immediate C2 also contributed to the downing of Flight PS752.

Iran's Final Report claimed that a communications outage occurred as Flight PS752 flew towards the SAM operator's location and that this led to his decision to fire the missile. Statements by Brigadier General Hajizadeh claimed that the communications outage was due to "jamming"[155] or an overloaded communications system.[156] However, media sources have quoted the Iranian Civil Aviation Organization as stating that no signs of jamming could be found.[157] Gholam Abbas Torki, the Military Prosecutor for Tehran, also indicated that this hypothesis was not substantiated.[158]

The Forensic Team found no evidence that any possible disruption was caused by "jamming". The more likely cause was insufficient capacity to handle the volume of communications generated by Iran's heightened defence posture. If this was the case, either radio communications were not coming through due to system overload (e.g. insufficient bandwidth) or the workload for the SAM unit's C2 was too high to process information as it arrived.

Moreover, the fact that this purported outage occurred raises questions as to the absence or adequacy of contingencies. Iran has not provided any credible explanation as to why military planners would not have put in place alternative lines of communication to maintain links between operators and their C2, especially with the number of civilian aircraft in Iranian airspace during a period of heightened military tensions.

See Annex F for details on concerns raised about the flight path of an Atlas Global Flight and Annex G for alternative theories on the shoot-down of Flight PS752.

Conclusion

The Forensic Team undertook an important mission as part of the Government of Canada's commitment to ensure transparency, accountability, and justice in the wake of the Flight PS752 tragedy on January 8, 2020. It examined and assessed all available information, including classified documents, in order to construct a factual account of the disaster and identify the critical elements and factors that contributed to it. The Forensic Team was supported by a whole-of-government effort to provide a credible assessment of the facts surrounding the downing of Flight PS752. As acknowledged, gaps in our knowledge remain. Only Iran has full access to the evidence, the crash site, witnesses, and those ultimately responsible. It is incumbent upon Iran to urgently and transparently address these issues.

The totality of information available to the Forensic Team indicates that while the SAM operator likely misidentified Flight PS752 as a hostile target, the SAM unit's immediate command and control very likely missed numerous opportunities to identify and correct the SAM operator's misalignment, recognize associated risks during the time the SAM unit was operational and, most importantly, take action to remove the operator from theatre until the misalignment could be rectified.

While the actions of the operator and of the SAM unit's immediate command and control were deficient, the acts and omissions by more senior Iranian military and civilian authorities also contributed to the downing by significantly increasing the risk to civilian air traffic:

- They launched a premeditated attack on US positions in Iraq that they believed, by their own admission, would likely generate a US response.

- They planned how they would likely respond to the anticipated US retaliation.

- They put their air defence on the highest level of alert and likely delegated down to a lower level authority to fire on aerial targets.

- They positioned anti-aircraft systems on high alert in close proximity to an international airport and tasked IRGC personnel with monitoring airspace in which approaching and departing civilian flights would be present.

- They conducted a severely flawed analysis, which determined that the risk of Iranian air defence forces misidentifying a civilian aircraft was "low."

- Based on this analysis and despite these proximate military threats, they decided to keep the airspace over Tehran open; they issued no official warnings to civilian aircraft and they implemented only one measure to prevent misidentification that would have applied to Flight PS752. This measure failed due to foreseeable military inadequacies.

In making these flawed decisions, it is the assessment of the Forensic Team that Iran's airspace management fell short of internationally recognized standards in place to ensure airspace safety. The Forensic Team found that Iran's determination that the risk was "low" and the corresponding decision to keep its airspace open over Tehran were both flawed, as was its decision not to provide official notification of the increased risk to airlines and pilots prior to Flight PS752's departure. Iran's Final Report did not provide any explanation as to why these basic preventative measures, which could have avoided this tragedy, were not taken.

Iran's actions also failed to account for recommendations from the Dutch investigation of the MH17 shoot-down. Since the downing of MH17, the international community has emphasized the importance of protecting civilian aircraft in conflict zones through sound risk assessment, the timely closure or restriction of airspace, and by calling on States to provide early and specific information to airlines on potential threats from military activities. Aside from designating military approval for flight departures from IKA, the Forensic Team could find no information demonstrating any attempt to mitigate risks to Tehran's civilian air traffic.

Iran's Final Report was absent a recognition that there is a broader context to consider in determining how this tragic event happened. The SAM operator's actions were situated within a pattern of decisions, acts, and omissions made by senior military and civilian authorities. Iran's accounting of the events to date, including in its Final Report, failed to provide a complete and transparent picture of the full range of the causes and contributing factors, including but not limited to, the military's monitoring of civil air traffic, communication of such information to front-line personnel, or the effectiveness of command structure supervision over the SAM unit and its operator.

The Forensic Team determined Iran has fallen well short of providing a credible explanation of how and why the IRGC downed Flight PS752. The Forensic Team believes that target misidentification was an important factor; however, the Iranian government cannot expect the international community and the families of the victims to set aside the other clear, immediate, and systemic causes and contributing factors. While the Forensic Team found no evidence that the downing of Flight PS752 was premeditated, this in no way absolves Iran of its responsibility for the actions it took – or failed to take – which led to the downing. Iran is responsible for failing to protect these civilian lives and for its lack of subsequent transparency.

This report has identified as many of the causes and contributing factors as possible and indicated, where available, the evidence that supports the Forensic Team's assessment. However, it is Iran that must provide solid evidence to establish the credibility of its account and remove any doubt regarding the chain of events that led to this tragedy. Without a credible and transparent accounting of the facts, the international aviation community cannot be assured that this tragedy will not occur again in the skies over Iran.

Furthermore, Iran's Final Report claimed that Iran instituted unspecified and unsubstantiated actions in response to its investigative findings. Iran has failed to clearly demonstrate what these actions were and what steps need to be taken to address the numerous deficiencies that caused and contributed to the downing of Flight PS752. Most troubling, Iran has not outlined any concrete actions taken by the Iranian military to address the stated cause of the tragedy – the launching of missiles at a civilian aircraft.

Moving forward, it is of particular importance for the victims' families, Canada, and the international community that Iran provide a transparent and credible explanation of the downing and provide facts to back up its assertions. Without knowing the answers to the many remaining critical questions, the international community cannot conclude that these deficiencies have been resolved. The international community is left to assume that civilian aircraft in Iranian airspace are still at risk, particularly when Iran heightens its defence posture during times of increased tension.

Annex A

RCMP Investigations
Flight PS752: Complaints of Potential Harassment/Intimidation

Background

Following the downing of Flight PS752, a number of complaints have been received from family members of victims in which they have alleged to have been, and continue to be, the targets of intimidation and threats. Some of these complaints have been made public by family members, and some have been received through other channels.

In the interest of public safety, all potential victims of intimidation have been asked to contact their local police to address any immediate safety concerns. The Royal Canadian Mounted Police (RCMP) takes all allegations seriously, and is interested in determining the full circumstances of each complaint in order to identify perpetrators and determine whether or not criminal charges may be appropriate.

RCMP Investigation and Response

The RCMP has been in regular liaison with police agencies across Canada to identify all known cases where family members may have been subjected to intimidation or harassment related to this matter. In collaboration with these police agencies, efforts remain underway in order to determine whether any evidence exists to support criminal charges against any known individual or groups behind such activities.

In the interest of privacy and in order to maintain the integrity of any ongoing investigations, the RCMP is unable to provide further operational details related to specific complaints. However, it can be disclosed that the alleged activities occurred both in Canada and abroad and were conducted in-person, online, and by telephone. It can be further noted that efforts remain underway to identify any connections between reported incidents, and any person or persons responsible.

Way Forward

The RCMP will continue to investigate all known complaints of intimidation, and it encourages any person to come forward with information that may assist in this regard.

The following is what was published on the Flight PS752 family portal and may be reiterated for the purposes of this report: The RCMP is aware of allegations of intimidation of the grieving families of the Flight PS752 and we take such complaints seriously. We want to ensure that anyone who feels they are being intimidated or is concerned for their own safety should immediately contact their local police to report such incidents. After a victim's family has contacted local police, the family is asked to contact the RCMP with the local police file number and the name of the local police force so that the RCMP can follow up. The RCMP works with local police on these issues. The RCMP has a dedicated Family Liaison Officer to support and receive information from Flight PS752 families for non-urgent communications.

Annex B

Iranian Military Structure and Defence Planning

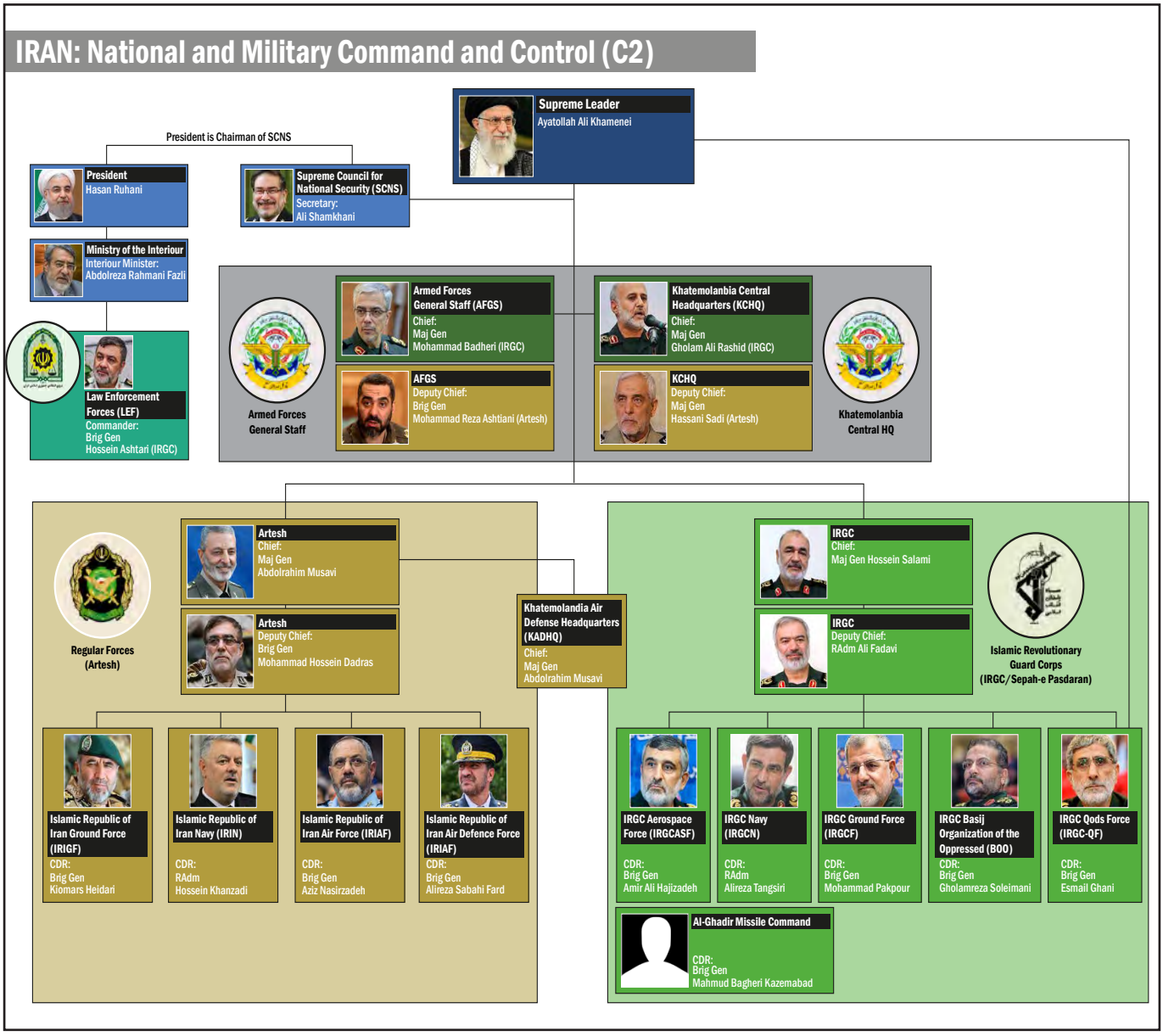

Figure 15: Organizational chart of key Iranian military and civilian leadership in January 2020[159]

Iran's constitution sets out the distribution of power in the country. The Supreme Leader is the commander-in-chief of the armed forces with the power to declare war and peace, approve military operations, and exercise command and control (C2). When the Supreme Leader decides to use military force, he informs the Supreme Council for National Security, which alerts the Armed Forces General Staff (AFGS) and Khatemolanbia Central Headquarters (KCHQ).[160] The AFGS and KCHQ pass orders to the regular military (Artesh) or the Islamic Revolutionary Guard Corps (IRGC), which transmit them to respective military services' chain of command. As demonstrated above, the AFGS technically oversees the IRGC.

The IRGC remains the main - but not the only - actor influencing and implementing Iran's security policy. Civilian government offices, departments and agencies, including the President and the Ministry of Foreign Affairs, have less influence than the IRGC over decisions in theatres where Iran's interests are primarily in the security realm. However, these actors have more influence over decisions relating to Iran's relations with the international community.

Like many bureaucracies, Iran's system features a division of roles as well as overlapping authorities. Within its military, the Artesh focuses on national defence against external threats; while the mission of the IRGC is to defend the regime and its system of government from any threat, foreign or domestic. Each has their own ground, naval, air, and air defence forces, according to open-source reporting.[161]

Given this dual military structure divided between the Artesh and the IRGC, questions such as who has effective control over Iran's airspace during periods of heightened alert are hard to answer definitively. Moreover, what remains unclear is not only how well both the Artesh and the IRGC coordinate among themselves but also how they interact with civil authorities such as the Ministry of Roads and Urban Development, particularly on questions of airspace management during times of crisis.

What's the difference between the Artesh and the IRGC? The Artesh focuses on national defence while the IRGC's priority is regime survival. The Artesh has an estimated size of 420,000 conscripts, generally serving 18-24 month assignments. The IRGC is approximately 190,000 strong and is considered the dominant military force with specialized training.

Annex C

International Aviation Standards and NOTAMS

International Aviation Standards and Recommended Practices

The Convention on International Civil Aviation (The "Chicago Convention"), to which Iran is a party, requires States to fulfill their responsibilities in ensuring that civil aviation operations conducted in their airspace are safe.

The standards provided in Annex 17 to the Convention describe how States should keep under constant review the level and nature of threats to civil aviation within their airspace and establish and implement policies and procedures to address them. Although the Annex does not specifically identify military threats within its text, they are expected to be included within any responsible risk analysis involving civilian aircraft when civilian aircraft fly within, or over, conflict zones.

The Annex further stipulates that States "share, as appropriate, with its airport operators, aircraft operators, air traffic service providers or other entities concerned, in a practical and timely manner, relevant information to assist them to conduct effective security risk assessments relating to their operations."

The International Civil Aviation Organization's (ICAO) guidance material provides support to States in meeting these standards where the threat is of a military nature and where airspace is considered to be within a conflict zone. ICAO guidance defines a conflict zone as "airspace over areas where armed conflict is occurring or is likely to occur between militarized parties and … airspace over areas where such parties are in a heightened state of military alert or tension, which might endanger aircraft." The guidance recommends that States assess threats to civil aviation in a conflict zone and notify civil aircraft operators of the nature and the extent of such threats that exist, as well as any measures to be taken to mitigate these threats via notices to airmen (NOTAMs) or other advisories.

Depending on the risk, ICAO member States could choose to prohibit or restrict access to their airspace as appropriate during times of military conflict and/or heightened tensions – this is typically done through a NOTAM. The decision to issue a NOTAM is usually the responsibility of the member State's Civil Aviation Authority, which, in this case, is Iran's Civil Aviation Organization – part of the Ministry of Roads and Urban Development. In Iran, however, the Supreme Council for National Security (SCNS) – the main government body that provides a forum for both military and civilian leaders to discuss and develop recommendations on Tehran's key priorities for recommendations to the Supreme Leader – also plays a role.[162]

In light of international standards and recommended practices, member States have closed or issued restrictions to their airspace during times of armed conflict.[163] ICAO member States have not agreed to set clear guidelines for how States choose to manage airspace restrictions. In other words, in international civil aviation there are no "unambiguous requirements specifying when States must close their airspace."[164]

For this reason, the Dutch Safety Board investigating the 2014 shoot-down of Malaysia Airlines MH17 over Ukraine recommended that States "receive more stimuli and support in such situations in order for them to be able to take this responsibility".[165] Building on this work, Canada has proposed the Safer Skies Strategy[166] that seeks to establish a common set of practices for sharing information, issuing warnings and restrictions regarding conflict zones, as well as enhancing the aviation industry's risk-management practices.

What Are NOTAMs?

NOTAMs and Aeronautical Information Circulars (AICs) are the most commonly used means to convey flight safety information – including conflict zone-related advisories/restrictions. The main difference between the two is the duration of their publication. NOTAMs are generally used to notify pilots of short-term events and are not designed to be valid for more than three months. On the other hand, an AIC is typically used to share long-term information of a purely explanatory or advisory nature that would affect flight safety.

At present, different States have taken different approaches to disseminating conflict zone information/notifications to air operators. For example, in Canada NOTAMs and AICs are used in a complementary fashion to ensure the most effective conveyance of conflict zone information. For imminent threats, Canada issues NOTAMs which are, over time, replaced by AICs.

Iran

Iran did not issue a NOTAM in the days or hours immediately prior to the downing of Flight PS752. Further, it did not issue any NOTAMs to advise of elevated risk in its airspace. It released NOTAMs A0086/20 and A0087/20 hours after the downing of Flight PS752 for the sole purpose of conveying air traffic management changes. A0086/20 was issued on January 8, 2020, at 05:49 UTC (09:19 TT) and restricted civilian air traffic from using the air space between PAXAT, RAGET and BOXIX – airspace waypoints that exist between Iran and Iraq. The second NOTAM, A0087/20 was issued shortly afterwards at 06:53 UTC (10:23 TT) to redirect civilian air traffic from certain flight information regions (e.g. OBBB - Bahrain and LTAA - Ankara) in the west of Tehran near the Iraq border.

Transport Canada advised that Iran has a history of issuing NOTAMs for planned military exercises and activities taking place near Iranian airports but could not find any instances of Iranian airspace closures due to active military operations or increased tensions with other States (including heightened tensions with the US in June 2019 and more recently).

Ukraine

The Ukraine State Aviation Administration (USAA, Civil Aviation Authority) had not issued a NOTAM prior to the downing of Flight PS752 and did not do so until January 8, 2020 (15:35 UTC / 19:05 TT). Ukraine NOTAM A0033/20 stated that Ukrainian air operators were prohibited from flying within the airspace of Iran and Iraq. A NOTAM remains in place prohibiting Ukrainian air operators from "performing flights" within Iranian airspace (NOTAM A4481/20).[167]

European Union

Approaches in the European Union (EU) vary, depending on the member States. The European Union Aviation Safety Agency (EASA) does not issue NOTAMs or AICs. Instead, it publishes Conflict Zone Information Bulletins (CZIB) on the basis of a "common EU risk assessment."

The first EASA CZIB on the airspace of Iran was issued on January 17, 2020. Prior to this date, they had issued two recommendations to the EU civil aviation authorities. There was an initial recommendation on January 8, 2020, for situational awareness, that overflight of Iraqi airspace should be avoided as a precautionary measure. This was followed by an update on January 10, 2020 which assessed the risk of operations over Iraq to be HIGH at all altitudes and HIGH over Iran below flight level 250. Further updates were issued on January 11, 2020 and January 28, 2020 with additional guidance as further information regarding Flight PS752 came to light. EASA reissued the CZIB on April 23, 2021 for Iran that advises caution in regards to the risk associated to civil aviation. This CZIB continues to be active at the time of publication of this report. The risk to operations is assessed to be HIGH for flight levels below 250.[168]

United States

In recognition of the elevated risk due to heightened tensions following Iranian retaliatory missile strikes targeting coalition bases in Iraq on January 7, 2020 at 23:50 UTC (03:20 TT January 8, 2020) the US Federal Aviation Administration (FAA) issued flight prohibitions for the Baghdad Flight Information Region prohibiting American carriers from "operating in the region due to heightened military activities and increased political tensions in the Middle East". Shortly after, on January 8, 2020 at 00:10 UTC (03:40 TT) - 2 hours and 32 minutes before the departure of Flight PS752 - the FAA issued a NOTAM prohibiting US carriers from operating in the Tehran Flight Information Region.

Transport Canada confirmed with its FAA counterparts that US NOTAMs are posted online at several locations; some posted instantly, while some take a bit of time to replicate across systems. To illustrate, on January 7, 2020 at 20:52 EST (January 8, 2020, 01:52 UTC / 05:22 TT and 03:52 EET in Kyiv), the FAA posted on its Twitter account, @FAANews that it had issued NOTAMs outlining flight restrictions over Iraq, Iran, and the waters of the Persian Gulf and the Gulf of Oman. Flight PS752 departed Imam Khomeini International Airport (IKA) a short 50 minutes later.

Open-source reporting tools such as OpsGroup and OSPREY usually pick up NOTAMs and send an alert; however, these alerts only go to those who subscribe to their services. The FAA also held a call about this NOTAM with US airlines and the International Air Transport Association but it did not include other countries. This information was also shared with the Expert Group on Risk Information Overflying Conflict Zones (EGRICZ)[169] and other foreign partners like Canada, and to a distribution list to which airlines and foreign partners subscribe.

Responsibilities of the Pilot-in-Command in Regard to NOTAMs

ICAO Annex 2 to the Convention on International Civil Aviation, Rules of the Air, defines the Pilot-in-Command as the pilot designated by the operator, as being "in command and charged with the safe conduct of a flight."

Prior to a flight's departure, the Pilot in Command receives an information package, including any relevant NOTAMs, flight plans, etc. It is the Pilot in Command's responsibility, according to ICAO standards, to review the information and be familiar with "all available information appropriate to the intended operation."

Most airlines employ flight planning systems which search for relevant NOTAMs. Flight dispatchers use these systems to develop flight plans. Once verified, flight plans are submitted electronically before the flight.

Note that ICAO also issues guidance on the role of the Air Operator (also known as the Air Carrier) and the Pilot-in-Command if there is a sudden outbreak of armed violence. Document 9554, the *Manual Concerning Safety Measures Relating to Military Activities Potentially Hazardous to Civil Aircraft Operations,* explains that once the usual coordination processes between civil and military authorities are no longer followed due to a sudden outbreak of violence, the Air Operator should assess the situation using the information available and take action so as not to jeopardize safety, including changing the route or not allowing the flight to depart.

Annex D

Flight PS752: Aircraft Details

Boeing 737-800: Owned by Ukraine International Airlines

The Flight PS752 aircraft was a Boeing 737-800 owned by Ukraine International Airlines (UIA), with manufacturer serial number 38124,[170] registration UR-PSR,[171] and line number 5977.[172] It was 3.6 years old and produced in Renton, Washington, US.[173] Its date of manufacture[174] and first flight was June 21, 2016.[175] It was delivered from the manufacturer to the airline on July 19, 2016.[176] The last scheduled maintenance of the aircraft was on January 6, 2020.[177]

Flight history for aircraft - UR-PSR

AIRCRAFT	TYPE CODE	MODEL
Boeing 737-8KV	B738	S08377
AIRLINE	CODE	SERIAL N UMBER (MSN)
Ukraine International Airlines	-	38124
OPERATOR	CODE	Age (Jun 2016)
-	-	4 years

DATE	FROM	TO	FLIGHT	FLIGHT TIME	STD	ATD	STA	STATUS
08 Jan 2020	Tehran (IKA)	Kyiv (KBP)	PS752	3:42	01:45	02:42	06:00	Landed 06:24

Figure 16: UIA Flight 752 (Accident Aircraft) registration and serial number information. FlightRadar24[178]

UIA began direct, non-stop flights between Kyiv and Tehran in 2014.[179] The airline expanded the frequency of flights in 2016 given the success of the route.[180]

Prior to January 8, 2020, the flight route between Kyiv and Tehran was also completed by other Boeing 737s in UIA's fleet, including UR-PSJ, UR-PSE,UR-PSF, and UR-PSI.[181]

Flight History of Flight PS752

According to UIA, Flight PS752 used a routine take-off heading similar to those of other UIA aircraft for months prior to the incident. The flight path was also similar to other carriers that operated flights from IKA.[182]

On January 8, 2020, the plane's three pilots had 31,200 combined flight hours on Boeing 737 aircraft.[183] The aircraft departed with a take-off mass of 72,468 kg,[184] following a delay during which passenger luggage had to be offloaded to meet the maximum take-off mass of 72,500 kg. All aircraft systems were functioning properly.[185] Flight PS752 did not deviate from its pre-approved flight course.[186]

Annex E

Arrivals and Departures from Imam Khomeini International Airport

Arrivals[187]

Start: January 8, 2020, 00:04 Tehran Time
End: January 8, 2020, 06:31 Tehran Time

No.	Flight	Airline	Last Point of Departure	Scheduled Time	Actual Time	Aircraft
1.	J29005	Azerbaijan Airlines	Baku, Azerbaijan	00:25	Landed 00:04	E190
2.	W5115	Mahan Air	Istanbul, Turkey	00:45	Landed 00:49	A310
3.	PS751	Ukraine International Airlines	Kyiv, Ukraine	00:55	Landed 00:57	B738
4.	TK874	Turkish Airlines	Istanbul, Turkey	00:50	Landed 01:17	A321
5.	IR750	Iran Air	Rimini, Italy	03:18	Landed 01:52	A310
6.	IR5318	Iran Air	Najaf, Iraq	—	Landed 01:59	A306
7.	W5143	Mahan Air	Damascus, Syria	—	Landed 02:13	A310
8.	IR710	Iran Air	London, UK	02:00	Landed 02:16	A332
9.	SU512	Aeroflot	Moscow, Russia	02:45	Landed 02:19	A320
10.	IR768	Iran Air	Istanbul, Turkey	02:30	Landed 02:37	A306
11.	KK1184	Atlas Global	Istanbul, Turkey	03:20	Landed 02:56	A321
12.	QR490	Qatar Airways	Doha, Qatar	3:35	Landed 03:18	A333
13.	B99717	Iran Airtour	Istanbul, Turkey	—	Landed 03:26	A306
14.	QR8408	Qatar Airways	Doha, Qatar	03:25	Landed 03:34	B77L
15.	TK872	Turkish Airlines	Istanbul, Turkey	03:50	Landed 03:47	A321
16.	QB2214	Qeshm Air	Istanbul, Turkey	02:50	Landed 03:49	A306

No.	Flight	Airline	Last Point of Departure	Scheduled Time	Actual Time	Aircraft
17.	IR726	Iran Air	Urmia, Iran	03:55	Landed 03:55	A332
18.	W582	Mahan Air	Kuala Lumpur, Malaysia	03:31	Landed 04:15	A343
19.	W576	Mahan Air	Shanghai, China	04:00	Landed 04:55	A346
20.	TK878	Turkish Airlines	Istanbul, Turkey	05:35	Landed 05:33	A333
21.	W570	Mahan Air	Delhi, India	05:20	Landed 05:37	A343
22.	EP3768	Aseman Air	Shiraz, Iran	06:25	Landed 06:31	Fokker 100

Departures from IKA before and after Flight PS752[188]

Start: January 8, 2020, 01:37 Tehran Time
End: January 8, 2020, 07:49 Tehran Time

No.	Flight	Airline	Last Point of Departure	Scheduled Time	Actual Time	Aircraft
1.	J2 9006	Azerbaijan Airlines	Baku, Azerbaijan	01:25	01:37	E190
2.	LX 4021 / LH 601	Swiss/Lufthansa	Frankfurt, Germany	02:25	02:43	A330
3.	TK 875	Turkish Airlines	Istanbul, Turkey	03:00	03:35	A321
4.	OS 872	Austrian Airlines	Vienna, Austria	03:45	04:23	A320
5.	SU 513	Aeroflot	Moscow, Russia	04:30	04:32	A320
6.	QR 491	Qatar Airways	Doha, Qatar	04:45	05:00	A320
7.	TK 873	Turkish Airlines	Istanbul, Turkey	04:45	05:07	A321
8.	KK 1185	Atlas Global	Istanbul, Turkey	05:15	05:17	A330
9.	QR 8408	Qatar Airways	Hong Kong	05:15	05:39	B777
10.	PS 752	Ukraine International Airlines	Kyiv, Ukraine	05:15	06:12	Boeing 737-800
11.	IR 721	Iran Airlines	Frankfurt, Germany	07:15	07:49[189]	A330

Annex F

Atlas Global Flight KK1185: An Unusual Flight Path?

In response to a concern expressed by a family member of one of the victims of Flight PS752 that Atlas Global Flight KK1185 may have been deliberately avoiding Iranian military installations, the Forensic Team took a closer look at this flight, which departed IKA nearly an hour prior to Flight PS752. While the below image from Flightradar24 depicts a highly abnormal route, it is extremely unlikely the route illustrated was actually flown by Atlas Global Flight KK1185. Airliners cannot make right angle turns or other sharp movements that are beyond the design limitations of normal flight. The most likely explanation for the depiction of the jagged-looking flight route of the Atlas Global route captured by Flightradar24 is either a software technical issue or a transponder error. Flightradar24 explains that these inaccurate depictions are the result of common "glitches". Aircraft "transponders can generate errors by transmitting random or incorrect position information" that "leads to impossible looking flight paths that often contain a jagged, switch-back look."[190]

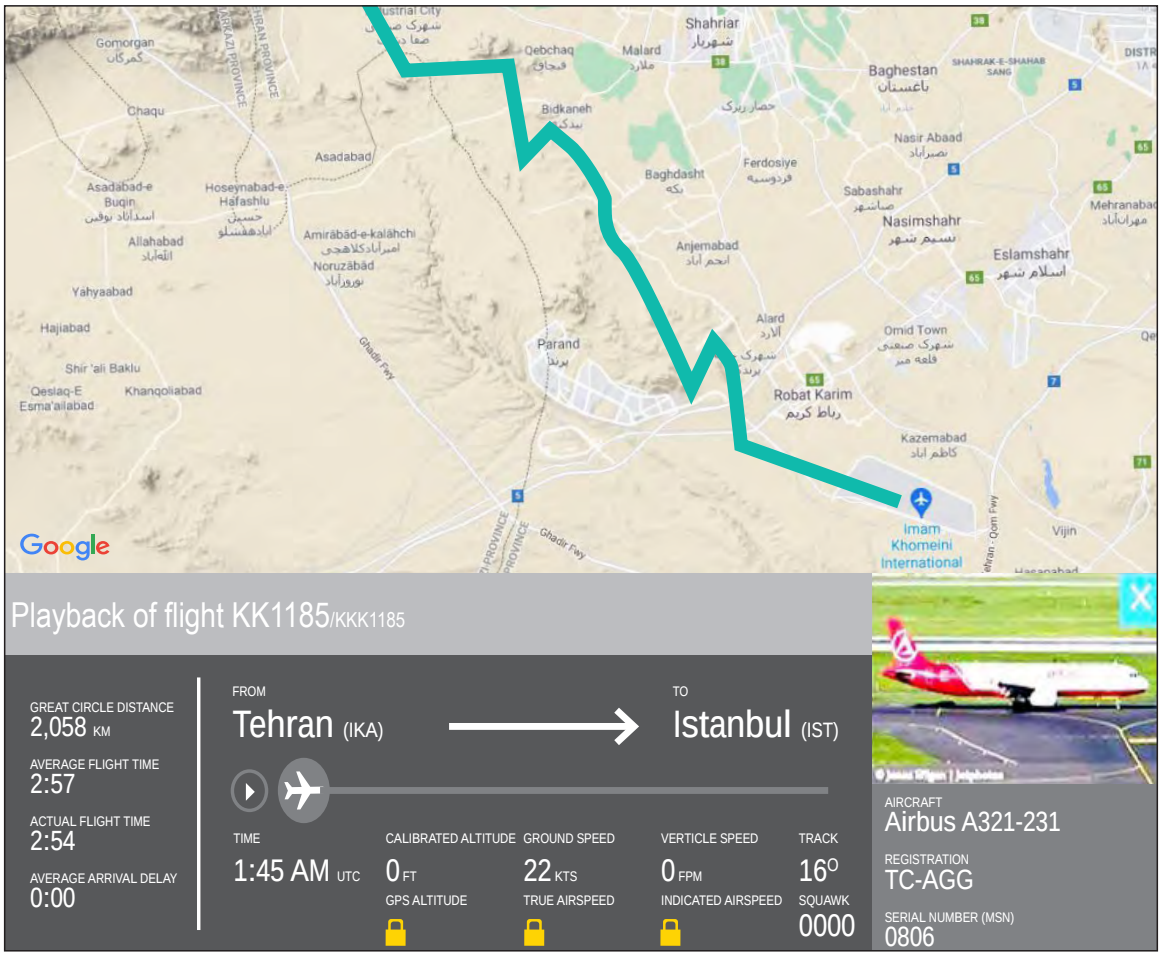

Figure 17: Flightradar24 - Flight path of Atlas Global KK1185 on the morning of January 8, 2020

Annex G

Alternative Theories and Official Statements for Why Iranian Airspace Was Left Open

Alternative theories have been suggested in the media and by members of Flight PS752 victims' families that Iranian civilian and military leadership kept Tehran's airspace open due to a variety of other considerations:

- Given how past military engagements or even threats of engagement have been the catalyst for wild fluctuations in Iranians moving money abroad, it has been claimed that it is possible that Iranian officials factored in other economic considerations and did not want to trigger an outflow of capital or a further devaluation of its currency by citizens seeking to shelter their capital in more stable markets.[191] The Forensic Team was unable to determine with certainty if any economic considerations were prioritized over others as part of Iran's airspace management decisions on January 7 to 8, 2020.

- Iran may have been concerned about giving the Americans advance notice of their plans to attack US positions in Iraq if Iranian airspace was closed for any period of time. In the CBC-obtained audio conversation between Hassan Rezaeifar, then head of Iran's investigation into the downing of Flight PS752, and a victim's family member in Canada, the former is heard saying that closing the airspace over Tehran could have tipped off the US about Iran's ballistic missile attack against Iraqi airbases.[192] In fact, Iranian officials told their Iraqi counterparts they were going to fire ballistic missiles towards US positions in Iraq hours before doing so, with the expectation the Americans would be advised.[193] While Rezaeifar's rationale could be a possible excuse for not closing Iranian airspace prior to the Iranian retaliatory attacks, it certainly does not explain why it would not be closed to civilian aircraft afterwards.

- Other explanations for keeping the airspace open suggest that Iranian officials wanted civilian traffic to act as a deterrent to an American counter attack. The Forensic Team has found no information to confirm that the use of "human shields" to deter an American attack was part of Iran's calculation at the time.

Official Statements on Airspace Management

- In the January 24, 2020 *Der Spiegel* interview, Iranian Foreign Minister Javad Zarif said that not closing the airspace "was a technical decision as well as a political decision."[194]

- After Iran admitted the shoot-down, General Amir Ali Hajizadeh, commander of the IRGC Aerospace Force, said that his units had asked officials in Tehran to close Iran's airspace and ground all flights, but this was to no avail.[195] The Forensic Team was unable to find any information to support that assertion.

Endnotes

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Comment: In this report at p.17, Iran requests a 2 second tolerance for stated times and a tolerance of plus or minus 2 degrees for the Air Defense Unit direction.

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[34] Ibid, 66 and 70.

[35] Civil Aviation Organization of the Islamic Republic of Iran. *Flight PS752 Accident. Flight Recorder Readout Report*, August 23, 2020, p. 3.

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[37] Ibid, 76.

[38] Ibid, 66.

[39] Ibid, 76.

[40] Civil Aviation Organization of the Islamic Republic of Iran, *PS752 Accident Investigation, Factual Report,* July 11, 2020, p. 9.

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