Sukhoi Superjet - Airborne Image Recorder Supported Investigation

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The Message

- Small investigation teams are able to lead a major accident investigations, if they ensure to follow and implement the full use of the resources made available by ICAO Annex 13.
- By the experience of this investigation [ref. 1], Airborne Image Recorders (AIRs) have been shown to be a vital evidence for the correct outcome of an air accident investigation. They are a great new tool for the investigator‘s toolkit. Stating that, the image data they contain must be handled with care and strict personal data protection ensured.

Introduction

In the early morning of July 21st 2013, Sukhoi Civil Aircraft RRJ-95B of Russian experimental registry 95005 with five crew members was performing flight test at Keflavik Airport (BIKF) in Iceland. The purpose of the flight test was to assess the performance of the Automatic Flight Control System, in Flight Director Mode during a go-around, after a missed approach, at radio altitude of 2-3 feet, with critical [right] engine shut down and crosswind exceeding 10 m/s (19.5 knots). For safety of this test, the landing gears were to be in the down and locked position during the final approach, until the aircraft had initiated the go-around and gained a positive rate of climb. The aim was to collect test data needed for the extension the aircraft‘s approval from CATII certificate to CAT IIIA certificate, which required flight tests to show compliance with EASA CS-AWO 140, Approach and Automatic Landing with an Inoperative Engine.

Figure 1: The Accident Site

At 05:23, shortly after the flight crew had initiated go-around for flight test #978 over RWY 11 and selected the landing gear lever to the UP position, the aircraft started to descend after having reached

a maximum radio altitude of 27 feet. This resulted in the fuselage aft lower belly and engine cowlings hitting the runway. The aircraft skidded off the end of the runway and came to rest 163 meters beyond the threshold of RWY 29 with its landing gears fully retracted.

Evacuation of the aircraft was hindered by the fact that the crew had not armed the slides prior to the flight as well, resulting in the left forward slide not deploying when the left forward door was opened during the evacuation. The evacuation was further hindered when the right forward slide twisted during inflation and ended up under the fuselage, rendering the right forward door un-useable for the evacuation.

Field Deployment

The Icelandic Transportation Safety Board (ITSB) deployed two investigators to the accident site, which is also its total number of aviation accident investigators. The investigation revealed that for a large transportation accident investigations, the number of investigators is too scarce for the tasks at hand in the initial phases of the investigation. The investigators needed to be in multiple places, working multiple tasks, in the initial days of the investigation.

Figure 2: Field Deployment

ITSB is a multimodal body [aviation, marine and traffic], where the aviation division has also trained a group of rescue personnel in order to assist in case of a major accident. This group participates with the ITSB in a bi-annual training for a major aviation accident in one of the airports in Iceland. Furthermore, the three divisions (aviation, marine and traffic) of the ITSB have trained together in case where a mutual interest crosses the three units, such as when training with the governmental ID department.

Figure 3: ITSB is Multimodal

In addition, Iceland and other Nordic countries, as well as Canada, have signed a MoU regarding a formal process for supporting each other with trained aviation accident investigators in the case of a major aviation accident.

Accredited Representative

On Monday July 22nd, formal contact was established between the ITSB and the Interstate Aviation Committee (IAC) regarding the accident. During these communications the ITSB was informed that although the IAC would be willing to assist, they would not be appointing an ACCREP to the investigation on behalf of the Russian Federation. It had been decided at higher level within the Russian government that the ACCREP would come from the Ministry of Industry and Trade, as the aircraft was on an experimental registry. That day a formal letter came from Russia, stating that the Head of the

department of Aviation Industry, under the Ministry of Industry and Trade, had been appointed as ACCREP on behalf of the Russian Federation. The ACCREP and his seven advisors travelled to Iceland that day and arrived shortly before midnight on Monday July 22nd, about 41 hour after the accident occurred. The seven advisors the ACCREP brought with him were from the manufacturer Sukhoi Civil Aircraft, as well as high profile Russian test pilots. The advisors party included the VP of Development and Certification as well as the Head of Flight Operations and Design Division of Sukhoi Civil Aircraft. The seven advisors were also supported by the Sukhoi Civil Aircraft flight test and maintenance personnel already in Iceland, working on the flight test program. This brought the Russian team in Iceland, working under the Russian ACCREP, up to about 25 personnel.

The International Investigation Chain

The first meeting with the ACCREP and his team was scheduled in the morning of July 23rd at the Keflavik Airport Crisis Center. For this meeting the whole Russian team (25) were present, as well as the Investigator-In-Charge (IIC) on behalf of Iceland (1). The Russians, politely, requested to lead the investigation. From the Russian point of view this was a new product build in Russia, the first major transport category Russian built aircraft to fulfill and have its certification validated under western aviation standards (EASA CS-25). Add to this fact that on one hand you had the nation with its extensive aviation manufacturing heritage and expert resources, while on the other hand you had a small island nation in the North-Atlantic Ocean with the total aviation accident investigators' resource of two. The odds were that this was not going to be an Icelandic led aviation accident investigation, except for the following reasons:

1) The accident occurred on Icelandic soil
2) Independence, as the Russian ACCREP was from government ministry
3) Access to EASA resources, as Iceland is a member state
4) ICAO Annex 13 dictates how the international co-operation and protocol regarding the investigation is to be handled. It provided the Icelandic investigation with access to all the relevant Russian resources. To put it simple, it leveled the playfield and protected all parties' right and order of participation.

The IIC made a short phone call to the director of the ITSB. It was decided that Iceland would not give away its right and obligation to lead the investigation. The IIC then located a very small room within the crisis center and requested the Russian ACCREP to attend a personal meeting on one-to-one basis. In that meeting the IIC, politely, rejected the request that the Russians had made regarding leading the investigation. At the same time the IIC stated that ICAO protocol regarding Annex 13 would be upheld to its fullest to ensure correct procedures and a full participation of the Russian Federation through its ACCREP, as well as his advisors as needed. With this the tension that had started to build up, which was a valid one when considering the economic and political interests the Russian Federation had in this accident, faded away.

Figure 4: ICAO Annex 13

Iceland would lead the investigation. The rules, procedures and protocols of ICAO Annex 13 would be followed. Russia would get full access to the investigation through its ACCREP. The investigation would be independent of any political and economic interests. The international investigation chain of ICAO Annex 13 held, as its weakest link in the form of a small national aviation investigation team of two stood firm, while at the same time utilizing its available international resources.

Language Barrier

The interviewing of the flight crew required the use of an interpreter. In addition, much of the data collected from the aircraft, in the initial phases of the investigation, was in Russian language. This affected the time it took to review and analyze the data. In the aftermath much of the data, such as manuals, was then also provided by the manufacturer in English format. In other cases the ITSB needed to have the material translated and for that purpose it was translated directly into Icelandic by an interpreter hired for the task by the ITSB.

Figure 5: Language Barrier

Although this hurdle did not present a problem during this investigation, investigation teams should ask themselves during auditing and/or peer reviews, how well they are prepared for language barriers and what procedures and plans they do have in place to make use of when those events present themselves.

Inflight Data

The accident occurred during a flight test. As a result, flight monitoring data was available for the investigation to much greater extent than would normally be available. This was both with regards to the number of parameters being monitored as well as by the frequency that some of those parameters were being monitored at. Many parameters were being monitored at a frequency rate of 10 per second, instead of the usual rate of 1 per second.

Figure 6: Inflight Data Collection

Finally, for the first time [to the ITSB knowledge] in the case of an accident of a large transport category aircraft, airborne image recordings of the cockpit were available. The cockpit was equipped by five video recorder cameras that video image recorded the actual accident event. This was vital for the investigation, as will be detailed further in the chapter on Airborne Image Recorder (AIR).

Flight Recorder Readout

For the flight recorders readout and analysis, the ITSB involved the Interstate Aviation Committee as technical advisor to the investigation and as such the IAC gained an official status within the investigation, regardless of the Russian ACCREP being outside the scope of the IAC.

The IAC performed the recorder readout and analysis for the ITSB on August 8th 2013, 18 days after the accident.

Figure 7: Flight Recorders

Investigation Direction

Mechanical failure was ruled out early in the investigation. The Airborne Image Recordings from the cockpit immediately revealed a manual input of the thrust lever for the right engine during go-around. This was the engine that had been shut down as part of the flight test during the final approach, while the thrust lever of the operating left engine remained close to the idle position.

On the technical side, further analysis was still required to explain why and how the Automatic Flight Control System had failed to engage, but the majority of the investigation headed early in the direction of human factors and fatigue. The Airborne Image Recorder (AIR) played a vital role in revealing the fatigue of the flight crew. If a picture is worth a thousand words, then what can be said about a video image recording that shows the events as they unfold, while supported with the readouts from the CVR and the FDR?

As the investigation headed early into the direction of human factors and fatigue, evidence was quickly collected and supported by further interviewing, that the flight crew had been both awake and active for close to 21 hours when the accident occurred. In addition the investigation showed the accident to have occurred during the low point in the pilot's flying circadian rhythm, when his performance capability and cognitive function were at its daily low point.

Airborne Image Recorder (AIR)

Figure 8: Cockpit RH side Video

There is no question about it, in the mind of the IIC of this investigation, the Airborne Image Recorder played a vital role in the investigation. The video image recordings it captured allowed the investigators to answer questions they would otherwise not have been able to answer in the investigation. In fact when the FDR failed to support the pilot's statement of activation of a go-around at the most critical moment of the test flight, a mere split of a second prior to the landing gears touching the runway, the Airborne Image Recorder revealed the truth of the pilot's statement. The investigation then made use of the extensive flight test data being collected as part of the flight test, as well as of the manufacturer's technical advisors. Data collected in this data bank, and not by the FDR, revealed that the go-around mode was engaged by the push of the TOGA switch,

Figure 9: Cockpit LH side Video Cameras

as the Airborne Image Recorder had revealed, but the aircraft was then inhibited from go-around engagement as the weight-on-wheel signal was received within one second. As a result no go-around engagement by the push of the TOGA switch was found on the FDR.

> *"After the AP disconnected, the pilot flying attempted go-around by pressing the TOGA button on the right throttle immediately prior to the landing gear touching the runway at 05:23:28.7. The FTI recorded a short "pulse" of GA mode engagement, which confirms that the signal from the TOGA button reached the auto flight system and its attempt to engage the GA mode on this computational step. At 05:23:29.5, the left LG WOW status appeared. Therefore, in accordance with the auto flight system logics, the A/T system was disconnected. GA engagement was inhibited by an asynchronous acquiring of WOW status by the two auto flight system master channel computers. The GA was not displayed in PFD. So, at 05:23:29.5 the following events had simultaneously occurred: Actual landing touchdown, A/T disconnect and GA mode engagement inhibit."*

Had only the FDR data been looked at and taken as granted, then the investigation would have found the pilot flying to have forgotten to implement a go-around by pushing the TOGA switch at the most critical point of the flight test.

Airborne Image Recorder

played a vital role

in this investigation

With the above in mind, one might say that Airborne Image Recorders should be implemented immediately into the world's commercial aviation fleet. The investigator's mind of the individual responsible with the task of IIC would concur with this, when not taking other factors into account. Instead, further reasoning revealed that the issue of confidentiality of such tools makes it a double edged sword.

Figure 10: View of the Cockpit

As vital of a tool the Airborne Image Recorder has been shown to be, for the 21st century aviation accident investigation toolkit, the question of personal data protection law remains. This is especially the case when taking into account that not all counties protect the information contained on CVR to the same extent.

The issue of confidentiality cannot be overlooked

In Iceland the protection of aviation accident investigation data is very strong. Per article 27 of the Icelandic law 18/2013, on transportation accident investigations, all data the ITSB collects is protected and cannot be accessed by an outside party. The only exception to this is per article 28 where the ITSB can by a court approval be made to submit some of this data [never its interviews or witness statements]. This is only the case if it has been shown that data cannot be accessed by any other means and then only if it is deemed that the granting of access to such data will outweigh the negative effect of providing such data. Finally the last constraint set on the access of such data by the court approval, is that it is then only provided to the transcript of the recordings, but not to the recording themselves. As of today, the ITSB has never been subjected to such court order.

It is standard procedure at the ITSB, after data download, to erase all data from the FDR and the CVR. This way, any later attempt of downloading of the data is prevented. Due to this protocol, the question of data ownership has been raised. The ITSB has always answers this by the statement that the data (FDR) is still owned by the party that owned the recorder (airline, manufacturer, pilot, etc.), but as it has now become a part of the investigation as an evidence that data can only be reviewed by the owner at the ITSB office. In case of personnel sensitive data that falls within the Icelandic law of data protection act, such as video and CVR recordings, only the investigators working on the investigation, and the investigation board members approving the report (if needed), are allowed to review the data. If subjected to a court order per article 28, the ITSB would only provide a transcript, describing what is heard on the CVR or seen on the Airborne Image Recordings.

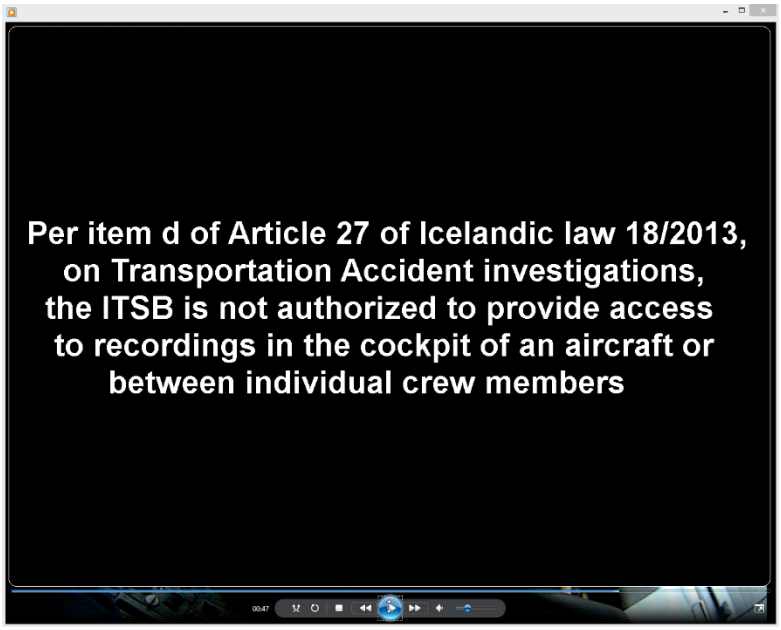

Figure 11: Not authorized to provide access to cockpit recordings

Conclusion

The Icelandic Transportation Safety Board concluded the following in its report on the Sukhoi Civil Aircraft RRJ-95B accident on July 21st 2013:

> *The ITSB would have liked to make the following safety recommendation to ICAO, but due to some nations not following ICAO protocol regarding CVR confidentiality it is withheld at this time:*
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> > *"For aircraft accident investigation purposes, research the drawbacks and benefits of installing cockpit video recording system into commercial aircraft, currently fitted with CVR."*

Seminars such as the ISASI 2016 in Iceland are a good place to start the necessary dialog to solve this issue and get us to a point where aviation accident investigators can be provided with the tool of

Airborne Image Recorder (AIR), while at the same time ensuring that flight crews' personal data protection is upheld.

The investigation produced nine safety recommendations following the accident, which may be put in the context that the aviation industry will be safer after the investigation. This was only possible due to the strong important links in the aviation investigation world.

Reference

1. The Icelandic Transportation Safety Board. The final report into the accident of Sukhoi Civil Aircraft RRJ-95B of Russian experimental registry 95005 at Keflavik Airport (BIKF) on July 21st 2013. http://www.rnsa.is/media/2672/m-01313-aig-09-russian-97005-final-report.pdf