RNSA

Rannsóknarnefnd samgönguslysa

Final report on aircraft serious incident

Case no.: **19-159F044**

Date: **28. October 2019**

Location: **RWY 01 at Keflavik Airport**

Description: **Declared emergency due to low fuel and landed on a closed runway**

SAMANTEKT Á ÍSLENSKU (ICELANDIC SUMMARY)

Þann 27. október 2019, tók Boeing 757-200 flugvél á íslenskri skráningu TF-ISF á loft frá flugvellinum í Seattle (KSEA) í áætlunarfarþegaflugi til Keflavíkurflugvallar (BIKF). Flugið var með flugnúmerið FI680 og kallmerkið ICEAIR 680, oft stytt í flug 680 í skýrslunni.

Eldsneytismagn við brottför var rétt yfir 30 tonnum og var áætlað eldsneytismagn við lendingu um 4,1 tonn. Eldsneytiseyðslan í farfluginu reyndist meiri en áætlað hafði verið.

Snemma morguns þann 28. október 2019, þegar flug 680 hóf lækkun inn til Keflavíkurflugvallar, var flugbraut 01 í notkun, en nothæfu flugbrautarástandi hafði ekki verið viðhaldið um nóttina á flugbraut 10/28.

Klukkan 06:04, þegar flug 680 var í aðflugi að Keflavíkurflugvelli, rann flugvél N812AM út af flugbrautarenda í lendingu á flugbraut 01 á Keflavíkurflugvelli. Þetta varð til þess að Keflavíkurflugvöllur lokaðist fyrir lendingar, þar sem ekki var hægt að nota flugbraut 10/28.

Flugi 680 var því stefnt í biðflug í 6000 fetum við stöðumið SOPAR. Flugstjóri flugsins ræddi við aðstoðarflugmanninn um að þeir hefðu ekki mikið eldsneyti til biðflugs.

Klukkan 06:10 hafði áhöfn flugs 680 samband við flugumferðarstjóra í aðflugsstjórn Keflavíkurflugvallar[1] og bað um síðustu bremsumælingu fyrir Reykjavíkurflugvöll, en sá flugvöllur var skráður sem varaflugvöllur flugsins. Flugumferðarstjóri í aðflugsstjórn Keflavíkurflugvallar svaraði að það tæki hálftíma að fá bremsumælingu á Reykjavíkurflugvelli.

Flugumferðarstjórar í aðflugsstjórn Keflavíkurflugvallar vissu hins vegar ekki að þá þegar var verið að undirbúa Reykjavíkurflugvöll fyrir opnun og búið að bremsumæla flugbraut 01/19 tvisvar, klukkan 05:49 og aftur klukkan 06:03. Rannsóknin leiddi í ljós samskiptaleysi á milli aðflugsstjórnar Keflavíkurflugvallar og flugradíóþjónustu (AFIS) Reykjavíkurflugvallar.

Flugmenn flugs 680 komust að þeirri niðurstöðu að þeir gætu ekki beðið í 30 mínútur eftir bremsumælingu frá Reykjavíkurflugvelli, þar sem þeir hefðu ekki tíma til að biðfljúga í 30 mínútur, og að Keflavíkurflugvöllur væri því þeirra eini kostur til lendingar. Í kjölfarið, klukkan 06:11, lét flugáhöfnin aðflugsstjórn Keflavíkurflugvallar vita að þeir hefðu ekki eldsneyti í það og að Keflavíkurflugvöllur væri þeirra eini valmöguleiki.

[1] FAXI TMA

Klukkan 06:17 var flugi 680 veitt heimild til þess að hefja lækkun fyrir aðflug að flugbraut 01 á Keflavíkurflugvelli. Flugumferðarstjórar í flugturninum á Keflavíkurflugvelli voru hins vegar í kjölfarið ekki fúsir til þess að veita lendingarheimild, þar sem flugvél var á flugbrautinni, nema að neyðarástandi væri lýst yfir.

Klukkan 06:18:30 upplýsti flugumferðarstjóri í aðflugsstjórn flugáhöfn flugs 680 um bremsumælingu á flugbraut 01 á Reykjavíkurflugvelli, 30-32-34. Flugáhöfn flugs 680 framkvæmdi ekki útreikninga á afkastagetu fyrir lendingu á Reykjavíkurflugvelli (BIRK) og hélt áfram lækkun í 3000 fet í undirbúningi fyrir lendingu á Keflavíkurflugvelli (BIKF).

Klukkan 06:20 lýsti flugáhöfn flugs 680 yfir neyðarástandi til að geta lent á Keflavíkurflugvelli, en þá var eldsneyti um borð komið niður í 2,8 tonn. Því næst áttu sér stað samskipti á milli áhafnarinnar og flugturns um hvers eðlis neyðarástandið væri sem og hvert ástandið væri á flugbrautinni. Klukkan 06:25 veitti flugumferðarstjóri í flugturninum á Keflavíkurflugvelli flugáhöfn flugs 680 leyfi til lendingar á eigin ábyrgð á flugbraut 01.

Klukkan 06:26 lenti flug 680 á lokaðri flugbraut 01 á Keflavíkurflugvelli, var þá eldsneyti um borð komið niður í 2,6 tonn. Skilgreint lágmarksvaraeldsneyti flugsins var 1666 kg.

Flugáhöfn og farþegar flugvélar N812AM voru um borð í flugvél N812AM á enda flugbrautar 01. Þeir höfðu ekki verið látnir vita að flug 680 væri að lenda á lokaðri flugbrautinni.

Lending flugs 680 gekk vel og fór flugvélin af flugbrautinni um akbraut A-1. Þegar flug 680 kom að hliði var eldsneyti um borð 2,4 tonn.

Að sögn flugrekandans höfðu engin af flugum þeirra á árunum 2017-2019 farið undir 30 mínútna lágmarksvaraeldsneyti.

Flug 680 lenti hins vegar á lokaðri flugbraut, svo að Rannsóknarnefnd samgönguslysa (RNSA) taldi rétt að skoða það flug nánar.

Flugbraut 01 á Keflavíkurflugvelli var opnuð að nýju klukkan 06:58. Ef að flug 680 hefði haldið áfram í biðflugi við SOPAR uns flugbrautin opnaði, þá hefði það þýtt aukaeldsneytiseyðslu upp á 2157 kg. Þá hefðu einungis rúmt 0,4 tonn af eldsneyti verið eftir við lendingu og aðeins rúm 0,2 tonn þegar flugvélin kæmi upp að hliði.

Ef að flug 680 hefði verið beint strax til Reykjavíkurflugvallar klukkan 06:18:30, þegar bremsumæling fyrir BIRK lá fyrir, þá hefði eldsneyti flugsins verið komið niður í um 1800

kg þegar komið var til BIRK klukkan 06:32:30, ennþá yfir lágmarksvaraeldsneyti flugsins upp á 1666 kg.

Miðað við MIÐLUNGS uppgefna bremsu sem mæld var klukkan 06:03 fyrir flugbraut 01 á Reykjavíkurflugvelli (BIRK), og flugáhöfn flugs 680 fékk upplýsingar um klukkan 06:18:30, sýndu útreikningar á afkastagetu flugs 680 við lendingu að ekki var hægt að lenda á Reykjavíkurflugvelli.

RNSA rannsakaði rekstur og samskipti á milli flugstjórnarmiðstöðvarinnar og alþjóðaflugvalla Íslands (BIKF, BIRK, BIAR og BIEG), einnig milli flugumferðarstjóra og flugrekanda til að kanna hvort veika hlekki í heildaröryggiskeðjunni væri að finna í tilfellum sem þessum, ef flugbraut/flugvöllur lokast.

Komst RNSA að þeirri niðurstöðu að þrátt fyrir að viðeigandi aðilar hefðu öryggisnet í kringum sína starfsemi, þá væri hver þeirra einungis að líta á það frá sínu sjónarhorni og að yfirsýn skorti á heildaröryggiskerfinu.

RNSA fann tilfelli þar sem einstök öryggiskerfi náðu ekki saman og gátu því valdið niðurbroti heildaröryggiskerfisins. Skýrslan fer ítarlega yfir þessi atriði.

Tíminn sem það tekur stóra farþegaþotu að fljúga frá Keflavíkurflugvelli til Reykjavíkurflugvallar, er styttri en tíminn sem það tekur að opna Reykjavíkurflugvöll á þeim tímum sem hann er lokaður. Þetta á bæði við ef það þarf að hreinsa snjó af flugbrautinni, sanda hana og bremsumæla, sem og ef að hækka þarf neyðarviðbragðsstig flugvallarins til að geta tekið á móti stórum farþegaþotum (CAT-7).

RNSA telur að Reykjavíkurflugvöllur hafi ekki verið heppilegur varaflugvöllur fyrir flugið, með tilliti til veðurspár, opnunartíma flugvallarins, þess tíma sem tekur að hækka neyðarviðbragðsstig flugvallarins og afkastagetu flugvélarinnar í lendingu.

RNSA leggur til sex tillögur í öryggisátt og eina mikilvæga ábendingu í skýrslunni.

SUMMARY

On 27. October 2019, a Boeing 757-200 aircraft on Icelandic registry TF-ISF took off from Seattle Airport (KSEA) for a scheduled passenger flight to Keflavik Airport (BIKF). The flight had flight number FI680 and the callsign ICEAIR 680, oft shortened as flight 680 in the report.

The departure fuel was just over 30 tons, with an estimated landing fuel of about 4.1 tons. The enroute fuel consumption was higher than planned.

In the early morning of 28. October 2019, when flight 680 started its descent towards Keflavik Airport, RWY 01 was in use, while usable runway condition of RWY 10/28 had not been maintained through the night.

At 06:04, when flight 680 was on an approach to Keflavik Airport, aircraft N812AM incurred a runway excursion during landing on the active RWY 01 at Keflavik Airport. This effectively closed Keflavik Airport for landings as RWY 10/28 was not useable.

Flight 680 was directed to hold at 6000 feet at waypoint SOPAR. The Commander (PF) noted to the First Officer that they did not have much fuel for holding.

At 06:10, the flight crew of flight 680 contacted Keflavik Approach and requested the latest braking action at Reykjavik Airport, which was their filed alternate airport. Keflavik Approach replied that it would take half an hour to get the braking action measurements at Reykjavik Airport.

Unknown to the ATCO in Keflavik Approach, Reykjavik Airport was already being prepared for opening this morning and runway brake measurement had already been performed twice on RWY 01/19 at Reykjavik Airport, at 05:49 and again at 06:03. The investigation revealed a lack of communications between Keflavik Approach and Reykjavik Airport.

The Commander of flight 680 stated to the First Officer that they did not have that time to wait for 30 minutes and that Keflavik Airport was then their only option. Subsequently, at 06:11, the flight crew replied to Keflavik Approach that they did not have fuel for that, and Keflavik Airport was their only option.

At 06:17 flight 680 was cleared to descent for approach to RWY 01 at Keflavik Airport. The ATCOs in Keflavik Tower were however subsequently unwilling to provide landing clearance due to an aircraft being on the runway, unless an emergency was declared.

At 06:18:30 Keflavik Approach provided flight ICEAIR 680 with braking action numbers 30-32-34 for RWY 01 at Reykjavik Airport. The flight crew of flight ICEAIR 680 did not perform landing performance calculations for Reykjavik Airport (BIRK) and continued its descent to altitude 3000 feet in preparation for landing at Keflavik Airport (BIKF).

At 06:20 flight 680 declared an emergency to be able to land at Keflavik Airport, when its remaining fuel was 2.8 tons. This was followed by communications between ATC and the flight crew regarding the nature of the emergency and information regarding the runway condition. At 06:25 Keflavik Tower permitted flight 680 to land at their discretion on RWY 01.

At 06:26 flight 680 landed on a closed RWY 01 at Keflavik Airport, with a remaining fuel of 2.6 tons. The defined final reserve fuel for flight 680 was 1666 kg.

The flight crew and passengers of aircraft N812AM were on board aircraft N812AM at the far end of RWY 01. They had not been informed that flight ICEAIR 680 was landing on the closed runway.

The landing of flight 680 went well, and the aircraft exited RWY 01 via taxiway A-1. When flight 680 arrived at the gate, its remaining fuel was 2.4 tons.

According to the flight operator, none of their flights in the 2017-2019 period had gone below the 30-minute final reserve fuel.

Flight ICEAIR 680 did however land on a closed runway, so the Safety Investigation Authority of Iceland (SIA-Iceland)[2] determined that particular flight required further study.

Runway 01 at Keflavik Airport was re-opened at 06:58. If flight ICEAIR 680 had continued its holding at SOPAR until the runway re-opened, it would have consumed extra 2157 kg of fuel. This would have meant just over 0.4 tons of fuel would have remained when it landed and only just over 0.2 tons of fuel would have remained when it arrived at the gate.

Had flight ICEAIR 680 diverted immediately to Reykjavik Airport (BIRK) at 06:18:30, when the braking action numbers for BIRK were available, the fuel would have been down to about 1800 kg when they arrived at BIRK at 06:32:30. This was still above the final reserve fuel of 1666 kg.

[2] Rannsóknarnefnd samgönguslysa (RNSA), in Icelandic

Using the MEDIUM braking action measurement from 06:03 for RWY 01 at Reykjavik Airport (BIRK) that was provided to the flight crew of flight ICEAIR 680 at 06:18:30, landing performance calculations showed that flight ICEAIR 680 could not land at BIRK.

SIA-Iceland investigated the operation and interaction between Reykjavik Area Control Center and the international airports in Iceland (BIKF, BIRK, BIAR and BIEG), and between air traffic controllers and flight operators, to look for weak links in the overall system, in cases of runway/airport closing.

SIA-Iceland found, that although the relevant parties had safety net around their operation, the parties were only looking at it from their point of view and not from the whole systematic point of view.

As a result, SIA-Iceland found that there were gaps in the safety systems between the relevant parties, which could lead to systematic failures. The report reviews these items extensively.

The time it takes a large gas turbine powered transport category aircraft to divert from Keflavik Airport to Reykjavik Airport is shorter than the time it takes to open Reykjavik Airport during its closing hours. This is both relevant in the case if the runway at Reykjavik Airport needs to be cleared of snow, sanded and braking measurement performed, as well as if the rescue and firefighting capability of the airport needs to be upgraded to accommodate a large transport category aircraft (CAT-7).

SIA-Iceland concluded that Reykjavik Airport was not a good choice of an alternate airport for the flight, considering weather forecast, the airport's opening hours, the time it takes to upgrade the airport's rescue and firefighting capability and the aircraft landing performance.

SIA-Iceland issued six safety recommendations and one safety action in the report.

Contents

1. FACTUAL INFORMATION

Location and time	
Location:	At Keflavik Airport
Date:	28. October 2019
Time[3]:	06:20

Aircraft	
Type:	Boeing 757-200
Register:	TF-ISF
Year of manufacture:	1991
Serial number:	24595
CoA:	Valid
Engines:	Two Rolls-Royce RB211-535E4

Other information	
Type of flight:	Commercial flight
Persons on board:	184 (6 crew and 178 passengers)
Injury:	None
Damage:	None
Short description:	Declared emergency due to low fuel and landed on a closed RWY 01 at Keflavik Airport

Commander (Pilot Flying)		
Age:	42 years	
Certificate:	ATPL/A	
Ratings:	B757/767	
Medical Certificate:	Class 1, valid	
Experience:	Total flight hours:	7,131 hours
	Total flight hours as Commander:	2,104 hours
	Total flight hours on type:	6,323 hours
	Last 90 days on type:	178 hours
	Last 24 hours on type:	8 hours

[3] All times in the report are UTC times, unless otherwise stated

First Officer (Pilot Monitoring)	
Age:	28 years
Certificate:	FCLS.A - ATPL/A
Ratings:	B757/767 B747-400
Medical Certificate:	Class 1, valid
Experience:	Total flight hours: 3,350 hours Total flight hours on type: 1,258 hours Last 90 days on type: 21 hours Last 24 hours on type: 8 hours

1.1. History of the flight

Flight ICEAIR 680 was a passenger flight from Seattle Airport (KSEA) to Keflavik Airport (BIKF) with a scheduled time of departure at 22:30 UTC on October 27th, 2019, being operated on a Boeing 757-200 aircraft registered as TF-ISF.

According to the flight plan, the planned ramp fuel before departure was 29,994 kg.

The aircraft's fuel tanks contained 2800 kg of Jet A-1 fuel from the last incoming flight and prior to the departure, the planned fuel uplift had been 27,195 kg of Jet A fuel. The actual fuel uplift was however 27,279 kg of Jet A fuel, 84 kg more than planned, resulting in a total fuel of 30,079 kg on board the airplane prior to departure.

According to the flight plan, the estimated landing fuel at destination was 4,128 kg, so the flight crew determined that they had sufficient fuel for the flight.

Prior to the departure the flight crew reviewed the TAF weather forecast and METAR weather observation for Keflavik Airport, as well as the enroute weather forecast. According to the flight crew, there were no concerns regarding the weather.

Reykjavik Airport (BIRK) was the planned alternate airport for the flight and the planned fuel for the flight to the alternate airport was 958 kg for a 14 minute flight at FL 90.

The preflight inspection was accomplished by the First Officer and the Commander was the Pilot Flying (PF).

The takeoff[4] was at 22:46:54. Both the takeoff and the climb were uneventful.

About 1 hour into the flight, the aircraft reached fuel checkpoint BOJAM, located at 52°06.3'N 117°42.9'W, four minutes ahead of schedule. According to the flight plan, the aircraft was to reach this fuel checkpoint with a planned remaining fuel of 24.6 tons. At checkpoint BOJAM about 24.9 tons of fuel remained.

For the fuel checkpoints, the flight crew used the TOTAL value (totalizer) on the fuel quantity indicator of the overhead panel.

At 00:56 UTC, on October 28th, the aircraft reached fuel checkpoint DUROT, located at 58°02.5'N 108°27'W, the remaining fuel and planned remaining fuel were both 20.4 tons.

[4] Air_Ground Relay changed from 1 to 0 (1=GROUND | 0=AIR)

After that, at subsequent fuel checkpoints at cruise altitude, the flight crew noticed that the aircraft fuel burn was slightly higher than planned.

The flight crew received several updated ATIS for Keflavik Airport during the flight. They noticed during the flight that the braking condition at Keflavik Airport was POOR, before it started improving again. The flight crew was not too concerned about it, because they also noticed that it had rained significantly with the temperature around freezing and they assumed the runway(s) needed de-icing.

At 05:33, when flight ICEAIR 680 aircraft reached its second last fuel check point, located at 66°N 030°W, the flight crew noticed that the aircraft had burned 700 kg of its 1272 kg contingency fuel.

At 05:40, the flight crew discussed the loss of 10 minutes of the flight time while crossing Oceanic. They also received ATIS information H for Keflavik Airport, which provided braking action of 38-47-53 for RWY 01. According to the PF, based on the braking action numbers, he planned to use Autobrake 1 during the landing.

At 05:43, the flight crew contacted Reykjavik Control, requesting to route direct to waypoint RENDU. Reykjavik Control replied that they were unable [to grant the request] at the moment, due to traffic.

At 05:47, when the aircraft reached its last fuel checkpoint, located at 65°16.1'N 026°46.6'W, at Top of Descent (TOD), the aircraft had burned 800 kg of its 1272 kg contingency fuel.

At 05:52, the flight crew discussed that the aircraft had difficulty keeping the descent profile, as it was 1500 feet below the profile, and that the PF increased the power. The flight crew also discussed that the wind was changing from a westerly wind to a northernly wind.

At 05:56, the flight crew contacted Reykjavik Control and repeated its request for a change in route, direct to RENDU. Reykjavik Control advised that they were working on it, to expect direct shortly, and to stand by.

At 05:58, Reykjavik Control contacted the flight crew and instructed them to contact Keflavik Approach at 119.3 mHz and that Keflavik Approach would clear them direct to RENDU as soon as possible. Subsequently, the flight crew contacted Keflavik Approach and reported that they were descending through FL100. Keflavik Approach replied with a

clearance to descend to 4000 [feet] and to proceed direct to RENDU, with QNH of 1034 [hPa].

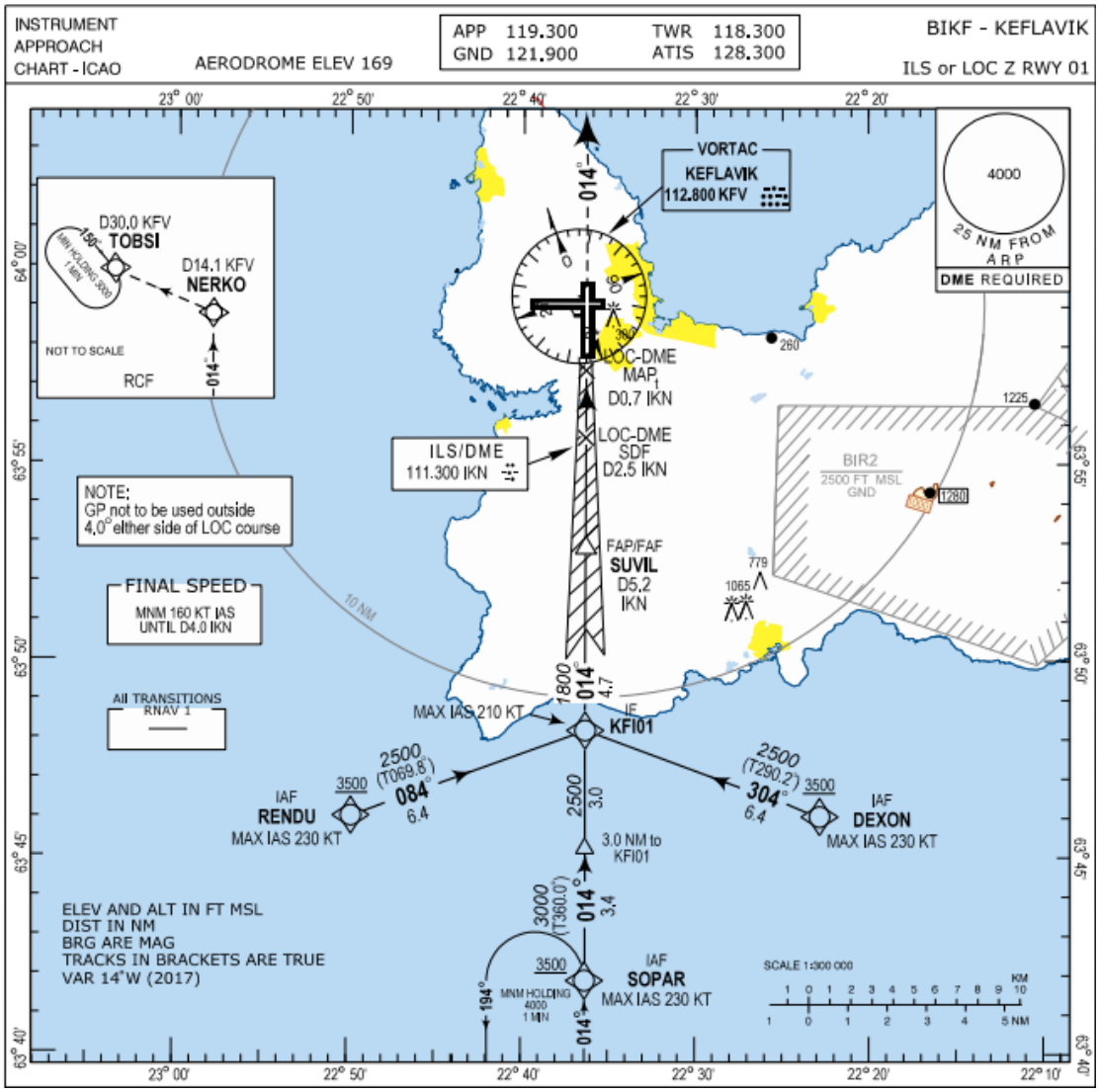


Figure 1: BIKF instrument approach chart – Showing RENDU and SOPAR

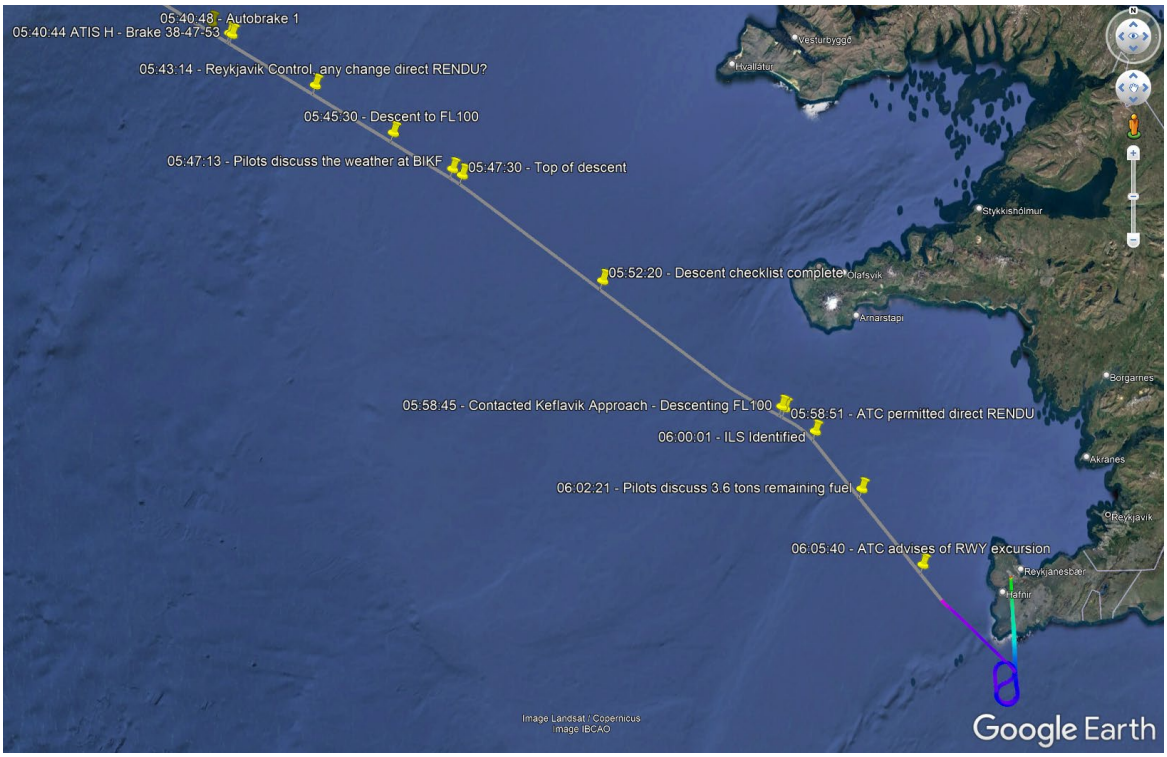


Figure 2: Flight path of flight ICEAIR 680 between 05:40 and 06:05

At 06:02, the flight crew contacted Keflavik Approach requesting speed below FL100. Keflavik Approach replied 260 [knots] maximum below FL100.

Then, also at 06:02, the flight crew discussed amongst themselves that the remaining fuel was 3.6 tons, per the totalizer on the overhead fuel panel, while the FMC was showing 300 kg more fuel remaining. They also discussed that this was not suitable as the FMC was showing a value that was higher than the totalizer indicated, and it would be more conservative to have it the other way around.

At 06:05, Keflavik Approach contacted flight ICEAIR 2B, which was ahead of flight ICEAIR 680, with instructions to proceed to, and hold at, waypoint SOPAR as a runway excursion had occurred at the active runway of the airport. The flight crew of ICEAIR 680 heard this communication on the frequency and started discussing it amongst themselves.

At 06:06, Keflavik Approach contacted the flight crew of flight ICEAIR 680 with instructions to proceed to, and hold at, waypoint SOPAR at 6000 feet. The flight crew read back the instructions and started preparing for the holding.

At 06:07, the Commander (PF) noted to the First Officer that they did not have much fuel for this [the holding].

At 06:08, flight ICEAIR 622 that had executed a go-around at Keflavik Airport, following the runway excursion, contacted Keflavik Approach to inquire into the status of RWY 10. Keflavik Approach replied that RWY 10 was not useable, as the last braking measurement there had been less than 18.

At 06:09, the Commander and the First Officer of flight ICEAIR 680 discussed that the minimum diversion fuel for Reykjavik Airport (BIRK) was 2.7 tons and that they needed updated weather for Reykjavik Airport (BIRK).

At 06:10, the First Officer of flight ICEAIR 680 had reviewed their available weather data and confirmed that the weather in Reykjavik was fine, but they needed the braking action. They also discussed that if the braking action in Reykjavik was insufficient, they would be forced to land at Keflavik Airport.

Subsequently at 06:10:35, the flight crew of flight ICEAIR 680 contacted Keflavik Approach and requested the latest braking action at Reykjavik Airport. Keflavik Approach told them to stand by.

At 06:10:47, Keflavik Approach contacted the flight crew of flight ICEAIR 680 with the following information:

> *"ICEAIR 680, at the moment there is no one in Reykjavik tower. We are calling them out and you can expect numbers in half an hour, and someone should be in the tower in 10 minutes."*

The Commander stated to the First Officer that they did not have that time and that Keflavik Airport was then their only option.

At 06:11:05, the flight crew replied to Keflavik Approach:

> *"Ok, we do not have fuel for that, so Keflavik is the only option."*

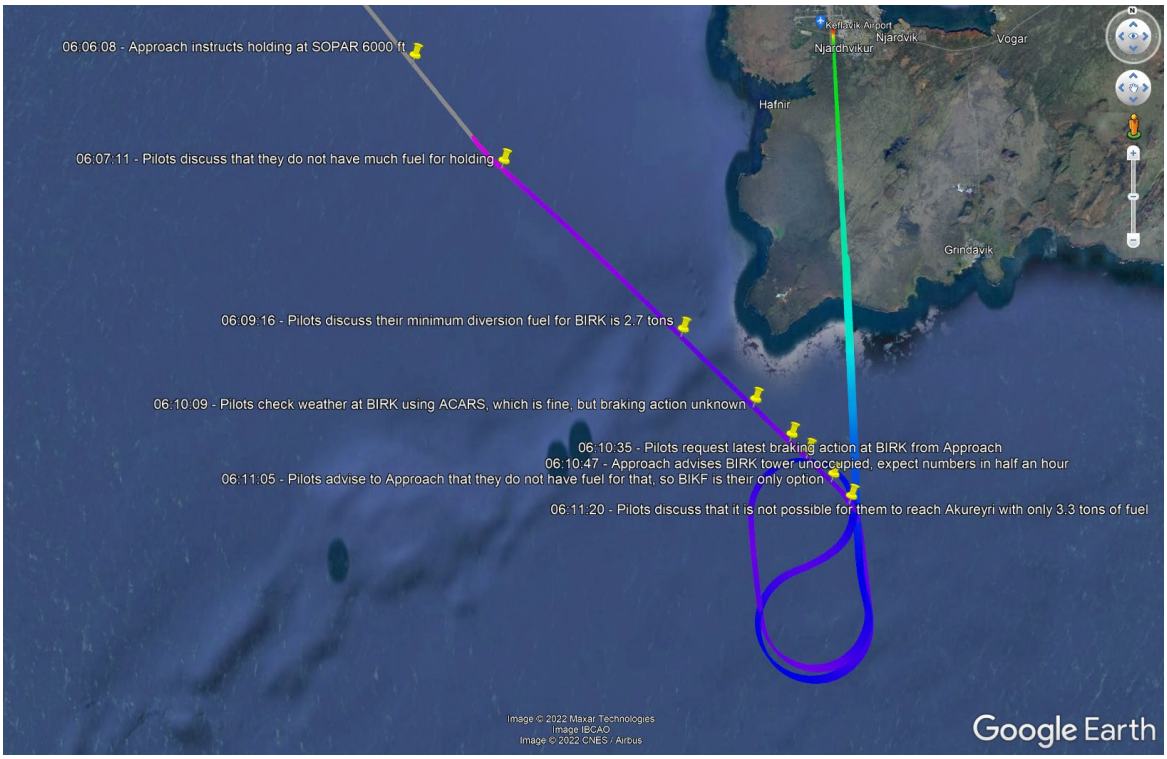


Figure 3: Flight path of flight ICEAIR 680 between 06:06 and 06:11

At 06:11:20, the Commander stated to the First Officer that they would not be able to go to Akureyri Airport with their remaining fuel of 3.3 tons. The First Officer concurred.

The flight crew discussed how long they could continue the holding. The aircraft was consuming 3 tons of fuel per hour. With less than 3.3 tons of remaining fuel and a minimum diversion fuel of 2.7 tons they had less than 600 kg of fuel available before they had to commit to either Keflavik or Reykjavik.

At 06:11:59, Keflavik Approach contacted the flight crew of flight ICEAIR 680 and informed them that nothing had been found damaged on the aircraft that incurred the runway excursion and that a tow truck was on its way to the runway.

The flight crew subsequently inquired if the aircraft excursion had occurred at taxiway N, to which Keflavik Approach replied that that was their understanding as well.

At 06:12:39, the Commander of flight ICEAIR 680 advised Keflavik Approach that they would have to commit to Keflavik Airport as they did not have the braking action at Reykjavik Airport.

Keflavik Approach replied that hopefully they would receive the braking measurement as soon as possible, but this [clearing the RWY excursion aircraft from RWY 01] should not take as long as getting the information from Reykjavik [Airport].

At 06:12:54, the Commander replied understood, but then added that they could not hold for half an hour, not even close. Keflavik Approach replied that it was copied.

At 06:13:06 the First Officer stated to the Commander that the FMC was calculating an available holding time of 12 minutes. The Commander replied that this was not correct as the FMC calculation was based on a [remaining] fuel value of 3.5 tons, while they had 3.2 tons remaining fuel [per the totalizer on the fuel quantity indicator on the overhead panel].

At 06:13:29, the flight crew concurred that they could hold for another 5-6 minutes.

At 06:15:46, the flight crew of flight ICEAIR 680 contacted Keflavik Approach with the following information:

"We are.. after this holding, we are going to have to proceed inbound for RWY 01."

At 06:15:55, Keflavik Approach replied:

"ICEAIR 680, confirm declaring an emergency."

The flight crew discussed the reply from Keflavik Approach before replying:

"Not a matter at this time, but we have minimum fuel."

At 06:16:06, Keflavik Approach replied:

"Ok. Can you accept to land on a runway that is occupied by vehicles?"

The flight crew discussed the reply from Keflavik Approach before replying:

"Where is the vehicle. Is it at the end of the runway?"

Keflavik Approach replied:

"Stand by, I will get a confirmation."

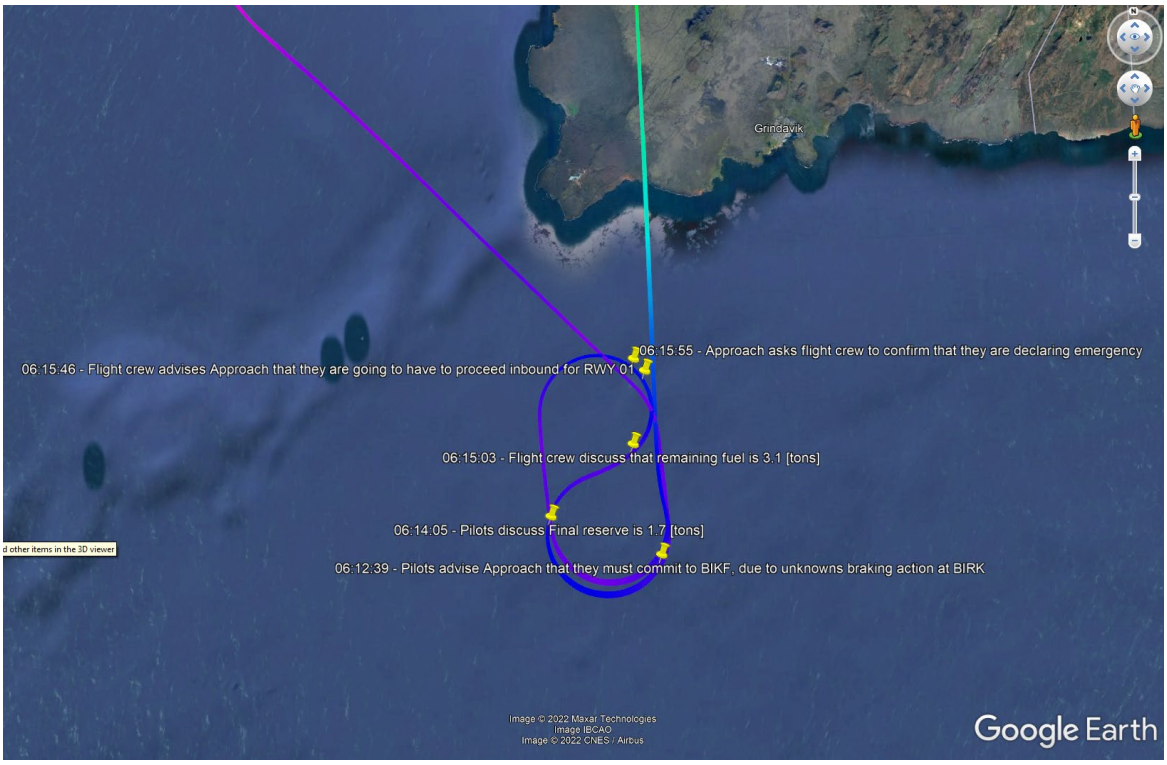


Figure 4: Flight path of flight ICEAIR 680 between 06:12 and 06:16

The flight crew discussed that they had no option, as they did not have the braking action at Reykjavik and that their remaining fuel was almost down to 3.0 tons.

At 06:17:37, Keflavik Approach contacted the flight crew of flight ICEAIR 680:

> *"ICEAIR 680, descend altitude 3000, QNH 1034."*

The flight crew of flight ICEAIR 680 replied:

> *"ICEAIR 680, Are we cleared for the approach?"*

At 06:17:48, Keflavik Approach replied:

> *"680, on your discretion you can get a clearance for the approach, but at the moment we have vehicles on the runway, on the far end, aircraft is run off the runway, still on the runway though and vehicles tending to it."*

The flight crew of flight ICEAIR 680 replied:

> *"Ok, thank you. Cleared for descent 3000, QNH 1034, ICEAIR 680."*

The flight crew set up the aircraft accordingly and initiated the descent.

At 06:18:30, Keflavik Approach contacted the flight crew:

"ICEAIR 680, I have the braking action at Reykjavik 30-32-34 Runway 01."

This was less than 8 minutes after Keflavik Approach had previously advised it would take half an hour to get the information on the braking action at Reykjavik.

The flight crew requested the braking action at Reykjavik again, which Keflavik Approach repeated, and the flight crew confirmed.

At 06:18:46, Keflavik Approach contacted the flight crew again:

"..and confirm that you are inbound for RWY 01 at Keflavik."

The flight crew replied:

"Affirm, ICEAIR 680."

At 06:18:52, Keflavik Approach contacted the flight crew again:

"680 at your discretion you are cleared for the approach."

The flight crew replied:

"At our discretion, cleared for the approach."

The flight crew subsequently set the aircraft up for the approach.

At 06:20:00, the flight crew discussed how low they were on fuel, which was down to 2.9 tons of remaining fuel.

The flight crew also discussed they were almost down to minimum diversion fuel [2.7 tons] and that they had not had the time to calculate the landing distance at Reykjavik Airport using the newly acquired braking measurements there.

They agreed that landing at RWY 01 at Keflavik Airport, under the current condition, was their best option.

At 06:20:17, Keflavik Approach contacted the flight crew again:

"ICEAIR 680, the tower is not willing to give you a landing clearance. Runway is occupied. We need an emergency declared and then land at your discretion."

At 06:20:33, the Commander replied:

> *"MAYDAY-MAYDAY-MAYDAY, ICEAIR 680, we are proceeding inbound for RWY 01."*

When flight ICEAIR 680 declared an emergency, its remaining fuel was 2.8 tons.

Keflavik Approach replied:

> *"ICEAIR 680, roger that, continue."*

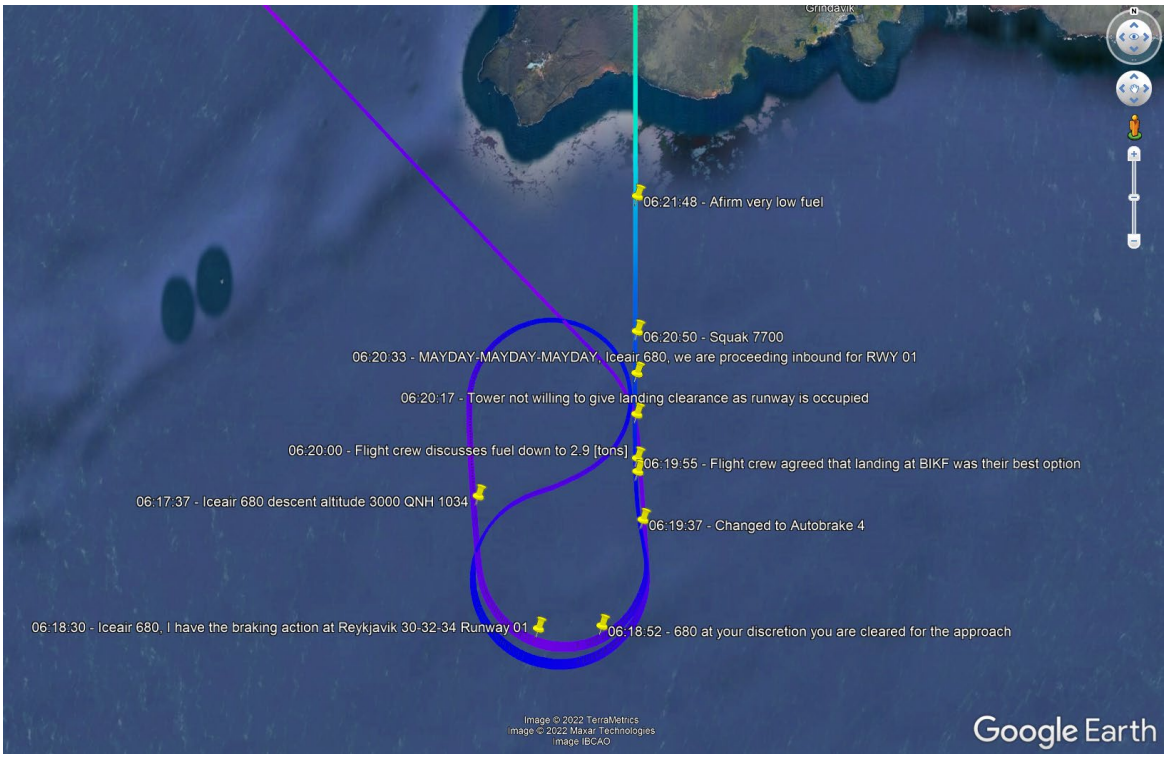


Figure 5: Flight path of flight ICEAIR 680 between 06:17 and 06:21

The flight crew squawked 7700 and continued the approach.

At 06:21:13, Keflavik Approach contacted the flight crew again:

> *"ICEAIR 680, for braking action contact tower 18.3"*

The flight crew changed their radio over to the tower frequency and contacted the tower:

> *"Tower 18.3, ICEAIR 680. Tower, good morning. MAYDAY, ICEAIR 680, inbound for the ILS RWY 01, do you have the latest braking action?"*

Keflavik Tower replied:

"ICEAIR 680, tower, affirm continue approach for RWY 01, is it a low fuel?"

The flight crew replied:

"Affirm, very low fuel."

Keflavik Tower replied:

"Roger, continue, be advised that there is an aircraft at the end of the runway, that is still on the runway with vehicles."

The flight crew replied:

"We are advised, ICEAIR 680."

Figure 6: Flight path of flight ICEAIR 680 between 06:21 and 06:26

At 06:22:44, the flight crew discussed that they had reached minimum diversion fuel.

At 06:23:41, Keflavik Tower contacted the flight crew again:

"ICEAIR 680, check the braking action numbers for RWY 01, 48-62-66."

The flight crew copied the information, continued their approach and the final preparation for landing.

At 06:25:29, Keflavik Tower contacted the flight crew again:

> *"ICEAIR 680, check the aircraft is on the runway end, about 15 to 20 meters from the threshold, wind 320/5 knots, RWY 01 landing is approved at the pilot's discretion."*

The flight crew replied:

> *"Landing approved."*

At 06:26:43, flight ICEAIR 680 landed on RWY 01 at Keflavik Airport and Autobrake 4 was employed.

When flight ICEAIR 680 landed, its remaining fuel was 2.6 tons.

Figure 7: Flight ICEAIR 680 vacated RWY 01 at TWY A-1

During the landing roll, the flight crew turned off the landing lights in order not to disturb the team working on the runway end, on the aircraft that had incurred runway excursion. Flight ICEAIR 680 vacated RWY 01 at taxiway A-1.

When flight ICEAIR 680 arrived at the gate, its remaining fuel was 2.4 tons.

Movement of the aircraft that had incurred the runway excursion (N812AM) at the far end of RWY 01 started at 06:46, or 20 minutes after TF-ISF landed.

At 06:47, SIA-Iceland was notified by Isavia of this serious incident of aircraft TF-ISF landing on a closed RWY 01 at BIKF, as well as of the earlier runway excursion of aircraft N812AM.

At 06:57, aircraft N812AM had been removed from RWY 01/19 and at 07:20 it had been parked in its designated space on the apron.

At 06:58 RWY 01 was back in operation, after all vehicles had exited the RWY. This was 54 minutes after the runway excursion had occurred at 06:04.

SIA-Iceland has issued a separate report into the runway excursion of aircraft N812AM, which can be found at the following link:

https://www.rnsa.is/media/4729/final-report-n812am-rwy-excursion-at-bikf-on-28-oct-2019.pdf

1.2. Flight information

```
Log Nr.: 3797 Page  2                                        KSEA-BIKF  ICE680

WEIGHT INFORMATION

TOTAL PAYLOAD  17700 KG (PAX 177 = 17700 KG   CGO&MAIL     0 KG)

              TOW           LW            ZFW
MAX OPS WT    113398        95254         84096
PLANNED WT    109497        84053         79925

ACTUAL  WT    ......

FUEL CALCULATION:                  FUEL BIAS IN %: 2.7
                                                    FUEL    TIME
DEST/ALTN  KEF / RKV               B/O DEST        25444   7:18
TIME       7:18/ 0:14              CONTING 5%       1272   0:22(    )
DIST       3152/ 51                B/O ALTN (BIRK)   958   0:14 FL 90
AV WC TO DEST     8 KTS HEAD       FINAL RESERVE    1666   0:30
                                   ADDITIONAL          0   0:00
T/O ALTN:                          COMPANY           116   0:02
ERA (3%):                          EXTRA             116   0:02
                                   TAXI              422    -
MINIMUM RAMP FUEL        :29762    PLANNED RAMP    29994   8:28

EST LAND FUEL AT DEST    : 4128    OTHER           .....   .....
(PLANNED RAMP-B/O DEST-TAXI)       FUEL ON BOARD   .....   .....

MINIMUM DIVERSION FUEL   : 2624
(B/O ALTN+FINAL RESERVE)


FUEL BURN INCREASE PER 1000 KG WEIGHT      195 Kg
                   PER   10 KT HEADWIND    564 Kg
```

Figure 8: Flight plan – Weight and fuel information

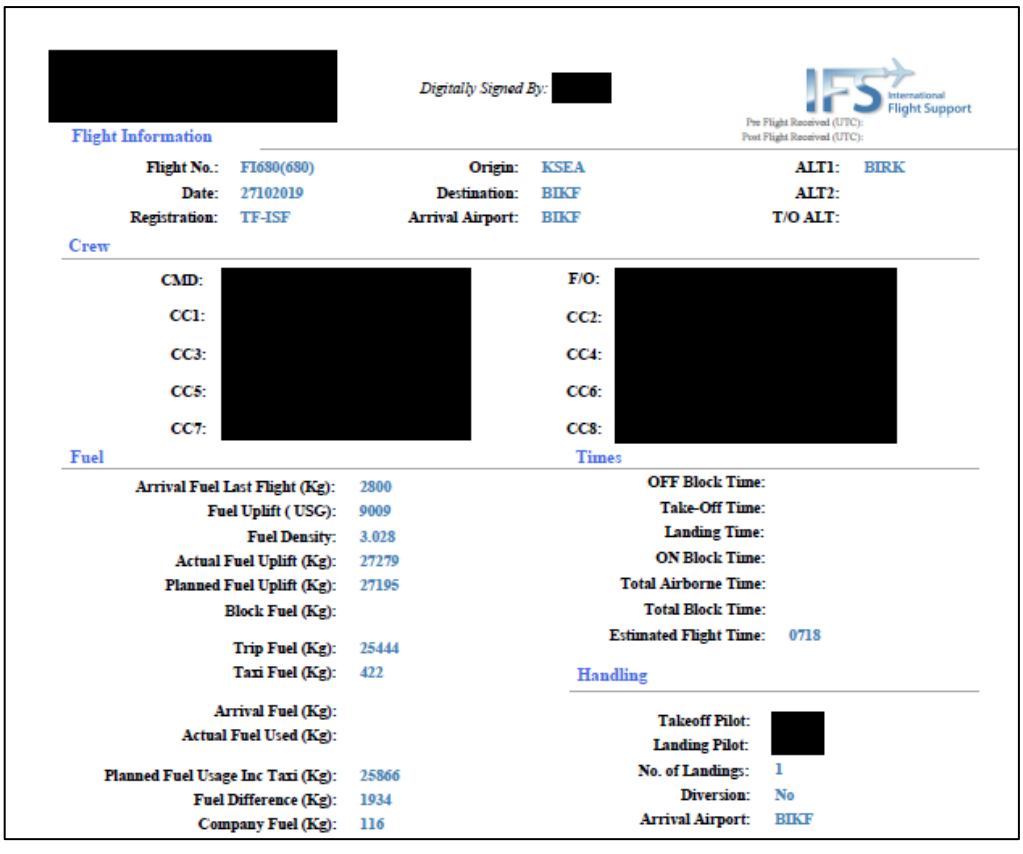
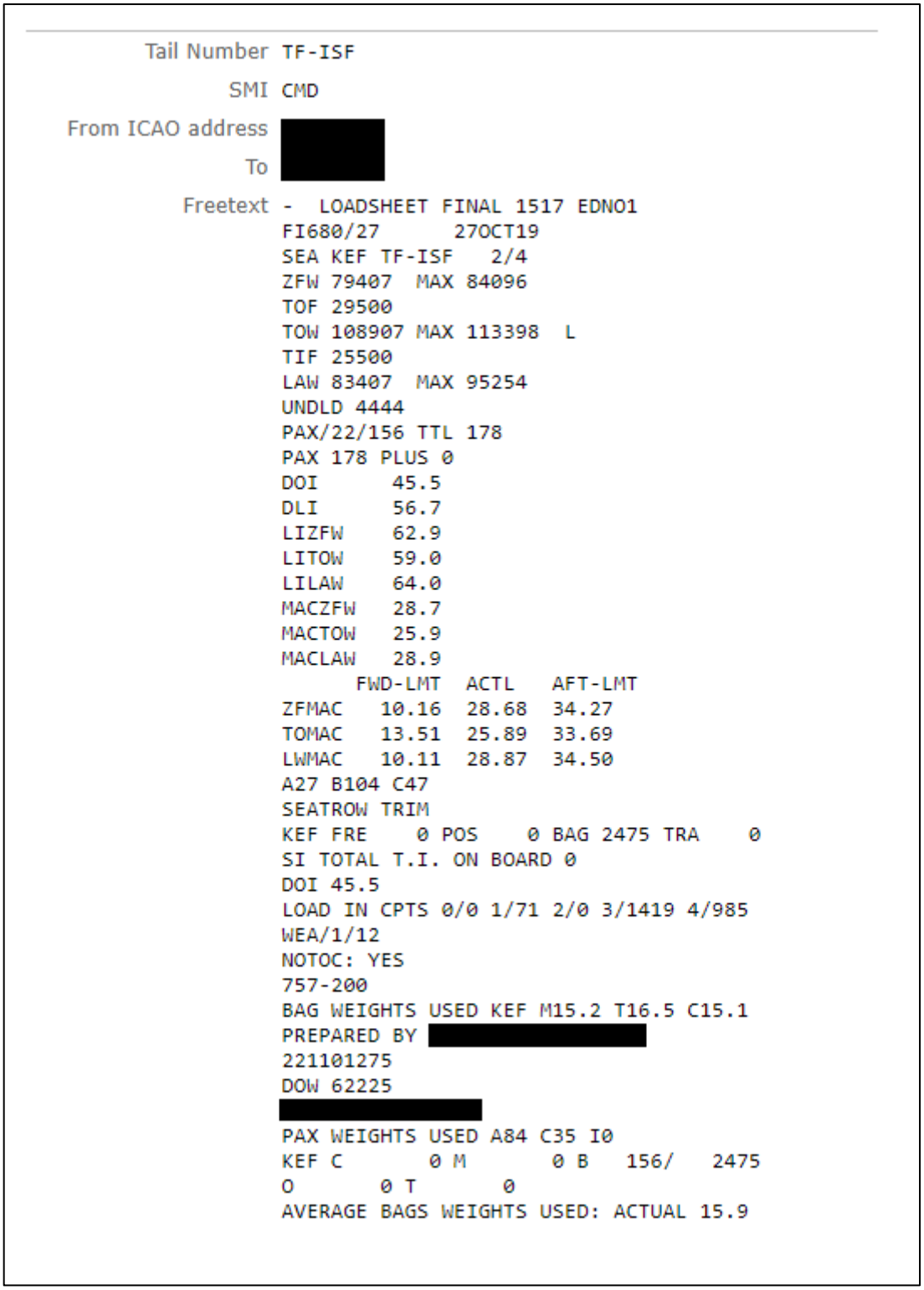


Figure 9: IFS program in the electronic flight bag – Flight and fuel information



Tail Number TF-ISF

SMI CMD

From ICAO address [redacted]

To

Freetext

```
-  LOADSHEET FINAL 1517 EDNO1
FI680/27      27OCT19
SEA KEF TF-ISF   2/4
ZFW 79407  MAX 84096
TOF 29500
TOW 108907 MAX 113398  L
TIF 25500
LAW 83407  MAX 95254
UNDLD 4444
PAX/22/156 TTL 178
PAX 178 PLUS 0
DOI      45.5
DLI      56.7
LIZFW    62.9
LITOW    59.0
LILAW    64.0
MACZFW   28.7
MACTOW   25.9
MACLAW   28.9
      FWD-LMT  ACTL   AFT-LMT
ZFMAC   10.16  28.68  34.27
TOMAC   13.51  25.89  33.69
LWMAC   10.11  28.87  34.50
A27 B104 C47
SEATROW TRIM
KEF FRE    0 POS    0 BAG 2475 TRA    0
SI TOTAL T.I. ON BOARD 0
DOI 45.5
LOAD IN CPTS 0/0 1/71 2/0 3/1419 4/985
WEA/1/12
NOTOC: YES
757-200
BAG WEIGHTS USED KEF M15.2 T16.5 C15.1
PREPARED BY [redacted]
221101275
DOW 62225
[redacted]
PAX WEIGHTS USED A84 C35 I0
KEF C       0 M       0 B   156/   2475
O       0 T       0
AVERAGE BAGS WEIGHTS USED: ACTUAL 15.9
```

Figure 10: Loadsheet for flight ICEAIR 680

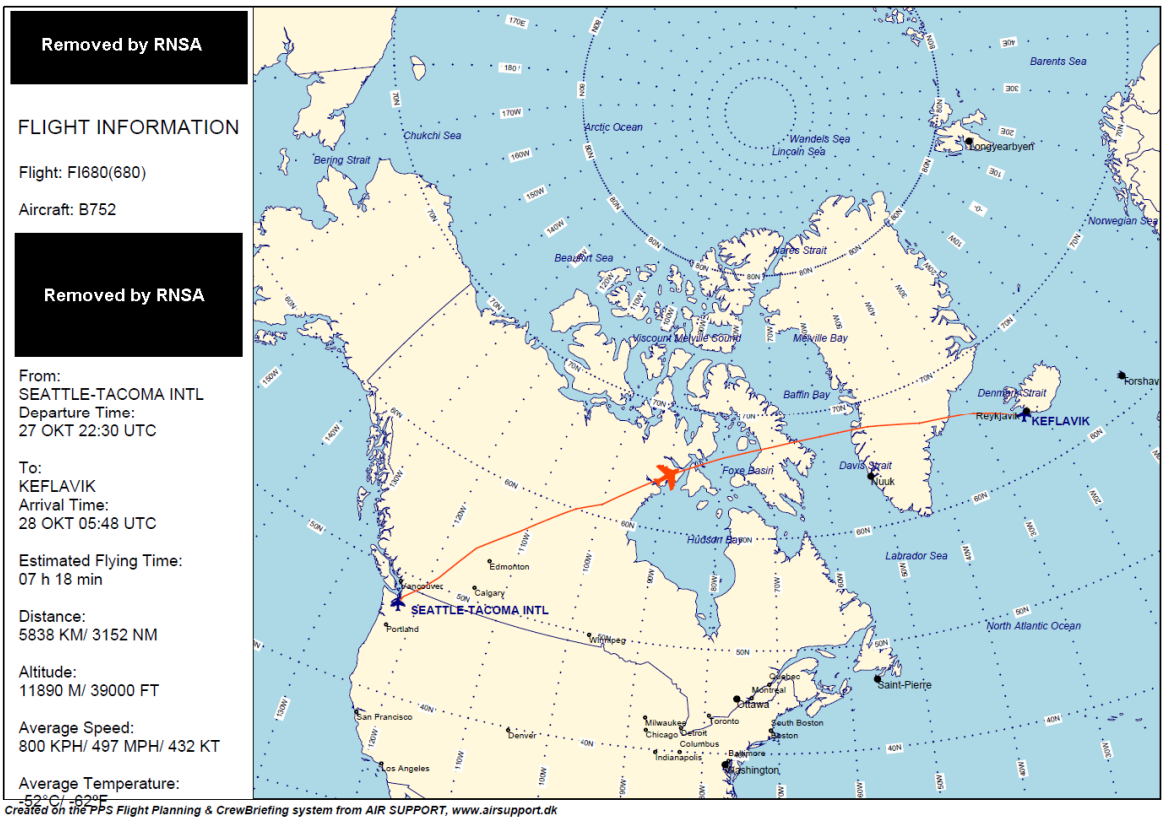


Figure 11: Planned flight route for flight ICEAIR 680

1.3. Meteorological information

The following weather data was issued for flight ICEAIR 680 at 21:34 UTC. The flight crew had this weather information in their possession as part of the flight package.

WX for flight **FI680(680)-KSEA-BIKF** (STD 272230)

(WX search performed 2019-10-27 21:34:15 UTC, for METAR, TAF and SIGMET.)

Departure airport KSEA - SEA - SEATTLE-TACOMA INTL RWY 16C 16L 16R 34C 34L 34R

```
METAR  272053Z  01007KT 10SM FEW090 FEW180 12/01 A3045 RMK AO2 SLP318 T01170006 58013=
TAF    272101Z  AMD 2721/2824 36006KT P6SM FEW100 FEW200 FM280200 VRB03KT P6SM FEW250
       FM281800 33005KT P6SM FEW250=
```

Destination airport BIKF - KEF - KEFLAVIK RWY 01 10 19 28

```
METAR  272130Z  01002KT 9999 -RA FEW007 SCT026 BKN045 04/01 Q1030=
TAF    271947Z  2721/2821 30008KT 9999 SCT020 BKN033 TX05/2815Z TN01/2721Z PROB40 TEMPO
       2802/2809 -SHRA BKN015=
```

Alternate airport BIRK - RKV - REYKJAVIK RWY 01 13 19 31

```
METAR  272100Z  15003KT 9999 FEW032 01/M03 Q1030=
TAF    271947Z  2721/2821 VRB02KT 9999 FEW035 TX05/2815Z TNM01/2723Z BECMG 2721/2723 9999
       SCT020 BKN030 BECMG 2802/2804 30010KT PROB40 TEMPO 2803/2809 -SHRASN BKN015 BECMG
       2813/2816 23008KT=
```

Alternate airport BIAR - AEY - AKUREYRI RWY 01 19

```
METAR  272100Z  17005KT CAVOK M12/M14 Q1030 R01/390095=
TAF    271947Z  2721/2821 18004KT CAVOK TX00/2815Z TNM11/2803Z BECMG 2812/2814 19014KT=
```

Alternate airport BIEG - EGS - EGILSSTADIR RWY 04 22

```
METAR  272100Z  19012KT CAVOK M02/M06 Q1029 RMK WIND GAGNHEIDI 26012KT=
TAF    271947Z  2721/2821 20010KT CAVOK TX01/2815Z TNM08/2806Z=
```

Alternate airport EGPF - GLA - GLASGOW RWY 05 23

```
METAR  272120Z  AUTO 21004KT 9999 NCD 03/01 Q1026=
TAF    271658Z  2718/2818 28007KT 9999 FEW040 PROB30 TEMPO 2803/2809 3000 BR=
```

Alternate airport CYWG - YWG - WINNIPEG/J A RICHARDSON INTL RWY 13 18 31 36

```
METAR  272100Z  29015KT 12SM -SN OVC022 M00/M06 A2995 RMK SC8 SLP155=
TAF    271738Z  2718/2818 31012G22KT P6SM SCT020 BKN060 BKN100 TEMPO 2718/2803 5SM -SHSN
       BKN020 OVC040 BECMG 2721/2723 29012KT FM280300 27010KT P6SM SCT020 BKN040 BECMG
       2804/2806 27012KT FM281200 24010KT P6SM BKN040 RMK NXT FCST BY 280000Z=
```

Alternate airport CYVP - YVP - KUUJJUAQ RWY 07 13 25 31

```
METAR  272100Z  15008KT 15SM FEW120 02/M05 A3015 RMK AC1 SLP215=
TAF    271740Z  2718/2806 19012KT P6SM FEW120 SCT240 BECMG 2720/2722 15010KT FM280000
       15008KT P6SM SCT080 BKN120 RMK NXT FCST BY 280000Z=
```

Adequate airport CYEG - YEG - EDMONTON INTL RWY 02 12 20 30

```
METAR  272100Z  30015G21KT 20SM FEW030 BKN120 BKN250 03/M06 A3008 RMK SC1AC7CI1 SC TR CI
       TR VIRGA SLP226=
TAF    272038Z  2721/2818 29018G28KT P6SM SCT120 BKN250 FM272300 33018G30KT 6SM -SN BKN030
       TEMPO 2723/2803 1SM -SHSN OVC020 PROB30 2723/2802 1/2SM SHSN BLSN VV006 FM280300
       33018G28KT P6SM -SN BKN030 TEMPO 2803/2808 2SM -SHSN OVC020 FM280800 35012G22KT
       P6SM BKN030 TEMPO 2808/2818 3SM -SHSN BKN020 BECMG 2816/2818 35018G28KT RMK NXT
       FCST BY 280000Z=
```

Adequate airport CYFB - YFB - IQALUIT RWY 16 34

```
METAR  272123Z  13002KT 10SM -SN OVC005 00/M01 A3011 RMK DZ2ST6 -SN INTMT SLP200=
TAF    271812Z  AMD 2718/2818 VRB03KT 3SM -SN BR BKN005 OVC025 TEMPO 2718/2724 P6SM NSW
       SCT008 OVC025 FM280000 VRB03KT 3SM -SN OVC008 TEMPO 2800/2810 P6SM NSW SCT008
       OVC020 BECMG 2806/2808 13008KT FM281000 13012KT P6SM -SN BKN015 OVC030 BECMG
       2813/2815 13015G25KT RMK NXT FCST BY 280000Z=
```

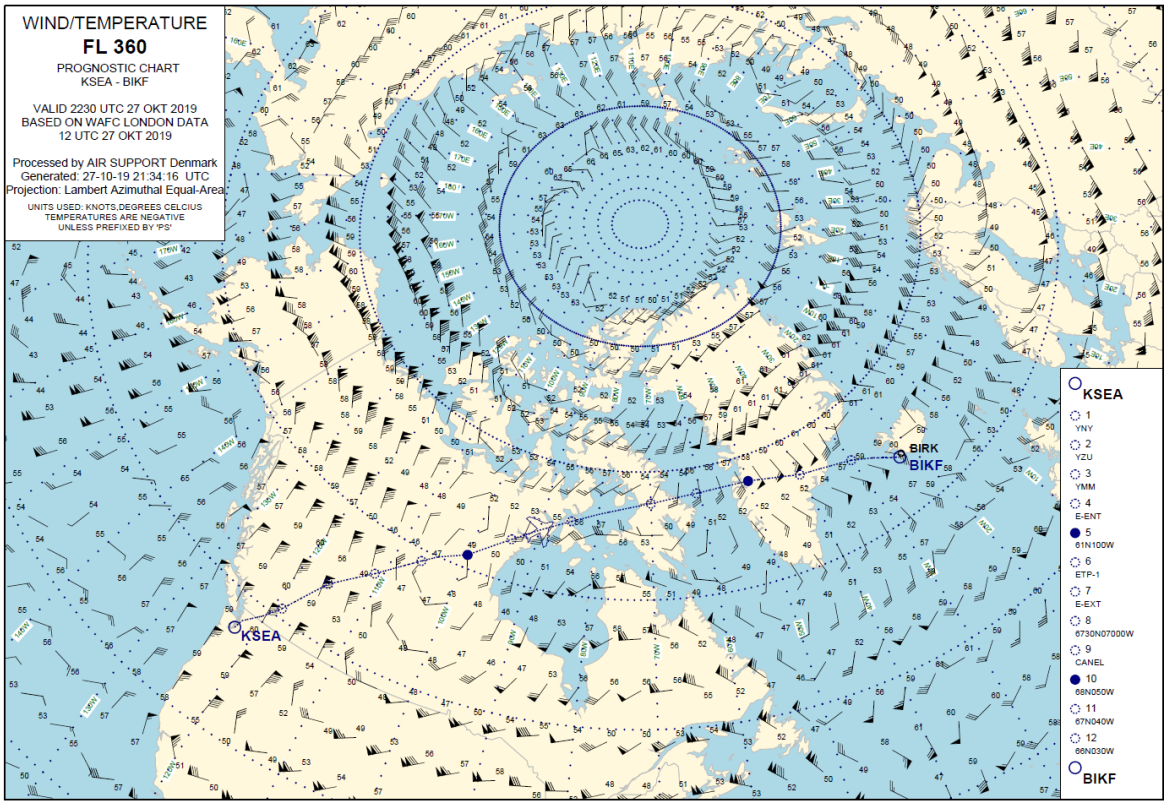
Adequate airport BGSF - SFJ - KANGERLUSSUAQ/SONDRE STROMFJOR RWY 09 27

```
METAR  272120Z  AUTO 05008KT 9999NDV FEW100/// BKN150/// M07/M10 Q1023=
TAF    271953Z  2719/2824 VRB05KT 9999 SCT120 BKN200 TEMPO 2800/2806 BKN060 BECMG
       2806/2809 BKN035 TEMPO 2814/2824 6000 -SN BKN020=
```


SIGMET(s) for KZSE FIR:

```
WSUS33 KKCI 272055 SIGMET
SIGW
MKCW WST 272055
CONVECTIVE SIGMET...NONE
OUTLOOK VALID 272255-280255
TS ARE NOT EXPD TO REQUIRE WST ISSUANCES.=
```

End of WX information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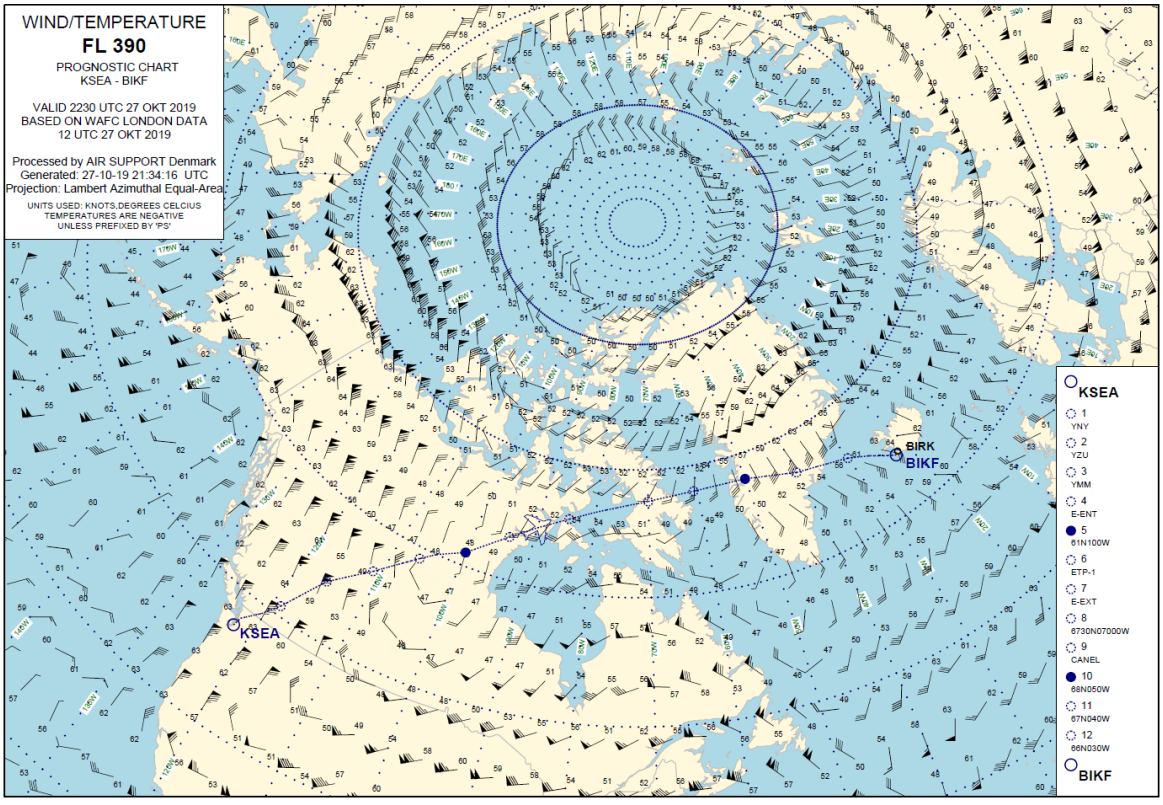
FL 360
PROGNOSTIC CHART
KSEA - BIKF
VALID 2230 UTC 27 OKT 2019
BASED ON WAFC LONDON DATA
12 UTC 27 OKT 2019
Processed by AIR SUPPORT Denmark
Generated: 27-10-19 21:34:16 UTC
Projection: Lambert Azimuthal Equal-Area
UNITS USED: KNOTS,DEGREES CELCIUS
TEMPERATURES ARE NEGATIVE
UNLESS PREFIXED BY 'PS'
KSEA
BIRK
BIKF
KSEA
1 YNY
2 YZU
3 YMM
4 E-ENT
5 61N100W
6 ETP-1
7 E-EXT
8 6730N07000W
9 CANEL
10 68N050W
11 67N040W
12 66N030W
BIKF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BASED ON WAFC LONDON DATA
12 UTC 27 OKT 2019
Processed by AIR SUPPORT Denmark
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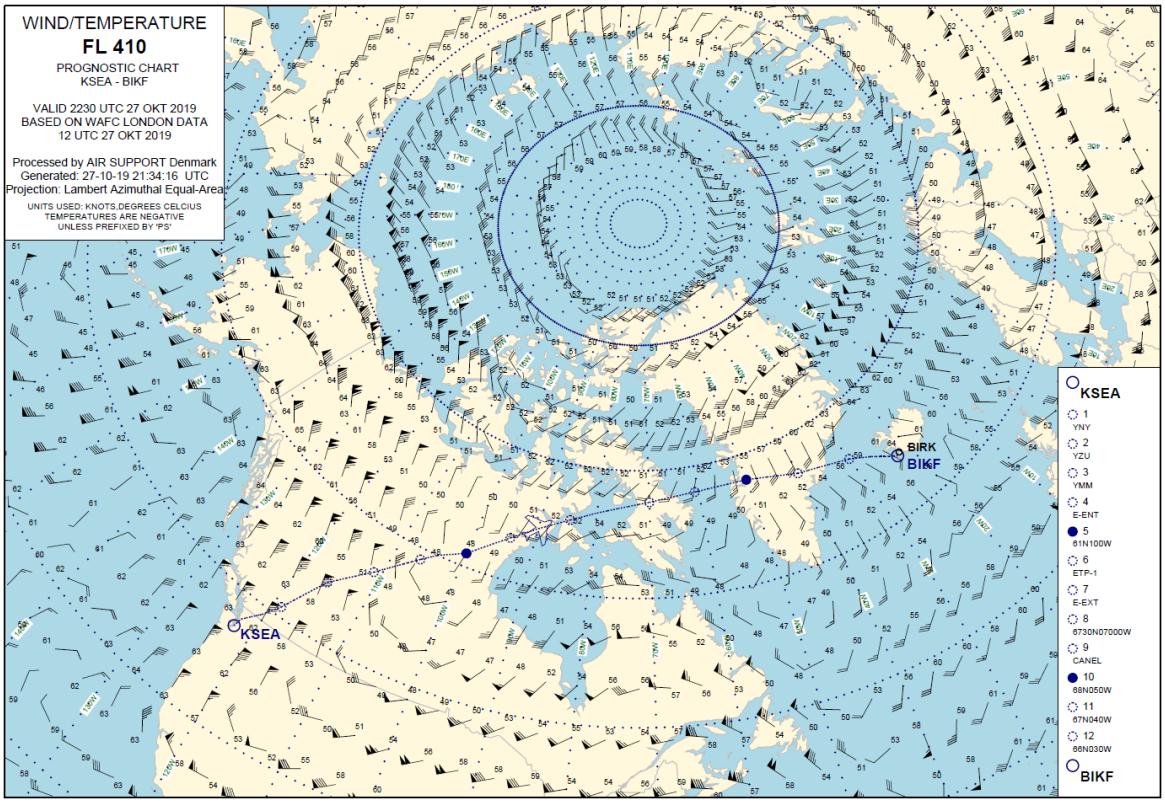
Projection: Lambert Azimuthal Equal-Area
UNITS USED: KNOTS,DEGREES CELCIUS
TEMPERATURES ARE NEGATIVE
UNLESS PREFIXED BY 'PS'
KSEA
BIRK
BIKF
KSEA
1 YNY
2 YZU
3 YMM
4 E-ENT
5 61N100W
6 ETP-1
7 E-EXT
8 6730N07000W
9 CANEL
10 68N050W
11 67N040W
12 66N030W
BIKF


WIND/TEMPERATURE
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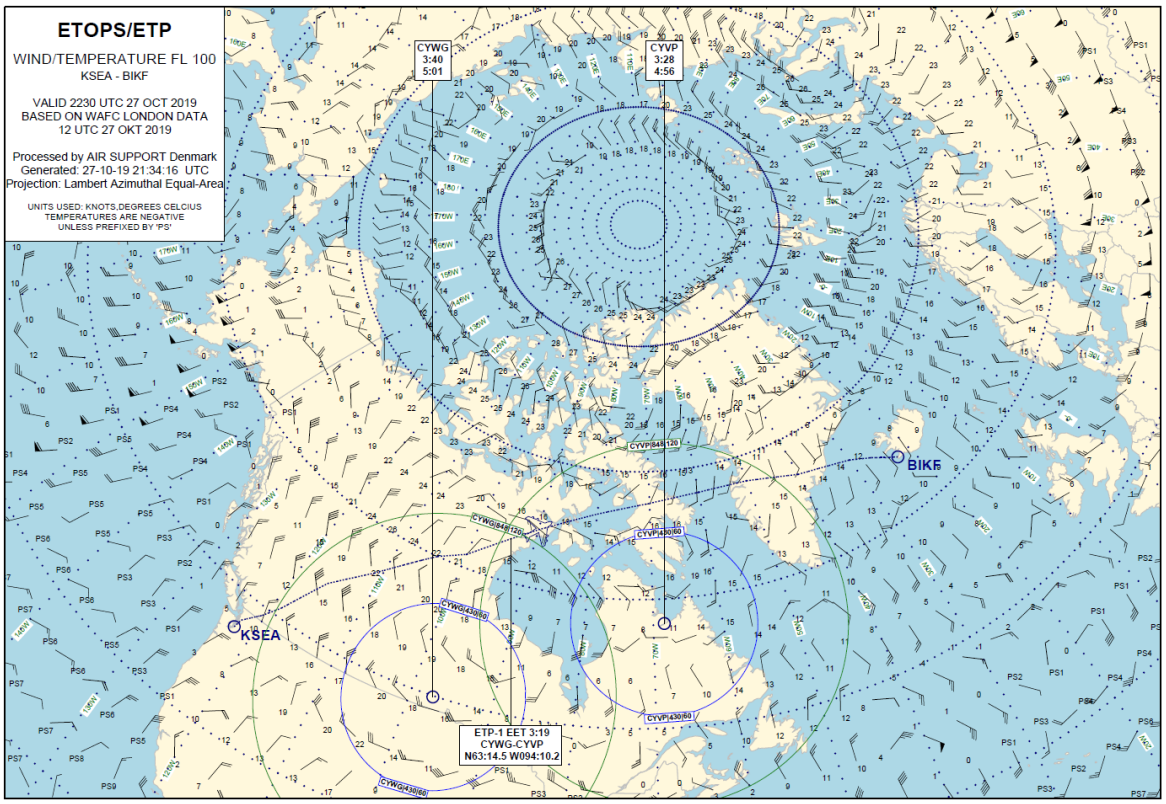
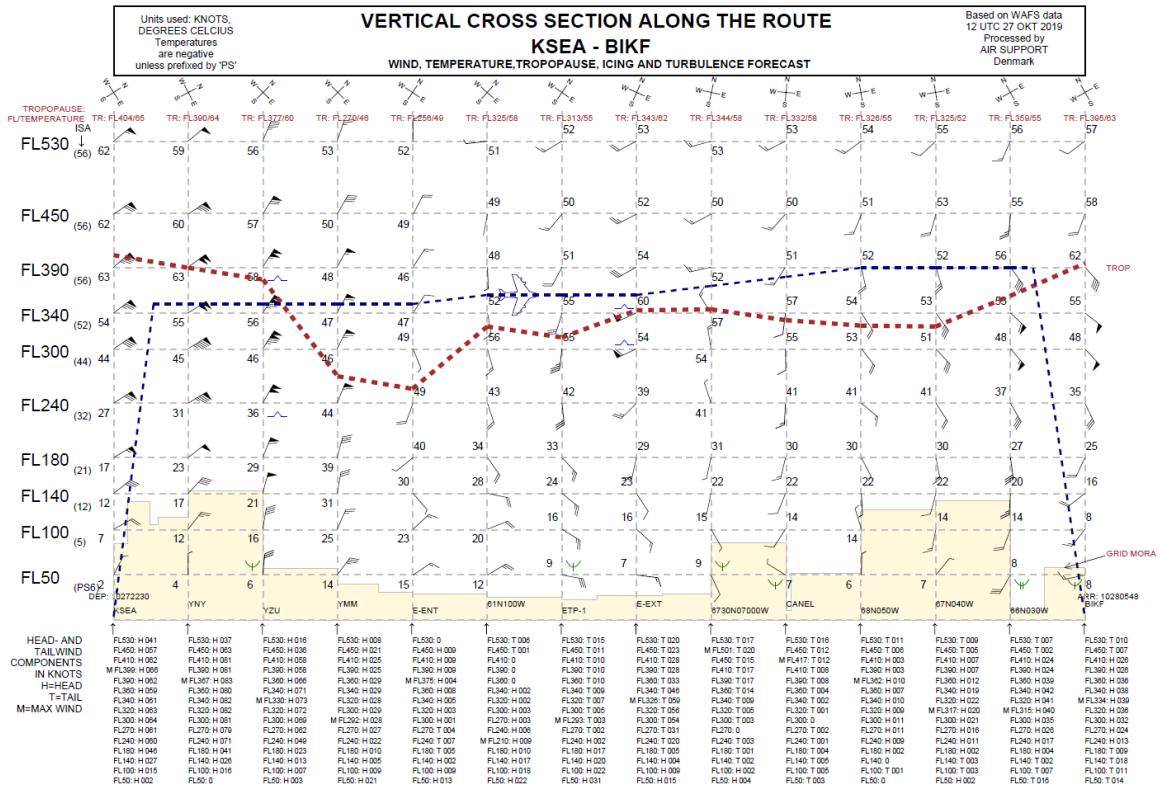
KSEA - BIKF
VALID 2230 UTC 27 OKT 2019
BASED ON WAFC LONDON DATA
12 UTC 27 OKT 2019
Processed by AIR SUPPORT Denmark
Generated: 27-10-19 21:34:16 UTC
Projection: Lambert Azimuthal Equal-Area
UNITS USED: KNOTS,DEGREES CELCIUS
TEMPERATURES ARE NEGATIVE
UNLESS PREFIXED BY 'PS'
KSEA
1 YNY
2 YZU
3 YMM
4 E-ENT
5 61N100W
6 ETP-1
7 E-EXT
8 6730N07000W
9 CANEL
10 68N050W
11 67N040W
12 66N030W
BIKF
KSEA
BIRK
BIKF


ETOPS/ETP
WIND/TEMPERATURE FL 100
KSEA - BIKF
VALID 2230 UTC 27 OCT 2019
BASED ON WAFC LONDON DATA
12 UTC 27 OKT 2019
Processed by AIR SUPPORT Denmark
Generated: 27-10-19 21:34:16 UTC
Projection: Lambert Azimuthal Equal-Area
UNITS USED: KNOTS,DEGREES CELCIUS
TEMPERATURES ARE NEGATIVE
UNLESS PREFIXED BY 'PS'
CYWG
3:40
5:01
CYVP
3:28
4:56
KSEA
BIKF
ETP-1 EET 3:19
CYWG-CYVP
N63:14.5 W094:10.2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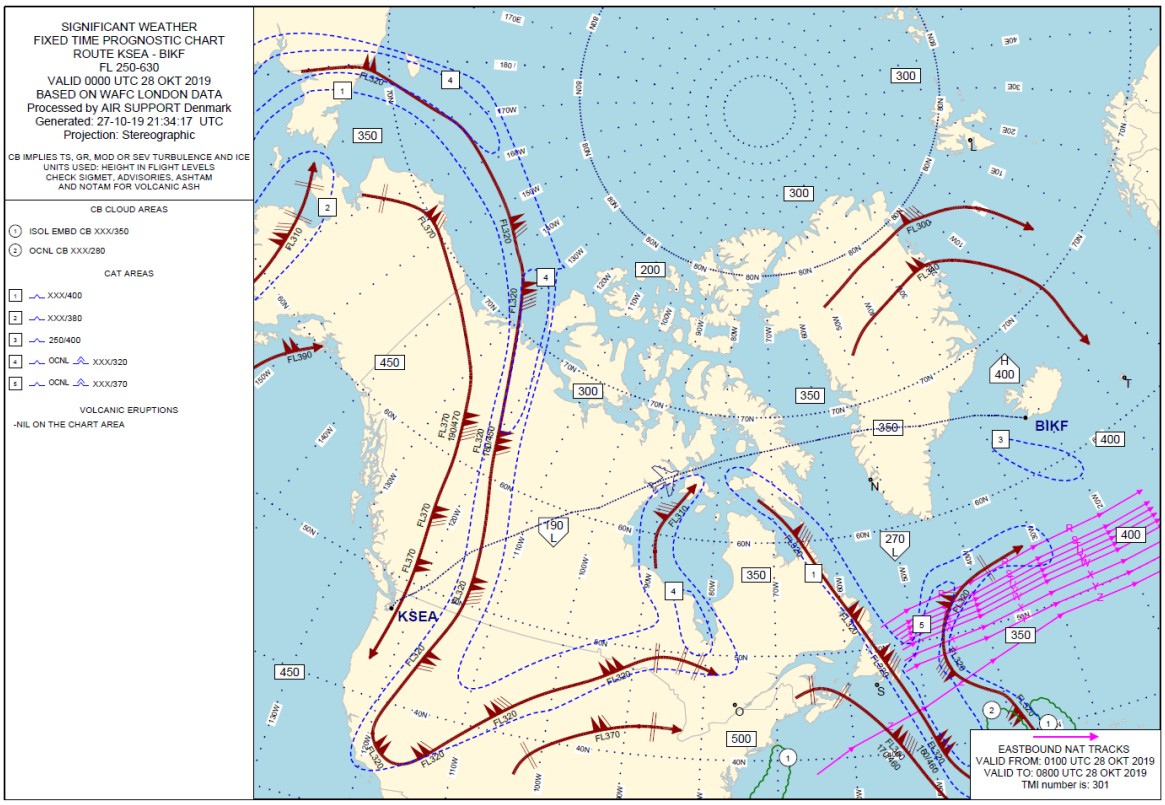
Temperatures are negative unless prefixed by 'PS'
VERTICAL CROSS SECTION ALONG THE ROUTE
KSEA - BIKF
WIND, TEMPERATURE,TROPOPAUSE, ICING AND TURBULENCE FORECAST
Based on WAFS data
12 UTC 27 OKT 2019
Processed by
AIR SUPPORT
Denmark
TROPOPAUSE: FL/TEMPERATURE
ISA
FL530
FL450
FL390
FL340
FL300
FL240
FL180
FL140
FL100
FL50
TROP
GRID MORA
DEP: 0272230
KSEA
YNY
YZU
YMM
E-ENT
61N100W
ETP-1
E-EXT
6730N07000W
CANEL
68N050W
67N040W
66N030W
AR: 10280548
BIKF
HEAD- AND TAILWIND COMPONENTS IN KNOTS
H=HEAD
T=TAIL
M=MAX WIND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FIXED TIME PROGNOSTIC CHART
ROUTE KSEA - BIKF
FL 250-630
VALID 0000 UTC 28 OKT 2019
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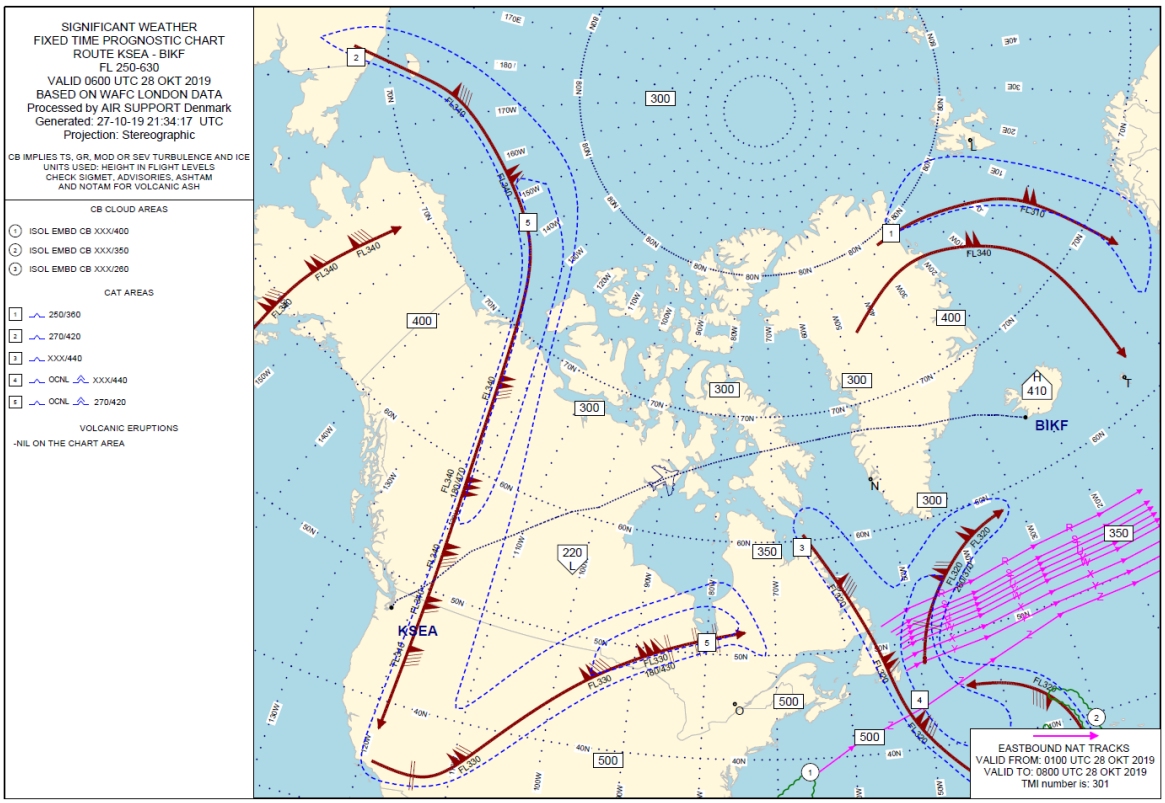
Processed by AIR SUPPORT Denmark
Generated: 27-10-19 21:34:17 UTC
Projection: Stereographic
CB IMPLIES TS, GR, MOD OR SEV TURBULENCE AND ICE
UNITS USED: HEIGHT IN FLIGHT LEVELS
CHECK SIGMET, ADVISORIES, ASHTAM AND NOTAM FOR VOLCANIC ASH
CB CLOUD AREAS
1 ISOL EMBD CB XXX/350
2 OCNL CB XXX/280
CAT AREAS
1 XXX/400
2 XXX/380
3 250/400
4 OCNL XXX/320
5 OCNL XXX/370
VOLCANIC ERUPTIONS
-NIL ON THE CHART AREA
KSEA
BIKF
EASTBOUND NAT TRACKS
VALID FROM: 0100 UTC 28 OKT 2019
VALID TO: 0800 UTC 28 OKT 2019
TMI number is: 301



The following TAF weather forecasts were issued for Keflavik Airport during 27-28 October 2019:

TAF BIKF 270800Z 2709/2809 35007KT 9999 SCT022 BKN032 TX04/2715Z TN00/2709Z
BECMG 2718/2720 33012KT

TAF BIKF 271102Z 2712/2812 VRB02KT 9999 SCT020 BKN030 TX04/2812Z TN00/2712Z
BECMG 2718/2720 30012KT
PROB40 TEMPO 2802/2809 -SHRA BKN015

TAF BIKF 271359Z 2715/2815 VRB02KT 9999 SCT020 BKN033 TX05/2815Z TN01/2721Z
BECMG 2720/2722 30012KT
PROB40 TEMPO 2802/2809 -SHRA BKN015
BECMG 2813/2815 24012KT

TAF BIKF 271621Z 2718/2818 31003KT 9999 SCT020 BKN033 TX05/2815Z TN01/2721Z
BECMG 2720/2722 30013KT
PROB40 TEMPO 2802/2809 -SHRA BKN015
BECMG 2813/2816 24013KT

TAF BIKF 271947Z 2721/2821 30008KT 9999 SCT020 BKN033 TX05/2815Z TN01/2721Z
PROB40 TEMPO 2802/2809 -SHRA BKN015

TAF BIKF 272221Z 2800/2900 30008KT 9999 SCT020 BKN030 TX07/2824Z TN02/2809Z
TEMPO 2800/2807 -SHRA SCT010 BKN015
BECMG 2821/2823 20013KT RADZ BKN010 OVC015

TAF BIKF 280101Z 2803/2903 30008KT 9999 FEW020 BKN030 TX07/2903Z TN02/2809Z
TEMPO 2803/2807 -SHRA SCT010 BKN015
BECMG 2821/2823 20013KT RADZ BKN010 OVC015

TAF BIKF 280101Z 2803/2903 30008KT 9999 FEW020 BKN030 TX07/2903Z TN02/2809Z
TEMPO 2803/2807 -SHRA SCT010 BKN015
BECMG 2821/2823 20013KT RADZ BKN010 OVC015

The following METAR weather observations were issued for Keflavik Airport around the landing on 28 October 2019:

METAR BIKF 280300Z 30006KT 9999 FEW021 02/00 Q1032

METAR COR BIKF 280330Z 31007KT 9999 -RA FEW021 BKN046 02/01 Q1032

METAR BIKF 280400Z 34006KT 9999 -RA FEW018 BKN049 03/02 Q1033

METAR BIKF 280430Z 33006KT 9999 -DZ FEW021 SCT034 BKN050 03/01 Q1033

METAR BIKF 280500Z 32006KT 9999 FEW018 SCT026 BKN045 03/01 Q1033

METAR BIKF 280531Z 35008KT 9999 FEW025 BKN045 02/01 Q1034

METAR BIKF 280600Z 36009KT 9999 -RA FEW018 SCT025 BKN040 03/01 Q1034

METAR BIKF 280630Z 33005KT 9999 -DZ SCT020 BKN040 03/01 Q1034

METAR BIKF 280700Z 32005KT 9999 -DZ FEW020 BKN033 04/02 Q1034

METAR BIKF 280730Z 32006KT 9999 -DZ FEW020 BKN033 03/00 Q1034

METAR BIKF 280800Z 31007KT 290V350 9999 -DZ FEW020 BKN033 05/00 Q1034

The following METAR weather observations were issued for Reykjavik Airport around the landing on 28 October 2019:

METAR BIRK 280500Z 16003KT 9999 FEW020 SCT050 M00/M02 Q1033
METAR BIRK 280600Z 17003KT 9999 FEW018 BKN040 BKN060 01/M01 Q1034
METAR BIRK 280700Z 13003KT 9999 FEW023 BKN040 01/M00 Q1034 R01/390037
METAR BIRK 280800Z VRB02KT 9999 FEW031 SCT037 BKN046 01/M01 Q1034 R01/390037

2. ANALYSIS

2.1. Weather

According to the flight crew the enroute weather was fine but over Greenland and towards Iceland there seemed to be more headwind than the flight plan had anticipated.

Review of the fuel data revealed that more fuel was being burned than planned per the flight plan, all the way since crossing waypoint 61°N 100°W.

2.2. Aerodromes

SIA-Iceland investigated the operation of Keflavik Airport as well as possible diversion airports (BIRK, BIAR and BIEG) in Iceland for large transport category aircraft. The investigation touched on items such as opening hours, airport operations, ATCO/AFIS availability, CAT capability for rescue and firefighting, manpower, shift arrangements, equipment, runway de-icing, braking action measurements and the operation at the day of the incident.

2.2.1. Keflavik Airport

Keflavik Airport (BIKF) is open 24 hours all days of the year.

Keflavik Airport is registered as CAT-8 for rescue and firefighting between 05:00 and 19:00 and as CAT-7 between 19:00 and 05:00. The CAT-7 and CAT-8 requirements are based on ICAO Annex 14, chapter 9.2 Rescue, and firefighting.

The investigation revealed that the airport operator, Isavia, had experienced difficulties maintaining good runway braking action during the night of the serious incident. It had rained between 3:30AM and 4:30AM, but due to low temperature and frozen ground, the rain froze on the runway. This, light rain/drizzle at low atmospheric temperature, with the ground surface temperature below freezing, is a prime condition for forming of a slippery surface. RWY 01 had therefore required runway deicing, which was performed multiple times during the night.

The investigation revealed the following braking action reported measurements in the morning of the serious incident at BIKF[5]:

- At 05:33AM RWY 01-19 braking measurement 0.38/0.47/0.53 - Average 0.46
- At 06:18AM RWY 19-01 braking measurement 0.61/0.62/0.50 - Average 0.58
- At 06:21AM RWY 01-19 braking measurement 0.48/0.62/0.66 - Average 0.58

At 06:04, aircraft N812AM slid off the end of RWY 01 during its landing roll. This closed RWY 01 for further traffic. SIA-Iceland launched a separate investigation into the runway excursion of aircraft N812AM. The report for that investigation can be found under the following link:

https://www.rnsa.is/media/4729/final-report-n812am-rwy-excursion-at-bikf-on-28-oct-2019.pdf

Decision was made by the Keflavik Airport Operations to remove aircraft N812AM from the edge of the runway, to be able to reopen it, instead of working on improving the RWY conditions of RWY 10. At the time that decision, neither ATC nor Keflavik Airport Operations had any knowledge of the fuel status of flight 680.

This decision was made due to the following reasons:

- Runway 10/28 had not been de-iced
- The last measured braking measurement at runway 10/28, performed at 03:54, had shown POOR braking conditions
- The Keflavik Airport Operations had determined that it would be quicker to remove aircraft N812AM from the serious incident site, than deicing RWY 10/28 to such an extent, that sufficient braking action could be gained on that runway
- De-icing RWY 10/28 would divert the Airport's Service manpower and equipment from the task of removing aircraft N812AM from the RWY excursion site, leading to delaying the reopening of RWY 01

SIA-Iceland reviewed the last braking measurements for RWY 28/10. It was performed at 03:54 and showed the braking action to be 0.25 / 0.18 / 0.14 (25-18-14), with an average of 0.19.

[5] The investigation (through comparison review of radio communications with the tower) revealed +31 minutes error in the timestamps in the braking measurement vehicle at BIKF. This has been corrected by removing 31 minutes from the timestamp

Per ICAO Annex 14, 0.25 and below is a POOR braking action.

The SIA-Iceland investigation revealed that, prior to the incident, the safety committee of the Icelandic Airline Pilots' Association had contacted, via a letter, the Icelandic Transport Authority raising their concern that often only one of the runways at Keflavik Airport was being maintained (cleared of snow and/or deiced) during winter conditions.

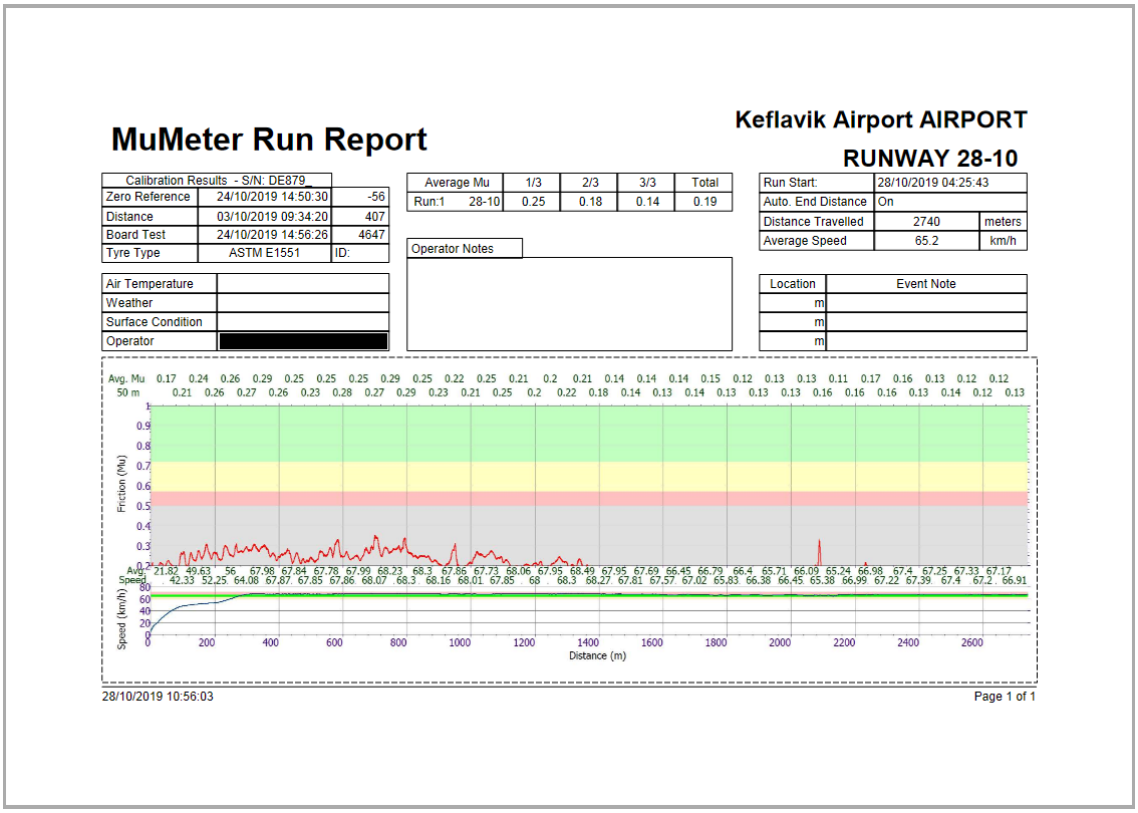


Figure 12: The last braking action measurement for RWY 10 prior to flight ICEAIR 680 landing (the time stamp is 31 minutes off as noted earlier)

According to chapter VR 710 19 5:4 of Isavia handbook for Keflavik Airport:

> *De-icing fluid can only be used on runway in use and its connecting taxiways, next to the runway.* [6]

The SIA-Iceland investigation indicated that cost (manpower, equipment, and deicing fluid) was the main factor for only one runway being maintained.

[6] Handbók Isavia fyrir Keflavíkurflugvöll, kafli VR 710 19 5:4 Hálkuvarnir: „Fljótandi ísvara má einungis nota beint á flugbraut í notkun og aðliggjandi akbrautir næst brautinni."

According to Isavia, this procedure was to be changed as a result of this serious incident in the following manner:

> *When the use of de-icing fluid is required on a runway, it shall be used on both airport runways. The runway in use shall always have priority, along with its connecting taxiways. Immediately following this the second runway shall be de-iced.*[7]

Instead of the suggested above change, the following change to chapter VR 710 19, has now been implemented in revision 8 of the manual:

> *Prepareness due to possible unexpected incident which requires change of runway in use: The runway that is not in use at any given moment, shall be maintained as needed with the aim that it will be ready for use as soon as possible, and no later that 30 minutes from the tower ATCO requesting a change of runway in use. Runway materials and methods that are necessary shall be used to fulfill this requirement.*[8]

2.2.2. Reykjavik Airport

In general, Reykjavik Airport (BIRK) is open between 07:00 and 23:00[9] with ATC service.

At the time of the serious incident, BIRK was registered as CAT-6 for rescue and firefighting and could be upgraded to CAT-7 with 30-60 minutes prior notice. The CAT-6 and CAT-7 requirements are based on ICAO Annex 14, chapter 9.2 Rescue, and firefighting.

- At 06:05, when the flight crew of flight ICEAIR 680 initially became aware of the runway excursion at Keflavik Airport, there were still 55 minutes until Reykjavik Airport was scheduled to open

[7] „Þegar þarf að nota fljótandi ísvara á flugbraut, skal hann notaður á báðar brautir vallarins. Ávallt skal þó gæta þess að braut í notkun sé í forgangi, ásamt aðliggjandi akbrautum. Í beinu framhaldi skal setja ísvara á seinni braut."

[8] Viðbúnaður vegna hugsanlegra óvæntra atvika sem kallar á skipti á flugbraut í notkun: Flugbraut sem ekki er í notkun hverju sinni skal þjónustuð eftir þörfum með það að markmiði að hún verði tilbúin til notkunar eins fljótt og unnt er, og í síðasta lagi 30 mínútum frá beiðni flugturns um brautarskipti. Beita skal þeim efnum og aðferðum sem nauðsynlegt eru til þess að uppfylla þetta markmið.

[9] Open between 07:00 and 16:00 on Christmas Eve and New Year's Eve and closed on New Year's Day, Easter Sunday, and Christmas Day

- At 06:08, when the flight crew of the aircraft ahead of flight ICEAIR 680 on the approach was informed by Keflavik Approach that RWY 10 at Keflavik Airport was not available, there were still 52 minutes until BIRK should open per its schedule
- At 06:10, when the flight crew of flight ICEAIR 680 contacted Keflavik Approach to inquire about the latest braking action at Reykjavik Airport, there were still 50 minutes until Reykjavik Airport should open per its schedule

At the time of the serious incident, according to the Iceland AIP AD 2.3, AFIS was available[10] outside operational hours of ATC with 15 minutes' prior notice for:

- Air ambulance and emergency flights
- The Icelandic Coastguard
- International flights that use BIRK as alternate airport
- Landings of scheduled flights subject to unforeseen delays
- Humanitarian flights

This meant Isavia guaranteed the tower would be manned with an AFIS operator within 15 minutes. This was not a guarantee that the airport would be open with active runway cleared and braking measurement available within 15 minutes. In fact, the response time it takes to make the airport operational to an aircraft, from the time the service is requested, will depend on the airport conditions, including the runway conditions, at that time.

According to an agreement between Isavia and the Ministry of Infrastructure this response time shall never exceed 1 hour.

Flight ICEAIR 680 was an international flight that used BIRK as an alternate airport and therefore it would have been possible to open BIRK for flight ICEAIR 680. In addition, this morning a Coast Guard flight[11] was to depart BIRK before normal opening hours, which resulted in the tower being manned by an AFIS operator earlier than normal opening hours and the airport opening early this day.

Regardless of the airport normally being closed for flights between 23:00 and 07:00 and the tower not being manned, Reykjavik Airport Operations starts their work to prepare the airport for opening before 7 o'clock.

[10] Surcharges apply
[11] Coast Guard flight 31, which was a helicopter

Reykjavik Airport Operations preparation, during winter operation, starts a few days in advance with the review of weather forecasts and ensuring that the necessary airport operation equipment is available and in working order.

One day in advance the weather forecasts are reviewed again, as well as the atmospheric and runway temperatures and the dewpoint. In the evening before, the runways are inspected, and the evening and night work planned as required with regards to the conditions and the weather forecast.

According to Iceland AIP AD 1.2.2.2:

> *The Aerodrome Operational Service monitors the condition of the maneuvering area and the apron within the published aerodrome hours of service. Snow removal is also available upon request outside opening hours.*

On the day of the serious incident, the initial runway inspection and dispersion of birds started at 05:39. The first two braking action measurements at BIRK in the morning of the serious incident had already been accomplished on RWY 01/19 at 05:49 and at 06:03, prior to the N812AM runway excursion at Keflavik Airport.

At 06:06 the Flight Data Specialist (FDS)[12] on duty in the Reykjavik Area Control Center (ACC) called the designated AFIS operator on duty at Reykjavik Airport Operations to advise that the Icelandic Coast Guard had just filed a flight plan from BIRK with a departure at 06:30. The designated AFIS operator advised that he was currently located in a sanding vehicle and would be in the tower in about 5 minutes.

The designated AFIS operator stopped his work as a Reykjavik Airport Operations person preparing the airport for opening and headed for the BIRK Tower to assume his AFIS role in the tower. This left one person on rescue and firefighting duty to finish preparing the runways and taxiways for the opening of the airport. At BIRK, sanding of RWY 01/19 and taxiway E started at 06:09.

At Reykjavik Airport, during slippery conditions, the runways, taxiways, and aprons are sanded to improve the surface conditions. Runway de-icing fluids are not used at BIRK.

The investigation revealed the following braking action measurements in the morning of the serious incident at BIRK:

[12] Fjarritun

Time	RWY	Mu A	Mu B	Mu C	Average Mu
05:49:54	1	0,29	0,29	0,30	0,28
	19	0,22	0,20	0,29	0,24
06:03:14	1	0,31	0,34	0,36	0,33
	19	0,31	0,32	0,26	0,31
06:34:12	1	0,35	0,39	0,40	0,38
	19	0,38	0,40	0,49	0,37
06:54:15	1	0,35	0,38	0,40	0,37
	19	0,33	0,38	0,47	0,36
07:10:41	1	0,35	0,38	0,41	0,38
	19	0,38	0,38	0,41	0,38
07:36:32	1	0,29	0,34	0,36	0,33
	19	0,32	0,34	0,36	0,34
08:03:52	1	0,29	0,34	0,38	0,34
	19	0,31	0,35	0,35	0,34
08:44:07	1	0,30	0,33	0,35	0,33
	19	0,30	0,36	0,44	0,33
09:18:54	1	0,31	0,33	0,42	0,32
	19	0,29	0,33	0,35	0,32

Figure 13: BIRK braking action measurements in the morning of 28. October 2019

At 06:14 the single person left on rescue and firefighting duty at the Reykjavik Airport Operations called the Flight Data Specialist (FDS) on duty in the Reykjavik Area Control Center (ACC) to notify that he was publishing a SNOWTAM for BIRK.

The following SNOWTAM (number 1575) was issued at 06:24, and it is the only SNOWTAM issued for BIRK between 5:00 and 8:00 on October 28th, 2019:

Mon Oct 28 06:24:39 2019
ZTA091
FF BICCSNOA BICCSNOB BICCSNOC
280625 BIRKYNYX
SWBI1575 BIRK 10280610
(SNOWTAM 1575
A) BIRK
B) 10280610 C) 01 F) 3/3/3 G) XX/XX/X H) 3/3/3 N) 3
B) 10280610 C) 13 F) 3/3/3 G) XX/XX/XX H) 3/3/3 N) 3
R) 3
S) 10281400
T) RWY 01 AND 13 CONTAMINATION 100 PERCENT RWY 01 SANDED
TWY AND APRON B/A POOR)

At 06:15, the BIRK Tower was manned by the AFIS operator.

At 06:16 the AFIS operator in the BIRK Tower called the Flight Data Specialist (FDS) on duty in the Reykjavik Area Control Center (ACC) for detailed information about the

scheduled Coastguard flight. The FDS provided the details of the Coastguard flight and then told the AFIS operator that there had been a runway excursion at Keflavik Airport, resulting in two aircraft diverting to Akureyri Airport and that he should expect aircraft diverting to Reykjavik Airport as well.

Subsequently, after the sanding operation was finished, Reykjavik Airport was opened at 06:30. The first flight of the day was the Coastguard flight that took off at 06:40.

Reykjavik Airport Operations runs on four duty shifts, each containing 3 persons, using the so-called 5-5-4 system. One of these persons on the duty shift, is a designated AFIS operator that can man the Tower with AFIS service outside the normal opening hours.

In addition, there is one person on standby shift and another available in case of significant snow days, which occurs 3-5 times a year. Over the winter months there are also 3 daytime workers along with the supervisor. So normally during the winter period, in total, there are 3-5 persons working in the evening and the nights (outside normal working hours) and 7-9 persons working during the daytime in the Reykjavik Airport Operation department. All of them have all the necessary experience and qualifications to operate all the necessary airport operation equipment. During the night of the incident, one person was missing from the duty shift, resulting in only 2 persons being on duty, as the supervisor had decided not to call out the standby shift person, as he had deemed it not necessary.

According to Isavia Regional Airports[13], situation can arise when only two Airport Operations persons are on duty at Reykjavik Airport during the closing hours. According to Isavia Regional Airports, this falls within the airport's CAT-3 category during the closing hours.

The investigation revealed that there was no mention of the CAT-3 categorization of the airport during closing hours in the Iceland AIP, in effect at the time of the serious incident. According to Iceland AIP BIRK AD 2.6, in effect at the time of the serious incident, BIRK AD category for rescue and firefighting was classified as CAT-6 and it could be upgraded to CAT-7 with 30–60-minute advance notice. When the Iceland AIP changed on 2. December 2022, the CAT-3 category rescue and firefighting during closing hours of Reykjavik Airport came into effect.

For the work in the morning of the serious incident, one sanding vehicle and one braking action measurement vehicle were used. There was another sanding vehicle and another

[13] Isavia Innanlandsflugvellir ehf, is a subsidiary of Isavia that operates the domestic airports in Iceland

braking action measurement vehicle available (two each in total), but as stated earlier there were only 2 persons on duty so they could not all be utilized simultaneously. All airport operation equipment was operational.

SIA-Iceland inquired how long it would take in general to clear a runway and measure the braking action after an unplanned request for landing from an aircraft that needed to divert to BIRK outside the airport's opening hours.

According to Reykjavik Airport management, it takes 20 minutes if snow needs to be cleared from the active runway. If there is only frost and slippery conditions, this takes less than 20 minutes.

On the day of this serious incident, it took 24 minutes, from the call of the FDS to the BIRK AFIS at 06:06 until the opening of the airport at 06:30. SIA-Iceland determined that this was most likely due to only two persons being on duty, one of whom assumed the role of AFIS.

It should also be noted that no snow removal operation had to be performed at the day of the serious incident, only sanding operation.

2.2.3. Akureyri Airport

In general, ATC service is provided at Akureyri Airport (BIAR) between 07:00 and 23:00[14].

At the time of the serious incident, Akureyri Airport was registered as CAT-6 for rescue and firefighting and could be upgraded to CAT-7 with 10 minutes prior notice. The CAT-6 and CAT-7 requirements are based on ICAO Annex 14, chapter 9.2 Rescue, and firefighting.

- At 06:05, when the flight crew of flight ICEAIR 680 initially became aware of the runway excursion at Keflavik Airport, there were still 55 minutes until Akureyri Airport was scheduled to open
- At 06:08, when the flight crew of the aircraft ahead of flight ICEAIR 680 on the approach was informed by Keflavik Approach that RWY 10 at Keflavik Airport was not available, there were still 52 minutes until BIAR was scheduled to open
- At 06:09 two aircraft (flight ICEAIR 622 and flight ICEAIR 2B) that had Akureyri Airport registered as an alternate airport in their flight plan, that were holding at SOPAR along with flight ICEAIR 680, diverted to Akureyri Airport

[14] Open between 07:00 and 16:00 on Christmas Eve and New Year's Eve and closed on New Year's Day, Easter Sunday, and Christmas Day

At the time of the serious incident, according to the Iceland AIP AD 2.3, AFIS and ATC service was available[15] outside the normal opening hours, with 30 minutes prior notice between 1. May and 30. September and 45 minutes prior notice between 1. October and 30. April.

According to an agreement between Isavia and the Ministry of Infrastructure, in the case of Akureyri Airport, the response time to make the airport operational shall never exceed 1 hour and standby shift is required for the airport.

Normally, Akureyri Airport Operations starts its work to prepare the airport for the daily traffic early in the morning. At the day of the serious incident, SNOWTAM was issued for BIAR at 05:51.

> Mon Oct 28 05:51:20 2019
> ZTB059
> FF BICCSNOA BICCSNOB BICCSNOC
> 280551 BIRKYNYX
> SWBI1573 BIAR 10280600
> (SNOWTAM 1573
> A) BIAR
> B) 10280600 C) 01 F) 4/4/4 G) 00/00/00 H) 5/5/5
> S) 28101400)

At Akureyri Airport, during slippery conditions, the runways, taxiways, and aprons are sanded to improve the surface conditions. Runway de-icing fluids are not used at BIAR.

In general clearing of runways starts at 06:00 at BIAR. This morning it was however not necessary to clear the runways as it had been cleared the day before and no precipitation had fallen overnight.

During the night there was one person on duty at Akureyri Airport Operations department and one AFIS operator on duty in the tower. The AFIS operator in the tower is also trained as Airport Operations person and has therefore the necessary training and qualification for fire- and rescue services. Both of them have all the necessary experience and qualification to operate all the necessary airport operation equipment.

At 06:00 three persons arrived for daytime work duty at the Airport Operations, replacing the nighttime duty person.

After the two aircraft diverted to BIAR at 06:09, the AFIS operator in the tower called in an Air Traffic Controller Officer (ATCO), and the AFIS operator therefore became available for

[15] Surcharges apply

fire- and rescue service duty once the ATCO arrived. All airport operations equipment were operational but were not needed as the runway did not need to be cleared that morning.

The first braking action measurements at BIAR that morning was performed at 06:26 for RWY 01. The braking action was measured 82-80-80.

The first landing at BIAR on this day was at 06:44, when flight ICEAIR 622 landed at RWY 19 (diverted from BIKF). The first takeoff from BIAR on this day was at 08:25, when flight ICEAIR 622 took off from RWY 19.

SIA-Iceland inquired how long it would take to clear a runway and measure its braking action after an unplanned request for landing from an aircraft that needed to divert to BIAR outside the airport's opening hours.

According to Akureyri Airport management, the airport is to be opened within 45 minutes during winter period (1. October to 30. April) and within 30 minutes during summer period (1. May to 30. September). Experience has however revealed that this can often take less time.

2.2.4. Egilsstaðir Airport

In general, AFIS service is provided at Egilsstaðir Airport (BIEG) between 07:00 and 23:00[16].

At the time of the serious incident, Egilsstaðir Airport was registered as CAT-5 for rescue and firefighting and could be upgraded to CAT-7 with 10 minutes prior notice. The CAT-5 and CAT-7 requirements are based on ICAO Annex 14, chapter 9.2 Rescue, and firefighting.

- At 06:05, when the flight crew of flight ICEAIR 680 initially became aware of the runway excursion at Keflavik Airport, there were still 55 minutes until Egilsstaðir Airport was scheduled to open
- At 06:08, when the flight crew of the aircraft ahead of flight ICEAIR 680 on the approach was informed by Keflavik Approach that RWY 10 at Keflavik Airport was not available, there were still 52 minutes until Egilsstaðir Airport was scheduled to open
- No aircraft diverted to Egilsstaðir Airport in the morning of the serious incident

[16] Open between 07:00 and 16:00 on Christmas Eve and New Year's Eve and closed on New Year's Day, Easter Sunday, and Christmas Day

At the time of the serious incident, according to the Iceland AIP AD 2.3, AFIS service was available[17] outside the normal opening hours, with 15 minutes prior notice between 1. May and 30. September and 30 minutes prior notice between 1. October and 30. April.

According to an agreement between Isavia and the Ministry of Infrastructure, in the case of Egilsstaðir Airport, the response time to make the airport operational shall never exceed 1 hour and standby shift is required for the airport.

Regardless of AFIS service not being provided between 23:00 and 07:00, Egilsstaðir Airport Operations starts its work to prepare the airport for opening earlier. SNOWTAM was issued for BIEG at 05:57.

> Mon Oct 28 05:57:36 2019
> ZTB087
> FF BICCSNOA BICCSNOB BICCSNOC
> 280558 BIRKYNYX
> SWBI1574 BIEG 10280600
> (SNOWTAM 1574
> A) BIEG
> B) 10280600 C) 04 F) NIL/NIL/NIL N) NIL
> R) NIL
> S) 10281400)

At Egilsstaðir Airport, during slippery conditions, the runways, taxiways, and aprons are sanded to improve the surface conditions. Runway de-icing fluids are not used at BIEG.

In general clearing of runways starts at 07:00 at BIEG, but if required it would start earlier. This morning it was not necessary to clear the runways.

During the night of the serious incident, as well as at during other nights, there was one person on duty at Egilsstaðir Airport Operations and one AFIS operator on duty in the tower. If it was previously known that an aircraft intended to land during nighttime, additional staff was always called on duty. All airport operation equipment was operational but not needed as the runway did not need to be cleared that morning.

No braking action measurements were performed at BIEG that morning, as the runways were clear and no slippery conditions.

According to Egilsstaðir Airport management, in general it takes 20 minutes to clear the runways during winter.

[17] Surcharges apply

2.3. Air Traffic Control

Air Traffic Control for flight ICEAIR 680 flying from Seattle to Keflavik, from once it entered the Air Navigation Services (ANS) of Isavia ANS[18] and until it landed, was divided into the following sections:

- The aircraft entered the WEST SECTOR of the Reykjavik Control Area (BIRD CTA) when flying above FL195 and through waypoint CANEL northwest of 68°N 060°W, west of the coast of Greenland
- The aircraft entered the SOUTH SECTOR of the Reykjavik Control Area (BIRD CTA) when flying above FL195 and through 66°N 030°W and the DOMESTIC AREA of the Reykjavik Control Area (BIRD CTA) when flying above FL245 and through waypoint INDES
- The aircraft entered the area controlled by Keflavik Approach at FAXI TMA below FL245
- The aircraft was changed over to Keflavik Tower below 3000 ft, during the final approach to Keflavik Airport

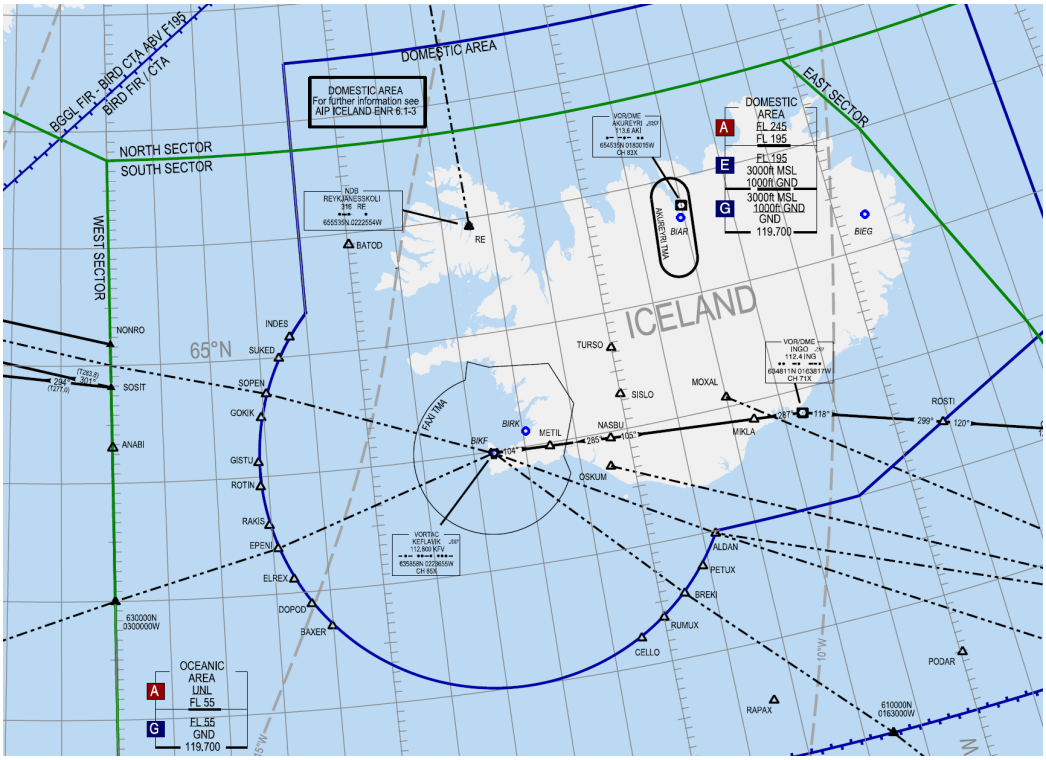


Figure 14: Part of the Reykjavik Control Area

[18] Isavia ANS, is a subsidiary of Isavia that operates the Icelandic Air Navigation Services

2.3.1. Reykjavik Area Control Center (ACC) - Oceanic

At 05:33, when the aircraft reached its second last fuel check point, located at 66°N 030°W, the flight crew noticed that the aircraft fuel burn during the flight had exceeded the flight plan by over 0.7 tons.

At 05:40, the flight crew discussed amongst themselves that they were 10 minutes behind schedule, while crossing Oceanic.

At 05:43, the flight crew contacted Reykjavik Control, requesting to route direct to waypoint RENDU. Reykjavik Control replied that it was unable [to grant the request] “at the moment”, due to traffic.

At 05:52, the flight crew discussed that the aircraft had difficulty keeping the descent profile, as it was 1500 feet below the profile, regardless of the PF having increased the power. The flight crew also discussed that the wind was changing from westerly wind to northernly wind.

At 05:56, the flight crew contacted Reykjavik Control and repeated its request to route direct to RENDU. Reykjavik Control advised that they were working on it, to expect direct shortly, and to stand by.

At 05:58, Reykjavik Control contacted the flight crew and advised them to contact Keflavik Approach at 119.3 mHz and that Keflavik Approach would clear them direct to RENDU as soon as possible.

2.3.2. Keflavik Approach

In the early morning on the day of the serious incident, there was one ATCO in Keflavik Approach taking care of the FAXI TMA. According to the ATCO, he considered the workload medium.

According to Isavia, aircraft N812AM received a braking action measurement of 35-44-59 for RWY 01 at Keflavik Airport from Keflavik Approach at 05:29. These were reversed values of the braking action measurements for RWY 19 from 05:24.

At 05:36, the ATCO in Keflavik Tower contacted the ATCO in Keflavik Approach to inform that the latest braking measurement was available on screen. This was a braking action measurement of 38-47-53 for RWY 01.

When an ATCO in the Keflavik Tower enters the braking action numbers onto his weather screen for Keflavik Airport, they simultaneously appear on the weather screen for Keflavik Airport which is located at the Keflavik Approach Controller station.

At 05:58, the flight crew of flight ICEAIR 680 contacted Keflavik Approach and advised that they were descending through FL100. The ATCO in Keflavik Approach replied with a clearance to descend to 4000 [feet] and to proceed direct to RENDU, with QNH of 1034 [hPa].

At 06:02, the flight crew contacted Keflavik Approach requesting speed below FL100. Keflavik Approach replied: *"260 [knots] maximum below FL100."*

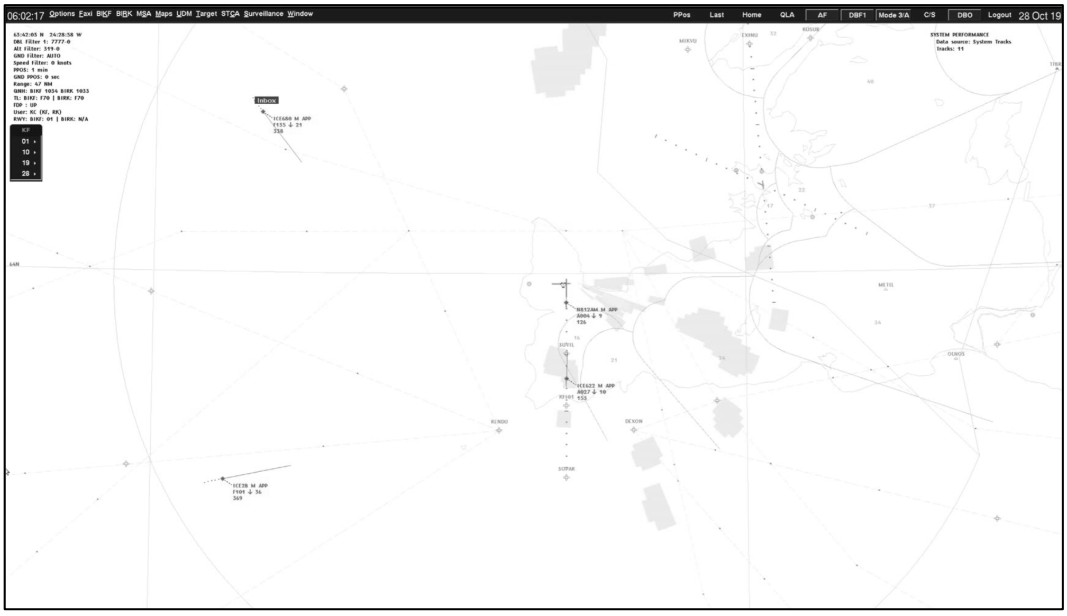


Figure 15: Picture of the radar screen in FAXI at 06:02:17

The flight crew of flight ICEAIR 680 then discussed amongst themselves that the remaining fuel was 3.6 tons.

At 06:04, aircraft N812AM incurred a runway excursion at RWY 01 at Keflavik Airport.

At 06:05, Keflavik Tower called Keflavik Approach to inform that aircraft N812AM had incurred a runway excursion, as well as informing that flight ICEAIR 622 was performing a go-around and the other aircraft on the approach needed to enter holding.

At 06:05, Keflavik Approach contacted flight ICEAIR 2B and instructed them to proceed to, and hold at, waypoint SOPAR at 5000 feet as runway excursion had occurred at the active runway of the airport. The flight crew of flight ICEAIR 2B read back the holding clearance.

At his time ICEAIR 680 was at 8000 feet, about 20 NM from Keflavik Airport.

At 06:06, Keflavik Approach contacted the flight crew of flight ICEAIR 680 with instructions to proceed to, and hold at, waypoint SOPAR at 6000 feet. The flight crew read back the instructions and started preparing for the holding.

At 06:07, the Commander (PF) of flight ICEAIR 680 noted to his First Officer that they did not have much fuel for this.

At 06:07 the flight crew of flight ICEAIR 622 contacted Keflavik Approach stating RWY heading [at an altitude of] 3000 [after the go-around]. Keflavik Approach instructed flight ICEAIR 622 to climb to 4000 feet and to initiate left turn direct to SOPAR. The flight crew read back the instructions.

At 06:08, another ATCO replaced the ATCO working the Keflavik Approach position. The replaced ATCO did however stay with and support the replacement ATCO, until flight ICEAIR 680 had landed. According to the replacement ATCO, he considered the workload high.

Then, also at 06:08, the flight crew of flight ICEAIR 622 contacted Keflavik Approach to inquire into the status of RWY 10. Keflavik Approach replied that RWY 10 was not useable, as the last braking measurement there had been less than 18. The flight crew of flight ICEAIR 622 replied that they would need to decide within 2-3 minutes whether to divert, but they had Akureyri as an alternate [airport]. The Approach ATCO requested that they notify him when they wanted to divert.

At 06:09, the Commander and the First Officer of flight ICEAIR 680 discussed among themselves that the minimum diversion fuel for Reykjavik Airport (BIRK), was 2.7 tons and that they needed updated weather for Reykjavik Airport (BIRK).

At 06:09, the flight crew of flight ICEAIR 622 and ICEAIR 2B contacted Keflavik Approach and requested and were granted a clearance to divert to BIAR.

At 06:10, the First Officer of flight ICEAIR 680 had reviewed their available weather data and confirmed that the weather in Reykjavik was fine, but they needed information on the braking action. They also discussed among themselves that if the braking action in Reykjavik was insufficient, they would be forced to land at Keflavik Airport.

Subsequently, at 06:10:35, the flight crew of flight ICEAIR 680 contacted Keflavik Approach and requested the latest braking action at Reykjavik Airport. Keflavik Approach told them to stand by.

At 06:10:47, Keflavik Approach contacted the flight crew of flight ICEAIR 680 stating that there was no one in Reykjavik Tower, that they could expect the braking action for Reykjavik in half an hour and that someone would be in Reykjavik Tower in 10 minutes.

The Commander of flight ICEAIR 680 stated to his First Officer that they did not have that time and that Keflavik Airport was then their only option. From the discussion on the flight deck of flight ICEAIR 680, SIA-Iceland determined that the flight crew was aware that they did not have enough fuel for their alternate airport (BIRK) based on this information, to expect braking action in half an hour.

According to the Approach ATCO he estimated that 30 minutes to be a reasonable estimate at night when Reykjavik Airport was closed to prepare the runway (sanding and performing braking action measurements), as he was unaware that Reykjavik Airport was being prepared to be operational this morning due to a Coast Guard flight.

According to Iceland AIP, Reykjavik Tower AFIS service is available[19] outside normal opening hours within 15 minutes. The investigation did however reveal that it took 24 minutes to open the runway for use at Reykjavik Airport this morning after the notification of the Coast Guard flight.

[19] For an international flight that has BIRK filed as an alternate airport, such as flight ICEAIR 680

The response time it takes to service an aircraft, from the time it requests opening of Reykjavik Airport until it has landed, will depend on the airport condition, including the runway condition, at the time.

Neither the ATCO in the Keflavik Approach position, nor the ATCO that he had relieved at 06:08, had asked for the runway condition at Reykjavik Airport, regardless of the flight crew of flight ICEAIR 680 contacting Keflavik Approach at 06:10:35 and requesting the latest braking action at Reykjavik Airport. Both ATCOs believed Reykjavik Airport to be closed and they were both unaware that braking action had been measured at BIRK at 05:49 and 06:03.

Both ATCOs in Keflavik Approach were also unaware that the Flight Data Specialist (FDS) on duty in the Reykjavik Area Control Center (ACC) had called the designated AFIS operator on duty at Reykjavik Airport Operations at 06:06 to advise that the Icelandic Coast Guard had just filed a flight plan from BIRK with a departure at 06:30.

At 06:10 when the above communications took place between Keflavik Approach and flight ICEAIR 680, the investigation revealed that braking action measurements taken at 05:49 and 06:03 for RWY 01 at Reykjavik Airport had not been updated automatically on the weather screen for Reykjavik Airport located at the Keflavik Approach Controller station, as they did for the braking measurements taken at Keflavik Airport.

SIA-Iceland determined this was because only ATCO's, not AFIS operator, in the BIRK tower update the weather screens with braking action numbers. Reykjavik Tower was only manned with an AFIS operator between 06:15 and 07:00. It was not until the scheduled opening of Reykjavik Airport at 07:00 that it was manned with an ATCO.

As of Autumn 2021, the airport operations persons on all international airports and domestic airports with scheduled flights in Iceland will issue Surface Condition Code and issue SNOWTAMs in case more than 10% of any 1/3 of the runway is covered with contaminant(s), or when the runway is wet during winter conditions. The SNOWTAMs are published in various locations on the internet, including on the Isavia official webpage:

https://www.isavia.is/fyrirtaekid/c-forflugsupplysingar/snowtam

During Reykjavik Airport opening hours, the Surface Condition Code and the published SNOWTAMs are also broadcasted on ATIS and appear on the Keflavik and Reykjavik Approach Control weather screens. Finally, Approach Control also has access to the issued SNOWTAMs on the following Isavia webpage for airport weather:

https://iws.isavia.is/

At 06:11, the flight crew replied to Keflavik Approach:

"Ok, we do not have fuel for that, so Keflavik is the only option."

This is the first time that ATC was made aware that flight crew of flight ICEAIR 680 had fuel concerns.

In Isavia MANOPS it states that when an aircraft is low on fuel it should be given an emergency handling. The ATCO does therefore not have to wait for the aircraft to declare emergency.

Per Isavia ANS, MANOPS: Part 6 – Emergencies, Attachment 1 Assist checklists for emergency or unusual situations, checklist J Fuel problems – Critical Fuel Status (E) may result in:

- Engine failure (multi engine aircraft)
- Engine failure (single engine aircraft)
- Diversionary or forced landing

ATC should be aware of communications problem through improper use of phraseology. Actual fuel should be verified using appropriate terms "minimum diversion fuel", "minimum fuel" or "low on fuel".

PAN PAN minimum fuel ACFT needs priority handling
MAYDAY FUEL with imminent danger to ACFT
Improper use of phraseology, verify actual fuel status!! (low on..., minimum... or minimum diversion fuel).
*Remember: **A** 'Acknowledge' - **S** 'Separate' - **S** 'Silence' - **I** 'Inform' - **S** 'Support - **T** 'Time'*
Keep ACFT high (save fuel)
Avoid ATC-caused GO AROUND
Inform landing aerodrome Inform the pilot of any anticipated delays or that no delays are expected
Ask if dangerous goods on board
Ask for number of Persons On Board (POB)
Clear RWY according to local instructions
Keep safety strip clear
Towing equipment on standby as appropriate.
If needed, inform pilot about: Next suitable aerodrome
Aerodrome details as soon as possible
WX information at landing aerodrome.
-Inform supervisor

The investigation revealed that the Approach ATCO did not refer to emergency checklist J, for Fuel Problems – Critical Fuel Status, as the workload was high, and he was busy with other tasks.

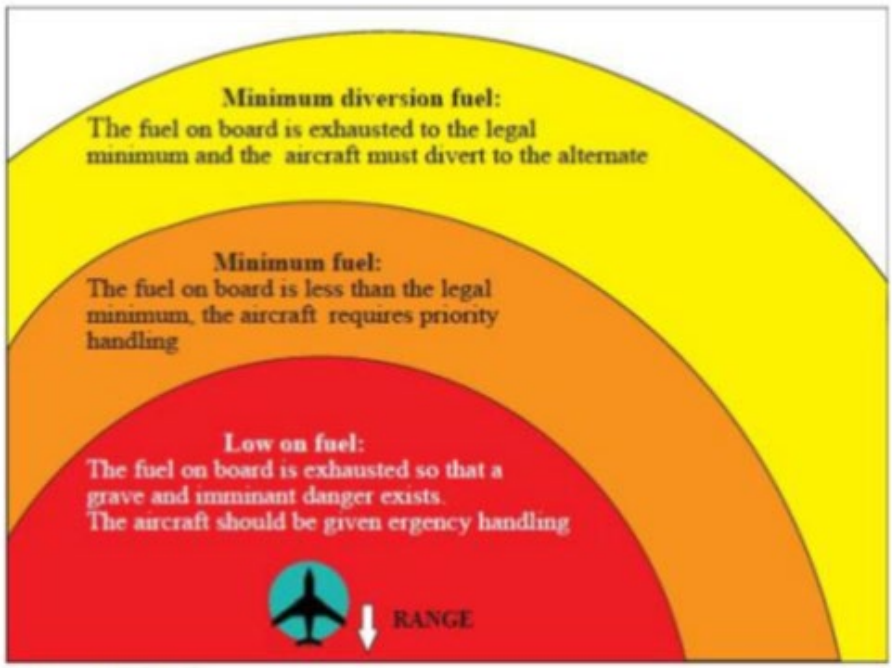


Figure 16: Phraseology of fuel status from checklist J Fuel Problems

At 06:11, the Commander of flight ICEAIR 680 stated to his First Officer that they would not be able to go to Akureyri Airport with their remaining fuel of 3.3 [tons]. The First Officer concurred. The flight crew discussed how long they could continue the holding. The aircraft was consuming 3 tons of fuel per hour. With less than 3.3 tons of remaining fuel and a minimum diversion fuel just under 2.7 tons they had approximately 600 kg of fuel available before they had to commit to either Keflavik or Reykjavik.

Subsequently, at 06:11:21, the Keflavik Approach ATCO contacted the Keflavik Tower ATCO to advice that two aircraft, flight ICEAIR 622 and ICEAIR 2B, were diverting to Akureyri. The Approach ATCO also informed that flight ICEAIR 680 only had fuel for either Reykjavik or Keflavik, they were holding, and asking about the condition of RWY 10 and how long it would take to get it operational. The Tower ATCO replied that it would take longer than removing the aircraft [N812AM] from the runway and that a tow truck was already on the way to remove the aircraft.

SIA-Iceland noted during this communication Keflavik Approach ATCO stated to Keflavik Tower ATCO that ICEAIR 680 only had fuel for either Keflavik or Reykjavik, regardless of the flight crew of flight ICEAIR 680 already having stated that Keflavik was their only option.

At 06:11:59, Keflavik Approach contacted the flight crew of flight ICEAIR 680 and informed them that nothing had been found damaged on the aircraft that incurred the runway excursion and that a tow truck was on its way to the runway. The flight crew subsequently inquired if the aircraft excursion had occurred at taxiway N, which Keflavik Approach replied to that it was their understanding.

At 06:12:39, the Commander of flight ICEAIR 680 advised Keflavik Approach that they would have to commit to Keflavik Airport as they did not have the braking action at Reykjavik Airport.

Keflavik Approach replied that hopefully they would receive the braking measurements as soon as possible, but this [clearing the RWY excursion aircraft from RWY 01] should not take as long as getting the information from Reykjavik [Airport].

The Commander replied understood, but then added that they could not hold for half an hour, not even close. Keflavik Approach replied that it was copied.

The flight crew discussed amongst themselves the fuel status and concurred that they could hold for another 5-6 minutes.

At 06:14 Keflavik Approach contacted Keflavik Tower to inform that flight ICEAIR 680 was committed to land at Keflavik Airport, as he did not have the fuel to wait for braking action numbers from Reykjavik Airport. The Approach ATCO also informed that flight ICEAIR 680 could not wait for half an hour. The two ATCOs discussed this and that this could become an emergency landing on the runway, short runway.

At 06:15, the flight crew of flight ICEAIR 680 contacted Keflavik Approach with the following information:

> *"We are.. after this holding, we are going to have to proceed inbound for RWY 01."*

Keflavik Approach replied:

> *"ICEAIR 680, confirm declaring an emergency."*

The flight crew discussed the reply from Keflavik Approach before replying:

> *"Not a matter at this time, but we have minimum fuel."*

According to ICAO Annex 6 and PANS ATM Doc. 4444:

> ***Minimum fuel.*** *The term used to describe a situation in which an aircraft's fuel supply has reached a state where the flight is committed to land at a specific aerodrome and no additional delay can be accepted.*

SIA-Iceland determined that this was the second time that ATC was made aware of that flight ICEAIR 680 had limited fuel and needed to land.

At 06:16, Keflavik Approach replied:

> *"Ok. Can you accept to land on a runway that is occupied by vehicles?"*

The flight crew discussed the reply from Keflavik Approach before replying:

> *"Where is the vehicle. Is it at the end of the runway?"*

Keflavik Approach replied:

> *"Stand by, I will get a confirmation."*

Subsequently, at 06:16, the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower and advised that flight ICEAIR 680 had stated that after the current holding, they would be proceeding inbound for RWY 01 at Keflavik Airport, with the intention to land. The Approach ATCO also advised the Tower ATCO that he had been pressing the flight crew of flight ICEAIR 680 to notify if it was an emergency or not. The Approach ATCO then inquired the Tower ATCO where the vehicles were located on the runway. The Tower ATCO advised that a braking measurement vehicle (Snowking) was currently on the runway, driving south and measuring the runway braking action, but other than that there were vehicles next to the aircraft at the far end of RWY 01, as the aircraft skidded off the runway as it was about to exit at taxiway N-4.

The flight crew of flight ICEAIR 680 discussed amongst themselves that they had no option, as they did not have the braking action at Reykjavik [Airport] and that their remaining fuel was almost down to 3.0 tons.

At 06:17:37, Keflavik Approach contacted the flight crew of flight ICEAIR 680:

> *"ICEAIR 680, descend altitude 3000, QNH 1034."*

The flight crew of flight ICEAIR 680 replied:

"ICEAIR 680, Are we cleared for the approach?"

At 06:17:48, Keflavik Approach replied:

"680, at your discretion you can get a clearance for the approach, but at the moment we have vehicles on the runway, on the far end, aircraft is run off the runway, still on the runway though and vehicles tending to it."

The flight crew of flight ICEAIR 680 replied:

"Ok, thank you. Cleared for descent 3000, QNH 1034, ICEAIR 680."

The flight crew set up the aircraft accordingly and initiated the descent.

While the above communications took place between the flight crew of flight ICEAIR 680 and the Approach ATCO, at 06:17, a call took place between the AFIS operator in the BIRK Tower and the Approach support ATCO. The Approach support ATCO was the ATCO that had been in the Approach position prior to 06:08 but stayed to support his replacement ATCO. During this communication the AFIS operator in the BIRK tower provided a braking action measurement of 30-32-34 for BIRK RWY 01, also stating it had been taken about 10 minutes earlier[20].

It was not until this time (06:17) that Keflavik Approach became aware of the already measured braking action from 06:03 for RWY 01 at Reykjavik Airport, although their values were slightly altered[21] due to miscommunication.

At 06:18:30, Keflavik Approach contacted the flight crew:

"ICEAIR 680, I have the braking action at Reykjavik 30-32-34 Runway 01."

This was less than 8 minutes after Keflavik Approach had previously advised it would take half an hour to get the braking action. This was also 15 minutes after the braking action was measured at Reykjavik Airport.

The flight crew requested the braking action at Reykjavik [Airport] again, which Keflavik Approach repeated, and the flight crew confirmed.

[20] It had actually been taken 14 minutes earlier at 06:03
[21] Stated braking action of 30-32-34, while the correctly measured values for RWY 01 at Reykjavik Airport at 06:03 were 31-34-36

The flight crew of flight ICEAIR 680 had not been able to perform any landing performance calculations for Reykjavik Airport until this time, as they had been lacking the runway braking action measurements.

According to the Commander, for the 1500 meter long runway at BIRK, the braking action was not good enough.

The investigation determined that at this point the flight crew was already descending to 3000 feet, preparing to start the approach, and committed to land at Keflavik Airport.

At 06:18:46, Keflavik Approach contacted the flight crew again:

"..and confirm that you are inbound for RWY 01 at Keflavik."

The flight crew replied:

"Affirm, ICEAIR 680."

At 06:18:52, Keflavik Approach contacted the flight crew again:

"680 at your discretion you are cleared for the approach."

The flight crew replied:

"At our discretion, cleared for the approach."

The investigation determined that per the MANOPS procedures[22], the Approach ATCO could have given flight ICEAIR 680 approach clearance for occupied runway due to critical fuel status as the flight crew of flight ICEAIR 680 had already declared minimum fuel.

According to Isavia, the Keflavik Approach ACTO added the phrase "at your discretion" as the Keflavik Tower ATCO stated that he could not give flight ICEAIR 680 landing clearance on an occupied runway. The SIA-Iceland investigation did however reveal that the Keflavik Tower ATCO had not made this statement up to this point.

At 06:18:58 the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower and advised that flight ICEAIR 680 was inbound and would be landing. The ATCO in Keflavik Tower noted that flight ICEAIR 680 would be landing and started to inquire further when

[22] MANOPS: Part 6 – Emergencies, Attachment 1 Assist checklists for emergency or unusual situations, checklist J Fuel problems

the ATCO in Keflavik Approach cut him off and informed that he was unable to get the flight crew of flight ICEAIR 680 to declare emergency, regardless of having pressed for it. The ATCO in Keflavik Tower noted this. The Keflavik Approach ATCO then requested that the Keflavik Tower ATCO require everyone to leave the runway, as well as informing the Tower ATCO that flight ICEAIR 680 was aware of the vehicles and the aircraft at the far end of RWY 01. The Approach ATCO also informed the Tower ATCO that he had not advised flight ICEAIR 680 of the braking measurement vehicle on RWY 01, as they could always contact that vehicle to require it to leave the runway in time. The two ATCOs discussed the inbound flight ICEAIR 680 and what kind of clearance to provide it with. The ATCO in Keflavik Approach recommended not providing him with landing clearance, but instead with "land at your discretion" and information about the aircraft on the runway. The Keflavik Tower ATCO then informed the Keflavik Approach ATCO that they were not willing to do this, with the aircraft still on the runway.

The flight crew of flight 680 discussed they were almost down to minimum diversion fuel [2.7 tons] and that they had not had the time to calculate the landing distance at Reykjavik Airport using the newly acquired braking measurements at Reykjavik Airport. They agreed that landing at RWY 01 at Keflavik Airport, under the current conditions, was their best option.

At 06:20:17, Keflavik Approach contacted the flight crew again:

> *"ICEAIR 680, the tower is not willing to give you a landing clearance. Runway is occupied. We need an emergency declared and then land at your discretion."*

At 06:20:33, the Commander replied:

> *"MAYDAY-MAYDAY-MAYDAY, ICEAIR 680, we are proceeding inbound for RWY 01."*

When flight ICEAIR 680 declared emergency, its remaining fuel was 2.8 tons.

Keflavik Approach replied:

> *"ICEAIR 680, roger that, continue."*

The flight crew squawked 7700 and continued the approach.

At 06:20:44 the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower and advised that flight ICEAIR 680 had declared emergency with the intention to land. The

ATCO in Keflavik Tower acknowledged this information and the two ATCOs also discussed that the flight had just squawked 7700. The Keflavik Tower ATCO acknowledged that flight ICEAIR 680 would be transferring over to the tower.

At 06:21:13 UTC, Keflavik Approach contacted the flight crew again:

"ICEAIR 680, for braking action contact tower 18.3."

At 06:22:58 the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower and advised that Approach had notified flight ICEAIR 680 to contact Keflavik Tower for braking action numbers. The Approach ATCO also advised Keflavik Tower not to provide flight ICEAIR 680 with landing clearance. The Tower ATCO concurred.

Flight ICEAIR 680 transferred over to the tower frequency and subsequently landed at 06:27.

At 06:33:17 the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower to inquire if they would try to get RWY 10 operational. The Tower ATCO advised that they were not deicing RWY 10 as all the manpower was helping with the aircraft [that had incurred a runway excursion].

At 06:38:49 the ATCO in Keflavik Tower contacted the ATCO in Keflavik Approach to advice that Snowking had stated that it would take some time to get RWY 10 operational. Snowking had stated that his staff was concentrating on getting the aircraft [N812AM] off the runway. The aircraft was undamaged, but it was taking some time to remove it due to very slippery conditions at its location.

At 06:56:57 the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower to inform that flight ICEAIR 771 was turning inbound. The Tower ATCO also advised that he could see from the tower that they were towing aircraft N812AM off the runway.

2.3.3. Reykjavik Area Control Center (ACC) - FDS

As noted in Iceland AIP AD 1.2.2.4, close coordination is between aerodrome operator and the Air Traffic Service provider to ensure compatibility between efficient snow clearance procedures and maximum utilization of the aerodrome.

At 06:06 the Flight Data Specialist (FDS) on duty in the Reykjavik Area Control Center (ACC) called the designated AFIS operator on duty at Reykjavik Airport Operations to advise that the Icelandic Coast Guard had just filed a flight plan from BIRK with a departure

at 06:30. The designated AFIS operator advised that he was currently located in a sanding vehicle and would be in the tower in about 5 minutes.

At 06:10 the Flight Data Specialist called the AFIS operator on duty in the Tower at Akureyri Airport to notify that flight ICEAIR 622 was diverting to Akureyri Airport and to inquire how much space was available at Akureyri Airport for Boeing 757 aircraft. The AFIS operator stated he was not sure, needed to check, but believed they would be able to fit four Boeing 757 aircraft at the airport. The FDS replied that there might be three Boeing 757 aircraft diverting to Akureyri and asked for confirmation that they could fit four Boeing 757 aircraft. The AFIS operator replied he was going to check on it for confirmation and would then reply.

The investigation revealed that the Flight Data Specialist on duty in the Reykjavik Area Control Center was not aware that the flight crew of flight 680 had requested the latest braking action at Reykjavik Airport from Keflavik Approach at 06:10 and that Keflavik Approach had responded that it would take 10 minutes to man the tower and 30 minutes to get the braking action numbers.

At 06:14 the single person left on rescue and firefighting duty at the Reykjavik Airport Operations called the Flight Data Specialist on duty in the Reykjavik Area Control Center (ACC) to notify that he was sending a SNOWTAM for BIRK.

As noted in Iceland AIP AD 1.2.2.7, information on surface conditions for BIRK, BIAR and BIEG is transmitted with SNOWTAM. It will therefore remain the responsibility of the pilot-in-command or operator to obtain the necessary information before take-off or landing at such aerodromes.

At 06:15 the Flight Data Specialist on duty in the Reykjavik Area Control Center called the AFIS operator on duty in the Tower at Akureyri Airport to notify of two aircraft that were diverting to Akureyri and to inquire if they had started working on the runway. The AFIS operator replied that the runway was ready. They also discussed that an ATCO was being called in for Akureyri Tower and that braking measurement was underway.

At 06:16 the AFIS operator in the Reykjavik Tower called the Flight Data Specialist (FDS) on duty in the Reykjavik Area Control Center (ACC) for detailed information regarding the upcoming Coastguard flight. The FDS provided the details of the Coastguard flight and then told the AFIS operator that there had been a runway excursion at Keflavik Airport, resulting in two aircraft diverting to Akureyri Airport and that he should expect aircraft diverting to Reykjavik Airport as well.

At 06:17 the flight operator's flight dispatch contacted the FDS in the ACC advising that he had been trying to contact Akureyri Airport, due to flight ICEAIR 622 that was diverting, but they were not answering. The FDS informed the flight operator that the ACC had already notified Akureyri Airport of the diverting aircraft and they had informed that the runway was ready and runway braking action measurements were underway.

At 06:18 the FDS called the AFIS operator in Akureyri Tower to re-emphasize that an ATCO should be called in for Akureyri Tower. The AFIS operator advised that the ATCO was already being called in, that the runway braking measurement was being performed as well as confirming that they had space for four Boeing 757 airplanes at Akureyri Airport.

At 06:21 the Flight Data Specialist (FDS) on duty in the Reykjavik Area Control Center (ACC) called the single person left on rescue and firefighting duty at the Reykjavik Airport Operations to inform that it would be possible that aircraft would be diverting from Keflavik Airport to Reykjavik Airport and to request the latest braking action measurement. The person on rescue and firefighting duty informed that he was sanding the runway and would subsequently perform braking action measurement.

At 06:32 the AFIS operator at Egilsstaðir Airport contacted the Flight Data Specialist in the Reykjavik Area Control Center to advice that he had heard that two aircraft were diverting from Keflavik Airport to Akureyri Airport and one additional aircraft was around Keflavik and inquired if this was something that could affect Egilsstaðir Airport and if the runway was closed at Keflavik Airport. The FDS replied that a runway excursion had occurred at Keflavik Airport, they were working on removing the aircraft and there was insufficient braking condition on the other runways, resulting in the aircraft diversions. The FDS also advised not having information about the inbound aircraft for Keflavik Airport. The FDS then inquired about the runway conditions at Egilsstaðir Airport. The AFIS operator at Egilsstaðir Airport replied that the runway condition was GOOD, clean runway and clear skies. The FDS replied that they did not expect, at the moment, that they would be sending any aircraft to Egilsstaðir, but they would be giving them heads up if anything changed.

At 06:39 the FDS contacted the single person left on rescue and firefighting duty at Reykjavik Airport Operations to inquire about the latest braking action measurement at Reykjavik Airport. The person on rescue and firefighting duty replied that they had already submitted the braking action measurement, but then when he went to his computer to locate them, he was unsuccessful retrieving the data from the computer. He therefore called the AFIS operator in BIRK Tower to request the braking action measurements that he had previously provided to the AFIS operator. The AFIS operator replied 34-39-40,

which the person on rescue and firefighting duty relayed to the FDS. According to Isavia, the actual braking action measurement taken at RWY 01 at BIRK at 06:34 had the values 35-39-40.

2.3.4. Keflavik Tower

RWY 01 was in use at Keflavik Airport in the morning of the serious incident. The runway had been de-iced (chemically wet) multiple times through the night.

There were two Air Traffic Control Officers (ATCO) and one Air Traffic Control Assistant (ATCA) on duty in Keflavik Tower that morning.

Before aircraft N812AM was expected to land, there was one ATCO in Keflavik Tower controlling both the Tower (TWR) and Ground (GND). The other ATCO, who was also the Supervisor in the Tower, was not in position and was downstairs resting.

The ATCA was taking care of the DATA terminal in the Keflavik Tower.

The ATCO controlling the Tower (TWR) and Ground (GND) considered the workload low in the morning. After this serious incident, when looking back, he considered the workload high after flight ICEAIR 680 was expected to land.

RWY 10/28 was ice-covered and unusable as its latest braking action measurement of 25-18-14, taken at 03:54, was POOR braking action.

At 05:33 an updated braking action measurement for RWY 01 at Keflavik Airport was 38-47-53. This was MEDIUM to GOOD braking action on the first third of the runway and then GOOD braking action for the remainder of the runway.

At 06:04 aircraft N812AM incurred a runway excursion at the far end of RWY 01.

At 06:04:42 Keflavik Tower cleared flight ICEAIR 622 to land on RWY 01, with instructions to roll out to the far end after landing and provided wind information 360°/5 knots. The flight crew of flight ICEAIR 622 read back the instructions.

According to the Keflavik Tower ATCO, he thought N812AM had vacated the runway via taxiway N-4. He stated having difficulties seeing N812AM due to darkness and the amount of lights at that position and with the Terminal in the background.

At 06:04:46 the flight crew of aircraft N812AM notified Keflavik Tower that they were at the end of the runway and would require a push back. Keflavik Tower noted this and told the flight crew of aircraft N812AM to stand by.

The ATCO realized that aircraft N812AM had gone off the runway, at the far end.

At 06:04:51 Keflavik Tower contacted the flight crew of flight ICEAIR 622 and instructed them to pull up and perform a go-around, as there was aircraft on the runway at the far end.

At 06:05:03 the flight crew of aircraft N812AM contacted the Tower and explained that they had gone off the runway end but were still [partially] on the runway.

The runway excursion closed the active RWY 01 at Keflavik Airport, as well as effectively closing Keflavik Airport for landing as RWY 10 had not been maintained during the night and its latest braking action measurement from 03:54 was 25-18-14.

At 06:05:16 UTC, Keflavik Tower called Keflavik Approach to inform that aircraft N812AM incurred a runway excursion, as well as flight ICEAIR 622 was performing a go-around and the other aircraft on the approach needed to enter holding.

At 06:05:33 the flight crew of flight ICEAIR 622 contacted Keflavik Tower to inform that they were on missed approach. Keflavik Tower affirmed the information and instructed the flight crew of flight ICEAIR 622 to contact Keflavik Approach.

At 06:05:37 the Tower ATCO contacted the Snowking to advice that the aircraft that just landed [N812AM] went off the runway and needed assistance. The Snowking advised being located at taxiway N 4 and confirming that the aircraft [N812AM] went off the runway end [runway excursion].

At 06:06:08 Keflavik Tower contacted the flight crew of aircraft N812AM to inform that they were getting a tow truck to tow them off the runway.

At 06:06:09 Keflavik Tower ATC Assistant (ATCA) contacted South Air to inform that aircraft N812AM needed a tow truck as it incurred a runway excursion at RWY 01.

At 06:07:01 the Tower ATCO contacted Keflavik Approach to advice that South Air, the handler of aircraft N812AM, was preparing a tow truck to remove the aircraft from the runway. The Approach ATCO inquired how long this would take and the Tower ATCO stated not knowing that. They briefly discussed the runway excursion.

At 06:08:35 South Air contacted the Tower ATCO to inquire where the runway excursion had occurred. The Tower ATCO stated it being at the RWY 19 end, between taxiways N-4 and N-3. South Air stated that they were still working on preparing the tug.

The investigation revealed that neither the ATCA nor the ATCO inquired South Air into how long it would take to get the tow truck ready, to drive it to the location of aircraft N812AM and to remove aircraft N812AM off the runway.

At 06:11:21 the Approach ATCO contacted the Tower ATCO to advice that two aircraft, flight ICEAIR 622 and ICEAIR 2B, were diverting to Akureyri. The Approach ATCO also informed that flight ICEAIR 680 only had enough fuel for either Reykjavik or Keflavik, they were holding, and asking about the condition of RWY 10 and how long it would take to get it operational. The Tower ATCO replied that it would take longer than removing the aircraft [N812AM] from the runway and that a tow truck was already on the way to remove the aircraft. Then they briefly discussed the diverted aircraft.

According to Isavia, at 06:12 the Tower ATCO asked the ATCA to call the Tower Supervisor [who was resting downstairs], for assistance. This was 8 minutes after the runway excursion of aircraft N812AM. According to the ATCO he did not consider getting help earlier since aircraft N812AM was able to taxi under its own power and he expected the situation to be easily managed.

According to the investigation, SIA-Iceland found both the Tower ATCO, taking care of the TWR and the GND frequencies, and the ATCA taking care of the DATA terminal to be very busy, as they were communicating with ground staff and incoming calls regarding the runway excursion.

At 06:12:35 Keflavik Tower ATC Assistant (ATCA) contacted the ATCO, who was resting downstairs and was also the Tower Supervisor and requested him to come upstairs as there was a medevac flight that went off the end of RWY 01. The ATCA also advised the Tower Supervisor that two aircraft had diverted to Akureyri Airport and one aircraft was in holding.

At 06:14:33 Keflavik Approach contacted Keflavik Tower to inform that flight ICEAIR 680 was committed to land at Keflavik Airport, as he did not have the fuel to wait for the braking action numbers from Reykjavik Airport. The Approach ATCO also informed that flight ICEAIR 680 could not wait for half an hour. The two ATCOs discussed this and that this could become an emergency landing on the runway, short runway.

At 06:16:02 the Snowking contacted the Tower ATCO to request permission to perform runway braking action measurement after the runway excursion, which the Tower ATCO approved.

At 06:16:21 the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower and advised that flight ICEAIR 680 had stated that after the current holding, they would be proceeding inbound for RWY 01 at Keflavik Airport, with the intention to land. The Approach ATCO had been pressing the flight crew of flight ICEAIR 680 to notify if it was an emergency or not. The Keflavik Approach ATCO then inquired the ATCO in Keflavik Tower where the vehicles were located on the runway. The ATCO in Keflavik Tower advised that a braking measurement vehicle was currently on the runway, driving south and measuring the runway condition, but other than that there were vehicles and the aircraft located at the far end of RWY 01, as the aircraft skidded off the runway as it was about to exit at taxiway N-4.

At 06:17 the Tower Supervisor (the ATCO that had been resting downstairs) entered the tower operation room and answered few calls on the Supervisor phone.

At 06:18:36 the Snowking contacted the tower ATCO. The Tower ATCO replied at 06:18:54 and the Snowking advised that the braking action measurement at RWY 01 were 50-62-61. The Tower ATCO asked him to hold.

At 06:18:58 South Air contacted the Keflavik Tower ATC Assistant (ATCA) to inform that they were working on locating the proper tow bar for aircraft N812AM and that was why he was not already on his way to the aircraft. The ATCO inquired how long this would take and South Air responded that it would take a few minutes to locate the tow bar.

At 06:18:58 the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower and advised that flight ICEAIR 680 was inbound and would be landing. The ATCO in Keflavik Tower noted that flight ICEAIR 680 would be landing. The ATCO in Keflavik Approach informed that he had been unable to get the flight crew of flight ICEAIR 680 to declare emergency, regardless of having pressed for it. The ATCO in Keflavik Tower noted this. The Keflavik Approach ATCO then requested that the Keflavik Tower ATCO require everyone to leave the runway, as well as informing the Tower ATCO that flight ICEAIR 680 was aware of the vehicles and the aircraft at the far end of RWY 01. The two ATCOs discussed the inbound flight ICEAIR 680 and what kind of clearance to provide it with. The ATCO in Keflavik Approach recommended not providing him with landing clearance, but instead with “land at your discretion” and information about the aircraft on the runway.

At the same time as this call was taking place between the Approach ATCO and the Tower ATCO, the Supervisor in the Tower (the ATCO that had previously been resting downstairs) was getting ready to replace the ATCO in the Tower position. According to Isavia, the ATCO that was being replaced in the Tower ATCO position, informed his replacement ATCO (the Supervisor) that flight ICEAIR 680 was going to land, but did not brief his replacement ATCO that flight ICEAIR 680 had minimum fuel and that their only option was Keflavik Airport. The replacement Tower ATCO (the Supervisor) was not content with giving flight ICEAIR 680 landing clearance to land on an occupied runway if it was not an emergency.

Therefore, after the Approach ATCO had recommended not providing him [flight ICEAIR 680] with landing clearance, but instead with "land at your discretion" and information about the aircraft on the runway, the Keflavik Tower ATCOs informed Keflavik Approach that they were not willing to do this, with the aircraft still on the runway.

In Isavia MANOPS it states that an ATCO can deny a clearance if the runway is occupied:

> ***310.3 DENIAL OF CLEARANCE:***
> ***310.3.3*** *Do not clear an aircraft to land or take-off if there is an obstruction, person, or vehicle on or adjacent to the landing area that may endanger the safety of aircraft.*
> ***310.3.4*** *If you refuse a request for a clearance for reason other than traffic, take the following actions:*
> *A. Advise the aircraft of the reason for denial of clearance.*
> *B. If the aircraft persists in its intention to land or take- off:*
> *1. quote any pertinent NOTAM, or directive regarding aerodrome conditions, and (E)*
> *2. when traffic permits, inform the aircraft that landing/take-off clearance cannot be issued and that landing/take-off will be solely the pilot's responsibility. (P)*

The Tower ATCO that was being replaced in position, did not realize that he had forgotten to brief his replacement ATCO on the fuel status of flight ICEAIR 680. No briefing (other than flight ICEAIR 680 was going to land and the content of the conversation with Keflavik Approach regarding "land at your discretion") was done when the Supervisor took over as ATCO in the Tower position.

At 06:20:44 the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower and advised that flight ICEAIR 680 had declared emergency with the intention to land. The ATCO in Keflavik Tower acknowledged this information and the two ATCOs also discussed that the flight had just squawked 7700. The Keflavik Tower ATCO acknowledged that flight ICEAIR 680 would be transferred over to the tower.

At 06:21:22 the Tower ATCO contacted the Snowking to advise that an aircraft on final approach had declared an emergency with the intention to land at RWY 01 so that they needed to remove all vehicles off the runway. The Snowking confirmed all vehicles off the runway. The Tower ATCO replied with a request of the latest braking action measurement. The Snowking replied that now the latest braking action measurement was 48-62-66.

Then, also at 06:21, there was a replacement of the Tower ATCO in position, when the other ATCO, who was also the Supervisor in the Tower, and who had previously been downstairs resting, took over the Tower position. After this serious incident, when looking back, the replacement ATCO considered the workload high.

At 06:21:29, the flight crew of flight ICEAIR 680 contacted the tower:

> *"Tower 18.3, ICEAIR 680. Tower, good morning. MAYDAY, ICEAIR 680, inbound for the ILS RWY 01, do you have the latest braking action?"*

The replacement Keflavik Tower ATCO replied:

> *"ICEAIR 680, tower, affirm continue approach for RWY 01, is it a low fuel?"*

The flight crew replied:

> *"Affirm, very low fuel."*

Keflavik Tower replied:

> *"Roger, continue, be advised that there is an aircraft at the end of the runway, that is still on the runway with vehicles.*"

The flight crew replied:

> *"We are advised, ICEAIR 680."*

It should be noted that in Isavia ANS, MANOPS: Part 6 – Emergencies, Attachment 1 Assist checklist J for Fuel problems is not in accordance with ICAO Annex 6 and PANS ATM Doc. 4444, as no definition of "low fuel" is in the MANOPS, only "minimum fuel".

In accordance to MANOPS, ATCO should render all assistance possible to an aircraft in an emergency:

> ***350.7 PRIORITY FOR LANDING***
> ***350.7.1*** *If an aircraft enters an aerodrome traffic circuit without proper authorization, it shall be permitted to land if its actions indicate that it so desires. If circumstances warrant, aircraft which are in contact with the controller may be instructed by the controller to give way so as to remove as soon as possible the hazard introduced by such unauthorized operation. In no case shall permission to land be withheld indefinitely.*
>
> ***350.7.2 In cases of emergency it may be necessary, in the interests of safety, for an aircraft to enter a traffic circuit and effect a landing without proper authorization.*** *Controllers should recognize the possibilities of emergency action and render all assistance possible.*

At 06:22:44, the flight crew of flight ICEAIR 680 discussed among themselves that they had reached minimum diversion fuel.

At 06:22:58 the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower and advised that Approach had notified flight ICEAIR 680 to contact Keflavik Tower for braking action numbers. The Approach ATCO also advised Keflavik Tower not to provide flight ICEAIR 680 with landing clearance. The Tower ATCO concurred.

At 06:23:06 the ATCO at Keflavik Tower transmitted the following on its Emergency Frequency:

> *Keflavik Tower calls - Alert Phase – Red – ICEAIR 680 on final approach 01 – Low on fuel – There is an aircraft on the runway on RWY 19 end*[23]*.*

This was confirmed by the appropriate emergency parties.

At 06:23:41, Keflavik Tower contacted the flight crew again:

> *"ICEAIR 680, check the braking action numbers for RWY 01, 48-62-66."*

The flight crew copied the information, continued their approach and the final preparation for landing.

At 06:25:00 the Tower ATCO contacted the Snowking to inquire about the exact position of aircraft N812AM *[is he past the threshold or is he by N on the runway?]*. The Snowking

[23] "Keflavík Turn kallar – Rautt - ICEAIR 680 er á lokastefnu 01 – Er low on fuel – Það er vél á brautinni á brautarenda 19

replied that the aircraft was not on the runway [RWY 01] but maybe 15-20 meters past the threshold [of RWY 19].

At 06:25:29 UTC, Keflavik Tower contacted the flight crew again:

> *"ICEAIR 680, check the aircraft is on the runway end, about 15 to 20 meters from the threshold, wind 320/5 knots, RWY 01 landing is approved at the pilot's discretion."*

The flight crew replied:

> *"Landing approved."*

At 06:26:43, flight ICEAIR 680 touched down on RWY 01 at Keflavik Airport and Autobrake 4 was employed.

When flight ICEAIR 680 landed, its remaining fuel was 2.6 tons.

The persons on board aircraft N812AM were not informed by Keflavik Tower, nor by Keflavik Ground that flight ICEAIR 680 was landing on the runway and were therefore unable to make any arrangements, such as disembarking the aircraft.

Neither of the ATCO working in the Tower realized at the time of the serious incident that their workload was high.

At 06:27:07 Keflavik Tower contacted the flight crew of flight ICEAIR 680 and instructed them to vacate the runway left at taxiway A, to contact Ground on 121.9 mHz and informed them that the braking action was POOR on the taxiways. The flight crew copied this information. Flight ICEAIR 680 vacated RWY 01 via taxiway A-1.

When flight ICEAIR 680 arrived at the gate, its remaining fuel was 2.4 tons.

At 06:27:42 South Air tug contacted the Tower ATCO to inform that he was holding short at taxiway Sierra-1 requesting permission to enter and to drive to the aircraft he was supposed to tow.

At this time, more than 21 minutes had passed since the Keflavik Tower ATCA contacted South Air to inform that aircraft N812AM needed a tow truck as it had incurred a runway excursion at RWY 01. According to South Air, they had run into problems locating the correct tow bar for aircraft N812AM.

At 06:28:19 the ATCO at Keflavik Tower transmitted the following on its Emergency Frequency:

> *Keflavik Tower re-calls - Alert Phase – Red – ICEAIR 680 landed on RWY 01 in Keflavik 06:28*[24]*.*

This was confirmed by the appropriate emergency parties.

At 06:51:28 the ATCO in Keflavik Approach contacted the ATCO in Keflavik Tower to inquire about the status. The Tower ATCO informed that this would only take few additional minutes and they would be removing the aircraft [N812AM] via taxiway N.

RWY 01 was back in operation at 06:58. This was 54 minutes after the runway excursion had occurred at 06:04.

2.3.5. Reykjavik Tower

According to Isavia Regional Airports, AFIS operator would only enter Reykjavik Tower when AFIS service was requested. In most cases AFIS operator was therefore not present in the tower to update the weather screen for Reykjavik Airport.

Reykjavik Tower was manned with an AFIS operator between 06:15 and 07:00. It was not until the scheduled opening of Reykjavik Airport at 07:00 that it was manned with an ATCO.

At 06:15, the BIRK Tower was manned by the AFIS operator, due to the Coast Guard flight scheduled to depart BIRK at 06:30 (before normal opening hours).

The AFIS operator called Approach at 06:15 but was put on hold immediately followed by the abrupt ending of the call due to Approach being busy handling communications with flight ICEAIR 680 during their holding at SOPAR.

Then, at 06:16, the AFIS operator in BIRK Tower called FDS in the ACC to advice that he was in the tower and requested the flight plan for the Icelandic Coast Guard flight that was taking off early in the morning. The FDS provided the Coast Guard flight plan details as well as advising that there had been a runway excursion at Keflavik Airport. The FDS also informed the AFIS operator in BIRK Tower that two aircraft were diverting to Akureyri Airport, as well as that an aircraft might also be diverting to Reykjavik Airport. No communications regarding the runway conditions at BIRK took place during this call.

[24] "Keflavík turn afturkallar – Hættustig – Rautt - ICEAIR 680 lenti á braut 01 í Keflavík 06:28

At 06:17 a call took place between the AFIS operator in the BIRK Tower and the Approach support ATCO (that had been in the Approach position prior to 06:08 but stayed to support his replacement ATCO), where the AFIS operator in the BIRK tower provided a braking action measurement of 30-32-34 for BIRK RWY 01, also stating it had been taken about 10 minutes earlier. The SIA-Iceland investigation revealed that the last braking action measurements for RWY 01 had been taken 14 minutes earlier [at 06:03] and that it was 31-34-36.

2.3.6. Akureyri Tower

After the two aircraft diverted to BIAR at 06:09, the AFIS operator in the tower called in an Air Traffic Controller Officer (ATCO), and the AFIS operator therefore became available for fire- and rescue service duty once the ATCO arrived.

The investigation revealed that no direct communications took place between the ATCO in Keflavik Approach and the Akureyri Airport AFIS operator. The Shift Supervisor[25] in the Reykjavik Area Control Center (ACC)[26] delegated the task of contacting BIAR to Flight Data Specialist (FDS) on duty in the ACC. There were no problems with the flow of communications, as the BIAR tower was manned the whole time, initially with an AFIS operator and subsequently with an ATCO.

The first landing at BIAR on this day was at 06:44, when flight ICEAIR 622 landed on RWY 19. The first takeoff from BIAR on this day was at 08:25, when flight ICEAIR 622 took off from RWY 19.

At the time of the serious incident, outside the normal opening hours of Akureyri Airport, ATC service in BIAR TMA, as well as Approach to Akureyri Airport, was provided by the SOUTH SECTOR in the Reykjavik Area Control Center (ACC).

SNOWTAMs can be accessed on the following Isavia webpage for airport weather:

https://iws.isavia.is/

[25] Varðstjóri
[26] Flugstjórnarmiðstöð

2.3.7. Egilsstaðir AFIS

At 06:32 the AFIS operator at Egilsstaðir Airport contacted the Flight Data Specialist in the Reykjavik Area Control Center to advice that he had heard that two aircraft were diverting from Keflavik Airport to Akureyri Airport and one additional aircraft was around Keflavik and inquired if this was something that could affect Egilsstaðir Airport and if the runway was closed at Keflavik Airport.

The FDS replied that a runway excursion had occurred at Keflavik Airport, they were working on removing the aircraft and there were insufficient braking conditions on the other runways, resulting in the aircraft diversions. The FDS also advised not having information about the inbound aircraft for Keflavik Airport. The FDS then inquired about the runway conditions at Egilsstaðir Airport.

The AFIS operator at Egilsstaðir Airport replied that the runway condition was GOOD, clean runway and clear skies. The FDS replied that they did not expect, at the moment, that they would be sending any aircraft to Egilsstaðir, but they would inform them if anything changed.

Relaying of information regarding Egilsstaðir Airport runway condition is provided directly to pilots by the airport's AFIS operator.

2.4. Flight Operation

The flight operator was testing different Electronic Flight Bag system solutions at the time of the serious incident. One of the Electronic Flight Bag system solutions being tested was from International Flight Support (IFS) and it was the one onboard flight ICEAIR 680 during the serious incident.

According to the flight operator, the testing of the various suppliers resulted in LIDO being selected.

In this report, when discussing alternate airport, it is being used in the context of destination alternate aerodrome, as described in CAT.OP.MPA.180 and CAT.OP.MPA.185 of EU regulation 965/2012.

From the flight plan (see Figure 8), it is apparent that the flight operator calculated 14 minutes diversion time for the alternate airport (BIRK) at FL 90.

- This is less than the 15 minutes prior notice required to man the BIRK tower with an AFIS operator per Iceland AIP BIRK AD 2.3 outside the normal opening hours, involving international flights that use BIRK as an alternate airport
- This is less that the 20 minutes it takes to clear snow from the active runway at BIRK, according to Reykjavik Airport management
- This is less than the 24 minutes it took to open BIRK at the day of the serious incident (with no snow removal required, but missing one Airport Operations person from the shift)
- This is also less than the 30-60 minutes prior notice required to upgrade Reykjavik Airport to CAT-7 for rescue and firefighting
- Finally, this is less than the up to 1 hour response time allowed in the agreement between Isavia and the Ministry of Infrastructure to open the airport

2.4.1. Fuel - Planning vs. Actual

SIA-Iceland analyzed the fuel planning versus the fuel burn throughout the flight.

Per the fuel plan, an excess fuel of 1.5 tons was available.

SIA-Iceland analyzed the fuel checkpoints data, as provided in the IFS program in the Electronic Flight Bag.

For the fuel checkpoints, the flight crew used the TOTAL value (totalizer) on the fuel quantity indicator of the overhead panel.

Position	Remaining fuel at checkpoints per the totalizer on the overhead fuel panel In tons (1000 kg)	Minimum Fuel Required In tons (1000 kg)	IFS Calculated Excess Fuel In tons (1000 kg)
KSEA - Takeoff	No fuel check	28.1	
ALPSE	28.5	27.0	1.5
TOC	27.1	25.3	1.8
YDC	26.9	25.0	1.9
YNY	25.8	24.1	1.7
BOJAM	24.9	23.1	1.8
YZU	No fuel check	21.7	
YMM	No fuel check	19.8	
DUROT	20.4	18.9	1.5
E-ENT	No fuel check	18.1	
YSF	19.5	18.0	1.5
60°N 104°W	18.9	17.4	1.5
61°N 100°W	17.8	16.4	1.4
ETP-1	No fuel check	14.9	
64°30'N 090°W	15.1	13.9	1.2
E-EXT	No fuel check	12.9	
66°30'N 080°W	13.1	12.1	1.0
67°30'N 070°W	11.3	10.4	0.9
CANEL	No fuel check	8.9	
68°N 060°W	9.7	8.7	1.0
68°N 050°W	8.1	7.2	0.9
67°N 040°W	6.3	5.5	0.8
66°N 030°W	4.6	3.9	0.7
TOD	3.9	3.3	0.6
INDES	No fuel check	3.2	
INGAN	No fuel check	2.9	

Figure 17: Fuel at fuel checkpoints throughout the flight as seen in the IFS

At the first fuel checkpoint, ALPSE, the remaining fuel was the same as the planned remaining fuel, or 28.5 tons. Then, in the early part of the flight, the fuel plan assumed less fuel than the fuel check points showed to be the case.

Halfway into the flight this turned around and the fuel plan started assuming more remaining fuel than was being recorded at the fuel checkpoints.

At 06:02:21, the flight crew discussed amongst themselves that the remaining fuel was 3.6 tons, per the totalizer on the overhead fuel panel, while the FMC was showing 300 kg more fuel remaining.

The totalizer on the fuel quantity indicator on the overhead panel, shows the remaining fuel, based on a fuel measurement in the fuel tanks, while the FMC calculates the remaining fuel based on fuel flow to the engines.

The flight crew discussed that this was not suitable as the FMC was showing a value that was higher than the totalizer indicated, and it would be more conservative to have it the other way around.

At 06:10:47 the flight crew received information from Keflavik Approach that there was no one in the Reykjavik tower and that they should expect braking action at Reykjavik Airport in half an hour.

At 06:11:20, the flight crew of flight ICEAIR 680 discussed that they had remaining fuel of 3.3 tons.

At 06:12:54, the Commander informed Keflavik Approach that they could not hold for half an hour, not even close.

At 06:13:06 the First Officer stated to the Commander that the FMC was calculating an available holding time of 12 minutes. The Commander replied that this was not correct as the FMC calculation was based on a [remaining] fuel value of 3.5 tons, while they had 3.2 tons remaining fuel [per the totalizer on the fuel quantity indicator on the overhead panel].

At 06:13:29 the flight crew concurred that they could hold for another 5-6 minutes. This time is based on a diversion to BIRK. If the flight is committed to BIKF the holding time is increased to 20 minutes based on landing with final reserve fuel of 1.7 tons.

At 06:16:02 the flight crew of flight ICEAIR 680 declared minimum fuel to Keflavik Approach.

At 06:20:33, when the flight crew of flight ICEAIR 680 declared emergency, the remaining fuel was 2.8 tons.

At 06:26:43, when flight ICEAIR 680 landed, its remaining fuel was 2.6 tons.

When flight ICEAIR 680 arrived at the gate, its remaining fuel was 2.4 tons.

The final reserve fuel for flight ICEAIR 680 was 1666 kg.

SIA-Iceland determined that the decision to commit to land at the closed RWY 01 at Keflavik Airport and declaring minimum fuel at 06:16:02, was most likely the safest option the flight crew could have made at that time, taking into account that they did not know that the braking action of the runways at BIRK had already been measured and that they had been told that they would not receive the braking action numbers until after half an hour.

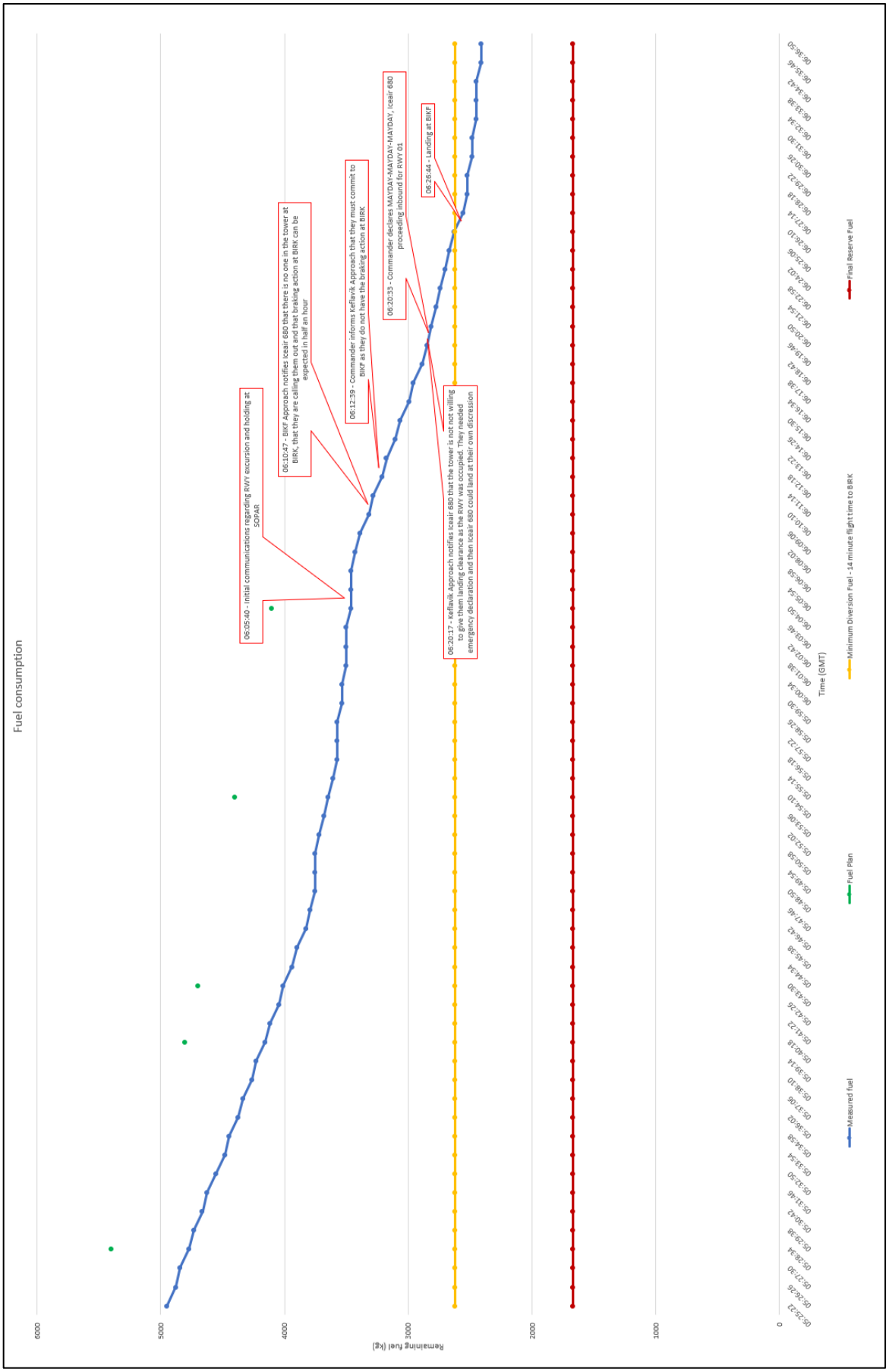


Figure 18: Fuel consumption during the last hour of flight

2.4.2. Alternate fuel

The alternate fuel per the flight plan was 958 kg, for a 14 minute flight at FL 90 to BIRK. This is the fuel required for the flight between BIKF and BIRK.

The alternate fuel in the flight plan did not take the following into account:

- Reykjavik Airport was scheduled to be closed (23:00 to 07:00) around the time flight 680 was scheduled to land at Keflavik Airport (06:05)
- The time it takes to man BIRK tower with an AFIS person during its closing hours (15 minutes)
- The time it takes to make a runway at Reykjavik Airport operational (possible clearing, sanding and/or braking action measuring required)
- The time it takes to upgrade the rescue and firefighting capability at Reykjavik Airport to the CAT-7 requirement of the B757-200 aircraft performing flight 680 (30-60 minutes)

In addition, according to the flight operator, none of their flights in the 2017-2019 period had gone below the 30-minute final reserve fuel.

Since flight ICEAIR 680 did not carry sufficient alternate fuel to account for the limitations associated with using BIRK as an alternate during its closing hours, as well as the fact that flight 680 landed on a closed runway, SIA-Iceland determined that the flight required a further study.

2.4.3. Landing on a closed RWY 01 at BIKF vs. holding until it re-opened

The flight crew of flight ICEAIR 680 had received the following information:

- At 06:11:59, Keflavik Approach informed that nothing had been found damaged on the aircraft that incurred the runway excursion
- At 06:23:41, Keflavik Tower provided an updated RWY 01 braking action measurement of 48-62-66

Keflavik Tower required flight ICEAIR 680 to declare an emergency.

The ATCO in Keflavik Tower did not issue a landing clearance, but instead a permission to land at pilot's discretion.

All vehicles were ordered off the runway before flight ICEAIR 680 landed.

When flight ICEAIR 680 landed, aircraft N812AM was located at the far end of the runway, 15-20 meters past the threshold of RWY 19.

The flight crew and passengers of aircraft N812AM were on board aircraft N812AM at the far end of RWY 01 when flight ICEAIR 680 landed on closed RWY 01. They had not been informed that flight ICEAIR 680 was landing on the closed runway.

Flight ICEAIR 680 landed with more fuel (2.6 tons) than the final reserve fuel (1666 kg).

At 06:17 Keflavik Approach contacted the flight crew of flight ICEAIR 680 with the instructions to descend altitude 3000, therefore leaving its holding at 6000 ft at waypoint SOPAR, while RWY 01 at Keflavik Airport was not back in operation until at 06:58. If flight ICEAIR 680 had continued its holding at 6000 ft at waypoint SOPAR until RWY 01 at Keflavik Airport was back in operation, it would have meant about 41 minutes of extra holding time.

SIA-Iceland calculated the fuel burn of flight 680 at 6000 ft at waypoint SOPAR, between 06:11:20 and 06:18:42, which turned out to be about 52.6 kg/min. Therefore, if flight ICEAIR 680 had continued its holding at SOPAR until RWY 01 at Keflavik Airport was re-opened at 06:58 it would have consumed extra 2157 kg of fuel.

This would have meant just over 0.4 tons of fuel would have remained when it landed and only just over 0.2 tons of fuel would have remained when it arrived at the gate.

2.4.4. Diverting to BIRK

At 06:18:30 UTC, Keflavik Approach contacted the flight crew:

"ICEAIR 680, I have the braking action at Reykjavik 30-32-34 Runway 01."

It took 24 minutes to open the runway for use at BIRK at the day of the serious incident, from the call of the FDS to the BIRK AFIS at 06:06, so Reykjavik Airport was open by 06:30 that morning.

Had flight ICEAIR 680 diverted to Reykjavik Airport at 06:18:30, when the braking action numbers for BIRK were available, considering the 14 minutes diversion time, Reykjavik Airport would already have been open when they arrived there, due to the early opening of the airport as a result of the departing Coastguard flight.

Per calculations based on FDR data, about 2900 kg of fuel would have remained at 06:18:30. At that time, flight ICEAIR 680 was located at an altitude of 6025 feet[27] above Mean Sea Level (MSL), so to climb to FL90, it would have to climb by close to 3000 feet.

If an immediate decision would have been taken to climb to FL90 and to divert to BIRK (14 minutes flight at FL 90), SIA-Iceland assumed[28] the climb would consume about 140 kg of fuel and per the flight plan the diversion would consume additional 958 kg of fuel, for a total of about 1100 kg. Then the fuel would have been down to about 1800 kg.

This is still above the minimum reserve fuel of 1666 kg, so SIA-Iceland concluded that an immediate emergency diversion to BIRK, when the braking action measurement at BIRK was provided to the flight crew of flight ICEAIR 680, would most likely not have consumed the final reserve fuel.

Reykjavik Airport would however only have been manned with AFIS service.

The METAR in effect at BIRK was as follows:

METAR BIRK 280600Z 17003KT 9999 FEW018 BKN040 BKN060 01/M01 Q1034

[27] ALTITUDE_Uncorrected according to FDR was 5395 feet at 06:18:30. Corrected for pressure altitude: 1) 1013 hPa – 1034 hPa = -21 hPa. 2) 5395 ft – (-21hpa) x 30 ft/hPa = 6025 ft
[28] Based on fuel consumption from 6000 ft to FL90 after takeoff, taking into account lighter gross weight this late into the flight due to fuel burn

SIA-Iceland requested the flight operator to perform landing performance calculations for aircraft TF-ISF, based on the parameters of the flight for BIRK. The flight operator complied and provided the following calculations:

LANDING

BIRK RWY01. TORA 5501ft/1677m, LDA 4878ft/1487m (Displaced threshold 190m).
81492kg, Wind 182/03 (TW3/XW0), QNH 1034, OAT 1°C, Flap 30, Autobrake off/max manual.

Inflight-Landing distances

MEDIUM
5749ft/1752m.

MEDIUM-GOOD
5127ft/1563m.

GOOD
4505ft/1373m.

DRY
3638ft/1108m.

An air distance allowance of 1500ft from threshold to touchdown is included.
Distances have been increased by 15% factor.

BIRK RWY19. TORA 5141ft/1567m, LDA 5141ft/1567m
81492kg, Wind 182/03 (HW3/XW0), QNH 1034, OAT 1°C, Flap 30, Autobrake off/max manual.

Inflight-Landing distances

MEDIUM
5382ft/1640m

MEDIUM-GOOD
4822ft/1470m

GOOD
4263ft/1300m

DRY
3445ft/1050m

An air distance allowance of 1500ft from threshold to touchdown is included.
Distances have been increased by 15% factor.

It would therefore not have been possible to land flight ICEAIR 680 at RWY 01/19 at Reykjavik Airport (BIRK) with the MEDIUM reported braking action from 06:03 that were provided to the flight crew of flight ICEAIR 680 at 06:18:30.

At 06:34 new braking action measurement was performed for BIRK RWY 01, 35-39-40, with an average of 38, which would move the braking action up to MEDIUM to GOOD.

Assuming that a diversion would have occurred immediately at 06:18:30 and the diversion time of 14 minutes, it would already been 06:32:30 when the aircraft had diverted to BIRK.

This is much closer to the next braking action measurement at 06:34. Using the updated braking action measurements at 06:34, with the braking action measurement up to MEDIUM to GOOD, the landing performance calculations showed that flight 680 could have landed at RWY 19 at BIRK (LDA 1567 m and required runway length 1470 m).

Flight ICEAIR 680 could therefore have landed at RWY 19 at Reykjavik Airport (BIRK) with the updated braking action at 06:34.

However, when the flight crew had to make the decision to divert, at 06:18, they did not have the braking action measurement that allowed them to land at BIRK (issued at 06:34).

Therefore, diversion to BIRK was never a viable option for flight 680, even after they received the braking action at BIRK at 06:18:30.

2.5. Safety measures already implemented

SIA-Iceland has identified the following safety measures that have already been implemented during the investigation.

2.5.1. Aerodrome Operator

Aerodrome category requirements for rescue and firefighting capability are based on ICAO Annex 14, chapter 9.2. According to ICAO Annex 14, chapter 9.2.45, the number of rescue and firefighting persons required for an airport is determined by performing a task resource analysis and the level of staffing must be documented in the Aerodrome Manual. Guidance for the task resource analysis can be found in the ICAO Airport Service Manual, doc 9137 Part 1.

Prior to the serious incident, Isavia had last performed task resource analysis[29] for rescue and firefighting in 2015. In the end of 2019, after this serious incident, the director of Isavia Regional Airports requested the task resource analysis for Aircraft Rescue and Fire Fighting (ARFF) for Reykjavik Airport to be updated, to ensure sufficient ARFF manpower as well as to include other integrated tasks. The analysis was to be based on the requirements in Icelandic regulation 75/2016 (which implemented EU regulation 139/2014), Isavia inhouse document SK160 01 and ICAO Airport Service Manual doc 9137 Part 1, article 10.5.

When the task resource analysis[30] was released in June 2020, it incorporated the above mandate for Reykjavik Airport (BIRK), Akureyri Airport (BIAR) and partially for Egilsstaðir Airport (BIEG)[31].

Reykjavik Airport

After this incident, after discussion with the flight operator of flight 680, Isavia set up an internal procedure VR510 02 for the Reykjavik Airport Authority. In VR510 02 it stated that the flight operator's Operation Center [NCC] would call the Airport Operations of Reykjavik Airport ahead to advise when Reykjavik Airport was being filed as an Alternate Airport. This procedure had the flaw that it was only applicable to the flight operator of flight 680 and did not take into account other flight operators filing BIRK as their alternate airport.

[29] ARFF – Aircraft Rescue and Fire Fighting
[30] Starfs og verkefnagreining vegna björgunar og slökkviþjónustu og öðrum samþættum verkefnum flugvallaþjónustu
[31] The ARFF has not been detailed specifically for BIEG

Instead, Isavia ANS has developed an intranet web-based system that allows the Tower and Airport Operations at Reykjavik Airport to have real time data on aircraft filing BIRK as their alternative. This system is up and running and shows all flights that have filed BIRK as an alternate airport, regardless of the flight operator.

According to Isavia Regional Airports, in June 2022 the director of Reykjavik Airport issued a mandate that if fewer than three Airport Operations persons are on duty, it should be filed in the Isavia Opscom system, as is done for the Reykjavik Airport tower in case the ATCOs staff is not fully manned. The same procedure is used if the necessary firefighting equipment is reduced. These Opscom reports are fed into Icetra mandatory reporting system. Furthermore, this will lead to NOTAM being released as the airport's firefighting category is lowered.

In an amendment to the Iceland AIP on 2. December 2022, BIRK AD. 2.6, the time to upgrade Reykjavik Airport from CAT-6, for rescue and firefighting, to CAT-7 during its operational hours was changed from 30-60 minutes to 45 minutes.

In the same amendment, Reykjavik Airport was downgraded from CAT-6 to CAT-3 for rescue and firefighting outside its operational hours. The time to upgrade Reykjavik Airport from CAT-3, for rescue and firefighting, to either CAT-6 or CAT-7 outside its operational hours was changed to 45 minutes.

Commonly scheduled passenger aircraft landing at Keflavik Airport, such as Boeing 737-800, Boeing 737-8/9 Max, Boeing 757-200 and Airbus 321, are all CAT-7 aircraft with respect to the airport rescue and firefighting category. This effectively means that now Reykjavik Airport always requires 45 minutes preparation time to support landing of those types of aircraft with respect to rescue and firefighting capability.

Diversion time to Reykjavik Airport, after notifying ATC, needs to take this into account.

Akureyri Airport

Isavia ANS has developed a web-based intranet system that allows the Tower and Airport Operations to have real time data on aircraft filing BIAR as their alternative. This system is up and running and shows all flights that have filed BIAR as an alternate airport, regardless of the flight operator.

At Akureyri Airport (BIAR), from 23:00 to 06:00, the Akureyri Airport Operations department is still manned with two persons. The AFIS role of one of them during night time has been cancelled, replaced with an ATCO on a standby shift. Therefore, both of the persons are available for rescue and firefighting tasks.

In an amendment to the Iceland AIP on 2. December 2022, BIAR AD. 2.6, the time to upgrade Akureyri Airport from CAT-6, for rescue and firefighting, to CAT-7 during its operational hours was changed from 10 minutes to 30 minutes.

In the same amendment, Akureyri Airport was downgraded from CAT-6 to CAT-3 for rescue and firefighting outside its operational hours. The time to upgrade Akureyri Airport from CAT-3, for rescue and firefighting, to CAT-4, CAT-5, CAT-6 or CAT-7 outside its operational hours was changed to 30 minutes.

Diversion time to Akureyri Airport, after notifying ATC, needs to take this into account.

Egilsstaðir Airport

Isavia ANS has developed a web-based intranet system that allows the Tower and Airport Operations to have real time data on aircraft filing BIEG as their alternative. This system is up and running and shows all flights that have filed BIEG as an alternate airport, regardless of the flight operator.

According to Isavia Regional Airports, the shifts in the Egilsstaðir Airport Operations department have been changed. Now there are four three man shifts that overlap.

2.5.2. Air Navigation Services

Akureyri Tower

According to Isavia Regional Airports, AFIS service is no longer provided at Akureyri Airport (BIAR) and instead ATCOs are on standby shifts during the night.

On 2. December 2022, Iceland AIP was revised with the change that ATC service can always be made available at Akureyri Airport outside normal opening hours, with 30 minutes advance notice, although surcharges and certain restrictions will apply.

Egilsstaðir AFIS

On 2. December 2022, Iceland AIP was revised with the change that AFIS service can always be made available at Egilsstaðir Airport outside normal opening hours, with 30 minutes advance notice, although surcharges and certain restrictions will apply.

2.5.3. Flight Operator

The flight operator increased the emphasis on the use of alternate airports in its pilot's simulator recurrent training after the serious incident.

The flight operator also requested that Isavia investigated if it would be possible to open the runways at Keflavik Airport earlier in a shorter version in case a runway became closed in the future in a similar circumstances, pointing out that between 2016 and 2017 the runways were operated in shortened version during runway re-construction phases at the airport.

2.5.4. Availability of Keflavik Airport in case of RWY closing

In March 2022, Isavia organized and hosted a workshop regarding the availability of Keflavik Airport in case of runway closing.

The workshop was attended by various parties, such as Isavia, Isavia ANS, Icelandair, the Icelandic Airline Pilots' Association, the Regional Emergency Coordination Center (police), SIA-Iceland and Icetra.

The aim of the workshop was to gather the various parties that could be involved in an emergency at Keflavik Airport resulting in a runway closure, to find out if it would be

possible to open such runway earlier in a shortened or limited version by predetermining such cases.

The conclusion of the workshop was that this was not a simple task, as the following issues had to be tackled:

- Possible contamination of the runway
- The whole landing zone of the aircraft that caused the runway closure was likely an investigation scene, both for SIA-Iceland and the police
- Runway inspection
- Runway cleaning – Possible FOD items, hydraulic, oil, fuel, etc.
- NOTAM issued
- Iceland AIP amendment
- Airport insurances
- Airport manager approval

The workshop conclusion was that re-opening of the runway in shortened or limited version would most likely not be possible in a timely manner for an inbound aircraft that was low on fuel or had other issues that required it to land immediately.

It would most likely only be feasible in case where it became apparent that the runway would remain closed at least over a significant part of a day, or for several days.

The workshop did however conclude that in case of a runway closure, the first priority with regards to re-opening the airport for landings, should be to inspect, investigate, clean and re-open the runway section where the other runway intersects the closed runway. This way, it would be possible to open the intersecting runway as soon as possible.

For this to work, the runway conditions of the intersecting runway (to the closed runway) would have to be satisfactory for landings. In the case of the serious incident, if the runway condition of RWY 10/28 had been maintained throughout the night prior to aircraft N812AM incurring a runway excursion at RWY 01, this option could have been utilized to re-open the airport for landings.

3. CONCLUSIONS

3.1. Systematic Failures

SIA-Iceland investigated the operation and interaction between the international airports in Iceland (BIKF, BIRK, BIAR and BIEG), ATC, and the flight operators, to look for broken links in the overall system, in cases of runway/airport closing (such as due to weather or landing mishaps) resulting in diversions. SIA-Iceland found, that although the relevant parties had a safety net around their operation, the parties were only looking at it from their point of view and not from the whole systematic point of view.

As a result, SIA-Iceland found that there were gaps in the safety system between the relevant parties, which could lead to systematic failures as discussed in the following sub chapters.

Since the serious incident, many of the gaps have been closed by safety measures taken by the relevant parties, but not all of them.

3.1.1. Aerodrome Operator – Runway conditions

Keflavik Airport

As RWY 10/28 had not been maintained during the night, with regards to braking condition, it was not possible to use RWY 10 for landing when RWY 01 closed due to the runway excursion of aircraft N812AM.

The procedure of Keflavik Airport (VR 710 19 5:4) at the time of the serious incident only permitted to use de-icing fluid on the runway in use and on the taxiways connected to the runway in use.

The following change to chapter VR 710 19, has now however been implemented in revision 8 of the manual:

> *Prepareness due to possible unexpected incident which requires change of runway in use: The runway that is not in use at any given moment, shall be maintained as needed with the aim that it will be ready for use as soon as possible, and no later that 30 minutes from the tower ATCO requesting a change of runway in use.*

Runway materials and methods that are necessary shall be used to fulfill this requirement.[32]

According to Isavia, regardless of the above change to chapter VR 710 19, extreme conditions can occur where it will not be possible to ensure a change in runway in use within 30 minutes. These are conditions when constant use of snowplows on the runway in use, or constant reapplication of runway de-icing fluid on the runway is necessary. Information on the current arrangement for winter operations at Keflavik Airport can be found under the following link[33]:

https://www.isavia.is/media/1/Winter%20Operations%20at%20Keflavik%20Airport.pdf

Reykjavik Airport

At Reykjavik Airport (BIRK), during slippery conditions, the runways, taxiways, and aprons are sanded to improve the surface conditions. Runway de-icing fluids are not used at BIRK, which means it can take much longer to improve the runway braking condition than if de-icing fluid was used.

Normally, between 23:00 and 07:00 there are three persons on duty in the Reykjavik Airport Operations department. When the serious incident occurred, there were however only two persons on duty.

On the day of the serious incident, the first braking action measurement was accomplished on RWY 01/19 at 05:49 and preparation of an early opening of the airport started at 06:06. The time it takes to prepare and open a runway at BIRK, greatly varies depending on its condition.

- According to Reykjavik Airport management, it takes 20 minutes if snow needs to be cleared from the active runway. If there is only frost and slippery conditions, this takes less than 20 minutes
- On the day of this serious incident, it took 24 minutes to open the runway for use. There was no snow removal involved, but the shift was missing one person

[32] Viðbúnaður vegna hugsanlegra óvæntra atvika sem kallar á skipti á flugbraut í notkun: Flugbraut sem ekki er í notkun hverju sinni skal þjónustuð eftir þörfum með það að markmiði að hún verði tilbúin til notkunar eins fljótt og unnt er, og í síðasta lagi 30 mínútum frá beiðni flugturns um brautarskipti. Beita skal þeim efnum og aðferðum sem nauðsynlegt eru til þess að uppfylla þetta markmið.

[33] Aðstæður geta myndast þar sem ekki verður unnt að tryggja 30 mínútna frest á því að ný flugbraut verði tiltæk í fafngóðu ástandi og hin. Einkum eru það skilyrði þegar stöðug viðvera snjóplóga á braut í notkun, eða síendurteknar efnameðferðir á braut er nauðsynleg. Upplýsingar um núgildandi ráðstafanir má sjá á heimasíðu Isavia.

- According to an agreement between Isavia and the Ministry of Infrastructure, the response time to open BIRK shall never exceed 1 hour

Therefore SIA-Iceland concluded that at the time of the serious incident, it could take 20-60 minutes to clear and open a previously snow covered runway during winter conditions at BIRK. There is no mention of this time in the Iceland AIP.

Akureyri Airport

At Akureyri Airport, during slippery conditions, the runways, taxiways, and aprons are sanded to improve the surface conditions. Runway de-icing fluids are not used at BIAR, which means it can take much longer to improve the runway braking condition than if de-icing fluid was used.

Between 23:00 and 06:00, there are two persons on duty in the Akureyri Airport Operations department. At 06:00 three persons start their duty, replacing the night shift.

In general clearing of runways starts at 06:00 at BIAR. This morning it was however not necessary to clear the runway as it had been cleared the day before and no precipitation had fallen overnight. The time it takes to prepare and open a runway at BIAR, greatly varies depending on the condition.

- According to the Akureyri Airport management, the airport is to be opened within 45 minutes during winter period (1. October to 30. April) and within 30 minutes during summer period (1. May to 30. September)
- According to an agreement between Isavia and the Ministry of Infrastructure, the response time to open BIAR shall never exceed 1 hour

Therefore SIA-Iceland concluded that at the time of the serious incident, it could take 45-60 minutes to clear and open a previously snow covered runway during winter condition at BIAR. There is no mention of this time in the Iceland AIP.

Egilsstaðir Airport

At Egilsstaðir Airport, during slippery conditions, the runways, taxiways, and aprons are sanded to improve the surface conditions. Runway de-icing fluids are not used at BIEG, which means it can take much longer to improve the runway braking condition than if de-icing fluid was used.

During night time when the incident occurred, there was one person on duty in the BIEG Service department and one AFIS operator in the tower.

After 07:00, there are three persons are on duty in the Egilsstaðir Airport Operations department.

In general clearing of runways starts at 07:00 at BIEG but it can be started earlier if required. This morning it was not necessary to clear the runways. The time it takes to prepare and open a runway at BIEG, greatly varies depending on the condition.

- According to Egilsstaðir Airport management, in general it takes 20 minutes to clear the runways during winter
- According to an agreement between Isavia and the Ministry of Infrastructure, the response time to open BIEG shall never exceed 1 hour

Therefore SIA-Iceland concluded that at the time of the serious incident, it could take 20-60 minutes to clear and open a previously snow covered runway during winter condition at BIEG. There is no mention of this time in the Iceland AIP.

3.1.2. Aerodrome Operator – Rescue and firefighting capability

Keflavik Airport

When the serious incident occurred in 2019, Keflavik Airport was registered as CAT-9 for rescue and firefighting capability. Since then, it has been downgraded as there are no longer scheduled flights using CAT-9 aircraft at the airport.

Today, Keflavik Airport is registered as CAT-8 for rescue and firefighting between 05:00 and 19:00 and as CAT-7 between 19:00 and 05:00.

Commonly scheduled passenger aircraft landing at Keflavik Airport, such as Boeing 737-800, Boeing 737 Max 8/9, Boeing 757-200 and Airbus 321, are all CAT-7 aircraft with respect to the airport rescue and firefighting category.

Boeing 757-300 and Boeing 767-300 aircraft that also commonly land at Keflavik Airport are CAT-8 aircraft with respect to the airport rescue and firefighting category.

It should therefore be highlighted that Keflavik Airport is not prepared, with respect to rescue and firefighting capability, to handle CAT-8 aircraft, such as the Boeing 767-300, between 19:00 and 05:00.

Keflavik Airport is the only CAT-8 capable airport in Iceland with respect to rescue and firefighting.

The aircraft involved in the serious incident was a Boeing 757-200 aircraft, or CAT-7 aircraft with respect to the airport rescue and firefighting category.

According to the Isavia operations handbook[34], the minimum requirement for CAT-7 response at Keflavik Airport is defined as two rescue and firefighting vehicles with two trained rescue and firefighting persons in each vehicle along with the SAR Branch Director[35], or a total of five trained persons.

The CAT-7 requirement with regards to rescue and firefighting capability is always fully supported at Keflavik Airport.

Reykjavik Airport

At the time of the serious incident, Reykjavik Airport was registered as CAT-6 for rescue and firefighting capability. Reykjavik Airport could be upgraded to CAT-7 capability with 30-60 minutes prior notice.

According to the Isavia operations handbook[36], the minimum requirement for CAT-6 response at Reykjavik Airport is defined as two rescue and firefighting vehicles and one trained rescue and firefighting person in each vehicle, or a total of two trained persons.

At Reykjavik Airport (BIRK), during the airport's closing hours between 23:00 and 07:00, the Reykjavik Airport Operations department is normally manned with three trained persons. With one of them dedicated as AFIS operator in the tower during and around takeoffs and landings, the two trained persons required would normally be available to man the two positions in the rescue and firefighting vehicles in case of CAT-6 capability.

The aircraft involved in the serious incident (flight ICEAIR 680), which had Reykjavik Airport filed as its alternate airport, was a Boeing 757-200 aircraft, or CAT-7 aircraft with respect to the airport rescue and firefighting category.

At the time of the serious incident, Isavia defined the minimum requirement for CAT-7 response at Reykjavik Airport as two rescue and firefighting vehicles with a total of three trained rescue and firefighting persons.

[34] Chapters VR710 21, VR710 23, VR710 24 and SK710 03
[35] Björgunarstjóri
[36] Chapters VR510 10, SK505 03 and SK505 04

At Reykjavik Airport (BIRK), during the airport's closing hours between 23:00 and 07:00, the Reykjavik Airport Operations department is normally manned with three trained persons. With one of them dedicated as AFIS operator in the tower during and around takeoffs and landings, that left two trained persons to man the three-man positions in the rescue and firefighting vehicles in case of upgrading the airport to CAT-7 capability. Normally there was also one trained person on standby shift, so, the manpower requirements for upgrading Reykjavik Airport to CAT-7 could be met during the airport's closing hours at by calling in the standby shift person.

In the case of the actual shift when the serious incident occurred, there were only two trained persons on duty in the Airport Operations department. With one of them dedicated as AFIS operator in the tower, that left one trained person to man the three positions in the rescue and firefighting vehicles. This was not a significant snow day at BIRK, so there was only one trained person available on the standby shift. If the standby person would have been called in, they would still have been one trained person short.

Therefore SIA-Iceland concluded, Reykjavik Airport could not be upgraded to CAT-7 capability with 30-60 minutes prior notice, with regards to rescue and firefighting, as stated in the Iceland AIP at the actual time of the serious incident.

After 07:00, there were 7-9 persons working in the Reykjavik Airport Operations department, fully supporting the CAT-7 requirement with regards to rescue and firefighting capability.

On 2. December 2022 BIRK AD 2.6 was amended, where Reykjavik Airport was downgraded from CAT-6 to CAT-3 for rescue and firefighting outside its operational hours.

On 2. December 2022 BIRK AD 2.6 was also amended in the Iceland AIP, in such a way that it always takes 45 minutes minimum notice to upgrade Reykjavik Airport to CAT-7 with respect to rescue and firefighting capability.

In 2022 Isavia also changed the minimum requirement for CAT-7 response at Reykjavik Airport. Now two rescue and firefighting vehicles with two trained rescue and firefighting persons in each vehicle are required, or a total of four trained persons.

In general at Reykjavik Airport (BIRK), during the airport's closing hours between 23:00 and 07:00, the Reykjavik Airport Operations department is still manned with three trained persons. With one of them dedicated as AFIS operator in the tower, two trained persons would be unable to man the four positions in the rescue and firefighting vehicles. If the

standby person would be called in, there would still be one person missing to man the four positions in the rescue and firefighting vehicles. This person would only be available on significant snow days.

Therefore SIA-Iceland concluded, Reykjavik Airport cannot be upgraded to CAT-7 capability during its closing hours, unless it was a significant snow day when both the standby duty person and the extra person due to significant snow day were available.

It should be noted that there is an exception. In case the aircraft landing at the airport with the highest CAT requirement has fewer than 700 movements (landings and takeoffs) in the three busiest months at the airport. The CAT capability of the airport may be one less than the requirement of the aircraft. This exception can allow a CAT-7 aircraft to land at CAT-6 capable airport, such as Reykjavik Airport.

Flight operators should however be aware that they would be landing the CAT-7 aircraft at the airport with CAT-6 capability with regards to rescue and firefighting.

Akureyri Airport

At the time of the serious incident, Akureyri Airport was registered as CAT-6 for rescue and firefighting and could be upgraded to CAT-7 with 10 minutes prior notice.

According to the Isavia operations handbook[37], the minimum requirement for CAT-6 response at Akureyri Airport is defined as two rescue and firefighting vehicles and one trained rescue and firefighting person in each vehicle, or a total of two trained persons.

The investigation revealed that both Boeing 757-300 and Boeing 767-300, CAT-8 aircraft, had diverted to Akureyri Airport in the past, due to poor weather and runway conditions at Keflavik Airport. There is an exception, in case the aircraft landing at the airport with the highest CAT requirement has fewer than 700 movements (landings and takeoffs) in the three busiest months at the airport, then the CAT capability of the airport may be one less than the requirement of the aircraft. This exception can allow a CAT-8 aircraft to land at CAT-7 capable airport, such as Akureyri Airport.

The two aircraft that filed Akureyri Airport as their alternate and diverted there during the serious incident (flights ICEAIR 622 and ICEAIR 2B), were Boeing 757-200 aircraft, or CAT-7 aircraft with respect to the airport rescue and firefighting category.

[37] Chapters VL530 05, SK505 03 and SK505 04

Isavia defined the minimum requirement for CAT-7 response at Akureyri Airport as two rescue and firefighting vehicles and two trained rescue and firefighting person in each vehicle, or a total of four trained persons.

At Akureyri Airport (BIAR), from 23:00 to 06:00, the Akureyri Airport Operations department is manned with two persons. At the time of the serious incident, with one of them dedicated as an AFIS operator in the tower during and around takeoffs and landings, three extra trained persons would be required to man the four man positions in the rescue and firefighting vehicles in case of upgrading the airport to CAT-7 capability.

SIA-Iceland therefore concluded that those three persons could not be called in within 10 minutes prior notice, both because of the short 10 minutes notice but also because there was no trained rescue and firefighting person on a standby shift during this time.

Therefore, between 23:00 and 06:00, SIA-Iceland concluded that Akureyri Airport could not be upgraded to CAT-7 capability with 10 minutes prior notice, with regards to rescue and firefighting, as stated in the Iceland AIP at the time of the serious incident.

At 06:00 on the day of the serious incident, three trained persons started their duty in the Akureyri Airport Operations department, replacing the night shift. They were supplemented by the Akureyri Airport Operations department AFIS operator, whom had been relieved by an ATCO in the tower. So, when the first aircraft landed at BIAR at 06:44 this morning, which was flight ICEAIR 622 diverting from BIKF, the airport already fulfilled the CAT-7 rescue and firefighting capability requirement of the aircraft.

On 2. December 2022 BIAR AD 2.6 was amended, where Akureyri Airport was downgraded from CAT-6 to CAT-3 for rescue and firefighting outside its operational hours.

On 2. December 2022 BIAR AD 2.6 was amended in the Iceland AIP, in such a way that it always takes 30 minutes minimum notice to upgrade Akureyri Airport to CAT-7 with respect to rescue and firefighting capability.

At Akureyri Airport (BIAR), from 23:00 to 06:00, the Akureyri Airport Operations department is still manned with two persons. The AFIS role of one of them has been cancelled, replaced with an ATCO on a standby shift. Therefore, both persons are available for rescue and firefighting tasks. In the case of an upgrade to CAT-7, it still requires four rescue and firefighting persons. So, the airport would be two rescue and firefighting persons short in case of upgrade to CAT-7.

Although the prior notice has been increased from 10 minutes to 30 minutes in the AIP, there are still no trained persons on standby shift in the Akureyri Airport Operations department from 23:00 and 06:00.

Therefore, between 23:00 and 06:00, SIA-Iceland concluded that Akureyri Airport still cannot not be upgraded to CAT-7 capability, regardless of the increased 30 minutes prior notice, with regards to rescue and firefighting, as stated in the Iceland AIP.

It should be noted that there is an exception. In case the aircraft landing at the airport with the highest CAT requirement has fewer than 700 movements (landings and takeoffs) in the three busiest months at the airport. The CAT capability of the airport may be one less than the requirement of the aircraft. This exception can allow a CAT-7 aircraft to land at CAT-6 capable airport, such as Akureyri Airport.

Flight operators should however be aware that they would be landing the CAT-7 aircraft at the airport with CAT-6 capability with regards to rescue and firefighting.

Egilsstaðir Airport

During the serious incident, none of the aircraft involved filed Egilsstaðir Airport as their alternate.

At the time of the serious incident, Egilsstaðir Airport was registered as CAT-5 for rescue and firefighting and could be upgraded to CAT-7 with 10 minutes prior notice.

The Aircraft Rescue and Fire Fighting response has not been detailed specifically for Egilsstaðir Airport. However, according to the Isavia operations handbook[38], the minimum requirement for CAT-5 response is defined as one rescue and firefighting vehicle and two trained rescue and firefighting persons.

At Egilsstaðir Airport (BIEG), during nighttime, there were two trained rescue and firefighting persons at the time of the serious incident. One of them was working in the Egilsstaðir Airport Operations department, while the other was the AFIS operator in the tower during and around takeoffs and landings, so one extra trained persons would be required to man the two man positions in the rescue and firefighting vehicle in case of the airport's registered CAT-5 capability.

[38] Chapters SK505 03 and SK505 04

Therefore, between 02:00 and 07:00, SIA-Iceland concluded that Egilsstaðir Airport could not maintain the registered CAT-5 capability at the time of the serious incident, with regards to rescue and firefighting, as stated in the Iceland AIP.

According to Isavia, the minimum requirement for CAT-7 response is defined as two rescue and firefighting vehicles and two trained rescue and firefighting persons in each vehicle, or a total of four trained persons.

At Egilsstaðir Airport (BIEG), from 02:00 to 07:00, the Egilsstaðir Airport Operations department was manned with one trained rescue and firefighting person at the time of the serious incident. So three extra trained persons would be required to man the four man positions in the rescue and firefighting vehicles in case of upgrading the airport to CAT-7 capability.

SIA-Iceland determined that those three persons could not be called in within 10 minutes prior notice, both because of the short 10 minutes notice but also because there was no trained rescue and firefighting person on a standby shift during this time.

Therefore, during night time, SIA-Iceland concluded that Egilsstaðir Airport could not be upgraded to CAT-7 capability at the time of the serious incident, with regards to rescue and firefighting, as stated in the Iceland AIP.

According to Isavia Regional Airports, BIEG AD 2.6 was to be amended in the Iceland AIP, in such a way that it would always take 30 minutes minimum notice to upgrade Egilsstaðir Airport to CAT-7 with respect to rescue and firefighting capability, as well as the CAT capability would be downgraded to CAT-3 during the airport's closing hours.

Review of the latest issue of the Iceland AIP prior to the release of the final draft report revealed that this change had not been implemented and therefore the 10 minute prior notice to upgrade the rescue and the firefighting capability of Egilsstaðir Airport remained in the AIP as well as the airport's CAT-5 capability during all hours. According to Isavia Regional Airports, this was to be corrected in the next issue of the Iceland AIP in such a way that it would always take 30 minutes minimum notice to upgrade Egilsstaðir Airport to CAT-7 with respect to rescue and firefighting capability, as well as the CAT capability would be downgraded to CAT-3 during the airport's closing hours. Subsequent inquire of the AIP prior to the release of the final report has revealed that this has been corrected.

According to Isavia Regional Airports, the shifts in the Egilsstaðir Airport Operations department have been changed. Now there are four, three man shifts that overlap. This

means, at a minimum there are always three trained persons on duty in the Egilsstaðir Airport Operations department.

Therefore, SIA-Iceland concluded that with this change, today the minimum requirement for CAT-5 response of two trained rescue and firefighting persons is being met.

Upgrading to CAT-7 capability requires four trained persons in the rescue and firefighting vehicles. With only three being available for this task today, SIA-Iceland concluded that Egilsstaðir Airport cannot be upgraded to CAT-7 capability with regards to rescue and firefighting, as stated in the Iceland AIP, except during the times when the shifts overlap.

It should be noted that there is an exception. In case the aircraft landing at the airport with the highest CAT requirement has fewer than 700 movements (landings and takeoffs) in the three busiest months at the airport. The CAT capability of the airport may be one less than the requirement of the aircraft. This exception can allow a CAT-7 aircraft to land at CAT-6 capable airport, such as Egilsstaðir Airport.

SIA-Iceland concluded that with shift change previously mentioned, today the minimum requirement for CAT-6 response of two trained rescue and firefighting persons could be met.

Flight operators should however be aware that they would be landing the CAT-7 aircraft at the airport with CAT-6 capability with regards to rescue and firefighting.

3.1.3. Air Navigation Services

Reykjavik Area Control Center

The investigation revealed a broken link in the system to be the lack of communication and/or information flow:

- Between Reykjavik Airport and Keflavik Approach, outside normal operating hours of Reykjavik Airport
- Inside the Reykjavik ACC, between Keflavik Approach and the FDS

The ATCOs in Keflavik Approach, located inside the Reykjavik ACC control room, believed Reykjavik Airport to be closed at 06:10, when flight 680 requested the latest braking action at BIRK, while the FDS already had activated Reykjavik Airport, due to a Coastguard flight, at 06:06.

It was not until in a communication between the AFIS operator at BIRK and the Keflavik Approach support ATCO, at 06:17, where Keflavik Approach became aware of the BIRK braking action measurements from 06:03. Nevertheless, the FDS in the Reykjavik Area Control Center called the AFIS operator at BIRK at 06:21 to request the latest braking action measurement and to inform that there would possibly be an aircraft diverting to BIRK.

The investigation revealed that there was a lack of operational oversight with a strategic perspective in the Reykjavik Area Control Center during the serious incident. The investigation revealed that there is no Shift Manager[39] on duty during nighttime to perform this task.

Keflavik Approach

Two braking action measurements were already available for Reykjavik Airport at 05:49 and 06:03, but Keflavik Approach did not have access to this information (the latter from 06:03) until 06:17. By that time Keflavik Approach had already informed the flight crew of flight ICEAIR 680 his estimate that they would not have the braking action numbers for Reykjavik Airport for half an hour.

That particular statement was the pivotal decision point for the flight crew of flight ICEAIR 680 deciding to land on a closed RWY 01 at Keflavik Airport.

SIA-Iceland concludes that it would have been preferable that the Approach ATCO contacted the designated AFIS person on duty at Reykjavik Airport to inquire about the runway conditions at BIRK.

It should be noted that analysis of the braking action measurement from 06:03 along with subsequent landing performance calculations during the investigation, revealed that flight 680 could not have landed at Reykjavik Airport, based on those runway conditions.

Keflavik Tower

The Tower ATCO that was being replaced in position at 06:21, did not realize that he had forgotten to brief his replacement ATCO on the fuel status of flight ICEAIR 680. No briefing, other than flight ICEAIR 680 was going to land and the content of the conversation with Keflavik Approach regarding “land at your discretion”, was performed when the Supervisor took over as ATCO in the Tower position.

[39] Aðalvarðstjóri

SIA-Iceland concludes that it would have been good practice if the Tower ATCO would have considered remaining in the seat and the incoming Tower ATCO supporting him instead of replacing in the Tower position, until after the serious incident.

3.1.4. AIP

According to Iceland AIP, Reykjavik Airport (BIRK), Akureyri Airport (BIAR) and Egilsstaðir Airport (BIEG) can all be made available outside normal opening hours, although surcharges and certain restrictions will apply.

SIA-Iceland found that there was different representation of data in the Iceland AIP between BIRK, BIAR and BIEG regarding how long it takes to man the towers with an ATCO or to provide AFIS service and how long it takes to upgrade the rescue and firefighting capability. The investigation also revealed that the AIP did not always support the actual capability of the airports.

There is also a lack of representation in the Iceland AIP on how long it can take to clear, sand and to perform braking action measurements.

SIA-Iceland also determined that the representation of the airport data in the Iceland AIP can lead flight operators to assume that an airport will be readily available when that might not be the case.

Many of the finding's SIA-Iceland had, with respect to the Iceland AIP, were corrected in an amendment issued on 2. December 2022.

3.1.5. Flight Operator

The time it takes an aircraft such as the Boeing 757-200 involved in the serious incident, to divert from Keflavik Airport to Reykjavik Airport is shorter than the time it takes to get Reykjavik Airport ready for operation.

This is due to the tasks at Reykjavik Airport that must be accomplished, during its closing hours, which include establishing AFIS service, preparing the runway and upgrading the rescue and firefighting capability.

In the flight documents of the serious incident flight (flight 680), the flight operator used 14 minutes as the diversion time to Reykjavik Airport.

This is less time than the following requirements for flight 680 landing at BIRK:

- AFIS service at BIRK can be provided within 15 minutes
- Preparing the runway can take 20-60 minutes
- Upgrading to CAT-7 rescue and firefighting capability requires 30-60 minutes prior notice

EC regulation 965/2012 CAT.OP.MPA.175 (7) Flight preparation, states:

> *(7) the provisions specified in the operations manual in respect of fuel, oil, oxygen, minimum safe altitudes, aerodrome operating minima and availability of alternate aerodromes, where required, can be complied with for the planned flight;*

Therefore, at the expected time of use the alternate airport the flight operator must ensure that the alternate airport is available for the aircraft performing the flight or take into account the time it takes to prepare and open the alternate airport in case of flight diversion to the alternate airport during its closing hours.

The aircraft involved in the serious incident (TF-ISF) was a Boeing 757-200 aircraft, or CAT-7 aircraft with respect to the airport rescue and firefighting category.

The takeoff time was at 22:47, with a flight time of 7 hours and 18 minutes. The ETA at BIKF was therefore at 06:05.

BIRK is closed from 23:00 until 07:00, but per Iceland AIP BIRK AD 2.3 it can be made available during its closing hours to international flights using BIRK as an alternate airport. Once such request is made by a diverting aircraft, the following needs to be considered:

- The time it takes to man BIRK tower with an AFIS person during its closing hours
    - At the time of the serious incident this was 15 minutes
    - At the time of the issue of this report, this is still 15 minutes
- The time it takes to upgrade the rescue and firefighting capability at Reykjavik Airport to the CAT-7 requirement of the B757-200 aircraft performing flight 680
    - At the time of the serious incident this was 30-60 minutes
    - At the time of the issue of this report, this is 45 minutes
- The time it takes to make a runway at Reykjavik Airport operational (possible clearing, sanding and/or braking action measuring required)
    - This will depend on the conditions at the airport at the expected time of use

- There is no mention of how long this will take in the Iceland AIP, but the investigation revealed that this can take 20-60 minutes

The alternate fuel in the flight operator's flight plan did not consider the time it takes to make Reykjavik Airport available during its closing hours.

SIA-Iceland determined that the decision to commit to land at the closed RWY 01 at Keflavik Airport and declaring minimum fuel at 06:16:02, was most likely the safest option the flight crew could have made at that time, taking into account that they did not know that the braking action of the runways at BIRK had already been measured and that they had been told that it would be 30 minutes until a braking action measurement could be provided to them.

3.1.6. The safety hazards in the current Icelandic alternate airport system

Keflavik Airport is the only CAT-8 capable airport in Iceland with respect to rescue and firefighting.

According to Iceland AIP, the other international airports (BIRK, BIAR, BIEG) can be upgraded to CAT-7, but it takes preparation time to upgrade the airports after request. In reality, in many cases upgrading the BIRK, BIAR and BIEG rescue and firefighting capability to CAT-7 is not possible as stated in the AIP. Instead, CAT-6 rescue and firefighting services are provided by the exceptions that there are fewer than 700 movements (landings and takeoffs) in the three busiest months at the airport[40].

The way the transatlantic routes via Keflavik Airport are built up, multiple flights are arriving at Keflavik Airport after long trans-Atlantic flights from North America late in the night and in the early morning, between 05:00 and 07:00.

These flights are therefore arriving during a time period when all the other international airports in Iceland (BIRK, BIAR and BIEG) are closed. In the case when any of these flights need to divert, those flights must be able to use the alternate airports.

- In the case of BIRK, SIA-Iceland determined with respect to the rescue and firefighting capability (upgrading to CAT-7), clearing the runways of snow, sanding and performing braking action measurements, the airport cannot accomplish this

[40] Isavia Operations handbook SK505 03 – 2, chapter 4.1; ICAO doc 9137 Part 1, chapter 2.1.3(b)

for flights diverting to the airport prior to 07:00, due to the short diversion time from BIKF and insufficient manpower, without the operators taking the time, necessary to prepare the airport for operation, into account.

- In the case of BIAR, SIA-Iceland determined with respect to the rescue and firefighting capability (upgrading to CAT-7), clearing the runways of snow, sanding and performing braking action measurements, the airport cannot accomplish this within the expected flight time for flights diverting to the airport prior to 06:00, due to insufficient manpower.

- In the case of BIEG, SIA-Iceland determined with respect to the rescue and firefighting capability (upgrading to CAT-7), clearing the runways of snow, sanding and performing braking action measurements, the airport cannot accomplish this within the expected flight time for flights diverting to the airport at any time, except when the three four man shifts overlap, due to insufficient manpower.

3.2. Causes

SIA-Iceland found the following to be the cause of the serious incident:

- Runway excursion at RWY 01 at 06:04 by aircraft N812AM, which closed RWY 01
- Insufficient alternate fuel, taking into account the time it takes to make BIRK operational during its closing hours
- The runway conditions at BIRK
- RWY 10 at Keflavik Airport had not been maintained overnight
- Lack of communications between Keflavik Approach and Reykjavik Airport
    - Keflavik Approach was unaware of Reykjavik Airport opening early this morning
    - Keflavik Approach was unaware of the braking action measurements taken at 05:49 and 06:03 at Reykjavik Airport

3.3. Contributing factors

SIA-Iceland found the following to be contributing factors to the serious incident:

- Keflavik Approach statement to flight ICEAIR 680, that they would not have the braking action numbers for Reykjavik Airport for half an hour
- Unclear information in the Iceland AIP as to how long it took to make BIRK available for landing

4. SAFETY RECOMMENDATIONS

SIA-Iceland recommends to Icelandair:

19-159F044 T1

> SIA-Iceland recommends to the flight operator to ensure that in the flight planning, the alternate fuel includes the time that is required to open the filed alternate airport for operation, if closed during the expected time of use.

SIA-Iceland recommends to Isavia Regional Airports:

19-159F044 T2

> SIA-Iceland recommends to Isavia Regional Airports to ensure that there is an established communication link between the Reykjavik Airport Operations department and Approach Control outside the BIRK normal opening hours.

19-159F044 T3

> SIA-Iceland recommends to Isavia Regional Airports to review the rescue and firefighting staffing at BIRK, BIAR and BIEG with respect to this report's findings, or advertise in the AIP that CAT-7 aircraft can land under the airport's CAT-6 capability as the airport has fewer than 700 movements (landings and takeoffs) in the three busiest months at the airport.

SIA-Iceland recommends to Isavia ANS:

19-159F044 T4

SIA-Iceland recommends to Isavia ANS to review if it would be feasible to install a procedure regarding broader information sharing and activation protocol, between the international airports (BIKF, BIRK, BIAR and BIEG), Approach Control, and the Reykjavik Area Control Center, in case of one of those airports closing.

19-159F044 T5

SIA-Iceland recommends to Isavia ANS to review the feasibility of having a shift manager, or train his deputies (shift supervisors), on duty during nighttime in the Reykjavik Area Control Center, for strategic oversight.

SIA-Iceland recommends to Icetra:

19-159F044 T6

SIA-Iceland recommends to Icetra to review the need to issue a guidance or instructions to operators on Icelandic AOC regarding fuel requirement to alternate airports in Iceland, in case of flight planned for the closing hours of BIRK, BIAR and BIEG, considering the time required to open these airports.

Safety Action:

SIA-Iceland recommends to all flight operators, both domestic and foreign, flying into Icelandic airports to ensure that in the flight planning, the alternate fuel includes the time that is required to open the filed alternate airport for operation, if closed during the expected time of use.

This final report was approved by following SIA-Iceland board members:

- Guðmundur Freyr Úlfarsson
- Bryndís Lára Torfadóttir
- Gestur Gunnarsson
- Hörður Arilíusson
- Tómas Davíð Þorsteinsson

Reykjavik 7. December 2023

On behalf of SIA-Iceland

Ragnar Guðmundsson
Investigator-In-Charge (IIC)