THE REPUBLIC OF CROATIA

Air, Maritime and Railway Traffic Accident Investigation Agency

Air Traffic Accident Investigation Department

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Zagreb, 4 June 2024

F I N A L R E P O R T

ON SERIOUS INCIDENT OF AIRCRAFT SAAB 340A, REGISTRATION HA-TAD

8 MAY 2023, ZAGREB INTERNATIONAL AIRPORT – FRANJO TUĐMAN

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CONTENT

OCCURENCE INFORMATION

Type of the occurrence:	Serious incident
Date:	8 May 2023
Local time:	19:15
Place:	Zagreb International Airport
Type of the aircraft:	Avion
Manufacturer / model:	Saab 340A-126
Registration:	HA-TAD
Owner:	Fleet Air International Kft.
Operator:	Fleet Air International Kft.
Number of persons on bord:	Three
Injuries:	No physical injuries
Damage to the aircraft:	Minor damage

INVESTIGATION

The Air, Maritime and Railway Traffic Accident Investigation Agency received information about the incident from Zagreb International Airport, and commenced a safety investigation. The safety investigation established the causes of the incident.

The incident occurred due to loss of pressure in the aircraft's hydraulic brake system, which occurred as a result of the pilot's decision to turn off the hydraulic pump.

AIA issued safety recommendations to the operator of the aircraft.

SUMMARY

On 8 May 2023, around 19:15 LT (19:15 local time), at the end of the flight from Sarajevo Airport (LQSA), and after landing at Zagreb International Airport, during parking, the aircraft began to move uncontrollably and crashed into an airport staff vehicle and a van.

There were three people on board the aircraft, one in the vehicles, and not a single person was injured.

The nose landing gear door, driving light, hydraulic pipe and glass-plastic lining were damaged on the aircraft. The vehicles were also partially damaged.

1. FACTS AND INFORMATION

1.1. FLIGHT INFORMATION

The following information about the preparation, the flight and the events after the landing, was obtained based on the statements of the persons who were on board the aircraft in question (pilot, co-pilot and mechanic).

For the Sarajevo-Zagreb flight in question, a crew consisting of two pilots and one mechanic arrived at Sarajevo Airport 50 minutes before the scheduled take-off. After loading the cargo, the pilot inspected

the aircraft before the flight, and noticed no problems on the aircraft. The nose and main landing gear and shock absorbers were in order, with no signs of oil leakage.

After that, they made a brief review of the flight plan, closed the door, and at 16:11 LT requested permission to start the engine. They received the permission from the tower and at 16:17 LT took off from Sarajevo, via point BOSNA 1A to Zagreb.

The flight took place during the day, and under favourable weather conditions, and all flight parameters were in the green area during the entire flight.

Having flown to Zagreb, they received permission to land and at 17:00 LT landed on runway 04. When the aircraft slowed down to a speed of less than 80 knots, the pilot took over control from the co-pilot. They went back on runway 04 and exited onto taxiway C. At 17.01 LT the tower gave them permission to park at stop W4 via taxiways C and F.

During the exit from runway 04, they performed the actions from the after-landing checklist (the mentioned check list can be found in Annex 1 of this report). When turning onto taxiway F at 17:02 LT, they heard an unusual and constant sound from the hydraulic pump, and immediately checked the pressure and oil level in the system. The pressure was in the normal range, while the level was slightly lower than usual, so by experience they turned off the hydraulic pump and performed the abnormal operation checklist.

Shortly thereafter, at 17:04 LT, the aircraft arrived at position 4W, where they turned left, as the marshaller had shown them. In that turn, they still perceived a low hydraulic oil level, but the main and emergency hydraulic accumulators were pressurized, which according to the abnormal operation checklist is enough to bring the aircraft to a safe stop.

The end of the parking was a little unclear to them, because they did not understand what the marshaller was showing them. They thought he was showing them that there was some problem outside the aircraft. Shortly after entering to position W4, a yellow hydraulic warning illuminated on the central warning panel (CWP). The aircraft stopped at 17.05 LT, so they showed the marshaller that the parking brake was active and that they needed chocks, but at the same moment, somewhat upset, the marshaller looked away and got into his vehicle, so the crew did not know if he had seen the last signal regarding the chocks, and for which it is not yet placement time, as the engines were still running.

The crew again checked the condition of the hydraulic system and proceeded to shut down the engine. At that moment, the aircraft began to move uncontrollably forward, towards the vehicles on the ground. Successive attempts to brake and turn failed, and the aircraft came to a stop when the nose landing gear hit a vehicle on the ground.

About an hour later, the police alcohol tested the crew and briefly questioned the crew with the assistance of a translator. The alcohol test established that the crew did not consume alcohol.

1.2. INJURIES

Injuries	Crew	Passengers	Other
fatal	0	0	0
serious	0	0	0
minor / none	3	0	1

1.3. DAMAGE TO THE AIRCRAFT

In this incident, as a result of the aircraft hitting the vehicle, both doors of the nose landing gear bent and broke in some places. The glass-plastic lining on the left side of the nose part of the fuselage, above the nose landing gear, broke and the hydraulic pipe, which is protected by said lining, bent and broke. Hydraulic oil leaked from the mentioned pipe, traces of which can be seen on the nose landing gear. The driving light on the front of the nose landing gear was also damaged.

Picture 1 - nose landing gear door

Picture 2 - glass-plastic lining

Picture 3 - hydraulic pipe

Picture 4 - driving light

1.4. OTHER DAMAGE

During the uncontrolled movement of the aircraft, it hit two vehicles on the ground. The vehicles were also partially damaged.

Picture 5 - damage to the van

Picture 6 – damage to the aircraft staff vehicle

1.5. PERSONAL INFORMATION

1.5.1. Commander

Male person, Italian citizen born in 1983. The person was piloting the aircraft in the accident in question, and possesses a valid ATPL(A) pilot's license issued on 10 August 2022 by the Italian authorities, with a valid authorization SAAB 340/IR until 30.11.2023 and with the expired authorization of ER ME MP and SAAB 340 until 30.11.2022.

He has been employed by Fleet Air International Kft. since 2018, and has total of 2,298 flight hours, and 2,059 hours on the aircraft in question.

1.5.2. Co-pilot

Male person, Ukrainian citizen born in 1986. He possesses a valid ATPL(A) license issued on 2 December 2022 by the Hungarian authorities, with valid authorizations SEP(sea) until 28.02.2023, SAAB 340 until 31.07.2023, C500/550/560 until 31.08.2023, MEP(land) until 31.12.2023, and SEP(land) until 31.01.2024.

The person has a total of 1,600 MP flight hours and also flies small single-engine aircrafts.

1.5.3. Mechanic

The mechanic, as the third person from the aircraft, was not involved in the events.

1.5.4. Marshaller

Male person, employee at Zagreb International Airport.

1.6. AIRCRAFT INFORMATION

Type of the aircraft:	Aeroplane
Manufacturer / model:	SAAB AB / SAAB 340A
Aircraft serial number:	126
Year of manufacture:	1988
Length:	19.75 m
Height:	6.7 m
Wingspan:	21.4 m
Maximum take-off weight:	13154 kg
Cruise speed:	283 knots
Total flight hours:	38876:00
Total number of cycles:	38606

The SAAB 340 is a twin-engine turboprop aircraft produced by the Swedish company SAAB AB. The aircraft is a low-wing, of metal structure with a pressurized cabin. Its production began in the early 1980s and SAAB 2000 version was later developed from it. It can carry 30-36 passengers depending on the configuration, or it can be used to transport cargo, for example the AF model. It was discontinued in 1998 due to the increase in competing models on the market. During the fifteen years of production, a total of about ten variants of the 340 model were designed. Currently, about two hundred of these aircrafts are still operational among thirty operators around the world. To this day, four aviation accidents of this model of aircraft have been recorded, in which there was material damage and the death of passengers and crew members.

The aircraft in question is registered in the Hungarian civil aircraft register. The owner and operator of the aircraft is the Hungarian company Fleet Air International Kft.

A review of the aircraft's technical documentation revealed no irregularities or inconsistencies.

1.7. METEOROLOGICAL INFORMATION

Meteorological conditions had no influence on this incident.

1.8. AIRPORT INFORMATION

Zagreb International Airport is the busiest Croatian airport. It is the main air hub in Croatia and the only Croatian airport with many year-round and winter routes. In March 2017, a new passenger terminal was opened, which significantly increased the airport's capacity.

Zagreb Airport is located about 15 kilometres southeast of the centre of Zagreb.

It is equipped for IFR and VFR traffic.

The runway is asphalt, 3252 m long, 45 m wide and orientation 04/22.

Airport operator, customs, AIT, ATS, MET, fuel, baggage, security and de-icing services are available 24 hours and medical services are available from 05:00 to 23:00 LT.

1.9. DESCRIPTION OF THE INCIDENT SITE AND INFORMATION AVAILABLE FROM THE INCIDENT SITE

The place of the incident was at the airport apron at position W4.

Picture 7 – incident site

1.9.1. Surveillance camera recording

Airport surveillance camera recording is available. The recording shows the aircraft at the time of the incident. After leaving the runway, the aircraft taxied to the parking position, where it stopped.

The recording also shows that at the time of approaching the parking position, as well as at the moment of stopping, the propellers turned at the same or similar speed, and during that time the angle of attack of the blades was the same or approximately the same. Such mode of operation of the propeller was also at the time when the aircraft moved again from the parking position.

It can also be seen that when approaching the parking position, the aircraft decelerated twice and finally stopped at the third deceleration.

25 seconds passed from the time the aircraft stopped until it started moving again.

Picture 8 - the aircraft shortly before starting to move again

The recording also shows that the marshaller was giving some kind of signs to the pilots with his hands, and then entered a vehicle located about twenty meters in front of the aircraft.

After that, the aircraft moves forward from the parking position. The recording shows that the initial acceleration when starting was high. Shortly after the aircraft started to move again, it stops accelerating and continues to move.

The movement of the aircraft took place forward, first about twenty meters to the vehicle in which was the marshaller. It hit the mentioned vehicle and pushed it several meters in the direction of its movement. The vehicle moved to the side by reverse drive, and the aircraft continued moving, slowly decelerating to a stop. Towards the end of its movement, the aircraft also damaged a van that was in its path.

On the recording, approximately 3 seconds after starting the aircraft from the parking position, a change in the angle of attack of the blades and a decrease in the speed of rotation of the propeller can be seen.

Picture 9 - the aircraft shortly after starting to move again

1.9.2. Inspection of the aircraft and damage to the aircraft

On 9 May 2023, the day after the incident, the aircraft in question was inspected at Zagreb International Airport, dr. Franjo Tuđman. The inspection revealed that the front part of the aircraft had visible damage in the form of a rupture of the glass-plastic lining and bending and rupture of the hydraulic metal pipe located behind the afore-mentioned lining. Damage to the nose landing gear door and the driving light located on the same was also visible. There were visible traces of hydraulic oil leaking from the above-mentioned ruptured hydraulic pipe on the nose landing gear and under the aircraft. All described damage was the result of the aircraft hitting the vehicle.

A preliminary inspection of the components of the braking system also revealed no visible technical malfunctions.

A detailed visual inspection revealed that there was no visible damage to the brake block, associated pipes and connections that could cause the brake system to stop working. The brake pad wear indicator pins were protruding about 20 mm, which indicated their correctness. The electrical installations of the landing gear were in order, with no visible damage.

1.10. ADDITIONAL INFORMATION

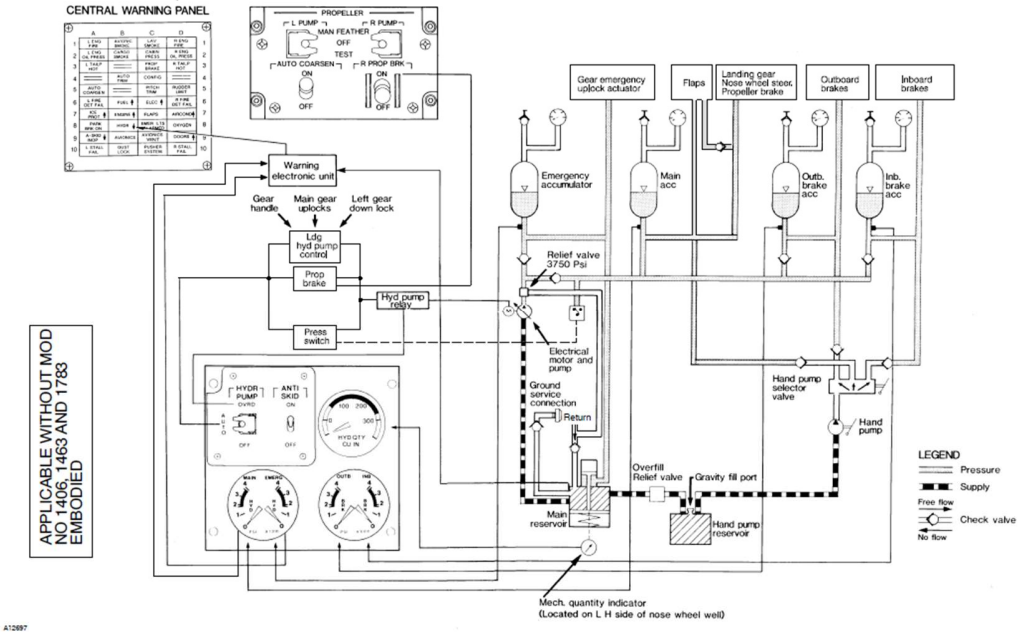
1.10.1. Aircraft Operators Manual

Aircraft hydraulic system

From the Saab 340A Aircraft Operators Manual, hydraulics section:

The hydraulic system is used to operate the flaps, landing gear, brakes, nose wheel steering and propeller brake. The system is composed of an electrically driven hydraulic pump that provides pressure for four hydraulic accumulators. A hand pump is also installed for emergencies (annex 4 contains details on using a hand pump). The main accumulator provides pressure to operate the flaps, landing gear, nose wheel steering and propeller brake. The emergency accumulator provides pressure to release the emergency landing gear lock. There are two more accumulators that supply the brakes with pressure.

The pump is started automatically in situations when the main accumulator pressure drops below 2100 psi (psi – pound per square inch; 1 psi = 0.06895 bar) and until it rises to 2900 psi, then when landing gear extension is selected and until the left landing gear does not lock in the down position when landing gear retraction is selected until both main landing gears are locked in the retracted position, when the nose wheel steering control is engaged, and when the propeller lock is engaged.



Picture 10 - hydraulic system scheme

The hydraulic system is also equipped with a hand pump that is used in case of need, i.e. when the electric pump cannot achieve the necessary pressure in the hydraulic system.

Hydraulic accumulators

Accumulators are of the piston type and are filled with gas (nitrogen) on one side, while hydraulic fluid is on the other side of the piston. The gas, which is under pressure, transmits pressure to the hydraulic fluid via the piston. Accumulator capacity is approximately 0.35 litres of hydraulic fluid when accumulator pressure is 2900 psi.

In case the pump stops working and the system pressure drops to 1650 psi, the piston in the accumulator will come to the end position and rest against the accumulator wall. The gas pressure in the accumulator will then be 1650 psi, and the hydraulic fluid will be forced out of the accumulator and its pressure will instantly drop to zero, since the piston that has descended to the accumulator wall can no longer create pressure on the hydraulic fluid. The accumulators then cease to be useful and the pressure in the hydraulic system instantly ceases to exist.

	Unit	Min	Normal	Max
1.1 OPERATING LIMITS				
Pressure				
– Electrical pump AUTO	psi	2050	2100–2900	2950
– Electrical pump OVRD	psi	–	3000	–
– Low pressure warning (HYDR)	psi	1800	1850	1900
Temperature				
– High temperature warning (HYDR)				
° Light on	°C	–	116	–
° Light off	°C	–	93	–
Quantity				
– Main reservoir				
° Capacity	cu. in liters	–	310 5.1	–
° Refill level (system pressurized)	cu. in liters	141 2.3	–	–
– Hand pump reservoir capacity	cu. in liters	–	150 2.5	–
1.2 HYDRAULIC FLUID SPECIFICATION				
MIL–H–5606.				

Picture 11 – pressure limits

Checklists for the hydraulic system abnormal operation

In the checklists for the aircraft hydraulic system abnormal operation, all the listed checks are for situations when a warning is activated on the central warning panel and refer to the pressure outside the prescribed limits and the temperature of the hydraulic fluid. No check is listed for unusual noises from the hydraulic pump.

The mentioned checklists can be found in Annex 1 of this report.

Aircraft parking brake

From the Saab 340A Aircraft Operators Manual, section 'landing gear':

The parking brake is activated by lifting the parking brake lever on the side lining of the left pilot's seat, and by pressing the brake pedal. By this procedure, if the pressure has exceeded 1500 psi, the parking brake valve will maintain pressure in the brakes. The valve will hold that pressure as long as the lever is in the up position and the pressure is above 950 psi.

The parking brake apply light on the central warning panel (CWP) illuminates when the brake is applied and the brake pressure is above 1700 psi and will turn off when it drops below 900 psi. So, there is a possibility that the parking brake is active and the CWP light is not on (pressure is between 1500 and 1700 psi).

1.10.2. Works on the aircraft after the serious incident in question

After completing all the necessary investigative actions on the aircraft in question, an inspection and works were carried out by the authorized aircraft maintenance company.

A detailed inspection was performed, and damaged components were replaced. On 17 May 2023, a CRS (Certificate of release to service) was issued.

The authorized company that carried out the above, submitted the technical documentation to this Agency for the purposes of the investigation. In the submitted technical documentation, there is no mention of the failure of an individual component or system that could have caused the braking system to fail.

1.10.3. Statement of the aircraft commander

In his statement the commander states:

For the Sarajevo-Zagreb flight in question, the crew arrived at Sarajevo Airport 50 minutes before the scheduled take-off. After loading the cargo, the commander did a pre-flight inspection of the aircraft, and he noticed no problems on the aircraft. The nose and main landing gears and shock absorbers were in order and without traces of oil leaks.

After that, they made a brief review of the flight plan, closed the door, and at 16:11 LT requested permission to start the engine. They received permission from the tower and at 16:17 LT they took off from Sarajevo, via point BOSNA 1A to Zagreb.

The flight took place during the day and under favourable weather conditions, and all flight parameters were in the green area during the entire flight.

After arriving in Zagreb, they received permission to land and landed on runway 04 at 17.00 LT. When the aircraft slowed down to a speed of less than 80 knots, the commander took over the controls from the co-pilot. They went back on runway 04, and exited on taxiway C. At 5:01 p.m. The tower gave them permission to park at stop W4 via taxiways C and F.

During the exit from runway 04, they performed the actions from the after-landing checklist. When turning onto taxiway F at 17:02 LT, they heard an unusual and constant sound from the hydraulic pump, and immediately checked the pressure and oil level in the system. The pressure was in the normal range, while the level was slightly lower than usual, so they turned off the hydraulic pump and ran the abnormal operation checklist.

Shortly thereafter, at 5:04 p.m., the aircraft arrived at position 4W, where they turned left, as the marshaller had shown them. In that turn, they still saw a low hydraulic oil level, but the main and emergency hydraulic accumulators were pressurized, which according to the abnormal operation checklist is enough to bring the aircraft to a safe stop.

The end of the parking was a little unclear to them, because they did not understand what the marshaller was showing them. They thought he was showing them that there was some problem outside the aircraft. Shortly after entering to position W4, a yellow hydraulic warning illuminated on the central warning panel (CWP). The aircraft stopped at 17.05 LT, so they showed the marshaller that the parking brake was active and that they needed chocks, but at the same moment, somewhat upset, the marshaller looked away and got into his vehicle, so the crew did not know if he had seen the last signal regarding the chocks.

The crew again checked the condition of the hydraulic system and proceeded to shut down the engine. At that moment, the aircraft began to move uncontrollably forward, towards the vehicles on the ground. Successive attempts to brake and turn failed, and the aircraft came to a stop when the nose landing gear hit a vehicle on the ground.

About an hour later, the police alcohol tested the crew and briefly questioned the crew with the assistance of a translator. The alcohol test established that the crew did not consume alcohol.

1.10.4. Statement of the co-pilot

On the day of the incident, the crew made a flight on the Sarajevo-Zagreb route with the aircraft in question. The co-pilot flew the aircraft from reaching a speed of 80 knots, and on landing until the speed dropped below 80 knots.

After landing, the commander took control again and taxied the aircraft to parking. When taxiing, the co-pilot (pilot on the right) has the task of following the correct driving route, traffic and obstacles on the way.

While taxiing, they heard that the hydraulic pump was working quite loudly, and the co-pilot saw that the hydraulic oil level was low, which he showed to the commander. The co-pilot continued to watch the road and traffic towards the parking position.

The commander checked the hydraulic system pressure, which was in the green area, therefore correct, and the co-pilot double checked and confirmed the same.

Upon arriving at the parking position, the marshaller seemed a little upset, probably because of the slow taxiing the commander had decided to perform. When they stopped, they failed to understand all the signs that the marshaller was showing them, which disturbed and confused them.

The commander stopped the aircraft at the intended position and asked for chocks, but the marshaller got into his vehicle.

The commander started to shut down the engine, and on that occasion the aircraft began to move uncontrollably towards the vehicles. The aircraft hit the vehicle with the nose landing gear and then came to a stop.

1.10.5. Statement of the marshaller

On that day, the marshaller steered the aircraft in question from SJJ to W4. During arrival, the aircraft was swirling and did not turn off the driving light. When it reached the point, he stopped it and indicated the crew to activate the parking brake. The commander indicated that the brake was set. The marshaller left the sticks in the vehicle and sat in it to write down the parking time and wait for the engine to shut down. At one point he looked up and saw that the aircraft was heading towards him. He quickly backed up to avoid being hit by the propeller. The aircraft hit the marshaller's vehicle, scraped the lower part of the nose on the roof of the vehicle and hit the left door of the same vehicle with the nose landing gear. The impact caused the vehicle to turn to the right, and the aircraft continued towards the cargo terminal, where it came to rest leaning against the van. After a few minutes, the marshaller tried to get out the left door, but it wouldn't open, so he got out on the right side of the vehicle.

2. ANALYSIS

2.1. DESCRIPTION OF EVENTS

The Sarajevo-Zagreb flight in question took place during the day and under favourable weather conditions. During the flight, the crew notice no signs of technical malfunctions of the aircraft.

Landing at Zagreb International Airport was normal, without any difficulties. Only after landing, while exiting the runway and taxiing towards the parking position, an unusual and constant sound of the hydraulic pump appeared.

After checking, the pilots found that no warning appeared and that the parameters of the hydraulic system were not of concern. However, due to the constant strange sound of the pump, they turned off the hydraulic pump.

They continue to taxi the aircraft towards the parking position, while the hydraulic system uses the pressure from the hydraulic accumulators (warnings for this scenario can be found in annex 2).

At the parking position the aircraft stops and then the hydraulic system warning lights illuminates on the central warning panel. The warning is activated in case of low pressure in any of the accumulators or in case of high temperature of the hydraulic fluid in the main fluid reservoir. In this case, it would be low pressure, because the pump is turned off, therefore does not create new pressure, and it cannot heat the liquid.

The pilots activate the parking brake and switch to the procedure of shutting down the engines that were still running, and the propellers were creating thrust. During that time, the marshaller gave the crew signs that were unclear to them, after which he sat in a vehicle that was located twenty meters in front of the aircraft.

Then the aircraft starts an uncontrolled movement forward. The marshaller, who was sitting in the vehicle at that moment, notices that the aircraft was approaching him, and by driving in reverse he manages to avoid the impact of the propeller on the vehicle. Nevertheless, the aircraft hit the marshaller's vehicle, scraped the lower part of the nose on the roof of the vehicle and damaged the left door of the vehicle with the nose landing gear. The impact caused the vehicle to turn to the right, and the aircraft continued towards the goods terminal, where it came to rest leaning against the van.

2.2. OPERATION OF THE HYDRAULIC PUMP

The operation of the hydraulic pump during flight and landing was in order. At some point, after the landing itself and during the departure from the runway, an unusual and unfamiliar sound to the pilots appeared on the pump, but the operation of the pump itself, judging by the indications on the central warning panel, was still in order.

Checklists for the hydraulic system abnormal operation do not mention the procedure for unusual noises from the hydraulic pump.

In the event of a hydraulic pump failure, the required pressure in the system is achieved through hydraulic accumulators. These accumulators, however, have a limited capacity. This means that by using the aircraft hydraulic system, the pressure in the accumulators will decrease. If the pressure in the accumulators does not rise with the operation of the electric or manual hydraulic pump, at some point, due to the use of the hydraulic system, it will drop to zero.

The drop in pressure to zero in the case when the pumps are not working, and only the accumulators are used, happens instantly. The pressure first drops to 1650 psi and the warning on the central panel is already activated before reaching that pressure. Immediately after that, when the piston in the accumulator has reached its end position and can no longer create pressure because it rested on the accumulator wall, the pressure in the aircraft hydraulic system drops to zero.

2.3. PARKING BRAKE

By pressing the foot pedals, the pilot uses the hydraulic system to activate the brakes that influence the wheels of the aircraft's landing gear. After that, by turning the parking brake lever, the brakes are 'blocked' and remain active.

The parking brake lever closes or opens the valve on the hydraulic system. That valve will keep the pressure on the brakes that the pilot previously achieved by pressing the brake pedal. However, the described does not function if the pressure in the system is below a certain value (1500 psi).

2.4. HYDRAULIC SYSTEM FAILURE IN OPERATING

After shutting down the electric hydraulic pump, the functioning of the hydraulic system continued with power from the hydraulic accumulators. The aircraft thus managed to reach the parking position and stop here. When arriving at the parking position, the pilot used the brake three times until the final stop (visible from the recording of the surveillance camera). Each braking additionally consumed the pressure supply from the accumulator.

The pilot then applied the parking brake. At that moment, apparently, all the pressure from the hydraulic accumulators was 'consumed' and the pressure in the hydraulic system instantly dropped to zero. The parking brake therefore failed to maintain pressure on the landing gear brakes. Apparently, the pilots were not aware of this at the time.

2.5. MOVEMENT OF THE AIRCRAFT FROM THE PARKING POSITION

After stopping and pulling the lever of the parking brake (the pilots do not mention checking the parking brake activation indication), which should have been activated, the pilot releases the foot brakes, which no longer need to be held down when the parking brake is activated. The pilot expected the aircraft to remain standing still.

On the central warning panel there is a light signalling that illuminates up when the parking brake is active. The pilots did not mention this signalling in their statements. It is very likely that they did not notice that the indicated light signalling was not turned on.

The engines were then still running and the propellers were generating thrust. When the pilot released the foot brakes, the aircraft began to move forward.

2.6. UNWANTED TAXIING OF THE AIRCRAFT

The initial acceleration was considerable. The pilots tried to stop the movement of the aircraft by pressing the foot brakes. Due to the loss of pressure in the hydraulic system, the brakes no longer functioned and the aircraft continued to move.

The pilots then changed the angle of the propeller blades so that they no longer generate thrust. They turned off the engines and the propellers gradually stopped.

The aircraft was still moving forward by inertia. Considering the brakes were not operating, there was no possibility of a controlled stop of the aircraft.

The movement continued until the front part of the aircraft hit the marshaller's vehicle (a smaller airport staff vehicle). The aircraft was pushing the afore-mentioned vehicle on the platform, until the marshaller who was in the vehicle swerved the vehicle out of the aircraft's path.

The aircraft continued to move, now at a reduced speed, until it hit a van that was in its path and stopped there.

2.7. PILOTS' PROCEDURE

The pilots reacted to the unusual and unknown sound of the hydraulic pump by turning it off. The checklists for the hydraulic system abnormal operation deal with cases of high hydraulic oil temperature and pressure drop in the system. There is no mention of difficulties of a different type, including the case of a change in the sound of the hydraulic pump. The procedure in such a situation is not defined.

The pilots, after the appearance of an unknown sound of the hydraulic pump, decided to turn it off. Such decision seems reasonable considering that the aircraft was on the ground, the movement speed was not high and the aircraft was expected to stop and the engine shut down soon. The pilots probably estimated that they had enough pressure from the hydraulic accumulators for all of this, and that it was better to turn off the pump, which seemed to be malfunctioning, as a precaution.

The pilot's decision and procedure worked until the moment when the supply of pressure from the hydraulic accumulators was consumed. The pilots probably had no realistic idea of how long the hydraulic accumulators could function without the hydraulic pump operating.

Shortly before stopping, the low-pressure warning light in the hydraulic system illuminated. The pilots then checked the state of the hydraulics and concluded that the system was still under sufficient pressure. They continued with the procedure of stopping and shutting down the engine.

After stopping and when the parking brake was activated, there was a sudden drop in pressure in the system. The reasons for the immediate pressure drop from 1650 psi to 0 psi are described in earlier sections. The pilots did not expect this, it is also possible that they did not have such detailed knowledge about the operation of the aircraft hydraulic system.

When the aircraft started to move from the parking position where it stopped for a short time, the pilots tried to control the aircraft by braking and turning, but the aircraft became completely uncontrollable. The pilots turned off the engines and set the angle of the propeller blades to 'feather' so that they would no longer produce thrust. That was all they could do at the time in terms of controlling the movement of the aircraft.

2.8. COMMUNICATION

In this incident, there were certain ambiguities in the communication between the marshaller and the crew.

The pilot stated that he could not fully understand all of the marshaller's signs, and he thought that he might be indicating some problem about the aircraft.

The co-pilot also states that there were unclear signs from the marshaller, and that he looked upset, and that the reason for this could have been the slow taxiing to the parking position.

In his statement, the marshaller says that the aircraft swirled during the taxing and did not turn off the driving light, but he did not state that there were any communication problems.

All mentioned regarding the communication between the pilot and the marshaller had no significant impact on the development of the difficulties that resulted in this serious incident.

3. CONCLUSION

3.1. FINDINGS

- The flight that preceded this serious incident proceeded normally, without difficulties or signs that would indicate the appearance of any technical problems,
- The landing was normal,
- During departure from the runway, an unusual sound of the hydraulic pump appeared,
- The hydraulic fluid level was within the prescribed limits,
- The pilots turned off the hydraulic pump, counting that the supply of pressure from the hydraulic accumulators would be sufficient for taxiing and parking the aircraft,
- Taxiing to the parking position took place slowly, and with the hydraulic pump turned off,
- Towards the end of the drive, the light warning of low pressure in the hydraulic system illuminated,
- When stopping, the pilot used the brake three times,
- The supply of pressure from the accumulator was completely consumed until the moment of the final stopping and applying of the parking brake, when the pressure suddenly dropped to zero,
- The wheel chocks have not been placed yet because the engines are still running,
- When the pressure in the hydraulic system ceased to exist, all brakes ceased to operate, as well as the ability to control the aircraft on the ground,
- Considering that after stopping, the propulsion system was still producing thrust, and the brakes were not functioning, the aircraft began to move forward uncontrollably,
- The pilots then shut down the engines using the normal shutdown procedure and the angle of the propeller blades in that case passed the angles from the lowest to the feather position, and according to the instructions in annex 2, they should have used the fire handles
- Thrust then ceased to exist, and the aircraft continued to move uncontrollably due to inertia,

- During the uncontrolled straight-ahead movement, until stopping, the aircraft damaged two vehicles that were in its path,
- After the inspection of the aircraft, only damages caused by a collision with a vehicle were found,
- In the technical documentation, after the replacement of the damaged components, there was no indication of malfunction of any other component.

3.2. CAUSE

Immediate cause:

Loss of pressure in the hydraulic system and consequently the inability to use the brakes and the inability to control the aircraft.

Contributing factors:

Insufficient knowledge of the pilot in terms of using the hydraulic system in the event of the electric hydraulic pump ceasing to operate.

4. SAFETY RECCOMMENDATIONS

Considering the findings obtained through this investigation, AIA issues the following safety recommendations to the company 'Fleet Air International Kft.' which is the owner and operator of the aircraft SAAB 340A, registration HA-TAD:

AIN04-SR-01/2024

To include in the emergency check list a text that will define that in the event of the electric hydraulic pump failure, one of the pilots, using a manual hydraulic pump, maintains the pressure in the aircraft's hydraulic system within the limit of 2100 - 2900 psi.

AIN04-SR-02/2024

To include a text in the emergency check list that will define that in the event of the electric hydraulic pump failure, the use of the pressure supply from the hydraulic accumulators will be rational, which means that all elements and actions that require the use of the aircraft's hydraulic system are carried out to the extent that it is necessary (e.g. driving without unnecessary turns and multiple braking...).

Investigator in Charge

Tomo Matić

5. ANNEXES

Annex 1. – After landing checklist

AFTER LANDING CHECK

Gust Lock	ON	RP
Ice Protection	SET	
Autocoarsen	OFF	
External Lights	SET	
HP Valves	CLOSED	
Diff. Pressure	CHKD	
Flaps	UP	
Radar/Transponder	STBY	
Auto Ignition Test (1)	PERF	

Annex 2. – Warning for use with hydraulic system without pressure or inoperative hydraulic pump

HYDRAULIC FLUID LOSS

(Cont'd)

After landing

WARNING

Do not taxi with bake system unpressurized. Once the aircraft has come to a stop after landing, shut down engines with Fire Handles to prevent uncontrolled forward thrust. Be aware that at low power setting it takes approximately 45 seconds for the engine to consume the remaining fuel before ceasing. Tow the aircraft to a safe parking.

Ensure that AUTOCOARSEN is selected to OFF prior to shutting down the engines.

NOTE

During taxiing with a non functional hydraulic pump, use nose wheel steering and brakes with great care. The functions will be abruptly lost when hydraulic accumulator pressure falls below about 1650 psi.

3. End of procedure.

Annex 3 – Checklists for the hydraulic system abnormal operation

2. ABNORMAL OPERATION

CONDITIONS	ABNORMAL PROCEDURES
2.1 HYDR LIGHT ON PROCEDURE APPLICABLE WITHOUT MOD NO 1463 AND NO 1783 EMBODIED	INDICATIONS – MASTER CAUTION. – HYDR (CWP)) light. – Possibly low EMER press ACTION 1. HYDR PUMP switch ..... OFF. **If EMER pressure below 1850 psi** WARNING Do not operate flaps before extending landing gear. 2. Landing Gear Handle ..... DOWN. – Extend landing gear immediately. 3. EMERG LDG Handle ..... PULL. 4. Land at the nearest suitable airport. 5. Operate Flaps and Brakes as outlined in procedure 3.2. HYDRAULIC FLUID LOSS. 6. End of procedure. **If EMER pressure normal** This indicates that the HYDR light was caused by high fluid temperature. **If time permits, let hydraulic fluid cool until light goes off** When light goes off and hydraulic service is required. 2. Operate HYDR PUMP in OVRD for as short time as possible to complete the hydraulic service. If HYDR light comes on again. 3. Terminate use of electrical pump. 4. Operate Flaps, Landing Gear and Brakes as outlined in procedure 3.2. HYDRAULIC FLUID LOSS. 5. End of procedure. **If no time for cooling** 2. Operate Flaps, Landing Gear and Brakes as outlined in procedure 3.2. HYDRAULIC FLUID LOSS. 3. End of procedure.

CONDITIONS	ABNORMAL PROCEDURES
2.2 HYDR LIGHT ON **PROCEDURE APPLICABLE WITHOUT MOD NO 1463 BUT WITH MOD NO 1783 EMBODIED** (Cont'd)	**INDICATIONS** – MASTER CAUTION. – HYDR (CWP)) light. – Possibly low pressure in one or more of the hydraulic accumulators. NOTE Low pressure in one or both BRK accumulators is always accompanied by low pressure in the MAIN accumulator. **ACTIONS** 1. HYDR PUMP switch ..... OFF. ◆ **If EMER pressure below 1850 psi.** **WARNING** Do not operate flaps before extending landing gear. 2. Landing Gear Handle ..... DOWN. – Extend landing gear immediately. 3. EMERG LDG Handle ..... PULL. 4. Land at the nearest suitable airport. 5. Operate Flaps and Brakes as outlined in procedure 3.2. HYDRAULIC FLUID LOSS. 6. End of procedure. ◆ **If MAIN pressure below 1850 psi and HYDR QTY indication below red radial.** **(Pressure in one or both BRK accumulators may also be below 1850 psi.)** 2. Proceed to procedure 3.2. HYDRAULIC FLUID LOSS. 3. End of procedure. ◆ **If MAIN pressure below 1850 psi and HYDR QTY indication normal.** **(Pressure in one or both BRK accumulators may also be below 1850 psi.)** 2. HYDR PUMP switch ..... OVRD. ◆ **If no time for cooling** 3. Proceed to procedure 3.2. HYDRAULIC FLUID LOSS. 4. End of procedure. ◆ **If pressure increases when in OVRD**

CONDITIONS	ABNORMAL PROCEDURES
(Cont'd)	3. Switch between OVRD and OFF as required to maintain pressure when operating hydraulic systems. 4. End of procedure. **If EMER and MAIN pressure normal** This indicates that the HYDR light was caused by high fluid temperature. **If time permits, let hydraulic fluid cool until light goes off** When light goes off and hydraulic service is required. 2. Operate HYDR PUMP in OVRD for as short time as possible to complete the hydraulic service. **If HYDR light comes on again** 3. Terminate use of electrical pump 4. Operate Flaps, Landing Gear and Brakes as outlined in procedure 3.2. HYDRAULIC FLUID LOSS. 5. End of procedure.
PROCEDURE APPLICABLE WITHOUT MOD NO 1463 BUT WITH MOD NO 1783 EMBODIED	**If no time for cooling.** 2. Operate Flaps, Landing Gear and Brakes as outlined in procedure 3.2. HYDRAULIC FLUID LOSS. 3. End of procedure.
2.3 HYDR LIGHT ON PROCEDURE APPLICABLE WITHOUT MOD NO 1783 BUT WITH MOD NO 1463 EMBODIED	**INDICATIONS** – MASTER CAUTION. – HYDR (CWP)) light. – Possibly low EMER press. **ACTIONS** 1. HYDR PUMP switch ..... OFF **If EMER pressure below 1850 psi and MAIN pressure approaches red radial line** CAUTION Leave Flaps in actual position. 2. Landing Gear Handle ..... DOWN. – Extend landing gear immediately. 3. EMERG LDG Handle ..... PULL.
(Cont'd)	

CONDITIONS	ABNORMAL PROCEDURES
(Cont'd) PROCEDURE APPLICABLE WITHOUT MOD NO 1783 BUT WITH MOD NO 1463 EMBODIED	4. Land at the nearest suitable airport. 5. Operate Flaps and Brakes as outlined in procedure 3.2. HYDRAULIC FLUID LOSS. 6. End of procedure. **If EMER pressure below 1850 psi and MAIN pressure normal** 2. Operate Landing Gear, Flaps and Brakes as outlined in procedure 3.2. HYDRAULIC FLUID LOSS. – Follow procedure as for HYD MAIN pressure low. 3. End of procedure. **If EMER pressure normal** This indicates that the HYDR light was caused by high fluid temperature. **If time permits, let hydraulic fluid cool until light goes off** When light goes off and hydraulic service is required. 2. Operate HYDR PUMP in OVRD for as short time as possible to complete the hydraulic service. **If HYDR light comes on again** 3. Terminate use of electrical pump. 4. Operate Landing Gear, Flaps and Brakes as outlined in procedure 3.2. HYDRAULIC FLUID LOSS. – Follow procedure as for HYD MAIN pressure low. 5. End of procedure. **If no time for cooling** 2. Operate Landing Gear, Flaps and Brakes as outlined in procedure 3.2. HYDRAULIC FLUID LOSS. – Follow procedure as for HYD MAIN pressure low. 3. End of procedure.

CONDITIONS	ABNORMAL PROCEDURES
2.4 HYDR LIGHT ON (WITH PROPELLER BRAKE APPLIED) PROCEDURE APPLICABLE WITHOUT MOD NO 1783 EMBODIED	**INDICATIONS** – MASTER CAUTION. – HYDR (CWP)) light. – Possibly low EMER press. **ACTIONS** 1. Shut down engine. ◆ **If EMER pressure below 1850 psi** 2. HYDR PUMP switch ..... OFF. 3. End of procedure. ◆ **If EMER pressure normal** This indicates that the HYDR light was caused by high fluid temperature. 2. R PROP BRK switch ..... OFF. To cool down the hydraulic fluid it is recommended to operate the flaps full down and up five to seven times. Before extending the flaps make positively clear that the flaps area is free from personell and ground equipment. ◆ **If HYDR (CWP) light goes off** 3. Wait 30 min. before re–application of propeller brake. 4. End of procedure. ◆ **If HYDR (CWP) light stays on.** 3. End of procedure.
2.5 HYDRAULIC MAIN PRESSURE LOW OR BRAKE PRESSURE LOW. PROCEDURE APPLICABLE WITHOUT MOD NO 1783 EMBODIED (Cont'd)	**INDICATIONS** – One or both BRK PRESS indicator and/or MAIN PRESS reading at or below red radial. NOTE Low pressure in one or both BRK accumulators is always accompanied by low pressure in the MAIN accumulator. **ACTIONS** 1. HYDR QTY indicator ..... CHECK. ◆ **If HYDR QTY indication decreasing or below red radial** 2. HYDR PUMP switch ..... OFF.

CONDITIONS	ABNORMAL PROCEDURES
(Cont'd)	3. Proceed to procedure 3.2. HYDRAULIC FLUID LOSS. 4. End of procedure. **If HYDR QTY reading normal** 2. HYDR PUMP Switch ..... OVRD. **If no increase in pressure when in OVRD** 3. Proceed to procedure 3.2. HYDRAULIC FLUID LOSS. 4. End of procedure. **If pressure increases when in OVRD.** 3. Switch between OVRD and OFF as required to maintain pressure when operating hydraulic systems. 4. End of procedure.

Annex 4 – Usage of hand pump in case of hydraulic fluid loss

HYDRAULIC FLUID LOSS

- A large number of hand pump strokes are required for flap and landing gear operation.
- Stroke resistance characteristics vary from very light to rather heavy.
- Position of handpump selector is important. Normally center for gear and flaps and at the outer end (left/ right) for inboard/outboard brakes. Small adjustments to these positions might be necessary to achieve enough pressure.
- A large number of hand pump strokes and continuous pumping is required to achieve and maintain enough brake pressure.
- Normal action with a faulty hydraulic pump is to tow the aircraft on ground. It is a challenging task to taxi on ground with just the handpump as pressure source.
- Direct entry into this procedure is when Hydraulic Quantity is low. The majority of Hydraulic fault related procedures refers to this procedure for Landing Gear, Flaps and Brake operation.
- Even though emergency extension does not require the Landing Gear handle to be selected down it shall be selected down for the obvious reason of agreeing with the Landing Gear position. It is also required for anti-skid function.
- Maximum speed for gear normal or emergency extension is 200 KIAS.