PRELIMINARY REPORT ON SERIOUS INCIDENT AT SVOLVÆR AIRPORT HELLE, NORWAY ON 2 DECEMBER 2010, INVOLVING BOMBARDIER DHC-8-103, LN-WIU OPERATED BY WIDERØES FLYVESELSKAP AS

This report is a preliminary and incomplete representation of AIBN's investigations in connection with the relevant aircraft incident. Report may contain faults and inaccuracies. The final report will be the Accident Investigation Board's official document concerning the incident and investigation.

This report has been translated into English and published by the AIBN to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

Aircraft:	
- Type and reg.:	Bombardier Inc. DHC-8-103, LN-WIU
Date and time:	Thursday 2 December 2010 18:18 hours.
Incident site:	Approx. 1.5 km north-northeast of the threshold of runway 19 at Svolvær Airport Helle (ENSH)(approx. N68°15'22" E14°40'44")
Weather conditions in accordance with last official observation at 17:50 hours, local time	METAR ENSH 1650 UTC 24030G44KT 8000 -SHRAGS FEW008 SCT012CB BKN014 05/03 Q1000 (Wind from 240 deg. 30 kt, gusting 44 kt, 8 km visibility, light rain and hail showers, few clouds at 800 ft, scattered cumulonimbus at 1,200 ft, broken cloud layer at 1,400 ft, temperature 5 °C, dew point 3 °C, QNH (barometric pressure) 1,000 hPa)
Light conditions:	Darkness
Operator:	Widerøes Flyveselskap AS
Flight type:	Scheduled passenger transport
Persons on board:	38 (2 pilots, 1 cabin crew, and 35 passengers)
Injuries:	None
Damage to aircraft:	None

INTRODUCTION

The Accident Investigation Board Norway (AIBN) was only made aware of the incident in December 2012, two years after it had taken place. Available information was considered, and additional information was obtained. After a consideration, the AIBN concluded in June 2013, that the event was to be classified as an incident. An investigation was not opened.

In February 2015, the incident generated significant attention, and AIBN made the consideration that the incident could contain a greater learning potential than first assumed. The decision not to investigate was reversed in accordance with the provisions[1]. AIBN opened an investigation in

[1] *In accordance with applicable provisions, the AIBN can, notwithstanding previous decisions, decide to investigate circumstances related to one or multiple aviation accidents or aviation*

March 2015. Based on the initial investigation, the Accident Investigation Board reclassified the incident to serious.

The information concerning the course of events are obtained from written reports from the crew, their detailed statements, and flight recorder data. It is almost five years since the time of the incident, and it must be taken into consideration that time may have affected the involved people's memories.

The AIBN has chosen to limit the scope of this preliminary report to considering the course of events based on accounts from the flight crew and flight data recorder data, taking the environment, weather, and visibility conditions into consideration. AIBN has obtained witness accounts from people on board the aircraft and eyewitnesses on the ground and in the tower. The statements correspond well with the flight recorder data and the information provided by the flight crew.

DESCRIPTION OF THE COURSE OF EVENTS

Initial part of flight

Widerøe flight 814 (WIF814) from Bodø Airport (ENBO) to Svolvær Airport Helle on 2 December 2010 departed at 17:55 hours. At this time, there was a south-westerly near gale, with gale force gusts. The wind direction varied, and there were showers and CBs in the area.

In flight, the crew obtained updated information on wind conditions at the destination. After approx. 20 minutes flight, they had almost arrived at the destination, and the wind had died down and was assessed to be within the operational limits set by the company[2]. They then commenced regular procedure with south-westerly wind, which is an instrument approach through the cloud layer (LOC 01), circle visually east of the airport and land in an southerly direction (see map and circling pattern in Appendix A).

Visibility below the clouds was good, and they had visual contact with the airport lights well before coming down to the minimum altitude. They started circling and followed the standard procedure, i.e. they lowered the landing gear, set the flaps to 15° and prepared engine and propeller controls for landing (condition levers max). The autopilot was disengaged before turning from the downwind leg (northerly direction) towards the base leg (westerly direction) in the circling pattern.

The role distribution was that the Commander (the captain) piloted the aircraft (Pilot Flying, PF) while the First Officer handled the other tasks (Pilot Monitoring, PM). The standard procedure during the circling phase is that the PF looks out and mainly bases the flying of visual references, while PM monitors the instruments and calls out any deviations from the correct speed and flight path.

On the downwind leg, the commander was concerned that the wind would carry the aircraft away from the airport and towards the mountains marked with white flashing avoidance lights (see Appendix A). The First Officer noticed a drop in airspeed, and called out "Check speed". The Commander adjusted the airspeed, but only marginally, as he saw and perceived that the airspeed

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incidents. AIBN decides the scope of the investigation and how to conduct it, cf. Section 12-13 of the Aviation Act).

[2] With variable wind in the sector 240-340 deg., Widerøe has a self-imposed restriction upon 25 kt., including wind gust force during the final 2 minutes

did not deviate significantly from what he had planned. The crew had not discussed increasing airspeed, which is often done in order to increase margins with strong winds and with unstable wind conditions. There was not particularly strong turbulence en route or while in the circling pattern.

The Commander's description of the critical phase

The Commander has explained that he maintained normal speed and started the turn to "base" at the usual point, meaning he had passed the airport and could see the airport lights behind him (approx. 45°). It was also completely dark, and he could not see the horizon or the sea below, after turning and flying along the base leg. During this phase, he knew that the lights from the airport were visible to his left, and he could see the red obstacle lights approx. 1 - 1.5 km north of the airport in front of him. The intention was to maintain circling altitude (600 ft) until they had made the turn for final approach and had a good position for landing.

According to the Commander's recollection the turn from base towards final approach had not started when he noticed the first sign of something abnormal. He noticed a significant drop in airspeed and that the aircraft started buffeting. At same time, the First Officer called out "Check speed". He immediately went to full engine power and pitched up to compensate, but the effect of the corrections were not as expected. Both airspeed and altitude continued to decrease, and it felt like the aircraft was falling or being pushed down.

The Commander pushed the control column (stick) forward to prevent stalling. When he pulled the stick back again to climb, the aircraft's "stick shaker" (mechanism that shakes the stick, warning that stalling is imminent) was triggered. He instinctively understood that he had to ease off on the pull-up (slight release of back pressure) to build up more speed first. While this was happening, he saw the red obstacle lights in front of him. According to his recollection he briefly looked at the altimeter during this phase and it indicated approx. 300 ft (approx. 90 metres).

The Commander focused on one of the red lights, and "staying low", in order to build up speed. It worked, and he started a climb and saw that they would pass the light at a safe altitude. About this time, after he had gained sufficient speed and the aircraft had started to climb, the First Officer unexpectedly assumed control. The Commander has explained that in his view that was not necessary, but decided not to oppose this.

The First Officer's description of the critical phase

The First Officer has explained that he monitored the instrument and had called out "Check speed" once during downwind, and once more at a point in the circling pattern. He believed the corrections were too small, considering the conditions. As they turned in for final approach, the "stick shaker" was triggered. He remembers that he was startled when the stick started shaking.

The First Officer has described that he was ready to perform the corrective measures required in such situations, but the expected callout and reaction from the Commander did not come. What happened next was that the nose of the aircraft made a significant dip, and he has stated that he then "*Stared straight down onto the black sea*". He remembers seeing a red light on an islet below.

The First Officer has explained that he instinctively grabbed the control wheel and pushed the engine controls all the way until they stopped (approx. 116 per cent). He remembers pulling the stick back with both hands, while thinking there is no way this will end well. However, they started to climb, and they climbed to a safe altitude where the situation came under control.

Further course of events

Briefly summarised, what happened after the First Officer had taken over the controls, was that the commander took on the role of Pilot Monitoring. He took the initiative to act in accordance with the procedures for missed approach. This included retracting the landing gear and flaps and adjusting engine power. During this phase, he became aware that they had probably overtorqued the engines. The crew decided to fly to Leknes, where weather conditions were better, and to land there. Both pilots agreed that it had to be the wind that had affected the aircraft.

Necessary coordination with air traffic services was carried out before the First Officer gave the passengers a short briefing. He mentioned that they had encountered wind conditions that had forced them to abort the approach, and that they would continue to Leknes. The Commander resumed the role as Pilot Flying, and the aircraft landed at Leknes approx. 23 minutes after the incident. Passengers were transported by bus to Svolvær.

In retrospect, both pilots have said that they were shaken after the incident. They had different perceptions of how low they had been. The Commander believed approx. 300 ft, while the First Officer estimated that they could have been as low as 150-200 ft.

Technical issues

There are no findings to indicate that technical faults or irregularities with the aircraft may have caused the incident or influenced the course of events

FDR data show that both the engines and the aircraft's structure (wings) were exposed to major stress during the incident. The torque on the engines was, however, only briefly above the normal values, and was, according to the maintenance documentation, not to be considered as an overtorque. The aircraft was later inspected without any signs of structural overload being found.

ACTION TAKEN AFTER THE INCIDENT

AIBN has noted that improved circling lights have been installed at Svolvær after the incident. Onshore lead lights have also been installed, as well as the circling pattern being expanded. Double PLASI has also been installed[3]. Use of turbulence forecast is another example of improvement. Svolvær airport has submitted plans for a new anemometer at Teisthaugen, north of the runway, in connection with the 2016 budget process.

Widerøe has been a driving force for the corrective actions mentioned above. The company has made positive comments regarding the cooperation and the response from the Service Provider Avinor in terms of infrastructure improvements that may enhance safety.

Through its flight operations safety program (Flight Data Monitoring, FDM), Widerøe has documented that the frequency of excessive banking[4] at altitudes from 500 ft and down to landing on Helle, was reduced after the changes to the circling pattern.

[3] *Pulse Light Approach Slope Indicator. Double PLASI provides altitude reference in a larger sector during the final*
[4] *At altitudes under 300 ft banking of more than 15° is considered "excessive", and at altitudes between 300 and 500 ft the limit is 30°*

PRELIMINARY ANALYSES OF DATA FROM THE FLIGHT RECORDER

Introduction

The relevant flight recorder (Flight Data Recorder, FDR) has no parameters to show the aircraft's geographical position and speed compared with the ground. Furthermore, it does not register stalling or triggering of the stall warning (stick shaker), or from which side of the cockpit the control input comes from. Cockpit Voice Recorder (CVR) recordings from the incident is not available.

The flight recorder has a number of parameters that show the position of the nose of the aircraft, airspeed, altitude, control column movements, control surface deflections, engine settings, turn rate, acceleration etc., which can be analysed in order to try to establish the course of events. A selection of the parameters are plotted and shown in Appendix B.

Data from the FDR show that the critical phase described by the crew, going from a perceived normal situation via an acutely dangerous situation to a climb from an extremely low altitude over sea, took place over the course of approx. 9 seconds (Cf. Appendix B, FDR time 103196-103205). At the lowest, the altitude according to the radio altimeter was 83 ft (25 m).

Generally, the FDR shows that the aircraft was in a normal situation, in the transition between “base” and “final” (heading approx. 230 degrees). The aircraft had the correct altitude (indicated barometric altitude 700 ft (ref. footnote 6), radio altitude approx. 350 ft), and airspeed corresponding to actual mass in calm conditions (aircraft's mass is estimated at approx. 14 800 kg). The airspeed initially dropped approx. 15 kt., and was on its way up again when it suddenly decreased from 100 kt. to 74 kt., which is a critically low value.

The aircraft lost approx. 270 feet over the course of 8 seconds. Preliminary analyses of the graphs from the flight recorder indicate that during these seconds, the aircraft was exposed to significant external influences. The Commander's reaction and correction of both attitude and engine power seem to have prevented stalling. The subsequent pull-up most likely prevented a crash into the sea.

Loss of airspeed and subsequent corrective actions

The records show rapid and significant variation in G-force (turbulence) lasting several seconds. The vertical acceleration fluctuates repeatedly down towards approx. 0.5 G, which is felt as if the aircraft is falling. At the same time, there are airspeed variations without associated control column movements, which would indicate wind shear.

FDR data (Appendix B) confirm a significant loss of airspeed and show that the aircraft banked to the left at the same time. The tendency towards increased banking was initially partially countered with the ailerons, and engine power was quickly increased to maximum (100 per cent), while the nose of the aircraft was raised to approx. 10 degrees above the horizon.

The left banking continued and varied while airspeed dropped and engine power increased. During the pull-up, as the aircraft passed 150 ft radio altitude in descent, a 26 degree banking to the left was recorded.

The increase in engine power as such should have increased lift and made the aircraft climb, but the pitch up may have contributed to counteract this favourable effect (increased angle of attack increase induced drag). However, the data show that instead airspeed continued to drop, and it dropped to 72 kt, which is 5 kt lower than the aircraft's stalling speed.

The FDR data show that the stick was moved rapidly forward when the airspeed was at its minimum. This supports the Commander's statement that he lowered the nose of the aircraft. The decisive forward motion of the stick significantly lowered the nose of the aircraft, from approx. 10 deg. above to approx. 14 deg. below the horizon in 2 seconds. The tendency in the airspeed reduction was reversed during this phase, and the aircraft continually accelerated until the situation was resolved.

Assessment of whether the aircraft stalled

The somewhat considerable variations in g-values during the critical phase, with fluctuations lower than 1 G, indicate external influence/air disturbance. While there are large variations in pitch and the descent rate is almost constant, the G-load show small movements of 1.2 to 1.3 G, simultaneously as the nose was lowered and in the first phase of the pull-up.

When stalling in still air, one would expect to see a noticeable reduction in G-load. It is worth noting that the values did not go below 1 G in connection with the nose dropping, and that none of the fluctuations stood out significantly.

The graph showing changes in the vertical acceleration does not, at any stage, correlate with the change pattern one would expect to see in connection with stalling in still air. AIBN's conclusion, in consultation with experts from the aircraft manufacturer Bombardier, is that the fluctuations were due to air disturbances and that the aircraft did not, at any time, stall.

Pull-up

Data from the FDR show that the pull-up started immediately following the abrupt forward movement of the stick - from a position approx. 10 degrees aft and to an position to an position approx. 9 degrees forward of neutral (the movement took approx. 0.4 seconds), as the radio altimeter showed 220 ft. The nose of the aircraft was still approx. 8 deg. above the horizon when the pull-up commenced. In other words, at the time the aircraft nose had only just started lowering from the starting point of 10 degrees up.

FDR data for the control column parameter show that the pull-up lasted approx. 3 seconds (cf. Appendix B, Time 103200.3 – 103203.2). The rate of backwards motion of the stick (the speed of the angle of the control column in the pull-up) can be read from the graph in Appendix B. From the starting value, the rate is changed twice, with approx. 0.5 second intervals (from approx. 14°/sec, reduction to approx. 10°/sec, followed by increase to 24°/sec), in connection with levelling off.

The pull-up is reduced after 3 seconds, when the stick was close to the rear limit. The change in pitch follows the movement of the control column, but due to inertia, there is an approx. 1.5 sec delay in response. The G-forces (vertical acceleration) also increase more or less in conjunction with the movement of the nose of the aircraft, i.e. with a 1.5-second delay from the movement of the control column. The maximum value of 2.7 G is reached 1.5 seconds after the stick is moved forward for level off.

During the 3 seconds the pull-up lasts, the nose of the aircraft is in constant motion. It moves from approx. 8 degrees above the horizon, down to 14.3 degrees below the horizon and back up again to the starting position of approx. 10 degrees above the horizon. This entire “bowing motion” lasts approximately 4 seconds. The pitch change rate while the aircraft is “bowing”, is almost the same going down and going up; approx. 12°/sec.

AIBN compared statements from the crew with FDR data, and believes to have identified the most probable time when the control wheel was taken over. The time that stands out is approx. 2 seconds prior to engine power being increased beyond maximum (Time 103201.3). This happens while the rotation rate in the pull-up is changed a second time, and the same split second[5] a distinct change is recorded in the movement of the aileron controls. The aileron input is another indication that a hand takes hold of the control column to pull it backwards. The assessments of the Accident Investigation Board as regards this item corresponds to assessments made by the aircraft manufacturer Bombardier.

Engine power adjustments

Data from the flight data recorder show that the aircraft accelerated forcefully when full engine power was initiated (from approx. 42 per cent to approx. 100 per cent in approx. 3 sec). Additional increase in engine power, from 100 per cent and up to approx. 116 per cent, is registered 3-4 seconds later. The initial increase was prior to the nose being pushed forward with the stick, while the second increase (from approx. 100 per cent to approx. 116 per cent in approx. 1.5 sec) is initiated when the stick nears the rear mechanical stop and the nose passes 10 deg. below the horizon, pitching upwards .

Loss of altitude and recorded minimum altitude

Data from the radio altimeter, which measures the shortest distance to the ground below the aircraft, show that the dramatic change of the nose position did not affect the altitude loss rate in any noteworthy degree. Height decreased rapidly, steadily, and continuously during the critical phase (rate in excess of 2 200 ft/min). The minimum recorded altitude was 83 ft (25 m) above the ground.

According to Bombardier, the FDR parameter for pressure altitude, shown in Appendix B, is identical to what the pilots would have seen on the altimeter[6]. This means that the indication probably showed incorrect (too high values) throughout the critical period. The airspeed error was the largest as the nose of the aircraft was pushed forward and at the beginning of the pull-up. Bombardier has confirmed that the error is due to the sensors, located below the aircraft's windshield, being exposed to faster changes in airstreams than what they are designed to detect.

COMMENTS FROM THE ACCIDENT INVESTIGATION BOARD

Introduction

The incident probably occurred as a result of the aircraft suddenly being subjected to significant variations in wind direction and/or wind speed. The wind also probably impacted the aircraft during the seconds the crew had to regain control. Information about observed wind has lead AIBN to believe that the aircraft may have been exposed to a significant wind shear, for example as a result of sudden loss of headwind or maybe even tailwind, due to a gust from a CB in the area. It is also possible that this came in an unfortunate combination with mechanical turbulence in the area due to the south-westerly gale.

A more detailed assessment of wind, turbulence and hazards in connection with approach and landing under such conditions will follow in the final report. Such external influence can explain the significant loss of airspeed that could not be counteracted despite quick correction.

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[5] *With reservations concerning different sampling rate of the parameters.*

[6] *AIBN's assessment is that the difference between the barometric altimeter and the radio altimeter is greater than expected, and not consistent with statements from the crew, and will investigate this further.*

Operational issues

The Commander and the First Officer have more or less the same perception of the course of events until the occurrence of the loss of airspeed when turning from base to final. They also have fairly similar statements on what happened during the climb, after control was definitely regained.

The Accident Investigation Board will summarise the discrepancies between the crew members in this manner:

Commander	First Officer
• Gave full engine power and lowered the nose of the aircraft when airspeed was lost and buffeting started • Intentionally kept the aircraft low and accelerated at a safe altitude towards a red obstacle light • Airspeed increased and climb was initiated prior to the First Officer unnecessarily took over the controls.	• "Stick shaker" activated • The nose was lowered as a result of external influence, without corrective measures being implemented from the side of the Commander • Instinctively assumed controls of the aircraft to avert crashing into the sea.

FDR data do not provide complete verification, but the Accident Investigation Board believes it has found explanations for the most important differences by analysing the available parameters. A key point is delay as a result of inertia in the aircraft's movement. This may had obscured the fact that the Commander already had implemented the measures the First Officer was waiting for. It is correct that the nose was below the horizon and that the aircraft was still losing altitude when the engine controls were moved completely forward until stop, but at the time AIBN believes the First Officer intervened, the stick had already been moved significantly back and the tendency had turned.

AIBN also wants to stress that the available data do not provide basis to say anything for certain on how the situation had developed further if the First Officer had not intervened. The tendency for altitude loss was countered, and it is AIBN's assessment that hypotheses concerning what could changed the outcome if one or more of the factors in this complex picture had changed, would be pure speculation. It is not possible to know how the Commander would have moved the controls had he retained them.

The high G force and low altitude above the sea show that the margins were small. It is important to note that during a perceived emergency situation, it was correct for the First Officer to intervene. In this case, things developed extremely quickly, and the critical phase was very short. The crew members can have perceived both the time and threat differently.

In this preliminary report, the AIBN can only conclude that the circumstances and outcome show that the crew successfully averted crashing into the sea after being exposed to a major wind shear at low altitude.

Likelihood for spatial disorientation

The Accident Investigation Board assessed that the risk of spatial disorientation was great in this instance, as the Commander flew on visual without visible horizon and in complete darkness. In particular, the powerful longitudinal acceleration during the initial increase in engine power could have caused so-called somatogravic illusion, a false sense of the nose of the aircraft raising. A possible illusion could explain some apparent discrepancies and circumstances which otherwise do not appear logical in this case. Specifically why the crew did not perceive just how low they were, why they reacted the way they did when exposed to a wind shear, and why they ended up with different perceptions of what had actually happened.

The AIBN has consulted the Aeromedical Institute of Norway (Flymedisinsk institutt, FMI) which has special expertise on the subject, in order to get a description of possible spatial disorientation involved, and the probability of them occurring. A preliminary report from FMI is enclosed as Appendix C. The report concluded as follows:

> *Based on available data, a preliminary analysis shows that conditions were in place for PF to have experienced a somatogravic illusion, both in the phase before moving the stick forward (second 103199) and while the aircraft accelerated with the nose pointed down towards the sea (second 103200-103202). This can have influenced him to keeping the nose lower than what he would have done with good visual references. The First Officer's perception of the situation would probably be less influenced by the illusionary forces as he had greater focus on the instruments. To what extent this actually influenced the flight cannot be determined for certain, but the forces that can create such an illusion were present in the relevant period of time.*

The mechanisms are briefly described in the enclosed report from FMI. The Accident Investigation Board will discuss this issue in more detail in the further investigation.

RELEVANT SAFETY ISSUES

Challenging weather and wind conditions during operations at the Norwegian network of airports with short runways have been addressed in a number of previous AIBN reports, and are a key issue in this investigation as well. In this regard, it is also natural to point out the balance between regularity and safety in the short runway operations. AIBN also wishes to draw attention to Report SL 2009/22 concerning an aviation accident at Hammerfest Airport 1 May 2005, with Widerøe’s DHC-8-103, LN-WIK. The report discusses wind conditions, regularity, and conditions associated with the short runway operations concept.

In its further investigation of the incident in Svolvær, the AIBN will assess risk management and safety margins when circling in darkness without a visible horizon and visible contours on the ground. The risk of spatial disorientation during such operations, and the company's handling of this risk factor, will be given attention.

The Accident Investigation Board Norway

Lillestrøm, 21 August 2015

ENSH/SVJ wideroe
HELLE

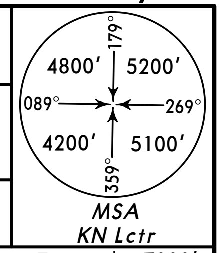
2 JAN 09 (11-1) Eff 15 Jan

SVOLVAER, NORWAY
LOC Rwy 01

BRIEFING STRIP ™

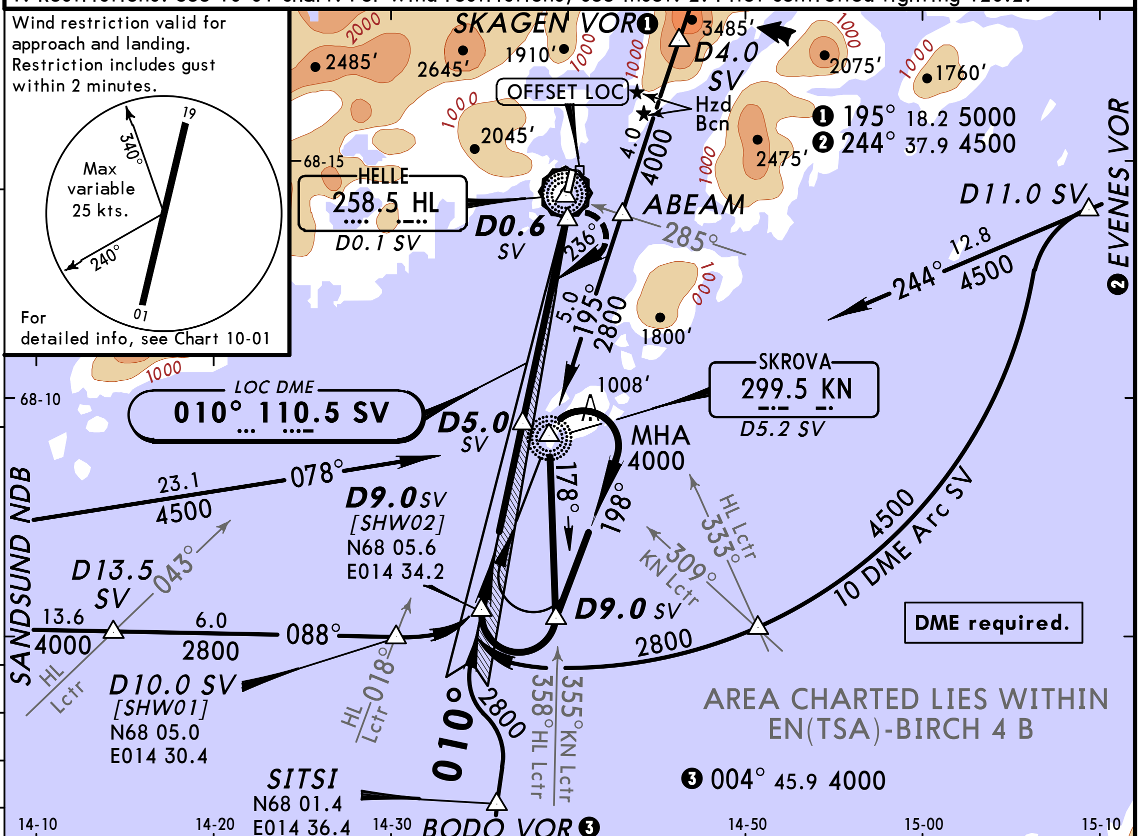
*HELLE Information	CUT (WIF)
120.2	131.425

LOC SV	Final Apch Crs	Minimum Alt D5.0 SV	MDA(H)	Apt Elev 29′
110.5	010°	1500′ (1471′)	330′ (301′)	RWY 29′

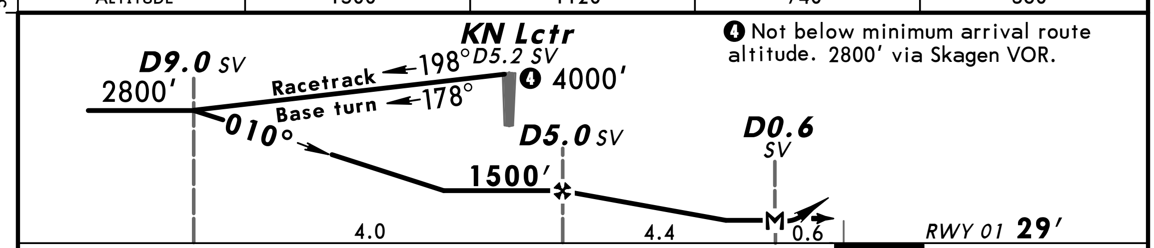


MISSED APCH: Turn RIGHT (APCH FLAP/25° BANK) to 236° and climb in LOC on 190° to 4000′ and join holding.

White avoidance lights 2 NM Northeast THR rwy 19. LOC CRS parallel offset East of RCL. Trans alt: 7000′
1. Restrictions: See 10-01 chart. For wind restrictions, see inset. 2. Pilot controlled lighting 120.2.



SV DME	5.0	4.0	3.0	2.0
ALTITUDE	1500′	1120′	740′	360′



❹ Not below minimum arrival route altitude. 2800′ via Skagen VOR.

Gnd speed-Kts	70	90	100	120	140	160
Descent Gradient 6.3%	447	575	638	766	894	1021
MAP at D0.6 SV						

HIALS
PLASI 4.5°

Refer to Missed Apch above

STRAIGHT-IN LANDING RWY 01		Max Kts	CIRCLE-TO-LAND	
MDA(H) 330′ (301′) ALS out			CEILING REQUIRED. Not authorized West of airport. PRECISION CIRCLING see APT chart. MDA(H)	
-100	VIS 1000m	109	580′ (551′)	2500m

PANS OPS 3W

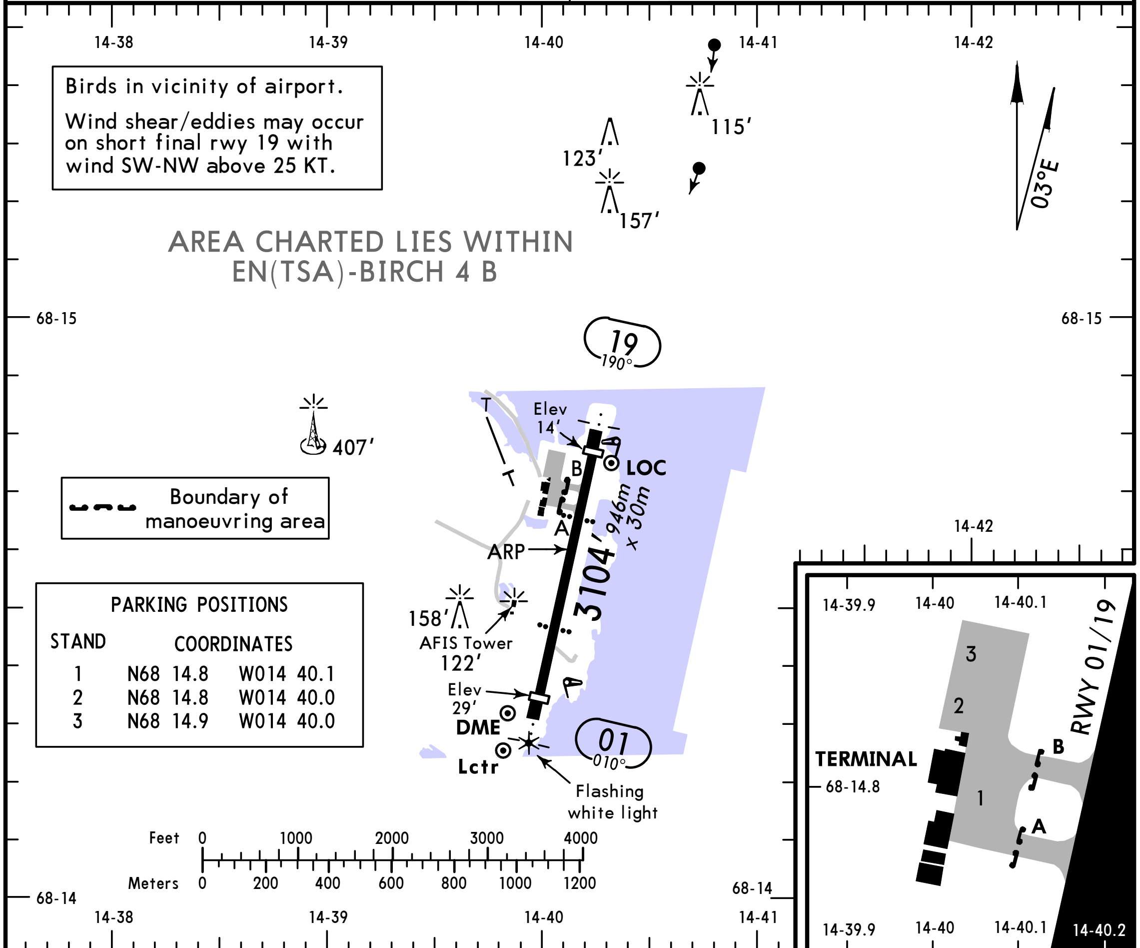
CHANGES: LOC course.

ENSH/SVJ wideroe **SVOLVAER, NORWAY**

Apt Elev **29'** 11 FEB 11 **10-9** HELLE

N68 14.6 E014 40.2

*HELLE Information	CUT (WIF)
120.2	131.425



ADDITIONAL RUNWAY INFORMATION

RWY		USABLE LENGTHS LANDING BEYOND Threshold	Glide Slope	TAKE-OFF	SLOPE %
01 ❶	❷HIRL *(50m)* CL *(50m)* ❷HIALS ❹PLASI-L (4.5°, MEHT 22') GAL grooved RVR	2644' *806m*		2874' *876m*	-0.63
19	❷HIRL *(50m)* CL *(50m)* ❷HIALS ❸SFL ❺PLASI-L (4.5°) GAL grooved RVR	2546' *776m*		2776' *846m*	+0.63

❶ Anti skid surface.

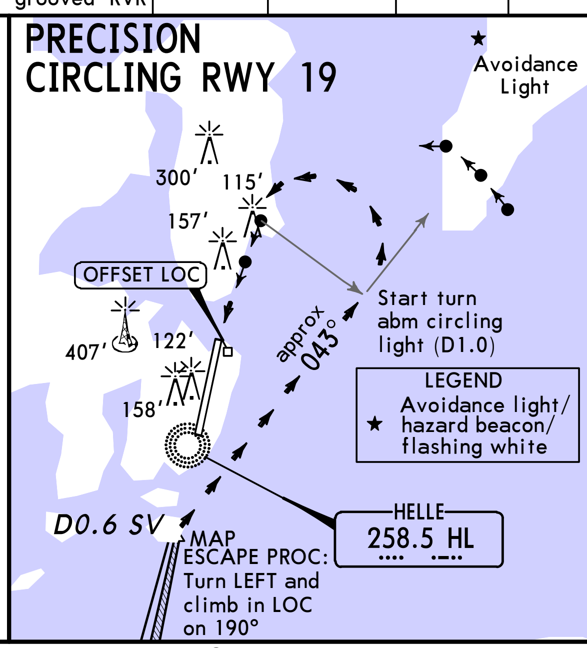
❷ Activate on 120.2 when HELLE Information inop. Key mike continuously 5 sec.

❸ From 1402m to 825m from THR (3 elements).

❹ Obstacles penetrates the obstacle clearance surface 886'(270m) in front of thresh 01 and 164'(50m) West of runway centerline.

❺ Restricted to max D5.0 SV.

PRECISION CIRCLING RWY 19



CHANGES: Circling lights.

Note: The map shown here is not the correct version. (The correct map has so far not been available.)

FDR-data

Acronyms and Abbreviations

AFM	Aircraft Flight Manual
CET	Central European Time
FDR	Flight Data Recorder
ICAO	International Civil Aviation Organization
KCAS	Calibrated Airspeed in knots
LWD	Left-wing down
MSN	Manufacturer Serial Number
RWD	Right-wing down
TED	Trailing-edge down
TEU	Trailing-edge up
UTC	Coordinated Universal Time (Zulu Time)
V_{FE}	Maximum flap extended speed
V_{MCL}	Minimum control speed, landing
V_{REF}	Landing reference speed

Factual Observations

Based on a review of the relevant flight data from the FDR, as presented in **Figure 1** and **Figure 2**, the following factual observations can be made in chronological order (sample times are in seconds):

(1) The aircraft was configured with flap 15 for approach and throughout the period of this analysis.

(2) From sample time 103190.0 through 103196.0, the aircraft magnetic heading decreased from 239 to 233˚, radio altitude decreased from 409 to 354 ft, and roll attitude decreased from -2˚ to -16˚ (LWD), indicating the aircraft was on a circling approach to runway 19. Airspeed is between 107.4 and 110.0 KCAS while the V_{REF} at incident flap setting and estimated weight is 100 KCAS. From the radio altitude during this period, the rate of descent is calculated to have averaged 552ft/min and is consistent with a 3˚ approach.

(3) From sample time 103196.1 to 103197.1, the airspeed decreases from 110.5 to 94.0 KCAS. During this period of time, longitudinal acceleration experiences little variation, remaining below 0.1 g while vertical acceleration decreases from 0.9 to 0.6 g.

(4) At sample time 103197.0, engine 1 and 2 torque are both at 42.0% and increase to 97.5% and 99.9%, respectively 3.0 seconds later. Normal engine torque operating range is 0-97.5%. Correspondingly, longitudinal acceleration is seen to increase from 0.1 to 0.5g during this period. Left and right elevators are at 6.0˚ and 2.2˚ respectively and ramp up to 9.8˚ and 6.3˚ 2.3 seconds later.

(5) At sample time103198.1, the speed has risen to 99.4 KCAS, but begins dropping rapidly. Pitch attitude is 5.9˚ nose up and increasing. The vertical acceleration is 0.6 g.

(6) At sample time 103199.3, the elevators travel TED for approximately 1.0 second before reversing sharply.

(7) At sample time 103199.8, airspeed drops below 76.5 KCAS, the estimated stall speed for the aircraft based on the AFM at the incident flap settings and estimated weight. The aircraft remains below the declared stall speed for approximately 0.7 seconds, decelerating to its lowest point of 72.0 KCAS at 103200.1. According to the AFM, V_{MCL} for the aircraft is 74.0 KCAS.

(8) At sample time 103199.9, the pitch attitude is 9.3˚ nose up and begins dropping.

(9) Between sample time 103200.3 and 103203.3, the left and right elevator deflections move TEU from –4.4˚ and 1.7˚ to 20.9˚ and 17.7˚ respectively. Speed increases from 72.7 to 127.7 KCAS while the rate of descent is calculated to be 2240ft/min over this span of time

(10) Between sample time 130201.9 and 103202.2, vertical acceleration is 0.4 g during which the pitch attitude is between 14.0 and 14.4˚ nose down.

(11) The lowest nose down pitch attitude of 14.7˚ is reached at sample time 103202.4 and begins nosing up.

(12) From sample time 103202.5 to 103204.9, the pitch attitude increases from 14.3˚ nose down to 11.2˚ nose up where it steadies. At sample time 103203.3, the elevator deflections begin to reduce.

(13) At sample time 103203.2, engine torque, having slowly increased over the previous 3.2 seconds to 104-5% now begins to ramp up. By sample time 103205.7 it is at 116% and remains at around 115% for the remainder of the analysis. Cautionary range for engine torque is 97.5-112.5%. During the interval which the torque is ramped up, airspeed climbs from 127.7 to 151.0 KCAS. V_{FE} at flap 15 is 148 KCAS according to the AFM.

(14) At sample time 103204.4, the minimum radio altitude of 83 ft was reached.

(15) At sample time 103204.5, the vertical acceleration reaches the maximum incident value of 2.7 g. According to the AFM, the maximum maneuver load limit with flaps extended is 2.0 g (2.5 g with flap retracted).

(16) Between sample time 103204.4 and 103208.4, radio altitude increases from 83 to 212 ft at an average calculated rate of climb of 1935 ft/min. Airspeed settles at around 150 KCAS beginning at 103205.1 and the pitch attitude reaches 11.3˚ nose up and settles. The left and right elevator deflections settle at 3.9˚ and 0.7˚, respectively, beginning at 103205.3, varying no more than 2˚ for the remainder of the analysis.

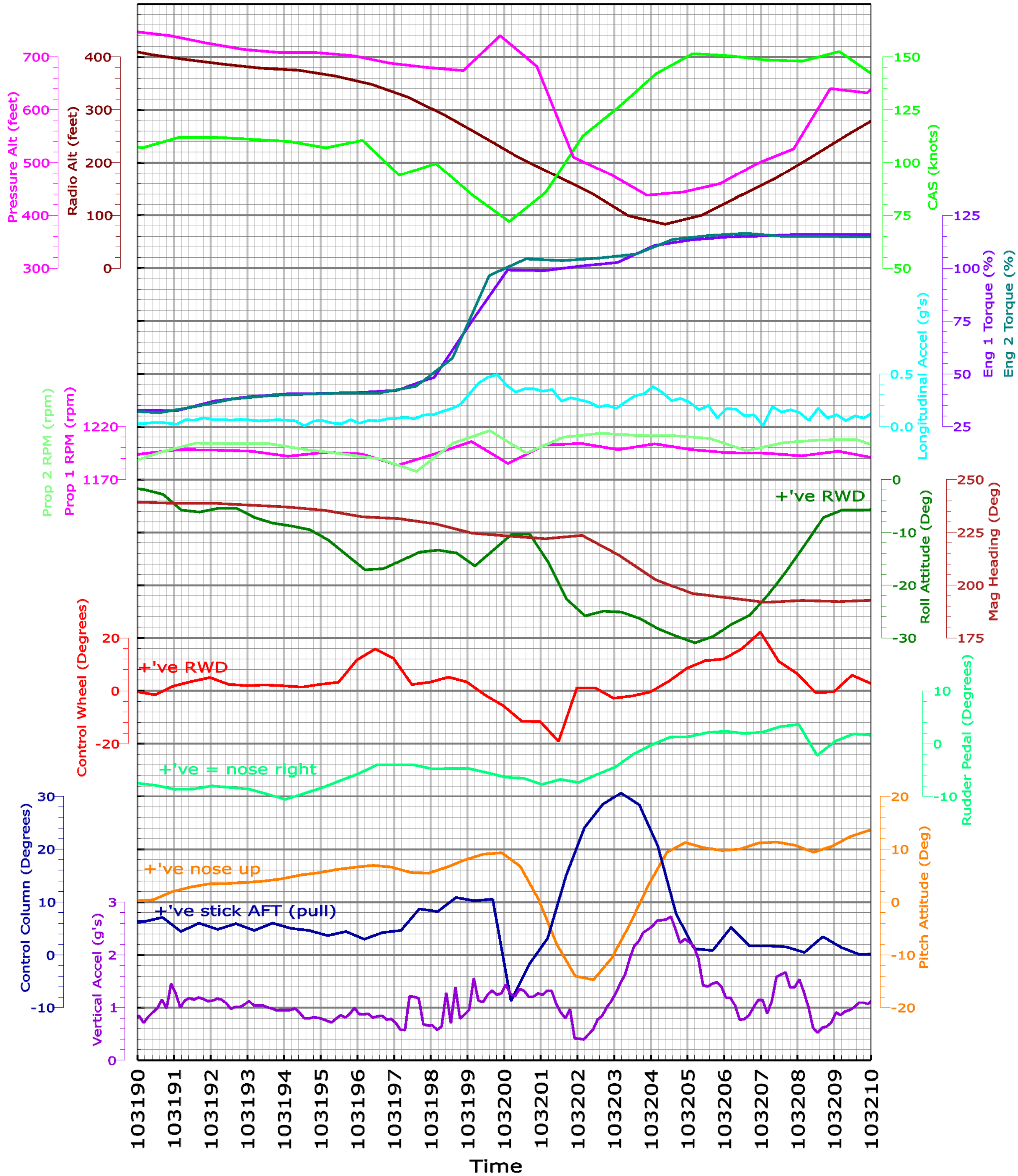


Figure 1: LN-WIU FDR Overview

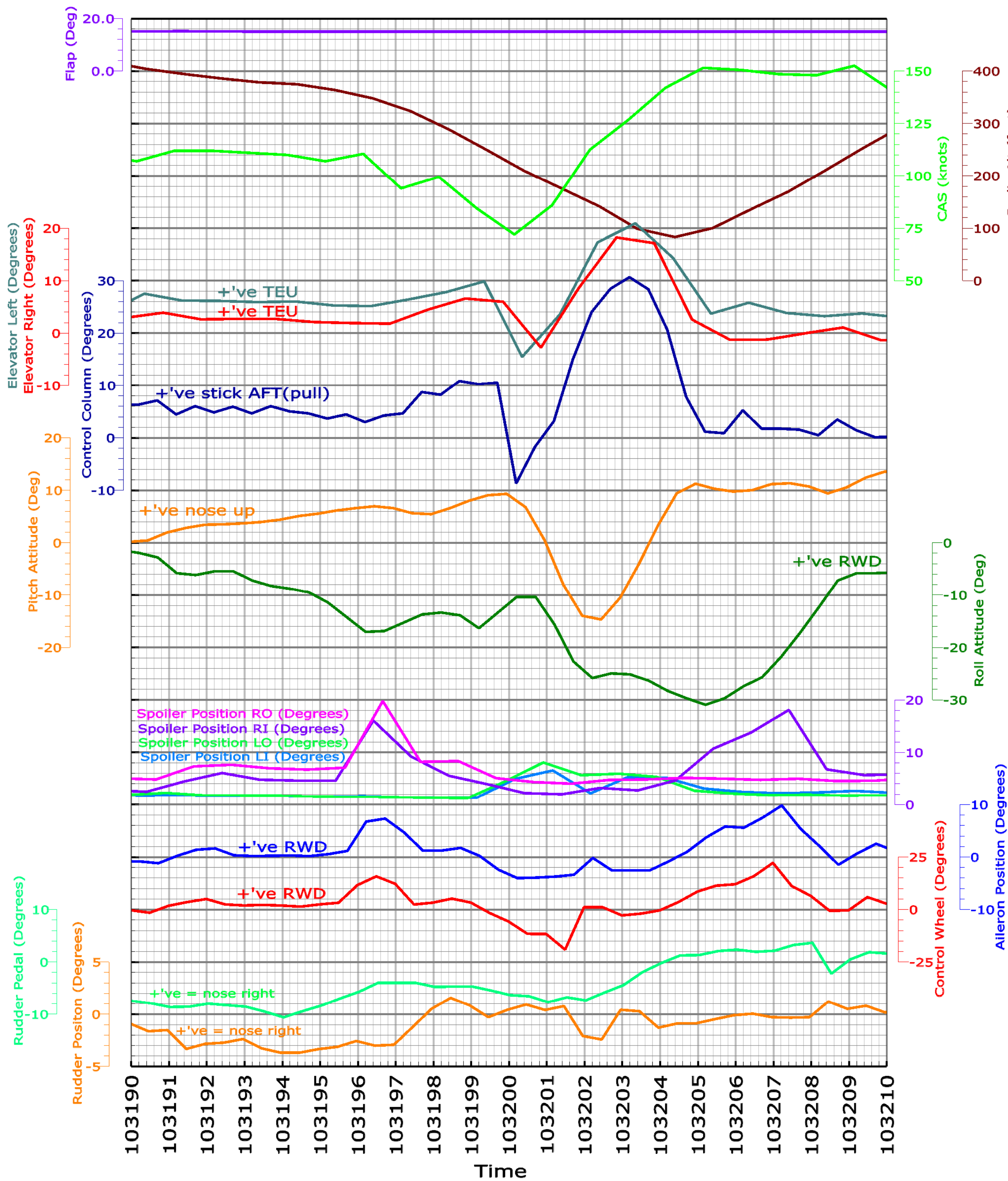


Figure 2: LN-WIU FDR Control Surface Parameters

Flymedisinsk Institutt

18.08.2015

Etter forespørsel fra Statens Havarikommisjon for Transport har Flymedisinsk Institutt foretatt en foreløpig analyse av hendelsene under Widerøes rute 814 fra Bodø lufthavn til Svolvær lufthavn Helle 2. desember 2010 med henblikk på mulige sanseillusjoner involvert.

Bakgrunn

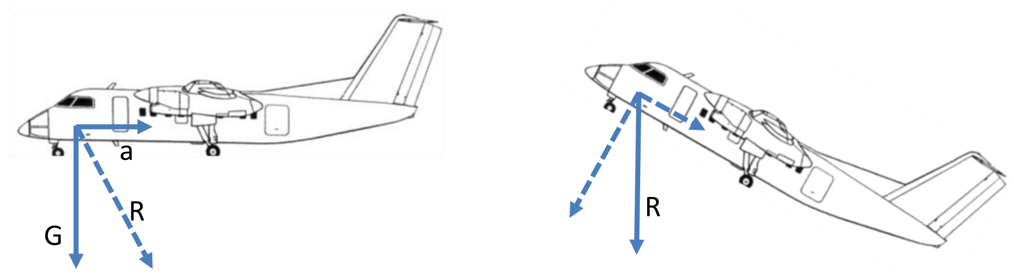
Menneskets sanseapparat er tilpasset livet på jordoverflaten, hvor orientering i rommet opprettholdes av det visuelle systemet (syn), det vestibulære systemet (balanseorgan) og det somatosensoriske systemet (hud-, ledd- og muskelsanser) på en samordnet måte. Når en pilot ikke kan se horisonten klart eller ikke ser på flyinstrumentene sine, er han/hun avhengig av det vestibulære og det somatosensoriske systemet for å orientere seg. Under de spesielle forholdene som råder i et fly fungerer imidlertid ikke disse sansene optimalt og kan gi feilaktig informasjon (McGrath, Rupert & Guedry, 2003). Dette kan føre til at piloten danner seg et uriktig bilde av sin eller flyets posisjon eller bevegelse relativt til bakken. Fenomenet kalles *spatial disorientation*, eller sanseillusjoner på norsk, og er en følge av det normale sanseapparatets reaksjon på stimuli det ikke er tilpasset.

Den somatograviske illusjon er en slik sanseillusjon: Når flyet akselererer, presses piloten bakover mot seteryggen. I fravær av visuelle referanser oppleves kombinasjonen av denne kraften og tyngdekraften som én resultantkraft, som piloten oppfatter som vertikalen (rett ned som tyngdekraften) (Benson & Rollin Stott, 2006). Piloten får derved en følelse av å være tiltet bakover og at flyets nese peker mer oppover enn det som er tilfellet. Se figur 1.

Figur 1. Resultantkraft og opplevd pitch

Reell pitch ved akselerasjon

Opplevd pitch ved akselerasjon



a= akselerasjon
G= tyngdekraft
R= resultant

Det er kjent fra andre hendelser at en slik illusjon kan påvirke piloten til å senke nesen på flyet (Air Accidents Investigation Branch, Department for Transport, 2010; Armentrout, Holland, O'Toole, & Ercoline, 2006; Bureau of Air Safety Investigation, 1991).

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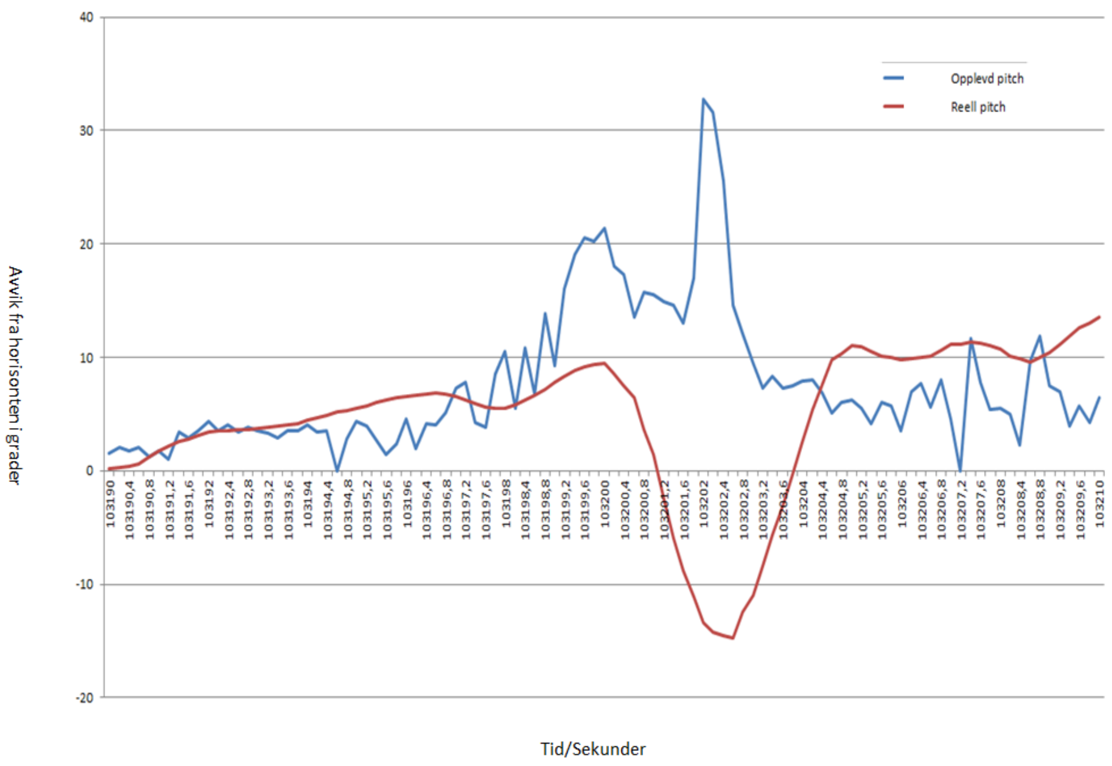
Den aktuelle hendelsen

Under den aktuelle hendelsen lå forholdene til rette for å oppleve en somatogravisk illusjon, da PF kun hadde noen få røde lys som visuell referanse. Disse er ikke tilstrekkelig til å motvirke en slik illusjon. Under slike forhold kan også enkeltstående lys være med på å forsterke en illusjon eller skape egne illusjoner.

I figur 2 er flyets reelle pitch (hentet fra flyets flight data recorder) under hele hendelsen plottet sammen med mulig opplevd pitch, basert på utregninger av resultantkraften. Resultantkraften antyder opplevd pitch nese opp under hele hendelsen, med økende tendens av nese opp inn mot øyeblikket hvor flyets stikke ble beveget forover (sekund 103199). Flyets reelle pitch begynte så å synke og var på det laveste nese ned ca. -15 grader. Samtidig økte resultantkraften og antydet nese opp med mer enn 30 grader på det høyeste (sekund 103202). Se figur 2.

Figur 2. Reell pitch versus opplevd pitch (resultantkraften) i grader avvik fra horisonten (0)



Konklusjon

Ut i fra tilgjengelige data viser foreløpig analyse at forholdene lå til rette for at PF kan ha opplevd en somatogravisk illusjon, både i fasen før han rettet stikka fremover (sekund 103199) og mens flyet akselererte med nesen ned mot havoverflaten (sekund 103200-103202). Dette kan ha påvirket ham til å holde nesen lavere enn han hadde gjort med gode visuelle referanser. Styrmannens oppfattelse av situasjonen ville sannsynligvis i mindre grad vært preget av illusjonskreftene, da han i større grad hadde fokus på flyinstrumentene. I hvilken grad dette faktisk påvirket flygingen kan ikke fastslås sikkert, men kreftene som kan skape en slik illusjon var til stede i det aktuelle tidsrom.

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