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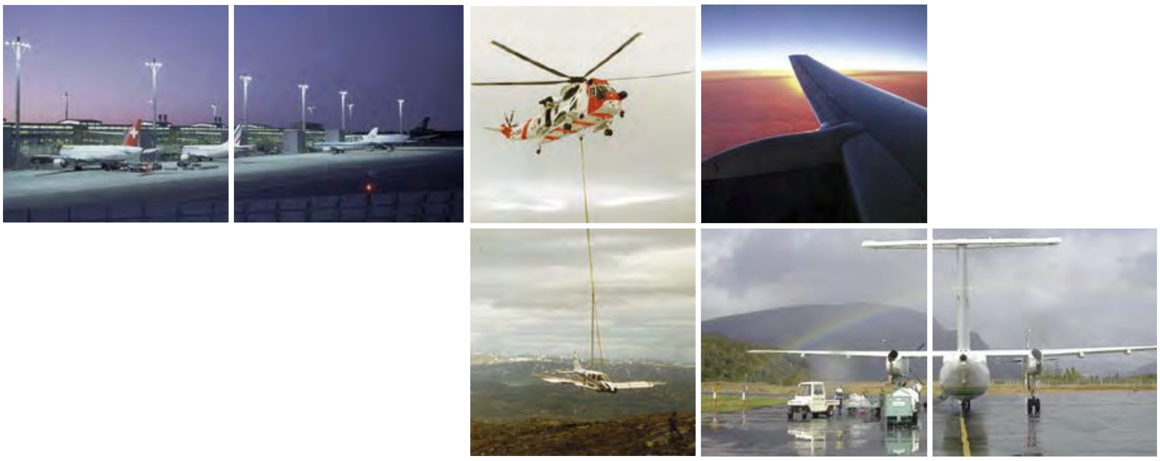

REPORT ON SUPPLEMENTARY INVESTIGATION - AIR ACCIDENT AT TORGHATTEN NEAR BRØNNØYSUND ON 6 MAY 1988 WITH DHC-7-102, LN-WFN

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REPORT

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This is a supplementary report to "Rapport om luftfartsulykke ved Torghatten nær Brønnøysund den 6. mai 1988 med Dash 7 LN-WFN" – Report 1989/04 (in Norwegian only)

SUMMARY

The SHT has carried out this supplementary investigation due to the doubts that have arisen concerning whether interference from mobile telephones may have been a factor in the accident with LN-WFN on 6 May 1988. It has been confirmed that there were two mobile telephones on board the aircraft.

During this investigation, the SHT approach has been to consider a "worst case scenario", assuming that the mobile telephones were emitting radiation, and that the possibility of influencing the aircraft's instruments and systems existed. The SHT has then tried to identify all areas where electromagnetic interference could have influenced on the course of events, and, if so, how. Thereafter, each of these areas has been analysed to find signs of influence. No such signs were found.

The conclusion is that the SHT, based on this supplementary investigation of the accident with LN-WFN, is of the opinion that the course of events was not influenced by interference from the mobile telephones on board.

1. INTRODUCTION AND BACKGROUND

1.1 The accident with LN-WFN

The accident took place on 6 May 1988 at 2030 hours (local time) with Widerøe's flight WF 710 en route from Namsos (ENNM) to Brønnøysund (ENBN). During the approach in clouds to Brønnøysund airport, the aircraft, a de Havilland Canada DHC-7-103 “Dash 7”, crashed into the mountain Torghatten. All 36 on board, 33 passengers and a crew of 3, were killed in the accident.

In August 1989, the Norwegian aviation accident investigation board published its investigation report concerning the accident. The report contains the following main conclusion:

> *The cause of the accident was that the last part of the approach was started about 4 NM too soon. The aircraft therefore flew below the safe terrain clearance altitude and crashed into rising terrain. The Board cannot indicate any certain reason why the approach started so early.*

According to plan, the aircraft would not start the descent to 1 500 feet before being within 4 NM of the airport. Instead, the descent started at 8 NM.

The report concerning the Torghatten accident has been public since its submission, and it has also been available on the SHT website since 2006 (Report 1989/04).[1]

1.2 Information not mentioned in the original investigation report

In May 2013, the SHT was approached by a witness who, just after the accident with LN-WFN, had reported to the Norwegian aviation accident investigation board that one of the passengers was carrying a mobile telephone when the aircraft started from Namsos during the flight to Brønnøysund. This was not mentioned in Report 1989/04.

Doubts therefore arose as to whether the witness' statements had been received when the accident investigation was carried out, and whether the Norwegian aviation accident investigation board had considered whether interference from a mobile phone could have been a causal factor.

In July 2013, the SHT decided to carry out a supplementary investigation, and announced the following:

> *The SHT has been made aware of information which seems to have been unknown when the tragic accident took place in 1988.*
>
> *Based on this new information, the SHT will investigate whether it can be documented that radiation from mobile phones may have influenced on the flight in question. The investigation of the new information will be documented and made public.*

[1] This report calls the agency that investigated the accident in 1988 the Norwegian aviation accident investigation board, and the current accident investigation agency is called SHT.

1.3 Delimitation of the supplementary investigation

The purpose of this supplementary investigation has not been to reopen the original accident investigation in its entirety. This new investigation has been restricted to cover any influence from mobile phones on the course of events. The SHT has not considered any other aspects of Report 1989/04.

2. FACT GATHERING

In addition to using the facts in Report 1989/04, the SHT has contacted several different sources to obtain information:

Source:	***Type of information:***
National Archives of Norway	- case documents
The Norwegian aviation accident investigation board (the SHT has been in contact with several members of the original investigation team)	- disturbances from mobile telephones as a topic in the original investigation
Widerøes Flyveselskap AS, as well as some retired pilots with experience from DHC-7	- technical and flight-operational information, as well as experience with disturbances from mobile telephones and other electronic sources
The Civil Aviation Authority - Norway[2], the Danish Transport Authority and the Accident Investigation Board Denmark	- registered incidents with DHC-7 in Norway, Denmark and other European countries (search in the European ECCAIRS database)
Viking Air Limited (current type certificate holder for DHC-7)	- registered incidents and experiences with DHC-7 worldwide
Honeywell Aerospace and Rockwell Collins	- instruments, navigation systems and autopilot
Air Greenland and Voyageur Airways (more recent DHC-7 operators)	- experience with disturbances from mobile telephones and other electronic sources
Air Accidents Investigation Branch – AAIB (UK)	- renewed review of data from the flight recorder in LN-WFN, focussing on signs of electromagnetic interference
The Norwegian Post and Telecommunications Authority	- questions concerning mobile telephones

[2] In addition, the Civil Aviation Authority – Norway helped by obtaining information from the New Zealand accident investigation agency.

3. INVESTIGATION RESULTS

3.1 Mobile phones on board the aircraft

The Norwegian aviation accident investigation board had handed over all documents in the case to the National Archives of Norway, where the SHT found the two reports the witness referred to. He had been a passenger on the scheduled domestic flight from Trondheim to Namsos, where the aircraft landed before continuing to Brønnøysund. When the witness left the aircraft in Namsos, he saw that the passenger sitting in the observer’s seat in the cockpit had a mobile phone.

In addition, there was on file a report to the Norwegian aviation accident investigation board from Grane and Hattfjelldal sheriff's department, describing the discovery of two mobile telephones at the crash site. According to the report, the mobile phones were the following models:

a. Mobira MD 50 NA

b. Mobira CU 59 D

The sheriff’s department also reported that they had contacted the telephone company and been informed that it was impossible to trace whether the telephones had been used on the day of the accident.

Both mobile telephones were of the NMT-450 type, a commonly used telephone network at the time of the accident.

3.2 Review of data from the aircraft's flight recorder

A graphic representation of data from the flight recorder was published as Attachment 5 “Printout of flight recorder” to Report 1989/04. A key sequence of about 90 seconds after second 1200 on the graph timeline appears to have been omitted by error in the printing process[3]. The SHT believes that this sequence is important to illustrate the last part of the course of events – also with a view towards considering any disturbances from mobile telephones. A new graphic representation, showing complete data from second 1200 and up until the accident, has therefore been enclosed with this report (see Appendix B).

The British Air Accidents Investigation Branch (UK AAIB) has its own laboratory for extracting and analysing data from flight recorders and voice recorders. Its expertise is used to a large degree by accident investigation agencies across Europe and the rest of the world. It was the UK AAIB, along with the Norwegian Defence Research Establishment, which originally assisted the Norwegian aviation accident investigation board after the accident with LN-WFN.

In connection with this supplementary investigation, the SHT presented the graphs from both the accident flight and the preceding flight (Trondheim – Namsos) to the UK AAIB and asked for a new analysis focusing on signs of irregularities which could indicate technical faults or interference – especially from mobile phones. During the flight from

[3] This sequence was included in the original report which the Norwegian aviation accident investigation board submitted to the printer. The part of the course of events covered by this sequence, is also covered in the report text itself.

Trondheim to Namsos, for instance, the performance graph for engine number two (E2TORQ) showed a sudden, short peak (see Appendix C). The SHT wanted to know if this was a possible sign of disturbance from one or more mobile telephones.

Concerning the peak on engine no. 2 on the flight between Trondheim and Namsos, the UK AAIB expert points out a coincident peak on the VHF2 parameter (radio no. 2) and explains that these two parameters are quite close in the data frame layout. It is therefore, according to the UK AAIB, likely that this is a single bit of the data stream (data dropouts/minor corruptions). This is a well-known and frequent phenomenon with this type of flight recorders, and is not considered to have any connection to interference from mobile phones.

Furthermore, it emerges from the response from the UK AAIB that there was nothing unusual with the parameters from the accident flight, with the exception of the signals from the electric elevator trim (E Trim). These have some marked dips around some of the trim changes which do not correlate to how an elevator moves (see Appendix B). This means that the line should have been more "smooth". The UK AAIB considers this as a deviation of lesser importance and which is not considered to have had an effect on the flight itself, and adds that one possible explanation could be a worn transducer.

3.3 Review of the aircraft's voice recorder

One of the mobile telephones belonged to a passenger sitting in the observer's seat in the cockpit. The SHT has reviewed the transcription from the aircraft's voice recorder and has not found any sign that the passenger in the cockpit spoke in the telephone. However, it is not known whether the telephone was turned on or off during the flight.

Nor can it be ascertained whether the mobile telephone in the passenger cabin was turned on or not.

The transcription has also been reviewed to check if the crew said anything about abnormal instrument readings, faults or other indications that something was wrong with LN-WFN. The communication between the commander and the first officer indicates that the cockpit crew did not register any form of disturbances.

3.4 The approach to Brønnøysund

The approach to Brønnøysund was a so-called VOR/DME non-precision approach, where the horizontal navigation was based on following a radial from a VOR station on the ground. In Attachment 1 "Track plot" to Report 1989/04 , there is a graphic presentation of the aircraft's course in the horizontal plane. It also emerges from the report that the accident site was about 800 metres left of the VOR radial LN-WFN navigated by. The Norwegian aviation accident investigation board has concluded that this deviation was within the applicable accuracy requirements of the VOR system. The SHT calculated that the deviation was about 4.9 degrees. A deviation of 4.9 degrees would also have satisfied today's tolerance limits for VOR systems, which is 5 degrees.

The vertical profile (the descent) was in stages – a so-called step-down approach where the aircraft would not fly below the given minimum altitudes at different distances from the runway. Signals from a DME ground station, which were read on an instrument in the aircraft, would be used to check that the aircraft held the correct altitude in relation to the distance from the airport.

In order to secure adequate terrain clearance, the approach procedure indicated that aircraft following the relevant VOR radial (041) would hold an altitude of at least 2 500 feet until reaching 10 NM from the runway. Thereafter, the aircraft would descend to 1 500 feet from 10 NM and in to 6 NM. From 6 NM to 4 NM, the original procedure required the aircraft to descend to 1 200 feet, whereas Widerøe's recently introduced procedure at the time required maintaining 1 500 feet until 4 NM. The approach map published in AIP Norway, as well as Widerøe's approach map, is reproduced in Attachments 3 and 4 to Report 1989/04.

Based on flight recorder data, and our own calculations, the SHT has prepared a new sketch showing the approach in the vertical plane. This provides a simplified presentation of the altitudes and distances LN-WFN had to the runway during its approach, seen in relation to the two approach procedures mentioned in the previous paragraph (see Appendix D).

3.5 Interference from mobile telephones and other electronic equipment in aircraft

Ever since mobile telephones and other electronic devices that can emit electro-magnetic radiation came into use, and were carried in-flight by passengers, there has been a discussion on whether they can disturb electronic systems and instruments in aircraft. Such disturbances are called electro-magnetic interference (EMI). Many cases of disturbances have been reported from all over the world. The suspicion has often been directed at personal electronic devices (PED) carried by passengers on board aircraft, such as mobile telephones.

Reported disturbances have mostly been of a sporadic and transient character, disappearing as suddenly as it arose. It has been typical for this type of disturbance that it is hard to reproduce in retrospect. As far as the SHT knows, it has never been proven that EMI from mobile telephones or other electronic devices carried on board (such as gaming devices and laptops) have been causal factors in aviation accidents.

On the other hand, it has not, in the SHT's view, been possible to categorically rule out that such electronic devices can cause disturbances on instruments, systems and equipment in the aircraft.

In expert circles, it has been claimed that both aircraft manufacturers and type certifying authorities were relatively unprepared for the development and volume of portable electronic devices, and that they failed to take this sufficiently into account when formulating requirements for the shielding of electronic aircraft systems. The main focus was more to protect the aircraft against lightning strikes and high intensity radiated fields from external sources such as radars and radio transmitters.

More recent certification specifications contain requirements for better shielding inside aircraft against interference from internal sources such as mobile telephones, while the requirements for reduced radiation from portable electronic devices have become more stringent. This has resulted in more lenient provisions relating to use of personal electronic devices in-flight. Telephoning from private mobile phones is, however, still subject to restrictions.

3.6 The effect of electro-magnetic interference (EMI) on the DHC-7 aircraft type

Although the aircraft type is not considered particularly advanced measured by current standards, DHC-7 had several electronic instruments and systems which the SHT has assessed in relation to EMI.

In addition to the electronic navigation aids listed in Item 1.8.2 in Report 1989/04, LN-WFN had a Sperry SPZ-700 autopilot system consisting of an SP-200 Autopilot and an FZ 500 Flight Director. In addition, the aircraft had electronic altimeters receiving information from two independent air data computers. The same computers delivered altitude and airspeed information electronically to the aircraft's other systems.

The aircraft's flight- and engine controls were, however, of a conventional mechanical or mechanical-hydraulic type – without electronic transfer of the control wheel inputs. Both air speed indicators and the vertical speed indicators on the cockpit instrument panel were also of a conventional pneumatic-mechanical type.

This investigation has focussed in particular on the two navigation systems used on the approach to Brønnøysund: VOR (radio navigation system) and DME (radio-based distance measuring system), as well as the aircraft's autopilot system.

The SHT has contacted a number of different sources to acquire information about any experience made with interference from mobile telephones or other electronic devices for as long as DHC-7 has been in operation (see list in Chapter 2). According to the obtained information, no serious accidents or incidents have been registered with this aircraft type, in which EMI has been a factor.

3.7 The manufacturer's assessment of electro-magnetic interference (EMI) on the aircraft's autopilot

The approach with LN-WFN was flown with the aircraft's autopilot engaged. The SHT has therefore described the accident and asked the manufacturer Honeywell Aerospace for their assessment of the possibility that EMI could have affected the autopilot. The response from the company's Product Integrity / Air Safety Investigator is given here:

> *I, along with other experts within Honeywell on this product, have spent the time since your request researching your question on the SP-200 autopilot (This was an SPZ-700 system which includes an SP-200 autopilot and an FZ-500 flight director.) I have spoken with our product experts who are very familiar with these particular products.*
>
> *Your question: We would appreciate any information you could give us concerning in-flight electro-magnetic interference from personal electronic devices (PED) on the autopilot. Is it in any way conceivable that it somehow could have disturbed the autopilot? Like for example disconnected the altitude hold function?*
>
> *What we were able to determine is the following:*
>
> - *These products were developed around 1970.*
> - *The SP-200 was certified in the Dehavilland DHC-5 around February of 1976. I was not able to determine when it was added to the DHC-7.*

- *These products, having been designed in the late 1960s and early 1970s, utilized analogue circuitry. These designs are, what we would characterize today as, big, heavy-current types of designs. They did not use low current, digital circuits, like we see in today's modern avionics.*
- *These products have been in use for a very long time and have spanned the introduction of the cell phone up to today's digital cell phone designs. Through that time period, Honeywell is not aware of reports of AP disconnects against this autopilot product as a result of external RF interference.*

Based on the information gathered and explained above, Honeywell feels strongly that an inadvertent autopilot disconnect would likely not have occurred.

4. SHT ASSESSMENTS

When this investigation was initiated, it quickly became clear that it was unlikely that the SHT would be able to conclude with certainty whether the two mobile telephones on board LN-WFN interfered with the aircraft's instruments or systems. Proving or disproving the existence of electro-magnetic interference in retrospect was in this case deemed to be almost impossible.

Instead, the SHT has applied a worst-case scenario, where the mobile telephones were turned on and emitted signals. Furthermore, it has been assumed that the mobile telephones, although the investigation results in Chapter 3 show that this is not likely, were able to interfere with the aircraft's instruments and systems.

In the following analysis, the SHT has sought to find out how the aircraft, theoretically, could have been influenced during the approach. This has then been seen against factual information about the accident, mainly from the flight recorder and the voice recorder, in order to investigate whether the mobile telephones may have had an effect on the course of events.

4.1 Different hypothetical scenarios with electro-magnetic interference

Deviations as a result of EMI can be divided into three main areas:

- Loss of control (steering):
- Horizontal navigation (the aircraft goes off course)
- Vertical navigation (the aircraft holds the wrong altitude or makes erroneous altitude changes).

Each of these three main areas has been discussed below.

4.1.1 Loss of control

Based on data from the flight recorder and the voice recorder, as well as description of the crash site and the aircraft wreckage (see Ch. 1.12 in Report 1989/04), the SHT believes that the crew had continuous control of the aircraft.

If, for example, LN-WFN started the descent from 1 500 feet against the crew's knowledge and will, this would very likely have emerged from the information on the voice recorder. In addition, the crew is unlikely to have lowered the landing gear and extended the flaps in the same routine manner as was the case when the premature descent started.

In addition, the SHT has found no indications of lack of, or misleading, information from the instruments that would have made it difficult to keep the aircraft straight and level. The investigations at the accident site show that LN-WFN had a normal attitude just prior to crashing into the terrain.

As no indications of problems with maintaining control of the aircraft have been found, consequently EMI cannot have been a factor in this area.

4.1.2 Horizontal navigation

If LN-WFN had followed VOR radial 041 exactly, the aircraft would have passed east of Torghatten, and the crash would have been avoided. However, the course deviation was within the then existing tolerance limits, and those which still apply for VOR systems. It was therefore something which could be expected and which had been factored into the approach procedure.

In general, the SHT does not consider it impossible that a VOR system can be influenced by interference from mobile telephones. This is supported by reports mentioned in Ch. 3.5 above. It can therefore be argued that the course deviation may have been a result of EMI - but this would not be possible to prove. However, the SHT believes that as long as the deviation was within the expected accuracy area for the VOR system, it would in any case be incorrect to characterise this as a causal factor.

4.1.3 Vertical navigation

The accident with LN-WFN happened because the aircraft came too low and therefore crashed into the Torghatten mountain. It was in other words a vertical navigation error. In Report 1989/04 it emerges that the descent from 1 500 feet started when the aircraft was 8 NM from the airport, which means that the descent started 4 NM miles early. No one has been able to provide a certain answer to why the descent started so early.

As the premature descent was the critical deviation from the planned approach profile, a key topic of this investigation has been to look for indications that EMI interference caused this.

The SHT has assessed the following opportunities for faults in the vertical navigation as a result of EMI:

- *The DME system*, in that the instrument gave the crew misleading information about the distance to the airport.

- *The autopilot system*, for example by an unintentional disconnection of the altitude hold function so that the aircraft started losing altitude without the crew being aware of this.

- *The altimeter systems and the altimeter indications*, faults which resulted in the aircraft being lower than indicated by the instruments.

Each of these three main areas is discussed below.

4.1.3.1 *The DME system*

If the instrument had shown 4 NM as the aircraft was at 8 NM, it would explain why LN-WFN started the descent from 1 500 feet too early. However, it emerges from Item 1.1.16 in Report 1989/04 that the crew, just after starting the descent, reported to the tower at Brønnøysund Airport that they were 8 NM from the airport. In addition, the Norwegian aviation accident investigation board writes the following in Item 2.6.1 of the report:

> *As regards DME distances, which the crew reported twice – 25 NM and 8 NM – these correlate with the calculated distance according to the DFDR.*

It was therefore also in the original investigation substantiated, both through calculations, and – most importantly – through the crew reporting 8 NM that they had not been tricked by misleading information from the DME system when they started the descent from 1 500 feet. When the SHT prepared the sketch in Appendix D, new calculations were carried out, also confirming that LN-WFN really had a distance of 8 NM when the crew reported this.

The DME system did in other words function as it should at the distance where a failure would have been most critical, and it is therefore not relevant to suspect any EMI effect.

4.1.3.2 *The autopilot system*

Aviation accidents have happened where the autopilot system has disconnected without the pilots noticing. If this had been the case with LN-WFN, it would have been necessary to investigate whether EMI effects could have been a contributing factor.

In Item 3.7 above, the manufacturer Honeywell Aerospace has explained why they consider it highly unlikely that the autopilot would disconnect as a result of EMI from the mobile telephones on board. This is also confirmed by the data from the flight recorder, which shows that there were no inexplicable deviations in heading or altitude, which could have indicated faults in the autopilot system.

Item 2.1.3 in Report 1989/04 states:

> *[…] at approx. D8 BNN – the aircraft left 1 500 feet after marked application of elevator trim. This should indicate that the descent was a deliberate action.*[4]

The SHT will in addition direct attention to the fact that the crew adjusted engine power as one would with a controlled descent (see Appendix B) and that the air speed was adjusted in a systematic and planned manner (see also Appendix B).

The SHT will also remark that the deployment of landing gear and flaps just before can be interpreted as another indication that the descent was initiated by the crew.

[4] "D8 BNN" means that the DME instrument showed a distance of 8 NM from Brønnøysund airport

When LN-WFN came down to 550 feet, the autopilot levelled out the aircraft in accordance with the preselected altitude on the Altitude Preselector. This is also a sign that the autopilot was intact and functioned normally.

The SHT is of the opinion that these indications combined make it probable that the descent from 1 500 feet was initiated by the crew and that it, accordingly, was not the result of an undiscovered EMI-induced disconnection of the autopilot.

4.1.3.3 *The altimeter system and the altimeter indications*

LN-WFN was flown on autopilot throughout the approach (cf. section. 2.8.1 in Report 1989/04). In accordance with the setting of the altitude pre-selector, LN-WFN levelled out at 1 500 feet as planned and remained at that altitude until the next descent sequence was initiated. The aircraft then levelled out at the next pre-set altitude of about 550 feet.

As the aircraft crashed into the terrain at approx. 560 feet[5], it appears that the autopilot's altitude measurement was within the expected tolerances when it levelled the aircraft out. The indications on the first officer's altimeter, as well as the standby altimeter, also correlated with the real altitude[6]. By measuring the altitude difference between the last levelling out and the preceding levelling out (1 500 feet) on the flight recorder's altitude graph (see Appendix B) it can be concluded that the autopilot also here levelled out at an altitude which correlates quite well with the real altitude.

In addition, the transcription from the voice recorder contains nothing to indicate that the crew noticed any deviation between the readings on the three altimeters in the cockpit, or that the levelling out were not in accordance with the altitudes that were pre-set on the altitude pre-selector.

The SHT believes that it can therefore be concluded that there were no significant deviations in the autopilot's altitude holding function, and that the levelling out took place at pre-set altitudes.

The SHT therefore believes that EMI interference in all probability was not a causal factor in this area.

5. CONCLUSION

During the investigation, the SHT approach has been a so-called “worst case scenario”, which assumes that the mobile telephones were emitting radiation, and that the possibility of influencing the aircraft's instruments and systems existed. The SHT has then tried to identify all areas where electromagnetic interference could affected the course of events, and, if so, how. Thereafter, an analysis has been prepared of each of these areas to find signs of influence. No such signs were found.

Based on this supplementary investigation of the accident with LN-WFNT, the SHT is of the opinion that the course of events was not influenced by interference from the mobile telephones on board.

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[5] Just prior to the crash, the aircraft's engine power was increased, and an ascent initiated.
[6] The reading on the commander's altimeter could not be obtained.

This report is hereby included as a supplement to "Rapport om luftfartsulykke ved Torghatten nær Brønnøysund den 6. mai 1988 med Dash 7 LN-WFN" – Report 1989/04 – which will remain unaltered.

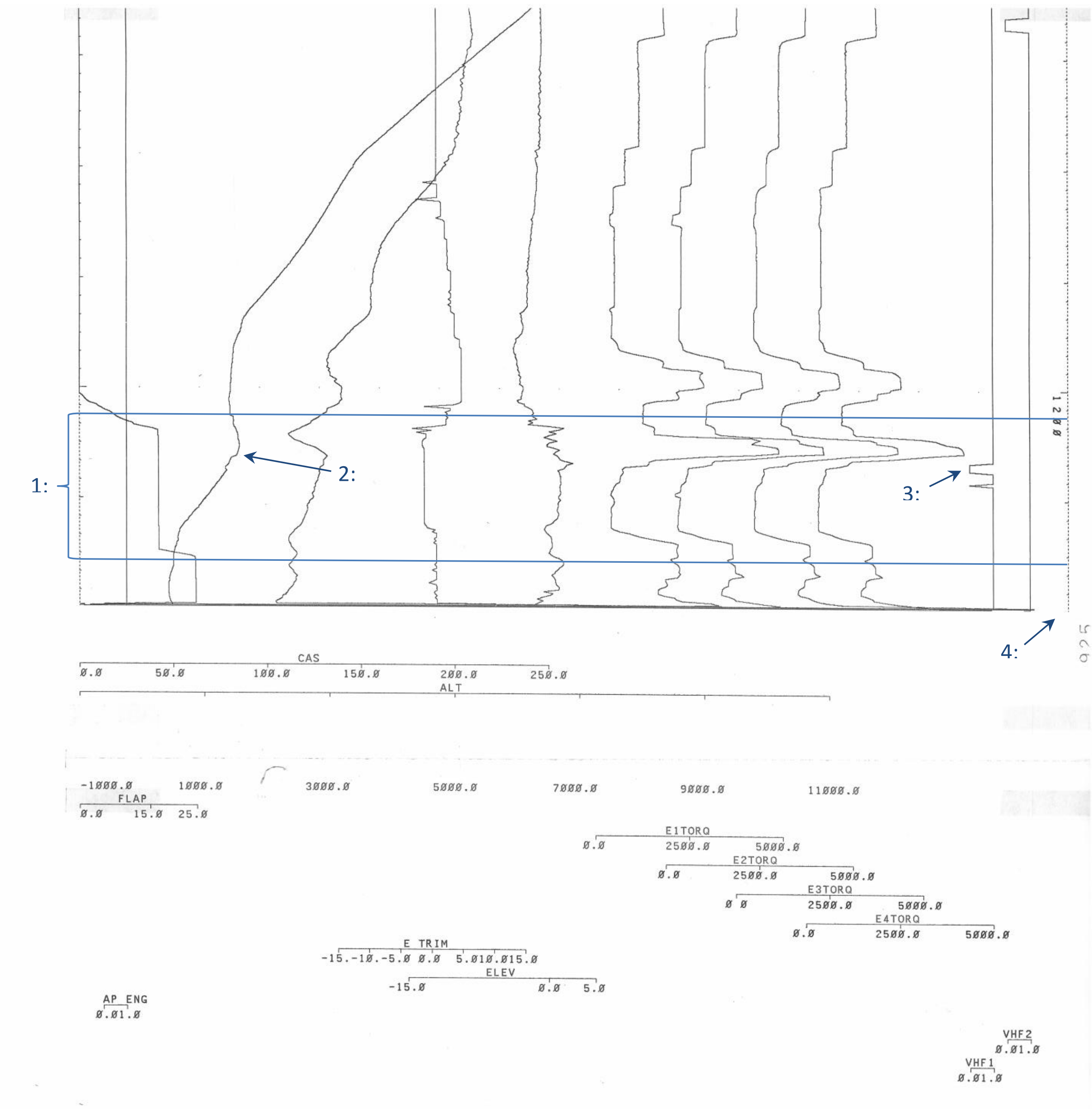
The Accident Investigation Board Norway (SHT)

Lillestrøm, 16 December 2013

APPENDICES

Abbreviations and terms used in the report:

Air Data Computer	An Air Data Computer collects data from the different aircraft sensors and calculates values that are transformed into electronic signals and fed to the instruments, navigation systems and the autopilot.
Altitude Preselector	System for pre-selecting altitudes – can be coupled to the auto pilot to make it level out at a pre-set altitude. If the auto pilot is not engaged, the system will inform the pilots by light, and/or sound, when the pre-set altitude is reached.
DME	Distance Measuring Equipment – radio-based distance measuring equipment for determining the aircraft's distance from a DME-station
E2TORQ	Engine number 2 Torque
ECCAIRS	European Coordination Centre for Accident and Incident Reporting Systems
EMI	Electro Magnetic Interference
Flight Director (FD)	The Flight Director calculates the course(s) and altitude(s) that must be followed for an aircraft to follow a chosen flight trajectory. This is displayed on the aircraft attitude indicator ("artificial horizon"). The auto pilot can be coupled to the FD
ft	foot or feet – 1 ft ~ 0,304 m
NM	Nautical Mile(s) – 1 NM = 1 852 m
NMT-450	Nordic Mobil Phone System (450 stands for 450 MHz)
non-precision approach	Instrument Landing System without Glide Path information
step-down approach	Non-precision approach where the altitude is reduced in steps to ensure sufficient terrain clearance
VHF	Very High Frequency – frequency range used for air navigation- and communication radios
VOR	VHF Omnidirectional Radio range – VHF directional navigation system
VOR-radial	Directional beam – a VOR-station sends out 360 directional beams corresponding to a compass



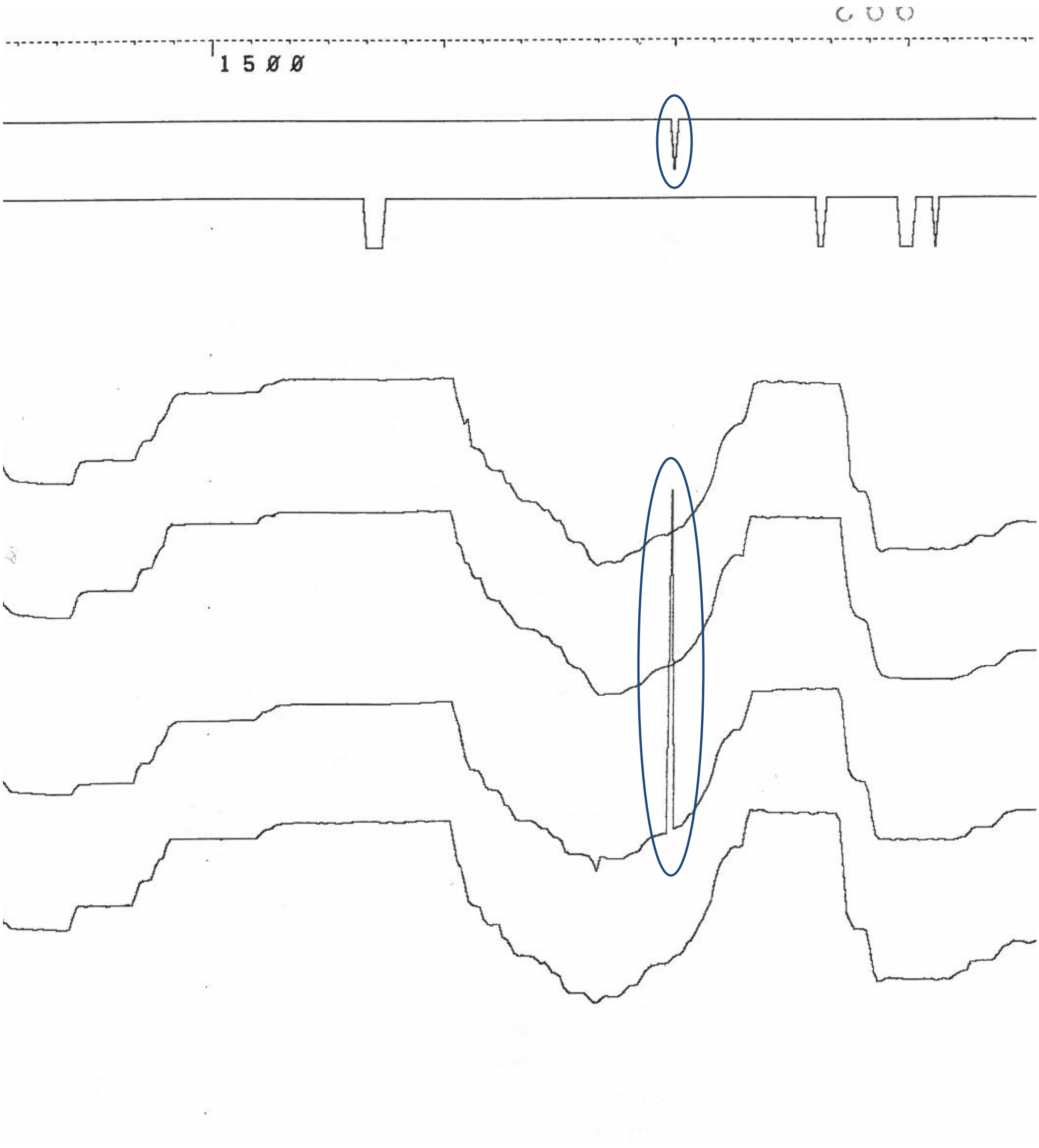
1: Sequence that was omitted in Attachment 5 to Report 1989/04 by a printing error

2: Start of decent from 1 500 ft on the altitude presentation (about 8 NM from the airport)

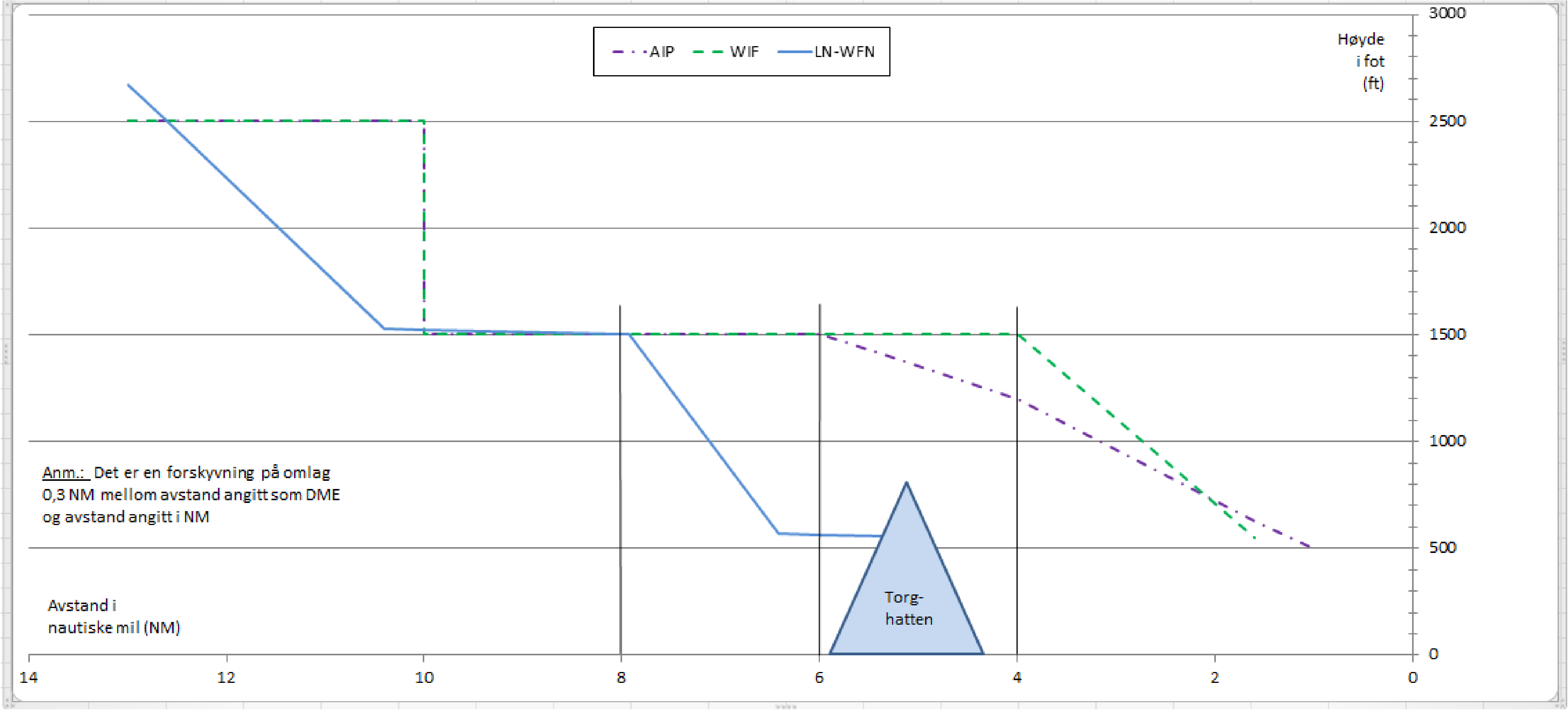
3: The crew reports to Brønnøysund TWR that LN-WFN is 8 NM from the airport

4: Time line

From the accident flight: Flight Data Recorder graphs showing the final part of the approach towards Brønnøysund airport



Flight Data Recorder graphs from the previous flight (Trondheim to Namsos). The sudden peak on the performance graph for engine number two (E2TORQ) and the coincident peak on the radio no. 2 (VHF2) are circled in.



Schematic presentation of the approach to Brønnøysund Airport – seen in the vertical plane. The lines marked AIP and WIF shows the AIP Norway and the Widerøe step-down – procedures, respectively. The graph for LN-WFN: The distances with corresponding altitudes are based on measurements taken from the FDR-graph (Appendix B), together with factual information in Report 1989/04. Each coordinate in the graph has subsequently been calculated and connected with straight lines.

Note: Due to the VOR/DME location on the airport there is a difference of about 0.3 NM between "DME" and "NM" distances.