Havarikommissionen
Accident Investigation Board Denmark

FINAL REPORT

Accident

29-1-2014

involving

BOMBARDIER INC. DHC-8-202

OY-GRI

ECCAIRS Release 5

Certain report data are generated via the EC common aviation database

FOREWORD

This report reflects the opinion of the Danish Accident Investigation Board regarding the circumstances of the occurrence and its causes and consequences.

In accordance with the provisions of the Danish Air Navigation Act and pursuant to Annex 13 of the International Civil Aviation Convention, the investigation is of an exclusively technical and operational nature, and its objective is not the assignment of blame or liability.

The investigation was carried out without having necessarily used legal evidence procedures and with no other basic aim than preventing future accidents and serious incidents.

Consequently, any use of this report for purposes other than preventing future accidents and serious incidents may lead to erroneous or misleading interpretations.

A reprint with source reference may be published without separate permit.

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FINAL REPORT

General

File number:	HCLJ510-2014-258
UTC date:	29-1-2014
UTC time:	11:42 hours
Occurrence class:	Accident
Location:	Ilulissat (BGJN)
Injury level:	Minor

Aircraft

Aircraft registration:	OY-GRI
Aircraft make/model:	BOMBARDIER INC. DHC-8-202
Current flight rules:	Instrument Flight Rules (IFR)
Operation type:	Commercial Air Transport Revenue operations Passenger
Flight phase:	Landing
Aircraft category:	Fixed wing Airplane
Last departure point:	Greenland (Denmark) BGSF (SFJ): Kangerlussuaq
Planned destination:	Greenland (Denmark) BGJN (JAV): Ilulissat
Aircraft damage:	Destroyed
Engine make/model:	PRATT & WHITNEY (CANADA) PW100 FAMILY (123D)

Notification

All times in this report are UTC.

The Aviation Unit of the Danish Accident Investigation Board (AIB) was notified of the accident by Ilulissat Aerodrome Flight Information Service (AFIS) on 29-1-2014 at 12:10 hours.

The Danish Transport Authority (DTA), the Canadian Transportation Safety Board (TSB), the European Aviation Safety Agency (EASA), the Directorate-General for Mobility and Transport (DG MOVE), and the International Civil Aviation Organization (ICAO) were notified on 29-1-2014. The US National Transportation Safety Board (NTSB) was notified on 7-2-2014.

The Canadian TSB and the US NTSB appointed accredited non-traveling representatives to the investigation.

The investigation was conducted by the AIB in close cooperation with the TSB Canada.

Synopsis

Upon landing on runway 07 at Ilulissat (BGJN) in gusting crosswind conditions above the aircraft and the operator limited maximum crosswind components, the left main landing gear collapsed.

The aircraft skidded off the left side of the runway in a nose right position and into the safety zone.

The aircraft continued an increasingly sideways skid in a nose right position, skidded down a steep snow-covered slope and impacted a rocky area approximately 10 meters below the runway elevation.

One passenger and one crew member suffered minor injuries.

The aircraft was destroyed.

The accident occurred in dark night and under visual meteorological conditions (VMC).

The investigation did not result in recommendations being made. However, the AIB addressed an area of safety concern to Transport Canada (TC).

Summary

Adverse crosswind conditions at BGJN led to flight crew target fixation, a flight crew divergence from the operator's stabilized approach parameters and a mental blocking of an appropriate decision on going around.

The flight crew divergence from the operator's stabilized approach parameters induced a non-stabilized approach, which in combination with power levers retarded below flight idle in flight resulted in an accelerated rate of descent leading to a hard landing, with side load on the left main landing gear at touchdown.

The left main landing gear structural fuse pin sheared as a result of lateral and vertical overload stress.

Cycling the power levers between ground and flight range prevented an appropriate deceleration of the aircraft and prolonged the landing roll.

The prolonged landing roll combined with the application of full left rudder and no decisive use of reverse thrust on the side with the unaffected main landing gear made it impossible for the flight crew to maintain directional control.

The lack of directional control resulted in the aircraft running off the side of the runway and the safety zone, respectively.

1 FACTUAL INFORMATION

1.1 History of the flight

The accident flight was a commercial IFR domestic passenger flight from Kangerlussuaq (BGSF) to BGJN.

Three crew members and 12 passengers were on board.

On the night before the day of the accident and on the last flight of that day, the crew on a flight from Upernavik (BGUK) to BGJN had to divert to BGSF due to adverse wind conditions at BGJN.

Before departure from BGSF, the commander was in contact (at 10:30 hours and at 10:32 hours) with the Aerodrome Flight Information Service (AFIS) operator at BGJN. The wind conditions were reported to be 130° magnetic 20 knots with a maximum of 40 knots. The braking coefficient values were reported to be 85, 84, and 83.

Furthermore, the commander was in contact with the meteorological office.

In the weather preflight planning folder, the flight crew marked two destination alternate aerodromes (BGSF and Nuuk (BGGH)).

There were no remarks to the aircraft pre-flight checks.

The aircraft departed BGSF at 11:06 hours.

The commander was the pilot flying and the first officer was the pilot monitoring.

At 11:10 hours and from Sondrestrom Flight Information Service, the flight crew got a special weather report (SPECI) valid for BGJN. The SPECI was issued at 11:09 hours. The wind conditions were reported to be 100° 20 knots maximum 30 knots. The visibility was 10 kilometers, broken clouds at 12 000 feet, temperature +3° Celsius, dewpoint -9° Celsius, and the QNH was 984 hPa.

Enroute, the flight crew decided to do a visual approach to runway 07 (steep approach - Precision Approach Path Indicator (PAPI) angle of 5.1°) and as a backup for the visual approach, the flight crew briefed the Non-Directional Radio Beacon (NDB)/Distance Measuring Equipment (DME) approach to runway 07. Furthermore, the flight crew agreed on a visual missed approach procedure.

Due to the wind conditions and consequently expected turbulence on final, the flight crew, as a backup for the visual approach, set up the aircraft Flight Management System (FMS) for a NDB/DME approach to runway 07 via NDB JV (367 KHz).

Furthermore, the flight crew agreed on a crosswind limitation at BGJN of 31 knots (including wind gusts).

The flight crew discussed the possible use of a flap setting of 15° instead of a flap setting of 35°.

Without remarks, the flight crew crosschecked the landing performance data for the use of a flap setting of 15°.

During descent, the flight crew got visual contact with the Ilulissat area.

At 11:33 hours on initial radio contact with Ilulissat AFIS (119.100 MHz), the flight crew reported the aircraft position to be 28 nm out from BGJN and passing 12 000 feet descending. The flight crew got the following information on runway in use and weather conditions:

- Runway in use was 07
- The wind conditions were 150° magnetic 24 knots - maximum 33 knots - minimum 17 knots,
- The cross wind was 24 knots
- The headwind was 5 knots
- The wind at threshold runway 25 was gusting to 41 knots
- The visibility was 10 kilometers
- Broken clouds were at 12 000 feet
- The temperature was +3° Celsius
- The dewpoint was -9° Celsius
- The QNH was 983 hPa

Due to the cross wind conditions, the flight crew decided to do a landing with a flap setting of 15°.

The landing reference speed (Vref) was set to 99 knots.

The flight crew asked Ilulissat AFIS for a confirmation of whether or not the cross wind of 24 knots included the gusting wind conditions up to maximum 33 knots. Ilulissat AFIS replied that the maximum wind was 35 knots and the cross wind was 26 knots.

The approach checklist was performed and the altimeters were set to 984 hPa.

Established on final to runway 07, the landing gear was selected down and the flap setting was set to 15°.

In order to reduce the time period on final approach, during which the aircraft was subjected to turbulence, the commander decided to fly the approach on the high side of the PAPI angle of 5.1°.

On a 5 miles final to runway 07, the wind conditions were reported to be 140° magnetic and 28 knots - maximum 35 knots and the cross wind was 26 knots.

The autopilot was disengaged.

The flight crew requested the AFIS operator to turn off the aerodrome beacon and dim the PAPI lights.

Passing 1000 feet Radio Altitude (RA), the first officer confirmed completion of the landing checklist.

No flight crew call out on stabilized approach was made.

Passing 500 feet RA, no flight crew call out on stabilized approach was made.

On short final to runway 07, the wind conditions were reported to be 140° magnetic and 25 knots – maximum to 39 knots. The first officer perceived the reported wind speed to be 29 knots.

The flight crew experienced moderate turbulence.

While the aircraft still being airborne but below a RA of 20 feet, the power levers were retarded below flight idle into ground beta range.

The aircraft touched down hard on the left main landing gear with a recorded normal load factor of +2.4 G with the propellers in ground beta range. The aircraft was rolling left through 6.6º and was pitched nose-up 2.0º, the airspeed was 103 knots (Calibrated Air Speed (CAS)), and the heading was 078º magnetic.

Upon touchdown on runway 07, the left main landing gear collapsed.

With the left main landing gear collapsed and after approximately 97 meters of runway rolling, the flight crew started to loose aircraft directional control.

Onwards and for a number of times, the power levers were cycled between ground and flight beta range.

It was the perception of the flight crew that the aircraft did not decelerate.

After approximately 382 meters of runway rolling, the aircraft skidded off the left side of the runway in a nose right position and into the safety zone. At this point, the aircraft was decelerating through 68 knots CAS, and the heading was 081º magnetic.

In the safety zone and approximately 120 meters before the aircraft departed the safety zone, the first officer called: *Parking brake*.

The aircraft continued an increasingly sideways skid in a nose right position. Shortly before, the aircraft skidded off the left side of the safety zone and in order to reduce the risk of a potential fire, the first officer selected both condition levers to fuel off. The first officer did not coordinate this action with the commander.

The aircraft departed the safety zone at an airspeed of 40 knots CAS, and on a heading of 068º magnetic.

The aircraft hit one of the PAPI lights to runway 25, skidded down a steep snow-covered slope and impacted a rocky area approximately 10 meters below the runway elevation.

The crew members initiated an evacuation of the aircraft. The overall evacuation took approximately 30-40 seconds.

Fire and rescue services arrived at the accident site.

1.1.1 Flight animation of the final approach and landing

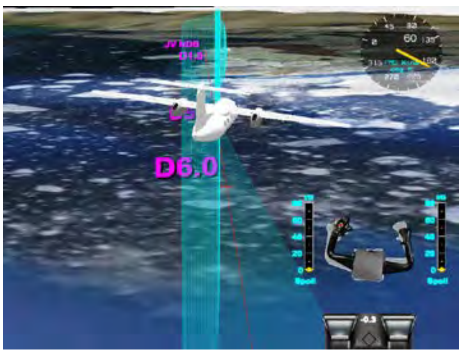
Based on recorded and processed flight data and other information, the following flight animation is a computerized approximation, which represents the AIB's best estimate of the accident sequence.

The data source is the Solid State Flight Data Recorder (SSFDR).

Due to data interpolation, certain actual SSFDR parameter values may not be presented in this animation.

In order to view the flight animation, please make sure that an appropriate internet connection is available.

Flight animation of the final approach and landing



1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal			
Serious			
Minor	1	1	

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

One runway edge light was destroyed.

One PAPI light to runway 25 was destroyed - see below in the red marking.

1.5 Personnel information

1.5.1 The commander

1.5.1.1 License and medical certificate

The commander (38 years) was the holder of a valid Danish Airline Transport Pilot License (ATPL (A)).

The ATPL contained the following type rating: DHC8/IR.

DHC8 is equal to Dash 8.

The type rating DHC8/IR was valid until 31-12-2014.

The PART-FCL medical certificate class one was valid until 9-7-2014. There were no remarks to the medical certificate.

1.5.1.2 Operator training

- On 28-4-2012, the type rating DHC8 CO-PILOT ONLY (the commander's Commercial Pilot License (CPL (A)) was issued
- In the time period from 9-7-2012 until 27-10-2012, the commander flew Dash 8 commander line flying under supervision
- On 4-12-2012, the commander's ATPL and the appurtenant type rating DHC8/IR were issued
- On 13-3-2013, the latest emergency and safety equipment training was performed
- In the time period from 27-9-2013 until 4-10-2013, the commander flew Dash 8 commander line flying under supervision
- On 4-10-2013 as commander, the latest Dash 8 line check was performed. This line check served as a Dash 8 commander release check, as well
- On 8-10-2013, the latest steep approach qualification training was performed
- On 9-10-2013 as commander, a combined Dash 8 Operator Proficiency Check (OPC)/License Proficiency Check (LPC) were performed. The OPC/LPC included training on "landing gear collapse" and "on ground emergency"
- On 8-1-2014, the latest Crew Resource Management (CRM) training was performed

At the time of the accident, the commander's route and aerodrome qualifications were valid.

1.5.1.3 Operator experience

- The commander had previous Dash 7 flying experience as first officer
- On 7-2-2013, as commander, a Dash 8 line check was performed
- On 24-4-2013, as commander, a Dash 8 OPC was performed
- In the period of time from 4-12-2012 until 17-10-2013, the commander acted as Dash 8 first officer

1.5.1.4 Flying experience

Total flying experience

	Last 24 hours	Last 90 days	Total
All types	7	64	4201
This type	7	64	739
Landings this type	-	-	-

Flying experience as Dash 8 commander

Confer the operator's Operations Manual (OM) part A chapter 4.1.5:

Following completion of a command course or a type rating course, a flight crew member is considered inexperienced on the type until he has achieved either 100 flying hours and flown 10 sectors within a consolidation period of 120 consecutive days, or until he has achieved 150 flying hours and flown 20 sectors (no time limit).

In the time period from 17-10-2013 until the time of departure from BGSF at the day of the accident, the commander, as Dash 8 commander, had achieved a total flying experience of 86:53 hours (ref. the operator's pilot logbook report system).

It was the responsibility of a commander to keep track of own commander experience level.

At the day of the accident and before the flight from BGSF to BGJN, the commander considered the experience level as Dash 8 commander to be more than 100 flying hours.

1.5.1.5 Duty time

Previous seven days

Duty begin	Duty end	Rest	Block time	Duty time	Flight Duty Period (FDP)
22-1-2014 08:00 (Standby)	22-1-2014 15:00			1:00	
23-1-2014 09:00	23-1-2014 20:36	14:49	5:52	11:36	11:21
24-1-2014 11:25	24-1-2014 16:18	17:47	3:29	4:53	4:38

25-1-2014 10:05	25-1-2014 15:35	44:45	3:24	5:30	5:15
26-1-2014 DAY OFF					
27-1-2014 12:20	27-1-2014 19:30	15:05	3:32	7:10	6:55
28-1-2014 10:35	28-1-2014 21:14	12:46	6.33	10:39	10:24

Cumulative block duty time totals

Months (2013)	Hours
January	37:35
February	30:02
March	19:16
April	21:59
May	22:27
June	43:32
July	83:04
August	39:54
September	45:47
October	37:53
November	12:40
December	13:22
TOTAL	407:31

1.5.2 The first officer

1.5.2.1 License and medical certificate

The first officer (41 years) was the holder of a valid Danish Commercial Pilot License (CPL (A)).

The CPL contained the following type ratings: MEP (land), SEP (land), DHC8/IR CO-PILOT ONLY and DHC7/IR CO-PILOT ONLY.

The type rating DHC8/IR CO-PILOT ONLY was valid until 30-6-2014.

The PART-FCL medical certificate class one was valid until 8-9-2014. There was one remark to the medical certificate: VNL (shall have available corrective spectacles for near vision and carry a spare set of spectacles).

1.5.2.2 Operator training

- On 29-5-2013, the latest emergency and safety equipment training was performed
- On 10-6-2013, the latest Dash 8 line check was performed
- On 4-9-2013, the latest Crew Resource Management (CRM) training was performed
- On 27-11-2013, the latest steep approach qualification training was performed
- On 27-11-2013, the latest Dash 8 OPC was performed. The OPC included training on “landing gear collapse” and “on ground emergency”

At the time of the accident, the first officer’s route and aerodrome qualifications were valid.

1.5.2.3 Operator experience

- The first officer had previous Dash 7 flying experience as first officer
- On 1-6-2012, the type rating DHC8 CO-PILOT ONLY (the first officer’s Commercial Pilot License (CPL (A)) was issued

1.5.2.4 Flying experience

	Last 24 hours	Last 90 days	Total
All types	7:13	137:44	1592:50
This type	7:13	137:44	1022:56
Landings this type	8	158	1397

1.5.2.5 Duty time

<u>Previous seven days</u>

Duty begin	Duty end	Rest	Block time	Duty time	Flight Duty Period (FDP)
22-1-2014 09:45	22-1-2014 16:01	21:49	2:51	6:16	6:01
23-1-2014 13:50	23-1-2014 23:14	12:11	3:33	9:24	9:09
24-1-2014 11:25	24-1-2014 22:22	60:28	6:01	10:57	10:42
25-1-2014 DAY OFF					
26-1-2014 DAY OFF					
27-1-2014 10:50	27-1-2014 19:30	15:05	3:34	8:40	8:25
28-1-2014 10:35	28-1-2014 21:14	12:46	6.33	10:39	10:24

<u>Cumulative block duty time totals</u>

Months (2013)	Hours
January	19:25
February	19:19
March	32:12
April	21:09
May	34:58
June	44:08
July	81:31
August	84:08

September	81:35
October	79:31
November	60:16
December	23:43
TOTAL	581:55

1.5.3 Cabin crew member

1.5.3.1 License and medical certificate

The cabin crew member was the holder of a valid Danish cabin crew member license.

The medical certificate was valid until 6-3-2016.

1.5.3.2 Operator training

Module 1 (Yearly recurrent)	Check date
Touch drills for exits:	29-9-2013
Emergency procedures:	29-9-2013
Emergency equipment:	29-9-2013
Accident/incident review:	29-9-2013
CRM 3:	22-9-2013
Security procedures:	29-9-2013
Crowd control:	29-9-2013
Line check:	15-4-2013
First aid:	17-4-2013

Module 2 (3 year recurrent)	
Smoke and fire:	8-3-2011
Handling pyrotechnics:	25-3-2011
Operating exits/slides:	16-4-2013
Use of life raft (if applicable):	9-3-2011
Security:	21-3-2011

Module 3
(Every 3 years)

Dangerous goods: 23-4-2011

1.5.3.3 Operator experience

In addition to Dash 8 flying experience as a cabin crew member, the cabin crew member also had previous Dash 7 flying experience.

1.5.3.4 Duty time

Previous seven days

Duty begin	Duty end	Rest	Block time	Duty time	Flight Duty Period (FDP)
22-01-2014 08:00 (Standby)	22-01-2014 16:00			2:00	
23-01-2014 11:00	23-01-201 21:26	109:09	5:39	10:26	10:11
24-01-2014 13:00 (Standby)	24-01-2014 21:00			2:00	
25-01-2014 DAY OFF					
26-01-2014 DAY OFF					
27-01-2014 DAY OFF					
28-01-2014 10:35	28-01-2014 21:14	12:46	6.33	10:39	10:24

1.6 Aircraft information

1.6.1 General

Registration:	OY-GRI
Type:	Dash 8
Model:	202
Manufacturer:	Bombardier Aerospace, Canada
Serial number:	477
Year of manufacture:	1997
Engine manufacturer:	Pratt & Whitney Canada Inc.
Engine type:	PW123D
Propellers:	Hamilton Standard Division, 14F-23
Aircraft total flight hours:	29 947
Aircraft total flight cycles:	41 968

1.6.2 Airworthiness and maintenance

The airplane maintenance records were verified to be in compliance with the established maintenance program and the airworthiness certificate was valid.

1.6.2.1 Aircraft latest A and C check

<u>A check</u>

The interval was 500 hours. The latest check was performed on 9-12-2013 (29 795:49 hours). Next check was due at 30 295:49 hours, or before 2-5-2014.

<u>C check</u>

The interval was 5 000 hours. The latest check was performed on 11-5-2011 (26 296:45 hours). Next check was due at 31 296:45 hours, or before 29-1-2015.

1.6.2.2 Left main landing gear maintenance and inspection

At the latest aircraft A and C check, the latest main landing gear maintenance was performed.

In 2013, three hard landing inspections were performed. There were no remarks.

1.6.3 Main landing gear system

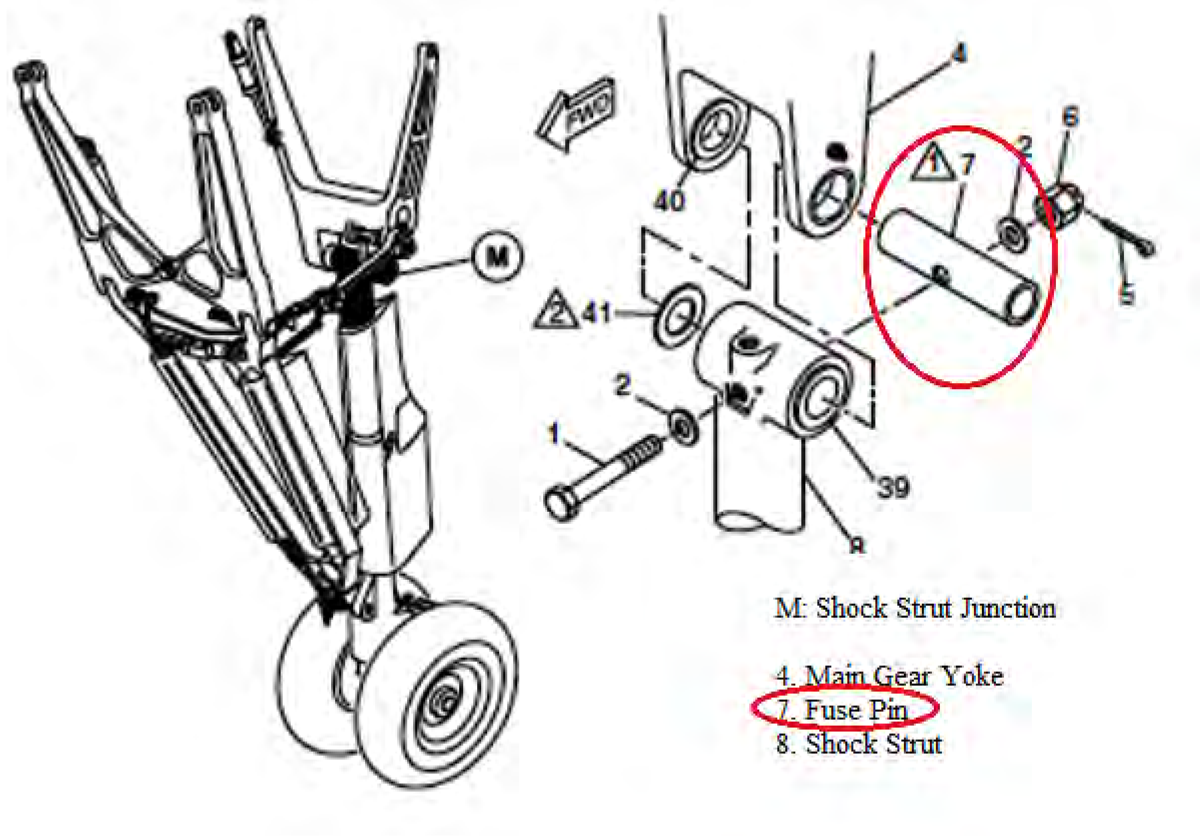
1.6.3.1 General

The retractable landing gear consisted of two main gear assemblies, one mounted in each nacelle under the wings, and a nose gear assembly mounted in a well in the front fuselage.

Both the main and the nose gear assemblies incorporated shock struts and dual wheels and were fully enclosed by doors when retracted.

1.6.3.2 Main landing gear structural fuse pin

A draft of the main landing gear and the structural fuse pin



Dynamic analysis of landing gear loads (Dash 8 Series 200 Model 201/202 Aircraft**)**

Conclusions (extract) - the AIB has inserted text in brackets.

An analysis of extremely hard two-wheel landings has been performed for the DHC-8 Series 200 Model 201/202 (and, by extension, for the Series 100A Model 105/106). The effect of airframe flexibility has been included.

Neither shock absorber nor tire will bottom at 12 ft/sec rate of descent (720 feet/minute). *These elements will bottom between 12 ft/sec and the rate of descent required to break the shear pin.*

In the level attitude the shear pin will fail at a rate of descent between 14.9 (894 feet/minute) *and 15.7 ft/sec* (942 feet/minute). *In the tail down attitude the shear pin will fail at a rate of descent between 16.6* (996 feet/minute) *and 17.15 ft/sec* (1029 feet/minute). *In both cases, at the instant of pin failure the horizontal ground load will be small.*

1.6.4 Operational flight plan

The AIB has erased the names of the crew members and the name of the operator.

See appendix 5.1

1.6.5 Mass and balance

1.6.5.1 Loadsheet issued to the flight crew at BGSF

The AIB has erased the names of the crew members and the name of the operator.

See appendix 5.2

1.6.5.2 Mass check of baggage and cargo

After the accident, the AIB checked the actual distribution and masses of the onboard baggage and cargo.

It was not possible to reweigh all baggage and cargo in baggage and cargo compartment number two, since some of the cargo was smashed fruit and vegetables.

The operator's load limitation of baggage and cargo compartment number two was 400 kg.

Loadsheet data		Actual data	
Compartment no. one:	495 kg	Compartment no. one:	405 kg
Compartment no. two:	400 kg	Compartment no. two:	473 kg (assumed)
Cabin baggage sock no. two:	106 kg	Cabin baggage sock no. two:	138 kg
Cabin baggage sock no. three:	106 kg	Cabin baggage sock no. three:	91 kg

Based on the actual mass distribution and mass data, a mass and balance recalculation made it likely that at the time of the accident, the aircraft was within the mass and centre of gravity limitations.

1.6.5.3 Use of cargo net

On the accident flight, the baggage and cargo in baggage and cargo compartment number one and two were assumed to be firmly fixed. For that reason, a cargo net was not used.

1.6.6 Crosswind limitations

1.6.6.1 Extract from the operator's Operations Manual (OM) part B.

See appendix 5.3

1.6.6.2 Extract from the Dash 8 Aircraft Flight Manual (AFM)

Maximum crosswind component (measured at a height of 10 meters) approved for take-off and landing on a hard, dry runway is 36 knots.

1.6.7 Route performance manual (RPM)

Extract from the operator's RPM.

	DHC-8-202 / PW 123D Route Performance Manual	Sheet : BGJN-07.110KT Date : Aug 18 2012
TORA 845 m ASDA 845 m TODA 845 m LDA 845 m	**ILULISSAT/JAKOBSHAVN** Slope -0.47% Downhill AD Elev 95 ft **BGJN/JAV 07.110KT**	**Opt.Flaps** Bleeds .... OFF Anti-skid ...... OPER **Static TO** **MTOP**

LANDING - Dry/Wet runway surface - Anti-ice OFF **MLM: 15649**

Flaps	T -15 kt	T -10 kt	T -5 kt	WIND Calm	H 5 kt	H 10 kt	H 15 kt
15	NA/NA	13008/NA	15085/11846	16466/13925	16466/14561	16466/15217	16466/15896
35	12822/NA	15781/11199	16466/13985	16466/16466	16466/16466	16466/16466	16466/16466

1.6.8 Flight deck door

1.6.8.1 General

Manufacturer: TTF Aerospace, LLC

Type: Reinforced flight deck door installation IAW FAA STC STO1195SE, EASA STC EASA.IM.A.S.02799

Part number: 02T1001-1

The reinforced flight deck door replaced the existing flight deck door and the flight deck door jamb structure.

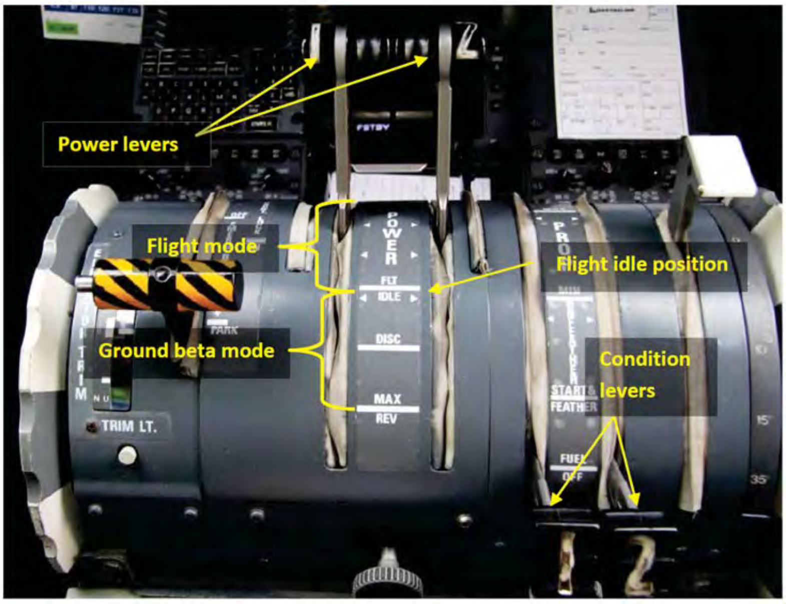
The new flight deck door latch system was designed to halt unauthorized entry.

The flight deck door latch assembly had no keyed entry on the passenger cabin side and it could not be opened from the passenger cabin without actuating the electronic strike from the flight deck side.

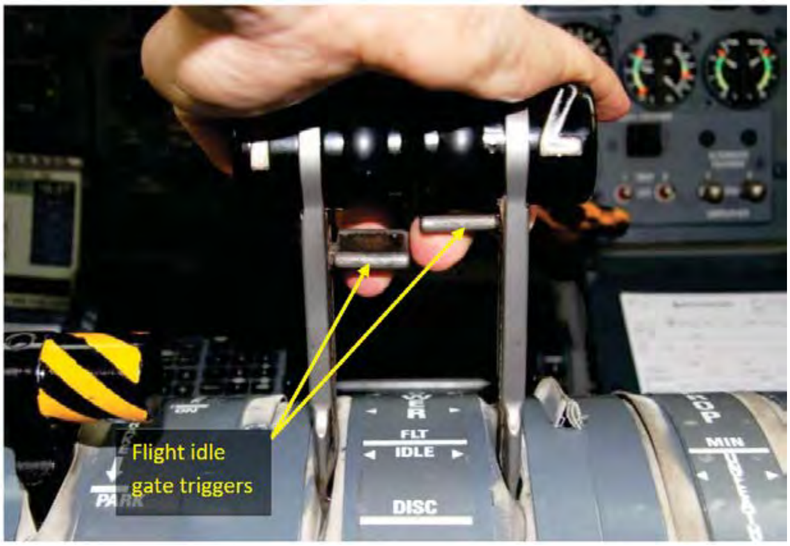
1.6.8.2 Emergency door release locations

See appendix 5.4

1.6.9 Engine controls



Exemplar picture of engine control quadrant



Exemplar picture of power levers showing flight idle gate triggers

1.6.9.1 Power levers

Extracts from the Dash 8 operating data manual (ODM) - see appendix 5.5

The two power levers, marked 1 and 2, control engine speed in the forward power range and engine speed and propeller blade angle in the idle through reverse beta range.

For normal flight operation in the forward thrust range propeller blade angle is controlled by a governor in the PCU, which regulates propeller speed (Np) in response to condition lever settings. Engine power is controlled by the power lever. As the power levers are retarded to FLT IDLE, with the condition levers at MAX, the PCU governor reduces blade angle as it attempts to maintain the selected propeller rpm. As blade angle reduces to + 27.5 degrees (at a point slightly above FLT IDLE), the power lever acquires direct blade angle control (beta range). At FLT IDLE, propeller blade angle decreases to +20.0 degrees.

Note
For descriptive reasons, the beta range of power lever movement above FLT IDLE is designated "flight beta" (useable while airborne) and the beta range between FLT IDLE and MAX REV" ground beta" (useable only while on the ground)."

A FLT IDLE gate prevents unintentional movement into the ground beta region. The gate is overridden by raising gate release triggers below the handgrips, allowing the power lever to be moved further aft until a spring detent labeled DI SC is reached. Through this range, propeller blade angle decreases from +20.0 degrees to +1.5 degrees (discing).

Further power lever movement aft moves the blades into reverse until the power levers reach MAX REV, where the blade angles are set at -11.0 degrees.

While in beta range, the mechanical fuel control unit (MFC) and the electronic control unit (ECU) regulate power to provide propeller underspeed governing in the FLT DLE/DISC range. While in the reverse thrust range, the MFC and ECU also regulate power and propeller speed, proportional to the amount of reverse blade angle selected with the power lever.

1.6.9.2 Condition levers

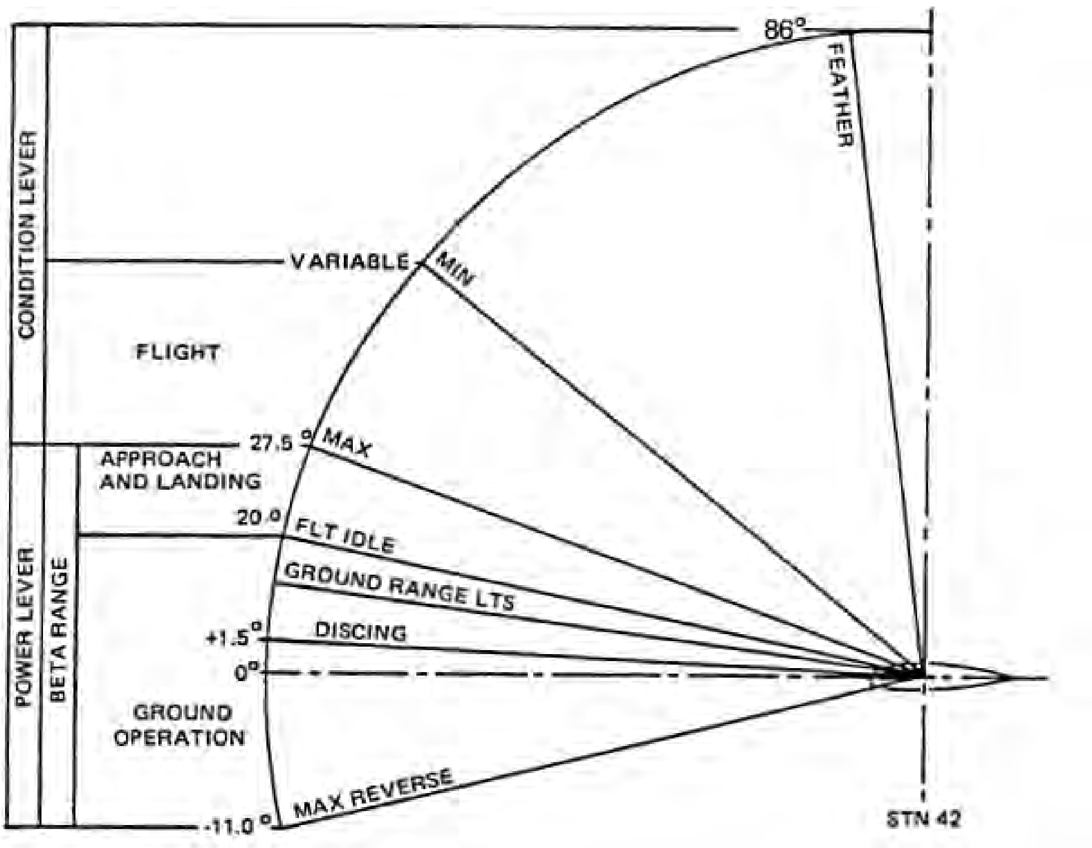
Extracts from the Dash 8 operating data manual (ODM) - see appendix 5.6

The two condition levers, located adjacent to the power levers and marked 1 and 2, set propeller rpm in the forward thrust range and provide manual propeller feathering and fuel on/off control for engine start and shutdown. Each condition lever provides input to the MFC and PCU of the related engine.

When in the forward thrust (constant speed) range, the position of the condition lever sets propeller rpm through input to the governor in the PCU. At MAX, propeller rpm is governed at approx. 1200. Moving the lever aft reduces governed rpm until at MIN rpm is approximately 900.

Moving the condition lever to START & FEATHER feathers the propeller and disables the propeller underspeed governing to allow "ground idle" engine operation. Moving the lever to FUEL OFF cuts off all fuel flow to the engine. Lift gates at the MIN and START & FEATHER positions prevent unintentional movement of the condition levers from MIN to START & FEATHER and from START & FEATHER to FUEL OFF.

1.6.9.3 Propeller blade angles



1.6.9.4 Beta backup protection (inflight only)

Advisory lights are provided on the left glareshield panel to indicate that the propellers are in the ground range of beta operation. Marked PROPELLER GROUND RANGE 1 and 2, each light is illuminated by a low blade angle switch that is actuated by the blade angle mechanical feedback mechanism. Illumination occurs when blade angle is decreasing through +16.5 degrees. A beta backup system provides protection against the propeller entering beta ground range unintentionally due to a PCU malfunction (while the power lever is above ground range). The system uses a beta back up signal, supplied by the low blade angle switch, which is relayed to the feather solenoid valve via a power lever-operated microswitch. The micro-switch will relay the beta backup signal only when the power lever is above the ground range position.

In the event the propeller enters ground range with the power lever above the ground range setting, the beta backup signal supplied by the low blade angle switch is relayed to energize open the feather solenoid valve, causing the propeller to begin feathering until blade angle increases past the ground range point. The low blade angle switch then closes the feather solenoid valve, restoring the original condition. The result is a continuous cycling in and out of propeller ground range, accompanied by on/off flashing of the related PROPELLER GROUND RANGE indicator light, until the cause of the fault is rectified. Provision is made to test beta backup function and to check serviceability of the power lever-operated microswitch by means of BETA BACKUP TEST switches on the pilot s side Console panel.

1.6.10 Beta warning
1.6.10.1 Beta warning horn

Extract from the Dash 8 ODM.

On airplanes incorporating Mod 8/2852, a warning horn is installed in the flight compartment to warn the flight crew if Beta range is selected on the Power levers while in flight. The Beta horn is armed by a signal from #1 Radio Altimeter when an altitude of 20 ft. is reached. The warning horn ceases when the Power lever is moved out of the Beta range or the aircraft is below 20 feet.

OY-GRI was equipped with a beta warning horn.

1.6.10.2 Beta warning label

Despite incorporation of the beta warning horn modification, incidents continued to occur, in which the power levers were selected aft of the flight idle gate, into the beta range during flight.

This fact caused the issue of the Airworthiness Directive (AD) CF-2012-33/Service Bulletin (SB) 8-11-115, which required the fitment of a beta warning label in the flight deck.

See appendix 5.7

On 26-2-2013 (28 591:50 hours), the operator performed the AD fitment of the beta warning label in the flight deck.

1.6.11 Emergency Locator Transmitter (ELT)

1.6.11.1 General

Manufacturer:	Artex – ACR Electronics, Inc
Model:	C406-2
Part number:	453-5001
Serial number:	170-12422
Date of manufacture	March 2010
Battery expiration date:	January 2018
Manufacturer information:	The ELT 453-5000 was certified under TSO-126 and ETSO-126, which required the ELT to have a crash activation sensor (G-switch) as defined in RTCA DO-204 and EUROCAE ED-62. The sensor activated only in the direction of flight. The activation threshold was 2.3g +/- 0.3g. The crash activation sensor must respond to a change in velocity of 4.5 fps +/- 0.5fps. These characteristics were tested over a minimum set of G forces ranging from 3, 6, 9, and 12 with a tolerance of +/- 1G.

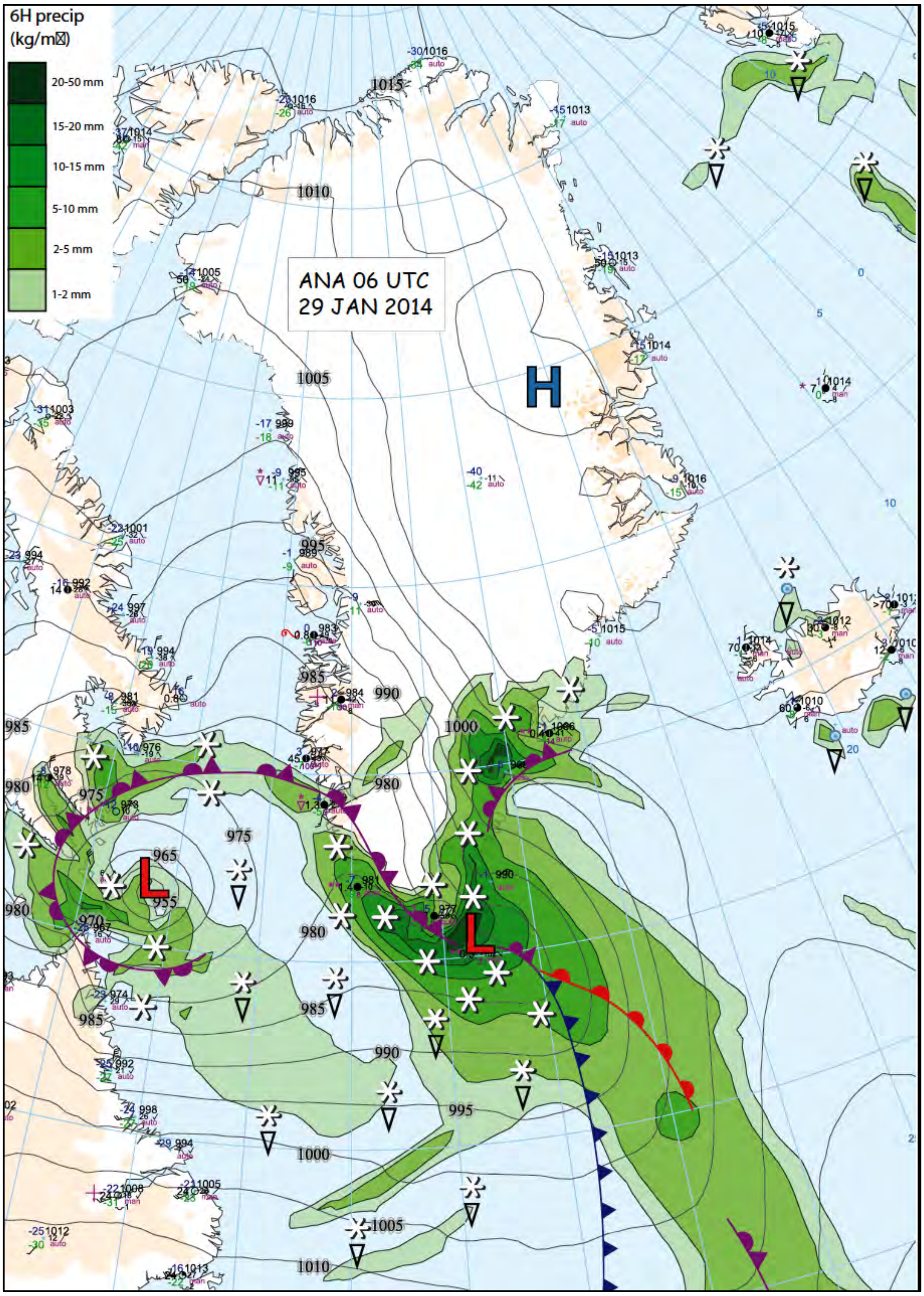
1.6.11.2 ELT examination

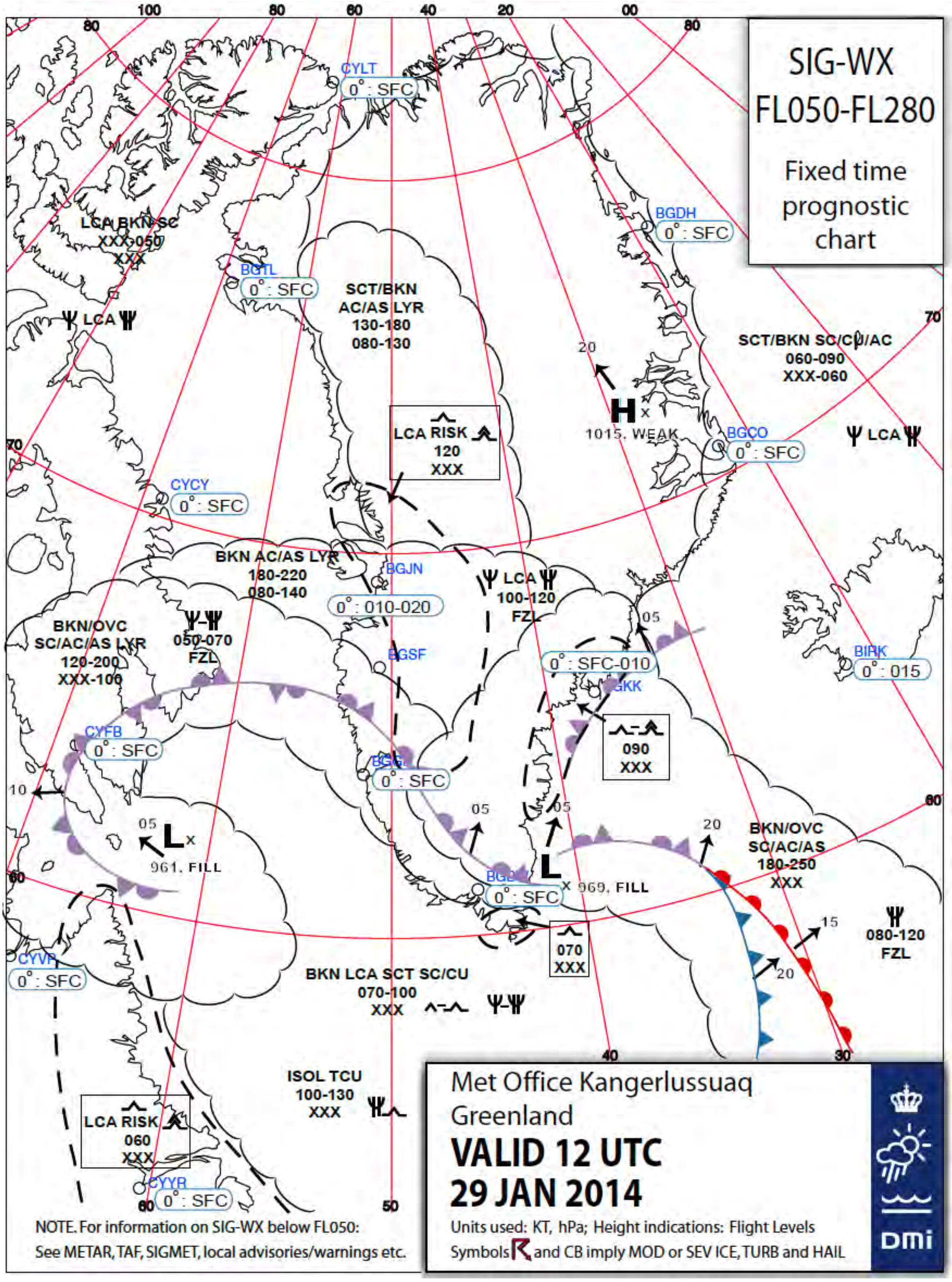
During the sequence of events, the ELT did not activate.

The ELT performed to design specifications on all levels.

1.7 Meteorological information

1.7.1 General




SIG-WX
FL050-FL280
Fixed time prognostic chart
LCA BKN SC
XXX-050
XXX
LCA
SCT/BKN
AC/AS LYR
130-180
080-130
LCA RISK
120
XXX
H
1015, WEAK
SCT/BKN SC/CU/AC
060-090
XXX-060
LCA
BKN AC/AS LYR
180-220
080-140
LCA
100-120
FZL
BKN/OVC
SC/AC/AS LYR
120-200
XXX-100
050-070
FZL
090
XXX
L
961, FILL
L
969, FILL
BKN/OVC
SC/AC/AS
180-250
XXX
080-120
FZL
070
XXX
BKN LCA SCT SC/CU
070-100
XXX
ISOL TCU
100-130
XXX
LCA RISK
060
XXX
CYLT 0°: SFC
BGDH 0°: SFC
BGTL 0°: SFC
BGCO 0°: SFC
CYCY 0°: SFC
BGJN 0°: 010-020
BGSF
0°: SFC-010
BIRK 0°: 015
CYFB 0°: SFC
0°: SFC
0°: SFC
CYVP 0°: SFC
CYYR 0°: SFC
Met Office Kangerlussuaq
Greenland
VALID 12 UTC
29 JAN 2014
Units used: KT, hPa; Height indications: Flight Levels
Symbols and CB imply MOD or SEV ICE, TURB and HAIL
DMI
NOTE. For information on SIG-WX below FL050:
See METAR, TAF, SIGMET, local advisories/warnings etc.

1.7.2 Weather information - flight crew preflight planning

At 10:39 hours, the flight crew updated their preflight planning weather information. The AIB extracted the below presented weather information.

1.7.2.1 BGSF

METAR:	bgsf 291020z auto 06013kt 9999ndv few110/// 02/m08 q0980=
TAF: (9 hours)	bgsf 290500z 2906/3012 08008kt 9999 bkn120 tempo 2906/2909 12015g30kt drsn tempo 3000/3012 bkn060=

1.7.2.2 BGJN

SPECI (AL):	bgjn 291028z 10023g40kt 9999 bkn120 03/m09 q0984=
METAR:	bgjn 290950z auto 10025kt 9999ndv bkn110/// ovc120/// 03/m09 q0984=
TAF: (9 hours)	bgjn 291037z 2910/2919 11020kt 9999 bkn120 tempo 2910/2916 11028g40kt 7000 blsn tempo 2916/2919 12022g32kt 7000 blsn=

1.7.3 METAR

1.7.3.1 BGSF

290920	bgsf 290920z auto 07012kt 040v110 9999ndv few100/// 01/m08 q0980=
290950	bgsf 290950z auto 06011kt 9999ndv few100/// 02/m08 q0980=
291020	bgsf 291020z auto 06013kt 9999ndv few110/// 02/m08 q0980=
291050	bgsf 291050z auto 05010kt 9999ndv few120/// 01/m08 q0980=
291120	bgsf 291120z auto 06010kt 9999ndv few130/// 01/m08 q0980=

1.7.3.2 BGJN

290950	bgjn 290950z auto 10025kt 9999ndv bkn110/// ovc120/// 03/m09 q0984=
291017 SPECI	bgjn 291017z 10021kt 9999 bkn120 03/m09 q0984=

291028 SPECI	bgjn 291028z 10023g40kt 9999 bkn120 03/m09 q0984=
291050	bgjn 291050z 10020kt 9999 bkn120 02/m09 q0984=
291109 SPECI	bgjn 291109z 10020g30kt 9999 bkn120 03/m09 q0984=
291150	bgjn 291150z 11029g40kt 9999 bkn120 02/m09 q0983=

1.7.4 TAF

1.7.4.1 BGSF

290500	bgsf 290500z 2906/3012 08008kt 9999 bkn120 tempo 2906/2909 12015g30kt drsn tempo 3000/3012 bkn060=
291100	bgsf 291100z 2912/3018 08008kt 9999 bkn120 tempo 2912/2920 12012g22kt tempo 3000/3012 bkn060=

1.7.4.2 BGJN

291000	bgjn 291037z 2910/2919 11020kt 9999 bkn120 tempo 2910/2916 11028g40kt 7000 blsn tempo 2916/2919 12022g32kt 7000 blsn=

1.7.5 Wind information

1.7.5.1 Wind model data

Based on wind model data, the Danish Meteorological Institute (DMI) calculated upper winds for the BGJN area.

Conclusion - AFTERCAST (subjective):

Altitude	Wind direction – true north	Wind speed - knots
10 000 feet	160	65
5 000 feet	160	60 (turbulent)
2 000 feet	130	50 (turbulent)
1 000 feet	120	45 (turbulent)

1.7.5.2 AFIS presented wind information

The Air Traffic Service (ATS) weather information system (named SAVS) was in use at all Greenlandic airports and heliports.

The SAVS presented winds to the AFIS operator was a two-minute mean wind with a 10-minute variation on wind direction and wind speed presented for both thresholds (runway 07 and runway 25).

Furthermore and based on a two-minute mean wind, crosswind, headwind or tailwind conditions for both thresholds (runway 07 and runway 25) were presented to the AFIS operator. However, it was not possible to issue information on crosswind, headwind or tailwind based on a three-second spot wind. In the calculation of crosswind, headwind or tailwind, the wind presentation system did not take in consideration extreme values of wind direction and wind speed.

At 11:42:11 hours, when the aircraft was on short final to runway 07, the AFIS operator reported the wind conditions for landing on runway 07 to be 140° magnetic and 25 knots – maximum to 39 knots.

The investigation revealed that due to a replacement of a computer on 27-12-2013, the AFIS presented threshold winds of runway 07 and runway 25, respectively, was exchanged by mistake.

For that reason at 11:42:11 hours, the reported wind conditions to the flight crew were the threshold wind of runway 25.

The actual and recorded threshold winds of runway 07 (the winds are extracted by the AIB):

Time	Wind direction - true north	Wind speed - knots (minimum- maximum)
11:41:01	95.0° - 122.0°	19.6 - 23.9
11:41:10	108.0° - 133.0°	19.6 - 32.7
11:41:20	105.0° - 133.0°	20.0 - 32.7
11:41:30	105.0° - 127.0°	20.6 - 27.4
11:41:40	109.0° - 127.0°	20.8 - 36.0
11:41:50	111.0° - 123.0°	21.4 - 36.0
11:42:00	111.0° - 123.0°	23.5 - 33.7
11:42:10	104.0° - 123.0°	23.5 - 29.6
11:42:20	102.0° - 113.0°	24.9 - 29.6
11:42:30	102.0° - 127.0°	24.9 - 29.8

The actual and recorded threshold winds of runway 25 (the winds are extracted by the AIB):

Time	Wind direction – true north	Wind speed - knots (minimum- maximum)
11:41:01	105.0° - 119.0°	28.4 - 39.3
11:41:10	101.0° - 125.0°	28.0 - 39.3
11:41:20	101.0° - 125.0°	28.0 - 35.2
11:41:30	101.0° - 126.0°	26.8 - 33.7
11:41:40	112.0° - 126.0°	23.0 - 33.7
11:41:50	112.0° - 126.0°	23.0 - 31.7
11:42:00	104.0° - 118.0°	22.6 - 27.0
11:42:10	104.0° - 118.0°	22.6 - 27.4
11:42:20	104.0° - 115.0°	22.6 - 27.4
11:42:30	105.0° - 115.0°	21.6 - 28.4

1.7.5.3 Presented winds by the aircraft FMS

The AIB extracted the wind information.

FMS 3017_41_211SN1165:

Altitude - feet	Wind direction - true north	Wind speed - knots
2457	164°	60
991	143°	57
482	135°	54
217	133°	48
184	133°	48
164	133°	48
144	132°	48
105	132°	47
79	132°	46
56	132°	45
20	131°	43
3	130°	41

FMS 3017_41_211SN1173:

Altitude - feet	Wind direction - true north	Wind speed - knots
2471	166°	55
1007	143°	51
495	134°	48
203	132°	42
180	132°	42
161	131°	42
131	131°	42
102	131°	41
82	130°	40
52	130°	38
23	130°	37
13	129°	35

1.8 Aids to navigation

1.8.1 NDB/DME RWY 07

As a backup for the visual approach, the flight crew set up the NDB/DME approach to runway 07. The approach procedure was based on the NDB JV (367 KHz) and the DME JA (111.950 MHz).

At the time of the accident, there were no reports on unserviceable approach aids to navigation at BGJN.

1.8.2 Flight inspection report

On 28-6-2014, the latest flight inspection on the aids to navigation was performed.

The conclusion of the flight inspection: *Unrestricted facility status.*

1.8.3 Operator's aerodrome charts

See appendix 5.8

1.9 Communication

1.9.1 General

The flight crew was in VHF radio contact with Sondrestrom TWR (118.300 MHz), Sondrestrom FIC (120.300 MHz) and Ilulissat AFIS (119.100 MHz).

1.9.2 ATS voice recording

The AIB obtained involved ATS voice recording. The recordings were of good quality and useful to the investigation.

1.10 Aerodrome information

1.10.1 BGJN aerodrome

Aerodrome position (ARP):	69° 14’ 35.58N 51° 03’ 25.60W
Elevation:	95 feet
Magnetic variation:	35 W (January 2009)
Annual change	Decreasing 34’
Runway identifications:	RWY 07 and RWY 25
Direction of runway 07:	035.9° (GEO) and 070.9° (MAG) in January 2009 068.1° (MAG) in January 2014 (calculated value)
Surface	Asphalt
Runway dimensions:	845 x 30 meters
Strip dimensions:	905 x 100 meters. Outside the strip, the area was rocky
PAPI to runway 07:	The PAPI angle to runway 07 was 5.1°. Minimum eye height over threshold (MEHT) was 33 feet.
Landing distance available (LDA) - RWY 07:	845 meters
Rescue and firefighting Service	CAT 5
Surface wind sensors:	Right of threshold 07 and 25

1.10.2 Aerodrome category

Confer the operator’s Operations Manual (OM) part A (category list) and OM part B (route and aerodrome training and qualifications), BGJN was a category A aerodrome.

All the operator’s flight crews were qualified for category A areas through initial training and normal operations.

1.11 Flight recorders

1.11.1 Solid State Flight Data Recorder (SSFDR)

Manufacturer: Honeywell, Part Number 980-4700-001 (Serial Number 2969)

The SSFDR recorded data at a frame rate of 64 words per second. The recording system included a Plessey Flight Data Acquisition Unit (FDAU) with part number 612-1-49780-202. The system was modified with a TIMCO Aviation STC6 for expanded parameters. The additional parameters that were added to the Dash 8 data frame included the following:

- Flight control positions (pitch, roll and yaw).
- Composite control disconnects (pitch and roll).
- Warning light status discretes (engine oil pressure, smoke, passenger and baggage doors, cabin pressure, check fire detector, main battery hot, and auxiliary battery hot).

The SSFDR appeared undamaged.

Approximately 26.9 hours of flight data were recovered including the accident flight, and the recovered flight data were useful to the investigation.

1.11.1.1 SSFDR data plots

The time axis is in Universal Coordinated Time (UTC) based on the time stamp from the Air Traffic Control (ATC) recording.

The VHF keying parameter was used to synchronize the SSFDR with the identical radio transmission recorded on the SSCVR.

The SSFDR data of interest are plotted in appendix 5.9 - 5.15 and appendix 5.18 - 5.20.

See appendix 5.9 - 5.15 and see appendix 5.18 - 5.20

However, since the Dash 8-202 was not equipped with ground spoilers, the ground spoiler deployed parameter recorded no information. Other data that would have been useful to produce the flight animation such as groundspeed, drift angle and latitude/longitude coordinates, were not recorded on the SSFDR. Position data were recovered from the Flight Management System (FMS).

Brake pressure was not recorded on the SSFDR.

The computed and recorded SSFDR airspeed was equivalent to Calibrated Air Speed.

The initial touchdown (based on vertical G spike) occurred at approximately 1142:21.4.

1.11.1.2 Engine shut-down

The SSFDR did not record the condition lever positions. However, both engine low hydraulic pressure discretes recorded a change to "low pressure" approximately two seconds before the aircraft departed the safety zone.

According to the aircraft manufacturer, the hydraulic pumps were engine driven. When the condition levers were moved to FUEL OFF, both of the engine driven hydraulic pumps caution lights illuminated (via condition lever micro switches; per design) in order to prevent the caution lights from cycling when an engine was shut down in flight.

Therefore, the recording of hydraulic "low pressure" during the ground roll suggested the condition levers had moved to FUEL OFF shortly before the aircraft departed the safety zone. Other data was also consistent with engine shutdown at that time. For example, the propeller RPMs were trending downwards and the engine oil pressure low discretes recorded "low pressure" at the end of the SSFDR recording.

See appendix 5.16

1.11.2 Solid State Cockpit Voice Recorder (SSCVR)

Manufacturer: Honeywell, Part Number 980-6020-001 (Serial Number 1270)

The SSCVR appeared undamaged.

The SSCVR data were recovered and were useful to the investigation.

1.11.3 Stopping of the SSFDR and the SSCVR

The SSCVR was determined to have stopped recording at the approximate time when the SSFDR stopped recording valid data; this occurred as the aircraft was moving down the steep slope.

The SSFDR continued to record non-synchronized binary data in memory for an additional 90 seconds after the FDAU stopped transmitting valid data. According to the aircraft manufacturer, the Dash 8-202 was equipped with a G-switch, which was located on the centre section of the front wing spar. The switch was designed to remove power to both the SSFDR and SSCVR when it senses +6 G forward deceleration.

At the time, when the valid SSFDR data ended and the SSCVR stopped, no significant accelerations were recorded.

According to the aircraft manufacturer, the AFCS interface box contained the power supply cards for the SSCVR. One possibility was that the power supply cards became unseated during the runway excursion, cutting power to the SSCVR. At the same time, as the engines were being shut down, it was possible that bus shedding caused an electrical problem with the FDAU, which resulted in the continuous transmitting of non-synchronized data for an additional 90 seconds. The above suggests that G-switch activation was not the reason for the recorders stopping, since the switch was designed to stop both recorders at approximately the same time.

1.11.4 Quick Access Recorder (QAR)

L3 microQAR memory card (Serial Number 123492)

Shortly after the accident, the QAR data chip was removed from the aircraft.

When comparing the QAR data to the SSFDR data, it was noted that the two data sets were identical, as expected, however during the runway excursion the QAR data ended approximately 5.5 seconds before the SSFDR data.

1.11.5 Flight Management System (FMS)

<u>FMS unit number one:</u>

Manufacturer: Universal Avionics Systems Corporation, Part Number 3017-41-211 (Serial Number 1165)

<u>FMS unit number two:</u>

Manufacturer: Universal Avionics Systems Corporation, Part Number 3017-41-211 (Serial Number 1173)

The two FMS units appeared undamaged. The FMS data of both units were recovered and were useful to the investigation.

The FMS data was overlaid with data from the SSFDR for comparison. In general, there was good agreement between the two data sets.

The differences in barometric altitude were likely due to temperature effects (SSFDR was corrected for non-standard temperature). The FMS recorded a derived vertical rate in feet per minute (fpm). A calculated SSFDR vertical rate was determined from the corrected barometric altitude by mathematically differentiating the altitude; since the SSFDR calculation resulted in significant fluctuations (noise), the results were smoothed using a moving 3-point average smoothing algorithm.

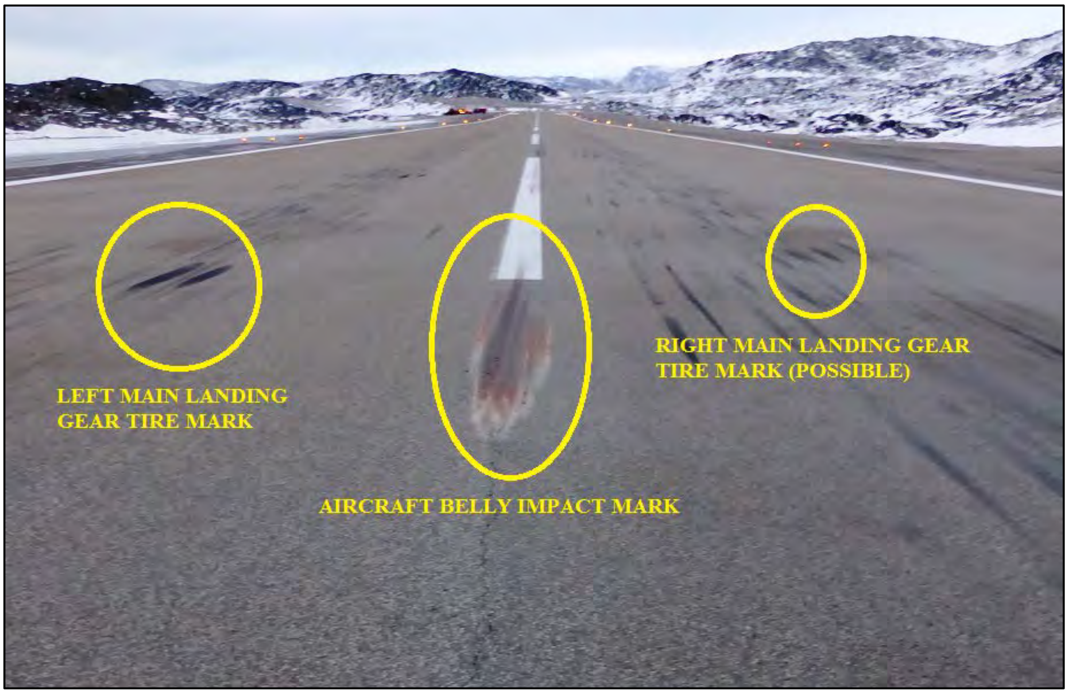
There was an approximate 5 degree difference in true heading between the FMS and SSFDR data.

See appendix 5.17

1.12 Wreckage and impact information

1.12.1 Impact events

Number	Distance from threshold (runway 07)	Events
1.	173 meters	Touchdown on the runway centerline See picture below



Number	Distance from threshold (runway 07)	Events
2.		Shearing of the left main landing gear structural fuse pin
3.		Collapse of the left main landing gear
4.	180 meters	Aircraft 2nd belly impact mark after which continuous belly marks

Number	Distance from threshold (runway 07)	Events
5.	196.5 meters	Slash marks from the left propeller/not feathered
6.	270 meters	Aircraft veering to the left of the runway centerline
7.	480 meters	Tire skid marks from an increasingly sideways skid in a nose right position
8.	555 meters	The aircraft ran off the left side off the runway and into the safety zone. Sideways skid in a nose right position. The aircraft hit one runway edge light
9.	720 meters	The aircraft departed the safety zone (slash marks from the left propeller/not feathered) and hit one PAPI light to runway 25
10.		The aircraft skidded down a snow-covered slope and impacted a rocky area approximately 10 meters below the runway elevation See pictures in chapter 1.12.2 (Impact area)
11.		On ground emergency

1.12.2 Impact area

1.12.3 Exterior damage to the aircraft

As a result of impacting rocks, the wing structure, the fuselage, the left propeller and the left main landing gear were destroyed.

1.12.4 Flight deck

Position of certain levers and switches:

- Emergency Brake: On
- Power Levers: Maximum reverse
- Conditions Levers Fuel Off
- Both Fuel Off Handles Pulled
- Tank Aux Pumps 1 and 2: On
- Fire Extinguisher Switches: Neutral
- Emergency lights: Arm
- Fasten seatbelts sign: On
- Battery Master: On

1.12.5 Interior damage to the passenger cabin

The passenger cabin was substantially damaged.

However, obstructions did not hinder free movement of the passengers during the evacuation.

1.12.6 SSFDR calculated rate of descent prior to touchdown

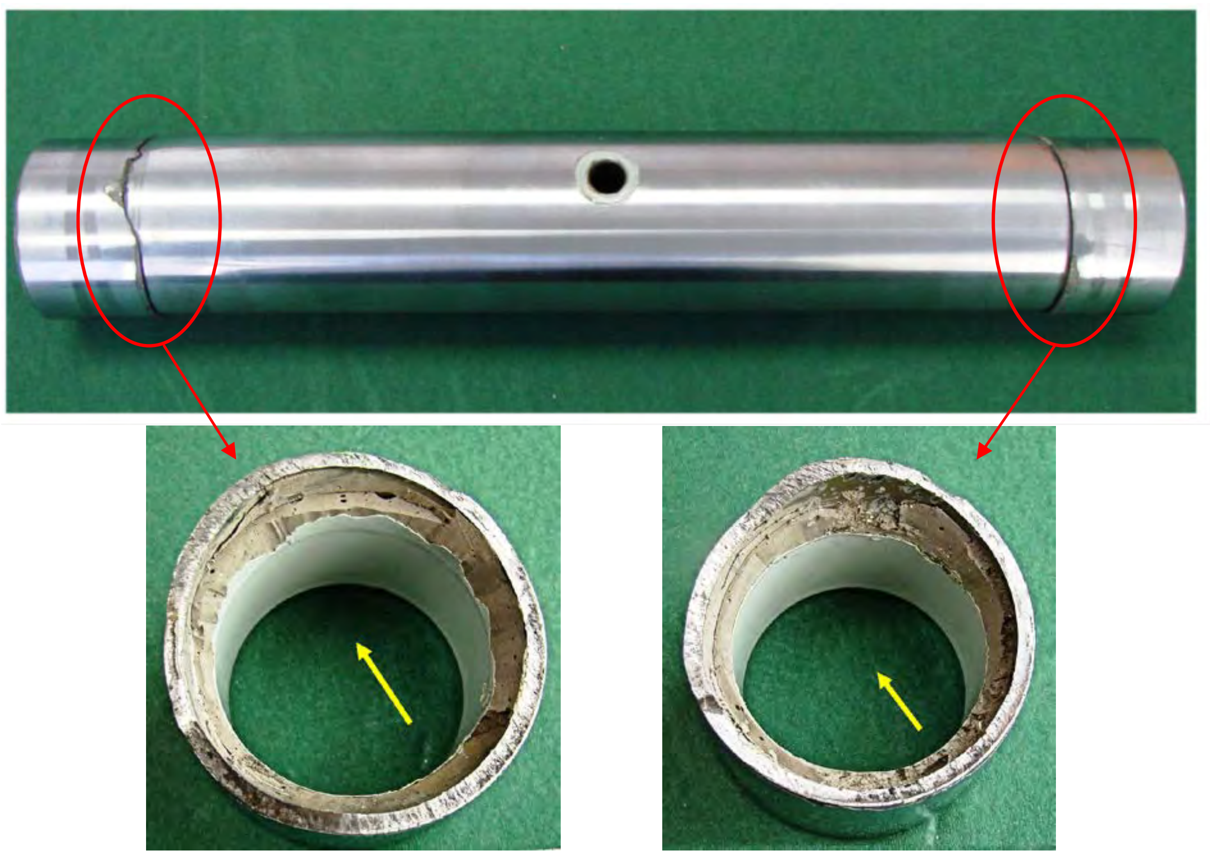
For the last 120 feet, SSFDR calculated data indicated an average rate of descent of approximately 1000 feet per minute.

For the most of the descent including the last 500 feet, SSFDR calculated data indicated an average rate of descent in excess of 1000 feet per minute.

1.12.7 Examination of the left main landing gear structural fuse pin

The investigation revealed the following findings:

- The left main landing gear structural fuse pin (part number: 10150-5 and serial number: 11EXC5958) sheared at two places - see below in red markings. The yellow arrows indicate the direction of shearing



- A laboratory analysis of the left main landing gear structural fuse pin concluded shearing as a result of lateral and vertical overload stress

- The laboratory analysis of the left main landing gear structural fuse pin did not reveal manufacturing imperfection

1.13 Medical and pathological information

None

1.14 Fire

There was no fire

1.15 Survival aspects

1.15.1 General

The impact forces were below the criteria for an automatic activation of the ELT.

Just before impact, the aircraft skidded down a steep snow-covered slope.

1.15.2 Exposure

At the time of the accident and confer the aircraft FMS, the remaining fuel on-board upon landing was approximately 1 664 kg.

Damages to the left wing caused leakage of fuel.

Neither passengers nor crew were exposed to fuel or any other substance.

1.15.3 Emergency exits

See appendix 5.21

The investigation revealed the following findings:

- The flight deck door was jammed
- The flight compartment escape hatch was operable and had been used
- The airstair door was partly jammed but had been used
- The forward cabin emergency exit was operable. During the evacuation of the aircraft, the commander entered the passenger cabin via the forward cabin emergency exit in order to check that no passengers were left in the passenger cabin
- The two mid passenger cabin emergency exits were jammed

The impact sequence caused aircraft structural deformations leading to jammed and partly jammed emergency exits.

The left mid passenger cabin emergency exit:

The right mid passenger cabin and forward passenger cabin emergency exits (the AIB has erased the name of the operator):

1.15.4 Passenger seating

See appendix 5.21

1.15.5 Seats and seatbelts

1.15.5.1 General

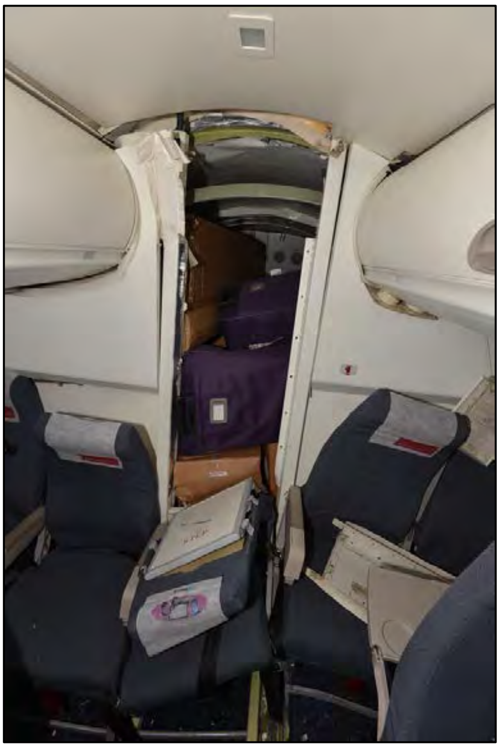
The passengers and the crew were using seatbelts.

Neither seats nor seatbelts were overstressed or suffered from malfunctioning.

1.15.5.2 Mid passenger seat in the rearmost passenger seat row

Before landing and for passenger comfort, the passenger seated in front of the baggage compartment internal access door changed seat.

At impact, forward moving cargo destroyed the mid passenger seat in front of the baggage compartment internal access door.



1.15.6 Evacuation

The flight crew did not verbally order an evacuation of the aircraft.

The crew members initiated an evacuation of the aircraft.

The flight crew found the flight deck door jammed and evacuated the flight deck through the flight compartment emergency exit hatch.

The cabin crew member and a passenger had difficulties opening a partly jammed airstair door. In cooperation with the commander from the outside of the aircraft, they succeeded.

From the outside of the aircraft, the commander opened the forward cabin emergency exit door.

The passengers and the cabin crew member evacuated the passenger cabin through the airstair door.

The overall evacuation took approximately 30-40 seconds.

Fire and rescue services arrived at the accident site and assisted on transporting crew and passengers to the terminal building.

1.16 Tests and research

None

1.17 Organization and management information

1.17.1 General

The operator was the largest air carrier in Greenland and constituted a major part of the Greenlandic traffic infrastructure.

The aircraft fleet consisted of helicopters, twin-engine turboprop aircraft and one long-haul aircraft.

The area of operation (passengers, cargo and emergency medical service) was mainly the European and North Atlantic region. The long-haul aircraft was approved for a worldwide operation.

The operator was the certificate holder of an approved maintenance organization.

The operator’s Air Operator Certificate (AOC) held an approved Operations Manual (OM) system containing operational documentation and limitations, and standard operating procedures (SOP).

Confer the operator’s Operations Specifications; the Dash 8 steep approach concept (including operator procedures and flight crew training) was approved by the DTA.

1.17.2 The operator’s Safety Management System (SMS)

For the purpose of operational control, the operator held an approved SMS including Flight Data Monitoring (FDM).

In this investigation, the AIB focused on the operator’s internal SMS audits of flight operations during the years of 2012 and 2013 (fixed-wing turboprop, flight crew training and load control).

Though the AIB survey of the operator’s SMS just provided a snapshot, it is the impression of the AIB that the operator’s SMS worked efficiently and contributed to a proactive operational control of the operator’s activities.

However, the AIB would like to point out one internal audit finding (26-11-2013) on load control in BGSF.

The internal audit finding addressed differences between cargo manifests and loading documentation and recommended preparation and implementation of new load control procedures.

At the time of the accident, the internal audit finding was still open.

1.17.3 FDM

Since the year 2012 and on the basis of FDM data, the operator had launched flight safety initiatives (for instance flight crew briefings, flight crew bulletins and FDM follow-up) in order to prevent and not least reduce the total number of non-stabilized approaches.

On request by the AIB, the operator made FDM presented unstable approach event-rates (a flap setting of 15° or a flap setting of 35°, respectively) for a time period of approximately 14 months.

See appendix 5.30 - 5.31

1.17.4 OM part B (extract)

1.17.4.1 Mandatory approach calls

See appendix 5.22

1.17.4.2 Stabilized approach parameters

See appendix 5.23

1.17.4.3 Normal landing

See appendix 5.24

1.17.4.4 Steep approach

See appendix 5.25

1.17.5 Aircraft flight manual (AFM) (extract)
1.17.5.1 Normal landing

See appendix 5.26

1.17.5.2 Emergency landing

See appendix 5.27

1.17.6 Dash 8 ODM (extract)
1.17.6.1 Landing gear failures

See appendix 5.28

1.17.6.2 Beta Lockout System (BLS)

Beta Lockout System (CR 873CH00011)

This system incorporates electrical circuits to prevent the propellers from entering the ground Beta range of operation during flight.

The Beta Lockout System (BLS) consists of a warning horn, revised beta backup enable logic, reworked PROP RPM gauges incorporating an Np trigger, automatic ECU MANUAL reversion logic, and automatic engine ignition activation logic. The system is activated and deactivated by ground/air logic combined with PLA.

The BLS is disable on the ground to allow for discing, by either 50 ft. RAD ALT or WOW signal with the warning horn enabled down to 20 ft. Setting the PLA less than Flight Idle while in the flight mode enables the system. Beta backup protection remains enabled regardless of PLA setting, while in the air mode.

The warning horn provides an aural warning as the Flight Idle gate is removed by lifting the power lever triggers, and before ground beta is actually selected. The revised beta backup enable logic *provides low blade angle protection independent of PLA while airborne, instead of the existing standard PLA greater than Flight Idle logic. The Np trigger is tripped upon detection of Np values in excess of 1000 PROP RPM when the power levers are set below the FLT IDLE gate in flight. This provides a discrete signal to increase the prop blade angle to reduce PROP RPM to values below the trigger point. The discrete signal is sent to the existing feather solenoid integral to the PCU. As PROP RPM decreases below the trip point the signal is discontinued. The automatic reversion of the ECU to MANUAL ensures that adequate fuel flows and high NH RPM are maintained.*

1.17.7 Quick reference handbook (QRH) (extract)

1.17.7.1 On ground emergency

See appendix 5.29

1.17.8 Training on landing gear collapse

Available tools to the operator's flight crews were the QRH (emergency landing) and considerations from the Dash 8 ODM.

The focus of the operator's training department on landing gear collapse was:

- Reverse thrust on the side with the unaffected main landing gear
- Use of differential wheel braking
- Nose wheel steering
- On ground emergency

1.18 Additional information

1.18.1 Inspection by the DTA

1.18.1.1 Inspection in year 2011

The DTA performed the inspection on 5-9-2011 (one day).

The inspection topics were:

- Flight crew training - Airbus 330
- Crew duty time limits and rest requirements

The inspection revealed one finding on nomination of line check commanders.

1.18.1.2 Inspection in year 2012

The DTA performed the inspection on 24-10-2012 (one day).

The inspection topics were:

- Quality system
- Flight safety and reporting
- Operational control
- Crew records
- Flight documentation

The inspection did not reveal any findings.

1.18.1.3 Inspection in year 2013

The DTA performed the inspection on 11-12-2013 (one day).

The inspection topics were:

- Quality system
- Flight safety and reporting
- Operational control
- Crew records
- Flight documentation

The inspection revealed three findings. One of the three findings was about flight safety audit scopes.

1.18.1.4 Dash 8 flight inspection

The DTA performed a Dash 8 flight inspection on 10-12-2013 (one day).

The Dash 8 flight inspection did not reveal any findings.

1.18.2 Inflight operation of propeller in beta range

1.18.2.1 Accident report issued by the Australian Transport Safety Board (ATSB)

The ATSB issued a final report on an accident (double propeller overspeed) to a Dash 8-315 occurring on 6-12-2011. An extract of the analysis of the report is attached to this report.

See appendix 5.32

1.18.2.2 AD CF-2013-15R1

See appendix 5.33

1.18.3 Safety information to the operator by the AIB

- On 30-1-2014, the AIB addressed a safety focus on load control (a divergence of the presented loadsheet mass and distribution data and the actual masses and distribution of the onboard baggage and cargo)
- On 16-4-2014, the AIB addressed a safety focus on non-stabilized approaches versus flight crew safety culture
- On 16-4-2014, the AIB addressed a safety focus on operation of Dash 8 power levers in ground beta range in flight

1.19 Useful or effective investigation techniques

In order to reveal pilot's perception of ATS crosswind reporting in Greenland, the AIB made a survey among the operator's fixed-wing pilots.

55 pilots represented the operator's fixed-wing pilot group. 48 pilots responded to the AIB survey.

The determined confidence level was 95% and the determined confidence interval was 5%. The required size of a spot check was 48.

The AIB considered the survey data to be valid.

See appendix 5.34

2 ANALYSIS

2.1 General

The licenses and qualifications held by the crew, flight and duty times, the documented technical status of the aircraft, the aircraft mass and balance and the aids to navigation had, in the AIB's opinion, no influence on the sequence of events.

However, the AIB noticed a divergence of the presented loadsheet mass and distribution data and the actual masses and distribution (including an overload of baggage and cargo compartment number two) of the on board baggage and cargo. Though not contributing to this accident but from an operational control point of view, the AIB finds it disquieting and a latent risk of future flight operations.

In the period of time from 4-12-2012 until 17-10-2013, the commander, type rated as Dash 8 commander, acted as Dash 8 first officer.

In spite of the fact that the commander upgrade training was performed in a consecutive period and that the training fulfilled all requirements, the effects of the commander training was not rapidly transferred and applied to create routines as a Dash 8 commander in an everyday flight operation.

This break in the commander's learning curve might have weakened the overall commander learning process (ineffective learning).

The AIB finds it conceivable that this finding indirectly affected the commander's decision making during the sequence of events.

2.2 Pre-flight planning and enroute weather reports

The flight crew planned the flight from BGSF to BGJN with the destination alternate aerodrome BGSF.

Wind conditions including gust were forecasted to be not only marginal but above the operator's predefined crosswind limitation for a successful landing at BGJN, taking into consideration:

- The operator's cross wind limitation of 25 knots (inexperienced commander and a short runway)
- The commander's phone calls to the AFIS operator at BGJN before departure from BGSF

- The latest TAF (at 10:37 hours) available to the flight crew before departure from BGSF at 11:06 hours.

From a preplanning point of view, the forecasted weather conditions (tempo 2910/2916 11028g40kt) at the expected approach time at BGJN were below the preplanning minima, which would require flight plan reflected preplanning with the use of two destinations alternate aerodromes instead of only one.

However, the difference between the commander's assumption of commander experience and the operator's logging of actual commander experience did have an inadvertent and negative impact upon the flight crew's decision making during the preplanning phase allowing a cross wind limitation of 31 knots.

Generally seen, the actual weather conditions at BGJN and enroute weather reports were equivalent to the forecasted weather conditions.

2.3 Approach to runway 07

2.3.1 General

Enroute, the flight crew agreed on doing a visual steep approach to runway 07 (PAPI angle of 5.1°), a cross wind limitation of 31 knots at BGJN, a flap setting of 15°, a Vref speed of 99 knots, and a visual missed approach procedure.

2.3.2 Crosswind

With reference to the operator's OM and the latest reported wind conditions from Ilulissat AFIS before landing (140° magnetic 28 knots - maximum 35 knots - cross wind 26 knots / 140° magnetic 25 knots - maximum to 39 knots), a landing was prohibited.

Taking the flight crew decision on a crosswind limitation of 31 knots into consideration, the operator's crosswind limitation was exceeded by approximately 6% - 19% (including gust).

Taking the operator's crosswind limitation of 25 knots into consideration (inexperienced commander), the operator's crosswind limitation was exceeded by approximately 32% - 48% (including gust).

Though, the AFIS presented threshold winds of runway 07 and runway 25, respectively, was exchanged by mistake, actual threshold wind data and additional aircraft FMS wind data supported the presence of adverse wind conditions for landing on runway 07.

However, the flight crew's perception of ATS crosswind reporting did influence their decision making process.

During descent to BGJN, the flight crew asked Ilulissat AFIS for a confirmation of whether or not the cross wind of 24 knots included the gusting wind conditions up to maximum 33 knots. Ilulissat AFIS replied that the maximum wind was 35 knots and the cross wind was 26 knots.

The reported ATS crosswind was based on a two-minute mean wind and did not take into account an actual gusting spot wind.

The flight crew did not challenge the reply on crosswind from Ilulissat AFIS and from that point, the flight crew apparently uncritically accepted further ATS crosswind reporting.

The AIB believes that the AIB survey among the operator's fixed-wing pilots (even though made after the accident) supported the assumption that from the view of the pilots, ATS crosswind reporting in Greenland was not unequivocal. For sure, the intention was guidance, but sometimes during a high flight crew workload, ATS cross wind reporting might inadvertently have led to undesirable decision making.

On short final to runway 07, the wind conditions were reported to be 140° magnetic and 25 knots - maximum to 39 knots. The combination of the ATS phraseology ("maximum to…… three niner knots) and at that time an increasing flight crew work load might have triggered the first officer's perception of an ATS wind speed reporting of "maximum two niner knots", which was below the flight crew agreed cross wind limitation of 31 knots.

2.3.3 Landing performance

The decision on landing with a flap setting of 15° and a Vref of 99 knots did not conflict with the operator's OM and the operator's RPM.

2.3.4 Non-stabilized approach

The divergence between the ATS reported QNH (983 hPa) and the flight crew's altimeter QNH setting of 984 hPa did not have impact on the sequence of events.

The decision on flying the approach on the high side of the PAPI angle of 5.1° (steep approach) in a tailwind condition and at a lower flap setting (15°) did affect the flight crew's handling of the aircraft and made it difficult to maintain the operator's stabilized approach parameters.

Passing 996 feet (SSFDR RA), the CAS was approximately 144 knots, which was approximately 21% in excess of the operator's maximum speed (119 knots) for a stabilized approach at the actual aircraft configuration.

Passing 493 feet (SSFDR RA), the CAS was approximately 138 knots, which was approximately 27% in excess of the operator's maximum speed (109 knots) for a stabilized approach at the actual aircraft configuration.

Passing approximately 200 feet RA (processed SSFDR data), the power lever were retarded to flight idle leading to a continuous high rate of descent (more than 1 000 feet per minute) resulting in the aircraft flying below the PAPI angle of 5.1 °.

Passing approximately 50 feet RA (processed SSFDR data), the power levers were at flight idle and the rate of descent was high (approximately 1 100 feet per minute). The CAS was approximately 128 knots, which was approximately 23% in excess of the operator's recommended threshold speed (Vref + 5 knots KIAS).

With reference to the operator's stabilized approach parameters, the final approach to runway 07 was not stabilized.

Though the flight crew had briefed on a visual missed approach procedure and taken into consideration a potential go-around, no flight crew call out on stabilized approach and no appropriate in-flight risk assessment by mutual verbal challenges were made, which had a direct influence on the sequence of events.

The non-optimum Cockpit Resource Management (CRM) on final approach to runway 07 might have suffered from:

- An inexperienced commander completing a commander training that was not rapidly transferred and applied to create routines as a Dash 8 commander in an everyday flight operation
- An increasing flight crew workload on short final (strong crosswind and moderate turbulence) leading to flight crew target fixation and a mental blocking of an appropriate decision on going around
- During a high flight crew workload, a mental and inappropriate transfer of flight crew aircraft handling technique from the Dash 7 to the Dash 8 (proactive interference)
- The flight crew potential interpersonal relations and expectations for mutual flight crew role responsibilities and actions (a level flight crew command gradient)
- The lack of optimum flight crew monitoring
- An unconscious commercial pressure, since the flight (same crew) from BGUK to BGJN the night before had to divert to BGSF

This non-stabilized approach was not an isolated operator event.

However and indicated by the operator’s FDM data, the flight safety initiatives towards non-stabilized approaches did reduce the total number of non-stabilized approaches (Dash 8) and thereby contributing to an optimized flight crew safety culture.

2.4 Left main landing gear collapse

2.4.1 Touch down

Just before touchdown in dark night lighting conditions, a non-stabilized approach in a crosswind condition above the aircraft and the operator crosswind limitations resulted in an abnormal aircraft landing attitude leading to almost no flare, a high sink rate and no use of an appropriate aircraft crosswind landing technique.

Like the ATSB accident report, the AIB finds it possible that certain elements might influence a pilot’s handling of the power levers:

- In turbulence, it is likely that pilots will grip the power levers more tightly
- It is natural for a pilot’s fingers to be touching the release triggers when holding the power levers
- It is likely that a pilot will move the triggers in some cases during turbulence
- In addition, pilot use the release triggers during each landing to move the power levers into the ground beta range in order to slow the aircraft down
- Due to anxiety to be able to stop the aircraft on a short runway, a pilot might be spring loaded to apply full reverse as soon as possible and thereby releasing the release triggers in flight

The SSFDR data from two out of three previous flights indicated the power levers in flight just before touch down being retarded below flight idle.

In flight when retarding the power levers below flight idle towards reverse but below 20 feet RA, the flight crew would not be presented to any aural warning. At that point, no safety barriers were left.

A non-stabilized approach in crosswind conditions above the aircraft and the operator’s crosswind limitations combined with the actual crosswind landing technique and the power levers retarded below flight idle in flight resulted in an accelerated rate of descent leading to a hard landing, with side load on the left main landing gear at touchdown.

According to its design, the left main landing gear structural fuse pin sheared as a result of lateral and vertical overload stress.

2.4.2 Landing roll

The SSFDR data indicated that during the landing roll, the commander initially applied full reverse on both engines (a short peak) followed by a partly, but not decisive, use of differential reverse.

Furthermore, the commander applied almost full left rudder and full right aileron deflection.

The AIB has not been able to identify why, but the SSFDR data indicated that the power levers during the landing roll cycled out and in of ground beta range (SSFDR recorded BETA and SSFDR recorded FEATHER (beta backup protection)).

Cycling the power levers out and in of ground beta range and thereby from time to time causing forward movement thrust prevented an appropriate deceleration of the aircraft and prolonged the landing roll.

The combination of applying full left rudder and no use of decisive reverse thrust on the side with the unaffected main landing gear made it impossible for the flight crew to maintain directional control.

The decision on applying full left rudder might be due to a visual illusion of the aircraft veering to the right, though the aircraft actually skidded sideways to the left but in an increasing nose right position.

At the latest OPC, both the commander and the first officer had trained how to handle a main landing gear collapse emergency. However, the flight crew did not succeed in transferring the training experience of handling a main landing gear collapse into an actual emergency.

Contributing factors might have been:

- The element of surprise
- Low Dash 8 commander experience (in total and on aircraft type)
- Increasing flight crew workload and target fixation on final approach to runway 07

In the safety zone, the first officer called: *Parking brake*. Brake pressure was not recorded on the SSFDR. For that reason, it was not possible to determine the actual time for the activation of the parking brake. However, no significant deceleration was observed.

Just after impact, the crew initiated an on ground evacuation of the aircraft.

By heart, the flight crew performed the on ground emergency checklist. Though, a few checklist items were forgotten and an evacuation was not verbally ordered by the flight crew, the evacuation was effective.

2.5 Survival aspects

2.5.1 General

The accident was survivable.

The aircraft skid down a snow-covered slope absorbed some of the impact forces and reduced the risk of serious injuries to passengers and crew.

The flight crew decision on not spending valuable time on the flight deck door emergency release handle mechanism and instead using the flight compartment escape hatch was optimum and reduced the overall evacuation time.

Though certain aircraft emergency exits were jammed due to the impact forces, the following interdependent conditions made the on ground aircraft evacuation effective:

- A decisive initiation of the aircraft evacuation by the crew
- Neither seats nor seatbelts were overstressed or suffered from malfunctioning
- Only minor injuries to passengers and crew
- No hindrances to free movement in the passenger cabin
- A limited number of passengers

However and for the sake of generating onboard alertness and certainty, the AIB would like to stress the importance of verbal evacuation ordering.

2.5.2 The mid passenger seat in the rearmost passenger seat row

From a survival aspect point of view, the mid passenger seat in front of the baggage compartment internal access door was an area of safety focus.

In this accident, no baggage and cargo net was in use, and the baggage compartment internal access door was not capable of withstanding the impact forces of the forward moving baggage and cargo. For that reason, the mid passenger seat in front of the baggage compartment internal access door was destroyed.

Use of a baggage and cargo net might reduce the risk of potential injuries to a passenger seated in front of the baggage compartment internal access door in case of an on ground emergency.

2.6 Operational control

The inspections by the DTA and the AIB snapshot survey of the operator's SMS did not reveal any significant safety lapses to the operator's operational control.

It is the impression of the AIB that the operator's SMS worked efficiently and contributed to a proactive operational control of the operator's activities.

However, the AIB addressed areas of safety focus to the operator:

- Non-stabilized approaches
- Dash 8 power lever handling into ground beta range in flight
- Load control

3 CONCLUSIONS

3.1 Findings

1. The licenses and qualifications held by the crew, flight and duty times, the documented technical status of the aircraft, the aircraft mass and balance, and the aids to navigation had no influence on the sequence of events
2. The presented loadsheet mass and distribution data was inconsistent with the actual masses and distribution of the onboard baggage and cargo
3. The commander training was not rapidly transferred and applied to create routines as a Dash 8 commander in an everyday flight operation
4. Wind conditions including gust were forecasted to be not only marginal but above the operator's predefined crosswind limitation for a successful landing at BGJN
5. The forecasted weather conditions at the expected approach time at BGJN were below the preplanning minima, which would require flight plan reflected preplanning with the use of two destinations alternate aerodromes instead of only one
6. The commander's assumption of commander experience and the operator's logging of actual commander experience did have an inadvertent and negative impact upon the flight crew's decision making during the preplanning phase allowing a cross wind limitation of 31 knots.
7. The actual weather conditions at BGJN and enroute weather reports were equivalent to the forecasted weather conditions
8. Enroute, the flight crew agreed on doing a visual steep approach (PAPI angle of 5.1 °), a cross wind limitation of 31 knots at BGJN, a flap setting of 15°, a Vref speed of 99 knots and a visual missed approach procedure
9. The Dash 8 steep approach concept (including operator procedures and flight crew training) was approved by the DTA
10. Taking the flight crew decision on a crosswind limitation of 31 knots into consideration, the operator's crosswind limitation was exceeded by approximately 6.% - 19% (including gust)
11. Taking the operator's crosswind limitation of 25 knots into consideration (inexperienced commander), the operator's crosswind limitation was exceeded by approximately 32% - 48% (including gust)
12. The reported ATS crosswind was based on a two-minute mean wind and did not take into account an actual gusting spot wind
13. Due to a replacement of a computer on 27-12-2013, the AFIS presented threshold winds of runway 07 and runway 25, respectively, was exchanged by mistake
14. The flight crew's perception of ATS crosswind reporting did influence their decision making process
15. The flight crew did not challenge the crosswind reporting from Ilulissat AFIS
16. ATS cross wind reporting in Greenland was not unequivocal to flight crews
17. The decision on landing with a flap setting of 15° and a Vref of 99 knots did not conflict with the operator's OM and the operator's RPM

18. The divergence between the ATS reported QNH (983 hPa) and the flight crew's altimeter QNH setting of 984 hPa did not have impact on the sequence of events
19. The decision on flying the approach on the high side of the PAPI angle of 5.1 ° (steep approach) in a tailwind condition and at a lower flap setting (15°) did affect the flight crew's handling of the aircraft and made it difficult to maintain the operator's stabilized approach parameters
20. Passing 996 feet (SSFDR RA), the CAS was approximately 144 knots, which was approximately 21% in excess of the operator's maximum speed (119 knots) for a stabilized approach at the actual aircraft configuration
21. Passing 493 feet (SSFDR RA), the CAS was approximately 138 knots, which was approximately 27% in excess of the operator's maximum speed (109 knots) for a stabilized approach at the actual aircraft configuration
22. Passing approximately 200 feet RA (processed SSFDR data), the power lever were retarded to flight idle leading to a continuous high rate of descent (more than 1 000 feet per minute) resulting in the aircraft flying below the PAPI angle of 5.1 °
23. Passing approximately 50 feet RA (processed SSFDR data), the power levers were at flight idle and the rate of descent was high (approximately 1 100 feet per minute). The CAS was approximately 128 knots, which was approximately 23% in excess of the operator's recommended threshold speed
24. With reference to the operator's stabilized approach parameters, the final approach to runway 07 was not stabilized
25. A non-optimum CRM on final approach to runway 07 led to flight crew target fixation and a mental blocking of an appropriate decision on going around
26. This non-stabilized approach was not an isolated operator event
27. Flight safety initiatives towards non-stabilized approaches reduced the operator's total number of non-stabilized approaches
28. A non-stabilized approach in a crosswind condition above the aircraft and the operator limited maximum crosswinds components resulted in an abnormal aircraft landing attitude
29. Though the aircraft still was airborne, the power levers were retarded below flight idle towards ground beta range
30. The SSFDR data from two out of three previous flights indicated the power levers in flight just before touch down being retarded below flight idle
31. In flight when retarding the power levers below flight idle towards reverse but below 20 feet RA, the flight crew would not be presented to any aural warning. At that point, no safety barriers were left
32. A non-stabilized approach in crosswind conditions above the aircraft and the operator's crosswind limitations combined with the actual crosswind landing technique and the power levers retarded below flight idle in flight resulted in an accelerated rate of descent leading to a hard landing, with side load on the left main landing gear at touch down
33. The left main landing gear structural fuse pin sheared as a result of lateral and vertical overload stress

34. The SSFDR data indicated that during the landing roll, the commander applied full reverse on both engines (a short peak) and almost full left rudder and full right aileron deflection
35. The SSFDR data indicated that the power levers during the landing roll cycled between ground and flight range
36. Cycling the power levers between ground and flight range prevented an appropriate deceleration of the aircraft and prolonged the landing roll
37. The combination of applying full left rudder and no decisive use of reverse thrust on the side with the unaffected main landing gear made it impossible for the flight crew to maintain directional control
38. The flight crew did not succeed in transferring the training experience of handling a main landing gear collapse into an actual emergency
39. The impact sequence caused aircraft structural deformations leading to jammed and partly jammed emergency exits
40. During the sequence of events, the ELT did not activate
41. The ELT performed to design specifications on all levels
42. The aircraft on ground evacuation was effective
43. The accident was survivable
44. A baggage and cargo net was not in use
45. The baggage compartment internal access door was not capable of withstanding the impact forces of the forward moving baggage and cargo

3.2 Factors

1. A non-optimum CRM on final approach to runway 07 led to flight crew target fixation and a mental blocking of an appropriate decision on going around
2. A non-stabilized approach in crosswind conditions above the aircraft and the operator's crosswind limitations combined with the actual crosswind landing technique and the power levers retarded below flight idle in flight resulted in an accelerated rate of descent leading to a hard landing, with side load on the left main landing gear at touchdown
3. The left main landing gear structural fuse pin sheared as a result of lateral and vertical overload stress
4. Cycling the power levers between ground and flight range prevented an appropriate deceleration of the aircraft and prolonged the landing roll
5. The combination of applying full left rudder and no decisive use of reverse thrust on the side with the unaffected main landing gear made it impossible for the flight crew to maintain directional control

3.3 Summery

Adverse crosswind conditions at BGJN led to flight crew target fixation, a flight crew divergence from the operator’s stabilized approach parameters and a mental blocking of an appropriate decision on going around.

The flight crew divergence from the operator’s stabilized approach parameters induced a non-stabilized approach, which in combination with power levers retarded below flight idle in flight resulted in an accelerated rate of descent leading to a hard landing, with side load on the left main landing gear at touchdown.

The left main landing gear structural fuse pin sheared as a result of lateral and vertical overload stress.

Cycling the power levers between ground and flight range prevented an appropriate deceleration of the aircraft and prolonged the landing roll.

The prolonged landing roll combined with the application of full left rudder and no decisive use of reverse thrust on the side with the unaffected main landing gear made it impossible for the flight crew to maintain directional control.

The lack of directional control resulted in the aircraft running off the side of the runway and the safety zone, respectively.

4 SAFETY RECOMMENDATIONS

4.1 Areas of safety focus

Based on this accident investigation, the AIB would like to point out areas of safety focus, in which preventive actions would be appropriate:

- Load control - consistent load documentation and aircraft loading (operator)
- Quality assurance of ATS hard- and/or software updates (Greenlandic airports)
- ATS crosswind reporting in Greenland (operator and Greenlandic airports)
- Flight crew training on Dash 8 flight crew power lever/flight idle gate trigger handling (operator)
- Dash 8 flight crew training on landing gear emergencies (operator)
- Dash 8 baggage compartment internal access door not resistant to emergency impact forces (operator and/or aircraft manufacturer)

4.2 Preventive actions

4.2.1 Flight safety plan - operator

Due to this accident, the operator launched a flight safety action plan (extract).

- Intensifying the efforts to reduce the number of non-stabilized approaches by strengthening the FDM
- In April 2014, the operator launched of a new stabilized approach concept. See appendix 5.35
- Wind limitations lowered generally and a new restricted runway concept introduced for STOL airports
- Changed criteria for determining status as experienced or inexperienced commander
- Further integration of Threat and Error Management in all training - status autumn 2014
- Focus on go-around and stabilized approaches during simulator training - status autumn 2014
- Duties and responsibilities of OCC with regard to operational control will be evaluated and possibly optimized - status autumn 2014
- Review and optimize processes regarding loading to ensure coherency between loadsheet and actual loading - status autumn 2014
- Description of SAVS data in OM-A to enhance pilot awareness of the data provided to AFIS - status autumn 2014
- Enhanced training regarding on ground emergency, power lever handling and stabilized approaches – status autumn 2014
- Description of AUTOMETAR in OM-A - status autumn 2014

- Introduction of commander awareness training for all commanders – status spring 2015
- Exchange of ballistic cockpit door with new door with improved design to reduce risk of stuck door - study ongoing
- Speed up the process of beta lockout installation - study ongoing
- Installation of baggage compartment safety net - study ongoing
- Enhanced companywide safety focus – ongoing

4.2.2 Safety bulletins - Greenland Airports

Greenland Airports issued two safety bulletins:

1. Quality assurance of SAWS data
2. ATS crosswind reporting

4.3 Area of safety concern

4.3.1 Motivation for the area of safety concern

The aircraft manufacturer had installed a beta warning horn to alert flight crews when the flight idle gate release triggers had been lifted.

However, this safety barrier was not effective below a RA of 20 feet and although such a feature significantly reduced the likelihood of inadvertent action in flight, it did not prevent it.

Audible warnings can be very effective at attracting attention, although experience has shown that they are not always heard or comprehended in sufficient time to make an effective response, particularly in times of high flight crew workload or distraction.

Furthermore, a warning label was installed in the flight deck. During times of high flight crew workload or distraction, the AIB finds the effect of this safety barrier very limited.

In this accident below a RA of 20 feet, no actual safety barriers (hardware safety net) were left. The AIB considers this finding to be a safety gap.

An AD on installation of a Beta Lockout System (BLS) (CF-2013-15R1) was issued on 3-12-2013. The BLS had to be installed within 6 000 hours air time or three years, whichever occurred first, from the effective date of issue of the AD.

However, the BLS was not designed to protect the aircraft in the low speed range of landing (it was disabled below a RA of 50 feet during approach). In this accident, the fitment of AD CF-2013-15R1 would not have prevented the flight crew from operating the propellers in ground beta range during flight (below a RA of 50 feet).

The SSFDR data from this accident and from two out of three previous flights indicated the power levers in flight below a RA of 20 feet being retarded below flight idle into ground beta range at the risk of excessive hard landings and consequential potential emergencies.

For that reason, the AIB addressed Transport Canada (TC) with the above-mentioned area of safety concern.

4.3.2 Reply by Transport Canada

A similar Beta Lockout System (BLS), as mandated by Airworthiness Directive (AD) CF-2013-15 has been installed on U.S. registered airplanes since 2002 (FAA AD 2000-02-13). In nearly a million hours of post modification operation, no major or safety re1ated issue associated with the BLS has been reported on those airplanes.

The available data confirms that the measures already in-place (mechanical idle gate, beta warning horn, and beta lockout systems), adequately mitigate the unsafe condition precipitated by propeller operation in Beta range during flight.

5 APPENDICES

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5.2 Mass and balance
5.3 Wind limitations
5.4 Emergency door release locations
5.5 Power levers
5.6 Condition levers
5.7 Airworthiness Directive CF-2012-33
5.8 Operator’s approach chart
5.9 Vertical profile - approach from 4.25 nm
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5.11 SSFDR approach
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5.30 Operator FDM readout - unstable approach flap setting 15°
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5.1 Operational flight plan

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Flight date : 29.01.2014
Flt No. :
Departure : BGSF TKOF Alt.: ___
Destination : BGJN GPS no.:
En-route Alt: ___
Alternate 1 : BGSF
Alternate 2 :
A/C Version : DHC8-202
Registration: OYGRI
Flight Level: FL 170 170
Average WC : 20 KTS TAIL
ATC Routing : SF W23 JV

3265 1 P

DEP INFO BGSF R27 080/8 18- -61 980
R07 150/24 M33-M41 x24 HW5
25641 +10 B120 +3/9 983

CMD: F/O: CA:

	BLOCK	AIR	SCHD
ARRIVAL			11:45
DEPARTURE	1105	1106	11:00
TOTAL TIME			0:40

AIR WAY	GRID MORA	FL	IDENT BGSF	FREQ 165ft	MT	TAS	GS	DIST. INT	DIST. ACC	TIME. INT	TIME. ACC	ETO	RETO	ATO	FUEL USED	FUEL MREQ	FUEL ACT	W/V	ISA	LATITUDE LONGITUDE N67:01.2 W050:41.4
DCT	58	CLB	SF	382.00	374	188	228	22	22	6	0:06	1112	X	X	112	1064	X	146/049	-14	N66:58.0 W050:56.5
W23	58	170	ABANA		030	287	327	30	52	7	0:13	1119	1116		189	987		146/049	-14	N67:28.1 W050:58.1
W23	31	170	DOBOB		030	287	297	24	76	5	0:18	1124			247	929		108/037	-13	N67:52.4 W050:59.4
W23	33	170	ANDRE ✓		031	287	297	38	114	8	0:26	1132			339	837		108/037	-13	N68:30.2 W051:01.5
W23	39	DSC	JV	367.00	031	268	280	44	158	9	0:35	1141			433	742		110/037	-12	N69:14.5 W051:04.3
DCT	39		BGJN	95ft	141	268	280	23	181	5	0:40	1146			476	699		110/037	-12	N69:14.4 W051:03.6
Alternate BGSF JV W23 SF																				
DCT	39	CLB	JV	367.00	321	290	327	10	191	2	0:42				502	673		108/037	-13	N69:14.5 W051:04.3
W23	39	180	ANDRE		211	290	276	44	235	10	0:52				619	557		108/037	-13	N68:30.2 W051:01.5
W23	33	180	DOBOB		211	290	276	38	273	9	1:01				719	456		108/037	-13	N67:52.4 W050:59.4
W23	31	180	ABANA		210	290	276	24	297	6	1:07				783	393		108/037	-13	N67:28.1 W050:58.1
W23	58	DSC	SF	382.00	210	290	276	30	327	7	1:14				862	314		108/037	-13	N66:58.0 W050:56.5
DCT	58	DSC	BGSF		094	290	263	27	354	6	1:20				933	242		108/037	-13	N67:01.2 W050:41.4

Log Nr.:8313 Page 1 PPS 8. 0. 81. 1 1T To be continued nex

Log Nr.: 8313 Page 2 SFJ-JAV

ICAO		WIND	FL	NM	MT	TIME	FUEL	---BLOCK---	
BGGH	GOH	104/ 64	240	328	218	1:14	737	2:24	1495
BGSS	JHS	122/ 52	240	185	240	0:42	420	1:52	1178
BGUQ	JQA	U142/ 41	210	162	015	0:35	368	1:45	1127
BGPT	JFR	112/ 60	240	460	210	1:48	1071	2:58	1830

ICAO		WIND	FL	NM	MT	TIME	FUEL	---BLOCK---	
BGAA	JEG	137/ 46	120	90	266	0:22	248	1:32	1007
BGMQ	JSU	122/ 52	240	272	227	1:02	619	2:12	1377
BGKK	KUS	164/ 33	230	418	153	1:37	962	2:47	1721

Climb : 32 NM in 0:08 hrs 105 Kg Descent: 40 NM in 0:08 hrs 69 Kg

1109 100/20 in 30 +10 B120 +3 9 Q984

15890

NIT 984/80

FUEL CALCULATIONS FL170

MAX CRUISE 900 RPM

FUEL	TIME	Kg	CHANGES
Trip	0:40	436	___
Alt1	0:40	457	___
Alt2	0:00	0	___
MCF		40	___
FRES	0:30	242	___
MREQ	1:55	1175	___
Taxy		40	___
Xtra	0:00	0	___
Ramp	1:55	1215	___
Xtra	___	___	___
Actual	___	2000	___

EX. FUEL CONSIDERATIONS FL170 Kg

+20 kts Head:	0:02	30
+40 kts Head:	0:06	61
+60 kts Head:	0:10	91

CORRECTIONS (MTOM)

FL	WC	TIME	TRIP	10KT	D/C
210	32	38.3	394	14	120
190	21	38.5	417	15	320
RPL170	20	38.6	436	15	487
150	31	37.5	425	15	375
130	27	38.0	439	15	499
110	36	37.7	431	15	430
LRC170		46.0	370		

ESTIMATED TRAFIC LOAD

Est.no. of pax: 11
Est.lugg/cargo: 165 Kg
Est.T/O Mass: 13055 Kg

WEIGHT.: Kg LMC

PTOM: ___
TOM : 14690 ___
ELM : 14254 ___
PAX : 12 ___

NEXT FLT

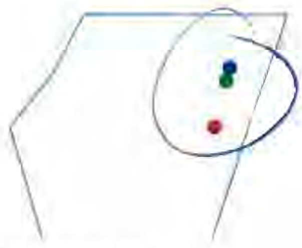
DOF OYGRI	140129	140129	140129
STD	1300	1350	1455
DEP	BGJN	BGAA	BGSS
DEST	BGAA	BGSS	BGGH
TRIP TIME	0024	0038	0055
PAX	29	30	34
BURN OFF	283	427	646
MIN FUEL	1023	1040	1512
MAX FUEL	2258	2301	2121
G/L	LOSS 3$/T	LOSS 5$/T	LOSS 7$/T

Sign. CMD ___

5.2 Mass and balance

Click - back to page

```
L O A D S H E E T          CHECKED           APPROVED     EDNO
ALL WEIGHT UNITS IN KG   SFJKL                              01

FROM/TO FLIGHT          A/C REG VERSION      CREW    DATE     TIME
SFJ JAV                 OY-GRI  Y37          2/1     29JAN14  0741
                           WEIGHT           DISTRIBUTION
LOAD IN COMPARTMENTS         1107   CPT1/495 CPT2/400 S02/106 S03/106

PASSENGER/CABIN BAG           842   4/7/0/1  Y 11  TTL 12  CAB 0
TOTAL TRAFFIC LOAD           1949
DRY OPERATING WEIGHT        10781
ZERO FUEL WEIGHT ACTUAL     12730 (  28065 LBS) MAX  14515      ADJ
TAKE OFF FUEL                1960 (   4321 LBS)
TAKE OFF WEIGHT  ACTUAL     14690 (  32386 LBS) MAX  16465      ADJ
TRIP FUEL                     436 (    961 LBS)
LANDING WEIGHT   ACTUAL     14254 (  31425 LBS) MAX  15649  L   ADJ

BALANCE AND SEATING CONDITIONS        LAST MINUTE CHANGES
DOI 81.6                         DEST  SPEC  CL/CPT  +-WEIGHT
LIZFW 121.4 MACZFW  34.7
LITOW 125.0 MACTOW  34.8
LILDW 124.2 MACLAW  34.8
DLI 116.4

TO:  84.0 I-------------*--I 133.9
LD:  81.9 I-------------*--I 132.9
ZF:  73.5 I--------------*-I 129.4

PAX DISTRIBUTION
100222112

UNDERLOAD BEFORE LMC         1395                LMC TOTAL

LOADMESSAGE BEFORE LMC
      /29.OYGRI.Y37.2/1
-JAV.4/7/0/1.0.T1107.CPT1/495.CPT2/400.S02/106.S03/106.PAX/0/11.SOC/0/8

SI
-JAV B/206.M/171.C/730

CAPTAINS INFORMATION/NOTES
CONFIG INFO: Y37 seats version incl. catering
PANTRY CODE: Less 2 HR
PAX CONSTANTS: Standard
DATA VERSION: 21 marts 2012
DATEBASE LAST UPDATED: 14-01-2014 15:06
SERIAL NR: AKM

END OF LOADSHEET
```



5.3 Wind limitations

Click - back to page

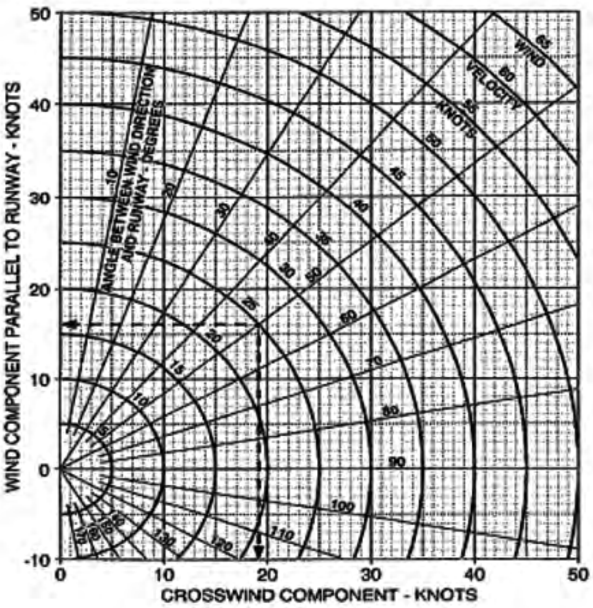
1.1.8 Wind limits

1.1.8.1 General

See AFM - PSM 1-82-1A SECTION 2 / § 2.3.3 / 2.3.4

MAX TAILWIND	Takeoff/landing	20 Kts
MAX CROSSWIND	Hard Dry surface	36 Kts
MAX TAILWIND	Steep Approach	10 Kts
MAX Wind for takeoff	Company Limit	50 Kts
Max Wind for landing	Company Limit	50 Kts

Note: For special wind limitations for specific airports or runways, see information contained in 5.3 of this manual.



has defined crosswind limitations as follows (gusts must be taken into account):

Crosswind limitations

Dry hard runway, experienced commander	36 knots
Dry hard runway, inexperienced commander	30 knots
Wet runway	30 knots
Gravel runway	30 knots

For runways shorter than 900 meters, and or less than 30 meters wide an additional safety factor of 5 knots shall be applied to all crosswind limitations given in this chapter. Gusts must be taken into consideration (i.e. for flight to BGSS with wet runway, the max crosswind would be 25 knots including gusts. For flight to BGSS with braking action 0.30 the max crosswind would be 15 knots including gusts).

5.4 Emergency door release locations

[Click - back to page](#)

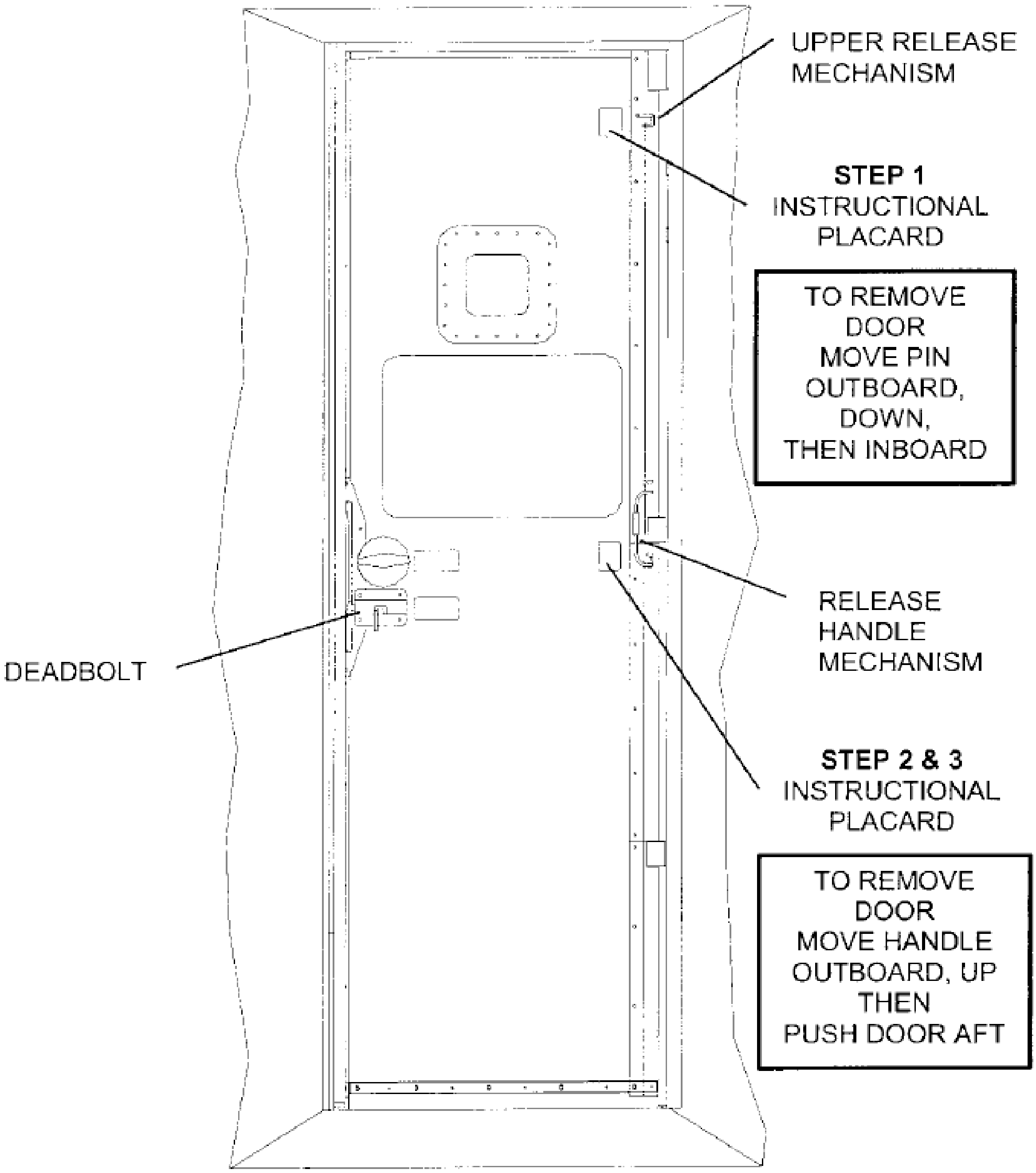
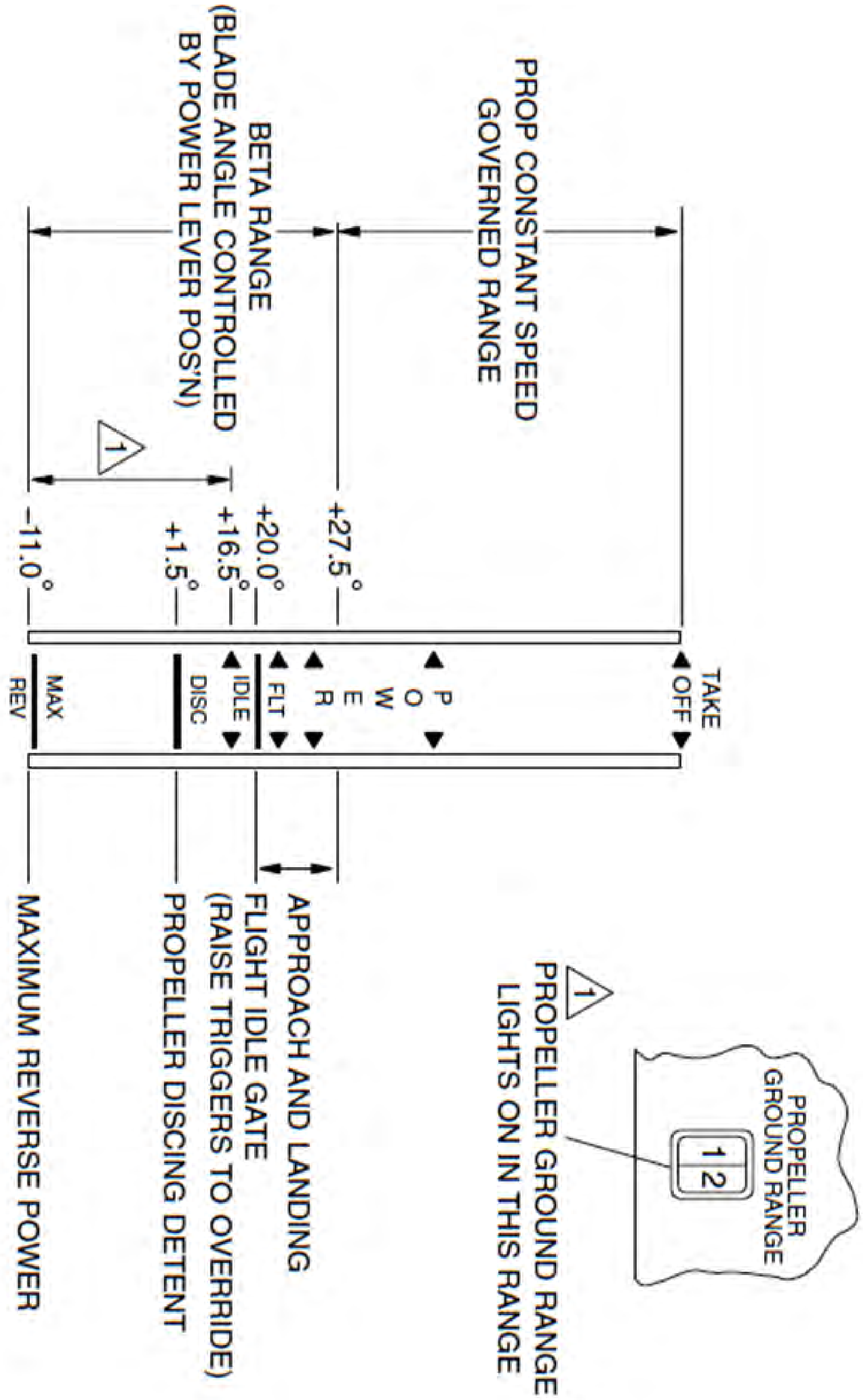


Figure 3.1-1 (Emergency Door Release Locations)

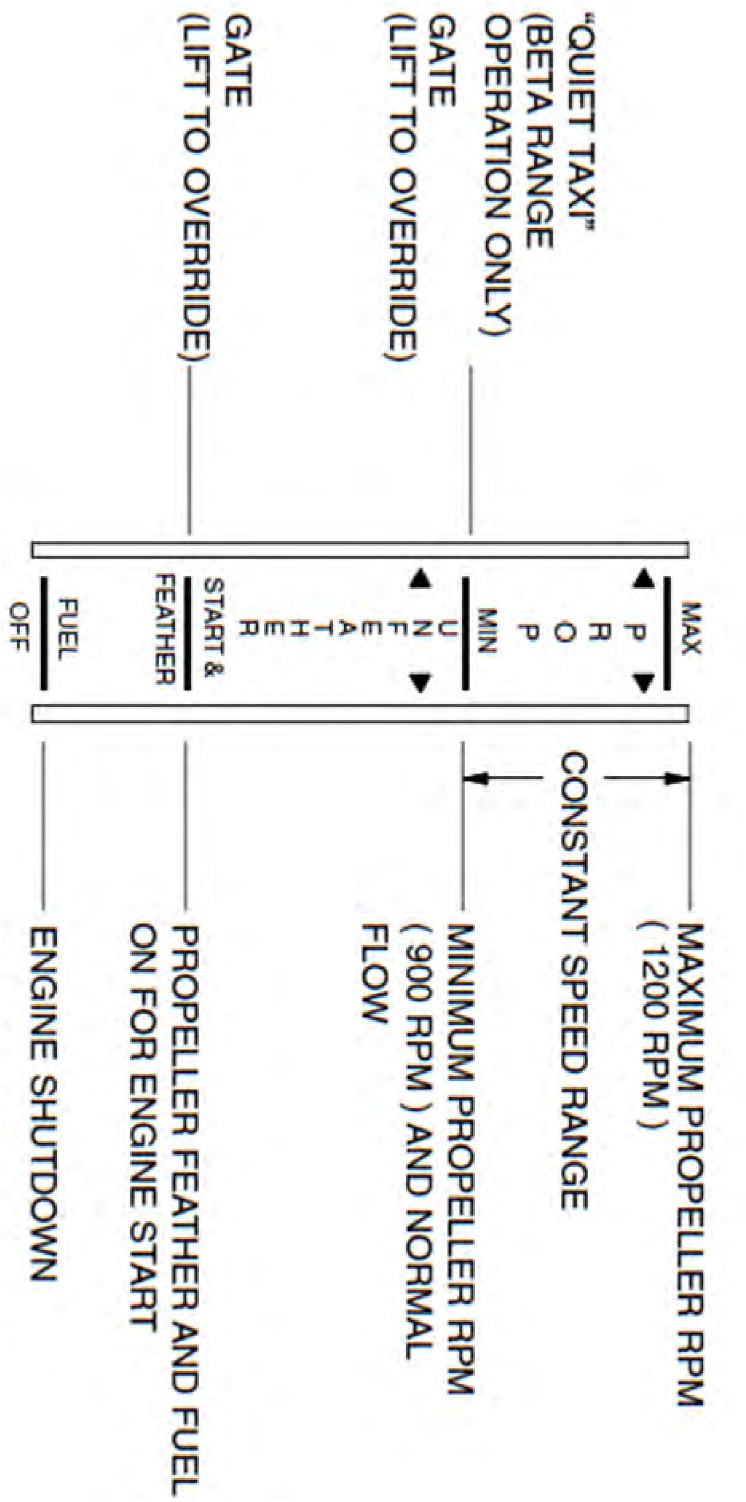
5.5 Power levers

[Click - back to page](#)



5.6 Condition levers

Click - back to page



5.7 Airworthiness Directive CF-2012-33

Click - back to page

Transport Canada **Transports Canada**

TP 7245E

No. CF-2012-33	1/1
Issue Date 13 December 2012	

AIRWORTHINESS DIRECTIVE

The following airworthiness directive (AD) may be applicable to an aircraft which our records indicate is registered in your name. ADs are issued pursuant to **Canadian Aviation Regulation (CAR) 521 Division X**. Pursuant to **CAR 605.84** and the further details of **CAR Standard 625, Appendix H**, the continuing airworthiness of a Canadian registered aircraft is contingent upon compliance with all applicable ADs. Failure to comply with the requirements of an AD may invalidate the flight authorization of the aircraft. Alternative means of compliance shall be applied for in accordance with **CAR 605.84** and the above-referenced **Standard**.

This AD has been issued by the Continuing Airworthiness Division (AARDG), National Aircraft Certification Branch, Transport Canada, Ottawa, telephone 613 952-4357.

Number: **CF-2012-33**

Subject: **In-Flight Operation of Propellers In Beta Range**

Effective: **7 January 2013**

Applicability: **Bombardier Inc. DHC-8 aeroplanes models 102, 103, 106, 201, 202, 301, 311, 314, 315, serial numbers 003 through 672.**

Excluding aeroplanes with CR 873CH00011 (Service Bulletin 8-76-24) incorporated.

Compliance: **As indicated below, unless already accomplished.**

Background: There have been a number of reported incidents, where flight crew operated the propellers in Beta range during flight on DHC 100/200/300 aeroplanes. In-flight Beta range operation of the propeller can result in over-speeding of the propeller. This condition can cause the associated engine to fail and the high drag resulting from the over-speeding propeller can adversely affect the controllability of the aeroplane.

Bombardier Inc. is in the process of introducing a Beta lockout system modification that will prevent the operation of propellers in Beta range during flight mode. Transport Canada will mandate incorporation of the Beta lockout modification when it becomes available. As an interim action to mitigate the risk of in-flight Beta range operation, Bombardier Inc. has issued Service Bulletin (SB) 8-11-115 to install a warning label in the flight compartment.

This AD is issued to mandate compliance with SB 8-11-115 requirements that a warning label be installed in the flight compartment to warn the crew against the operation of the propellers in Beta range during flight.

Corrective Actions: Within 400 flight hours or 60 days, whichever occurs first, from the effective date of this AD, install a warning label in accordance with the instructions in SB 8-11-115, Revision A, dated 03 December 2012, or later revisions approved by the Chief, Continuing Airworthiness, Transport Canada,

Compliance with earlier version of SB 8-11-115 meets the intent of this AD.

Authorization: For the Minister of Transport, Infrastructure and Communities,

ORIGINAL SIGNED BY

Acting Chief, Continuing Airworthiness

Contact:

5.8 Operator's aerodrome charts

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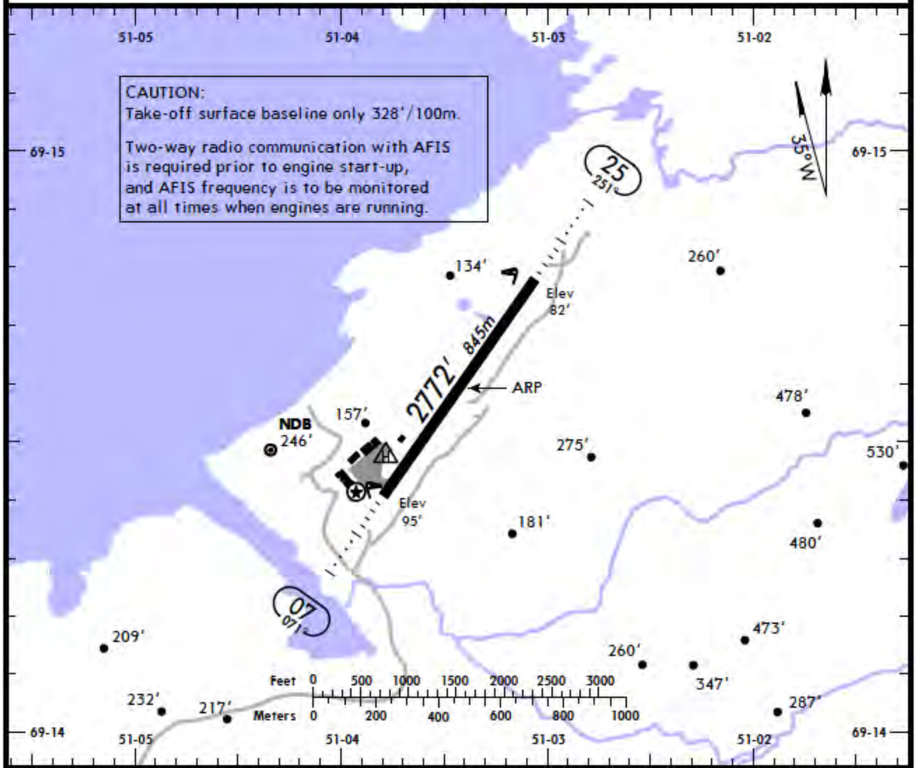
BGJN/JAV
Apt Elev **95'**
N69 14.6 W051 03.4

JEPPESEN
19 NOV 10 (10-9)

ILULISSAT, GREENLAND
ILULISSAT

*ILULISSAT AFIS
119.1



ADDITIONAL RUNWAY INFORMATION

RWY		USABLE LENGTHS LANDING BEYOND Threshold	Glide Slope	TAKE-OFF	WIDTH
07	HIRL HIALS PAPI(angle 5.1°)				98' 30m
25	HIRL HIALS PAPI(angle 5.6°)				

Standard TAKE-OFF ■ & IFR DEPARTURE PROCEDURE

	LVP must be in Force RCLM (DAY only) or RL	RCLM (DAY only) or RL	NIL (DAY only)
A B	250m	400m	500m
C D	NOT APPLICABLE		

■ Operators applying U.S. Ops Specs: CL required below 300m.

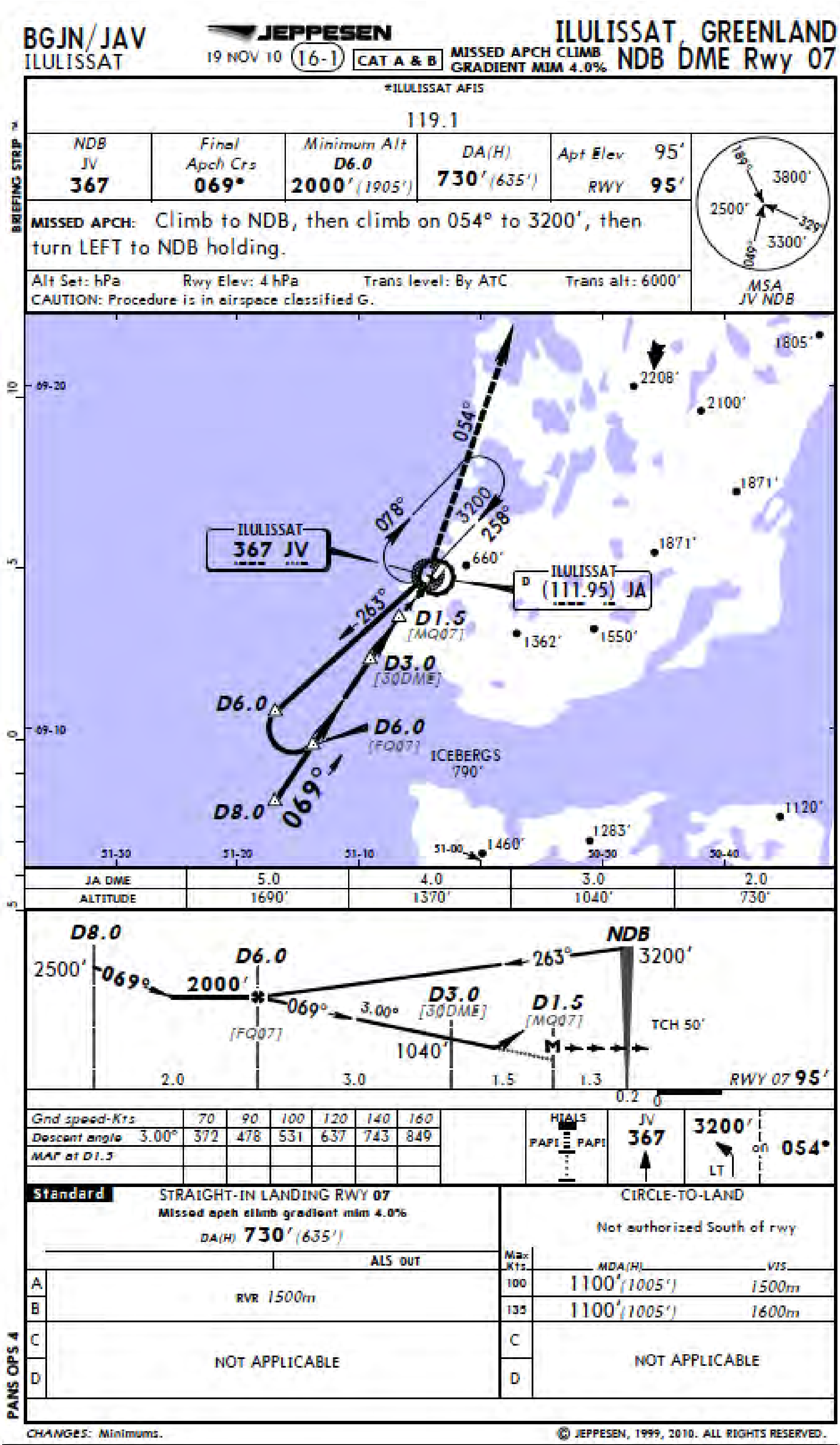
IFR DEPARTURE PROCEDURE

RWY 07: Climb STRAIGHT AHEAD to 800', then turn LEFT onto heading 281° and maintain until passing 3000', then continue climb.

RWY 25: Climb STRAIGHT AHEAD until passing 3000', then continue climb. Minimum climb gradient 280'/NM (4.6%) up to 3000'.

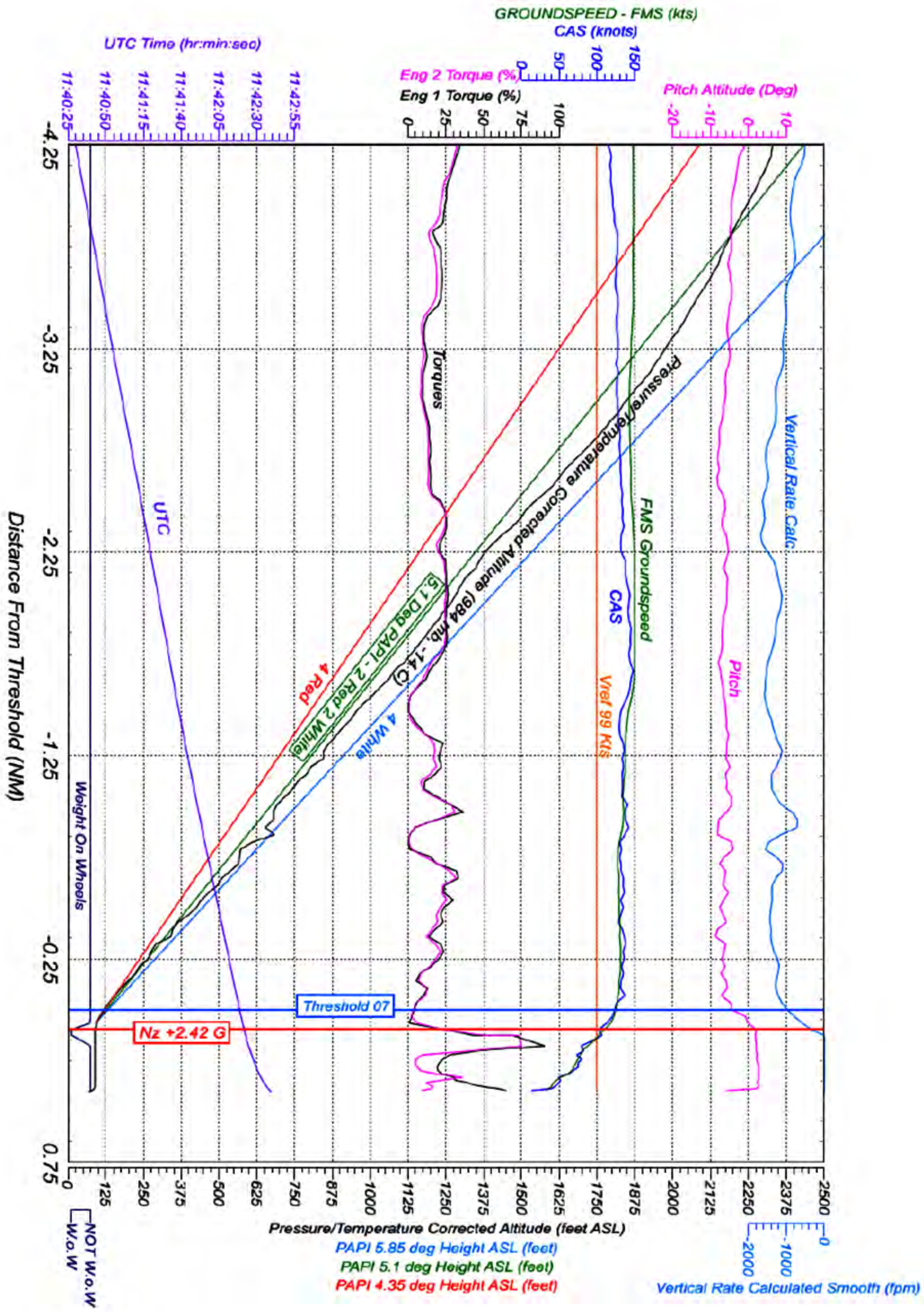
CHANGES: Minimums.

Click - back to page



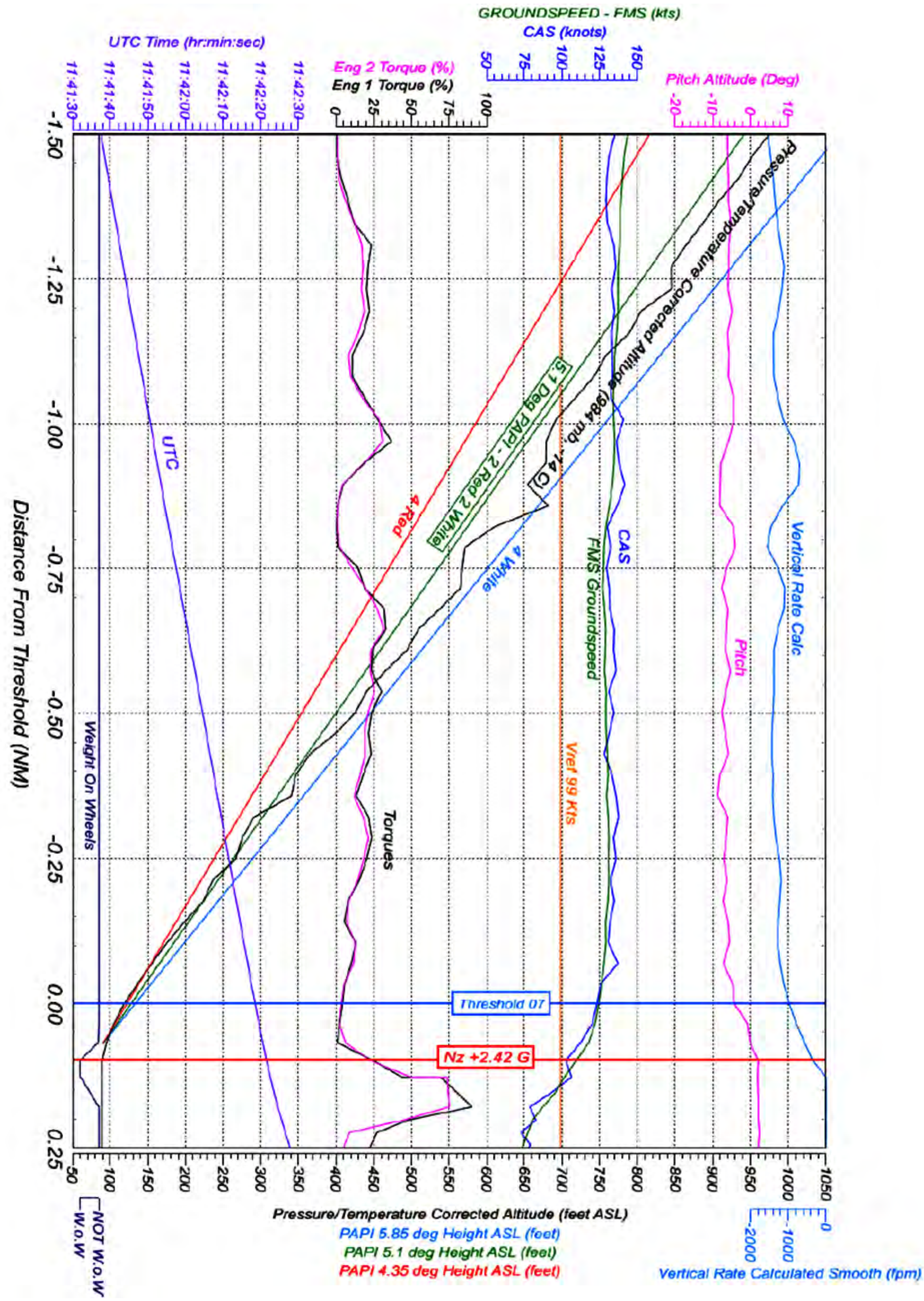
5.9 Vertical profile - approach from 4.25 nm

[Click - back to page](#)



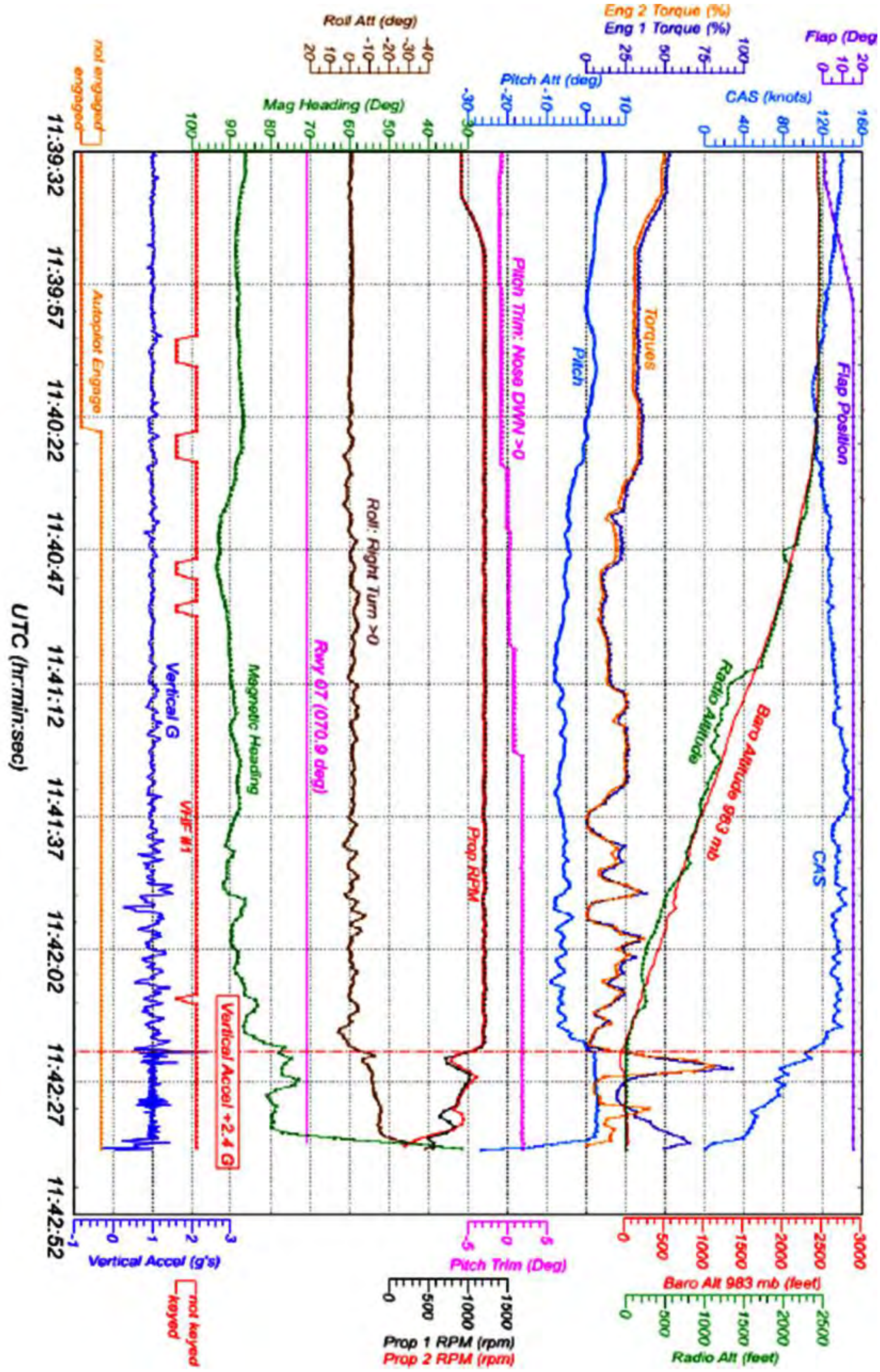
5.10 Vertical profile - approach from 1.5 nm

Click - back to page



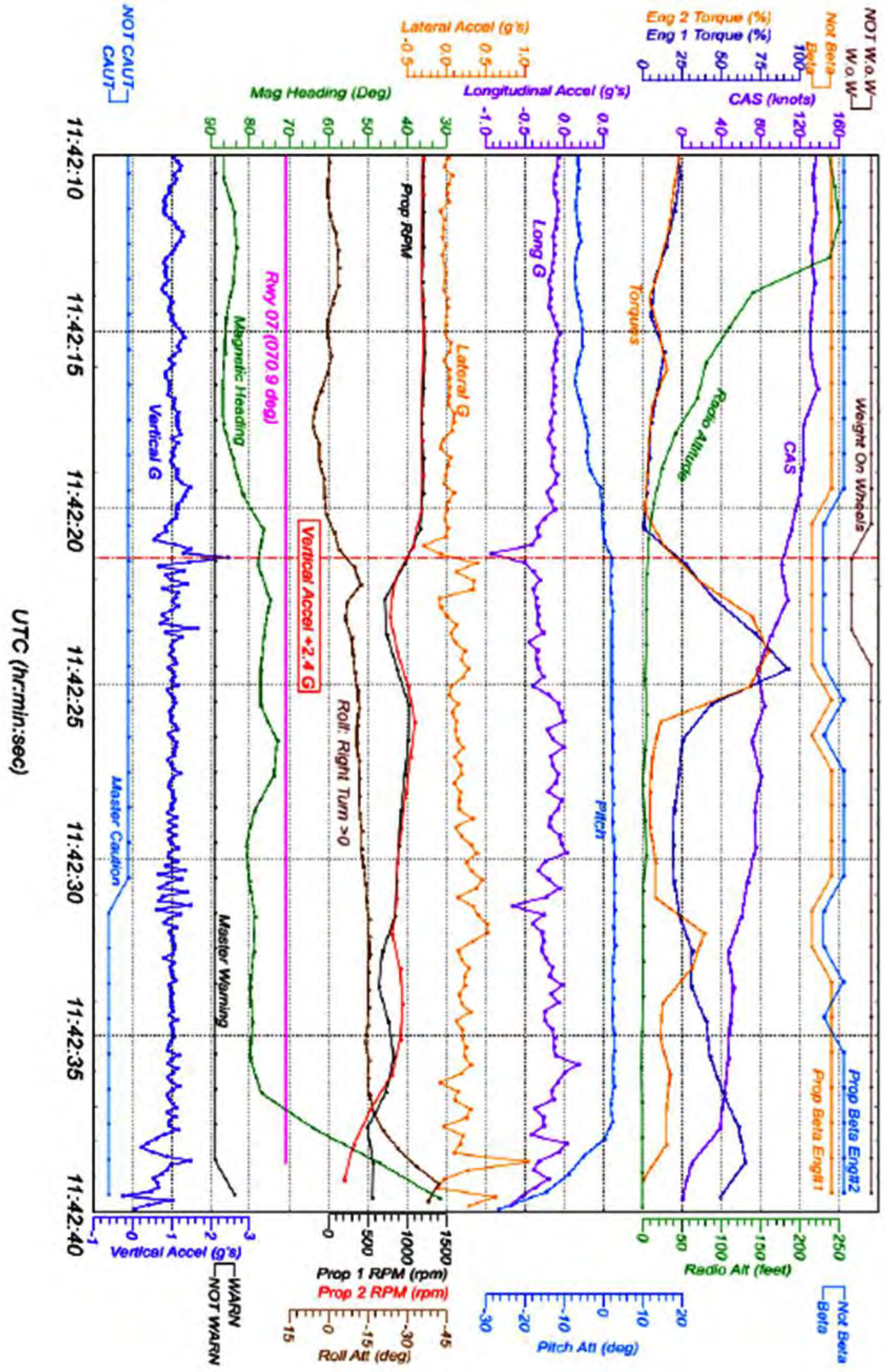
5.11 SSFDR approach

Click - back to page



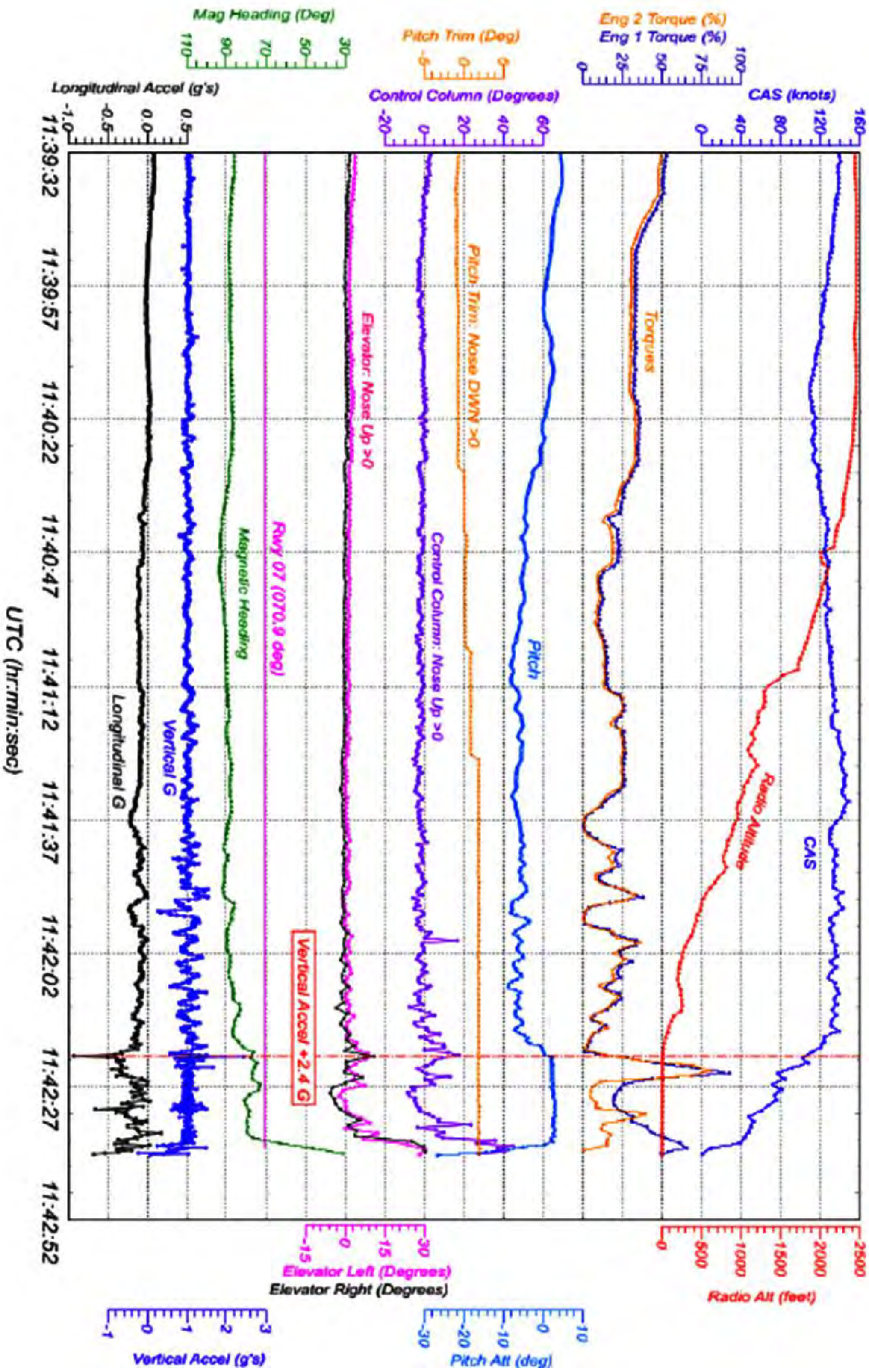
5.12 SSFDR landing

[Click - back to page](#)



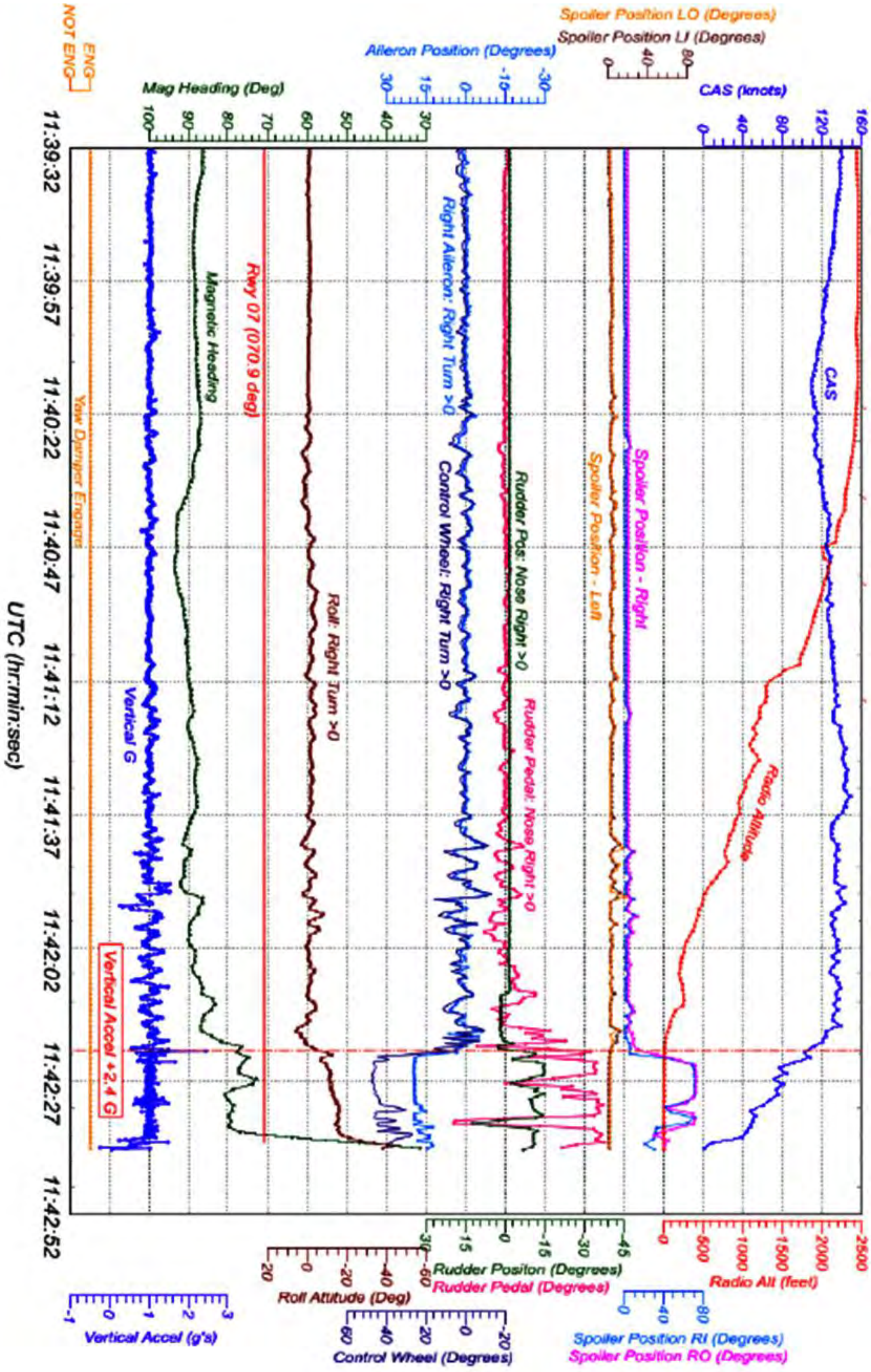
5.13 SSFDR longitudinal controls

[Click - back to page](#)



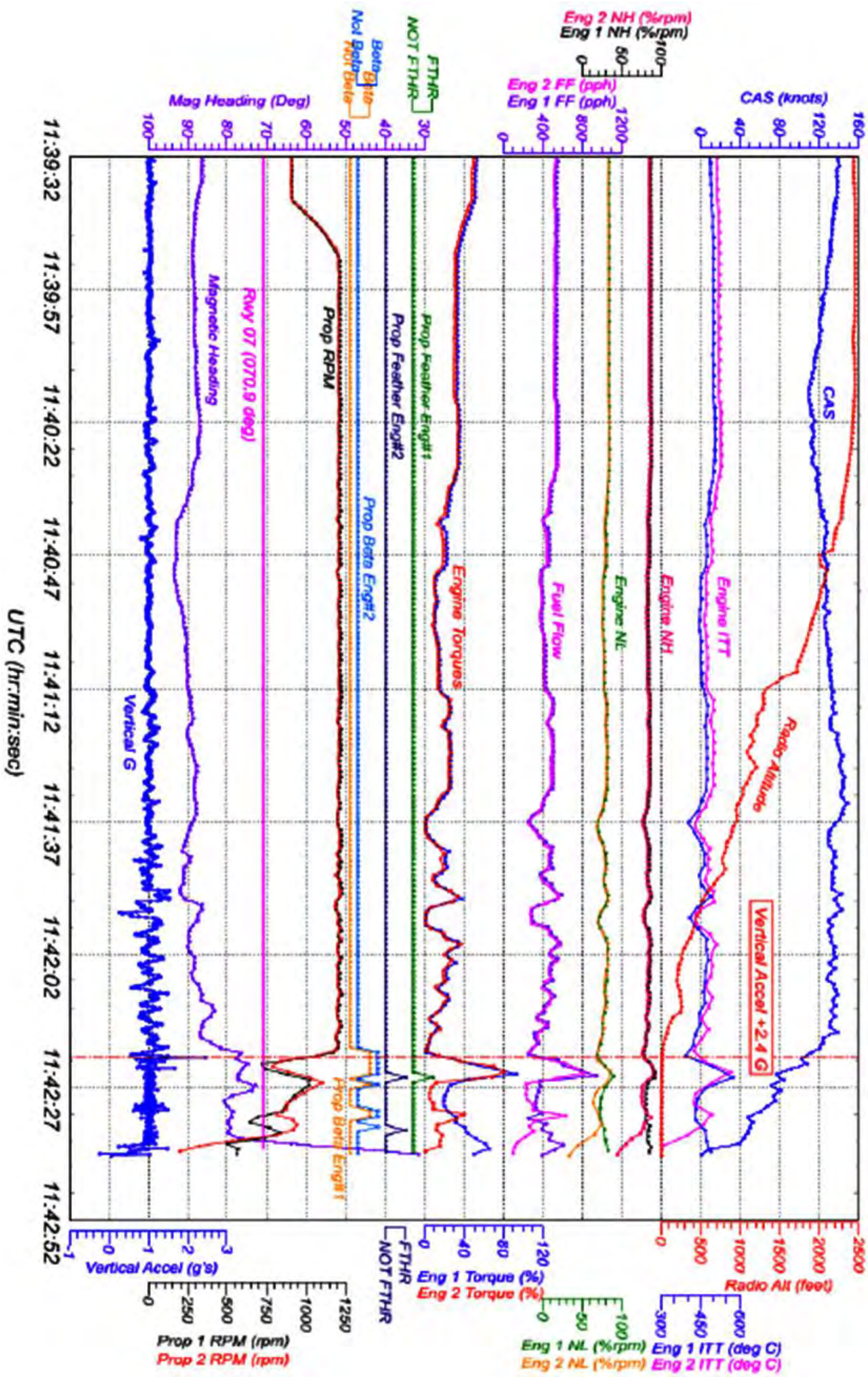
5.14 SSFDR lateral controls

Click - back to page



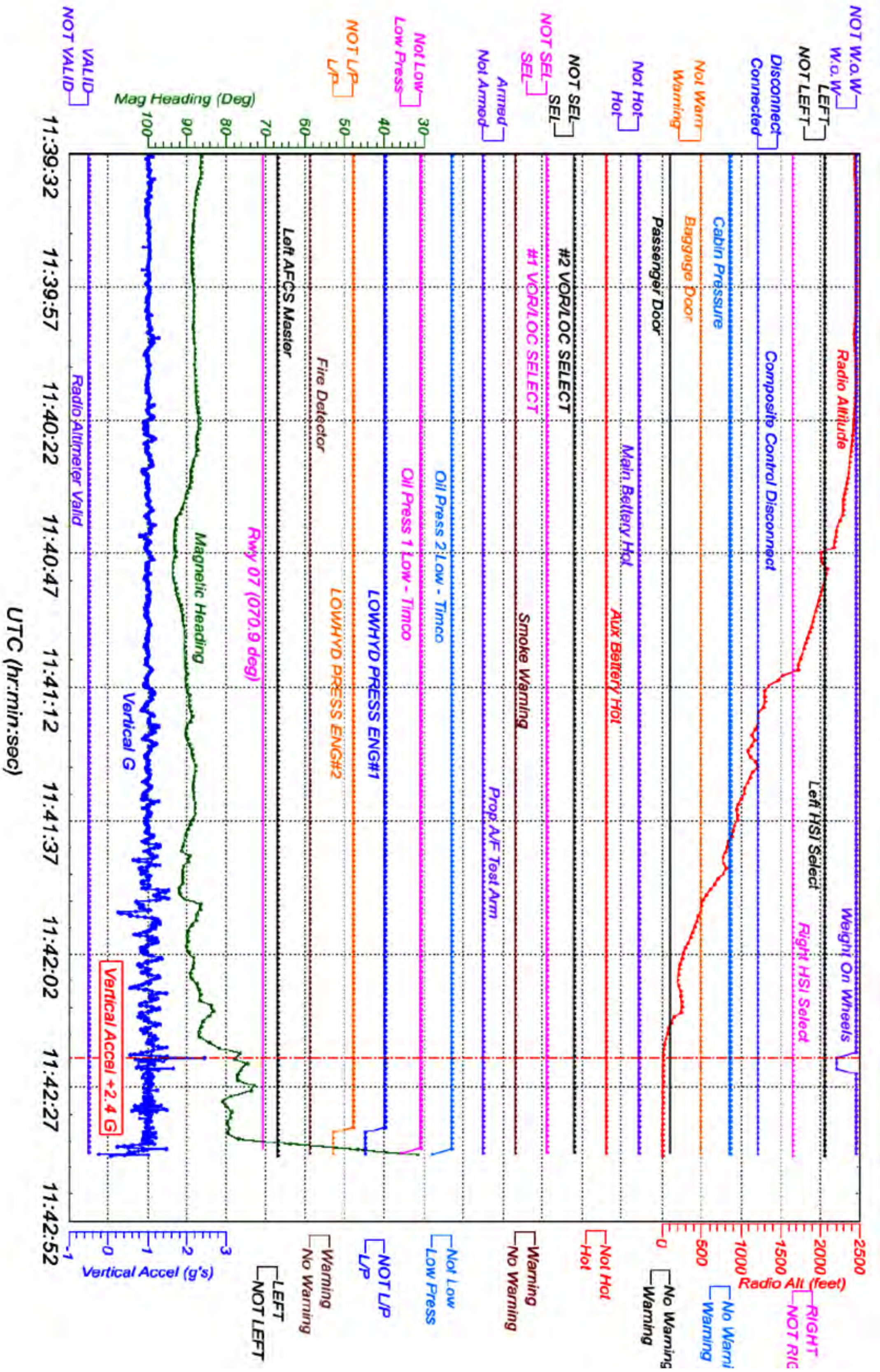
5.15 SSFDR engines and propellers

Click - back to page



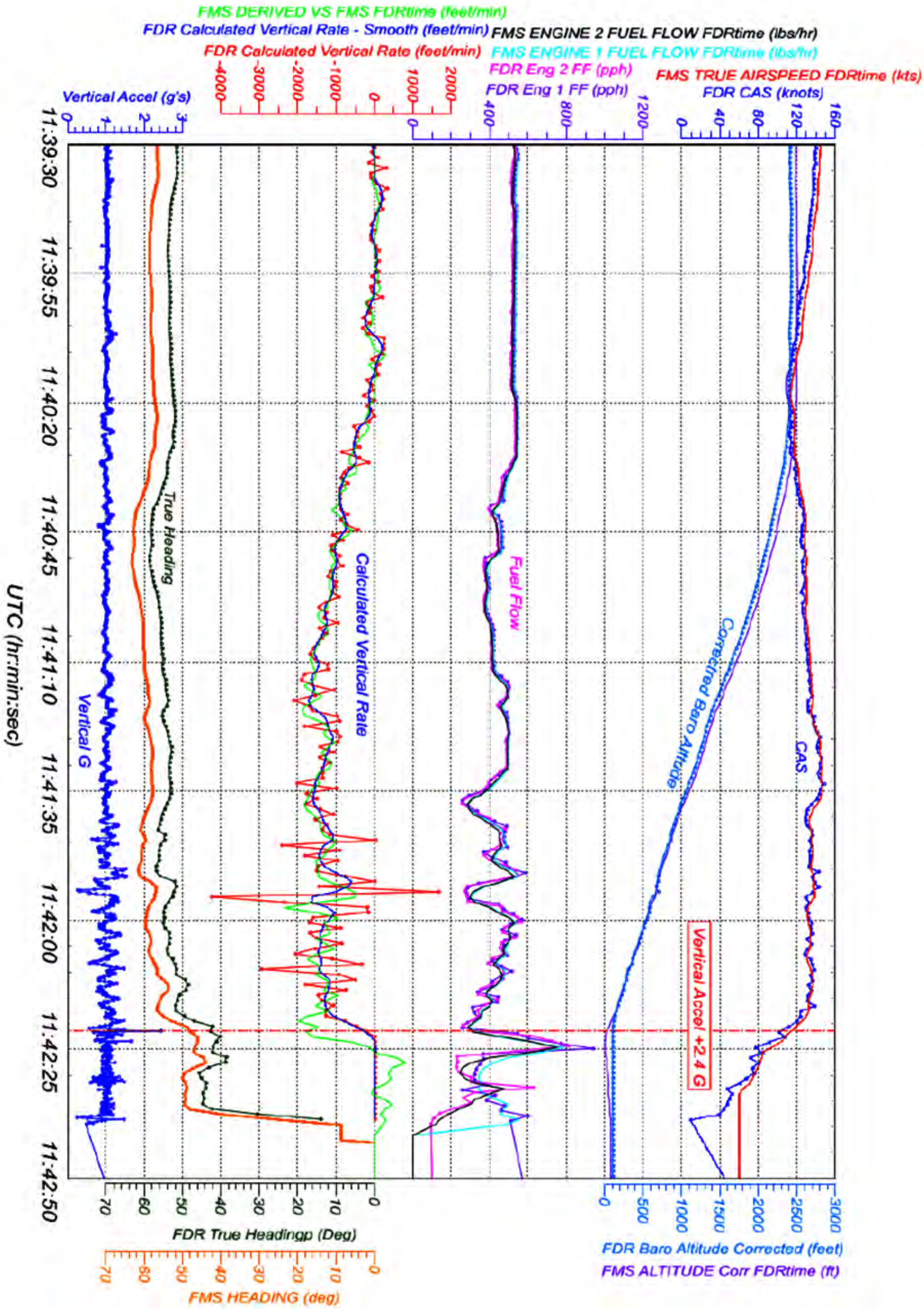
5.16 SSFDR discretes

[Click - back to page]



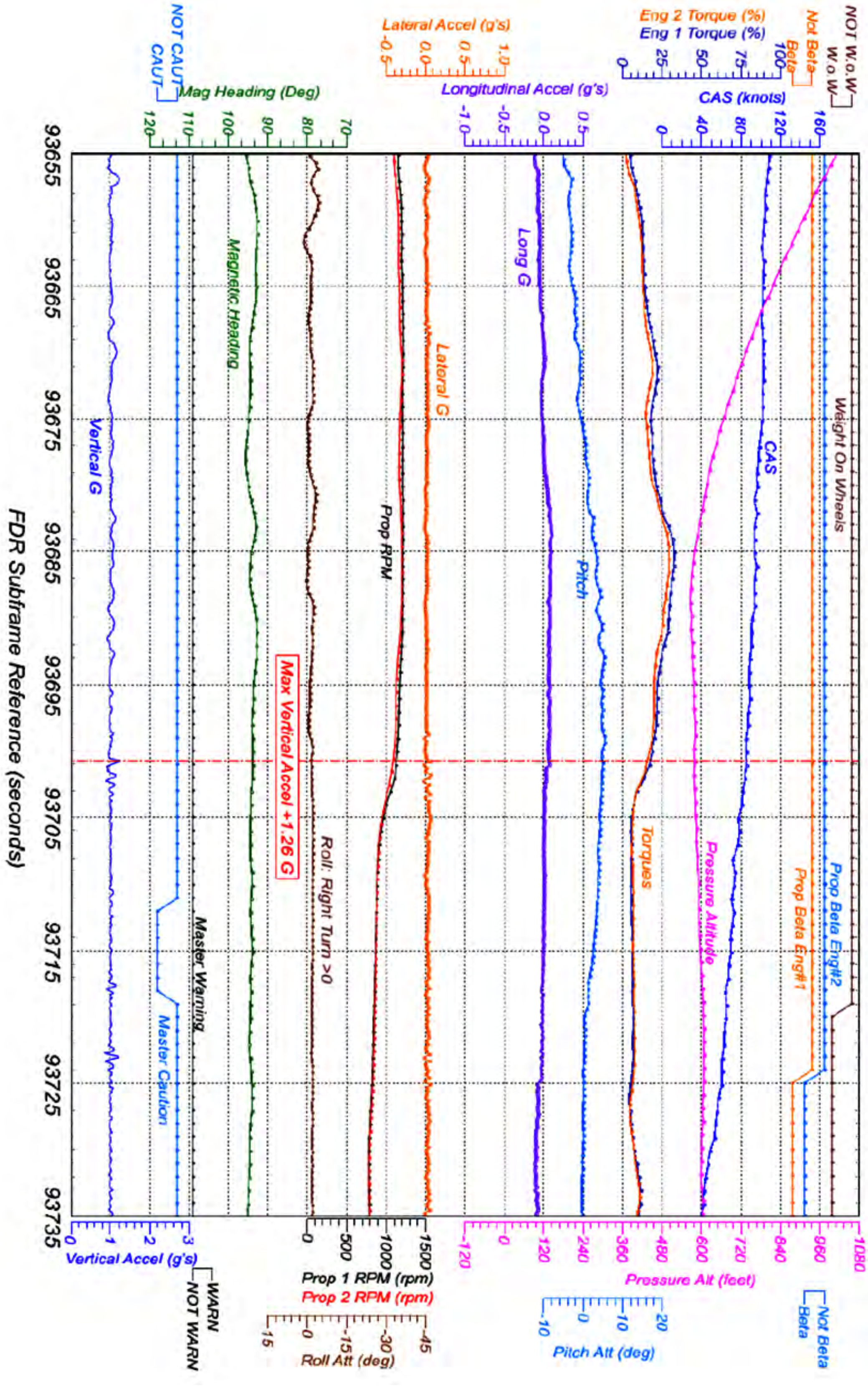
5.17 FMS and SSFDR data comparison

[Click - back to page](#)



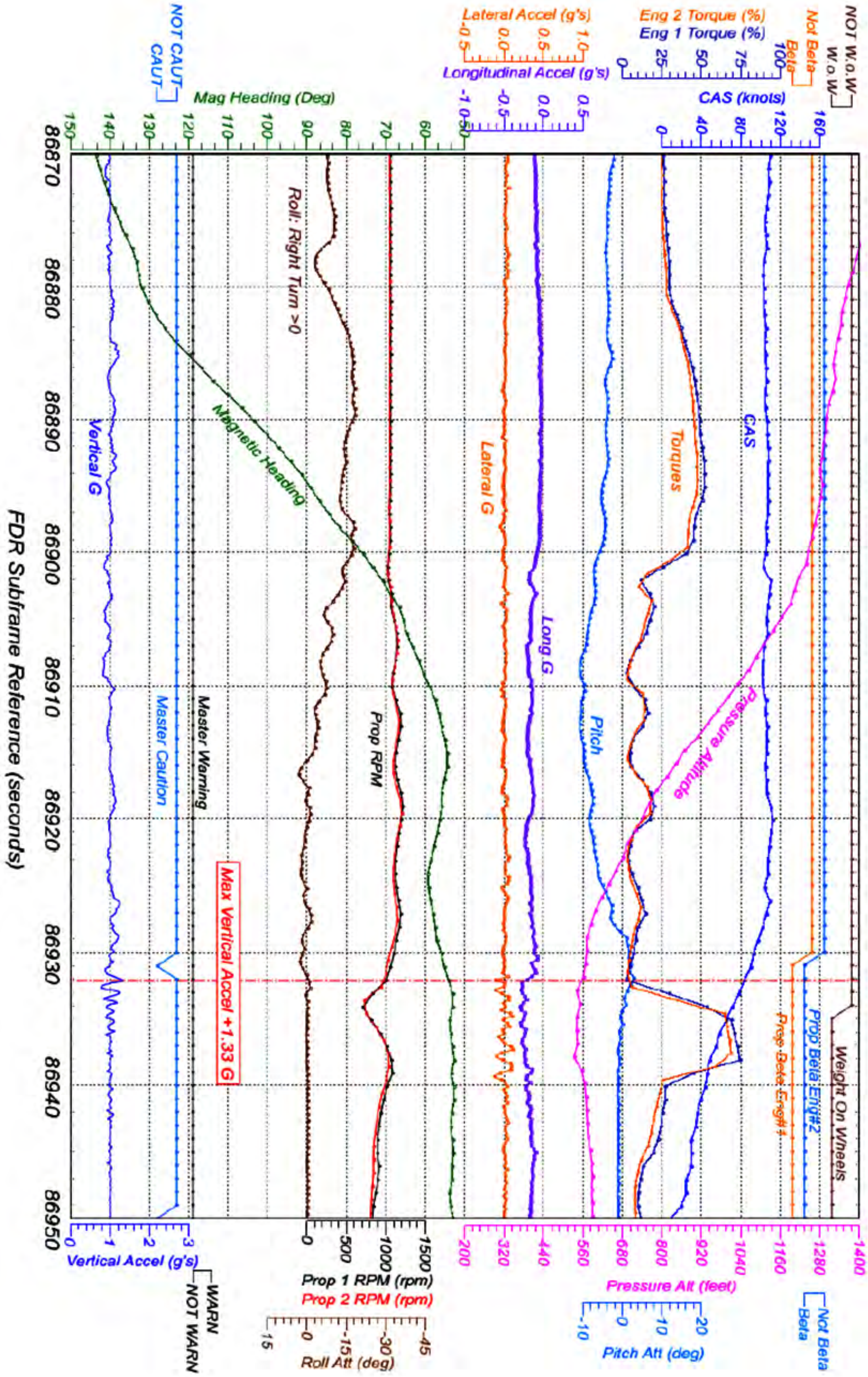
5.18 SSFDR previous flight number one

[Click - back to page]



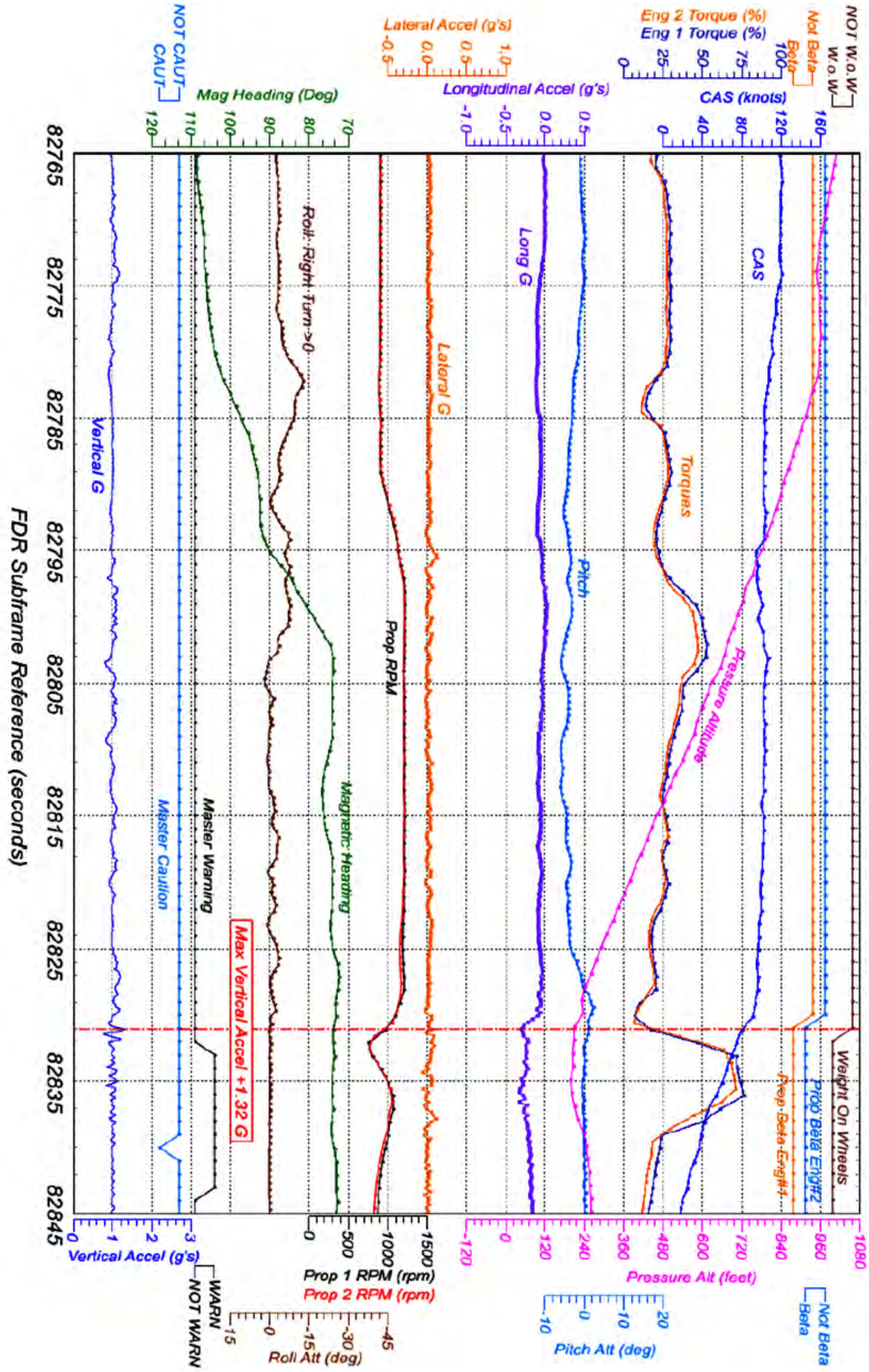
5.19 SSFDR previous flight number two

[Click - back to page](#)



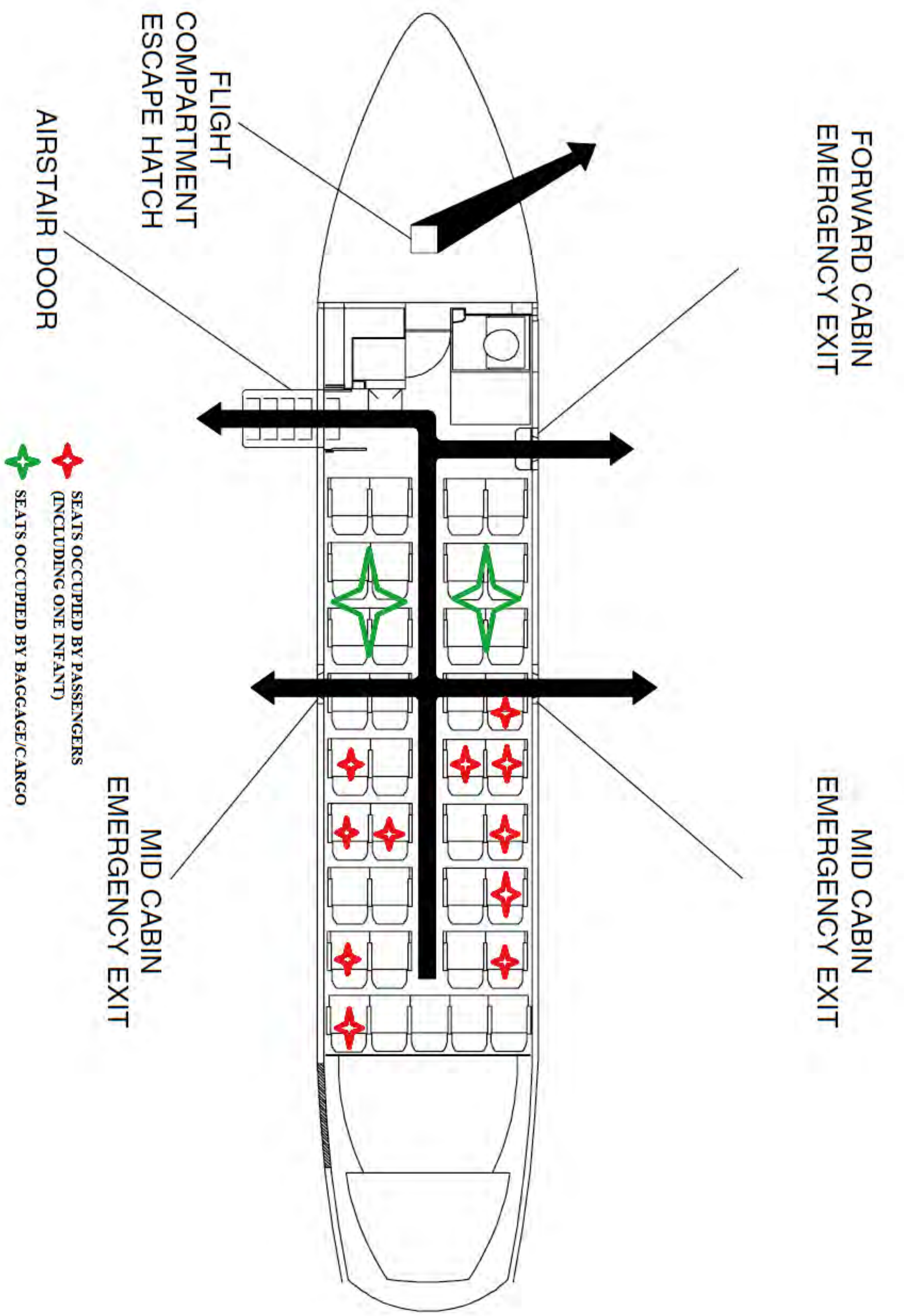
5.20 SSFDR previous flight number three

[Click - back to page](#)



5.21 Emergency exits and actual passenger seating

Click - back to page (emergency exits) Click - back to page (passenger seating)



5.22 Mandatory approach calls

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2.1.1.4 Table 1: Calls for VISUAL Approach

ACTION	FP	NP
500 feet above, field elevation.	Fly the aircraft within all criteria for stabilized approach configuration. "CHECKED "	"STABILIZED"

5.23 Stabilized approach parameters

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2.1.7.1.5 Stabilized approach parameters

Stabilized approach is defined in OM-A(A) 8.1.3.7. The parameters for the DHC-8 are as follows:

Flight path		Configuration	Speed		Rate of Descent	
Precision Approach	1 dot LOC/GP	Flaps for landing (flaps 35 can be delayed until short final), gear down	1000 feet	500 feet	1000 feet	500 feet
Non-precision approach	1 dot 5° NDB		+ 20 kts - 5 kts	+10 kts -0 kts	Max. 1500 ft./min	Max 1000 ft./min
Visual approach	Wings level at 300 feet				Max. 2000 ft./min	Max. 1000 ft./min

Note: When established on a steep approach glideslope, as indicated by the PAPI or other visual glideslope guidance, a descent rate exceeding 1000 feet/min is acceptable.

Note: Do not attempt to land from an unstable approach.

In the event of either pilot noticing approach conditions outside the above parameters after passing 1000 feet above the runway level, corrections must be made. If below 500 feet above the runway level, a missed approach must be executed.

2.1.7.1.5.1 Callouts in the event of an unstabilized approach

In the event that the approach is, or becomes, unstabilized, the following callouts will be made:

Observation	Callout	Response
Airspeed +20/-5 from briefed approach speed, or airspeed -5 from flap max limit speed	"AIRSPEED"	"GO-AROUND" or "CORRECTING"
Rate of descent in excess of 1000 feet/min (for other than steep approaches)	"DESCENT RATE"	"GO-AROUND" or "CORRECTING"

5.24 Normal landing

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2.1.12 Normal landing

Once the runway is established visually for IFR approaches or once approach angle can be judged on base leg VMC, the aircraft should always be maneuvered to set up or continue a normal 3° glide path to the runway, unless a steep approach is being used. The touchdown aiming point should be approximately 800 feet to 1000 feet from the threshold (i.e. normal ILS or PAPI touchdown point).

If flaps 35° is intended, read Landing Checklist down to the line and complete the checklist when flaps 35° has been selected on final.

At approximately 200 feet AGL, the power should be reduced to smoothly decelerate the aircraft to cross the runway threshold at 50 feet with a speed of V_{REF} to V_{REF} + 5 KIAS. Normally the minimum torque setting will be approximately 15%.

At 10-15 feet, commence the flare and slowly retard the power levers. Avoid over-rotation in the flare (pitch angle over 6° to 8°), as there is a danger of striking the tail on touchdown.

WARNING!

Do not chop or reduce the power levers to flight idle in the air or a firm landing will result.

5.25 Steep approach

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2.1.12.2 Steep approach

See AFM PSM 1-82-1A SECTION 6 / supplement 12 for limitations.

In order to increase proficiency and improve safety, a steep approach is normally flown when available.

However, in suitable conditions with good visibility and in daylight a normal 3° glideslope may be flown at the commander's discretion (refer to 2.1.12.1 Landing without visual or electronic glideslope indication for further).

When it is determined that a steep approach shall be utilized, a comprehensive briefing shall be performed. As with any normal approach, the aircraft shall be configured with flaps 15 and landing gear down prior to PAPI intercept.

When one white light shows on the PAPI, the NP, on command, will select flaps 35 (if applicable) and activate the EGPW STP APR push light to enable steep approach (Mode I excessive descent rate) alert biasing. Torque should be reduced to approximately 20%, depending on conditions and landing mass. The steep approach shall be flown initially at VREF + 10 knots, reducing gradually so as to cross the threshold at VREF.

During descent, maintain glide path with elevator and use only small power changes to maintain desired airspeed. In gusty conditions maintain average airspeed at corrected VREF. Do not attempt to eliminate entirely the airspeed excursions as this may require excessive power changes. A smooth, positive flare is required after a steep approach to ensure the avoidance of a hard landing. Steep approaches with tailwinds are to be avoided, as the chances of a hard landing are increased with a tailwind.

5.26 Normal landing

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4.4 LANDING PROCEDURES

4.4.1 NORMAL LANDING.

Where the planned landing flap is greater than the approach flap, when landing is assured:

1. FLAP selector lever – 15° or 35°.

   NOTE

   To avoid inadvertent flap selection, release flap selector latch following movement of flap selector from last selected position.

2. Airspeed – VREF (figure 5–8–1) flap 15° or (figure 5–8–2) flap 35°.

   NOTE

   The airspeed indicator is the primary speed reference; however the ADI FAST–SLOW indicator may be used as an aid in managing engine power to maintain VREF appropriate to flap angle.

3. Condition levers – MAX.
4. POWER levers to FLT IDLE before touchdown then to DISC after touchdown. Check PROPELLER GROUND RANGE advisory lights illuminate.

   NOTE

   At airport altitudes greater than 5,000 ft, power may be required in the landing flare to decrease touchdown descent rate.

   CAUTION

   Pitch attitudes greater than 8° in the landing flare may cause the tail to contact the runway.

   NOTE

   The nosewheel should be promptly brought into contact with the runway following mainwheel contact.

5. Anti–skid brakes – As required.

5.27 Emergency landing

[Click - back to page](#)

3.16 EMERGENCY LANDING

3.16.1 EMERGENCY LANDING PROCEDURES

When it is known that a landing must be performed which could be identified as an emergency landing due to the presence of factors which introduce a hazard to the airplane and its occupants, the following points should be addressed as applicable.

1. Instruct Flight Attendant(s) to brief and prepare passengers appropriate to the emergency.
2. If possible ensure that no passengers are seated in the plane of the propellers.
3. Secure all loose items in flight compartment and cabin.
4. Complete all necessary radio communications with the ground relative to the intended landing.
5. Review the procedure to be followed covering all aspects of crew actions and coordination.
6. Consider the applicability or suitability of a practice approach and overshoot.
7. Ensure that pilot and copilot shoulder harnesses are secure and locked.
8. GPWS – Deactivate by pulling circuit breaker B9 (EGPWS MS 8Q100880 – B3) on left rear circuit breaker panel.
9. CABIN ALTITUDE AUTO/MAN/DUMP switch – DUMP.
10. EMER LIGHTS switch – ON.
11. BATTERY MASTER switch – OFF.

5.28 Landing gear failures

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SAFETY OF FLIGHT SUPPLEMENT

NO. 11

MAY 28/10

SAFETY OF FLIGHT SUPPLEMENT, LANDING GEAR FAILURES

LANDING GEAR FAILURES

Structural failure of the landing gear is not covered under Type Certification, therefore, no specific Airplane Flight Manual procedure covering this malfunction is provided or required.
When it is known that a landing must be performed which could be identified as an emergency landing due to the presence of factors which introduce a hazard to the airplane and its occupants, paragraph 3.16, Emergency Landing, of the Airplane Flight Manual (AFM), outlines the main points to be addressed as applicable.

The intent of the following is to provide a list of considerations that may assist the flight crew in their decision making process. The information presented will not always be appropriate for the conditions being experienced by the flight crew. Ultimately, the flight crew will have to make the final decisions given the information presented to them in the particular emergency situation.

One Main Landing Gear Unsafe, Nose Landing Gear And Opposite Main Landing Gear Down And Locked:

If the Alternate Landing Gear Extension procedure has been completed and, it cannot be verified that both main landing gear are down and locked by the normal means and the landing gear cannot be retracted, the flight crew must perform a landing with one main landing gear unsafe. The flight crew must assume and prepare for the gear to collapse on landing.
In this situation, in addition to the direction of AFM paragraph 3.16, Emergency Landing, the following additional items are offered for consideration:

- Reduce landing weight through fuel burn
- Passengers must be moved from the seats in the plane of the propellers and re–seated elsewhere in the cabin. Priority is to be given to the passengers seated on the side with the indicated unsafe main landing gear
- Crosswind (if any) would be advantageous from the side with the un–affected main landing gear
- Land with flap 35°

- Fly the appropriate VREF for the landing weight
- Giving due regard to the specific approach to be follow, flight conditions and possible missed approach; prior to commencing the final approach, feather and secure the engine on the side with the affected main landing gear
- On touchdown, maintain maximum wing down lateral control on the side with the un–affected main landing gear,
- If the unsafe main landing gear collapses, in an effort to reduce the airplane turning moment in the direction of the failed main landing gear, apply maximum braking and reverse thrust on the side with the un–affected main landing gear.
- Feather and secure the operative engine
- Be prepared to action an Engine Fire On Ground procedure.

5.29 On ground emergencies

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ON GROUND EMERGENCIES

- Emerg Brake .... On
- Power Levers .... Flight Idle
- Condition Levers .... Fuel Off
- Pull Fuel Off Handle (affected engine) .... Pull
- Tank Aux Pumps 1 and 2 .... Off

IF Fire:

- Extg switch (affected engine) .... Fwd Btl

IF Fire persists, Wait up to 30 secs:

- Extg switch .... Aft Btl

IF Evacuation:

- Emergency Lights .... On
- Fasten Belts .... Off
- Evacuate .... as req'd
- AC /DC Ext Pwr / APU .... Off
- Battery Master .... Off

5.30 Operator FDM readout - unstable approach flap setting 15°

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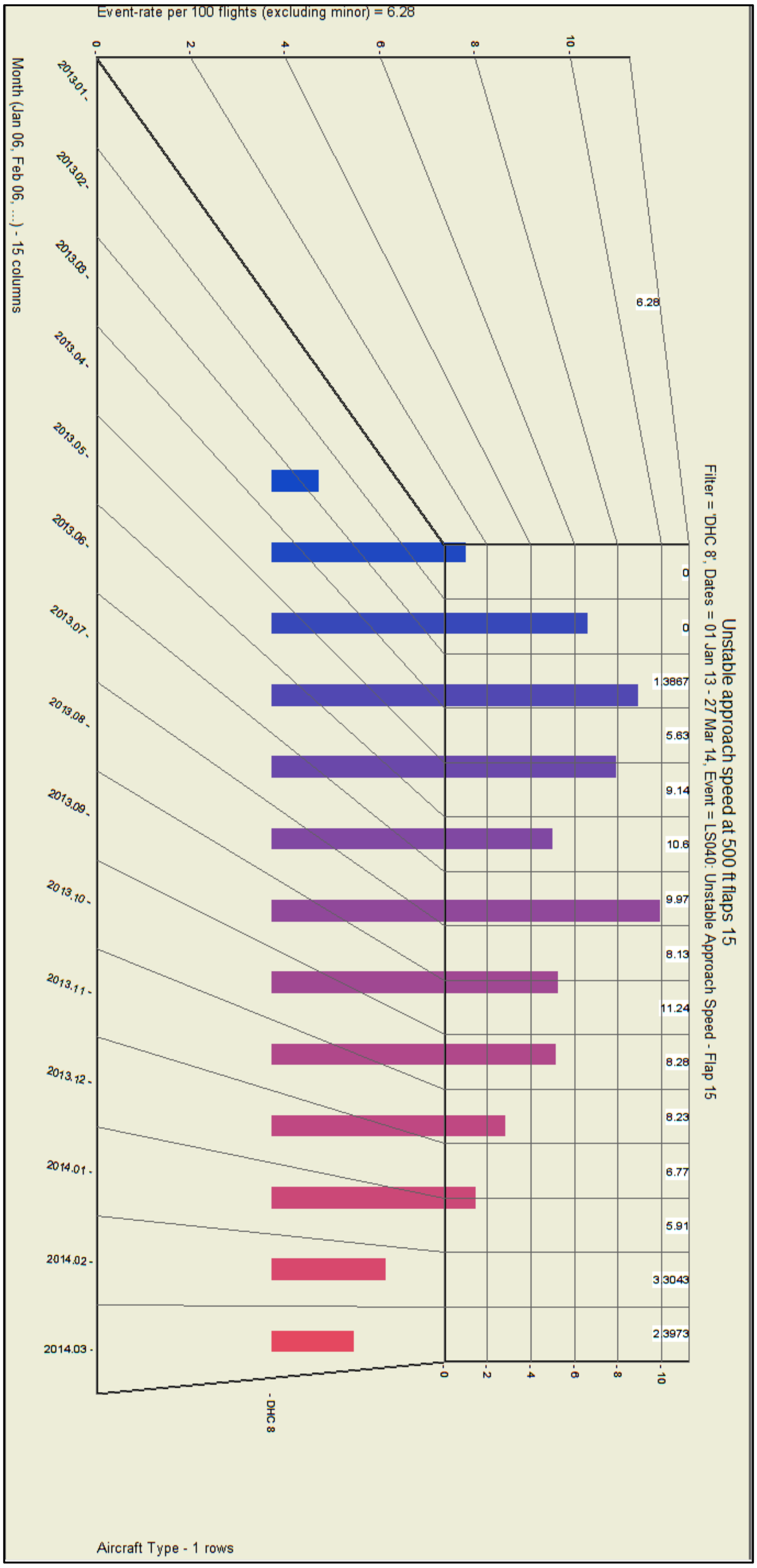

5.31 Operator FDM readout - unstable approach flap setting 35°

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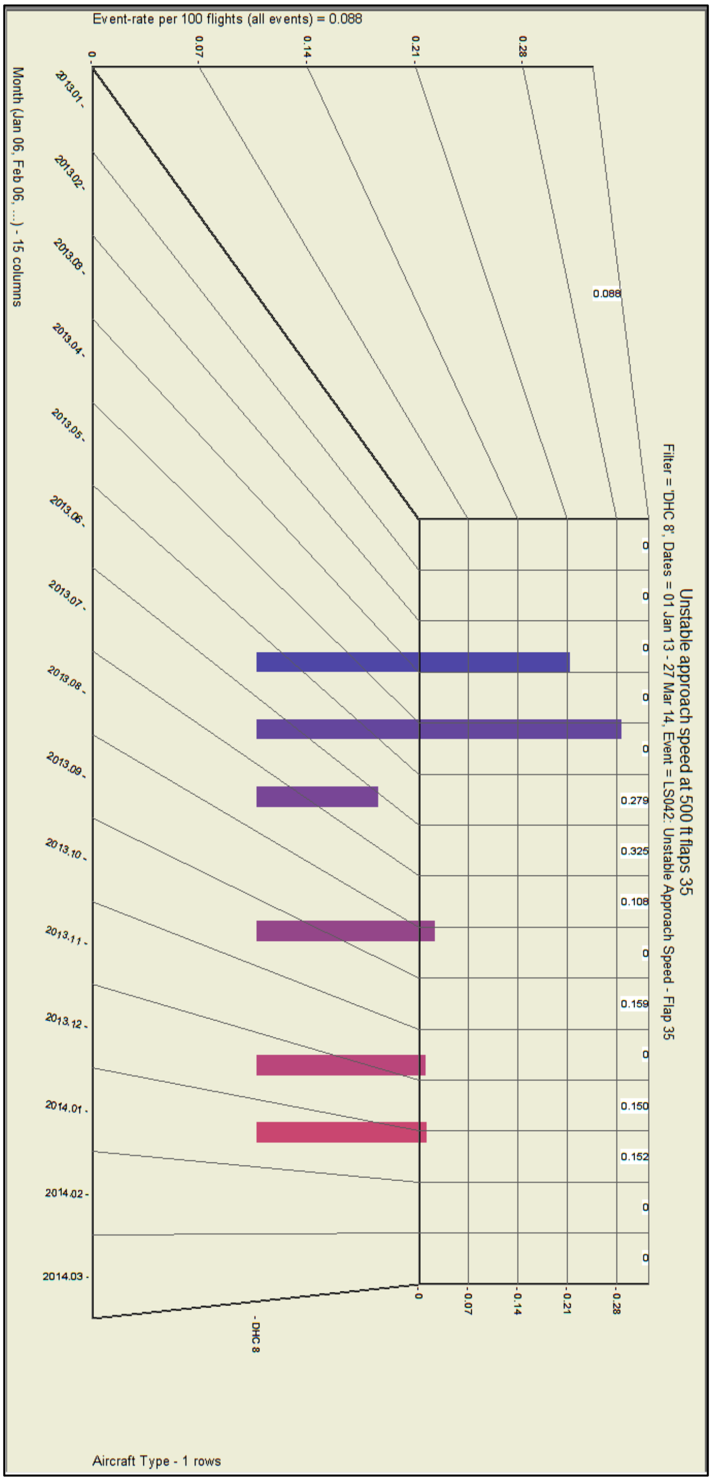

5.32 Extract of ATSB accident report

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ANALYSIS

The occurrence

During the occurrence, the DHC-8-315 aircraft was on descent with the power levers in the flight idle position. The first officer's hand was on the power levers. When the aircraft encountered turbulence, the first officer's fingers inadvertently lifted one or both of the flight idle gate release triggers and moved the power levers below the flight idle gate, which resulted in a double propeller overspeed event.

This type of occurrence has a significant potential to result in serious consequences. If the power levers are moved below the flight idle gate during flight, the propeller speed control and overspeed protection systems are inhibited. When combined with high airspeeds, the propellers will be driven by the airflow much like a windmill and, depending on aircraft speed, could result in the propeller rpm limits being exceeded. If not detected and recovered very quickly, this situation can lead to one or both engines failing. In this case, the first officer quickly realised the situation and moved the power levers forward of the flight idle gate before engine damage occurred.

Propeller overspeed protection

At the time of the occurrence, a significant number of DHC-8-100, -200 and -300 aircraft in Australia and other countries outside the United States and Papua New Guinea did not have a beta lockout system installed to prevent propeller overspeed in the advent of below flight idle selection in flight, nor were they required to.

Power lever and propeller system design

The aircraft design included features to reduce the likelihood of the inadvertent movement of the power levers below flight idle and into the ground beta mode during flight. These included the flight idle gate, which required a separate action (lifting the release triggers) before being able to move the levers past the gate.

Although such a feature significantly reduces the likelihood of inadvertent action, it does not prevent it. There are multiple ways in which a pilot could inadvertently bypass the gate. For example, as with this occurrence and some others, during turbulence it is likely that pilots will grip the power levers more tightly. As it is natural for a pilot's fingers to be touching the release triggers when holding the power lever, it is therefore likely that a pilot will move the triggers in some cases during turbulence.

In addition, pilots use the release triggers during each landing to move the power levers into the ground beta range in order to slow the aircraft down. It is a routine, skill-based action. In some cases, particularly when under high workload or distraction, skill-based actions will be confused with other actions, particularly those that share similar features.[10] Such errors are commonly known as 'slips'. It is

[10] Reason, J 1990, *Human Error*, Cambridge University Press.

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conceivable that occasionally, under unusual flight conditions or workload or distraction, the action of slowing an aircraft down in flight, by pulling back on the power levers, could be confused with the action of slowing the aircraft down on the ground.

The manufacturer had installed a beta warning horn to alert pilots when the flight idle gate release triggers had been lifted. Audible warnings can be very effective at attracting attention, although experience has shown that they are not always heard or comprehended in sufficient time to make an effective response, particularly in times of high workload or distraction.[11] The potential effectiveness of the DHC-8 beta warning in achieving a rapid response was further limited by the fact that pilots had not had the horn demonstrated to them during training.

In summary, the DHC-8-100, -200, -300 power lever design had features that significantly reduced the likelihood that flight crew would pull the power levers below flight idle in flight. However, there have been several documented occurrences where flight crews have bypassed the flight idle gate during flight. Although the likelihood of any such occurrence on each flight is very low, the potential for any such event to result in engine damage and a more adverse outcome is significant. No other transport category turboprop aircraft in use in Australia were associated with a similar design issue.

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[11] Rehman, N 1995, *Flightdeck crew alerting issues: An aviation Safety Reporting System analysis*, US Department of Transportation / Federal Aviation Administration Report DOT/FAA/CT-TN94/18.

5.33 Airworthiness Directive CF-2013-15R1

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Transport Canada / Transports Canada

TP 7245E

No.	1/2
CF-2013-15R1	
Issue Date **3 December 2013**	

AIRWORTHINESS DIRECTIVE

Number: **CF-2013-15R1**

Subject: **In-flight Operation of Propeller in Beta Range**

Effective: **17 December 2013**

Revision: **Supersedes AD CF-2013-15, issued 5 June 2013.**

Applicability: **Bombardier Inc. model DHC-8-102, -103, -106, -201, -202, -301, -311, -314, -315 aeroplanes, serial numbers 003 through 672.**

Excluding aeroplanes with Customer Request (CR) 873CH00011 (Service Bulletin 8-76-24) incorporated.

Compliance: **As indicated below, unless already accomplished.**

Background: There have been a number of reported incidents, where the flight crews have operated the propellers in Ground Beta range during flight on DHC-8-100/200/300 aeroplanes. In-flight Beta range operation of the propeller can and has resulted in over-speeding of the propeller(s). This condition, not only can cause the associated engine to fail, but the high drag resulting from the over-speeding propeller can adversely affect the controllability of the aeroplane.

Notwithstanding the fact that affected models of DHC-8 aeroplanes are equipped with Beta warning (horn) system as mandated by Transport Canada AD CF-99-18, to alert the flight crew of impending Ground Beta range operation during flight, the existing system design does not prevent propeller operation in Beta range during flight.

In order to prevent the operation of propellers in Ground Beta range during flight on the affected aeroplanes, Bombardier Inc. has issued Service Bulletin (SB) 8-76-35 to install new electrical circuits (Beta Lockout System) that are designed to prevent the propellers from entering the Beta range of operation during flight. The AD CF-2013-15 was issued on 5 June 2013 to mandate the incorporation of SB 8-76-35 to install a Beta Lockout System on all affected aeroplanes.

Bombardier Inc. has now revised SB 8-76-35 to correct an error in the CR number noted in the Effectivity section of the SB. Accordingly, this revised AD is issued to reflect the correct CR number in the Applicability section of this AD to read 873CH00011, in accordance with SB 8-76-35 Rev A, dated 11 September 2013.

Corrective Actions: Within 6000 hours air time or 3 years, whichever occurs first, from the effective date of this AD, install a Beta Lockout System in accordance with Bombardier Inc. SB 8-76-35 Rev. A dated 11 September 2013, or later revisions approved by the Chief, Continuing Airworthiness, Transport Canada.

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Compliance with the original issue of SB 8-76-35 dated 15 May 2013 meets the mandated requirements of this revised AD.

Authorization: For the Minister of Transport,

ORIGINAL SIGNED BY

Chief, Continuing Airworthiness

Contact:

5.34 AIB survey

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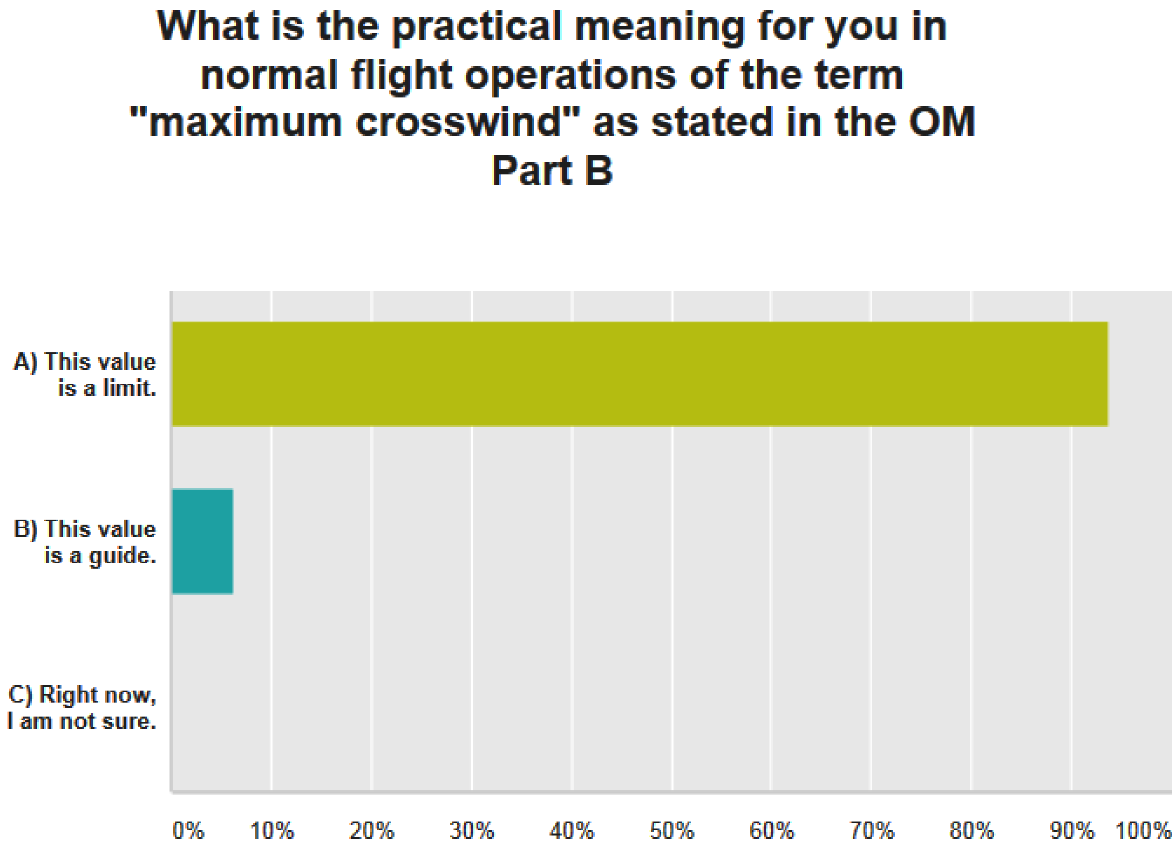
48 pilots responded to this question.



Options		Response rate
A)	This value is a limit	93.75%
B)	This value is a guide	6.25%
C)	Right now, I am not sure	0.00%

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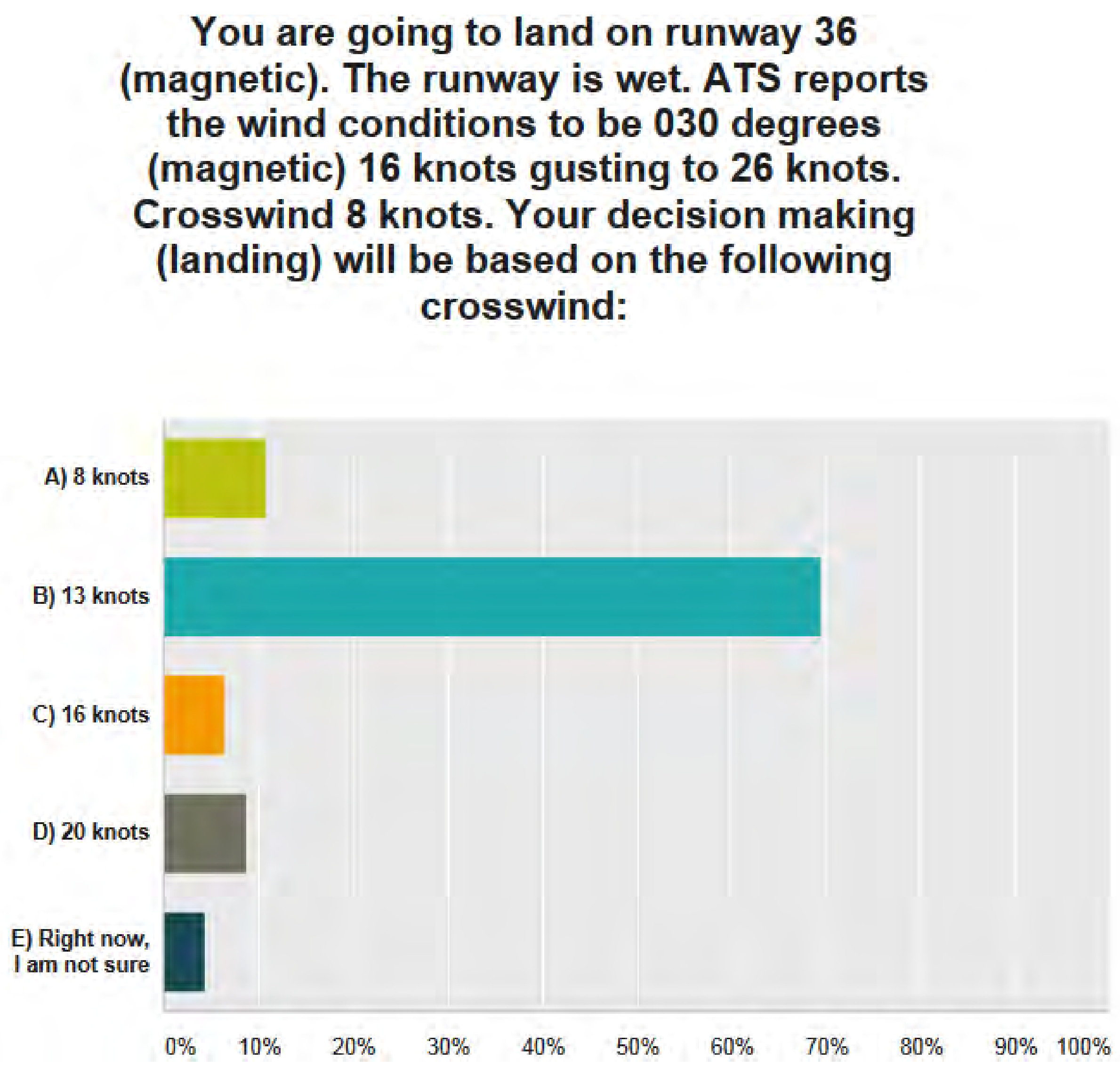
46 pilots responded to this question. Two pilots made no replies.



Options		Response rate
A)	8 knots	10.87%
B)	13 knots	69.57%
C)	16 knots	6.52%
D)	20 knots	8.70%
E)	Right now, I am not sure	4.35%

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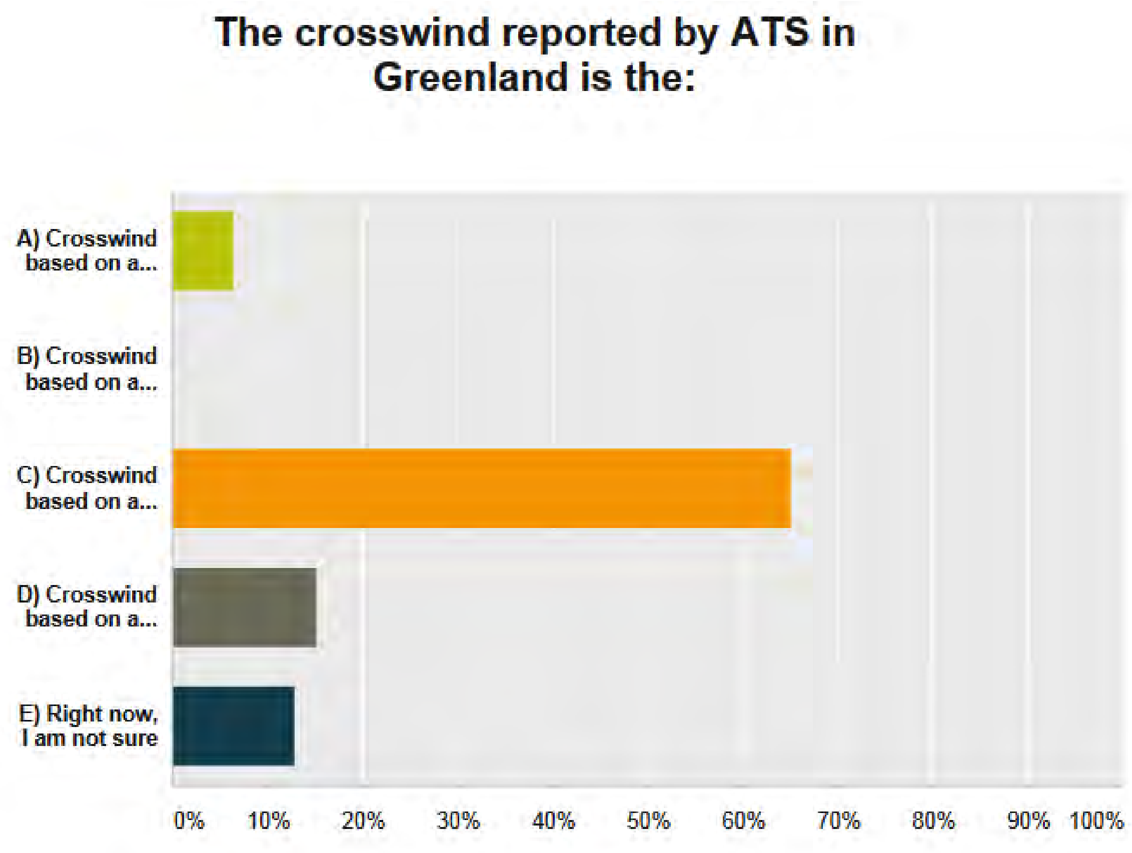
46 pilots responded to this question. Two pilots made no replies.



Options		Response rate
A)	Crosswind based on a three-second spot wind	6.52%
B)	Crosswind based on a three-second spot wind including gusts	0.00%
C)	Crosswind based on a two-minute mean wind	65.22%
D)	Crosswind based on a two-minute mean wind including gusts	15.22%
E)	Right now, I am not sure	13.04%

5.35 Stabilized approach concept - April 2014

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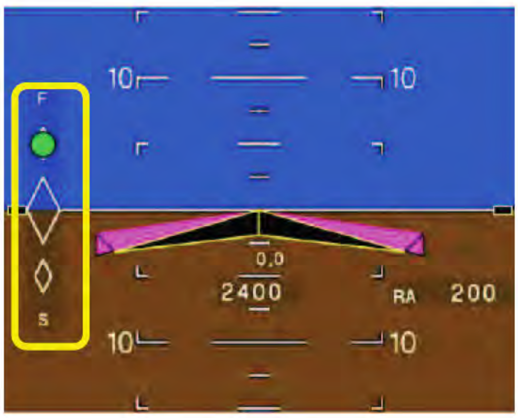
2.1.7.1.5 Stabilized approach parameters

Stabilized approach is defined in OM-A(A) 8.1.3.7. The parameters for the DHC-8 are as follows:

Flight path		Configuration	Speed		Rate of Descent	
Precision Approach	1 dot LOC/GP	Flaps for landing (flaps 35 can be delayed until short final), gear down	1000 feet	500 feet	1000 feet	500 feet
Non-precision approach	1 dot 5° NDB		Lower limit: V_{REF} Upper limit: V_{TRGT} +20	Lower limit: V_{REF} Upper limit: V_{TRGT} +10	Max. 1500 ft./min	Max 1000 ft./min
Visual approach	Wings level at 300 feet				Max. 2000 ft./min	Max. 1000 ft./min
Power setting appropriate for the aircraft configuration above flight idle.						

Since the airspeed indicator is lacking a dampening function, using this instrument as the primary means to establish stabilized/unstabilized conditions in turbulent weather poses some limitations.
For this reason, the Slow/Fast indicator on the EADI is used as the primary means for PM to establish the speed function of stabilized criteria.



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The aircraft is considered in a stabilized state concerning speed, when the fast/slow indicator is visible and "alive" between the V_{REF} mark and the top of the screen. This position equals speed ranging from V_{REF} to $V_{TRGT}+10$

The airspeed indicator remains the primary speed reference for PF.

IVSI is considered primary reference for determining stabilized approach parameters concerning Rate of Descent.

Note: When established on a steep approach glideslope, as indicated by the PAPI or other visual glideslope guidance, a descent rate exceeding 1000 feet/min, but no more than 1450 feet/min is acceptable.

Note: Unique approach conditions or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing including a threat and error risk assessment.

WARNING!
Do not attempt to land from an unstable approach.

In the event of either pilot noticing approach conditions outside the above parameters after passing 1000 feet above the runway level, corrections must be made. If below 500 feet above the runway level, a missed approach must be executed.

2.1.7.1.5.1 Callouts in the event of an unstabilized approach

In the event that the approach is, or becomes, unstabilized, the following callouts will be made:

Observation	Callout	Response
Airspeed outside stabilized limits from briefed VTRGT or airspeed -5 from flap max limit speed	"AIRSPEED"	"GO-AROUND" or "CORRECTING"
Rate of descent in excess of 1000 feet/min (for other than steep approaches)	"DESCENT RATE"	"GO-AROUND" or "CORRECTING"