THE DUTCH SAFETY BOARD

Emergency landing at sea with Britten-Norman Islander near Bonaire on 22 October 2009

Limited number of comments included following review by Harry Horlings - AvioConsult, graduate of the USAF Test Pilot School - the highest level flight training in the world.

The review was not finished, too many errors in the report.

Were the writers of this report and the members of the Guidance committee experts, cognizant investigators? The answer will become clear after reading the comments.

This format of this report is not in agreement with the format as recommended in the Appendix of ICAO Annex 13 and, hence, not i.a.w. the ICAO Manual of Aircraft Accident Investigation.
This makes the use of the report for cognizant readers, who are involved in improving aviation safety, more difficult.
ICAO issued the format for a reason. Accident Investigation Reports required by ICAO are for cognizant aviators, not for the general public.

On page 2, the Board writes that "the objective of these investigations is solely to prevent future accidents or incidents and, when the results give cause to do so, issue recommendations".

THE most important recommendations to prevent future engine failure related accidents are regrettably not included. These most important recommendations are:

1. The Owners handbook/ Flight Manual needs to be improved with data and procedures for the pilots to reduce the drag while one engine is inoperative, and hence increase the distance traveled. The EASA and FAA Flight Test Guides provide guidelines - please refer to the Downloads page of www.avioconsult.com.
In addition, errors in the handbook need to be corrected.
2. Pilot training needs to be improved to include safe operations with one engine inoperative, by adding the requirement to maintain a small bank angle away from the inoperative engine which reduces the rudder generated sideslip while the airspeed is Vyse (os Vxse), and with improved knowledge of the real value of minimum control speed Vmca.
3. Weight and Balance data needs to be used and applied more adequately.

Many errors were found in this report. The investigation should be re-opened in order to improve the report and hence, make it possible to improve the safety of flight operations with BN-2 type airplanes as well as with other multi-engine airplanes.

Emergency landing at sea with Britten-Norman Islander near Bonaire on 22 October 2009

Required to also list in the title, i.a.w. ICAO Annex 13:
the name of the operator,
nationality and registration marks
of the aircraft.

The Hague, may 2011 (project number 2009090)

THE DUTCH SAFETY BOARD

The Dutch Safety Board has been set up to carry out the task of investigating and determining the causes or probable causes of individual or categories of incidents in all sectors. The objective of these investigations is solely to prevent future accidents or incidents and, when the results give cause to do so, issue recommendations. The organisation consists of a Board with five permanent members and a professional bureau. The Dutch Safety Board appoints guidance committees for specific investigations.

	Dutch Safety Board		Guidance committee
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This report is published in the Dutch and English languages.
In the event of conflict in interpretation, the Dutch text will be deemed binding.

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Orange underlining means inappropriate word/ translation.

CONSIDERATION

Red line means error.
This report presents ...

~~The present report is~~ the result of the investigation carried out by the Dutch Safety Board into the accident near Bonaire with a Britten-Norman Islander of the Divi Divi Air airline company on 22 October 2009. The Britten-Norman Islander is a twin-engine aircraft that can accommodate ten people. The aircraft was on a flight (DVR014) from Curaçao International Airport (Hato airport) to Bonaire International Airport (Flamingo airport). The pilot died and a few passengers were slightly injured during the accident. The aircraft was seriously damaged. The investigation was carried out at the request of the former government of the Netherlands Antilles (the government of Curaçao after the constitutional reform on 10 October 2010). This request was made to the Dutch Safety Board on 17 November 2009. The aircraft and the pilot were recovered on 18 December 2009. In addition to the accident investigation, the Dutch Safety Board investigated the alerting process and the emergency services after the accident. All involved parties have cooperated with the investigation.

damaged beyond repair?

There is intensive air traffic between the islands of Aruba, Bonaire and Curaçao and among themselves to transport passengers and (small) goods daily. These air services are maintained by several medium-sized and small airline companies. The involved aircraft belonged to the Divi Divi Air airline based in Curaçao. The Board is of the opinion that persons who make use of this kind of transportation have no other choice than to give the safeguard of their safety temporarily and completely in the hands of the transporting company, and have to trust at all times that that safeguarding does not show deficiencies. This will impose high demands to this transportation regarding safety, risk management, and oversight.

Was the company not issued an Air Operator Certificate?

The aircraft departed without problems from Hato airport. The right engine failed at an altitude of 3500 feet after having flown approximately a quarter of the route. The pilot feathered the right propeller and undertook a few restart attempts but without result. The cause of the right engine failure could not be determined.

After the right engine failed, the pilot continued his flight to Bonaire. With that, the aircraft position was still near Curaçao and the nearest airport was Hato. To continue the flight to Bonaire was contrary to the principle for twin-engine aircraft as defined in the legislating for civil aviation in the Netherlands Antilles (Civil Aviation Regulations Netherlands Antilles - CARNA) that the aircraft must be landed at the nearest suitable airfield after an engine failure.

level flight (or started drifting down)

It emerged whilst continuing the flight that the aircraft could not maintain ~~a horizontal~~ flight with one operating engine due to overloading. The investigation showed that the aircraft was overloaded by 9% above the maximum ~~structural~~ take-off weight. At that point in time the pilot could have still turned back to Curaçao. A non-acceptable risk was taken by continuing the flight under these conditions. Ultimately, the destination could not be reached and an emergency landing at sea became unavoidable.

Term not defined in airplane manual

was

Although the pilot himself is responsible for the loading of the aircraft and completion of the load and balance sheet, the investigation has shown that Divi Divi Air management paid insufficient supervision on the safety of the flight operation with its Britten-Norman Islanders. This resulted in insufficient attention to the risks of overloading. It has been shown that Divi Divi Air used standard passenger weights that were too low. A random sample of flight operations has shown that the maximum applied take-off and landing weights were regularly exceeded. The internal Divi Divi Air supervision system regarding the load and balance programme was inadequate. This refers to the way in which risks for passengers and the pilot are assessed and are controlled structurally. The load sheets were not checked (afterwards). Audits were not carried out either. Only the maximum structural take-off weight was applied during training, practical training, exams and air operation and, therefore, the pilots were insufficiently aware of the weight restrictions of the aircraft. In addition, different management tasks were combined and, therefore, it is possible that insufficient arrangements were made with regard to the related responsibilities.

or were the standard weights too low?

is normally called "weight and balance". Includes airplane, fuel, load, cargo, etc. weight as well!

It has also emerged that the then oversight body for civil aviation in the Netherlands Antilles, the Directorate of Civil Aviation, supervised the operational management of Divi Divi Air only to a limited degree. The operational restrictions that formed the basis for the flight operation of Divi Divi Air were missing in the air operator certificate, in the certificate of airworthiness of the aircraft that crashed and in the approved General Operating Manual of Divi Divi Air. The required (demonstrable) relation between the standard passenger weight and the actual passenger weight was missing. Deviations between the (approved) safety instruction cards and the life jackets on-board went unnoticed during the annual inspections. It is true that a higher standard passenger weight was set after the accident but this still offers insufficient safeguard against exceeding the maximum allowed take-off weight with regard to the Britten-Norman Islanders operated by Antillean airlines.

Due to the shortcomings of both the internal supervision as well as the external supervision (oversight) on the operational management of Divi Divi Air with regard to the load and balance programme (related to training and operation), essential 'checks and balances' were missing that are required for safeguarding the system's safety. This means that the legal rules (CARNA) and the limitations specified by the aircraft manufacturer were not being met. The Board is of the opinion that a lack of oversight on the operational activities and processes may not be an excuse to fulfil one's own responsibility insufficiently.

Investigations into similar occurrences at other places in the world in the past confirm the shortcomings found in this accident: the lack of a relation between the standard and actual passenger weight, the lack of internal supervision of the load and balance programme of the airline and the lack of oversight with regard to this.

The Board would like to note that during the audit organised by the International Civil Aviation Organization (ICAO) in 2008 regarding the implementation of its standards and recommended practices in the civil aviation rules in the Netherlands Antilles, a large number of findings were reported. This resulted in a 'corrective action plan' to correct these findings. From the investigation of the accident on 22 October 2009 a number of shortcomings has been found regarding the oversight performed by the Directorate of Civil Aviation. It has also been shown that the recording system of the radio communication with Hato Tower is not able to record actual time. This problem exists for several years. This malfunction of the recording system hampered the accident investigation. Although the Safety Board did not investigate the progress of the corrective action plan that followed after the ICAO audit, the Board is very concerned about the safety oversight of the civil aviation in Curaçao.

The pilot did not act as can be expected from a captain during the flight and the preparation for the emergency landing. The landing was performed without flaps selected down, which meant that the aircraft was flying at a higher landing speed than was required. In addition, it emerged that the pilot had insufficiently ensured that the passengers had understood the safety instructions when they boarded the aircraft. Nor did the pilot undertake sufficient attempts to inform the passengers about the approaching emergency landing at sea after the engine had failed and, therefore, they could not sufficiently prepare for this.

The pilot was obviously not aware of the flight technique to reduce the drag following the failure of an engine and increase the range.

Moreover, it emerged that the safety equipment and instructions on-board the Britten-Norman Islanders of Divi Divi Air in use were not in order. Three passengers were not wearing a life jacket during the emergency landing and one passenger had donned his life jacket back to front.

The nose of the aircraft including the cockpit was seriously damaged during the landing on water. All nine passengers could leave the aircraft themselves through the emergency exits and were picked up from the water thanks to private boats that were nearby. The pilot lost consciousness upon landing. Shortly after, the aircraft sank to the bottom with the pilot still on-board. The Board would like to note that despite the shortcomings during the flight, the pilot, ultimately, managed to land the aircraft in such a way at sea that all passengers survived this accident without serious injury. It is sad that the pilot himself died during this.

It has been shown with regard to the alerting process and the emergency services that there was limited coordination between the different emergency services and, therefore, they did not work optimally. The incident site command (CoPI) that should have taken charge of the emergency services in accordance with the Bonaire island territory crisis plan was not formed. Insufficient multidisciplinary drills were organised and assessed in the past for executive officials. This meant that they were insufficiently prepared for their task. In addition, the boats of the fire service and the police had not been deployable for a longer period of time.

The Dutch Safety Board has arrived at the following recommendations regarding this accident:

Divi Divi Air

The Board recommends to Divi Divi Air to demonstrate the following to the Curaçao Civil Aviation Authority:

1. that the load and balance programme, the pilot training, the safety equipment and instructions of the Britten-Norman Islander aircraft in use are brought up to standard and comply with the legal requirements, and the limitations specified by the aircraft manufacturer, and that the risks of the load and balance programme are assessed and structurally controlled in the safety management system.

Minister of Traffic, Transport and Division of Urban Planning and Housing of Curaçao

The Board recommends that the minister:

2. Ensures that the CARNA is correctly applied and the user specifications by the manufacturer of the Britten-Norman Islander being used at airlines that fall under the supervision of the Curaçao Civil Aviation Authority in light of the findings as phrased (in conclusion 6) in this report.
3. Provides the Dutch secretary of State of Infrastructure and Environment, being the responsible member of the government for Kingdom Affairs the follow-up status of the ICAO audit 2008 findings in relation to the findings in this report.

Governor of Bonaire

The Board recommends the governor who has supreme command of the support services and the emergency services:

4. Ensures that the alerting process and the emergency (supporting) services are improved by regularly practising with deployment of multiple disciplines, assessment of this practise and taking measures of arisen shortcomings.

T.H.J. Joustra
Chairman of the Dutch Safety Board

M. Visser
General Secretary

LIST OF ABBREVIATIONS

AFM	aircraft flight manual
AOC	air operator certificate
AOM	aircraft operations manual
ATPL	airline transport pilot licence
BCAR	British Civil Airworthiness Requirements
BN-2	Britten-Norman Islander
BON	Bonaire
B3	commercial pilot licence (Netherlands Antilles)
CARNA	Civil Aviation Regulations for the Netherlands Antilles
CCAA	Curaçao Civil Aviation Authority
CG	centre of gravity
CITRO	Citizens Rescue Organisation of Curaçao
CLTOW	climb-limited take-off weight
CoPI	incident site command
CTR	control zone
CUR	Curaçao
DCANA	Directorate of Civil Aviation Netherlands Antilles.
DGH	Bonaire Healthcare and Hygiene Service
DHC-6	De Havilland Canada Twin Otter
DHC-8	Bombardier (de Havilland Canada) Dash 8
DIAT	Divi Divi Air internal audit team
DME	distance measurement equipment
DVR	Divi Divi Air (airline flight number code)
EFZ	Economic Fiscal Zone
EEW	empty equipped weight
ELT	emergency locator transmitter
EOC	emergency operations centre
ERC	island disaster coordinator
ERNA	island regulation Netherlands Antilles
ESF	emergency support functions
FAA	Federal Aviation Administration (United States of America))
feet	unit of measure for altitude (1 foot = 0.305 metres)
FIR	flight information region
FL	flight level
GPS	global positioning system
GRIP	coordinated regional incident response procedure
Hg	Mercury
hp	horse power
hPa	hectopascal; ~~calculations are based on 1 hectopascal = 3 feet~~
IAS	indicated airspeed
ICAO	International Civil Aviation Organization
ILS	instrument landing system
IMO	International Maritime Organization
inch	1 inch = 2.54 centimetres
IR	instrument rating
ISA	international standard atmosphere (ICAO)

Definition? Standard for a BN-2? Or was this introduced by the investigation committee?

measuring

is unit of measure for pressure

?? number in unit of pressure = number in unit of altitude?? At what altitude? Not a correct engineering statement. Delete.

Bad use of units. In addition, on page 73, footnote 129, 1 hPa = 27 ft!

knots	1 knot = 1.852 kilometres per hour
lb	unit of measure for English pound; 1 lb = 0.454 kilogram~~s~~
LW	landing weight
MD-11	Boeing (McDonnell Douglas) MD-11
MD-80/82	Boeing (McDonnell Douglas) MD-80/82
MEA	minimum en route altitude
MEL	multi-engine landplane [/ Min. equipment list]
MLW	maximum landing weight
MSL	mean sea level
MTOM	maximum take-off mass
MTOW	maximum take-off ~~mass~~ [weight]
MZFW	maximum zero-fuel weight
NA&A	Netherlands Antilles & Aruba
NAATC	Netherlands Antilles Air Traffic Control
Nautical mile	1 nautical mile = 1852 metre~~s~~
NDB	non-directional beacon
~~NM~~ [nm]	nautical mile [nm is a symbol, not an abbreviation. NM is New Mexico!]
NTSB	National Transportation Safety Board (United States of America)
PIC	pilot in command
QNH	atmospheric pressure ~~on the surface of the earth reduced to~~ [at mean sea level in the given region at the given instant. QNH = Q-code for Normal Height] mean sea level ~~in the ICAO standard atmosphere~~
ROV	remotely operated vehicle
RPM	revolutions per minute
RT	radio telephony
SAFA	safety assessment of foreign aircraft
SAR AREA	search and rescue area
SB	service bulletin
STINAPA	national parks foundation Bonaire
STIRANA	national foundation for disaster preparedness Netherlands Antilles
STOL	short take-off and landing
TAF	terminal aerodrome forecast
TAS	true airspeed
TOW	take-off weight
TTW	territorial waters
US gallon	United States gallon; calculations are based on 1 US gallon (3.785 litres) of fuel = ~~6~~ lb [6 lb at 30°C? 1 USGal gasoline @ 15° C = 5,87 lb) (Kerosine = 6,7 lb)]
UTC	coordinated universal time
VFR	visual flight rules
VOR	VHF (very high frequency) omnidirectional ~~range~~ [ranging]
ZFW	zero-fuel weight

1 INTRODUCTION

ICAO standard is title: Synopsis. Chapter 1 is reserved for Factual Information.

Contents does not agree with the requirements of Annex 13/ Appendix either.

1.1 Reason for this report

On 22 October 2009, a Britten-Norman Islander of the type BN-2A-26 with one pilot and nine passengers on-board made an emergency landing at sea south west of Klein Bonaire, Netherlands Antilles,[1] after the right engine failed. The nine passengers were able to exit the aircraft virtually uninjured and were picked up by nearby boats. The pilot lost consciousness upon landing. Shortly after, the aircraft sank to the bottom with the pilot still on-board. The aircraft wreckage with the pilot's body in it were recovered some time later.

There is intensive air traffic between the Netherlands Antilles Islands among themselves and Aruba to transport passengers and (small) goods daily. These air services are maintained by several medium-sized and small airlines. The involved aircraft belonged to the Divi Divi Air airline based in Curaçao. Civil aviation oversight in the Netherlands Antilles was the responsibility of the Directorate of Civil Aviation of the Ministry of Traffic and Transport.

The Netherlands Antilles government, in this case, the supervisory body, the Directorate of Civil Aviation, is primarily responsible for safety investigations into the cause(s) of the accident. The Directorate of Civil Aviation started an investigation directly after the accident. On 26 October 2009, the Directorate of Civil Aviation published a preliminary report[2] with provisional findings.

The Dutch Safety Board can investigate occurrences taking place on the Antilles at the request of the Netherlands Antilles government.[3] On 17 November 2009, the Dutch Safety Board was invited by the Netherlands Antilles government to launch an investigation.[4] The Safety Board also investigated the issues linked to the alerting and the emergency services after the accident.

1.2 The investigation

1.2.1 Objectives

The Dutch Safety Board sets great store by its reports being accessible to an audience that is as wide as possible. The present report is the result of the investigation into the occurrence carried out by the Board. The investigation has two objectives. Firstly, the Board intends to draw lessons from this occurrence to prevent repetition and to limit the consequences of similar occurrences in the future. Secondly, the purpose of the investigation is to inform stakeholders including victims, surviving relatives and involved authorities on what took place on 22 October 2009. An investigation to apportion blame or liability is expressly not a part of the Board's investigation.

1.2.2 Investigation questions

The main investigation question related to the accident is: "What are the facts of the accident and which (underlying) factors played a role in this?"
This question can be broken down into three secondary investigation questions each contributing to one or more objectives of the investigation:
1. What caused the right engine to fail?
2. Why could the aircraft not complete its flight after the right engine failed?
3. What course did the alerting and the emergency services take?

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1 At the time of the accident the Netherlands Antilles were a part of the Kingdom of the Netherlands and were composed of Curacao and Bonaire (the Leeward Islands) and Sint Maarten, Saba and Sint Eustatius (the Windward Islands).

2 The preliminary report is a provisional report that has been drawn up in accordance with the International Civil Aviation Organization (ICAO) standards. If the accident concerns an aircraft with a maximum mass of over 2250 kg, the state conducting the investigation will draw up a provisional report and sends this to ICAO and the involved member states within 30 days.

3 Dutch Safety Board Act, article 4, paragraph 1, sections b and g.

4 With a reference to the National Decree dated 13 August 2009 no. 09/0883.

When answering the investigation questions, direct causes as well as underlying causes are taken into account.

1.2.3 Demarcation and working procedure

The investigation into the cause describes and analyses the facts up to and including the alerting and the emergency supporting services after the emergency landing. See Appendix A for a description of the demarcation and the method.

The report describes the governmental situation as it was at the time of the accident on the Netherlands Antilles. At 10 October 2010 a constitutional reform took place in the Kingdom of the Netherlands. Because of this the islands Curacao and Sint Maarten[5] each became a new country within the Kingdom of the Netherlands.[6] The islands Bonaire, Saba and Sint Eustatius (now known as the Caribbean Netherlands) acquired a status as "special municipality" of the Netherlands.

Because of the constitutional reform the law and regulations changed and a number of involved organisations changed names and/or responsible ministry. These changes are described in Section 3, frame of reference, and Section 4, involved parties and their responsibilities.

1.3 Reader's guide

This report comprises seven sections. The actual facts of the incident and other relevant facts are described in Section 2. It also contains a short description of relevant concepts. Section 3 pays attention to the assessment framework. The involved parties and their responsibilities are described in Section 4. Section 5 describes the underlying factors of the incident and contains the analysis of the facts with regard to the emergency landing, the alerting, emergency services and medical assistance. The conclusions are formulated as they have ensued from the investigation in Section 6. Section 7 contains recommendations.

The International Civil Aviation Organization (ICAO) has determined guidelines and recommended practices for the investigation of accidents and serious incidents in civil aviation. These are included in Appendix 13, "Aircraft Accident and Incident Investigation" of the Chicago Convention. A report based on Appendix 13 has a fixed structure: Factual information, analysis, conclusions and recommendations. The format of Section 2, factual information, is in accordance with Appendix 13. This report uses the same format, adding two sections after the factual information section. These sections contain the assessment framework of the Dutch Safety Board and the parties involved and their responsibilities.

Is called "Annex" in ICAO docs (3x)

5 This concerns the southern, Dutch part of the island Sint Maarten. The northern part is French.
6 A status comparable to that of the island Aruba.

2 FACTUAL INFORMATION

Is Chapter 1 in ICAO format.
Why not used?

2.1 Introduction

On 17 November 2009 the Dutch Safety Board received a request from the Directorate of Civil Aviation Netherlands Antilles (DCANA) of the Ministry of Traffic and Transport of the Netherlands Antilles to investigate the accident with the Divi Divi Air Britten-Norman Islander that took place near Bonaire on 22 October 2009. The Directorate of Civil Aviation started an investigation immediately after the accident. The Dutch Safety Board started its investigation upon receiving the request from the Directorate of Civil Aviation.

This section provides the main facts that are important to discover the causes of the accident. A few relevant concepts are briefly discussed in Section 2.2. Section 2.3 discusses the course of the flight and the rescue of the passengers as well as the alerting and emergency services. The remaining factual information is provided in the sections that follow on from this one.

2.2 Relevant concepts

Definitions

Where are these definitions from? The BN-2 flight/ owners manual?

"Load and balance" sheet
Before every flight, a "load and balance" sheet is completed. The "load and balance" sheet provides the pilot with information about the take-off weight, passengers, luggage, freight, fuel distribution and centre of gravity of the aircraft. The weight is shown in pounds (lb)[7] for the aircraft in this report.

No lateral limits for BN-2? I.e. lateral fuel asymmetry. Is of importance after engine failure.

, but a lateral limit exists as well (max. fuel asymmetry).

Centre of gravity of an aircraft
The centre of gravity is the centre of mass of the aircraft. For calculations of the centre of gravity it is assumed this point is on the longitudinal axis (lengthwise) of the aircraft. For safe flight operation, the centre of gravity should be within the limits set by the manufacturer. The location of the centre of gravity is expressed in terms of the distance to a reference point (datum). This reference point is the leading edge of the mainplane for the Britten-Norman Islander. The distance to the wing leading edge is expressed in inch.[8] The location of the centre of gravity for a loaded aircraft is determined by the centre of gravity of the empty aircraft and the payload (passengers, luggage, freight and usable fuel quantity[9]).

i.a.w. a TCDS: 0.8 in. behind cambered leading edge between wing and fuselage (Sta. 134.5).

Aircraft payload
The payload of an aircraft includes the passengers and crew, (hand) luggage, freight and the load of the usable fuel quantity.

Empty Equipped Weight
The empty equipped weight[10] is the aircraft's weight without payload (without passengers, luggage, freight and usable fuel).

Maximum Zero-fuel Weight
The maximum zero-fuel weight (MZFW)[11] is the maximum allowed aircraft weight including payload but excluding usable fuel. The limiting factor for this is the strength of the aircraft construction.

structure

Maximum Take-off Weight
The maximum take-off weight (MTOW)[12] is the maximum allowed aircraft weight on take-off with the aircraft construction strength as the limiting factor.

No, not normally only weight! There is more, refer to CLTOW below. Can also be performance limited.

inch

7 One lb = 0.454 kg.
8 One lb = 2.54 cm.
9 The fuel quantity in the tanks consists of usable fuel and non-usable load. These quantities are specified in the flight manual.
10 The empty equipped weight is in this report also referred to as the Basic Weight (Annex J).
11 Maximum Zero Fuel Weight (MZFW).
12 Maximum (Structural) Take-Off Weight (MTOW).

Appendix

Is this definition presented in the BN-2 AFM? No, it's not, CLTOW is not mentioned in the graphs on pages 73, 74 below. The MTOW data graphs include limitations due to altitude and temperature, and minimum climb requirements.
In an accident investigation report, no new parameters should be introduced, except in recommendations, if the investigators conclude this to be necessary.

Maximum Landing Weight

Wrong definition under this head, replace takeoff with landing (MLW)

The maximum ~~take-off~~ weight (MTOW)[13] is the maximum allowed aircraft weight on ~~take-off~~ with the aircraft construction strength as the limiting factor.

For BN-2, MLW = MTOW (legend page 73, 74)

and other aspects as density altitude

Climb-limited Take-off Weight

~~The climb-limited take-off weight (CLTOW)[14] is the maximum take-off weight which still meets the certification requirements for climbing after take-off when one engine has failed. The climb-limited take-off weight depends on the altitude of the airport above mean sea level and the outside air temperature. This take-off weight can be read in the graph from the flight manual.[15] According to the flight manual a higher climb-limited take-off weight is possible with the restriction to operate in Visual Flight Rules (VFR) conditions and with approval of the oversight authority. See Appendix C.~~

Maximum ~~Allowed~~ Take-off Weight

at local temperature and altitude conditions.

The maximum ~~allowed~~ take-off weight of an aircraft ~~before a flight~~ is the maximum weight with which the aircraft is allowed to take off. ~~This weight can be the maximum take-off weight (MTOW) or the climb-limited take-off weight (CLTOW). The lower of these two weights must be taken into account for determining the allowed weight.~~ The legend in the graphs shows that the graph applies for both TO and Landing! With flights of short duration, the maximum landing weight (MLW) can be of influence on the determination of the maximum allowed take-off weight. This is the case when ~~the lower weight of~~ the MTOW ~~or CLTOW~~ is higher than the sum of the MLW and the ~~required~~ fuel for the flight. This is the case with flights between Curacao and Bonaire.

used (reserves do not count).

No, MTOW and MLW are the same, i.a.w. Graph in App. C. Both 6600 lb

Flap

camber of the

, when used, increases

A flap is an adjustable part on the trailing edge of a wing that ~~ensures that~~ the surface area of a wing and/or the wing ~~profile are/is changed.~~ The flaps are extended in steps and positioned downwards during the landing, which means that the wing area and the ~~curve~~ of the wing gradually become larger and larger. The lift of the wings, therefore, increases ~~and the pilot can reduce the speed.~~

takeoff and

and the drag

camber

allowing a lower airspeed

Stall warning

A stall is the situation where the airflow can no longer follow the wing profile[16] due to an increase of the angle of attack of the aircraft's wing. The wing will then lose its lift to a large extent and, therefore, the aircraft will ~~soon~~ lose altitude should the pilot not intervene. A stall warning system is used to generate the required warning approaching a stall. In the Britten-Norman Islander this warning activates the red stall light on the instrument panel and a loud ~~tone is heard.~~

horn

Is not a correct stall definition! Stall is the condition in which the increase in incidence of an airplane wing gives little or no increase in lift and may cause loss of control and/ or altitude.

What was Vso2?
(CARNA § 8.8.6.2)

2.3 Description of the events

Incomplete aircraft information in this §.

2.3.1 History of the flight and the rescue of the passengers

On 22 October the pilot concerned got up at 05.00[17] and drove towards the airport at about 05.30. After preparing the aircraft, with registration PJ-SUN, he piloted two return flights from Curaçao International Airport (hereinafter to be referred to as Hato airport) to Bonaire International Airport (hereinafter to be referred to as Flamingo airport). No problems occurred during these four flights. The departure for the next flight, "DVR014", was planned at 09.30. The nine passengers booked for this flight, who had already had their luggage weighed, had to wait before they could board because the pilot had ordered the aircraft to be refuelled prior to this flight. The refuelling invoice of flight DVR014 specifies that fuel was taken up between 09.28 and 09.38. The luggage of these passengers and some additional cargo consisting of a few boxes had already been loaded on to the aircraft. The passengers were welcomed by the pilot when they boarded. The pilot informed them they should keep their ~~waist~~ belts fastened during the flight and that the safety cards were located in the seat pockets. From the passenger statements it can be deduced that these instructions were

lap

13 Maximum ~~(Structural)~~ Landing Weight (MLW).
14 Climb-limited Take-Off Weight (CLTOW).

Not used in BN-2 manuals

15 A note with the graph states that some airports have an allowed take-off weight that is lower than the ~~climb-limited~~ take-off weight due to operational factors such as the length of the take-off runway, the obstacle clearance, etcetera. These factors do not apply to this investigation.
16 The wing angle of attack is the angle between an imaginary line between the wing leading edge and the wing aft edge with the airflow.
17 All times used in this document are local Netherlands Antilles times (UTC-4) unless specified otherwise.

trailing

? Not 3500 ft? Refer to page 64.
What was the transition altitude?

not heard by all of the passengers. The pilot and the passenger seated next to him fastened their waist and shoulder belts.

Approximately ten minutes after the estimated time of departure, after having received the required approval from the Hato Tower air traffic control tower (hereinafter to be referred to as Hato Tower) via the on-board radio the engines were started without any problems. The flight manual engine ground checks were not extensively performed because these are part of the first flight of the day engine checks in accordance with the General Operating Manual.[18] Around 09.47 the PJ-SUN took off for a flight with visual flight rules (VFR) to Bonaire. After take-off the aircraft climbed to flight level 035 (FL035).[19] Figure 1 shows the flight path of the PJ-SUN.

Figure 1: reconstruction of flight DVR014; radar echoes of the aircraft including altitude and groundspeed [sources: Coastguard NA&A and NAATC data]

Some of the passengers had flown for some years, several times in a week with Divi Divi Air. From the passenger statements it can be deduced that the pilot brought the aircraft into level flight at FL035 and reduced the power from climb power to cruise power. The passenger next to the pilot stated that engine power ceased the moment that the pilot was adjusting (one of) the levers on the throttle quadrant. Some passengers reported they felt a jolt that moment. Some passengers reported the engine sputtered shortly before it ceased. No sound from which a mechanical problem was heard and no smoke was detected. Passengers stated that the pilot increased the left engine power, feathered[20] the right propeller and trimmed away the forces to the rudder pedals due to the failure of the right engine. They also reported that the pilot attempted to restart the right engine two or three times but to no avail. Around 09.52 the pilot reported to the Hato Tower controller: *Divi 014 requesting to switch to Flamingo, priority landing with Flamingo, have lost one of the engines*. The controller acknowledged this message.

The pilot continued the flight to Bonaire flying with the left engine running and contacted Flamingo Tower air traffic control (hereinafter to be referred to as Flamingo Tower) at 09.57 and reported: *014, Islander inbound from Curaçao, showing, I got one engine out, so we are landing with one engine, no emergency at this stage, I'm maintaining altitude at, 3000 feet, we request priority to landing runway 10, currently 24 miles out, estimating at, 18*. The Flamingo Tower controller

18 Section 8.4.2, First Flight of the Day Checks, Operating Procedures, Divi Divi Air General Operating Manual, 1 June 2008.

19 The term flight level (FL) indicates the pressure altitude above a standard pressure datum of 1013.2 hectopascal. Flight levels are expressed in hundreds of feet calculating from this datum with an altitude of zero. FL035, therefore, means 3500 feet above the datum, which does not automatically mean that this is 3500 feet above ground with regard to the air pressure that dominates at that moment in time.

20 The feathering of the propeller blades is when the propeller blade pitch angle is selected in the position of the lowest drag.

MSL

ambient

exists

in that region.

authorised the approach to runway 10. The air traffic controller requested the pilot to report when he left 3000 feet altitude, which he immediately did.

The radar data shows that the PJ-SUN descended approximately 140 feet per minute on average from the moment the engine failed up to the emergency landing. According to the statements of a few of the passengers, the aircraft pitch attitude increased[21] during the descent of the aircraft and it was higher than usual. The indicated airspeed on the airspeed indicator was lower than when flying with two working engines.[22] The pilot did not inform the passengers regarding the failure of the right engine or his intentions. A few passengers were concerned and started to put on the life jackets having retrieved them from under their seats. The passenger next to the pilot could not find his life jacket,[23] while others had some trouble opening the plastic bags of the life jackets. They also agreed on a course of action for leaving the aircraft in case of an emergency landing in the water.

At 10.08 the pilot informed the Flamingo Tower that he was approaching and was ten nautical miles away, flying at 1000 feet and expected to land in ten minutes. At 10.12 the pilot reported the distance to be eight nautical miles and that he was having trouble with the altitude which was 600 feet at that moment. The traffic controller authorised the landing. At 10.14 the pilot reported to be six nautical miles away and flying at an altitude of 300 feet. During the last radio contact at 10.15 the pilot indicated to be at five nautical miles distance flying at 200 feet and that he was still losing altitude. The pilot was going to perform an emergency landing near Klein Bonaire. The aircraft subsequently turned a little to the left towards Klein Bonaire. According to a few passengers, the pilot turned around towards them and indicated with hand signals that the aircraft was about to land and he gave a thumbs-up signal to ask whether everyone was ready for the approaching emergency landing.

There were life jackets for all people on-board. The pilot, the passenger seated next to him and two passengers seated in the back row did not have their life jackets on. The passengers in rows two through to four had put on their life jackets. One passenger had put on his life jacket back to front.

According to the statements of the passengers, the stall warning (loud tone) was activated on and off during this last part of the flight. A short time before the emergency landing until the moment of impact with the water the stall warning was continuously audible. From the statements of the passengers it follows the all cabin doors were closed throughout the descent and the landing.

The passenger' statements differ in describing the last part of the flight until the impact of the aircraft with the water surface. One passenger stated that the aircraft fell down from a low height and impacted the water with a blow. Other passengers mentioned a high or low aircraft pitch attitude during impact. Most of the passengers stated that during impact the left wing was slightly down. The aircraft hit the water at 10.17 at a distance of approximately 0.7 nautical miles[24] from Klein Bonaire and 3.5 nautical miles west of Bonaire. The left front door broke off from the cabin and other parts of the aircraft on impact.

The aircraft was lying horizontally in the water. The height of the waves was estimated 0.5 metre by one of the passengers. The cabin soon filled with water because the left front door had broken off and the windscreen had shattered. The passenger behind the pilot was trapped, but was able to free herself from this position. All nine passengers were able to leave the aircraft without assistance using the left front door opening and the emergency exits.
A few passengers sat for a short time on the wings before the aircraft sank. The passengers formed a circle in the water. The passengers who were not wearing life jackets kept afloat by holding onto the other passengers.
One passenger reported that the pilot hit his head on the vertical door/window frame in the cockpit or the instrument panel at impact causing him to lose consciousness and may even have been

21 The nose position of the aircraft in relation to the horizon.
22 The statements of the passenger seated to the right of the pilot and that of the passenger seated behind to the right of the pilot indicated that the flight speed was between 80 to 65 knots during the descent and lower than 70 to 65 knots during the last part of the flight (1 knot = 1,852 km per hour).
23 He stated that he hand signalled this to the pilot. The investigation has shown that the life jackets in the pouches were under the first row seats. See Section 2.17.3.
24 One nautical mile = 1.852 metres.

wounded. The attempts of one or two passengers to free the pilot from his seat were unsuccessful. A few minutes after the accident, the aircraft sank with the pilot still on-board.

Approximately five minutes after the emergency landing, two boats with recreational divers who were nearby arrived on the scene. Divers from the first boat tried to localise the sunken aircraft based on indications from the passengers. The people on the other boat took nine passengers out of the water and set course to Kralendijk where they arrived at approximately 10.37. The police and other emergency services personnel were awaiting the passengers on the quay. Six passengers were transported to the hospital where they were discharged after an examination. The other three went their own way.

2.3.2 The alerting and the emergency supporting services

The actions undertaken by the various parties to assist the passengers are described below based on the statements of various involved parties.

Air traffic control

The pilot called Flamingo Tower at 09.57. He reported that one of his engines had failed and that he was planning to land with one working engine. The air traffic controller warned the fire service, the area control centre in Curaçao, the Flamingo Tower supervisor and the duty airside officer. When it became clear that the aircraft was going to carry out an emergency landing at sea, the air traffic controller informed the aforementioned organisations of this. After the aircraft had landed on the water, the air traffic controller informed the police.

Airport

When the duty airside officer received the information of the planned landing with one engine of DVR014 he notified the manager airport operations at approximately 09.59. In accordance with the airport crisis response plan the involved personnel were informed and were called to go to the emergency operations centre (EOC). The EOC was activated at 10.01. When the aircraft had made an emergency landing at sea, the manager airport operations immediately called for an airport crisis team meeting. Subsequently, the Directorate of Civil Aviation was notified of the events. They requested to assist two of their inspectors, who were preparing for travel to Bonaire. One inspector arrived shortly thereafter in the EOC as he was already on the island. Next, the director of Flamingo airport was fully briefed on the events. Thereafter, the director left to attend the (island) crisis staff meeting. The airport requested Divi Divi Air to deliver, amongst others, the general declaration[25] form and the load and balance sheet. Some Divi Divi Air staff joined the EOC and handed over copies of the requested information. Subsequently this information was handed over to the inspector of the Directorate of Civil Aviation.

Fire service

The air traffic controller informed the airport fire service[26] at approximately 10.05 about the flight DVR014 problems. The twelve firemen, the staff on duty at the time, used the available vehicles (three crash tenders and two fire engines) to drive to the runway. Around 10.08 the vehicles were in position. The air traffic controller reported around 10.15 that the aircraft was about to land. A few minutes later the air traffic controller informed the fire service that the aircraft had landed to the south west of Klein Bonaire. The number of occupants was not yet known. The fire service commander, after hearing about the emergency landing, drove the fire service car to the port and, with the police officer on duty, took a pilot service boat to the accident site. When at sea, they passed alongside the boat that picked up the passengers. They stopped for a moment to count the passengers. There were nine passengers on the boat. The passengers indicated that the pilot was still missing. The fire service commander subsequently continued to the accident site. One of the divers there informed him that the aircraft was already too deep to reach. The deputy fire service commander, who was also on duty on that moment,[27] together with a number of fire service men on duty went to the harbour to return a little while later because they could not provide assistance.

25 In the general declaration document, which is necessary for international flights, the names of the crew and the passengers, the aircraft registration number, and the itinerary were given.

26 The fire service of Bonaire is also the airport fire service. The main fire service station is on the airport site.

27 The fire service have a duty roster for the officer on duty in which the fire service commander and the deputy fire service commander are alternately on duty.

After the fire service commander received an invitation by mobile phone to join the crisis staff, he sailed back to the harbour. The fire service commander subsequently went back to the port. No incident site command (CoPI) was established.

The police
The central police post was informed by both the fire service commander and the air traffic controller at approximately 10.18 that a Divi Divi Air aircraft had landed at sea. The central reporting centre subsequently informed various police officers as well as the Netherlands Antilles and Aruba Coastguard and the National Parks Foundation (STINAPA) that manages the area. As indicated above, the police officer on duty went to the port immediately after being informed and went to the accident site with the fire service commander. At 10.25 one of the boats with recreational divers near the accident site reported by telephone to the police station that they were on their way to the site. A telephone call with Divi Divi Air informed the police, at 10.27, that there were nine passengers on-board the aircraft. The police decided to deviate traffic to ensure the road to the pier was free for the ambulances. This measure did not have the desired result: ambulances could not reach the pier easily due to the many people who had gathered. At 10.56 the police received a list of the names of the passengers from Divi Divi Air. Mobile phones were used instead of the available two-way radio. The mobile communication network became overloaded, which meant that the required exchange of information among the emergency services did not take place.

Hospital and Healthcare & Hygiene Service
The head of Healthcare and Hygiene Service (DGH) was informed by telephone regarding the accident at about 10.25 by a pilot who was in the air ambulance aircraft stationed at Hato airport. This pilot had heard rumours about a crashed aircraft. The acting governor at Bonaire called the head of the DGH a few minutes later reporting that a Divi Divi Air aircraft had crashed near Klein Bonaire. He requested the head of the DGH to come to the (Bonaire) executive board. The head of the DGH, next, informed the hospital about the accident. The ambulance on standby was sent to the Kralendijk pier by the hospital. A second ambulance was asked to be on standby. The first ambulance at first drove towards the Flamingo airport because it was not clear where it should be heading. After a few attempts to contact the hospital using a mobile phone, the two-way radio in the ambulance was used to contact the police. The police told the ambulance to go to the pier. When they arrived at the pier, there was a large crowd watching and the ambulance had trouble getting to the pier. The second ambulance arrived at the pier a few minutes later, with an anaesthetist on-board. The boat with the rescued passengers arrived a little later. The ambulance crew examined the passengers briefly.

Six passengers were transported to the hospital by the two ambulances. The hospital had already made the necessary preparations for the arrival of the casualties. Approximately thirty beds were made available, including six for special care. A few passengers left the pier by their own means. Six passengers were examined at the hospital. The arrival of outsiders at the hospital entrance that also attempted to enter the hospital led to jostling and disorder. A single passenger was found to have light injuries. After a medical examination which took 45 minutes, the victim support of both the police and the DGH took care of the passengers.

Netherlands Antilles & Aruba Coastguard
The Curaçao Coastguard Centre, located at the naval base Parera on Curaçao, that is also the regional “Rescue Coordination Centre” received a report at 10.19 that a Divi Divi Air aircraft had landed at sea near Klein Bonaire. This report was received from both the central police station on Bonaire and the area control centre on Curaçao. An emergency locator transmitter (ELT) message was also received from the United States of America nautical coordination centre in Puerto Rico, which monitors the Caribbean. The message originated from the ELT on-board the PJ-SUN.

At 10.19 a Royal Netherlands Navy helicopter that was performing a training flight reported on the radio to Flamingo Tower. The navy helicopter flew to the site of the emergency landing upon the request of the air traffic controller. The navy helicopter reported the location of the aircraft in the water to the Coastguard Centre.

The Coastguard Centre subsequently requested that units including a Panther Coastguard patrol vessel, a rescue vessel of the Citizen Rescue Organisation Curaçao (CITRO) and a Coastguard helicopter would go to the location to provide assistance. The Coastguard helicopter also took a liaison officer to liaison between the Coastguard and the local authorities.

At 11.03 the Coastguard Centre was aware that all nine passengers had been rescued and only the pilot was missing. The HNLMS Pelikaan support vessel of the Royal Netherlands Navy that was performing diving operations to the south of Curaçao was sent to the location of the emergency landing to localise the aircraft and to attempt to recover the body of the pilot. The search and rescue operation was stopped at 12.15. Some vessels stayed at the scene. The aircraft not be localised with the available equipment.[28] By the end of the afternoon, the units withdrew after marking the location of the occurrence with a buoy.

Bonaire Island council, executive board and governor
The police commissioner notified the governor of Bonaire, who is charged with overall command when responding to disasters or major accidents, at approximately 10.30. He immediately went to the executive board location. On the way he was called by the director of Flamingo airport who informed him that the aircraft that had crashed near Klein Bonaire was a Divi Divi Air aircraft carrying passengers.

Upon arrival at the executive board the commander decided to convene a meeting of the crisis staff consisting of consultants appointed by him and representatives of the executing services. The governor was in contact with the Coastguard at 10.49 for the first time. The Coastguard specified it was aware of the accident and that emergency services boats were being sent. The governor, next, informed the prime minister of the Netherlands Antilles. The first meeting of the crisis staff was held at 11.00 and included representatives of the Police department, Flamingo airport and the DGH. The fire service commander who is charged with the operational leadership according to the crisis plan was not present because he was on his way to the accident site. The ESF (emergency support functions) groups to be deployed according to the crisis plan were determined during the meeting. The most important issues were the identification of the aircraft, retrieving information on the number of passengers and the preparations for the reception of passengers. The crisis staff was concerned in view of the registration and aftercare of the casualties since some of the passengers had gone home after they had been taken to the quay. The meeting was adjourned around noon. A second meeting was held at approximately 13.30. This meeting included a representative of the Directorate of Civil Aviation who explained how to perform an accident investigation. A liaison officer, who had been sent by the Netherlands Antilles and Aruba Coastguard by helicopter to Bonaire, was also present at the crisis staff meeting.

2.4 Personal injury

The accident resulted in the death of the pilot and four[29] of the nine passengers were slightly injured. The passengers seated in the first three of the five rows were more injured than the others. These injuries varied per passenger and included injuries to the face, bruised ribs and bruises. The table below classifies the victims according to the definitions applied by ICAO.

Injury	*Cockpit crew*	*Passengers*	*Total*
Fatal	1	0	1
Serious	0	0	0
Minor	0	4	4
None	0	5	5
Total	1	9	10

Table 1: injury to passengers

28 The aircraft wreckage was at a depth of 190 meters, outside the range of the sonar equipment of the HNLMS Pelikaan.
29 The hospital uses different standards for the classification of injuries than the International Civil Aviation Organization (ICAO). A single passenger was slightly injured according to the hospital standards.

2.5 Damage to the aircraft

The aircraft suffered extensive damage as a result of the impact with the water. During the impact, the left front door and the left main landing gear broke off from the aircraft and the left propeller shattered. These parts were found floating in the water. The nose and cockpit section of the aircraft were seriously deformed. The aircraft was salvaged on 18 December 2009. The aircraft sustained damage to both wings and to the flap drive mechanism. The damage did not affect the investigation.

Figure 2: PJ-SUN after it was salvaged

2.6 Other damage

The emergency landing caused the aircraft to end up in seawater where it sank to the seabed. The seabed at the location where the accident occurred is 190 m deep and the immediate surroundings consist exclusively of sand. There are no indications that the environment suffered as a consequence.

2.7 Pilot information

English nationality, 32, employed by Divi Divi Air since September 2009 and flew the Britten-Norman Islander (BN-2). Before that he was employed as from 2007 by Solomon Airlines on the Solomon Islands as co-pilot on the DHC-6 Twin Otter and by Winair in Sint Maarten where he flew the DHC-6 Twin Otter as co-pilot and the BN-2 Islander as captain. He was trained in, among others, Australia.

Certificate of competence	***: Antillean pilot licence B3[30] - Fixed wing and American ATPL.[31]***
Ratings	: BN-2, MEL, IR, RT.[32]
Britten-Norman Islander type rating	: 23 October 2008, valid until 1 November 2009.
Route check	: 27 August 2009.
Medical certificate	: B3, 27 October 2008, 1-year validity and FAA[33] first class.
Flying experience	: Total of 1738.9 hours. : Total of 1536.5 hours multi-engine (land)plane. : Total of 565 hours BN-2.

30 Commercial Pilot Licence Netherlands Antilles.
31 Airline Transport Pilot Licence.
32 Ratings: Britten-Norman Islander, multi-engine landplane, instrument flying, radio telephony.
33 Federal Aviation Administration (FAA) of the United States of America.

2.8 Aircraft information

stiffeners
(ref.: TCDS and SB)

The PJ-SUN, a Britten-Norman Islander, is a two-engine propeller aircraft (high-wing) with two 260 hp piston engines. The landing gear cannot be retracted. The aircraft was built in 1973 as type BN-2A-8 with serial number 377. Before the PJ-SUN was used by Divi Divi Air, it flew in various countries and for various airlines. During maintenance activities by a certified Canadian maintenance company in 2006, it emerged that the PJ-SUN was equipped with ~~extra reinforcements~~ to the fire walls near the engines by which the aircraft complied with the certification requirements of a BN-2A-26.[34] Upon inquiry with the aircraft's manufacturer, it emerged that these reinforcements were implemented when it was built. The aircraft has a large luggage compartment and compartment door.

Until the accident flight, the PJ-SUN had flown 16,670 hours. The certificate of airworthiness was valid until 31 July 2010. The PJ-SUN has been added to the Divi Divi Air fleet in May 2002.

Figure 3: archive photo of PJ-SUN

Is this RPM limit a fixed limit, i.e. can the pilot no longer set 2700 RPM?
2700 RPM is used on page 35 and in Appendix M in this report!

Were MTOW, Vmca and enroute climb/ performance data in the AFM valid for these propellers and the reduced RPM?

Was this change authorized in a TCDS? Was the Owners Manual amended for performance and min. control speeds?

HP? at RPM? 260 HP at 2700 RPM?

The engines of the PJ-SUN were of the Lycoming make, O-540-E4C5. The last complete overhaul of both engines was performed by the engines' manufacturer. The number of operating hours after the overhaul before the accident flight was 1311 hours for the left engine and 214 hours for the right engine. Both engines were originally equipped with two-bladed propellers, which were later replaced by four-bladed propellers for noise restrictions.[35] These four-bladed propellers did not limit the engine performance. The maximum continuous revolutions per minute was decreased from 2700 to 2500 RPM for noise restrictions. for what operations? Over land? Not emergency!

alter?

The left and right flap are operated by one wing situated electric actuator connected with push-pull drive rods. The actuator is operated with the flap actuator spring-centre control switch that is mounted on the pilot's console. The flaps can be set in three positions: up, take-off and down. The flap position indicator (pointer) is mounted on the left side of the roof instrument panel.

overhead?

The aircraft was equipped with a passenger address system.

The maintenance documents of the aircraft from before the accident did not specify any defects or technical complaints that still needed to be resolved.

harnesses

The Britten-Norman ~~Islander's cabin~~ has a total of ten seats, including the pilot's seat (front left).[36] There were five rows of two seats one behind the other. The first row of seats had ~~waist~~ and shoulder ~~belts~~. The other four rows of seats ~~had waist belts~~. The aircraft has three doors. A front left door for the pilot and the passenger next to him, a centre right door for passengers in rows two and three and a back left door for passengers in rows four and five. The windows in the doors are the emergency exits. The luggage of the passengers and additional freight is loaded ~~on to the~~

lap

34 Type Certificate Data Sheet A-92, Issue no. 8, 8 December 1998, Transport Canada. Not found
35 The propellers are made of wood and manufactured by MT-Propeller Entwicklung GmbH.
36 The aircraft is equipped with two control columns. One for the pilot in the front left seat and one for the co-pilot or instructor in the front right seat.

(or passenger)

were equipped with lap belts only

secures luggage and cargo in place.
(not only to prevent forward displacement!)

aircraft using the luggage door in the aft section of the cabin. A freight net[37] prevents the luggage and freight from moving towards the forward section of the cabin.

The load and balance sheet for flight DVR014 specified a take-off weight of 6600 lb and the centre of gravity was within the authorised limits. An average weight of 160 lb (including hand luggage) was applied for the pilot and the passengers. The table below indicates the weights as specified on the load and balance sheet.

The EEW does not comply with the most recent weighing report (App. J)

	Weight specified on in the "load and balance" sheet [lb]
Empty Equipped Weight	4367
Pilot/passenger 1	320
Passengers 2/3	320
Passengers 4/5	320
Passengers 6/7	320
Passengers 8/9	160
Luggage	93
Fuel load	700
Take-off weight (TOW)	6600

Table 2: overview of weights as specified on the load and balance sheet for flight DVR014

The load and balance sheet for flight DVR014 is included in Appendix D.

The most recent weight and balance (weighing) report in Appendix J. (page 99)

Substantial deviations were determined during the investigation between the specified and the actual weights. These deviations are further elaborated in the analysis in Section 5.

Is this also i.a.w. the type certificate (data sheet)?

According to the flight manual, the following maximum weights were applicable to the PJ-SUN:
Maximum Take-off Weight (MTOW) : 6600 lb.
Maximum Landing Weight (MLW) : 6300 lb.
Maximum Zero-Fuel Weight (MZFW) : 6300 lb.
Climb limited Take-off Weight (CLTOW) : 6250 6600 lb.[38]

Equal to MTOW (Graph in App. C sup 22 for BN-2A-26)

Even lower at high alt. and/or temp.

Does the AFM define a CLTOW?

What kind of fuel?

The total fuel tank capacity is 137 US gallon (822 lb). 7 US gallons (42 lb) of this is non-usable fuel and cannot be used for flight planning.

804 lb (5.87lb/USGal)

41 lb

The allowable range for the centre of gravity of the aircraft is between 21.0 and 25.6 inches measured from the point of reference.

datum.

at weight 6600 lb (App L)

Appendix J

Missing data in this paragraph: Vto, Vland, Vs, Vso2, Vmca, Vyse, Vxse, OEI ceiling, etc.

2.9 Meteorological data

A weather report of the Meteorological Department of the Netherlands Antilles and Aruba indicated that there were some clouds at an altitude of 700 feet at the time of the accident. There was 40 km visibility range.

Current data on the ground measured at 10.00:

local time? If so, add "all times are local times".

Wind direction : 093 degrees.
Average wind speed : 11 knots.
Air temperature : 31 degrees Celsius.

maximum (i.a.w. flight manual, app. C)

QNH?

37 The PJ-SUN was equipped with a canvas for this purpose.
38 Assuming an outside air temperature of 31 degrees Celsius, an air pressure of 1010 hectopascal, and an airport elevation (Hato airport) of 29 feet at the time of the accident, the climb limited take-off weight is 6250 lb. When approval of the supervisory body is given to use supplement 22 of the flight manual this take-off weight is 6600 lb. See Annex A.

This is analysis, not facts.

An "assumed" OAT means something else in aviation.

Was this the case? Is not in appendix A!

QNH

The estimated upper wind direction, speed and temperature that applied from 07.00 to 19.00:

Altitude [feet]	*Direction and speed [degrees/knots]*	*Temperature [degrees Celsius]*
500	090/15	29
1000	100/20	27
2000	100/20	25
3000	120/20	22
FL050[39]	130/15	19

Table 3: upper wind data [source: Meteorological Department of the Netherlands Antilles and Aruba]

2.10 Navigation tools

Usually listed as VOR/DME

The navaids at Hato airport are an ILS,[40] DME[41] and a VOR.[42] Flamingo airport has an NDB.[43]

According to Hato airport the DME was out of service from 18 August 2009 until the end of 2009. The ILS/DME combination was out of service from 20-23 October 2009.

ILS/DME? Does that exist? Do you mean VOR/DME? Was it operative on 24 Oct.?

The on-board radios of the PJ-SUN were set to the frequencies of the aerodrome air traffic control services at Hato airport (Hato Tower) and Flamingo airport (Flamingo Tower). The on-board navigation equipment was set to the Hato airport ILS, DME and VOR.

The PJ-SUN was equipped with a GPS navigation system. The navigation system is able to provide the actual position of the aircraft with the distance from the airport and the estimated time of arrival.

2.11 Communication

During the flight, the pilot had radio contact with Hato Tower and Flamingo Tower. Recordings of the conversations between the pilot and air traffic control were available for the investigation. The Hato Tower transcript had a non-constant time difference between the recorded time and the actual time. This seemed to be a persistent problem of several years and it could not be fixed for the purpose of this investigation.[44] Only a transcript of the conversations between the pilot and Flamingo Tower have, therefore, been included in Appendix E.

The air pressure (QNH) used by the air traffic control at Hato Tower at the time of flight DVR014 was 1010 hectopascal or 29.83 inch Hg.[45]

2.12 Airport information

2.12.1 Hato airport at Curacao

elevation is

Hato airport is used for civil and military air traffic. The airport has one terminal for passenger handling. The airport is located at 29 feet above mean sea level.
Hato has one take-off and landing runway (11/29). The runway length is 3410 meters.

the (local) transition altitude, flight levels (FL) are used.

39 When the altitude is higher than ~~a specific value the term Flight Level (FL) is used~~. Flight level 50 ~~indicates an altitude of approximately 5000 feet~~.

means an altitude of exact 5000 ft above the 1013.2 hPa pressure level (set in the Kollsman window of the altimeter).

40 Instrument landing system.
41 Distance measuring equipment.
42 VHF Omnidirectional ~~Range~~. Ranging
43 Non-directional beacon.
44 Conversations are stored on various "audio tracks".
45 The ~~outside~~ air pressure is indicated in hectopascal or inch Mercury (Hg) units.

? is also inside air pressure (in Tower and BN-2)...: meant is: atmospheric elevation is

2.12.2 Flamingo airport at Bonaire

Flamingo airport ~~is used for civil air traffic. The airport~~ has one terminal for passenger handling. The airport is located at 19 feet above mean sea level.
Flamingo has one take-off and landing runway (10/28). The runway length is 2880 m.

2.13 Flight recorders

The aircraft was not equipped with a cockpit voice recorder[46] or flight data recorder.[47] There is no obligation to have this for this type of aircraft.

2.14 Aircraft wreckage information

upright

The aircraft wreckage was in a horizontal position on the seabed. The front left door and the back left door were missing. The centre right door was opened. See figure 4.

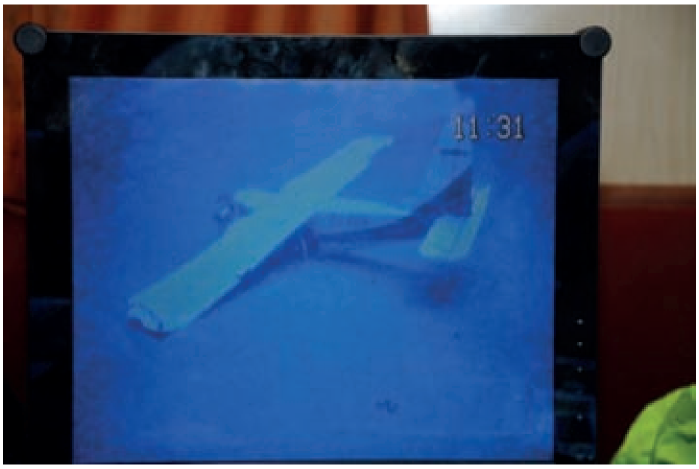

Figure 4: monitor with an image of the PJ-SUN on the seabed

The aircraft wreckage was investigated after it was salvaged. The following was found during the technical investigation: the left main landing gear and wheel was broken off, the left propeller was splintered and the underside of the left engine cowling was damaged. The right propeller was intact and feathered. The nose wheel landing gear was bent backwards and upwards. The aircraft nose and cockpit section and the left wing tip were depressed and twisted upwards. The upper side of the cockpit instrument panel was against the roof. The control column at the pilot's side was broken off. The control column at the passenger's side was slightly bent to the left. See Figures 5 and 6.

The windshield was shattered. The fuselage skin at the underside of the aircraft along the length of the cabin was dented between the stiffeners. The cabin floor was twisted upwards at the aft door frame of each of the three doors. From the front left door, which was found directly after the accident, as from the door centre right the door handle was in the locked position. The locking pin from the locking mechanism from both doors was clearly visible and was intact. The front left door hinges showed signs of overstress fractures. The windows from both doors were missing. Various locations of the aircraft, among others the horizontal empennage and the left wing has various deformations of the supporting strcuture and fuselage plate. The tailcone as broken off. The flaps were in the upward position.

both the left and right panes?

46 The cockpit voice recorder stores conversations and background noises in the cockpit.
47 The flight data recorder stores the flight parameters.


Figures 5 and 6: side view of the deformation of the aircraft nose and cockpit (seats removed) Left: damage to aircraft nose, cockpit floor twisted upwards. Right: instrument panel against the roof.

The instrument indications and the position of the switches in the cockpit could have been changed by the impact with the water. The positions after the salvage, therefore, do not provide reliable information on the indications and positions during the emergency landing.

All parts of the aircraft were found at the location of the emergency landing except the left back door. This door was lost during the evacuation of the aircraft. There are no indications that parts had broken off during the flight.

2.15 Medical and pathologic information

The pilot returned to Curaçao on 20 October 2009 from the United States of America. He spent 21 October, the day before the accident, at home with his girlfriend relaxing and doing some household chores. He had a slight cold but was otherwise fit and healthy and he slept well the night before the accident. There are no indications that the pilot had not sufficiently rested before the flight. Nor are there any indications that show that the pilot was receiving medical treatment or used medication which could influence his flying skills.

The body of the pilot was exposed to the sea for approximately two months. The body was found in the aircraft on the left cockpit seat. The waist and shoulder belt of the pilot were still fastened.

A British aviation pathologist performed an autopsy. Physical abnormalities were not found during the autopsy that may have had an influence on the accident occurring. The toxicological research did not provide any indication that could have negatively influenced the functioning of the pilot during the accident. The autopsy of the pilot demonstrated that the left side of his skull was bruised at two locations where bleeding may have ensued. These findings match the passengers' statements that the pilot hit his head during the emergency landing at sea. These wounds would not as such have caused his death. These wounds were such that the pilot probably hit his head and became unconscious. Based on the passengers' statements and the relatively light injuries, it can be stated that the emergency landing was survivable. The lack of a direct cause of death caused by the impact with the water makes it probable that the pilot drowned when the aircraft sank.

2.16 Fire

There are no indications of fire during the flight.

2.17 Survival aspects

The bruises sustained by the pilot's head during the emergency landing, the backward inclination of the pilot's seat which caused the passenger behind him to be trapped as well as the problems regarding the life jackets indicated by the passengers were reason for an investigation on the survival aspects. The room to move, the waist and shoulder belts and the seat structure of the front row seats, the life jackets and the safety instruction cards were investigated.

2.17.1 Room to move from the cockpit seat

The pilot was seated on the left cockpit seat. The room to move for a person of standard build seated in this seat is limited. The room to move was limited on the left side due to the left front door with a plastic air ventilation duct above. The left front side was bordered by the vertical window and door frame. At the front side it was limited by the instrument panel and the (left) control column and at the front right side by the engine control levers. See figure 7.

Figure 7: cockpit space of a comparable Britten-Norman Islander viewed from the second row

Lap belt (+ search & replace elsewhere)

2.17.2 Waist and shoulder belt

The waist and shoulder belts (three-point seat belt) of the front row seats were investigated. The shoulder belts are inertia reel seat belts. Nothing extraordinary was found when investigating the seat belts.

harness

2.17.3 Front row seats

The seats have a metal structure. The backrest has a hinged connection to the frame at the bottom. The seat and rest are covered with padding. The seats and the frame were not deformed. The unused life jackets were in the stowage pouch under both front row seats. By pulling the tab of the press-stud the stowage pouch opens and the life jacket can be taken from it.

Figures 8 and 9: front and side view of the front row seats with the unused life jackets still in the stowage pouch

2.17.4 Life jackets

The life jackets on-board Divi Divi Air Britten-Norman Islander aircraft are of the Eastern Aero Marine type, model 35, and are located in a stowage pouch. This was also the case in the PJ-SUN. The plastic pouch has a tear-off cord on one side. The passengers stated they had trouble opening the life jacket pouches. This may have been caused by attempting to open the wrong end or the side of the package.

The life jackets have two inflatable pockets, each with its own gas cartridge and inflation valve. It also includes a valve to be used to inflate it by mouth. The life jacket is pulled over the head and the single waist-strap is fastened using the plastic fastener. The belt can be pulled tight with a single pull.

One passenger stated that he had donned his life jacket back to front and had inflated it. A reconstruction demonstrated that the life jacket can be donned back to front without difficulty. It is, however, difficult to fasten the waist-strap at the back. Inflating the life jacket is also difficult because the handles to open the gas cartridges are then located at the back. A back-to-front inflated life jacket proved to be very uncomfortable. It would not stabilise the wearer in the water and breathing would be restricted.

2.17.5 Safety instruction cards

The safety instruction cards are located in the pocket at the back of every seat rest and to the left and right of the seats for the front row. The emergency exits are illustrated on one side of the card. The corresponding text is small and difficult to read and the description to open the pilot's door (left front door) and the emergency window (window to be used as an emergency exit) is complicated. The back of the safety instruction card provides instructions on the use of the seat belts and the life jacket and for the "brace" position.[48] See Appendix F.

48 There are various "brace" or "crash" positions for the passengers. Every country has developed its own position that is based on research performed by their national aviation authority. The general "brace" position for seats equipped with a waist belt where the passenger is seated facing forwards is as follows:
- Put the hands on or as close as possible to the surface that is most likely to be hit upon collision (for example, the bulkhead or seat in front).
- Lean over to some degree to avoid jackknifing or submarining.
- Place the feet flat on the floor.

Is this copied out of the BN-2 procedures? Facts?

The stowage pouch under the seat and the actions required to open it were not included on the safety instruction card. The life jacket on the card has two waist-straps, but the life jackets on-board have only one waist-strap. The back of the life jacket on the card did not match the actual life jackets on-board.

2.17.6 Random check
A random check of two other Divi Divi Air Britten-Norman Islander aircraft, of which one aircraft was in the hangar for maintenance, demonstrated that another type of stowage pouch was also used for the life jacket under the seats (under seats three and four, respectively, of the ten seats). This type of pouch used Velcro for the opening. This pouch was opened by pulling the red strap attached to the tab of the pouch. In some cases, however, the red strap had been pushed into the pouch making it inaccessible. In these cases it was difficult to open the pouch and it was not easy to determine how to open it. See figure 10.

Figure 10: removed seats and stowage pouch with an accessible red pulling strap (left) and with an inaccessible pulling strap (right)

2.18 Tests and further investigations

This section refers to the partial investigations for the engine investigation, the Divi Divi Air refuelling policy and the training of Divi Divi Air pilots.

2.18.1 Engine investigation
The engine investigation was performed at the Lycoming engine factory. See Section 5.2 for the results of this investigation and the analysis thereof.

The aircraft was on the seabed with flaps up. When the aircraft wreckage was hoisted, the hoisting straps around each wing had cut through the flap drive rods. The result was that the flaps of both wings were no longer connected to each other and could move independently from each other. The position of the flaps after the recovery was, consequently, not an indication of the position of the flaps during the emergency landing. It also emerged that the electrical flap motor was no longer connected to the drive unit. It could not be determined whether this was the result of the impact with the water or the recovery work. The flaps did not show any external damage or deformation as a result of the impact and, therefore, it is not probable that the flaps were down during the emergency landing and retracted due to the impact with the water. The retraction of the flaps after the impact by the flap motor due to a short circuit is not deemed probable.

2.18.2 Loading of the aircraft
Three people are involved regarding the loading of the aircraft, that is, someone at the check-in desk, a loader on the platform, and the pilot at the aircraft. These three people but also the Divi Divi Air employees at the office are linked to each other through a wireless communication system (trunking).[49] At least fifteen minutes before the flight but also often earlier, passengers and cargo can no longer be checked in. The employee at the check-in desk has a form with passenger names and the weight of their (weighed) luggage. Offered cargo is weighed and the weight is specified on the package using a felt-tip pen. The loader will be told by the check-in desk employee how many

49 This is a type of handheld transceiver system where everybody from the group can listen in.

adults, children and babies must be allowed on-board and the number of items and the weight of passenger luggage. Next, the cargo is placed on a trolley and taken to the aircraft. Passenger luggage has priority over cargo and, in principle, will always go with the passengers (an exception is when a passenger has multiple heavy suitcases; then he or she must choose which should be taken with the next flight). The pilot fills in the load and balance sheet at the aircraft. In addition to the passengers and their luggage, the pilot may decide to take cargo from the trolley when the weight and volume allow this. Cargo will, therefore, not be accepted for a specific flight. After 15.00 and sometimes before, cargo is no longer accepted when the probability is small that it will be transported on that very same day. Cargo that remains behind after the last flight will be stored for the following day or will be returned to the sender.

2.18.3 Refuelling policy

Depending on the day of the week, the Divi Divi Air flight schedule includes up to sixteen (separate) flights a day between Curaçao and Bonaire. It is noted that the Britten-Norman Islander fuel type is not available in Bonaire. Divi Divi Air, therefore, arranged the filling of the fuel tanks required for the daily operation of the Britten-Norman Islander aircraft as follows. The fuel tanks during the first flight were not full. This was because of the weight, since the freight of the first flight of the day included newspapers. With the following flights the fuel quantity to be taken depended on the expected number of passengers and baggage. Several pilots stated that to save (refuelling) time fuel was uplifted regularly for several flights together. A full tank of fuel was sufficient for three return flights Curaçao - Bonaire.

The fuel supplier reported that prior to the accident Divi Divi Air Britten-Norman Islander aircraft were completely refuelled regularly. After the accident filling the tanks completely occurred less often.

2.18.4 Pilot training

The Divi Divi Air pilots participate in a theoretical training course (ground training) and a practical training course on the Britten-Norman Islander when they are not qualified to fly with the aircraft. The practical training course is given on the aircraft. The practical training is split into type qualification and route training. (Semi) annual[50] proficiency checks are also performed to check the competence of the pilots.

Pilots are made to familiarise themselves with the subjects contained in the flight manual during theoretical training. Interviewed pilots stated that the use and determination of the climb-limited take-off weight and the maximum structural landing weight were not a part of this training. Neither were the applicable CARNA performance requirements checked or discussed. The pilots had not themselves studied the climb-limited take-off weight and the maximum structural landing weight in the flight manual either. The maximum take-off weight of 6600 lb was the only limit weight applied with regard to a flight.

because the BN-2 manuals don't use this...

In accordance to Divi Divi Air, the theoretical training for Divi Divi Air pilots has been provided by different instructors and with the endorsement of the Directorate of Civil Aviation. Divi Divi Air has stated that these instructors must at least have a commercial pilot licence and some also had a flight instructor licence. According to Divi Divi Air these instructors had at least 500 hours of flying experience with the Britten-Norman Islander.

The flight training for the type qualification consists of procedures relating to flying with one failed engine and performing an emergency landing with one engine inoperative. It is generally not usual to use a flight simulator for this type of relatively small transport aircraft with regard to practical training.

There is no separate procedure for a landing on water (also referred to as ditching) in the flight manual of the Britten-Norman Islander. The procedures for a landing with one engine inoperative can be found in the section emergency procedures of the flight manual. Instructions for ditching can be found in the Divi Divi Air General Operating Manual. The emergency procedures of Divi

50 Pilots under the age of 40 take the proficiency check once a year. Pilots over the age of 40 take the proficiency check every six months.

Divi Air state that the pilot must select the flaps completely down for the landing with one engine inoperative. Training in this is also provided.

The type qualification examination with a Britten-Norman Islander takes place in the presence of an operational inspector from the Directorate of Civil Aviation in a seat in the second row and by the examiner type appointed by the Directorate of Civil Aviation in the seat next to the pilot. The appointed examiner type can be the (certified) chief pilot or another examiner. The examiner and the chief pilot are certified for flying with the Britten-Norman Islander and for taking exams. The items that were carried out during the examination are ticked off on the type qualification examination sheet. The procedures associated with the failure of one engine and flying and landing with one engine inoperative are standard items of the exam. The chief pilot stated that the climb-limited take-off weight and the maximum structural landing weight were not a part of the exam.

The route training is provided by a certified pilot appointed by Divi Divi Air. In accordance with Divi Divi Air, pilots are given the explanation about the briefing for passengers that must be provided before the beginning of the flight and in emergency situations during the route training. These briefings are specified in the General Operating Manual. Pilots are also taught to return even when engine problems occur past halfway the route Curaçao - Bonaire due to the prevailing eastern trade wind, the better landing options on the east coast of Curaçao and the better technical and assistance facilities on Curaçao.

The profchecks are performed by the chief pilot or an instructor, who are certified for this task. The items carried out during the profcheck will be ticked-off on the profcheck sheet. The procedures associated with the failure of one engine and flying and landing with one engine inoperative are standard items of the profchecks. The application of the climb-limited take-off weight or the maximum structural landing weight was not examined during these profchecks.

Aside from ticking-off/signing the items on the type qualification examination, the profcheck, and the route training sheets, Divi Divi Air did not keep a personal training file with up-to-date information of the pilots.

2.19 Organisation and management information

Chapter 4 lists the involved parties.

2.20 Additional information

Data files of the International Civil Aviation Organization and of foreign bodies investigating civil aviation accidents were checked for similar occurrences in the past. This yielded three occurrences where there was a difference in the weights specified on the load and balance sheet and/or used weights and the actual weights. The relevant data of these occurrences are specified below.

2.20.1 Occurrence 1

A Britten-Norman Islander BN-2A-26, two pilots and eight passengers made a domestic flight from Baie-Comeau, Quebec, to Rimouski (Canada) on 7 December 1998.[51] After a five-hour delay due to snow storms, the aircraft took off. The aircraft's pitch attitude suddenly increased at an altitude of approximately 500 feet, causing the aircraft to become unstable. The aircraft executed an emergency landing in the nearby St. Lawrence River. The captain and two passengers survived the accident. Relevant conclusions from the investigation state that the aircraft was overloaded and exceeded the maximum allowed take-off weight by more than 200 lb. This had contributed towards the reduced aircraft performance. The co-pilot did not wear safety belts, which is why this person sustained serious head injury. One of the passengers would have had a better probability of survival if life jackets had been available on-board (which is not mandatory). The report states

51 Aviation Investigation Report A98Q0194, Transportation Safety Board of Canada.

that if the supervisory body had adhered to this company's audit plan, the gaps in training and operation would probably have been detected before the accident.

2.20.2 Occurrence 2

A Raytheon (Beechcraft) 1900D crashed shortly after take-off for a scheduled domestic flight at Charlotte-Douglas International Airport (United States of America) on 8 January 2003.[52] All passengers (two crew members and 19 passengers) were killed. The accident was caused by the crew losing control due to incorrect maintenance work to the elevator system. A centre of gravity that was substantially different because it was behind the aft limit as determined by the manufacturer contributed to this. A relevant underlying factor was the "weight and balance" programme applied by the airline: the use of average weights does not guarantee that the aircraft will actually be loaded within the defined limitations. The lack of periodical checks of passenger and luggage weights or the application of average weights was not (yet) representative. Furthermore, the average standard weights for passengers and luggage used by the supervisory body were not representative and there was a lack of supervision of the airline's "weight and balance" programme. The report also states that an incorrect calculation of weight and of the centre of gravity is still possible when using the airline's "weight and balance" programme that was modified following the accident.

2.20.3 Occurrence 3

A Britten-Norman Islander BN-2A-20, one pilot and nine passengers, made a domestic flight from Lajmoli to Pekoa International Airport (Espiritu Santo) on 19 December 2008. The investigation[53] showed that the aircraft was overloaded when it left (by at least 7%) and flew at too low an altitude to avoid a collision with the mountains. When the pilot realised this, he made an emergency landing in the trees. The steep slope and the vegetation seriously damaged the aircraft's nose section, resulting in the death of the pilot and the passengers sitting in the front. Contributing factors were the poor condition of some of the safety belts and the lack of pre-flight safety instructions. It was also shown that insufficient quantities of safety instructions cards were on-board for all passengers.

52 Aircraft Accident Report NTSB/AAR-04/01.
53 Report 09-001, Transport Accident Investigation Commission, New Zealand.

3 ASSESSMENT FRAMEWORK

3.1 General

An assessment framework is an essential part of an investigation of the Dutch Safety Board. It provides a description of the situation as may be expected based on regulations, guidelines and the specific details of our own responsibility. Insight can be gained into where improvement is possible and/or additions are required by testing based on this and by identifying abnormalities.

The assessment framework of the Board consists of three parts. The first part concerns legislation and regulations that are in force for civil aviation. The second part is based on the international and national guidelines from the sector as well as internal corporate guidelines, manuals and management systems. The third part describes the expectations of the Board with regard to the manner in which the involved parties provide the details for their own responsibility for safety and safety management.

3.2 Civil aviation

3.2.1 Legislation and regulations

The regulations of civil aviation are strongly focused on an international level. The basis for this part of the reference framework is, therefore, mainly formed by international regulations and guidelines.

This section makes a distinction between, on the one hand, binding legislation and regulations and, on the other hand, non-binding standards. Many of the international regulations are not binding directly but become binding when the regulations are implemented in national legislation.

INTERNATIONAL REGULATIONS

The international regulations relevant to this investigation are the Standards and Recommended Practices in the Appendix of the Chicago Convention of the International Civil Aviation Organization (ICAO). It includes the following ICAO appendices:

- Appendix 6 - *Operation of Aircraft*
- Appendix 8 - *Airworthiness of Aircraft*
- Appendix 11 - *Air Traffic Services*
- Appendix 14 - *Aerodromes*

These are called "Annexes" by ICAO! Missing here are:
Annex 12 - SAR, and
Annex 13 - ... Accident Investigation ...

Nearly all countries in the world are a member of the Convention on International Civil Aviation (also referred to as the Chicago Convention). The Kingdom of the Netherlands, including the Netherlands Antilles, are members of the Convention. The Convention contains principles and regulations about innumerable issues that are important to the development of international civil aviation. It is also a part of the legal basis for the establishment of ICAO. The Chicago Convention has a large number of appendices in which various topics are arranged with a large degree of details. These appendices are not binding to the same extent as the Convention itself but do play a large role within the regulations of international civil aviation. The appendices contain, amongst others, standards and recommended practices. The member states are, in any case, obliged to implement the standards as meticulously as possible in their national legislation. When a standard is not implemented, this should be reported to ICAO. A recommended practice is a recommendation that a member state may include in its national legislation. There is, however, no obligation to do so and not including a recommended practice need not be reported.

NATIONAL LEGISLATION OF THE NETHERLANDS ANTILLES

1. Luchtvaartlandsverordening (2001) (national aviation regulation, 2001). This regulation is based on, for example, the Convention on International Civil Aviation, including the corresponding ICAO appendices.
2. Landsbesluit luchtverkeer (2005) (air traffic national decree, 2005), including appendices. This decree is for the execution of Article 22 paragraph 1 of the national aviation regulation.
3. Landsbesluit toezicht luchtvaart (2003) (aviation supervision national decree, 2003), for the execution of various articles in the national aviation regulation.
4. Beschikking luchtwaardigheid van luchtvaartuigen (2008) (aircraft airworthiness order, 2008), for the execution of Articles 59 and 77, second paragraph, Article 83, second paragraph, under f, Article 84, first paragraph, under d, Article 84, third and fourth paragraphs, Article 93, third paragraph, and Article 95, first paragraph of the aviation supervision national decree. The relevant appendix of this order that falls under what is commonly referred to as the Civil Aviation Regulations Netherlands Antilles (CARNA) is:
   - Appendix A related to the aircraft airworthiness order (OJ 2008, no. 19), Part 5 - Airworthiness.
5. Beschikking voorbereiding en uitvoering van vluchten (2008) (preflight and flight operations order 2008), for the execution of Articles 114, 121, 125 and 127 of the aviation supervision national decree. The relevant appendices that belong to this order that fall under the CARNA are:
   - Appendix A related to the preflight and flight operations order (OJ 2008, no. 22), Part 7 - Aircraft Instruments and Equipment.
   - Appendix B related to the preflight and flight operations order (OJ 2008, no. 22), Part 8 - Aircraft Operations.

The relevant obligations that apply from the Appendices with regard to 5 - Airworthiness, Part 7 - Aircraft Instruments and Equipment and Part 8 - Aircraft Operations are further described in Appendix G.

3.2.2 Consequences constitutional reform

By means of a temporary provision by law the CARNA has been made applicable after the constitutional reform on 10 October 2010.

3.2.3 Guidelines

RELEVANT MANUALS

BRITTEN-NORMAN AIRCRAFT

Aircraft flight manual

The aircraft flight manual approved by the British Civil Aviation Authority is part of the Britten-Norman Islander BN-2A-26.[54] This manual includes the description of the aircraft, normal procedures, emergency procedures and aircraft performance data.

The goal of the aircraft flight manual is:

- to provide operational procedures, performance, and system information the cockpit crew need for a safe and efficient flight operation with a Britten-Norman Islander.
- to serve as comprehensive reference for use during training for the BN-2A-26.
- to serve as a review guide for use during recurrent and skill checks.
- to provide necessary operational data.
- to establish standard procedures and practices.

The flight manual has six sections. Section 1 contains general information. Section 2 contains the aircraft limits. Section 3 contains the emergency procedures. Section 4 contains the normal procedures. Section 5 contains the performance data. Section 6 contains the data about the weight and centre of gravity position. It also has appendices.

54 Islander BN2A Flight Manual FM/7, Revision 12 - 1 January 2003.

Relevant information in Section 3, Emergency procedures, from the flight manual:

HANDLING ON ONE ENGINE - General

"The aeroplane is perfectly docile on one engine and should maintain an altitude of 5200 feet at a gross weight of 6300 pounds in international standard atmospheric conditions."

at what other conditions? If not listed, Section 3 is incomplete.

ESSENTIAL CONSIDERATIONS - General
"(...) Although procedures and performance data are given in this manual for both the aircraft manufacturer's recommended normal climb power (2500 revolutions per minute at full throttle) and maximum continuous power (2700 revolutions per minute at full throttle) the pilot must use the full maximum continuous power rating of the engine(s) when safety considerations so dictate."

on page 21, max. cont. RPM is listed as 2500!

LANDING WITH ONE ENGINE INOPERATIVE
"Make an initial approach at approximately 65 knots IAS with the flaps selected to TAKE-OFF (25 degrees). When committed for landing, select FLAPS DOWN (56 degrees) and reduce speed over the threshold to a value compatible with the information scheduled in section 5 and touchdown normally."

LANDING WITH FLAPS UP
"Make an approach at 65 knots IAS and a normal landing.
Note: The aeroplane will tend to float for some distance."

Nothing on Vmca, Vyse, Vxse and required bank angle for maximum OEI performance? These airspeeds are relevant for maintaining control and for minimum drag - for longest flying distance after engine failure.

DIVI DIVI AIR

required in

General Operating Manual
As a result of the CARNA, Divi Divi Air has drawn up a General Operating Manual[55] of the airline on behalf of operational management. The relevant sections are: Section 1, Introduction; Section 3; Management Structure of Divi Divi Air, Section 5; Flight Crew Qualifications/Duty Limitations and Rest Requirements, Section 6; Training,[56] Section 7; Flight Management, Section 8; Operating Procedures, Section 9; Weight and Balance, Section 11; Carriage of Passengers, Section 14; Emergency Procedures, and Section 17; Flight Safety.

The General Operating Manual[57] contains a description of the Divi Divi Air internal audit team (DIAT) that performs audits every six months to ensure compliance with the procedures for safe operation, airworthy aircraft and the practicability of operational and safety equipment. This audit includes aircraft performance and weight, and the aircraft's balance and payload.

The General Operating Manual[58] describes how to deal with the weight distribution of passengers, luggage and freight in the aircraft. These paragraphs also specify the average weights for passengers and the limit weights for take-off and landing of the Britten-Norman Islander.

The manual states that when all seats are taken by passengers, the only way to influence the centre of gravity is to add or remove luggage and/or freight from the rear of the cabin. This should be done by following the captain's instructions. The mentioned paragraphs also state that the passengers should be seated in such a way that the weights are evenly distributed across the length of the cabin.
The applied average weight for an adult passenger and a pilot including hand luggage is 160 lb.
The maximum take-off weight of ~~the Britten Norman Islander is~~ 6600 lb. The maximum landing weight is 6300 lb.

PJ-SUN was
(other Islanders might have other MTOW's)

This Operating Manual was obviously not amended i.a.w. Supplement 22 of the AFM! Graphs list MLW = MTOW for model BN-2-26! (App. C)
If 6300 lb is still right, why no supplement in the AFM?

55 Approved by the Directorate of Civil Aviation on 1 July 2006.
56 Refers to the Training Manual for the training contents.
57 Paragraph 1.8, DIAT General.
58 Paragraphs 9.4, Weight Distribution, and 9.5, Aircraft Performance.

The General Operating Manual[59] states that extra fuel may be uplifted if payload permitting and if it saves time on ground stops when multiple legs are flown.

The General Operating Manual[60] describes the passenger address information. It is stated that passenger address is a very important item in terms of safety and service towards the passengers.

It must be given once all passengers are seated. The passenger address must be in English or in any other language generally spoken by the passengers. If any foreign passengers are on-board, a translation can be done.

The passenger address before take-off must contain:
- Use of seat belts
- baggage properly stowed and clear of emergency exits.
- Non smoking regulations.
- Location of the Divi Divi Air emergency procedure card.
- Location of emergency exits.
- Location of life vests.

The General Operating Manual[61] contains the following relevant instructions in the event that a forced water landing becomes necessary:
- Send distress message including position, altitude, course heading, speed, and estimated
- position of landing and time.
- Consider sea state and surface wind when selecting direction for landing.
- Advice passengers of the emergency (see passenger address information).
- Instruct passengers to remove ties and shoes (water landing) sharp objects from clothing and eye wear.
- Stow loose articles and hand luggage.
- Select assisting passengers and instruct them.
- Instruct passengers on emergency landing positions - seat belt on and adjusted with no slack - bend forward as far as possible and cushion head with arms - hold position until aircraft has stopped.
- Instruct passengers to "bend forward" just prior to touchdown.
- Touchdown with an airspeed as low as possible, but maintain control so that landing is made in good position relative to waves and swells.

The manuals states that waves are created and maintained by the wind. Consequently, landings should be made across the waves, into the wind. If a swell system is evident, the landing should be made parallel to the swells along a crest. Since swells do not necessarily run with the wind, the landing should be made as much into wind as possible. If wind velocity is so high as to make this procedure impractical, the touchdown should be made on the up slope of a swell near the top. The use of power will allow a flat approach and a touchdown in the best position.

The manual states that, if possible, turn the aircraft towards the area of population to aid in rescuing. This may be the nearest island, a passing ship or another aircraft.

The General Operating Manual[62] contains a description of reporting subjects relating to safety. Two reporting systems exist: one for anonymous reports and a formal system for 'trip reports'.

The General Operating Manual[63] contains a short description of the emergency equipment and the life jackets on-board and amongst others some instructions how to use the passenger's waist belt during the flight.

59 Paragraph 9.6.4 Extra Fuel.
60 Paragraph 7.3.3 Passenger Address (P.A.).
61 Paragraph 14.4 Ditching - With Time Available, 14.4.1 General.
62 Paragraph 14.11, Accident Prevention and Post Accident Administration.
63 Paragraphs 17.1 Emergency Equipment, and 17.2, Passenger Cabin Safety.

Training Syllabus
Training in the Britten-Norman Islander follows a syllabus approved by the Directorate of Civil Aviation.[64] The training syllabus does not contain detailed information regarding the training program. The syllabus gives a general summary of the topics that are given during the three-hour theory training (ground training) including the emergency procedures, the aircraft performance (e.g. during take-off and climb) and the aircraft's load and balance. The syllabus contains a summary of topics that are trained during three one-hour sessions on the aircraft where the normal, abnormal and emergency procedures are performed for the type qualification. There are two more sessions dealing with route training. There is a briefing before and after every session.

3.3 Alerting and emergency supporting services

The emergency landing at sea near Klein Bonaire resulted in measures being taken to start involving the emergency services. Various parties are involved in these activities where an accident at sea is concerned. The tasks and authorisations of the parties involved have been arranged at various levels.

INTERNATIONAL REGULATIONS

Based on a number of international treaties, the countries involved are obliged to maintain a search and rescue organisation.
- Convention on International Civil Aviation (ICAO - 7 December 1944, Chicago). Appendix 12, Search and Rescue, of this convention is relevant.
- International convention regarding search and rescue at sea (IMO[65] - 7 April 1979 Hamburg).[66]
- Maritime Search and Rescue Plan for the Greater Caribbean Area (1984).

NATIONAL LEGISLATION OF THE NETHERLANDS ANTILLES

Bonaire crisis response island ordinance
The island regulations Netherlands Antilles, ERNA, does not include any legal provisions regarding disasters. The Coastguard Kingdom Act of the Netherlands Antilles and Aruba does state that the coastguard has to provide emergency supporting services and crisis response services.[67] Where local crisis response is concerned, some statutory matters have been laid down in the Bonaire crisis response island ordinance.[68] The Bonaire crisis response island ordinance includes regulations regarding the preparation for and response to disasters. This ordinance states, for example, that an island crisis plan should be in place. This crisis plan should give a general indication of what should be arranged in order to effectively respond to disasters.

Crisis plan and crisis response plans
The crisis plan for the island territory of Bonaire has been developed as a manual for a structured and coordinated approach to serious, large-scale accidents and disasters. In addition, the assigned organisations such as Bonaire airport and the coastguard of the Netherlands Antilles and Bonaire have a crisis response plan with procedures for preparing the response to a serious accident. The underlying principle is that this should be linked to the daily practices of every part of the island organisation. Appendix H includes a concise description of the abovementioned plans.

Still valid for this airplane model (-26), with 4-bladed props and reduced RPM?

64 Divi Divi Air Britten-Norman BN-2A-8 Islander Training Syllabus, 7 June 2003 version.
65 International Maritime Organization.
66 The Hamburg convention (1979) has not been ratified yet by the Netherlands Antilles.
67 Article 2, fourth paragraph (b) of the Coastguard Kingdom Act of the Netherlands Antilles and Aruba.
68 Island ordinance dated 13 August 2002, no. 1 that defines the rules for preparing and responding to disasters, Bonaire.

3.4 Assessment framework for safety management

In the past it has emerged that the structure and details of the safety management system plays a crucial role when controlling and improving safety continuously. This applies to all organisations, private and public ones, that are active or that are involved more from a distance in activities where a potential hazard to people may occur.

In principle, the way in which the organisation's own responsibility for safety is defined in greater detail can be tested and assessed from different points of view. There is, therefore, no universal handbook that can be used in all situations. The Board itself has, therefore, selected five safety items to be addressed that provide an idea about which aspects may play a role to a greater or lesser extent. The items to be addressed selected by the Board are based on (international and) national legislation and regulations and are, in many cases, broadly accepted and implemented standards. The five items to be addressed are further explained in Appendix N.

The Board recognises that the assessment of the method in which organisations define the details of their own responsibility with regard to safety will depend on the involved organisations. Aspects such as, for example, the nature of the organisation or the scope may be important within this context and should, therefore, be involved in the assessment.

4 INVOLVED PARTIES AND THEIR RESPONSIBILITIES

The overview below specifies the parties who have played a role in the accident. A distinction has been made between the aviation and the alerting and emergency (supporting) services. When there are consequences for the parties concerned because of the constitutional reform of the Kingdom of the Netherlands on 10 October 2010, these are added in short.

Aviation

4.1 Captain of flight DVR014

The captain is responsible for a safe flight operation in accordance with the Civil Aviation Requirements Netherlands Antilles. The captain should adhere to the aircraft's operational restrictions and the airline's regulations. The captain has final responsibility for the aircraft's payload and for informing the passengers about emergency situations during the flight. During the flight, the captain may deviate from the airline regulations, operational procedures and standard methods when this is deemed necessary in the interest of safety.

4.2 Divi Divi Air

Divi Divi Air[69] is a small airline established in 2000 and based in Curaçao that offers flights between Curaçao and Bonaire as well as other charter flights within the region. In 2003 also the Divi Divi Maintenance company was established for the purpose of aircraft maintenance. The two current owners have taken over the companies in 2004. In 2005-2006 its services were expanded between Curaçao and Bonaire (daily, approximately eight round trips). The fleet consists of four two-engine aircraft: two Britten-Norman Islander aircraft (after the loss of the PJ-SUN), one Cessna 402B and one Dornier 228.

As holder of the air operator certificate (pursuant to CARNA), Divi Divi Air is responsible for the safe flight operation of its aircraft. The person who is generally responsible within Divi Divi Air is the accountable manager/managing director.[70] The accountable manager/managing director is responsible for overall management and is in charge of the company. Due to the small size of the company and its services, the position of managing director is combined with those of director of operations and chief financial officer. The director of operations is in charge of and supervises daily activities regarding flight and ramp operations.

The chief pilot[71] assists the director of operations where policies and standard operational procedures are concerned and manages the pilots. The chief pilot must have thorough knowledge of all applicable procedures and ensure that pilots adhere to the operational restrictions specified in the (flight and general operation) manuals. The position of chief pilot is combined with the position of assistant manager of flight operations. The assistant manager of flight operations is responsible for ramp and charter operations and the loading and unloading of the aircraft. The assistant manager supervises these operations and the loading.

4.3 Ministry of Traffic and Transport (Netherlands Antilles)

The Directorate of Civil Aviation of the Ministry of Traffic and Transport of the Netherlands Antilles is the body responsible for civil aviation safety on the Netherlands Antilles with the exception

69 The Divi Divi is a tree that is prevalent in the Caribbean. The species that have been shaped by the trade wind are well-known. A tree that grows in one direction like that is also referred to as a "wind tree".
70 The accountable manager/managing director is a former co-pilot of MD-80/82 and the DHC-8 aircraft.
71 The Chief Pilot is also captain of the MD-11 for a large airline as well as flight instructor and flight examiner.

of Aruba. At the time of the accident, the Directorate of Civil Aviation employed the following inspectors: two flight technical inspectors (one in training), three airworthiness inspectors, two air traffic control inspectors and one security/dangerous goods inspector.[72]

The inspectors hold ramp,[73] route, base and station inspections.[74] Ramp and route inspections have priority over the other inspections. The inspectors also contribute to the creation of civil aviation policies, certification of maintenance companies and airlines, certification of maintenance and flight personnel, certification and registration of aircraft, and investigation of aircraft accidents. Up to 2004, a flight technical inspector of the Directorate of Civil Aviation was stationed on Sint Maarten for the Windward Islands.

After the constitutional reform the Curaçao Civil Aviation Authority (CCAA) of the Ministry of Traffic, Transport and Division of Urban Planning and Housing of Curaçao is responsible for the civil aviation safety on Curaçao.

4.4 Air traffic control on Curaçao and Bonaire

The Netherlands Antilles Air Traffic Control (NAATC) established in its current form on Curaçao in 2006 is a company with limited liability and fell under the responsibility of the Minister of Traffic and Transport. The NAATC is responsible for the air traffic services in the Curaçao flight information region. This includes the area air traffic services of the flight information region as well as the approach and aerodrome air traffic services for Flamingo airport. The NAATC operates an area control centre on Curaçao equipped with a Raytheon air traffic control system and a (primary and secondary) radar site on Curaçao. It also has an office on Flamingo airport for aerodrome control.

The approach and aerodrome air traffic services of Hato airport fell under the responsibility of the Curaçao island government.

Air traffic services include three tasks: air traffic control, flight information and alerting service. The area control centre provides alerting service in the Curaçao flight information region.

After the constitutional reform the minister of Traffic, Transport and Division of Urban Planning and Housing of Curaçao is responsible for the NAATC as well as the approach and aerodrome air traffic services of Hato airport.

4.5 Britten-Norman Aircraft

Britten-Norman Aircraft is the manufacturer of, among others, aircraft of the BN-2 "Islander" aircraft. This type of aircraft is a short take-off & landing (STOL) aircraft and has been constructed in the United Kingdom since 1965. Britten-Norman Aircraft is responsible for manufacturing aircraft, parts and related systems, for providing after sales support and for issuing aircraft and maintenance manuals.

4.6 Lycoming engines

Lycoming is one of the largest manufacturers of aircraft piston engines. In addition to the manufacture of new engines, Lycoming also has a department that deals with complete engine overhauls in the United States of America. Lycoming is responsible for constructing engines, parts and related systems, for providing after sales support and for issuing engine and maintenance manuals.

72 The Civil Aviation director and an airworthiness inspector were killed at the time of the earthquake in Haiti on 12 January 2010 when they attended a regional conference of the Caribbean Aviation Safety and Security Supervision System. This inspector was the investigator in charge of the investigation into the PJ-SUN accident that was performed by the Directorate of Civil Aviation.
73 Ramp inspections are comparable to SAFA-inspections (safety assessment of foreign aircraft).
74 Base inspections are inspections of an airline at the airport that also serves as its home base. Station inspections are inspections of an airline at another airport than its home base.

4.7 Flamingo airport

The airport is located approximately one kilometre south of Kralendijk, the capital of Bonaire. The runway basically begins next to the sea and runs inland; it is crossed by a public road. The annual number of flight movements is approximately 20,000.

The airport is classified as a category 9 airport.[75] The airport organisation consists of approximately 70 employees.

After the constitutional reform the minister of Infrastructure and Environment of the Netherlands is responsible for Flamingo airport.

4.8 Fire service Bonaire[76]

Due to the small scale of the fire service Bonaire, the fire service is also responsible for the Flamingo airport. The fire service' head office is located at the airport because of the obligations set in the International Civil Aviation Organization. The fire service have repressive, preventive and preparatory tasks including preventing, limiting and fighting fires and averting danger and disasters. The fire service have 46 professional employees, 39 of which are on shift work. Three crash tenders and two fire fighting cars are stationed at the airport. The fire service also has a lifeboat but that has been unavailable for quite some time due to engine problems.

After the constitutional reform the minister of Safety and Justice of the Netherlands is responsible for the Bonaire fire service.

Alerting and emergency supporting services

4.9 Local authorities (island council, executive board, governor)

Based on the island regulation of the Netherlands Antilles it has been determined that the council of every island(territory) should consist of the island council, the executive board and the governor. The island secretary is head of the administrative system. The executive board is responsible for the fire service and for supervising anything that may be a fire hazard as well as other issues. The executive board ensures that all divisions of the island organisation specified in the crisis plan have been trained and are attuned to each other in such a way that effective commitment is guaranteed within the context of response to disasters and serious accidents.[77]

The executive board has assigned the operational coordination of preparations for the response to disasters to the island disaster coordinator (ERC), i.e. the fire service commander. This person performs this task under the executive board's responsibility. In addition to the administrative tasks, the governor also has supreme command of the fire service and has command when responding to a disaster. The governor also heads the police force.

4.10 Bonaire police

The police have the responsibility of investigating any possible criminal offence, to maintain order and to guarantee safety. Bonaire has approximately 50 people available and as many vehicles. There is also a boat but that has been unavailable for quite some time due to a mechanical problem. The police headquarters has a central incident room where all incoming and outgoing reports are

75 Crisis response plan aviation accidents Bonaire, 8 June 2005. Category 9 means (ref. ICAO, Annex 14, volume 1, Section 9) that the available extinguishing capacity and the rescue capacity is sufficient to limit the consequences of the effects of an aircraft accident with an aircraft with a length up to 76 meters to a minimum.
76 The fire service of Bonaire is involved in both aviation and alerting/emergency supporting services.
77 Crisis plan for the island Bonaire.

registered. The Bonaire police are established in the centre of Kralendijk, near the executive board and the port.

After the constitutional reform the minister of Safety and Justice of the Netherlands is responsible for the Bonaire police.

4.11 Bonaire hospital and healthcare and hygiene service

The only hospital on Bonaire is the San Francisco hospital, which is part of the Fundashion Mariadal, located at the northern side of Kralendijk with a capacity of 36 beds. The hospital has an emergency room, an operations room, and a blood bank. The medical provisions are not sufficient to deal with a large number of casualties. When the occasion arises, the assistance of Red Cross volunteers and local doctors can be called in. There are three ambulances on the island.

The Bonaire healthcare and hygiene service is responsible for the general healthcare and public hygiene on Bonaire.

After the constitutional reform the minister of Health, Welfare and Sports of the Netherlands is responsible for normal healthcare on Bonaire.

4.12 Netherlands Antilles & Aruba Coastguard

The Coastguard Netherlands Antilles and Aruba (Coastguard NA&A) is responsible for the emergency services (search and rescue) and disaster response in a large sea area surrounding the Netherlands Antilles and Aruba. The coastguard centre is located on Curaçao with offices on Curaçao, Aruba and Sint Maarten. The Coastguard NA&A has sea and air units available, but can also appeal to, for example, units of the Royal Netherlands Navy that are stationed in the area. The coastguard centre operates as a nautical operation centre, central incident room and maritime/ aeronautic rescue coordination centre.

After the constitutional reform the coastguard of the Netherlands Antilles and Aruba changed its name into Dutch Caribbean Coast Guard.

5 ANALYSIS

5.1 Introduction

The accident is analysed in this section. This section provides the answer to the primary investigation question posed in Section 1.2.2: *What are the facts of the accident and which (underlying) factors played a role in this? This question can be split into three secondary investigation questions: What caused the right engine to fail? Why could the aircraft not complete its flight after the right engine failed? What cause did the alerting and emergency services take?*
The following topics are dealt with: engine investigation, flight preparation, flight operation, application of average passenger weight, maximum allowed weight, training, handling of the pilot, Divi Divi Air safety management and supervision, oversight, timeline of radio communication, alerting and emergency supporting services. In conclusion the measures are described that the parties involved took after the accident.

5.2 Engine investigation

The technical investigation showed that damage to the left propeller indicates that high power was selected with regard to the left engine up to the time of impact. The right propeller was feathered. The operating cables to the engines and the propellers (gas, mixture and propeller pitch adjustment) were intact. Due to the serious damage to the aircraft's nose and the cockpit section as a result from the impact on the water, as well as the serious corrosion due to exposure to the sea water of the aircraft and the engines for approximately two months, the operation of the engines and the propellers from the cockpit could not be checked any more. The fuel supply lines from the tanks to the engines were intact and did not contain obstructions. There was a sufficient amount of fuel available in the tanks.

Under supervision of the Dutch Safety Board both engines have been disassembled and investigated by the engine manufacturer. All engine parts were seriously corroded due to the long-term exposure to the sea water. During the disassembly, there were no indications that parts had overheated or suffered from insufficient lubrication. There were no traces of extraordinary wear and tear. Damage to the engines due to the impact with the water were also minor. Besides corrosion damage, which was severe at some places, both engines were in good condition. The magnetos and carburettors were corroded to such an extent that these could not be functionally tested. No mechanical problems were found to indicate that the engines were not capable of producing sufficient power.

Whether the engine failure was caused by carburettor ice was also investigated. Statements from pilots flying the Britten-Norman Islander show this does not occur on Curaçao and Bonaire.

It was concluded that the left engine was still providing high power up to the emergency landing on the water. The right propeller was feathered. From the statements of the passengers it follows that, considering the attempts to restart the engine, the right engine did not stop due to an engine seizure. This is supported by the absence of indications of overheating or lack of lubrication of engine parts. The cause of the failure of the right engine could not be determined. Due to the condition of the engine and the aircraft the technical investigation was limited.

5.3 Flight preparation

This section reconstructs the take-off weight and the centre of gravity of flight DVR014. First the empty equipped weight data of the PJ-SUN was checked. Next, the load (including passengers, (hand) luggage, freight and fuel quantity) of the aircraft were checked. The weight of the pilot and of the passengers was retrieved, the luggage and freight were weighed (after drying) and the fuel load was checked. This data was then used to calculate the take-off weight and the centre of gravity of the aircraft.

, its

5.3.1 The empty equipped weight and moment

The used load and balance sheet of the PJ-SUN specified a (pre-printed) empty equipped weight and related moment arm[78] and moment[79] of the centre of gravity. These were 4367 lb, 26.76 inch and 116,900 lb*inch respectively. See Appendix D. On 19 August 2009, the empty equipped weight of the PJ-SUN was determined for the last time. The weight and balance report specifies that the empty equipped weight and the corresponding moment arm and moment were 4326 lb, 23.04 inches and 99,669 lb*inch, respectively.[80] See Appendix J.

an incorrect

The above shows that the used load and balance sheet of the PJ-SUN specified the old empty equipped weight and corresponding moment arm and moment of the centre of gravity. This load and balance sheet was approved by the Directorate of Civil Aviation on 22 September 2006. According to the CARNA, the empty equipped weight should be checked every three years.[81] This is done by weighing the aircraft.

EEW

23.04 is further forward than 26.76

The empty equipped weight of the PJ-SUN was 41 lb lower (4367 - 4326) than the weight specified on the sheet. The aircraft's centre of gravity was 3.72 inch[82] (26.76 - 23.04) too far aft but within the allowable envelope range. The moment was 17,231 lb*inch (116,900 - 99,669) too high. The latter resulted in the starting point of the diagram in the load and balance sheet to be shifted to the left by 172 units.

'units' not defined, use 'lb.in/100' as in the sheet.

smaller

not relevant for EEW

moment

It can be concluded that the pre-printed load and balance sheet of the PJ-SUN as used during the accident flight specified higher values for the empty equipped weight and moment in comparison with the data included in the last weighing report for the PJ-SUN. However, the effect of this on the (cause of) the accident is deemed negligible.

than

??? Accuracy of moment arm is in .01 inch! Refer to the yellow line in Appendix D.

5.3.2 The payload of the aircraft

When calculating the weight of the aircraft during the take-off, Divi Divi Air used average weights for occupants. The applied average weight for an adult occupant including hand luggage amounts to 160 lb (approximately 73 kg).

The investigation showed that the actual average weight of the occupants (excluding hand luggage) of flight DVR014 amounted to 187 lb (85 kg).[83] It also emerged that the heaviest persons were seated in the three aft rows. This resulted in the centre of gravity moving backwards. The location of the centre of gravity will be further discussed in Section 5.3.3.

The load and balance sheet of flight DVR014 specified the pilot and eight passengers. The weight of the ninth passenger was missing. The aircraft's zero-fuel weight was also not specified on the sheet. See Appendix D. The investigation showed that all passengers were present in the terminal on time and there were no last minute payload changes.

Few more errors, see Appendix D.

The luggage labels specified the weight of the passengers' luggage. The total weight of the luggage was 110 lb (50 kg). Furthermore, freight was stored in the luggage compartment.[84] Divi Divi Air was unable to hand over the weight report of this freight. On being asked after the accident, Divi Divi Air estimated the freight to weigh 44 lb (20 kg). The luggage weighed by Divi Divi Air and the estimated weight of the freight of flight DVR014 came to a total of 154 lb.

The load and balance sheet specified the weight of the luggage, including freight, to be 93 lb. See Appendix D. The investigation showed that the actual weight of the luggage including hand luggage and the freight amounted to 230 lb.[85]

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78 The moment arm is the distance in inches (1 inch = 2.54 cm) from the weight to a reference point. The reference point of the Britten-Norman Islander is the wing leading edge.

79 The moment is the weight x the moment arm. This is expressed as: lb*inch.

80 According to the weight and balance report, the calibration certificate had expired (3 June 2009) for the used scales at the time of weighing (19 August 2009). The effect of the expiration on the aircraft's weight is deemed negligible.

81 CARNA, 5.6.1.9 AIRCRAFT MASS AND BALANCE.

82 3.72 inch is approximately 9 centimetre.

83 The table in Annex K contains the obtained weights of the occupants per seat row.

84 According to Divi Divi Air, the freight consisted of two boxes containing lamps, a removal box containing bread, an electric kettle and a bag containing documentation.

85 The weight of the removal box containing bread was not included. Its weight could not be determined as the bread was in a state of decomposition when it was salvaged.

The load and balance sheet specified the amount of fuel on-board of flight DVR014 to be 700 lb. On the day of the accident, the PJ-SUN made five flights including the accident flight. The fuel supplier's tank showed that refuelling had taken place before flights DVR012 and DVR014. Table 4 contains an overview of the five flights using the relevant data specified on the load and balance sheets: the fuel quantity on-board, the take-off weight, and the amount of fuel taken. Data regarding flight DVR012 is missing as its load and balance sheet could not be retrieved.

The refuelling invoice for flight DVR012 specifies that 26 US gallon (156 lb) of fuel was taken up between 07.52 and 07.56. The aircraft was not refuelled completely. The refuelling invoice for flight DVR014 specifies that 83 US gallon (498 lb) of fuel was taken up between 09.28 and 09.38. According to the statement of the refuelling employee, the aircraft for flight DVR014 was refuelled completely. This is confirmed by a number of passengers who stated that the fuel gauges in the cockpit indicated full during the flight.

Flight number	***From - To***	***Fuel quantity [lb]***	***Take-off weight [lb]***	***Refuelled [US gallon]***
DVR010	CUR-BON	500	6137	-
DVR011	BON-CUR	450	6357	-
DVR012	CUR-BON	Not available	Not available	26
DVR013	BON-CUR	450	6517	-
DVR014	CUR-BON	700	6600	83

Table 4: Overview of the amount of fuel on-board and take-off weight as specified on the load and balance sheets and the amount of fuel taken

The total fuel tank capacity of the Britten-Norman Islander is 137 US gallon. In view of the amount of fuel taken before flight DVR014, there was 137 - 83 = 54 US gallon (324 lb) of fuel available in the tanks. Including the required fuel reserve there was 6 US gallon short on fuel for a return flight to Bonaire.[86] The aircraft needed to be refuelled. The pilot had the aircraft refuelled completely for flight DVR014. The investigation has shown that the aircraft were refuelled regularly (see Section 2.18.2).

The fuel weight of a completely refuelled aircraft (137 US gallon) is 822 lb. The amount of unusable fuel in the tanks (a total of 7 US gallon) is 42 lb. The unusable fuel has been included in the empty equipped weight. The maximum amount of fuel that should have been specified on the load and balance sheet for a completely refuelled aircraft would then have been 780 lb (822 - 42). As a fuel quantity of 700 lb was specified on the load and balance sheet, the amount was 80 lb too low.

It can be concluded that the load and balance sheet for flight DVR014 was incomplete (missing ninth passenger) and incorrect (specified weight of the (hand)luggage, freight and fuel quantity was too low). This prevented the total take-off weight on the sheet to exceed the maximum take-off weight. This will be further discussed in Section 5.5.

5.3.3 Maximum structural weight and centre of gravity

The load and balance sheet specified the take-off weight of flight DVR014 to be 6600 lb. As indicated in Section 5.3.2, the aircraft's zero-fuel weight was not specified on the sheet. Table 5 lists the weights specified on the load and balance sheet, the actual weights as established in the preceding section and the maximum structural weights for the PJ-SUN.

The table shows that the actual zero-fuel weight was 6431 lb and the actual take-off weight was 7211 lb. Fuel consumption during the flight should be subtracted from the take-off weight to calculate the landing weight. For a flight from Curaçao to Bonaire, including fuel for take-off and

86 A required fuel amount of 60 US gallon (360 lb) is assumed. This includes 30 US gallon for the return flight from Curaçao to Bonaire; 7 US gallon of unusable fuel and 23 US gallon for the required 45 minutes of fuel reserve.

taxiing, a fuel amount of 15 US gallon (90 lb) is required.[87] This means the actual landing weight is 7121 lb (7211 - 90).

Appendix K contains the weights from table 5 including the corresponding moment arms and moments. These were used to calculate the position of the centre of gravity. The actual centre of gravity was at 25.1 inch close to the aft limit but was still within the allowable range as defined by the manufacturer. The aft limit was 25.6 inches from the datum plane.[88] The positions of the centres of gravity are displayed in Appendix L.

	PJ-SUN weights [lb]			***Exceedance***
	"Load and balance" sheet for flight DVR014	***According to the reconstruction***	***Maximum structural***	
Empty Equipped Weight	4367	4326		
Pilot/passenger 1	320	342		
Passengers 2/3	320	342		
Passengers 4/5	320	390		
Passengers 6/7	320	401		
Passengers 8/9	160	399		
Luggage	93	231		
Zero-Fuel Weight (ZFW)	-	6431	(MZFW) 6300	2%
Fuel load	700	780 ← 763		
Take-off weight (TOW)	6600	7211 ← 7204	(MTOW) 6600	9%
Landing weight (LW)	-	7121	(MLW) 6300	13%

Table 5: List of specified, reconstructed and maximum structural weights of flight DVR014

6600 i.a.w. FM

The actual zero-fuel weight (ZFW), the take-off weight (TOW) and the landing weight (LW) were all three higher than the applicable structural limits. The ZFW, TOW and LW were too high by 2%, 9% and 13%, respectively.

It is noted that on the load and balance sheets in use there was no space reserved to fill in the required trip fuel and the landing weight.

It is concluded that flight DVR014 was overloaded and had a centre of gravity located close to the aft limit. As result of the overload, the maximum structural limit weights of the aircraft were exceeded.

5.3.4 ~~Climb-limited~~ take-off weight

The investigation showed that the Directorate of Civil Aviation has taken the performance data specified in the flight manual as the benchmark for the Britten-Norman Islander's performance requirements. Based on the British Civil Aviation Airworthiness Requirements (BCARs), the Briiten-Norman Islander was found to be suitable for transport of passengers. The corresponding approved flight manual contains the instructions for the use and the restrictions of the aircraft. In addition, the state where the aircraft is registered may impose further restrictions. These restrictions are included in the CARNA for aircraft and airlines registered in the Netherlands Antilles. At the time of the accident they were applicable to the PJ-SUN and Divi Divi Air.

The CARNA, for example, lays down climb requirements for commercial air transport with multi-engine aircraft with a capacity of nine passengers at most.[89] The aircraft must meet these

87 Divi Divi Air pilots have stated that the PJ-SUN used approximately 15 US gallon (90 lb) of fuel for a flight from Curaçao to Bonaire.

88 The wing leading edge is the datum plane.

89 8.8.4.2 Restricted Performance Multi-Engine Aircraft. This concerns 8.8.4.2 (a). Three performance requirements are defined here. Performance requirements (1) and (3) impose the largest restrictions: a vertical speed of at least 200 feet per minute immediately after take-off or at least 200 feet per minute after a go-around due to an aborted landing. Conditions? ISA?

climb requirements should an engine fail after take-off. Application of these climb requirements would pose a large restriction on the aircraft's maximum allowable take-off weight.[90] When the climb requirement cannot be met the CARNA states that the aircraft must meet the performance limitations that apply to single-engine aircraft.[91] The CARNA states that the aircraft must follow a route in daylight and under visual meteorological conditions from which a safe emergency landing can be performed in case of engine failure.[92] There are no climb-requirements for single engine aircraft.

Is CLTOW defined in the flight manual? Not in App. M (page 100)

According to the flight manual the climb-limited take-off weight (CLTOW) is 6250 lb.[93] The manual contains a supplement (number 22) which allows a higher take-off weight to be used under VFR conditions only. When applied a climb-limited take-off weight of 6600 lb maximum is possible. For application of this supplement approval must be given by the supervisory body. Neither in the enclosure[94] of the Divi Divi Air's air operator certificate, nor in the certificate of airworthiness of the PJ-SUN, the restrictions relating to the climb-limited take-off weight according to the CARNA or those in supplement 22 of the flight manual were inserted. These restrictions were not included in the Divi Divi Air General Operation Manual either.

The investigation has shown that airlines who fly with a Britten-Normal Islander aircraft on Curaçao applied a maximum take-off weight of 6600 lb at the time of the accident. Divi Divi Air stated that this take-off weight had been used since 2002. Correspondence between Divi Divi Air and the Directorate of Civil Aviation has shown that applying 6600 lb as the take-off weight took place with the endorsement of the Directorate of Civil Aviation. It can be drawn from the above that airlines from Curaçao had implicit permission to apply 6600 lb as the climb-limited take-off weight but that the related restrictions have not been applied (down the years).

Not i.a.w. Flight Manual (6600 lb)

Because of the short flight duration the climb-limited take-off weight (6600 lb) is not the determining factor but the maximum structural landing weight (6300 lb) is. The fuel consumption for the flight Curaçao-Bonaire is about 90 lb. Because of this the maximum allowable take-off weight for this flight is 6390 lb. The actual take-off weight (7211 lb) was 13% above the maximum allowable take-off weight (6390 lb).

<=7204 9%

Max.

Aircraft weight	***[lb]***
Climb-limited take-off weight (normal)	6250
Climb-limited take-off weight (supplement 22)	6600
Maximum structural landing weight	6300
Maximum allowable take-off weight (maximum structural landing weight + 90 lb trip fuel)	6390
Werkelijke startgewicht Actual TOW	7211

Table 6: overview of relevant aircraft weights

Not i.a.w. Flight Manual

It can be concluded that the maximum allowable take-off weight of the aircraft for the flight from Curacao to Bonaire was exceeded with 13%. The founding restrictions to issue Divi Divi Air's air operator certificate were not inserted in this certificate, nor in the certificate of airworthiness of the PJ-SUN, nor in the Divi Divi Air General Operation Manual. These restrictions imply that in daylight only and in visual meteorological conditions a route is followed from which a safe emergency landing can be performed in case of engine failure.

Rate of Climb

90 The climb requirements are described in vertical speed (feet per minute) instead of in gradient (%). For slow flying aircraft like the Britten-Norman Islander this is unfavorable. It is also not clear what 'immediately after take-off' means in relation to the height above the ground in the take-off segment. The climb-limited take-off weight is about 5675 lb when applying the vertical speed requirement on the beginning of the take-off segment, which is 50 feet. See Annex M for the determination of the climb-limited take-off weight.

Annex M is for en route climb, not for takeoff with takeoff flaps!

91 8.8.4.2 Restricted Performance Multi-Engine Aircraft (b).

92 8.8.4.1 Single-Engine Aircraft.

93 Assuming an outside air temperature of 31 degrees Celsius, an air pressure of 1010 hectopascal, and an airport elevation (Hato airport) of 29 feet at the time of the accident, the climb-limited take-off weight is 6250 lb. See Annex A. Appendix M?

94 The Operations Specifications in which information with regard to the operational conditions for flight execution are included.

5.4 Flight operation

5.4.1 The engine failure

In spite of the exceeded weight, the flight proceeded normally until there was a failure of the right engine. This happened shortly after the climb had changed into horizontal flight at approximately 3500 feet. The pilot opted for this altitude instead of the usual 2000 feet. No reason could be determined for this.

According to the statement from the passenger next to the pilot the engine failure occurred when the pilot reduced the power from climb-power to cruise-power. The corresponding actions to adjust the power are reducing manifold pressure with the throttle levers, reducing engine revolutions with the propeller pitch control levers and leaning the air-fuel mixture with the mixture control levers. However, leaning the air-fuel mixture with the mixture control levers on the altitude Divi Divi Air is flying is not common practise. If the pilot reduced, for unknown reason, the air-fuel mixture of the right engine too much, it would have caused the engine failure. However, by ~~directly~~ reselecting the mixture control lever into a richer air-fuel mixture the engine would resume its normal operation.

is not necessary at the altitudes flown...

not failure, reduced rpm

immediately

The possibility that the pilot could have operated the switches of the right engine magnetos instead of the electrical fuel pump switch by mistake was investigated also. Switching off the magnetos could explain sudden engine failure. This possibility, however, is not deemed probable due to different reasons. Firstly, because there are no reasons for the pilot to operate the electrical fuel pump switches at that moment in time. These would have been switched off after passing an altitude of 1000 feet in accordance with the procedures. Secondly, because the failure would stop immediately after resetting the switches to the original position. Thirdly, because the position of the magneto switches above the pilot and those of the electrical fuel pump to the right above the pilot are clearly separated from each other on the top control panel of the right engine. Investigated was also whether inadvertent switching can be a result of the pilot flying with a different aircraft flight type. The pilot followed flying training for commercial pilot in the United States of America using a different type twin-engine aircraft during the week preceding the accident.[95] The shape of the switches of the electrical fuel pumps and magnetos as well as the position of these switches in the cockpit of that aircraft type deviate substantially from those in the Britten-Norman Islander.

According to statements from the passengers the pilot applied full power to the left engine after the engine failure. Thereafter he feathered the right propeller and undertook two or three attempts at restarting the right engine. The high power applied to the left engine up to the emergency landing on the water and the feathered right propeller was also determined through the technical investigation.

It can be assumed that when the right engine failed the pilot undertook the appropriate actions, i.e. full power to the functioning left engine and feathering the right engine propeller. Next he tried to restart the right engine but without result. There are no indications that the engine failure was caused by inadvertent handling of the pilot.

The pilot obviously did not reduce the drag by banking a few degrees away from the inoperative engine. This requirement might not have been listed in the AFM, which is a deficiency.

5.4.2 The decision to fly to Bonaire

According to statements from the passengers, the right engine failed even before the aircraft had passed the east part of Curaçao. The time of the engine failure could not be precisely determined. The probable range where the engine failure occurred was determined on the basis of NAATC and the Coastguard NA&A radar data, data from Hato Tower and Flamingo Tower, and the statements from passengers (See figure 1, Section 2.3.1).

not "land as soon as possible" in emergency procedures?

The pilot had the choice to continue the flight to Bonaire or return to Hato airport. The radio messages show that the pilot did not regard the situation as an emergency situation and decided to fly on to Flamingo airport with a request for priority landing. Five minutes after the final radio message with Hato Tower the pilot contacted Flamingo Tower. He specified the distance to Bonaire (24 nautical mile) and the estimated time of landing as well as other issues. This indicated that the pilot was aware of the distance to Flamingo airport. Because the aircraft was equipped with a GPS navigation system the pilot could read the aircraft's distance from Flamingo airport and the

95 According to the pilot's logbook he has flown with a PA-44-180 Piper Seminole.

estimated time of landing. In the subsequent radio messages to Flamingo Tower, the pilot specified the distance to be covered and again the estimated time of landing.

In general, the principle applies that after engine failure a twin-engine aircraft should land at the nearest suitable airport. This principle is a requirement in the CARNA.[96] With approximately three quarters of the flight still ahead, returning to Hato airport would have been the right decision. Returning would have had the additional advantage of a tailwind of approximately 20 knots due to the prevailing eastern trade wind. Based on the actual altitude and rate of descent the range to Hato airport would have been amply sufficient. The decision to continue the flight was also contrary to the route training. Also later on, when the aircraft could not maintain a level flight, returning to Curaçao would have been possible until approximately halfway the route (due to the overweight).

It can be concluded that the pilot's decision to continue the flight after the engine failure is against the general known principle for twin-engine aircraft, as required in the CARNA, and did not correspond with the route training. With regard to the pilot's responsibility to execute a safe flight an engine failure is a crucial moment of decision. By continuing the flight the pilot took an unacceptable risk.

In paragraph 5.7 the choices and handling of the pilot will be further discussed.

Not in agreement with Annex M.

at

5.4.3 *Flying with a weight that exceeded the climb-limited take-off weight*

The Britten-Norman Islander flight manual states in Section 3 (Emergency procedures): "*The aeroplane is perfectly docile on one engine and should maintain an altitude of 5200 feet at a gross weight of 6300 pounds in international standard atmospheric conditions.*" When taking the temperature into account at the time of the accident, this means that the aircraft with a weight of 6300 lb should have been able to maintain an altitude of approximately 3500 feet on one engine.

However, the investigation showed that the actual take-off weight was 7211 lb. The engine failure occurred after approximately one quarter of the flight had been completed. When a fuel consumption of 25 lb is assumed from engine start-up to when the engine failed,[97] the weight at that time would have been 7186 lb. According to the flight manual, the aircraft's climb rate with this weight and a non-functioning engine would be negative.[98] This means that the aircraft cannot maintain a level flight and, therefore, descends. If the actual take-off weight would have been 6600 lb instead of 7211 lb according to the flight manual the aircraft had a small positive climb speed up to 2000 feet maximum with one failed engine and with the actual outside air temperature.

inoperative *maintain level flight*

It can be concluded that the aircraft with one ~~non-functioning~~ engine could not ~~a~~ level flight due to the exceeded weight.

+ inappropriate speed and bank

Speed for best ROC (Vyse) is usually not the speed for best angle of climb (Vxse).

5.4.4 *The rate of descent after the engine failure*

The radar images show that after the engine failed the average groundspeed was approximately 65 knots. See figure 1, Section 2.3.1. With the prevailing eastern trade wind of 15-20 knots, the average indicated airspeed would have been 75-80 knots.[99]
The flight manual specifies 65 knots as the recommended speed for flying on one engine, irrespective of the aircraft's weight. This speed yields the best climb performance since the angle of climb is the largest. *+ provided a small bank angle into the good engine is being maintained. Was this condition presented in the AFM?*
The flight manual does not indicate the best speed when the altitude cannot be maintained after an engine failure. Such a speed also results in the best aircraft performance when the altitude cannot be maintained after an engine failure and a drift-down is required. The angle of descent is minimal and the distance to be covered in the drift-down is the largest at this speed. When this speed is not specified in the flight manual, it is usually best to use the speed with the best climb performance with one non-functioning engine as the best (descent) speed. Due to the high take-off weight, this speed will have been slightly higher than 65 knots during the PJ-SUN's accident flight. *+ bank angle*

96 8.6.1.29 DIVERSION DECISION (…) the pilot in command shall land the aircraft at the nearest suitable aerodrome at which a safe landing can be made whenever an engine of an aircraft fails or is shut down to prevent possible damage.
97 About 90 lb of fuel will be consumed for the flight from Curaçao to Bonaire.
98 With an indicated airspeed of 65 knots, the vertical speed at 3500 feet is -95 feet per minute. At sea level, the vertical speed is -40 feet per minute. See Annex M.
99 Taking into account that the indicated airspeed is about 5 knots less than the true airspeed.

calibrated

In aviation: rate of descend/ climb (ROD / ROC)

Why was not recommended/ required for the manufacturer to include this speed + bank angle? (Vxse). Speed for max. range is Vyse!

> Why not the increased drag due to an inappropriate bank angle mentioned here as well?
> Bank angle for lowest drag should have been a few degrees into the operating engine.
> Does the Flight Manual of a BN-2 not specify this? Would be a major deficiency + worth a recommendation.

Section 5.4.3 describes how the PJ-SUN was unable to maintain a level flight due to the too high take-off weight. Furthermore, the aircraft flew at a higher speed, meaning the angle of descent was not optimal which had a negative influence on the distance covered during the drift-down.[100]

From statements made by the passengers it can be concluded that the pilot increased the aircraft's pitch attitude at times during the final part of the descent.[101] This resulted in a decreased airspeed where the stall warning was briefly audible. The pilot could not apply more power to the left engine to compensate because it was already set at full power after the engine failure. The Britten-Norman Islander's stall speed with one non-functioning engine with flaps up and the other engine at full power is not specified in the flight manual. This stall speed could be determined with the assistance of the manufacturer and using a flight test report. With a correction for the exceeded weight, this speed is approximately 47 knots.[102] This means that the aircraft at times flew at a lower speed during the descent than was desirable.[103] This too had an adverse effect on the covered distance.

It is concluded that the recommended speed for flying on one engine (65 knots) was not maintained during the descent.

5.4.5 The emergency landing on the water

The decision to continue flying to Bonaire after the engine failed and the subsequent radio messages with Flamingo Tower seem to indicate that the pilot was convinced he would make it to Flamingo airport. During his last radio message at 200 feet altitude he stated he would make an emergency landing at sea. It can be inferred from this that the pilot had postponed an emergency landing until the last moment.

The investigation showed that the left engine provided full power until the impact and that the pilot did not extend flaps for the emergency landing. It is likely that the pilot postponed their selection in order to come as close to Bonaire as possible. When flaps are selected, drag increases, which in this situation would have had an adverse effect on the covered distance. Passengers stated that prior to the impact with the water the stall warning was continuously audible. From this it follows that the airspeed was near the stall speed or as close as possible with flaps up and full power on the left engine. When taking the statements of passengers, the injuries of passengers and pilot and the aircraft's damage and damage pattern into account, the conclusion that the aircraft impacted the water surface with high aircraft pitch attitude and left wing slightly down is justified.[104] The impact of the left main gear with the water imparted a nose-down pitching moment causing the aircraft's nose to contact the water surface. This happened in a very short time. The result was serious damage to the aircraft's nose and cockpit section (see figure 5 in Section 2.14).

Landing on water (i.e. ditching) is a controlled emergency landing, with additional instructions.[105] This means that the procedures for an emergency landing apply. The flight manual contains in the emergency section procedures for a 'one engine inoperative' landing. The Divi Divi Air General Operating Manual contains instructions for ditching. The forces that an aircraft is exposed to when it ditches can be high. That is why ditching should take place with a speed as low as possible. This can be achieved by extending the flaps. A stall situation should be avoided because it will result in uncontrolled impact with the water surface.

From the flight path (see figure 1 in Section 2.3.1) and the radio contact with Flamingo Tower shortly before the emergency landing follows that the pilot changed course in order to land as close to Klein Bonaire. According to a passenger the waves were approximately 0.5 metre high.

100 With an average indicated airspeed of 65 knots and an average groundspeed of 50 knots, an average decent rate of approximately 85 feet per minute ((125+40):2)) according to the flight manual, results in approximately 3250 feet loss of altitude across a distance of 32 nautical mile (distance between the location of the engine failure and Flamingo airport).
101 By increasing the aircraft's pitch attitude, the aircraft's nose is raised in relation to the horizon.
102 The manufacturer specifies 44 knots as the stall speed for a Britten-Norman Islander equipped with tip tanks, one functioning engine, one non-functioning engine, and 6300 lb weight.
103 The decreasing speed to (near) the stall speed results in an increase of drag and has an adverse effect on the aircraft's performance.
104 When the balance weight for the aileron extending from the left wing came into contact with the water, the control column was turned to the left hard.
105 *Safety Sense Leaflet 21c Ditching*, Civil Aviation Authority.

From this it can be assumed that the landing on the water surface and against the wind would not provide difficulties.

The aircraft's damage and damage pattern, in particular the bend in the cockpit floor and the resulting backward tilt of the pilot's seat, that trapped the passenger behind the pilot (see Section 5.4.6) are strong indications that virtually all damage was the result of the impact with the water. There are no indications that this damage is the result from the aircraft coming into contact with the seabed.

It is concluded that the aircraft impacted the water surface with low speed, a high pitch attitude and the left wing slightly down. The flaps were not extended during the landing and the left engine provided maximum power. The emergency landing was executed in such a manner that it was a survivable ditching: nine out of ten occupants survived the accident. The aircraft sustained serious damaged during the landing.

5.4.6 The consequences of the hard landing for the pilot

The investigation has shown that the pilot's seat structure was still intact and the cockpit floor had tilted upwards during the accident. This caused the seat with backrest to lean backwards. The backward tilt had created space between the upper body of the pilot and his shoulder belt. The end of the shoulder belt was fixed to the aircraft. With the room to move in the cockpit the head of a person of normal build seated in the pilot's seat would collide with the air ventilation duct (see Section 2.17.1). The aircraft impacted the sea in a high-pitch and left-wing-low attitude, immediately followed by a nose-down pitch moment. The severe deformation of the cockpit section and, therefore, the created room at the shoulder belt combined with a movement towards left forward probably contributed to the injury to the pilot's head. His head probably hit the air ventilation duct or the front door frame, which caused his loss of consciousness. This analysis concurs with the findings of the autopsy in Section 2.15. The pilot probably drowned when the cabin filled with water and sank after the emergency landing.

The conclusion is that the pilot drowned after losing consciousness due to the high impact forces of the aircraft with the water in a left-wing-low attitude. It is probable that the pilot's head collided with the air ventilation duct or the front door frame.

5.4.7 Safety instructions and safety equipment

The PJ-SUN was equipped with a public address system. The noise level in the cabin, even when only one engine is in operation, is high. Because of this the effectiveness of the public address system during flight is minimal. According to Divi Divi Air the public address system is used only when the aircraft is on the ground with stationary running engines for instance to inform the passengers of a delay.

The following emerged from the investigation with regard to the safety instructions when boarding. Some passengers stated to have only heard the instructions for the safety belts and the location of the safety instruction card while other passengers stated not to have heard any instructions. In accordance with the Operating Manual, the safety instructions may be given in English and the pilot must also specify the location of the emergency exits and the life jackets. The pilot spoke English. It cannot be determined whether all instructions were given by the pilot after boarding or that passengers did not understand (a number of) the instruction(s) because they were in English.

The passengers stated that the pilot did not inform the passengers after the engine failure regarding the problems and the consequences for the flight. One of the reasons for this may have been that the pilot was convinced he would make it to Bonaire. When the aircraft was at an altitude of 200 feet, he informed air traffic control that he would perform an emergency landing near Klein Bonaire. According to the passengers, shortly before the emergency landing the pilot turned around towards them and indicated with a hand signal that the aircraft was about to land and he gave a thumbs-up signal to indicate whether everyone was ready for the approaching emergency landing.

According to the General Operating Manual[106] the pilot should provide instructions to the passengers prior to an emergency landing if and when there is sufficient time. These instructions include providing information on the emergency situation, storing the hand luggage in the cabin, pulling the waist belt tight and adopting the brace position when requested shortly before landing.

One of the immediate actions when preparing for an emergency landing is warning the passengers in order that they have sufficient time to prepare themselves. The injuries to the faces of the passengers during this accident emphasise the requirement of these warnings. The ability to cope of the passengers prevented a worse outcome. If the pilot does not have the time to provide safety instructions one course of action might have been to request the passenger next to him or directly behind him to pass on instructions. Reference could be made to the safety instruction cards and requesting the passengers to help and monitor each other. Such an instruction "select assisting passengers and instruct them" is addressed in the ditching instructions of the General Operating Manual. However, due to the high noise level in the cabin this action makes only sense when there has been made an agreement with the passengers during boarding, thus when everyone is able to hear it. The Operating Manual does not have such an instruction for the pilot to arrange this with the passengers during boarding.

A few passengers were worried after the engine failure and undertook action themselves. They also agreed on how to leave the aircraft in case of an emergency landing and to put on life jackets. The pilot and the passenger seated next to him did not put on a life jacket even though these were under their seats (see Section 2.17.3). The passengers in the last row did remove the life jackets from under their seats but did not put them on. It is plausible that the passengers were distracted due to the high level of noise in the cabin. The fact that the forward view from the last row is more limited may have contributed to the passengers in this row being less able to see the pilot's signs.

According to the CARNA, an aircraft flying over water must be equipped with a life jacket for every person on-board.[107] There are no regulations regarding the right moment to put on a life jacket. Usually, airlines will have drawn up their own procedures regarding life jackets. Divi Divi Air did not draw up procedures regarding this. For small twin-engine transport aircraft in the General Aviation category, i.e. the Britten-Norman Islander, it is customary for those on-board to put on their life jackets in the event of a failing engine. There is usually insufficient time and opportunity to put on the life jacket should the remaining and functioning (second) engine fail.[108]

From the moment the engine failed the pilot mainly concentrated on controlling the aircraft. He realised too late that Flamingo airport would not be reached and that he would have to perform an emergency landing on the water. In view of the low altitude at the time the emergency landing was commenced (200 feet), it is likely that the pilot gave a thumbs-up signal due to the short amount of time remaining before performing the emergency landing. The high level of noise in the cabin, the absence of an effective public address system, and the absence of instructions for the passengers about communication in flight, probably contributed to the pilot's handling of the situation. Despite these limitations, the Dutch Safety Board is of the opinion that the actions of the pilot do not fit in with his role as captain and his responsibility to execute a safe flight. It may be expected from a captain that he undertakes sufficient attempts to inform passengers about an imminent emergency situation and how passengers can best prepare for this.

The investigation has also demonstrated that the illustrations on the Britten-Norman Islander safety instruction cards did not correspond with the equipment on-board and that some illustrations were missing. The instruction cards did not include an illustration of the pouches under the seats nor instructions on how to open these pouches. The life jacket illustrations had two and not a single waist belt and the life jackets had a different back than the actual life jackets on-board.

It is concluded that during boarding the pilot did not assure himself sufficiently whether the safety instructions for the passengers were fully understood. By virtue of his responsibility as a captain, the pilot undertook insufficient attempts to prepare the passengers for the imminent emergency situation after the engine failed. The high noise level in the cabin and the lack of agreements with

106 Paragraph 14.4, Ditching - With Time Available.
107 7.8.1.10 INDIVIDUAL FLOATATION DEVICES.
108 Also see *Safety Sense Leaflet 21c Ditching*, Civil Aviation Authority.

the passengers about the communication method should there be an emergency situation may have contributed towards this. The safety instruction cards of the Britten-Norman Islander aircraft were, furthermore, insufficiently clear for an emergency landing.

5.5 The maximum allowed weight

A random check was carried out on the take-off weight as specified on the load and balance sheets of flights performed by Divi Divi Air with the Britten-Norman Islander aircraft during approximately three months prior to the accident flight and shortly thereafter.[109] The CARNA states that before take-off of a commercial flight a pilot must check whether the payload, the weights and the centre of gravity on the load manifest are in compliance with the operational restrictions of the aircraft.[110] The managing director of Divi Divi Air stated that the pilots of Divi Divi Air complete and sign the load and balance sheet themselves. The random check confirms that the sheets are completed and signed by the pilots.

The random check showed that flights with a weight exceeding the maximum allowed weight for a flight between Curaçao - Bonaire (6390 lb, see Section 5.3.4) were not limited to the accident flight. See Appendix N. Exceedances occurred in various flights with all three Britten-Norman Islander aircraft in use. The maximum structural landing weight (6300 lb) was exceeded in 61% of the investigated flights due to the fact that 6600 lb was kept as the only limit. In 32% of the investigated flights a take-off weight of exactly 6600 lb was written down. When also standard passenger weights are used this is an indication that the weight values on the load and balance sheet do not match the actual values. Generally, this concerns the weights of both luggage and fuel. This strongly indicates that the aircraft's maximum structural take-off weight of 6600 lb was exceeded in those cases. The exceedances also occurred when several other pilots flew the Britten-Norman Islander aircraft for Divi Divi Air.

A weight of 160 lb (73 kg) was applied as average passenger weight including hand luggage during the flights that were randomly spot-checked. The investigation showed that the actual average weight of the people on-board amounted to 187 lb (85 kg) in the accident flight. This is considerably higher than the applied average passenger weight. The actual average weight during the accident flight may have been higher due to the fact that the hand luggage had not been taken into account. The substantial difference indicates that the actual average weight of the passengers is probably more than 160 lb. This was also apparent after the accident when the passenger weight was assessed by Divi Divi Air and an average weight of 176 lb (80 kg) was registered. Also see Section 5.12. The new average passenger weight will be discussed in Section 5.9.

The substantial difference between the applied average passenger weight prior and during the accident and the actual average weight, results in the maximum structural take-off weight and the maximum aircraft zero-fuel weight being exceeded on a regular basis.

It is concluded that the maximum structural limit weights and the climb limited take-off weight of all three Britten-Norman Islander aircraft in use during flights between Curaçao and Bonaire and vice versa were being exceeded on a regular basis. This was caused by both the application of the maximum structural take-off weight (6600 lb) as the only limit and the application of an average passenger weight (160 lb) that was substantially lower than the actual passenger weight.

5.6 Training

The pilot who died had first flown with Solomon Airlines on the Solomom Islands and subsequently with Winair in Sint Maarten as a co-pilot on the Twin Otter. He flew for Winair as a captain on the Britten-Norman Islander as from 23 October 2008. In accordance with Winair, the pilot performed above average during the proficiency checks (that were held every six months) and the route checks and he provided clear (English) briefings to passengers. Winair stated that the emergency

109 According to the CARNA, airline companies of the Netherlands Antilles have to retain the load and balance sheets until three months after the flight.

110 8.7.3.14 FLIGHT PLANNING DOCUMENT DISTRIBUTION AND RETENTION: COMMERCIAL AIR TRANSPORT.

procedures associated with engine failure and flying and landing with one engine inoperative are standard items to be carried out during the type qualification examination and the profcheck. This is in accordance with the signed type qualification examination and profcheck sheets on the Twin-Otter and the Britten-Norman Islander of the deceased pilot. The procedures related to an emergency landing on water was verified during the verbal part of the profcheck but not during a flight within this context. According to Winair, the following procedures were adhered to: the prescribed airspeed during engine failure is 65 knots, the prescribed airspeed during the approach is 70 knots (with flaps ~~up~~) and 80 knots (without flaps) and the landing on water is performed without engine power and with minimum airspeed against the stall speed with flaps down. fully? When Winair stopped flying with Britten-Norman Islander aircraft, the pilot started to fly for Divi Divi Air.

down (land flaps?)

Pardon? Flaps up = without flaps.

The pilot who died received training from Divi Divi Air in August 2009. Since he already had a commercial pilot licence to fly with the Britten-Norman Islander, a profcheck was deemed sufficient instead of following the type qualification training. Before this, he also first followed the ground training. Next, the pilot received approximately 7.50 hours of route training involving flights between Curaçao and Bonaire in accordance with his logbook. This was concluded with a route check with flights between Curaçao and Bonaire during 4 hours. According to the signed profcheck and route check sheets of the deceased pilot these checks were performed satisfactorily.

The training syllabus of Divi Divi Air contains a summary of the subjects that are part of the training. The content of the training is not further described. In accordance with the training syllabus, the ground training includes a lesson that has as its subject performance charts and load and balance. The interviews have shown that the climb-limited take-off weight and the maximum structural landing weight were not a part of the training. The maximum (structural) take-off weight of 6600 lb was only used as the limit in the calculations during training. It seems strange to the Dutch Safety Board that attention was not paid to the correct application of these weight limits during this lesson. Since attention was not paid to the climb-limited take-off weight and the maximum structural landing weight during the training, it is possible that insufficient know-how was available in this area within the company. This meant that it became possible that the pilots and management were insufficiently aware of the risks of flying with high take-off weights. This led to irregularities when filling in the load and balance sheets and regular exceedance of the maximum take-off and landing weight as shown by the random sample.

According to Divi Divi Air, training with the aircraft included the procedures associated with one engine failing and the related instructions for the passengers. The actions associated to an emergency landing on water are also verified during the verbal part of the profchecks and not during the flight at Divi Divi Air.

The emergency landing was performed without flaps and with maximum engine power on the left engine. In accordance with the training, an emergency landing on water is practised with flaps and without engine power. The statements, however, have shown that the emergency landing on water was only trained verbally. This difference between training and practice is possibly an explanation for the way in which the pilot acted.

It is concluded that Divi Divi Air pilots who flew with the Britten-Norman Islander aircraft were insufficiently aware of the risks of flying with overweight. This was caused because this issue was paid too little attention during the ground training, practical training, examinations and profchecks. The emergency landing on water was not performed in accordance with the training because it was performed without flaps and with engine power.

5.7 Pilot's handling

Prior to and during the flight, the pilot performed actions and took decisions for which a conclusive explanation cannot be found. These are discussed here.

Witness statements have shown that the pilot threw the wheel blocks in the hangar before departure of the first flight on the day of the accident. He was also verbally curt to a customs official on Bonaire who pointed out to him the incorrect aircraft registration that was specified on the general declaration form. Both observations may point to an irritated frame of mind of the pilot that may have negatively affected his decision-making process during the accident flight.

Only 6 US gallon of fuel had to be added to obtain the required quantity of fuel for flight DVR014. The pilot, however, had the aircraft's tank filled completely for this flight. This was in contrast with the previous flight from Hato Airport where the pilot did not have the aircraft refuelled completely. Due to the refuelling, the aircraft left approximately ten minutes later than the scheduled time. The investigation has shown that the Britten-Norman Islander aircraft in use were completely refuelled regularly. Another explanation for this could not be found.

The ninth passenger was missing and the values for the baggage, cargo and fuel weights were left empty on the load and balance sheet filled in by the pilot for flight DVR014. The only possible explanation for this is that filling in the weight of the ninth passenger and the correct baggage, cargo and fuel weights would have made the total take-off weight on the sheet higher than 6600 lb. This would have been reason for keeping the aircraft on the ground as it would have exceeded the weight limit of 6600 lb that is applied by Divi Divi Air. The supposition is justified that the pilot must have been aware that the aircraft was being overloaded.

The aircraft climbed to FL035 instead of the usual 2000 feet altitude. An explanation for this could not be found. It is possible that the pilot choose this altitude due to the overweight. This choice, therefore, implicitly infers the consideration that a higher altitude is required should there be engine failure with overweight to cover the same distance than without overweight.

Engine failure occurred after approximately a quarter of the route had been covered after which the flight continued towards Bonaire. The pilot reported the engine failure to the aerodrome air traffic control of Hato Airport. He also requested to receive permission to switch to the frequency of the Flamingo Airport (Flamingo Tower) aerodrome air traffic control for a priority landing. He reported to Flamingo Tower that an engine had failed and that there was no emergency situation involved. It can be deduced from the radio communication that the pilot made a conscious decision to continue flying. Continuing to fly, however, was contrary to the principle for twin-engined aircraft to land at the nearest suitable airport. It was also contrary to the Divi Divi Air policy. However, the most important reason why the pilot should have decided to return to Hato Airport was that it was virtually certain that reaching the destination would be impossible under these conditions. During the second radio contact with Flamingo Tower, the pilot stated he would continue to fly at 3000 feet. However, the flight course shows that the aircraft was descending. It may be assumed that the pilot must have been aware of the aircraft's weight that was too high because the aircraft could not, in any case, maintain altitude at that moment in time. The pilot must also have been familiar with the usual headwind. Returning to Curaçao would have been possible during the descent up to approximately halfway the route. It is possible that the fact that the aircraft was flying at a higher altitude than normal and that visibility amounted to 40 kilometres, must have contributed to the decision to continue flying to Bonaire. This visibility meant that he could clearly see his destination. This, however, would not have been a logical choice even if the aircraft had reached Bonaire because maintenance facilities for Divi Divi Air were not available at Flamingo Airport and, moreover, the correct fuel type for the Britten-Norman Islander is not available there. This indicates that the pilot had insufficient capacity at that moment in time to deal with the conditions.

The investigation has shown that the recommended airspeed for flying with one engine inoperative was not maintained. From the statements of the passengers it can be deduced that the pilot mainly concentrated on controlling the aircraft at the lowest airspeed possible from when engine failure occurred. Sometimes also the stall warning was heard. It is possible that the pilot was so involved with this that he did not find an opportunity to inform the passengers about the emergency situation and to prepare them for the ditching. It is possible that this is also the reason why he did not select flaps down for the landing either. A conclusive explanation for the actions of the pilot could not be found. It would probably not have come this far if the internal supervision and oversight on the operational management of Divi Divi Air with regard to the load and balance programme had worked better. Sections 5.8 and 5.9 deal with this issue.

To conclude, the Dutch Safety Board would like to note that, despite shortcomings in the flight operation, the aircraft ultimately ended up in the sea in such a way that all passengers survived this accident without serious injuries.

5.8 Divi Divi Air safety management and supervision

The following emerged from the random sample of the load and balance sheets of flights between Curaçao and Bonaire:

- Exceedances of the maximum structural landing weight (6300 lb) occurred in 61% of the investigated flights.
- A take-off weight of exactly 6600 lb occurred in 32% of the investigated flights. This is an indication that the baggage and fuel weights on these load and balance sheets probably do not match the actual weights when using standard average passenger weights (160 lb). This is a strong indication that the maximum structural take-off weight of 6600 lb was exceeded in those cases.
- The exceedance of the maximum allowed take-off weight is not limited to the accident flight but takes place with all three Britten-Norman Islander aircraft being used and with different pilots.

The investigation also showed that airline companies on Curaçao that fly with the Britten-Norman Islander for all flights applied a maximum take-off weight of 6600 lb and a standard average passenger weight of 160 lb at the time of the accident. Divi Divi Air indicated that these weights have been used since 2002. This took place with the approval of the Directorate of Civil Aviation. Divi Divi Air management stated that it was unaware of the (structural) weight exceedances prior to the accident. Divi Divi Air refers to the 'self-dispatch and release operation' of the aircraft that is executed under the responsibility of the pilot.

The Dutch Safety Board views the responsibilities as follows. Following on from what Divi Divi Air writes in the introduction page of its General Operating Manual (translation): "*(…) a public company providing safe transportation between the Islands*",[111] Divi Divi Air needs to ensure that passengers are transported safely. "Safely" is deemed to mean in accordance with the legal regulations (CARNA) and the limitations specified by the aircraft manufacturer. Divi Divi's operational management must ensure that these regulations and limitations are met. What is commonly referred to as checks and balances must be integrated in the Divi Divi Air operational process for this purpose to check whether the aforementioned regulations and limitations are being met. This refers to the way in which the risks for passengers and the pilot are chartered and are controlled structurally. This type of operational management is in line with the assessment framework of the Dutch Safety Board and these principles are accepted and applied within an international context. In addition, the above infers that a lack of oversight on the operational activities and processes may not be an excuse not to fulfil one's own responsibility or to fulfil it insufficiently.

The above principles are also in line with the CARNA. In accordance with the CARNA,[112] a responsibility is assigned to the pilot delegated by the operations director with regard to the correct completion of the load and balance sheet and the handling of the aircraft (commonly referred to as the self-dispatch and release operation). The responsibility for the full operation and, therefore, including the responsibilities delegated to the pilot, reside with the air operator certificate holder and/or the director operations.[113] According to the General Operating Manual, the chief pilot must have thorough knowledge of all applicable procedures and ensure that pilots adhere to the limitations specified in the flight manual.

The investigation has shown with regard to operational management that internal audits had not been performed on the operational activities and processes as described in the General Operation Manual since the introduction of the CARNA in 2008. The internal supervision of Divi Divi Air failed seriously because the limitations specified in the flight manual and the procedures in the General Operating Manual were not met. The findings from the investigation with regard to the load and balance programme of Divi Divi Air confirm the lack of internal supervision: the use of the old

111 1.0 Introduction to the GOM, 1.1 General.
112 CARNA Implementing Standards 8.7.2.2
113 CARNA Implementing Standards 8.7.2.2 and CARNA 8.7.2.3.

aircraft empty equipped weight and moment of the PJ-SUN, the regularly incorrect completion of the load and balance forms by pilots, the great difference between the applied average and actual passenger weight and the exceedance of the maximum allowed take-off and landing weight for flights between Curaçao and Bonaire (see Section 5.5). Frequent checks of the completed load and balance sheets and assessment of the applied average passenger weight and hand luggage weight could have led to improvements. This also applies to the (annual) inspection of the safety instruction cards with the life jackets on-board of the Britten-Norman Islander aircraft. Divi Divi Air management has indicated that more attention was paid in ensuring that the Divi Divi Maintenance company and the maintenance permit were in order.

Divi Divi Air has a reporting system for anonymous reports and a formal reporting system for the findings of the pilot during the flight (trip reports). Since the introduction in 2008 of these reporting systems, two formal reports have been made according to the managing director. There is no relation between these reports and the accident. There have not been (anonymous) reports regarding the application of the take-off weight, the use of the load and balance sheet or the load of the Britten-Norman Islander aircraft.

According to Divi Divi Air, the pilot who died broached the subject of applying a take-off weight that was too high in his opinion immediately after he had passed his route check with Divi Divi Air management. He referred to the lower take-off weight that was applied in the Britten-Norman Islander aircraft at his former employer (Winair) at Sint Maarten. The chief pilot stated that he had contacted this airline on Sint Maarten after holding this conversation with the pilot who died. Subsequently, this subject was not again discussed with the pilot. Enquiries at Winair showed that a maximum take-off weight of 6200 lb was applied there in relation to the decreased performance of the Britten-Norman Islander when an engine had failed. This was required because flying had to take place at an altitude of 5000-5500 feet for certain destinations.

The investigation has shown that important management tasks at Divi Divi Air are combined due to the small size of the company and the limited extent of its services. The position of managing director is combined with the positions of director of operations and chief financial officer. The director of operations is in charge of and supervises daily activities regarding flight and platform operations. The position of chief pilot is combined with the position of assistant manager of flight operations. De assistant manager of flight operations is responsible for platform and charter operations and aircraft loading. The assistant manager supervises these operations and loading. The findings of the investigation seem to indicate that the positions and related responsibilities were not sufficiently fulfilled due to the combining of aforementioned management tasks, in particular, that of chief pilot.

It can be concluded that Divi Divi Air management paid insufficient attention to the operational consequences and risks that are linked to the self-dispatch and release operation. This meant that the internal control system of Divi Divi Air failed seriously. Audits were not performed with regard to the operational processes and, therefore, the obligations set in the General Operating Manual were not met. Divi Divi Air did not apply the use restrictions of the aircraft manufacturer with regard to the maximum structural landing weight. It is possible that combining various management tasks contributed towards this since insufficient specific details were defined for the related responsibilities.

5.9 Oversight

The investigation has shown that Divi Divi Air has been using the standard load and balance sheet for the Britten-Norman Islander aircraft since 2002. Pre-printed on this sheet are the empty equipped weight, the relating moment arm and moment of the centre of gravity and the average weight (160 lbs) of both the pilot and passengers (including hand luggage) as well as other issues. 6600 lb was used as the maximum allowed take-off weight with the approval of the Directorate of Civil Aviation.

The following relevant findings were found during two platform inspections performed by the Directorate of Civil Aviation in 2005 when using the standard load and balance sheet (in essence):

- The sheet does not have an approval stamp from the Directorate of Civil Aviation.
- The load and balance sheet shows the number of passengers and a standard weight for the luggage in a pre-printed format. The actual number of passengers and the weight of the luggage are completed in the 'Correction Last Minute Changes' section of the sheet.
- The take-off weight on many load and balance sheets is not correct.

In addition, it was reported during a route inspection in 2005 that a take-off weight of 6541 lb was filled in by the pilot on the load and balance form while this weight should have been 6881 lb after recalculation. It was reported within this context that the aircraft was overloaded by 281 lb because the maximum allowed take-off weight was 6600 lb.

Then the pre-printed luggage weight on the load and balance sheet was deleted and the sheet got an approval stamp from the Directorate of Civil Aviation. The pre-printed average passenger weights remained on the sheet, but the pilot had to complete the number of passengers and the position where the passengers were seated. As of February 2006 a stamp for approval was requested for the applicable load and balance sheet after every weighing of the aircraft. The load and balance sheet for the PJ-SUN was approved on 22 September 2006. See Appendix D.

Regarding the use of an average weight for those on-board, there must be a relation between the average weight and the actual weight in accordance with the CARNA.[114] The use of an average weight for those on-board is also recorded in the General Operating Manual of Divi Divi Air that was approved by the Directorate of Civil Aviation in 2008. There is no mention of a relation between the average weight and the actual passenger weight in the manual.

According to the administration of the Directorate of Civil Aviation, the previous owners of Divi Divi Air as well as other Antillean airline companies had already implemented the use of average passenger weights in the past. A flight technical inspector[115] stationed at Sint Maarten reported a difference in average weights as applied by the airlines of the 'Windward Islands' and the 'Leewards Islands'[116] in a 2003 internal letter[117] addressed to the Civil Aviation Director. This inspector indicated that the airlines at the Windward Islands used 165 lb per passenger while the Leeward Islands used 187 lb per passenger. In that respect the inspector also mentioned Divi Divi Air. The inspector suggested all airlines at the different islands use the standard passenger weight of 187 lb.[118]

As indicated by the internal letter, Divi Divi Air applied a higher average passenger weight in the past (187 lb) than they have been applying since 2006 (160 lb). During the investigation the Directorate of Civil Aviation could not explain these differences. Enquiries made at the Winair airline in Sint Maarten have shown that a standard passenger weight of 165 lb (including hand luggage) was applied there. The standard weight was increased to 182 lb (including hand luggage) after the accident.
Neither the Directorate of Civil Aviation nor Divi Divi Air could substantiate the required relation between average passenger weight and actual passenger weight.

114 8.8.2.7 DETERMINATION OF AVERAGE PASSENGER MASS (a) No person may use average passenger mass in the computation of aircraft loading and centre of gravity, unless there has been a determination of the relationship between the actual mass being carried and the selected average mass to determine their validity. (b) The method for the determination of the relationships shall be determined through the method prescribed by the Director.

115 Letter dated 14 November 2003.

116 There was no position of flight technical inspector of the Directorate of Civil Aviation at Sint Maarten as from 2005.

117 This concerned the Windward and Leeward Islands where the Directorate of Civil Aviation was in charge of supervision in 2003. The Windward Islands are Sint Maarten, Saba and Sint Eustatius. The Leeward Islands are Curaçao and Bonaire.

118 The flight technical inspector referred to the importance of the evalutation of passenger weights in response to an accident with a Beechcraft 1900 in 2003 and a report of the Federal Aviation Administration of the United States of America concerning this accident. Also see Aircraft Accident Report NTSB/AAR-04/01 of which a summary is included in Section 2.20.2.

An extensive number of studies and regulations by foreign oversight bodies on the use of an average passenger weight are freely obtainable.[119] These studies and guidelines address the risks of the use of an average passenger weight regarding aircraft with approximately nine passengers or less.[120] The average weight used for aircraft with a relatively small number of passengers will be relatively high. With a relatively low average passenger weight, the weighing of the occupants is of greater importance when flying near the maximum allowed take-off weight will take place. In these cases there is a higher probability of exceeding the maximum weight.

This is the reason why the Dutch Safety Board has a remark regarding the standard average passenger weight of 176 lb (including hand luggage) introduced after the accident for the airlines on Curaçao that use the Britten-Norman Islander aircraft. Also see Section 5.12. In view of the high probability of deviations when applying a standard average passenger weight with regard to this relatively small aircraft, the Dutch Safety Board is of the opinion that 176 lb offers insufficient protection against exceeding the maximum allowed take-off weight.

The found deficiencies in this investigation are an indication of insufficient supervision on the operational management of Divi Divi Air. This, in turn, meant that it had not been identified that the requirements set in the CARNA had to be met. These deficiencies are related to the following:

- The lack of operational conditions in Divi Divi Air's air operator certificate that are related to not being able to comply with the climb-limited take-off weight and, therefore, only flying by daylight, under visual meteorological conditions with the Britten-Norman Islander, and that a safe emergency landing can be made in case of engine failure. Such conditions were not included in the Divi Divi Air General Operation Manual either.
- The lack of the required (demonstrable) relation between the average weight and actual passenger weight.
- The failure of Divi Divi Air's internal supervision system for the load and balance programme.
- The lack of observation of existing differences between the (approved) safety instruction cards and the life jackets on-board the Britten-Norman Islander aircraft.

An audit of the Netherlands Antilles by the International Civil Aviation Organization (ICAO) carried out in 2008 reports the following relevant findings:

- The CARNA does not include an obligation for airlines to implement a flight safety programme.[121]
- There is not enough technical staff to perform the supervision tasks in relation to aircraft operations (during the audit, two of the three inspectors were about to leave the Directorate of Civil Aviation).[122]
- The procedure for auditing training manuals and syllabi is not extensive enough and needs to include, amongst other things, the initial, repeating and specialised training.[123]
- A procedure to monitor the measures implemented by airlines after inspections to ensure the measures is implemented in a timely manner.[124]
- There is no (voluntary) system for (non-punitive) incident reporting regarding safety.[125]

119 *Standard passenger and baggage weights*, Civil Aviation Advisory Publication (CAAP) 235-1, Civil Aviation Authority, Australia, September 1990.
Standard Passenger Weights - Use and Validity of Standard Values, A04H0001 - Interim Aviation Safety Recommendations, Transport Canada.
Aircraft weight and balance control, Advisory Circular AC 120-27E, Federal Aviation Administration, 6 October 2005.

120 Applying 77 kg as the average passenger weight instead of the measured weights with a twelve-person aircraft has a 25% statistical chance of overload. This chance is reduced to 0.0014% when applying this average weight to a Boeing 747 with 400 passengers [Source CAAP 235-1(1)].

121 Finding OPS/07, Annex 1-4-07, Draft final report on safety supervision audit of the civil aviation system of the Kingdom of the Netherlands, January 2009.

122 Paragraphs 3.3.3.3 and 3.3.3.5, The Netherlands Antilles, Critical element 3 - State civil aviation system and safety supervision functions. Draft final report on safety supervision audit of the civil aviation system of the Kingdom of the Netherlands, January 2009.

123 Finding OPS/09, Annex 1-4-07, Draft final report on safety supervision audit of the civil aviation system of the Kingdom of the Netherlands, January 2009.

124 Finding OPS/18, Annex 1-4-07, Draft final report on safety supervision audit of the civil aviation system of the Kingdom of the Netherlands, January 2009.

125 Finding AIG/16, Annex 1-4-07, Draft final report on safety supervision audit of the civil aviation system of the Kingdom of the Netherlands, January 2009.

Due to the ICAO findings, a 'corrective action plan' for correction was drawn up in 2009. At the time of the accident, two operational inspectors (one in training) were employed and the internal procedures regarding the aforementioned findings had been modified according to the Directorate of Civil Aviation. A flight safety programme and (voluntary) incident reporting system have not (yet) been implemented.

The findings of the ICAO audit may explain the deficiencies found in the supervision role of the Directorate of Civil Aviation.

Essential checks and balances were missing that were required to safeguard the safety of the system due to both the internal supervision (see Section 5.8) and the oversight on the operational management of Divi Divi Air with regard to the load and balance programme failing. This is confirmed by the investigation of similar occurrences at other places in the world in the past (see Section 2.20). They also point to the shortcomings found with regard to this investigation: the missing relation between the standard average and actual passenger weight, the lack of internal control on the airline's load and balance programme and the lack of oversight on the airline.

It can be concluded that there was insufficient oversight on the operational management of Divi Divi Air. The importance of a correct application of the CARNA for the existing aviation activities and processes was insufficiently recognised within this context. It is also concluded that the standard average passenger weight of 176 lb set after the accident still offers insufficient certainty that the exceedance of the maximum allowed take-off weight will not occur regarding the Britten-Norman Islander aircraft currently being used by Antillean airline companies.

5.10 Timeline for radio communication

The investigation has shown that radio communication between Hato Tower and pilots is recorded on different sound tracks. The time indications on these sound tracks are not synchronised with each other and do not correspond with the actual time. Therefore the exact time when the communication took place cannot be determined. This appeared to have been a problem for several years and it could not be fixed for the purpose of this investigation. The transcript timeline from the moment of PJ-SUN's take-off on the Hato Tower frequency until the switch to Flamingo Tower frequency could, therefore, not be precisely determined.
The radio communication between air traffic control and pilots is, of course, important to the investigation. A correct time indication of the communication that corresponds with the actual time is of great importance. This applies to investigations of aircraft with and without flight recorders.

It is concluded that the transcript timeline from the radio communication between the PJ-SUN on the Hato Tower frequency could not be determined due to a recording system synchronisation problem of the radio communication with Hato Tower in relation to the actual time when the communication took place. The result of this was that the moment of engine failure was determined less accurate.

5.11 Alerting and emergency supporting services

5.11.1 Governor and crisis response staff Bonaire

The police notified the governor of Bonaire, who is charged with overall command when responding to disasters or major accidents, ten minutes after the emergency landing. Although the information on the number of victims was unknown, the governor stopped the tasks that he was currently involved in and went to the executive board and called a meeting of the island crisis response staff. In accordance with the Bonaire island territory crisis plan, the crisis response staff, led by the governor, consists of the island disaster coordinator (the fire service commander), ESF group coordinators and other consultants and representatives of the various services as appointed by the governor. From this position, the governor and staff tried to gain an overview of the situation in order to deploy the right ESF groups. The fire service commander was absent during the first meeting of the crisis response staff at 11.00. Because, in accordance with the island crisis plan, the fire service commander is charged with the operational leadership when responding to disasters and major accidents (unless the governor decides differently), this position within the crisis response staff was not held during the first phase. This did not influence the crisis response staff's performance for the passengers were dropped off at the port at 10.37 (Twenty minutes after the emergency landing). The possible consequences for the performance of the crisis response staff caused by the fire service commander's absence could have been more serious had the nature and scope of the effects of the accident been greater.

It is concluded that the island crisis response staff could not optimally function during the first phase due to the absence of the fire service commander who should have acted as operational manager. The consequences of this have been slight because of the nature and relative scope of the effects of the accident.

5.11.2 Incident site command
The fire service commander drove the fire service vehicle to the port and took a pilot service boat to the accident site after receiving the report of the aircraft's emergency landing at sea. By doing this, the fire service commander assumed the tasks of the fire service officer on duty. Normally, in accordance with the Bonaire island territory crisis plan, the fire service duty officer on duty serves as the leader of the incident site command (CoPI). From statements of the fire service it can be concluded that there was insufficient communication between the commander and the officer on duty regarding their mutual actions and tasks. Because of this, a CoPI was not established. Because the commanding officials on duty from the fire service, police, and DGH did not meet in a CoPI, there was insufficiënt harmonisation between them. When it became known that the victims of the aircraft accident would be transported to the Kralendijk port, a CoPI should have been formed there. The quick sequence of events (the passengers were brought ashore only twenty minutes after the emergency landing) may have contributed to the fact that a CoPI was not set up.

It can be concluded that important tasks that require harmonisation between the various emergency support services, for example the reception and transport of victims, traffic control and the securing of accident sites, were not optimally executed. The effects of this were limited due to the fortunate circumstance that people with private boats were in the neighbourhood of the accident site to help the victims and bring them into safety.

5.11.3 Airport and fire service (ESF group 4: safety, hazardous substances, rescue)
After the first report (approaching aircraft with engine failure), the airport and the fire service responded in accordance with the aircraft accident crisis response plan, alert stage 1, by activating the airport's emergency operations centre (EOC) and taking up a runway position, respectively. A completely new situation arose when a report came in stating that the aircraft had made an emergency landing at sea. For example, the aircraft accident crisis response plan does not contain a sub plan for emergency landings at sea. The fire service, moreover, could not perform a rescue operation at sea because the fire boat (with life-saving equipment) was out of order due to a malfunction.
When it was known that the aircraft had made an emergency landing at sea, the role of the airport changed from active response to one of giving assistance and coordination because the occurrence had not taken place on the airport. As already mentioned, the fire service officer on duty who had to coordinate the ESF groups as the leader, from a CoPI, did not fulfil this task. The fire service did not fulfil any significant role in the further course of the emergency supporting services after the accident.

It can be concluded that the fire service responded adequately to the first alert by rushing to the airport runway, but was insufficiently prepared for the actual accident (an emergency landing at sea) both with regard to drawing up the plan and its execution. Also, the fire boat was out of order.

5.11.4 Police (ESF group 5: public order)
The police did not sufficiently follow the procedures discussed in the Bonaire island territory crisis plan. The police duty officer on duty went to the scene of the accident instead of contacting his colleagues from other the disciplines to form a CoPI. The police could not offer any assistance at the site of the accident because the police boat was out of order due to a malfunction. The police units that went to the port pier to control traffic and clear the road did not sufficiently succeed. The ambulances had difficulty in reaching the pier because the area had not been sufficiently secured.

A chaotic situation occurred at the pier because of the gathering of emergency service employees, spectators and press.

It can be concluded that the police did not optimally execute its responsibilities in disaster situations, i.e. keeping law and order and controlling traffic. There was insufficient communication with other emergency support services. Also, the police boat was out of order.

5.11.5 Hospital Bonaire and DGH (ESF group 6)

The crowd at the quay and the many people who gathered at the hospital led to congestion at both locations. Ambulances had difficulties reaching the pier. It was difficult to distinguish emergency service employees from other people (spectators and press) that tried to enter the hospital too. Consequently the registration and reception of the passengers both at the pier and in the hospital did not run smoothly. Two institutions working independently from each other (police and the DGH) were involved in assisting casualties. First care for casualties was given by the police and the handing over to DGH was minimal. Immigration officers were also at the scene. The hospital had prepared to deal with casualties. The hospital has a total capacity of 36 beds. Approximately thirty beds were made available, including six for special care. Afterwards it emerged that these were too many beds. These problems could have been prevented had there been a better information exchange between the various ESF groups (through the CoPI).

It is concluded that the reception and registration of the casualties did not run smoothly despite the relatively low casualty count. There was insufficient communication between medical services and other emergency support services.

5.11.6 Netherlands Antilles & Aruba Coastguard

The Coastguard was notified by Bonaire central police station immediately after the accident had occurred. A Navy helicopter on training quickly arrived at the scene. The helicopter did not have specific life-saving equipment on-board but could monitor the emergency supporting services that was provided through the boats present. Later, the Panther Coastguard patrol boat, a rescue boat of the Citizen Rescue Organisation Curaçao (CITRO) and a Coastguard helicopter with a liaison officer were sent to the scene. However, because the passengers had already been rescued from the water and the aircraft with pilot were at an unreachable depth, rescue activities stopped around noon.

The Coastguard concluded from the accident that communications should be opened with the Netherlands Antilles Air Traffic Control (NAATC) on a regular basis. This should ensure that they are informed earlier when the NAATC receives messages from aircraft in distress during the flight instead of only being notified after an emergency landing or an accident occurs. The deployment of a liaison officer at the scene at Bonaire was viewed as a positive experience by the crisis response staff.

5.11.7 Flamingo Tower

The Dutch Safety Board would like to make a comment regarding the air traffic control shortly before the emergency landing with regard to search and rescue. During the approximately eighteen minutes of radio communication between Flamingo Tower and PJ-SUN, the air traffic controller did not ask for the number of persons on-board. There is no obligation to do so because this information can be found in the flight plan. The flight plan, however, usually cannot be immediately accessed because the tower air traffic control works with a ‘strip’ that does not include the number of persons on-board. When an emergency situation is likely to occur, it is important to know the number of persons on-board for search and rescue purposes. It is probable that the air traffic controller did not inquire after the number of persons on-board during early radio communications because the pilot had not reported an emergency situation. A suitable moment to request this would have been during the second radio communication when the pilot stated an engine had failed. Emergency services could have used this information to, for example, determine the number of required hospital beds.

It can be concluded that knowing the number of persons on-board of an aircraft for search and rescue purposes early on and notifying the ESF groups of this number are important. Air traffic control can provide this information.

5.11.8 Evaluation, learnt lessons and improvement
The governor of Bonaire asked the ESF groups to draw up an evaluation report about the emergency services. An evaluation was made mid-2010 together with four of the involved warning and emergency services. An evaluation report has not been made and the evaluation has not yet led to improvement actions. Learning points on a strategic level are: the need for clear plans to clarify the responsibilities of involved parties and the need to have good agreements with other partners on the island, such as boat owners, hotel owners, diving schools and the National Parks Foundation that possess resources and resources to assist in the event of a serious occurrence. In this case, the (quick) sea rescue was mainly possible because of private boat owners since the local authorities did not have boats available for immediate deployment. When an accident at sea is involved, the Coastguard is charged with the implementation and coordination of rescue activities. The presence of a Coastguard liaison officer provided clear insight into the communication with the Coastguard and its method of operation. Although the governor assessed the aforementioned learning points for himself, no general assessment with all involved parties has been made nor have measures of improvement been applied up until now. This also applies to the (few) drills that took place in the past. A drill for the Bonaire island territory crisis plan was performed at GRIP II level[126] in 2007. At the airport an aircraft crash was simulated. In 2009 a Red Cross drill took place that led to an accident with a small aircraft in the centre of the island. The police and fire service participated in this drill. No assessments were drawn up from these drills.

An evaluation performed by the airport management concluded that drills to learn to respond to aircraft accidents at sea as part of the airport's crisis response plan is advisable. Because the runway of Flamingo airport virtually runs to the beach, an aircraft accident at sea is a realistic possibility. A clear division of tasks and centrally organised communication would also help improve crisis response. Mobile phones were used instead of the appropriate two-way radio communication resources. The mobile communication network became overloaded, which meant that the required exchange of information did not occur.

It is concluded that up to now no overall evaluation of the Divi Divi Air aircraft accident took place and that the accident did not lead to improvement measures regarding the emergency services. Evaluations from several individual alerting and emergency services suggest improvement possibilities in the division of tasks, scenario development and use of communication resources. Organisations participating in crisis response have incidentally trained together in the past but sufficient evaluations have not been made of this.

5.12 Measures taken after the accident

After the accident, the Directorate of Civil Aviation, Divi Divi Air and the involved alerting and emergency services took actions or implemented the measures below.

5.12.1 Actions taken and measures implemented by the Directorate of Civil Aviation of the Netherlands Antilles after the accident

- Antillean airline companies flying with Britten-Norman Islander aircraft must weigh their passengers and luggage before each flight and must complete the load and balance sheet. After evaluation, this obligation was converted to the following choice: weighing or applying the increased average weight of 176 lb (80 kg) for adult passengers (including hand luggage).
- Inventory of the different types of Britten-Norman Islander in the Netherlands Antilles and determining the related limit weights including the climb-limited take-off weight.

5.12.2 Actions taken and measures implemented by Divi Divi Air after the accident

- Shortly after the accident, at their own initiative the decision was taken to allow nine people on-board per flight at most.
- Divi Divi Air started weighing passengers at both airports, on Curaçao and on Bonaire, on 5 November 2009. The results were sent to the Directorate of Civil Aviation on a weekly basis. After three months of weighing, the standard average passenger weight was set to 176 lb by

126 Coordinated regional incident response procedure, level 2.

the Directorate of Civil Aviation. Divi Divi Air has linked a maximum number of nine people on-board (including the pilot) per flight to this weight so that cargo can be transported.

- Newspapers must not be carried (first flight of the day).
- Maximum half-full refuelling after every return flight.
- The maximum allowed take-off weight is 6300 lb.
- Flight altitude to Bonaire is 3500 feet. Flight altitude to Curaçao is 4500 feet.
- A check must be performed to ensure passengers are briefed by ground staff and the pilot to ensure completeness.
- All Britten-Norman Islander safety instruction cards have been changed and replaced.
- The safety instructions card is now also shown at the check-in desk.
- The load and balance sheet has been improved and replaced.
- Pilots have received instruction regarding the proper use of the load and balance sheet.
- Heavier passengers will occupy the four front seats. If the ground staff cannot place the heavier passengers at the front of the aircraft at check-in, the pilot will explain it is better for the aircraft's centre of gravity.
- The remaining two Britten-Norman Islander aircraft currently being used have been checked on possible damage as a result of exceeding the maximum structural landing weight. Defects have not been found.

So, transition altitude is higher than 4500 ft? Why then FL's used on page 15?

5.12.3 Action taken by the alerting and emergency supporting services

- Four of the involved alerting and supporting emergency services were evaluated in mid-2010.

The most important measures to prevent engine failure accidents in the future are missing. Contact AvioConsult.

No changes required to Flight and Training manuals?

6 CONCLUSIONS

The pilot was obviously not aware of the consequences of an inoperative engine on the control and performance of the airplane.
Therefore, the most important "causal factors" are missing:
1. The airplane took off heavily overloaded - the drift-down altitude after engine failure, and the required ROC (§ 8.8.6.2.) were not calculated by the investigators.
4. Range performance after engine failure was not optimized, by maintaining Vyse (or Vxse) and the required small bank angle to minimize the drag and maximize the range.
5. Engine-out training of the pilot was inadequate.
6. (Highly probable) Engine-out definitions & procedures in BN-2 Flight Manual were inappropriate.
7. Errors (ISA) in the Performance Charts, both engines operating and one engine inoperative.
8. In One Engine Inoperative performance chart legend, the required aircraft configuration data are missing, as are the required airspeed and bank angle for the performance data to be valid. The abbreviation ISA is used inappropriately by the airplane manufacturer.

Causal factors

1. After one of the two engines failed, the flight continued to Bonaire. By not returning to the nearby situated departure airport, the safest flight operation was not chosen.
   - Continuing to fly after engine failure was contrary to the general principle for twin-engine aircraft as set down in the CARNA, that is, to land at the nearest suitable airport.

[took off] [level]

2. The aircraft could not maintain horizontal flight ~~when it continued with the flight~~ and an emergency landing at sea became unavoidable. [above?]
   - The aircraft departed with an ~~over~~load of 9% ~~when compared to~~ the maximum ~~structural~~ take-off weight of 6600 lb. The pilot who was himself responsible (self-dispatch and release) for the loading of the aircraft was aware of the overloading or could have been aware of this. A non-acceptable risk was taken by continuing the flight under these conditions where the aircraft could not maintain altitude due to the overloading.

[Not only himself. Why then all of the actions and measures implemented by Divi Divi?]

3. The pilot did not act as could be expected when executing the flight and preparing for the emergency landing. [i.a.w. procedures?]
   - The landing [ditching] was executed with flaps up and, therefore, the aircraft had a higher landing speed.
   - The pilot ensured insufficiently that the passengers had understood the safety instructions after boarding.
   - The pilot undertook insufficient attempts to inform passengers about the approaching emergency landing at sea after the engine failure and, therefore, they could not prepare themselves sufficiently.

Contributing factors

Divi Divi Air

4. Divi Divi Air management paid insufficient supervision to the safety of amongst others the flight operation with the Britten-Norman Islanders. This resulted in insufficient attention to the risks of overloading.

   Findings:
   - The maximum structural take-off weight of 6600 lb was used as limit during the flight operation. Although this was accepted by the oversight authority, formal consent was not granted for this. [By whom? 6600 lb was obviously listed in Flight Manual.]
   - A standard average passenger weight of 160 lb was used on the load and balance sheet while the actual average passenger weight was significantly higher. This meant that passenger weight was often lower on paper than was the case in reality. [as listed]
   - A take-off weight of exactly 6600 lb completed on the load and balance sheet occurred in 32% of the investigated flights. This is a strong indication that the luggage and fuel weights completed were incorrect in these cases and that, in reality, the maximum structural take-off weight of 6600 lb was exceeded. [frequently.] [in fact?]
   - Exceedances of the maximum structural landing weight of 6300 lb occurred in 61% of the investigated flights. [and 6600 lb?]
   - The exceedance of the maximum allowed take-off weight took place on all three of the Britten-Norman Islander aircraft in use and with different pilots.
   - Insufficient attention was paid to aircraft weight limitations during training.
   - Lack of internal supervision with regard to the load and balance programme.
   - Combining management tasks at Divi Divi Air, which may have meant that insufficient details were defined regarding the related responsibilities.

- The Empty Equipped Weight and Balance data used prior to the accident flight were incorrect, i.e. not i.a.w. the most recent weighing report.
- The pilot drew the moments on the pre-printed graph on the load and balance sheet inaccurately.
- The ISA temperature labels at the temperature lines in MTOW charts are incorrect and unclear and might result in inappropriate use and errors.

5. The safety equipment and instructions on-board the Britten-Norman Islander aircraft currently being used were not in order.

at the time of the accident?

Findings:
- Due to the high noise level in the cabin during the flight it is difficult to communicate with the passengers during an emergency situation.
- The safety instruction cards did not include an illustration of the pouches under the seats nor instructions on how to open these pouches. The life jacket was shown with two and not a single waist belt and the life jackets had a different back than the actual life jackets on-board.

Directorate of Civil Aviation Netherlands Antilles (currently the Curaçao Civil Aviation Authority)

6. The Directorate of Civil Aviation's oversight on the operational management of Divi Divi Air was insufficient in relation to the air operator certificate involving the Britten-Norman Islander aircraft in use.

Findings:
- The operational restrictions that formed the basis for using 6600 lb were missing in the air operator certificate, in the certificate of airworthiness of the PJ-SUN and in the approved General Operating Manual of Divi Divi Air. The restrictions entail that flying is only allowed during daylight, under visual meteorological conditions, and when a route is flown from where a safe emergency landing can be executed in case of engine failure.
- The required (demonstrable) relation with the actual average passenger weight was missing in relation to the used standard passenger weight for drawing up the load and balance sheet.
- The failure of Divi Divi Air's internal supervision system for the load and balance programme.
- Not noticing deviations between the (approved) safety instruction cards and the life jackets on-board during annual inspections.
- The standard average passenger weight of 176 lb set after the accident offers insufficient security that the exceedance of the maximum allowed take-off weight of flights with Antillean airline companies that fly with the Britten-Norman Islander will not occur.

Other factors

Recording system of radio communication with Hato Tower

7. The recording system used for the radio communication with Hato Tower cannot be used to record the actual time. This means that the timeline related to the radio communication with Hato Tower cannot be exactly determined.

The alerting and the emergency services on Bonaire

8. There was limited coordination between the different emergency services and, therefore, they did not operate optimally.

Findings:
- The incident site command (CoPI) that should have taken charge of the emergency services in accordance with the Bonaire island territory crisis plan was not formed.
- Insufficient multidisciplinary drills have been organised and assessed for executive officials who have a task to perform in accordance with the Bonaire island territory crisis plan and the airport aircraft accident crisis response plan in controlling disasters and serious accidents. They were, therefore, insufficiently prepared for their task.

9. The fire service and police boats could not be deployed for a longer period of time.

7 RECOMMENDATIONS

More recommendations than presented here result from the additional conclusions.

The Dutch Safety Board has arrived at the following recommendations regarding this accident:

Divi Divi Air

The Board recommends to Divi Divi Air to demonstrate the following to the Curaçao Civil Aviation Authority:

1. that the load and balance programme, the pilot training, the safety equipment and instructions of the Britten-Norman Islander aircraft in use are brought up to standard and complies with the legal requirements, and the limitations specified by the aircraft manufacturer, and that the risks of the load and balance programme are chartered and structurally controlled in the safety management system.
2. Improve the Engine-out training of the pilots.
3. Improve the load and balance sheet to list the EEW data of the most recent weighing.

Minister of Traffic, Transport and Division of Urban Planning and Housing of Curaçao

The Board recommends that the minister:

2. Ensures that the CARNA is correctly applied and the user specifications by the manufacturer of the Britten-Norman Islander being used at airlines that fall under the supervision of the Curaçao Civil Aviation Authority in light of the findings as phrased (in conclusion 6) in this report.
3. Provides the Dutch secretary of State of Infrastructure and Environment, being the responsible member of the government for Kingdom Affairs the follow-up status of the ICAO audit 2008 findings in relation to the findings in this report.

Governor of Bonaire

The Board recommends the governor who has supreme command of the support services and the emergency services:

4. to ensure that the alerting process and the emergency (supporting) services are improved by regularly practising with deployment of multiple disciplines, assessment of this practise and taking measures of arisen shortcomings.

Britten-Norman Aircraft

1. Review the BN-2 AFM/ Owners handbook on the subject of control and performance after engine failure and improve the manual to be in accordance with the certification and flight test standards (EASA and FAA). Errors in the handbook need to be corrected.

2. Review the BN-2 Performance charts for the inappropriate use of "ISA" and line-labels, and improve.

3. Add the required bank angles and airspeeds for both maximum endurance (Vxse) and maximum range (Vyse) to the engine-out performance data in the AFM, and the bank angle for Vmca to be valid.

Administrative bodies to which a recommendation is addressed are requested to make known their position regarding this recommendation to the relevant minister within six months after publication of this report. Non-administrative bodies or persons to whom a recommendation is addressed are requested to make known their position regarding the follow-up of this 74 recommendation to the relevant minister within one year. Copies of these responses should simultaneously be issued to the Chair of the Dutch Safety Board and the Minister of Public Safety and Justice.
On the expiry of the response period the Dutch Safety Board will publish the responses to the report on the Board's website, www.onderzoeksraad.nl. When no responses are received the Board also gives notification of the fact on the aforementioned website.

APPENDIX A: JUSTIFICATION OF INVESTIGATION

Dutch Safety Board report and investigation
On 17 November 2009 the Dutch Safety Board received a request from the Directorate of Civil Aviation of the Ministry of Traffic and Transport of the Netherlands Antilles to investigate the accident with the Divi Divi Air Britten-Norman Islander that took place near Bonaire on 22 October 2009. The Dutch Safety Board immediately started its investigation.

In accordance with international agreements and guidelines, the Dutch Safety Board maintains contact with the involved states:
- The Netherlands Antilles: Bonaire: where the accident occurred, and Curaçao: the country of registration of the aircraft as well as where the airline is established.
- United Kingdom: the country of the aircraft manufacturer and aircraft design.
- The United States of America: the country of the engine manufacturer and engine design.

The following parties and organisations offered their services:
- Bonaire fire service
- Bonaire hospital
- Bonaire police
- Bonaire Regional Service Centre
- British Consulate in Curaçao
- Britten-Norman Aircraft
- Curaçao airport
- Dienst Gezondheidszorg en Hygiëne (Bonaire DGH)
- Directorate of Civil Aviation Netherlands Antilles
- Divi Divi Air
- Flamingo airport
- Governor, island secretary and employees of the Bonaire administrative system
- Lycoming Engines;
- Netherlands Antilles Air Traffic Control
- Netherlands Antilles & Aruba Coastguard
- United Kingdom Air Accident Investigation Branch
- United States Department of Defense
- United States of America National Transportation Safety Board

The following investigations and activities were performed in.

- From 22 October until mid-November 2009 the preliminary investigation took place of the investigators led by an investigator in charge of the Directorate of Civil Aviation Netherlands Antilles.

- From 15 November until 20 November 2009 an investigation was performed by the accredited representative of the British Air Accident Investigation Branch upon the request of the Directorate of Civil Aviation Netherlands Antilles.

- 23 November - 29 November 2009: preliminary conversations between the Dutch Safety Board project manager/investigator in charge and the authorities of Curaçao and Bonaire. The information about the accident, gathered by the Directorate of Aviation, was shared with the Dutch Safety Board. This concerned the following (this is not an exhaustive list): the passenger interviews/statements, the transcript of radio communication with Flamingo Tower, meteorological data and data of the aircraft and the airline concerned. The found objects and broken-off aircraft parts obtained after the emergency landing were handed over to the Dutch Safety Board.

- 1 December 2009: start of the investigation and salvage operations on Bonaire under the supervision of the Dutch Safety Board.

- 3 December 2009: first salvage attempt by Smit Salvage. USNS Henson helped secure the location of the aircraft wreckage. Attaching hoisting cables between the fuselage and engines appeared impossible because of the rigidity, mass and dimensions of the steel hoisting cable and limited capacity of the remotely operated vehicle (ROV). The salvage vessel did not retain the right position, which resulted in damage to the ROV supply cable because it scraped against the steel anchor cable.

- 5 December 2009: second salvage attempt by Smit Salvage. Salvage was delayed by one day because a new supply cable and light "Dyneema"[127] hoisting cable had to be flown in. This attempt failed due to a wrongly fitted seal on the ROV supply cable when the cable was replaced, which resulted in water damage to various electrical components.

- 8 December 2009: third salvage attempt by Smit Salvage. At first, salvage seemed successful because of an extra anchor and increased engine power of the underwater robot. Placing the hoisting belts around the wings was difficult because both the ROV supply cable and hoisting line ended up between the cracks of the wing and flaps and elevator and horizontal empennage. Within several hours the hoisting lines were put in place. One of the steel anchor cables got trapped around the right aircraft wing because of the increasing and changing current and the dragging of the anchor. The ROV supply cable also got entangled and damaged, which led to losing the ROV connection and the underwater activities could not be visualised. The decision was then taken to cease salvage operations. The hoisting cable, ROV supply cable and anchor cable were cut and together with the ROV left on the seabed.

- 18 December 2009: salvage of the aircraft wreckage and pilot was resumed under supervision of the Dutch Safety Board with the Skandi Carla. This modern vessel with multiple large ROVs can retain the right position in a turbulent sea. Within three hours, the entangled anchor cable was cut,[128] the lost ROV recovered, the hoisting cable hooked up to the previously attached hoisting belts and the aircraft was hoisted and placed on-board of the ship. Even though hoisting belts with 10 cm diameter were used, the anchor cables cut several decimetres into the metal of the wing. The deceased pilot remained intact and in place during the salvage operations. After the aircraft was placed on-board of the ship the pilot was taken out of the cockpit by a local Dutch forensic detective, a Dutch fire service officer and a local police officer. After identification and drawing up a statement regarding the discovery of the body, the mortal remains were transported to the Parera navy base on Curaçao by a Coastguard patrol boat. There the mortal remains were transferred to an undertaker hired by the British consulate for further transport in an air-tight coffin to the United Kingdom for autopsy and to be transferred to the next of kin.

- After the recovery of the mortal remains, the engines and cabin were cleaned with fresh water. The fuel supply lines from the tanks to the engines were intact and did not contain obstructions. After the carburettors' fuel lines were disconnected, a mixture of fuel and seawater poured out of the lines. Both fuel tanks were emptied and the content stored.

- On-board of the Skandi Carla, both wing tips were removed up to the engines' suspension points to be taken by road from the Curaçao Brion shipyard to the Curaçao Coastguard hangar.

127 Dyneema is a registered trade mark.
128 The steel anchor cable had a diameter of five cm.

Figure 11: Skandi Carla

- 19 December 2009: aircraft wreckage in Curaçao Coastguard hangar.
- 20 December 2009: retrieved all luggage from aircraft to dry for later weighing. The box from the luggage compartment containing wet bread was disposed of in a waste container.
- 21 December 2009: both propellers and engines were removed from the aircraft by Divi Divi Air ground engineers under the supervision of the Dutch Safety Board. Awaiting two engine containers for transportation provided by the engine manufacturer in consultation with the manufacturer, the decision was taken to remove the spark plugs and immerse the engines in Jet Fuel. The latter was done to stop the corrosion process.
- 25 January 2010: luggage weighing and technical investigation of aircraft wreckage.
- 27 January 2010: sending engines to engine manufacturer for investigation.
- 10 and 11 February 2010: engines investigated at the manufacturer in the United States of America under the supervision of the Dutch Safety Board.
- 11 May 2010: exchanging data with accredited representative of the Air Accident Investigation Branch and the representatives of Britten-Norman Aircraft in Bembridge, Isle of Wight, United Kingdom.
- 20 January - 8 February 2011: due to comments on the draft final report verification of factual information regarding the aircraft, the payload, the training, and the supervision was performed on Curaçao and Sint Maarten.

Note
The airworthiness inspector who acted as the investigator in charge during the investigation of the accident of the Directorate of Civil Aviation and the Director of Civil Aviation died in the earthquake of Haiti on 12 January 2010 when they attended a meeting of the Caribbean Aviation Safety and Security Oversight System.

Scope
The investigation of the Dutch Safety Board focused on determining the causes or probable causes, the underlying factors that have led to and the possible structural safety deficiencies that formed the basis for the accident. The Dutch Safety Board decided not to only investigate the accident itself but also the alerting and the emergency services after the accident.

The Dutch Safety Board has not investigated the consequences of the overloading on the aircraft construction of the PJ-SUN. This also applies to other Britten-Norman Islander aircraft of other Antillean airlines that presumably only applied 6600 lb as the take-off weight.

Interviews
Within the framework of the investigation, interviews were held with the managing director, the chief pilot and a number of Divi Divi Air pilots, inspectors of the Directorate of Civil Aviation Netherlands Antilles, Curaçao and Bonaire air traffic controllers, representatives of Curaçao and Bonaire airports, the fuel supplier, the person with whom the pilot shared a home, the pilot's father and girlfriend, representatives of Bonaire fire services, the Bonaire governor and island secretary, the Bonaire police, representatives of the Bonaire hospital, the Dienst Gezondheidszorg en Hygiëne (Bonaire DGH), the Red Cross, and the Coastguard of the Netherlands Antilles and Aruba.

Analysis
The analysis focused on the reconstruction of the accident and the direct and underlying causes. The organisation for raising the alarm and the emergency services was also investigated.

Project team

J.W. Selles	Investigation Manager

Basic team

K.E. Beumkes	Project Manager/Investigator in Charge
C. van Antwerpen (until July 2010)	Senior Investigator
W.F. Furster	Investigator

Any real airplane expertise?

Support

W. Goedhart	External expert (Bonaire Regional Service Centre)
P.J.J.M. Verhallen	Senior Investigator
Ms J. Zwaan	Project Assistant

Due to international involvement support was given by the following accredited representatives:
T. Atkinson, Senior Inspector of Air Accidents (Operations), Air Accident Investigation Branch, United Kingdom
L. Schiada, Senior Air Safety Investigator, National Transportation Safety Board, United States of America

At the request of the Dutch Safety Board and the Air Accident Investigation Branch, an autopsy was performed in the United Kingdom by the following external expert: Wing Commander G. Maidment, Consultant Pathologist, Department of Aviation Pathology, Royal Air Force Centre of Aviation Medicine.

APPENDIX B: COMMENTS PARTIES INVOLVED

A draft report (without consideration and recommendations) was submitted for inspection of factual inaccuracies to the parties or persons directly involved in accordance with the Dutch Safety Board Act:

- Air Accidents Investigation Branch, United Kingdom
- Bonaire hospital
- Bonaire International Airport
- Britten Norman Aircraft, United Kingdom
- Curaçao Minister of Traffic, Transport and Division of Urban Planning and Housing
- Dienst Gezondheidszorg en Hygiëne Bonaire (Healthcare and Hygiene service Bonaire)
- Divi Divi Air
- Dutch Caribbean Coast Guard
- Dutch Minister of Defence
- Dutch Minister of Health, Welfare and Sports
- Dutch Minister of Infrastructure and Environment
- Dutch Minister of Internal and Kingdom Affairs
- Dutch Minister of Safety and Justice
- Dutch Transport and Water Management Inspectorate, Aviation Division
- Father of deceased pilot, United Kingdom
- Fire service Bonaire
- Girlfriend of deceased pilot
- Governor and island secretary Bonaire
- Korps Politie Caribisch Nederland (Bonaire police)
- Lycoming Engines, United States of America
- National Transportation Safety Board, United States of America
- Netherlands Antilles Air Traffic Control
- Tower air traffic controller of Hato Tower and Flamingo Tower

The comments have been processed as follows:

In so far supplements, non-textual, and factual inaccuracies are concerned, the Safety Board has incorporated the comments received into the final report. This type of comment is not mentioned separately.

Substantive comments is provided with a remark. In some cases these comments are incorporated in the final report and in some cases not. These remarks are mentioned in a table that can be found on the website of the Dutch Safety Board: www.safetyboard.nl.

APPENDIX C: ~~CLIMB-LIMITED~~ TAKE-OFF WEIGHT

Maximum

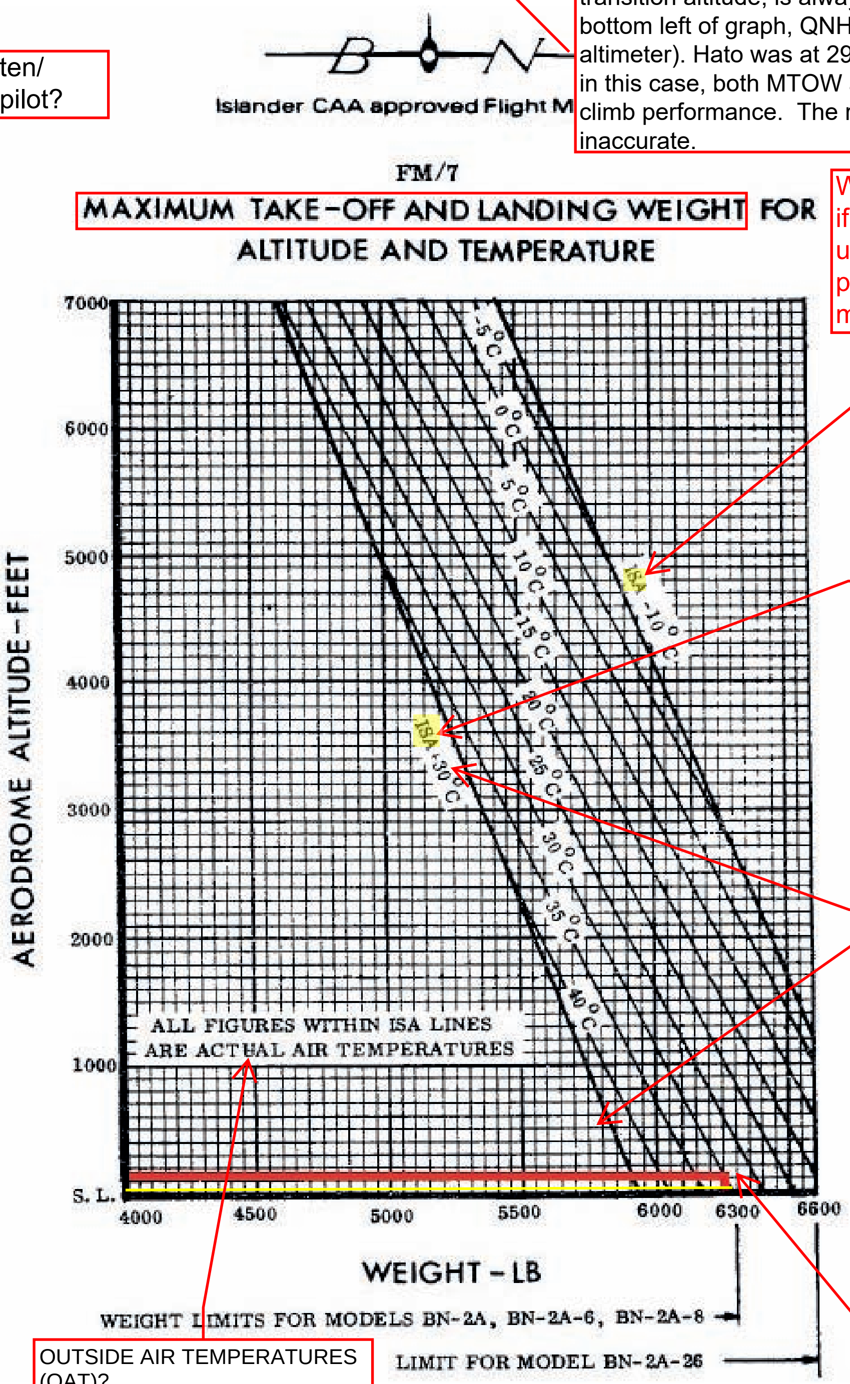
Is not climb limited, but altitude and temperature limited (that leads to climb limits)! The legend of the graph lists MTOW and MLW, not CLTOW.
The min. required climb performance is or should be included in the graphs.

~~Climb-limited~~ take-off weight

The ~~climb-limited~~ take-off weight (CLTOW) of PJ-SUN for Hato airport can be read from the graph from the flight manual below. ~~The altitude of Hato airport in the (ICAO) standard atmosphere (1013 hectopascal) is required for this. This is calculated using the airport altitude and air pressure compared to the mean sea level and the outside air temperature at the time of the take-off. These values were 29 feet, 1010 hectopascal and 31 degrees Celsius, respectively.~~
~~The airport altitude in standard atmosphere is 29+27(1013-1010)=110 feet.[129] The relevant CLTOW in the graph is 6250 lb.~~

Was this written/ verified by a pilot?

The elevation of an airport, like all altitudes below the transition altitude, is always presented in ft MSL (SL on bottom left of graph, QNH set in Kollsman window of the altimeter). Hato was at 29 ft MSL, so at an OAT of 31° C, in this case, both MTOW and MLW were 6250 lb for min. climb performance. The red line is too high and inaccurate.



Why is this graph included if the aircraft operated under supplement 22, next page. Is confusing; doesn't make sense.

The use of ISA with the figures is confusing and incorrect. Is this line for +15 (ISA at SL) - 10 = +5° like for the most left side line? No, this line must be for an actual OAT of -10°C (would be ISA - 25°). No adding of 15° required.
The label on the other side requires adding 15°C. Unacceptable error.

Replace ISA with OAT: and add in the legend that the temperature decrease with altitude (Theta) is i.a.w. the ISA.

Is +30° correct? Seems on 40° line. Label (45°C) must be positioned lower to avoid interpolation errors.

OUTSIDE AIR TEMPERATURES (OAT)?

Red line is too high (>29 ft MSL).

129 The following has been used in the calculations: 1 hPa = 27 feet.

See remarks on previous page - not used in graphs

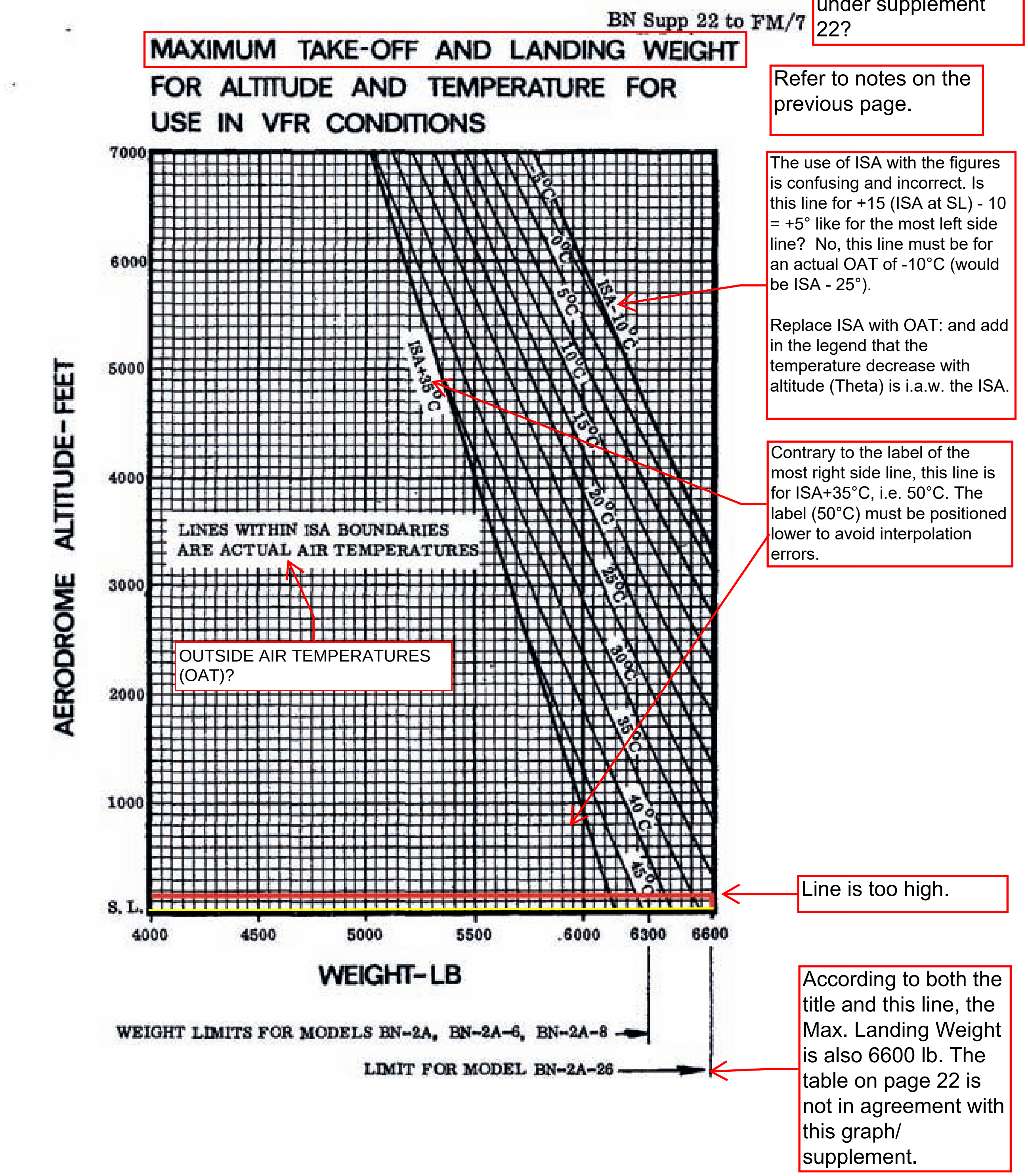
~~Climb-limited~~ take-off weight according to supplement 22

maximum

takeoff and land

The ~~climb-limited~~ take-off weight according to supplement 22 of the flight manual can be read from the graph below. From this it follows that a take-off weight of 6600 lb is allowed from Hato airport up to about 33 degrees Celsius outside air temperature with the restriction to ~~fly~~ in VFR conditions ~~and with the approval of the Directorate of Civil Aviation.~~

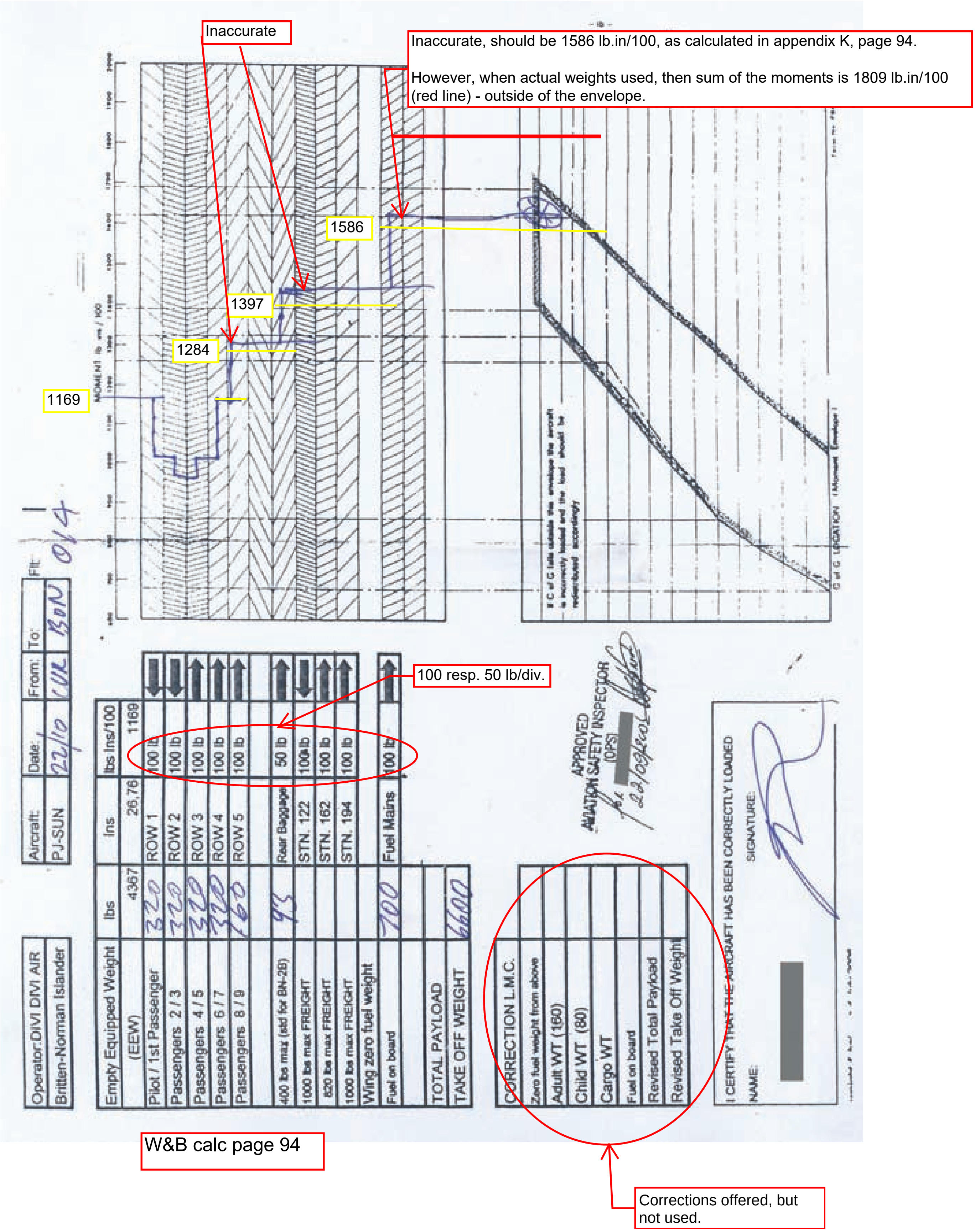
Was the aircraft approved to operate under supplement 22?



The performance graph for One Engine Inoperative is in Appendix M, page 98.

APPENDIX D: FLIGHT DVR014 LOAD AND BALANCE SHEET

This appendix shows the 'load and balance' sheet for flight DVR014 as completed by the pilot.



Operator: DIVI DIVI AIR
Britten-Norman Islander

Aircraft:	Date:	From:	To:	Flt:
PJ-SUN	22/10	CUR	BON	014

	lbs	Ins	lbs Ins/100
Empty Equipped Weight (EEW)	4367	26.76	1169
Pilot / 1st Passenger	320	ROW 1	100 lb
Passengers 2 / 3	320	ROW 2	100 lb
Passengers 4 / 5	320	ROW 3	100 lb
Passengers 6 / 7	320	ROW 4	100 lb
Passengers 8 / 9	160	ROW 5	100 lb
400 lbs max (std for BN-2B)	95	Rear Baggage	50 lb
1000 lbs max FREIGHT		STN. 122	100 lb
820 lbs max FREIGHT		STN. 162	100 lb
1000 lbs max FREIGHT		STN. 194	100 lb
Wing zero fuel weight			
Fuel on board	700	Fuel Mains	100 lb
TOTAL PAYLOAD			
TAKE OFF WEIGHT	6600		

CORRECTION L.M.C.	
Zero fuel weight from above	
Adult WT (160)	
Child WT (80)	
Cargo WT	
Fuel on board	
Revised Total Payload	
Revised Take Off Weight	

I CERTIFY THAT THE AIRCRAFT HAS BEEN CORRECTLY LOADED

NAME: [redacted]

SIGNATURE:

APPROVED AVIATION SAFETY INSPECTOR [redacted] (OPS)

APPENDIX E: AIR TRAFFIC CONTROL TRANSCRIPT

This appendix provides the radio communication between Flamingo Tower air traffic control and the PJ-SUN at the time of the accident.

NAATC Netherlands Antilles Air Traffic Control

Netherlands Antilles
Air Traffic Control N.V.
Seru Mahuma z/n
Curaçao
Netherlands Antilles
Tel.: (599-9) 8393-506
Fax: (599-9) 8683-012

Transcript DVR014 - October 22 2009

DNL = DNL2990
DVR = DVR014
N = NAVY274
T = Flamingo Tower

Playback freq. 118.7 started at 13:55 UTC

13:56:10

DNL - Confirm, DNL2990 for taxi and ready to copy clearance.
T - DNL2990 taxi, line up rwy10, cleared to Curaçao A563, climb and maintain FL60, squawk 1721.
DNL – Roger, cleared taxi and turn backtrack rwy 10, cleared Curaçao A563, FL60, squawking 1721, DNL2990.
T - That is correct.

13:57:07

DVR – Flamingo tower DVR014.
T - DVR014, flamingo go ahead.
DVR – Eh, 014, islander inbound from Curaçao, eh, showing, eh, I got one engine out, so we are landing with one engine, no emergency at this stage, I'm maintaining altitude at, eh, 3000 feet, we request priority to landing rwy10, currently 24 miles out, estimating at, eh, 18.
T - DVR014 say again your distance out?
DVR – Currently 24 miles.
T - Confirm 24 nautical miles?
DVR – Affirm, 24 miles, DVR014.
T - DVR014 continue approach runway is 10, the wind is 120 at 10, the QNH 2988.
DVR – 2988, continue approach, 014.
T - And report leaving FL30
DVR - …..(unreadable)….leaving 30, 014.
T - Flamingo.

NAATC Netherlands Antilles Air Traffic Control

Air Traffic Control N.V.
Seru Mahuma z/n
Curaçao
Netherlands Antilles
Tel.: (599-9) 8393-506
Fax: (599-9) 8683-012

13:58:42

DNL – DNL2990 is ready for departure.
T - DNL2990 cleared for take off runway10. wind is 110 at 10, cross the beacon westbound 40 or above.
DNL – Roger. cleared for take off runway 10. beacon at 40 or above. and we copy the islander, DNL2990.
T - Flamingo.

14:02:24

T - DNL2990 airborne time on the hour, request your level passing?
DNL – Eh, we are leaving four one for sixty, DNL2990.
T - Roger, contact Curaçao control, frequency 127.1, so long.
DNL – Twenty seven ten, so long.

14:08:45

DVR – And DVR014 approaching 10 miles, estimating in ten minutes, maintaining 1000 feet.
T - DVR014, flamingo roger, continue approach and report final.
DVR – Report final, 014.

14:12:00

DVR – Eh, Divi eh 014, I am at 8 miles, 600 feet and I'm struggling to maintain altitude.
T - DVR014, flamingo roger, cleared to land runway10, wind is 120 at 12.
DVR – Cleared to land , 10 12.

14:14:21

DVR – I am at 6 miles, 300 feet.
T - DVR014, flamingo roger.

14:15:17

DVR – At, eh, I am still going down at 200 feet now, eh, doubting I'm gonna make the runway end.
T - DVR014 say again for flamingo?
DVR – Eh, I am at 5 miles, 200 feet, still losing altitude, I'm gonna try make a force landing off little Bonaire.
T - Confirm are you able to make it?
DVR – Negative, not be able to make the airfield.
T - Flamingo roger.

NAATC Netherlands Antilles Air Traffic Control

Netherlands Antilles
Air Traffic Control N.V.
Seru Mahuma z/n
Curaçao
Netherlands Antilles
Tel.: (599-9) 8393-506
Fax: (599-9) 8683-012

14:19:07

N - Flamingo, NAVY274, bon dia.

14:19:29

N - Flamingo tower, NAVY274, good afternoon, bon dia.

14:19:44

T - Station calling flamingo, go ahead.
N - Good afternoon mam, NAVY274.
T - NAVY274 flamingo go ahead.
N - ….(unreadable)….approach, the lynx helicopter with ….(unreadable)…. pob, at the moment squawkingVFR and first of all mam, we would like to make a practice approach NDB for rwy10.
T - NAVY274, I have an islander just, eh, ditch in the sea, to the south of klein Bonaire. Can you proceed there for search and rescue?
N - Roger, confirm, eh, you have a, eh, ditched aircraft?
T - That is correct, islander, Divi Divi.
N - Roger, NAVY274, eh, we do have ….(unreadable)…. operating at the moment, we could proceed inbound to have a look.

14:21:15

N - Flamingo, NAVY274.
T - NAVY274, flamingo go ahead.
N - Are there surface contacts proceeding inbound to that position as well?
T - NAVY274, flamingo say again.
N - Are there ships proceeding inbound to that position as well?
T - I have nothing else proceeding inbound to there.
N - Roger, we are unable to reach at the moment, but we can have a look, eh, if there are any survivors, mam.
T - Ok, copy that. Can you contact your company for assistance?
N - Eh, we will copy, eh, contact PJC RCC, eh, at Curaçao.
T - Flamingo.

14:22:43

N - Curaçao, NAVY274, do you have an exact location for ditched aircraft?
T - The aircraft is still at south of the south point of klein Bonaire.
N - Roger, copied, proceeding inbound to have a look

14:23:37

T - NAVY274 there are 10 pob.
N - Roger, 10 pob, NAVY274.

NAATC Netherlands Antilles Air Traffic Control

Netherlands Antilles
Air Traffic Control N.V.
Seru Mahuma z/n
Curaçao
Netherlands Antilles
Tel.: (599-9) 8393-506
Fax: (599-9) 8683-012

14:27:23

T - Coastguard 274, flamingo.
N - Coastguard 274, flamingo go ahead.
T - Is the plane still floating?
N - Negative, eh, we see, eh, old parts of the aircraft on top of the water, there are 2 small vessels with divers at the scene of accident and we have divers in the water looking for survivors, over.
T - Roger.

14:32:45

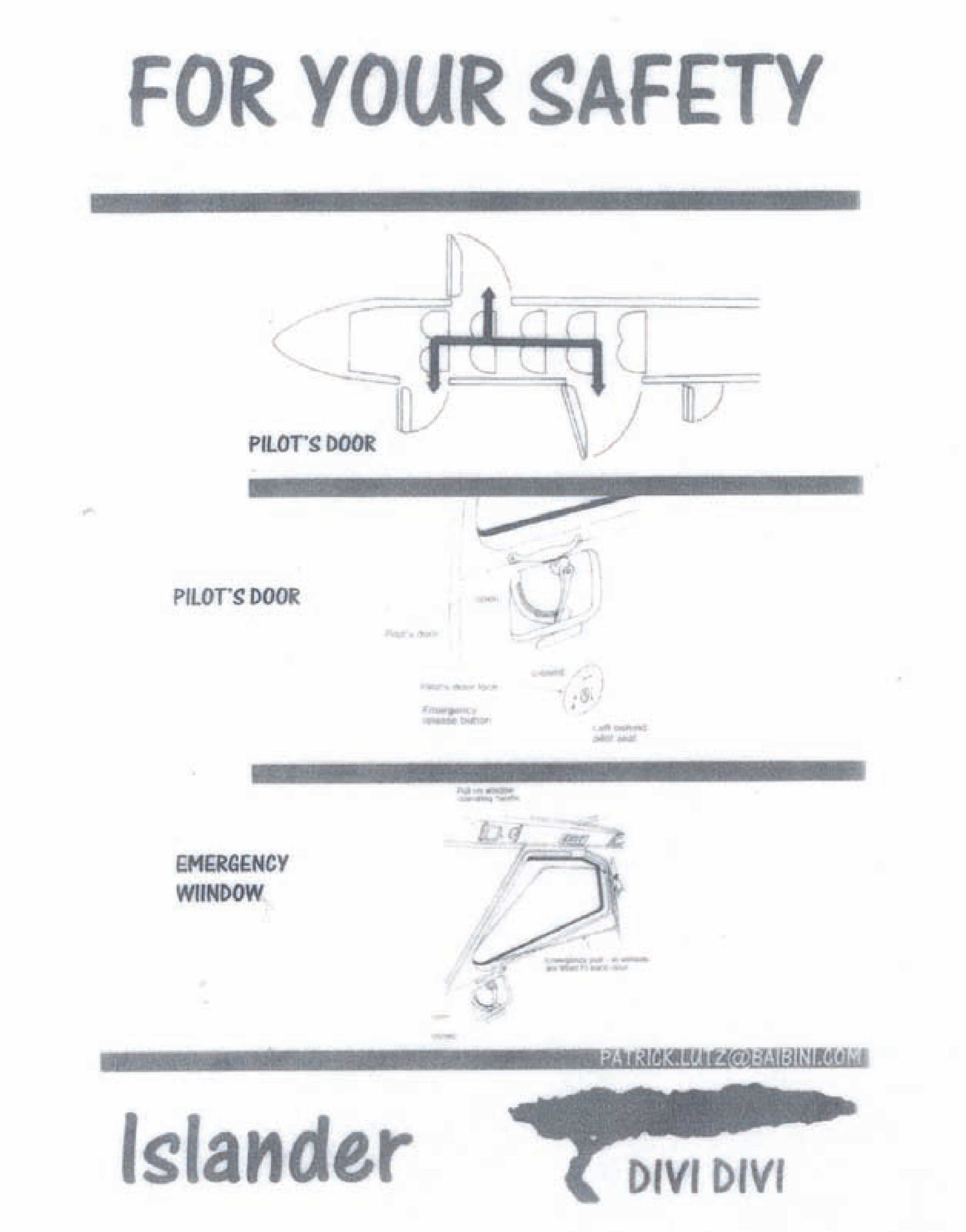
N - Flamingo, Delta mission, NAVY274.
T - NAVY274, flamingo go ahead.
N - Flamingo, NAVY274, we will remain in location klein Bonaire, eh, to look for survivors, we operate at 2500 feet and below.
T - NAVY274, flamingo roger.
N - And for your information RCC Curaçao is informed.
T - Roger, that's copied.

Playback stopped at **14:35:00**

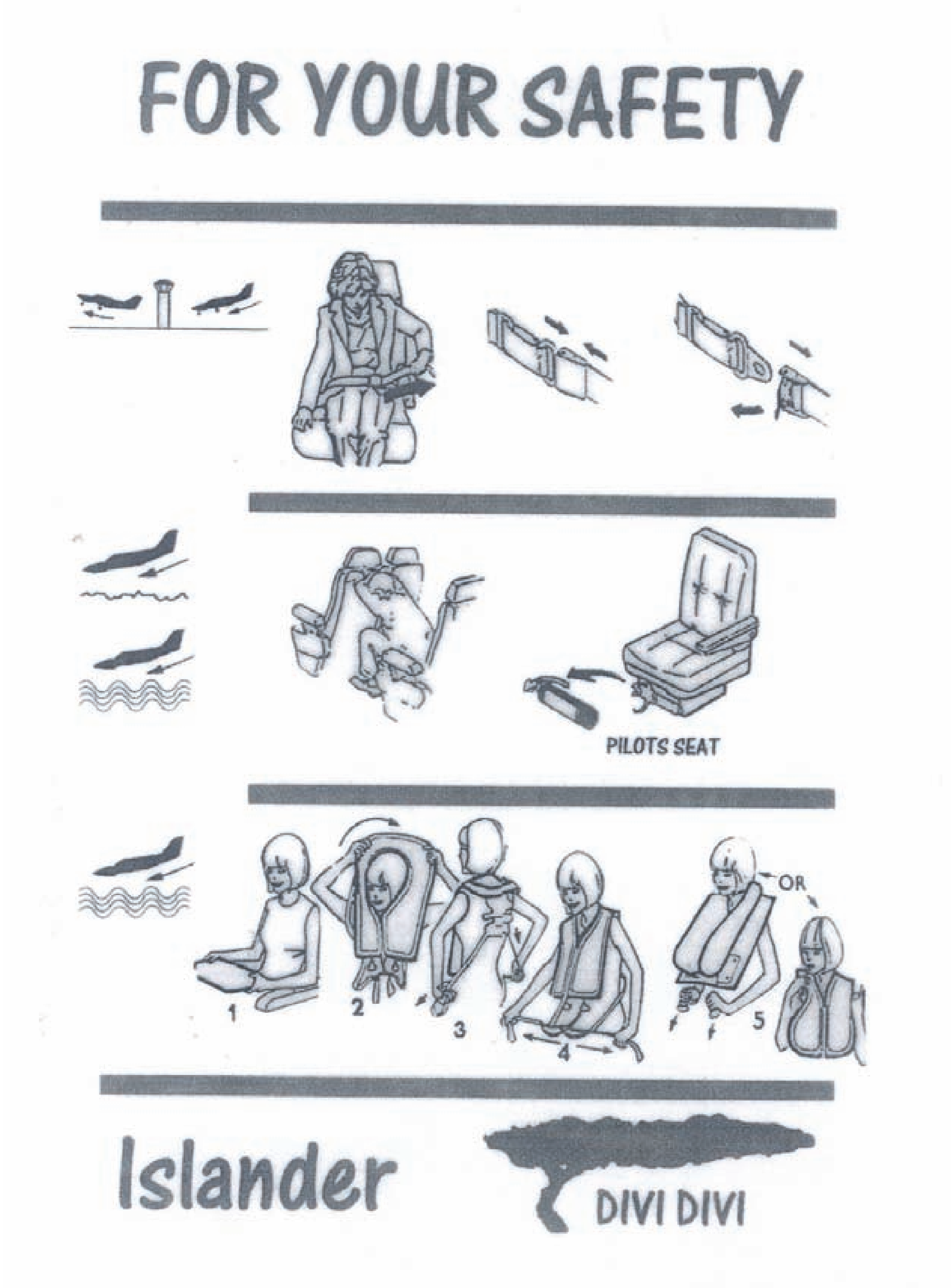
NAATC Netherlands Antilles Air Traffic Control

APPENDIX F: SAFETY INSTRUCTION CARD

Front side of the Britten-Norman Islander safety instruction card - Divi Divi Air



Back side of the Britten-Norman Islander safety instruction card - Divi Divi Air



APPENDIX G: CIVIL AVIATION REGULATIONS NETHERLANDS ANTILLES

Relevant regulations as described in Appendix A, related to the Standards for airworthiness of aircraft (O.J. 2008, no. 19), Part 5 - Airworthiness of the Civil Aviation Regulations of the Netherlands Antilles (CARNA). Also the regulations as described in Appendix A, relating to the Standards for preflight and flight operation (O.J. 2008, no. 22), Part 7 - Aircraft Instruments and Equipment, and Appendix B, relating to the Standards for preflight and flight operation (O.J. 2008, no. 22), Part 8 - Aircraft Operations of the CARNA.

Part 5 - Airworthiness

5.6 AIRCRAFT MAINTENANCE AND INSPECTION

5.6.1.9 AIRCRAFT MASS AND BALANCE
(a) General
(...)
(b) Periodic Determination of Mass
Unless otherwise approved by the Minister further determination of mass shall be done subsequent to the initial determination or mass determination arrived at in accordance with the above and at the intervals specified in the following;

(1) (...)
(2) Aircraft with a MTOM below 5700 kg, every 3 years.

Part 7 - Aircraft Instruments and Equipment

7.8 EMERGENCY EQUIPMENT

7.8.1.1 Emergency Equipment: All aircraft
Each item of emergency and flotation equipment shall be:

(1) Readily accessible to the crew and with regard to equipment located in the passenger compartment, to passengers without appreciable time for preparatory procedures;
(2) Clearly identified and clearly marked to indicate its method of operation;
(3) Marked as to date of last inspection; and
(4) Marked as to contents when carried in a compartment or container.

7.8.1.10 Individual Flotation Devices

(a) No person may operate an aircraft on flights over water, or a seaplane on any flight, unless it is equipped with one life jacket or equivalent individual flotation device for each person on-board.
(b) All life jackets or equivalent individual flotation devices shall be stowed in a position easily accessible from the seat or berth of the person for whose use it is provided.

(...).

Part 8 - Aircraft Operations

8.2 AIRCRAFT REQUIREMENTS

8.2.1.8 CIVIL AIRCRAFT FLIGHT MANUAL, MARKING AND PLACARD REQUIREMENTS

(a) No person may operate a civil aircraft unless there is available in the aircraft: (1) A current, approved AFM or RFM; or (2) An AOM approved by the Director for the AOC holder; (3) If no AFM or RFM exists, approved manual material, markings and placards, or any combination thereof, which provide the PIC with the necessary limitations for safe operation.
(b) No person may operate a civil aircraft within or over the Netherlands Antilles without complying with the operating limitations specified in the approved AFM or RFM, markings and placards, or as otherwise prescribed by the certifying Authority for the aircraft's State of Registry.
(c) Each operator shall display in the aircraft all placards, listings, instrument markings or combination thereof, containing those operating limitations prescribed by the certifying Authority for the aircraft's State of Registry for visual presentation.

8.6 FLIGHT RULES FOR ALL OPERATIONS

8.6.1.11 AIRCRAFT LOADING, MASS AND BALANCE

(a) No person may commence a flight unless all loads carried are properly distributed and safely secured, taking into consideration the effect of the mass on centre of gravity and floor loading limitations.

(b) No person may commence a flight unless the calculations for the mass of the aircraft and centre of gravity location indicate that the flight can be conducted safely and in accordance with the aircraft limitations, taking into account the flight conditions expected.

(c) Unless otherwise authorized by the Director, the computations for the mass and balance shall be based on the AFM or RFM method for determination of the CG and the mass values used for these computations shall be based on the:

(1) Aircraft empty mass derived through a periodic weighing of the aircraft;

(2) Actual mass of the required crew, their equipment and baggage;

(3) Actual mass of the passengers, their baggage and cargo; and

(4) Actual mass of the usable fuel boarded.

(d) For commercial air transport operations, no person may commence a flight unless these mass and balance computations are accomplished by qualified persons and are in conformance with the additional mass and balance requirements of Subpart 8.8 for AOC holders.

8.6.1.21 AIRCRAFT OPERATING LIMITATIONS

No person may operate a civil aircraft within or over a Netherlands Antilles territory without complying with the terms of its certificate of airworthiness, the operating limitations specified in the approved AFM or RFM, markings and placards, or as otherwise prescribed by the certifying Authority for the State of Registry.

8.6.1.29 DIVERSION DECISION

(a) Except as provided in paragraph (b) of this subsection, the PIC shall land the aircraft at the nearest suitable aerodrome at which a safe landing can be made whenever an engine of an aircraft fails or is shut down to prevent possible damage.

(…).

8.7 FLIGHT OPERATIONS

8.7.1.1 AIRCRAFT AIRWORTHINESS AND SAFETY PRECAUTIONS: GENERAL AVIATION

(a) A flight shall not be commenced until the pilot-in-command is satisfied that:

(1) the aircraft is airworthy, duly registered and that appropriate certificates are aboard the aircraft;

(2) the instruments and equipment installed in the aircraft are appropriate, taking into account the expected flight conditions;

(3) any necessary maintenance has been performed in accordance with Subpart 8.3;

(4) the mass of the aircraft and center of gravity location are such that the flight can be conducted safely, taking into account the flight conditions expected;

(5) any load carried is properly distributed and safely secured; and

(6) the aircraft operating limitations, contained in the flight manual, or its equivalent, will not be exceeded.

(b) The pilot-in-command shall ensure to have sufficient information on climb performance with all engines operating to enable determination of the climb gradient that can be achieved during the departure phase for the existing take-off conditions and intended take-off technique.

8.7.1.3 AIRCRAFT AIRWORTHINESS AND SAFETY PRECAUTIONS: COMMERCIAL AIR TRANSPORT OPERATIONS

(a) A flight shall not be commenced until flight preparation forms have been completed certifying that the pilot-in-command is satisfied that:

(…)

(4) the mass of the aircraft and center of gravity location are such that the flight can be conducted safely, taking into account the flight conditions expected;

(5) any load carried is properly distributed and safely secured;

(6) a check has been completed indicating that the operating limitations of Subpart 8.8 can be complied with for the flight to be undertaken; and

(7) the Standards of this Subpart relating to operational flight planning have been complied with.
(b) Completed flight preparation forms shall be kept by an operator for a period of three months.

8.7.2 OPERATIONAL CONTROL SYSTEM: COMMERCIAL AIR TRANSPORT

8.7.2.1 GENERAL
(a) An air operator's organizational chart must clearly show that the commercial function of the air operator (operations co-ordination) has no direct link or no authority over the air operator's operational control system.
(b) Operations conducted under Part 8 of these CARNA regulations require either a 'Type A' or 'Type B' operational control system.
(c) Another organization may be contracted to exercise operational control on behalf of an air operator.

8.7.2.2 APPLICABILITY
(...)
(b) A 'Type B' classification shall apply to air operators:
(1) operating cargo-only aeroplanes; or
(2) carrying passengers in Commercial Air Transport when:
(i) operating 6 or fewer aeroplanes with a passenger-seating configuration of fewer than 20; or
(ii) operating 3 or fewer propeller-driven aeroplanes with a passenger-seating configuration of 20 or more but fewer than 60.
(...).

Note: See IS: 8.7.2.2 for the 'Type A' and 'Type B' Operational Control Systems description.
Note: For purposes of this section, a combination of cargo and passenger flights will be considered passenger operations.

Implementing Standards CARNA Part 8

TYPE B - OPERATIONAL CONTROL SYSTEM

(a) RESPONSIBILITY AND AUTHORITY
Operational control is delegated to the pilot-in-command of a flight by the Director of Operations who retains responsibility for the day-to-day conduct of flight operations.
(...)
(e) DISPATCH RELEASE
Flights operated under this system are self-dispatched and released by the pilot-in-command. Where an air operator chooses to use a Dispatch Release, as required under a Type A system, the flight dispatcher preparing that release shall be qualified in accordance with Type A operational control system.

8.7.2.3 RESPONSIBILITY FOR OPERATIONAL CONTROL
(a) Each AOC holder conducting flight operations under Part 8 or a designated representative shall have responsibility for operational control over any flight operated under the terms of his AOC.
(b) An operator shall establish and maintain a method of exercising operational control approved by the Director.

8.7.3 FLIGHT PREPARATION

8.7.3.14 FLIGHT PLANNING DOCUMENT DISTRIBUTION AND RETENTION: COMMERCIAL AIR TRANSPORT
(a) For commercial air transport operations, the PIC shall complete or review and sign the flight release form before commencing a flight indicating that he/she is satisfied with-
(...)
(2) The load manifest, showing the distribution of the load, centre of gravity, takeoff and landing mass and compliance with maximum operating mass limitations, and performance analysis;
(...)
(6) That a check has been completed indicating that the operating limitations for the aircraft in use can be complied with for the flight.

(b) No person may take off an aircraft unless a copy of all flight preparation documents, signed by the PIC, are retained and available with a company representative at the point of departure, unless a different retention method has been approved by the Director.
(c) The PIC shall carry a copy of the documents specified in paragraph (a) of this subsection on the aircraft to the destination aerodrome.
(d) These documents will be retained by the AOC holder for at least 3 months.

8.7.4 IN-FLIGHT PROCEDURES

8.7.4.1 GENERAL
(a) All aircraft shall be operated:
  (1) in compliance with the terms of its certificate of airworthiness or equivalent approved document;
  (2) within the operating limitations prescribed by Director;
  (…)
  (4) within the operating limitations contained in the aircraft's flight manual, or its equivalent.
  (…)
(c) No person may commence a flight unless the calculations for the performance of the aircraft in all phases of flight indicate that the flight can be conducted safely and in accordance with the aircraft's designed performance limitations for any operation, taking into account the flight conditions expected.

Note: When applying performance data, each person performing calculations shall account for the aircraft configuration, environmental conditions and the operation of any system or systems that may have an adverse effect on performance.

(d) No person may commence a flight that, given the aircraft's mass and assuming normal engine operation, cannot safely clear all obstacles during all phases of flight, including all points along the intended en route path or any planned diversions.
(e) No person may commence a flight without ensuring that the maximum allowable mass for a flight does not exceed the maximum allowable takeoff or landing mass or any applicable en route performance or landing distance limitation considering the:
  (1) Condition of the takeoff and landing areas to be used;
  (2) Gradient of runway to be used (landplanes only);
  (3) Pressure altitude;
  (4) Ambient temperature;
  (5) Current and forecast winds; and
  (6) Any known conditions (e.g., atmospheric and aircraft configuration), such as density altitude, which may adversely affect performance.
(f) For commercial air transport operations, no person may commence a flight unless the performance computations are accomplished by qualified persons and are in conformance with the additional performance requirements of this Subpart for AOC holders.

8.8 AIRCRAFT OPERATING AND PERFORMANCE LIMITATIONS

8.8.2 MASS AND BALANCE

8.8.2.5 DETERMINATION OF AIRCRAFT EMPTY OPERATING MASS
(a) The holder of an AOC shall not operate an aircraft unless:
  (1) The aircraft has been weighed during the period of three years immediately preceding the operation, and a mass and balance report has been produced which shows the aircraft's empty operating mass and which is available in respect thereof;
  (…).

8.8.2.6 DETERMINATION OF ACTUAL PASSENGER MASS
(a) When making the determination of actual mass, the passengers' personal belongings and carry-on baggage must be included.
(b) The determination of the mass of the passengers and their items shall be conducted immediately prior to boarding and at an adjacent location.

8.8.2.7 DETERMINATION OF AVERAGE PASSENGER MASS

(a) No person may use average passenger mass in the computation of aircraft loading and CG, unless there has been a determination of the relationship between the actual mass being carried and the selected average mass to determine their validity.

(b) The method for the determination of the relationships shall be determined through the method prescribed by the Director.

8.8.3 APPLICABLE MASS AND PERFORMANCE

8.8.3.1 AIRCRAFT PERFORMANCE CALCULATIONS

(a) No person may commence a flight in commercial air transport without ensuring that the applicable operating and performance limitations required for this Part can be accurately computed based on the AFM, RFM or other data source approved by the Director.

(b) Each person calculating performance and operating limitations for aircraft used in commercial air transport shall ensure that performance data used to determine compliance with this Part can, during any phase of flight, accurately account for:

(1) Any reasonably expected adverse operating conditions that may affect aircraft performance;

(2) One engine failure for aircraft having two engines, if applicable; and

(3) (...).

(c) When calculating the performance and limitation requirements, each person performing the calculation shall, for all engines operating and for inoperative engines, accurately account for:

(1) In all phases of flight:

(...)

(v) Ambient temperatures and winds along intended route and any planned diversion; and

(vi) Flight paths and minimum altitudes required to remain clear of obstacles; and

(2) During takeoff and landing:

(...)

(iv) Pressure altitudes at takeoff and landing sites;

(v) Current ambient temperatures and winds at takeoff;

(...).

8.8.4 RESTRICTED PERFORMANCE AIRCRAFT

8.8.4.1 SINGLE ENGINE AIRCRAFT

Except as provided in section (...), no person may operate a single-engine aircraft used for passenger carrying operations in commercial air transport unless that aircraft is continually operated:

(1) In daylight;

(2) VMC, excluding over the top of any cloud layer; and

(3) Over such routes and diversions there from that permit a safe forced landing to be executed in the event of engine failure.

8.8.4.2 RESTRICTED PERFORMANCE MULTI-ENGINE AIRCRAFT

(a) No person may operate a restricted performance multiengine aircraft with a passenger capacity of 9 passengers or less in commercial air transport carrying passengers that will be unable to comply with the performance limitations of this Part, unless that aircraft is continually operated at a mass that will allow it to climb, with the critical engine inoperative:

(1) At least 200 feet per minute immediately after takeoff;

(2) At least 50 feet a minute when operating at the MEA of the intended route or any planned diversion, or at 5000 feet MSL, whichever is higher; and

(3) At least 200 feet per minute in the climb-out following a balked landing.

(b) If the aircraft's performance capability is computed to be less than specified in paragraph (a) of this subsection, the person(s) operating that aircraft shall comply with the performance restrictions applicable to single-engine aircraft.

8.8.6 EN ROUTE LIMITATIONS

8.8.6.2 AEROPLANES - ONE ENGINE INOPERATIVE

No person may take off an aeroplane used in commercial air transport having two engines unless that aeroplane can, in the event of a power failure at the most critical point en route, continue the flight to a suitable aerodrome where a landing can be made while allowing:

(1) For reciprocating engine powered aeroplanes:

(i) At least a rate of climb of 0.079 (0.106/number of engines installed) $V_{so}2$ (when V_{so} is expressed in knots) at an altitude of 300 meter (1000 feet) above all terrain and obstructions within 9.3 km (5 statute miles), on each side of the intended track; and

(ii) A positive slope at an altitude of at least 450 m (1500 feet) above the aerodrome where the aeroplane is assumed to land;

(...).

Vso2 of BN-2 = ? Not presented in § 2.

8.9 PASSENGER CARRYING OPERATIONS

8.9.1 GENERAL PASSENGER CARRYING REQUIREMENTS

8.9.1.6 PASSENGER BRIEFING

(a) No person may commence a takeoff unless the passengers are briefed prior to takeoff regarding procedures on:
  (...)
  (2) Emergency exit location and use;
  (3) Use of safety belts;
  (4) Emergency floatation means location and use;
  (5) Fire extinguisher location and operation;
  (6) Placement of seat backs;
  (...)
  (8) The passenger briefing card.
(b) Immediately before or immediately after turning the seat belt sign off (if applicable), the PIC shall ensure that the passengers are briefed to keep their seat belts fastened while seated, even when the seat belt sign is off.
(c) Before each takeoff, the PIC shall ensure that any persons of reduced mobility are personally briefed on:
  (1) The route to the most appropriate exit; and
  (2) The time to begin moving to the exit in event of an emergency.

8.9.1.7 IN-FLIGHT EMERGENCY INSTRUCTION

In an emergency during flight, the PIC shall ensure that all persons on-board are instructed in such emergency action as may be appropriate to the circumstances.

8.10 CREW MEMBER AND FLIGHT OPERATIONS OFFICER QUALIFICATIONS: COMMERCIAL AIR TRANSPORT

8.10.1.14 INITIAL AIRCRAFT GROUND TRAINING

(a) No person may serve nor may any AOC holder use a person as a crew member or flight operations officer unless he or she has completed the initial ground training approved by the Director for the aircraft type.
(b) Initial aircraft ground training for flight crew members shall include the pertinent portions of the operations manuals relating to aircraft-specific performance, mass and balance, operational policies, systems, limitations, normal, abnormal and emergency procedures on the aircraft type to be used.
  (...).

8.10.1.15 INITIAL AIRCRAFT FLIGHT TRAINING

(a) No person may serve nor may any AOC holder use a person as a flight crew member unless he or she has completed the initial flight training approved by the Director for the aircraft type.
(b) Initial flight training shall focus on the manoeuvring and safe operation of the aircraft in accordance with AOC holder's normal, abnormal and emergency procedures.
(c) An AOC holder may have separate initial flight training curriculum which recognise the experience levels of flight crew members approved by the Director.

APPENDIX H: DESCRIPTION OF THE CRISIS (RESPONSE) PLANS

Bonaire crisis response island ordinance[130]
The island ordinance is local legislation on the Bonaire island territory wherein rules concerning preparation and response to disasters are laid down. This ordinance states that the island council should draw up an island crisis plan wherein is stated how the authorities will respond to disasters in order to prevent them (article 3). The island ordinance also prescribes that a crisis plan be defined for specific disasters regarding which the nature and the consequences can be foreseen in which measures are included that have been implemented to prepare for the response to a specific disaster (article 4). This is the Bonaire aircraft accident crisis response plan and the maritime Coastguard crisis response plan for the Netherlands Antilles and Aruba for the aviation accident disaster type.

Bonaire island territory crisis plan
The crisis plan has been developed by the authorities as a manual for a structured and coordinated approach to serious, large-scale accidents and disasters. The Bonaire crisis plan consists of nine specific sub plans that cover a specific area such as public order and safety, healthcare and administrative issues. These sub plans describe the required actions/activities for every organisation involved in crisis response. Small, specialised teams called ESF groups (emergency support functions) are appointed to draw up and maintain these sub plans. Besides maintaining the sub plans, the ESF groups also have responsibility for the practise and repressive realisation of the plans.

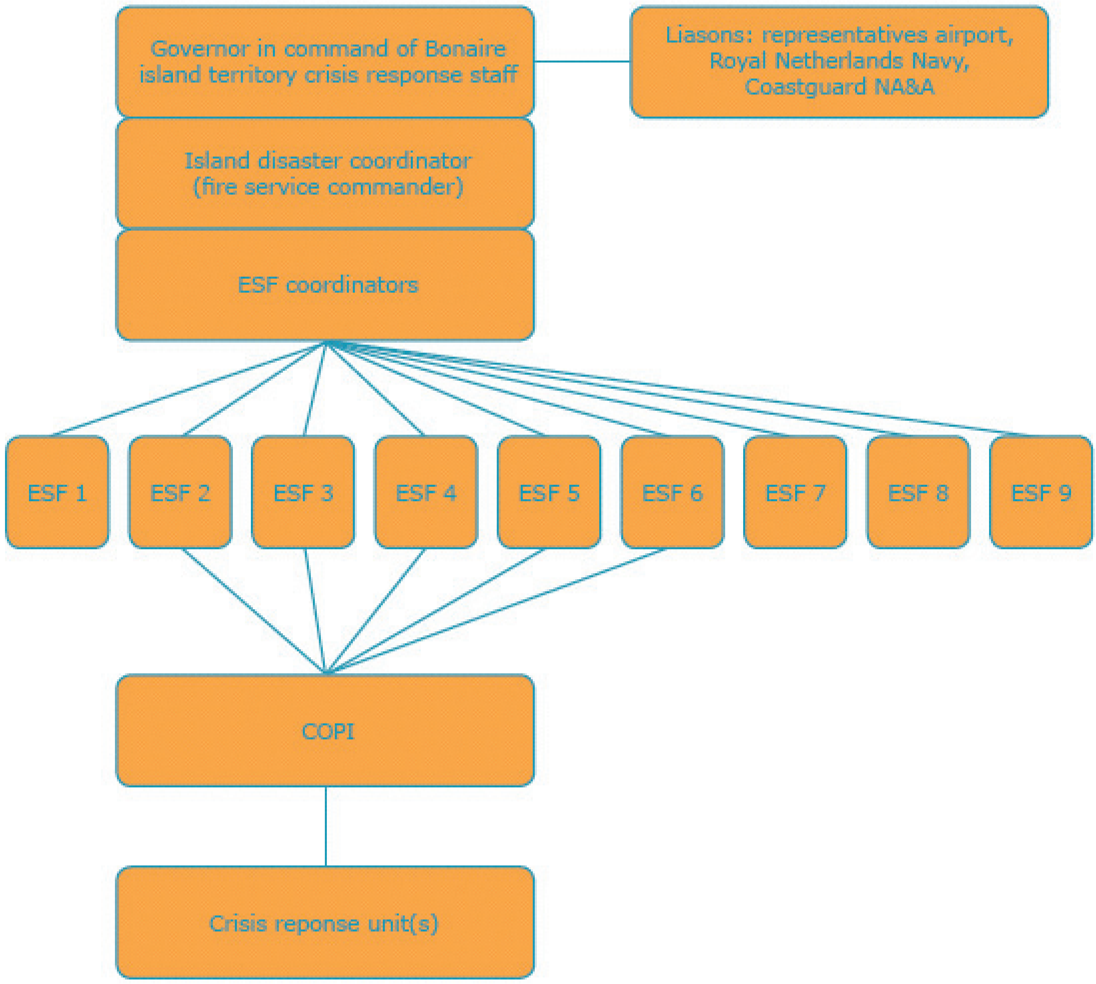


Figure 12: schematic representation of the Bonaire island territory crisis plan

130 Island ordinance dated 13 August 2002, no. 1 that defines the rules to prepare for responding to disasters, Bonaire.

The crisis plan regulates the composition and tasks of the various/different officials of the ESF groups. The scaling structure of the crisis response organisation and alerting are also described. If the incident involves clear consequences for the immediate area, the alarm is scaled up to a higher level (GRIP II). Administrative parties who have a seat in the island crisis response staff group are also alerted.

The crisis plan has three levels: strategic, tactical and operational. The highest, or strategic level, consists of the Island crisis response body led by the governor, along with the island disaster coordinator (ERC; the fire service commander), ESF groups coordinators and other consultants and representatives of the various services as appointed by the governor. The tactic level consists of combined ESF groups. On an operational level, there is the incident site command (CoPI) consisting of at least officials of the fire service, police and the Dienst Gezondheidszorg en Hygiëne (Bonaire DGH) that controls the crisis response unit(s). The fire service officer on duty[131] will act as the leader of the CoPI.

Crisis response plans
The relevant appointed organisations have a crisis response plan with procedures to correctly prepare the response to a serious accident. These plans are harmonised with the authorities and other involved parties. The governor draws up crisis response plans in accordance with island regulations. The underlying principle is that this should be linked to the daily practices of every part of the island organisation. Organisations are responsible for preparing for any task assigned to them within the crisis response plan. The island executive Board oversees the execution of these responsibilities.

Bonaire aircraft accident crisis response plan
The Bonaire aircraft accident crisis response plan[132] should prepare the authorities, airport and emergency services (of Bonaire) for possible aircraft accidents. The crisis response plan fits in with the Bonaire island territory crisis plan. The aviation accident crisis response plan describes the different accidents and scenarios very globally. The different alerting phases, the involved services and organisations and the alerting and warning are described in greater detail. The "response and emergency supporting services" organisation structure is described on both an island and local level at the location of the accident. A detailed description of the response and emergency supporting services in the event of an aircraft accident within the airport area is included in the plans. Other scenarios are not discussed in detail. Attention is also paid to the "tasks and competences of the Netherlands Antilles" in the event of an aircraft accident and the maintenance of the document and the drill programme are described.

Netherlands Antilles and Aruba Coastguard maritime crisis response plan
Providing emergency services and responding to a disaster at sea is a task of the Netherlands Antilles & Aruba Coastguard (NA&A Coastguard). This task is further elaborated in the NA&A Coastguard maritime crisis response Plan. The basic principle is that (local) governors are responsible for crisis response on their own island and inland waters. The prime minister of the Netherlands Antilles is responsible for crisis response in territorial waters and when disasters go beyond the island's territory. Maritime emergency services and crisis response are implemented under supervision of the Coastguard Centre. This has been further elaborated in four separate sections by the NA&A Coastguard for a number of specific disasters, that is, an environmental disaster, aviation accident, shipping accident and a natural disaster.

The NA&A Coastguard maritime crisis response plan consists of three levels: strategic, tactical and operational. The highest, the strategic level, consists of two levels. On a national level and under the leadership of the Ministry of General Affairs, there is the national disaster coordinator (in this case, the director of STIRANA (national foundation for disaster preparedness Netherlands Antilles) who is charged with preparing and executing the crisis response organisation. On an island level, the island disaster staff acts under the management of the local governor. NA&A Coastguard liaison officers participate on both strategic levels.

131 The fire service have a duty roster for the officer on duty in which the fire service commander and the deputy fire service commander are alternately on duty.
132 Bonaire aircraft accident crisis response plan, version 1.03. Date of the last update 22 June 2006.

The tactical level consists of the island operational team as is the case on Bonaire with regard to the coordinators of the different executive services and organisations (emergency support functions) that control the operation. On an operational level, the Coastguard centre acts as the operations centre for search and rescue activities and maritime crisis response and is charged with the operational leadership and deployment of resources.

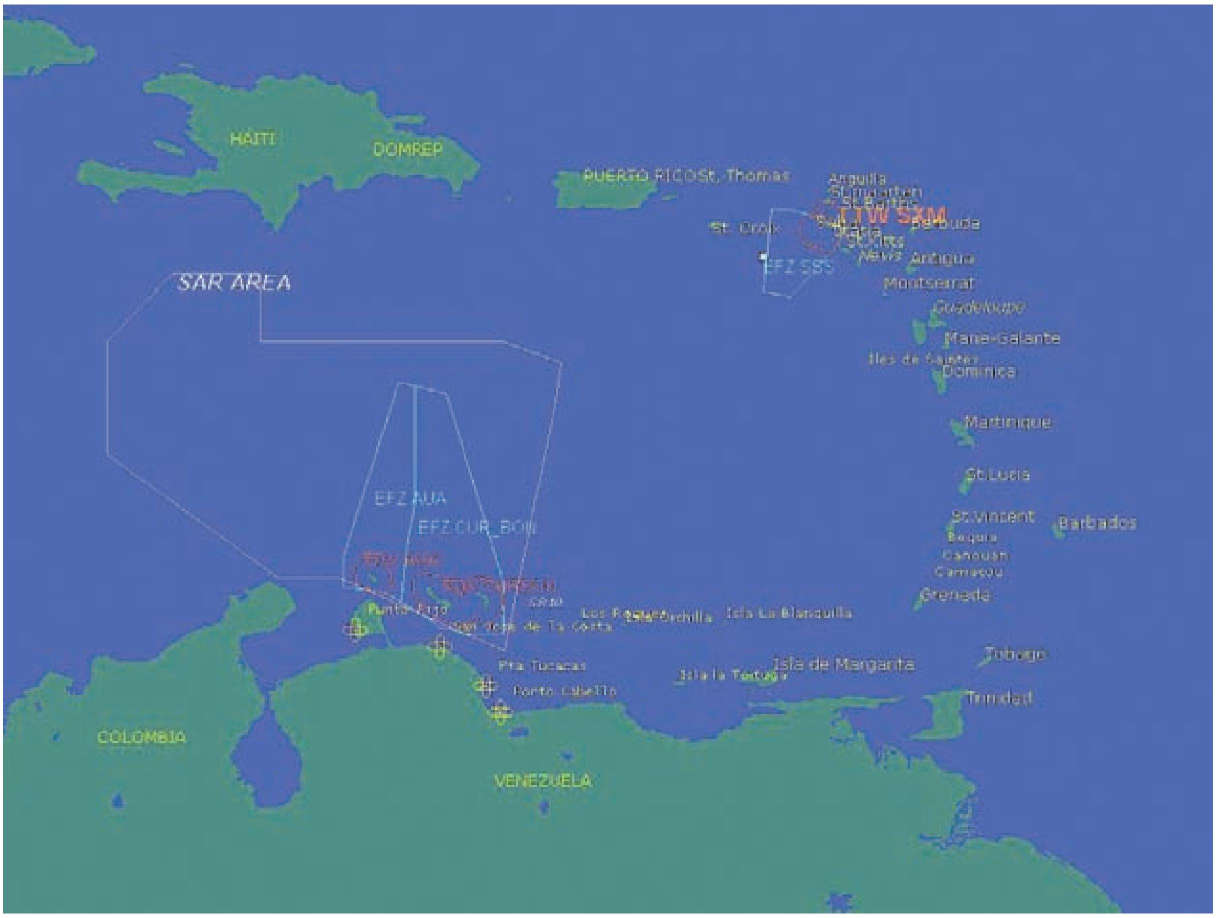


Figure 13: Netherlands Antilles & Aruba Coastguard operational area

When it involves an aircraft accident at sea, the NA&A Coastguard is charged with the operation of the rescue and providing emergency supporting services. The crisis response organisation of the island where the victims are brought on to shore will, next, take responsibility for passenger reception and care.

APPENDIX I: ASSESSMENT FRAMEWORK CONCERNS

Safety management refers to the way in which the details are provided with regard to organisations' responsibilities in relation to safety in addition to defining this through the available legislation, regulations, standards and guidelines. For example, the way in which risks are mapped for those involved and the way in which risks are controlled in a structural manner. The organisation requires a structure to ensure that the whole process can be executed and made transparent and to create possibilities for continued improvement. This structure is called the safety management system. Various previous incidents have shown that the safety management system structure and the elaboration of the system by the various parties involved plays a crucial role in the management, assurance and continued improvement of safety.

The Dutch Safety Board bases its investigations on five general safety principles. These principles are used to determine whether and how the parties have fulfilled their own responsibilities with regard to safety. The Dutch Safety Board informed the Dutch Ministry of the Interior and Kingdom Relations about this through a letter.

1. *Acquiring demonstrable insight into safety risks as the basis for the safety approach*
   The starting point to achieve the required level of safety is:
   - exploration of the entire system; and
   - making an inventory of the related risks.

   This information is used to determine which risks must be controlled and the related preventive and repressive measures.

2. *Demonstrable and realistic safety approach*
   A realistic and practical safety approach, i.e. a safety policy, must be defined to prevent and control undesired events. This safety approach is based on the following:
   - relevant legislation and regulations in force (section 3.2);
   - available standards, guidelines and best practices from the sector, personal insights and experiences from the organisation and the safety targets specifically defined for the organisation.

3. *Implementing and enforcing the safety approach*
   The implementation and enforcement of the safety approach and controlling identified risks takes place through:
   - a description of the method in which the used safety approach is realised focussing on specific goals and plans including the preventive and repressive measures that arise from this approach;
   - transparent and unambiguous subdivision of responsibilities with regard to the safety on the work floor that is accessible to all for the implementation and enforcement of safety plans and measures;
   - clear definition of the required staff deployment and expertise for the various tasks;
   - a clear and active central coordination of safety activities;
   - realistic practising and testing the safety approach.

4. *Making the safety approach stricter*
   The safety approach must be continuously assessed and fine tuned based on:
   - the regular performance of (risk) analyses in the area of safety, observations, inspections and audits and, in any case, every time a basic principle changes (proactive approach);
   - a monitoring system and investigation of near accidents and incidents in the complex and an expert analysis thereof (reactive approach).

Based on this, assessments are made and improvement issues are brought to light that can be used to actively steer.

5. *Management steering, commitment and communication*

The management of the involved parties/organisation must:

- take care internally for clarity and realistic expectations with regard to the safety ambition, ensure there is a climate of continuous improvement of safety on the work floor;
- clearly communicate externally about the general working method, the verification method thereof, procedures with regard to deviations and exceptions, etcetera, based on transparent and defined agreements with the environment.

APPENDIX J: PJ-SUN WEIGHT AND BALANCE REPORT

This appendix contains the last current PJ-SUN weight and balance report. It should be noted that it is stated in this weight and balance report (19 August 2009) that the validity of calibration (3 June 2009) of the used scales had expired two months earlier. The effect of this on the aircraft's weight is ~~deemed~~ negligible.

WEIGHT AND BALANCE REPORT

SCALE S/N (R) S/N: 29847	(B) S/N: 29731	(Y) S/N: 29845	CALIBRATION DATE : 3-6-2008
Scales P/ :GECFB-10000-A3	Type: Electronic(load cell)		CALIBRATION DUE : 3-6-2009
Date Weighed: Aug 19, 2009	Place Weighed: DiviDivi Hangar Curacao N.A.		
Model: BN2A-26	Registration No: PJ-SUN	Serial No: 0377	

Weighing Point	Scale Reading	Correction On Scale	Net Weight	Arm (Inches)	Moment
LEFT MAIN	1985	0	1985	40.7	80789.5
RIGHT MAIN	1855	0	1855	40.7	75498.5
SUBTOTAL BOTH MAIN					
NOSE	486	0	486	-116.5	-56619
TOTAL (AS WEIGHED)			4326		999669

Weighing Record

Description	Net Weight	Arm	Moment
Total (As Weighed)	4326	23.04	99669
Oil on Airplane FULL OIL			
Total of items weighed but not part of Basic Weight ** FULL FUEL** Less Usable			
Total of basic items not included in Airplane when weighed			
Basic Airplane			

Remarks and calculations: Aircraft weighed in a closed Hangar, with residual fuel in main tanks, all seats installed, full oil, life jackets, flight manuals, First aid kit and fire extinguisher on board. Plat form scales model GECFB-10000-A3.

Was this 42 lb unusable fuel?

New Basic Weight	4326
New Moment	99669
New C.G.	23.04
Useful Load	2274
Mechanic	[redacted]
License Nr.	[redacted]
Signature	
Date	19-Aug-2009

Divi Divi Maintenance

FORM DDM-15

Numbers on Load and Balance sheet page 75 are different.

APPENDIX K: CALCULATION FLIGHT DVR014 ACTUAL CENTRE OF GRAVITY

This Appendix reconstructs the position of the centre of gravity of flight DVR014. The weights as filled in on the load and balance sheet (Appendix D) and the actual weights (after measuring) with corresponding moment arms and moments are displayed in the table below.

The position of the actual centre of gravity is determined by dividing the total moment (180,980 lb.inch) by the total actual weight (7211 lb). The actual centre of gravity was virtually located at the aft limit (25.1 inch) but was still within the limitations as defined by the manufacturer. The aft limit lies at 25.6 inch from the datum plane.

It should be noted that the position of two passenger travelling bags that were in the cabin were not taken into account. The weight of this additional luggage was added to the overall luggage weight in the reconstruction. This has not had any consequences for the calculation of the total weight. The effect on the forward shifting of the centre of gravity can be considered slight.

		Moment arm	***Weight as completed***		***Reconstruction (actual weight)***	
	Station number[133]	Station no. - 134.5[134]	Weight	Moment	Weight	Moment
		inch	lb	lb.inch/100	lb	lb.inch/100
Empty equipped weight (EEW)		26.76 (old) 23.04 (actual)	4367	1168.6	4326	996.7
Row 1 (pilot and passenger 1)	89	-45.5	320	-145.6	342	-155.6
Row 2 (passengers 2 and 3)	120	-14.5	320	-46.4	342	-49.6
Row 3 (passengers 4 and 5)	150	15.5	320	49.6	390	60.5
Row 4 (passengers 6 and 7)	179	44.5	320	142.4	401	178.4
Row 5 (passengers 8 and 9)	207	72.5	160	116.0	399	289.3
Luggage	255.5	121	93	112.5	231	279.5
Zero-Fuel Weight (ZFW)					6431	1599.2
Fuel	161.5	27	700	189.0	780	210.6
Take-off weight (TOW)			6600	1586.1	7211	1809.8
Fuel consumption CUR-BON					90	
Estimated Landing weight					7121	
Centre of gravity zero-fuel weight (ZFW) of the reconstruction:						24.9 inch
Centre of gravity take-off weight (TOW) of the accident flight:						24.0 inch
Centre of gravity take-off weight (TOW) of the reconstruction:						25.1 inch

Table 7: overview of completed and actual weights with the related moment arm and moment

133 The manufacturer divided the aircraft into station numbers for design and construction purposes as well as other issues. The position of these station numbers are mentioned in the flight manual and are expressed in inch with respect to the nose of the aircraft; station number 0. See figure 14.

134 Station number 134.5 inch is the wing leading edge based on which the position of the centre of gravity is calculated. See figure 14.

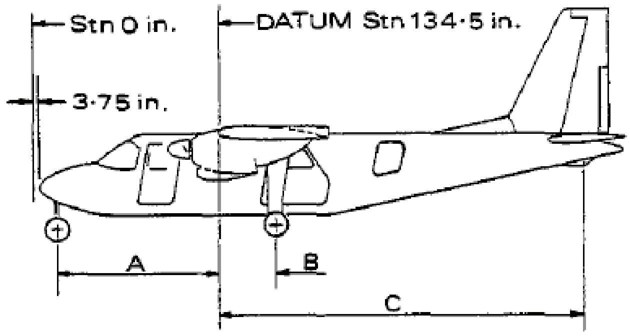
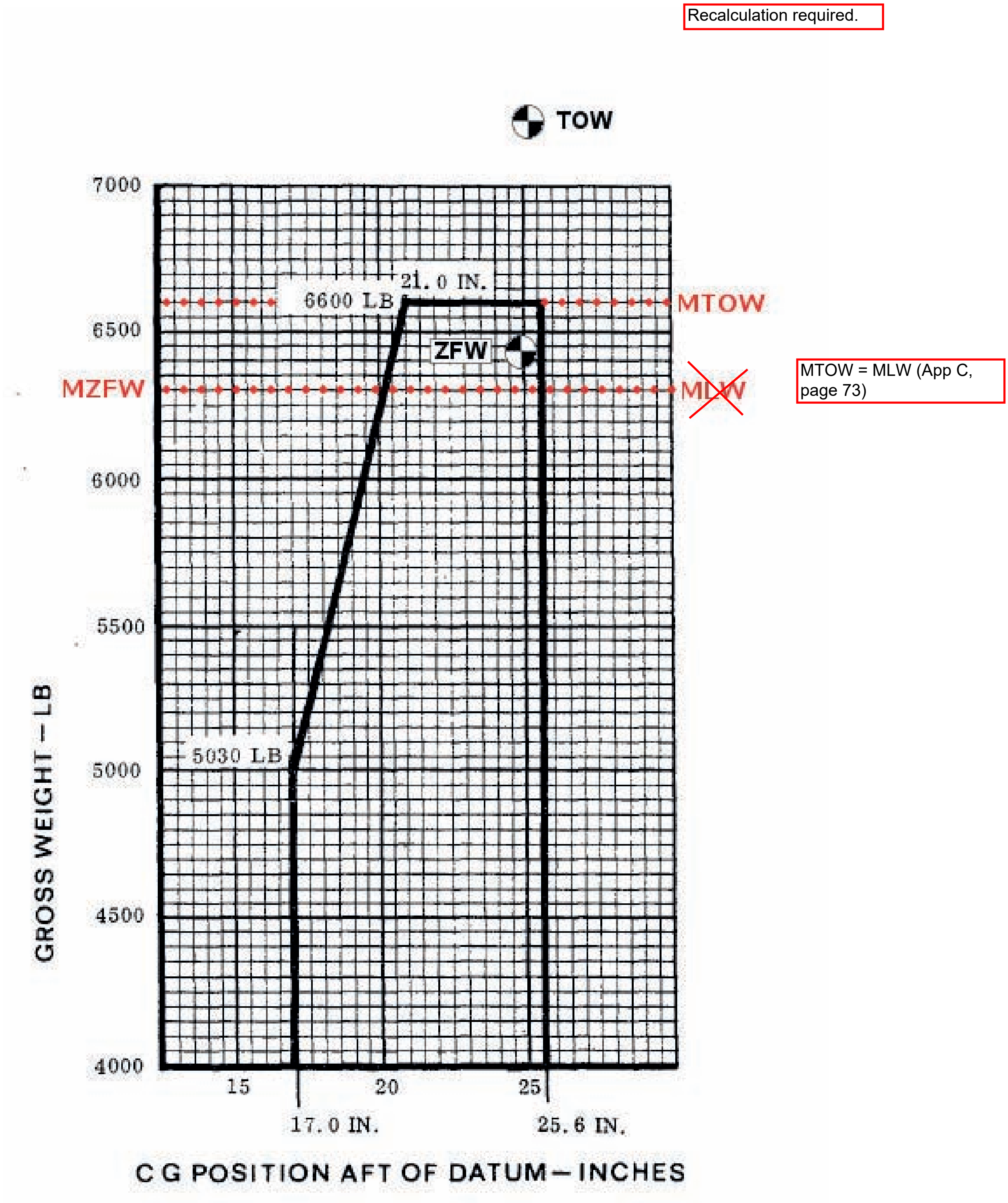


Figure 14: representation of station numbers of aircraft nose and wing leading edge

APPENDIX L: POSITION OF THE ACTUAL CENTRE OF GRAVITY IN THE DIAGRAM

The position of the actual centre of gravity was at 25.1 inch at a take-off weight (TOW) of 7211 lb and is displayed in the diagram below from the flight manual. The position of the actual zero-fuel weight centre of gravity was at 24.9 inches at a zero-fuel weight (ZFW) of 6431 lb.



APPENDIX M: RATE OF CLIMB WITH ONE ENGINE

+ bank angle for minimum drag.

The rate of climb (vertical speed) with one working engine at 2700 RPM and an airspeed of 65 knots can be read from the graph below. The rate of climb is a function of the ~~flying~~ altitude, air temperature, and aircraft weight. The extrapolation in the figure was carried out with the manufacturer's consent. The results are displayed in the table below. It should be noted that the values are gross values. This means that the reductions in performance of aircraft as they are used more and become older have not been taken into account. In practice, these values will be lower.

called: aging aircraft.

Graph line colour	Altitude [feet]	Temperature in standard atmosphere (ISA) [degrees Celsius]	Estimated temperature[135] [degrees Celsius]	Weight [lb]	Rate of climb [feet per minute]
blue	sea level	15	31 ~~(ISA+16)~~	7186	-40
green	160[136]	15	31 ~~(ISA+16)~~	5675	200
red	3500	8[137]	21 ~~(ISA+13)~~	7186	-125

Table 8: rate of climb with one failed engine

Why this column? Actual OAT at SL is required to use in the graph on the next page.

Estimated? SL temp was measured (=OAT). Other temps are i.a.w. ISA. Only state ISA, not ISA + xx.

21? (would be ISA + 6) or 31 - 7 = 24 (ISA + 9)?? The temp difference between SL and 3500 ft is 7° C (i.a.w. standard lapse rate (theta) - footnote 137) If 31° at SL, then 24° at 3500 ft. Did writers understand ISA and performance calculations? No.

Confusing, isn't it? ISA should not be mentioned.

An engine produces power dependant on the OAT, not ISA. Therefore, the OAT (at SL) should be used to enter the graph on the next page, not ISA + or - some value. OAT is read from a OAT gauge in the cockpit. No recalculation to some ISA referenced temp should be necessary. The temp lapse rate (theta) of the temperature lines in the graph is i.a.w. ISA. To avoid misinterpretation, the manufacturer should have presented an example.

It would be easier for a pilot if the manufacturer had provided OAT lines and numbers in the graph to avoid the pilot from calculating the temp at SL when an engine failure occurs during flight (find drift down altitude), or when taking off from a high altitude airport.

?? What are you saying? Why this table row and associated footnote, and why the green line in the graph below? Why 160 ft? Where is the requirement? The writers obviously didn't understand performance calculations.

What weight? MTOW!

approximately

135 Based on the high altitude temperatures in Section 2.9.
136 Assuming 50 feet (take-off segment) above ground level Hato airport. This corresponds with 160 feet (50+110) in the standard atmosphere.
137 Temperature decrease with increasing altitude is 2 degrees Celsius per 1000 feet.

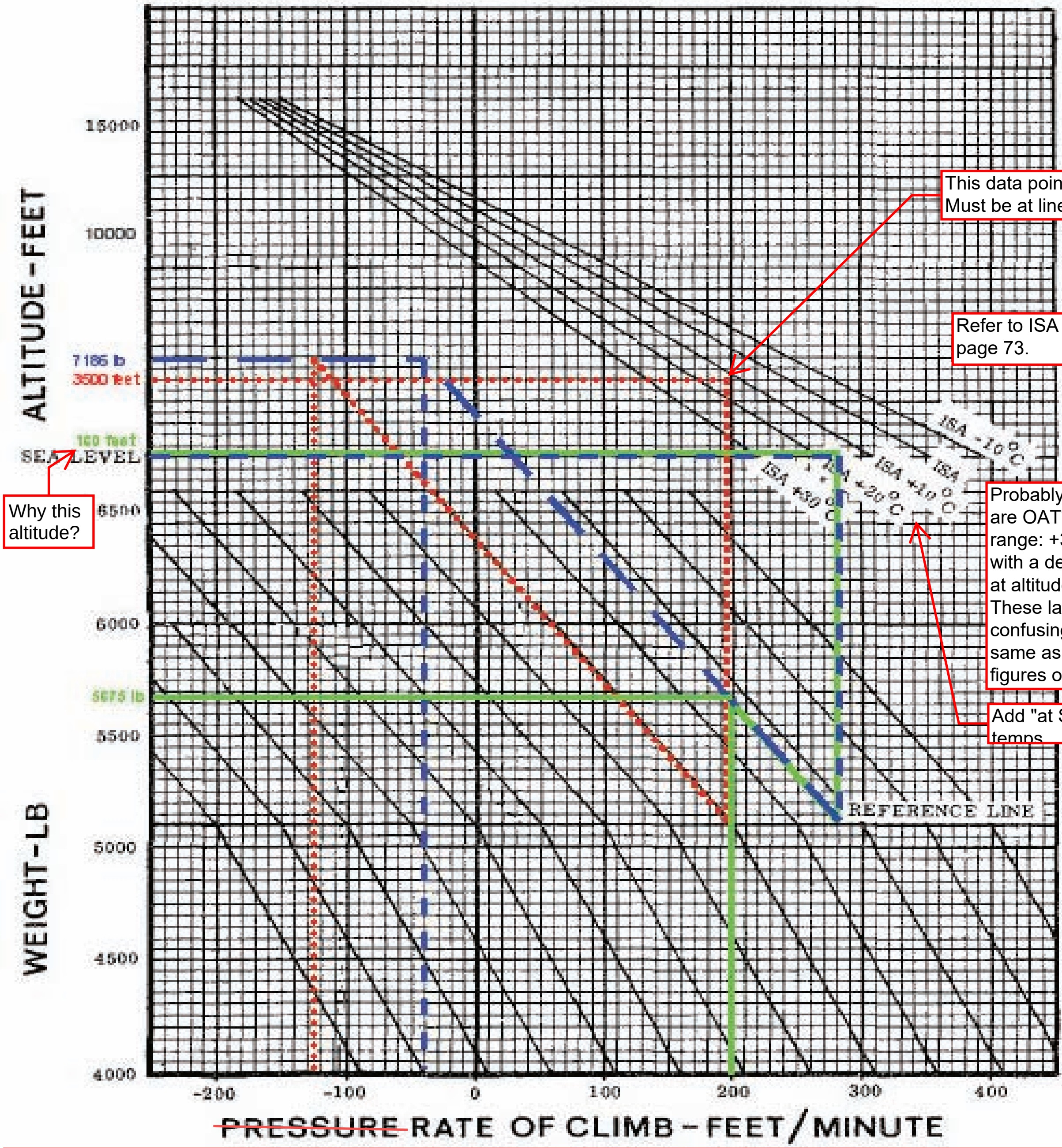
Why was the drift down altitude not determined?

Why was the weight for ROC>= 0.079 Vso2 (§ 8.8.6.2, page 87) above 1000 ft not determined?

Islander CAA approved Flight Manual

FM/7

EN ROUTE CLIMB – ONE ENGINE INOPERATIVE



This data point is not right. Must be at line 31°C SL.

Refer to ISA notes on page 73.

Why this altitude?

Probably meant here are OAT's at SL, range: +30° to -10°C, with a decrease (theta) at altitude i.a.w. ISA. These labels are confusing and not the same as used in figures on page 73.

Add "at SL" to these temps.

If this is the complete page out of the Flight Manual? The manufacturer should have:
- Added sample lines to show the correct use of the graph to avoid mis-use and mis-understanding.
- Used OAT rather than ISA +/- xx°C (OAT is shown by OAT gauge in cockpit).

For the presented data to be valid, the legend of this graph should have shown:
- Required airspeed (usually Vyse).
- Required bank angle (usually 3° away from the inoperative engine at Vyse, i.e. straight flight!).
- Airplane configuration, like propeller feathered, power setting operative engine, flaps, etc.

APPENDIX N: RANDOM CHECK OF THE LOAD AND BALANCE SHEETS

A random check was carried out on the take-off weight as completed in the load and balance sheets of flights performed by Divi Divi Air with the Britten-Norman Islander aircraft in use, all of the type BN-2A-26. For this purpose were investigated the completed load and balance sheets in a period before the accident flight and thereafter.

The applied average weight for pilot and passengers (including hand luggage) on these sheets was 160 lb. The MTOW of the BN-2A-26 is 6600 lb. The MLW and MZFW are each 6300 lb. The maximum CLTOW is 6600 lb.[138] The fuel consumption for a flight between Curacao and Bonaire is 90 lb. Therefore the maximum allowable take-off weight for a flight between Curacao and Bonaire is 6390 lb (MLW including fuel consumption CUR-BON).

Observations
The completed load and balance sheets and corresponding passenger lists with the luggage labels and luggage weight of a total of 94 flights, including the accident flight, that were performed in the period 10 August 2009 up to and including 1 November 2009 were studied. The table below contains the number of investigated flights per aircraft registration.

Registration	*Number of investigated flights in period of time*
PJ-SUN	43
PJ-SKY	43
PJ-SEA	8
Total	94

Table 9: overview of number of investigated flights per aircraft registration

Only copies without luggage labels were investigated with regard to the passenger lists from Bonaire to Curaçao. For these flights, therefore, the luggage weight on the related load and balance sheet could not be checked.

Results
- 30 of 94 flights (32%) had 6600 lb as specified take-off weight.
- 57 of 94 flights (61%) had a specified take-off weight higher than 6390 lb.
- Aforementioned results occurred for all three aircraft in use and with different pilots.
- The same weight for luggage and/or fuel for different flights on one day with the same aircraft occurred.
- The weight of luggage regularly deviates from the total of the weights indicated on the luggage labels. The luggage labels sometimes use different weight units, for example, lb and kg.

Conclusions
1. The maximum allowable take-off weight of 6390 lb (maximum structural landing weight including fuel consumption for the flight) exceeded in 61% of the investigated flights.
2. A take-off weight of exactly 6600 lb that occurs in 32% of the investigated flights, is an indication that the weight values on the load and balance sheet do not match the actual values. Generally, this concerns the weights of both luggage and fuel. This strongly indicates that the aircraft's maximum structural take-off weight was exceeded in those cases.
3. The accident flight was not the only flight to exceed the maximum allowed take-off weight; all three aircraft in use did under different pilots.

138 Assuming a maximum outside air temperature of 33 degrees Celsius, an air pressure of 1010 hectopascal and an airport elevation (Hato airport) of 29 feet at the time of the accident.

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