DUTCH SAFETY BOARD

Near mid-air collision, near Lelystad Airport

Near mid-air collision, near Lelystad Airport

The Hague, August 2018

The reports issued by the Dutch Safety Board are public.
All reports are also available on the Safety Board's website: www.safetyboard.nl
Photo cover: A. Oferta

The Dutch Safety Board

When accidents or disasters happen, the Dutch Safety Board investigates how it was possible for these to occur, with the aim of learning lessons for the future and, ultimately, improving safety in the Netherlands. The Safety Board is independent and is free to decide which incidents to investigate. In particular, it focuses on situations in which people's personal safety is dependent on third parties, such as the government or companies. In certain cases the Board is under an obligation to carry out an investigation. Its investigations do not address issues of blame or liability.

	Dutch Safety Board		
Chairman:	T.H.J. Joustra E.R. Muller M.B.A. van Asselt		
Secretary Director:	C.A.J.F. Verheij		
Visiting address:	Lange Voorhout 9 2514 EA The Hague The Netherlands	Postal address:	PO Box 95404 2509 CK The Hague The Netherlands
Telephone:	+31 (0)70 333 7000		
Website: E-mail:	safetyboard.nl info@safetyboard.nl		

N.B. This report is published in the English language with a separate Dutch summary. If there is a difference in interpretation between the report and the summary, the report text wil prevail.

CONTENT

GENERAL INFORMATION

Occurrence number:	2015077
Classification:	Serious incident
Date and time of occurrence:	1 August 2015, 17.48[1]
Location of occurrence:	Near Lelystad Airport, the Netherlands
Aircraft registration number:	D-IROL
Aircraft model:	Dornier Do-228-100
Aircraft type:	Twin-engine turboprop aircraft
Flight type:	Non-scheduled passenger flight
Flight phase:	Approach
Damage to aircraft:	None
Number of crew members:	Two
Number of passengers:	Sixteen
Aircraft registration number:	PH-4D3
Aircraft model:	Tecnam P92 Echo Super
Aircraft type:	Microlight aircraft
Flight type:	Private flight
Flight phase:	Approach
Damage to aircraft:	None
Number of crew members:	One
Number of passengers:	One

1 All times in this report are local times unless stated otherwise.

Injuries:	None
Other damage:	None
Light conditions:	Daylight

SUMMARY

On 1 August 2015 a twin-engine turboprop aircraft, conducting a non-scheduled commercial air (passenger) transport flight from Texel Airport to Lelystad Airport, and a microlight aircraft (MLA, or microlight) nearly collided in mid-air near Lelystad Airport. Both flights were operating under visual flight rules (VFR) and in total 20 persons were onboard these aircraft. The microlight returned from a local flight on its way to runway 05 (grass runway) of Lelystad Airport. The twin-engine turboprop was approaching the main runway 05 (asphalt). It was not until a late stage of conflict that the pilot of the microlight could make an evasive action. The crew of the turboprop aircraft had not seen the microlight at all. The investigation showed the limitation of the 'see-and-avoid' principle for air safety during VFR operations explaining the direct cause of the event.

Though evasive actions might prevent a mid-air collision, during approach and landing a successful evasive action can still be disastrous when resulting in an aerodynamic stall or loss of control whilst close to the ground. Therefore, in addition to the direct cause of this near mid-air collision, the investigation also focussed on the effectiveness of the 'straight-in approach' procedure to prevent near mid-air collisions in circuit areas or Aerodrome Traffic Zones (ATZ).

Additional findings of the investigation revealed that, in particular at uncontrolled aerodromes, safety is impaired when the executed flight path is non-compliant to the prescribed procedure. This also was the case with the twin-engine turboprop aircraft and another company aircraft which both flew to Lelystad Airport several times that day. Non-compliance may also occur at other comparable uncontrolled aerodromes in the Netherlands where 'straight-in approaches' are allowed.

For this incident flight non-compliance likely was the result of misinterpretation of an ambiguous 'straight-in approach' procedure by the crew of the turboprop aircraft. Furthermore, the 'straight-in approach' procedure of Lelystad Airport has officially been documented in an aeronautical publication, but its flight path was not shown on the visual approach chart. This also contributed to the non-compliance. Non-adherence to the prescribed 'straight-in approach' procedure increases the risk of (near) mid-air collisions with (other) aerodrome traffic.

The safety level of the passengers onboard the twin-engine turboprop aircraft was less than the usual standard for commercial air transport due to absence of radar service (separation) and a traffic collision warning system as a safety net.

ABBREVIATIONS

AAL	Above aerodrome level
AIP	Aeronautical Information Publication
ATC	Air traffic control
ATS	Air traffic services
ATSB	Australian Transport Safety Bureau
ATZ	Aerodrome traffic zone
BASI	Bureau of Air Safety Investigation
BFU	Bundesstelle für Flugunfalluntersuchung
CPL(A)	Commercial pilot licence (aircraft)
CTR	Control zone
DME	Distance Measuring Equipment
EASA	European Aviation Safety Agency
EASP	European Aviation Safety Program
EFB	Electronic flight bag
EHLE	Lelystad Airport (ICAO identifier)
EHTX	Texel Airport (ICAO identifier)
EPAS	European Plan for Aviation Safety
FIC	Flight information centre
FIS	Flight information service
FL	Flight level
IAS	Indicated airspeed
IFR	Instrument flight rules
GA	General aviation
GPS	Global positioning system
GS	Ground speed
KNMI	Royal Netherlands Meteorological Institute
MAC	Mid-air collision
MCTOM	Maximum certified take-off mass
MLA	Microlight aircraft
MOPSC	Maximum operational passenger seating configuration
MST	Member state task
NDB	Non directional beacon
NM	Nautical mile
NMAC	Near mid-air collision
QNH	Altimeter setting with reference to mean sea level
RMT	Rule making task
RPL(A)	Recreational pilot licence (aircraft)
RT	Radio telephony

SOP	Standard operating procedure(s)
SPT	Special operations task
TAS	True airspeed
TABS	Traffic awareness beacon system
TCAS	Traffic Alert and Collision Avoidance System
TMA	Terminal control area
UDP	Uniform daylight period
UTC	Co-ordinated universal time
VAC	Visual approach chart
VFR	Visual flight rules

1 FACTUAL INFORMATION

1.1 History of the flights

On 1 August 2015 at 16.50, a Tecnam P92 Echo Super microlight aircraft (registration PH-4D3) departed from the grass runway 23 at Lelystad airport (EHLE) for a local recreational flight under visual flight rules (VFR). Onboard the single engine two-seater aircraft were the pilot and a passenger. PH-4D3 left the circuit area of microlight aircraft and continued in a south-westerly direction for a recreational flight.

The flight was planned to (entirely) take place in uncontrolled airspace, Class G, with an upper boundary at 1,500 feet. The pilot of PH-4D3 used transponder code 7000 with altitude encoding.[2] When returning to Lelystad Airport, the pilot steered northeast and flew parallel to highway A6 (see figure 1) towards the compulsory reporting point Victor. According to radar information, at this stage of flight PH-4D3 maintained a cruising altitude of approximately 900 feet with a ground speed of 78 knots. When the pilot contacted Lelystad Radio on 123.825 MHz (frequency for microlight aircraft), the aerodrome radio operator advised him about the local QNH and that (grass) runway 05 was in use with a left-hand circuit.

2 This code is mandatory for all VFR traffic with an operational transponder as specified in the Aeronautical Information Publication (AIP) of the Netherlands, unless otherwise prescribed or instructed by air traffic control or flight information service.

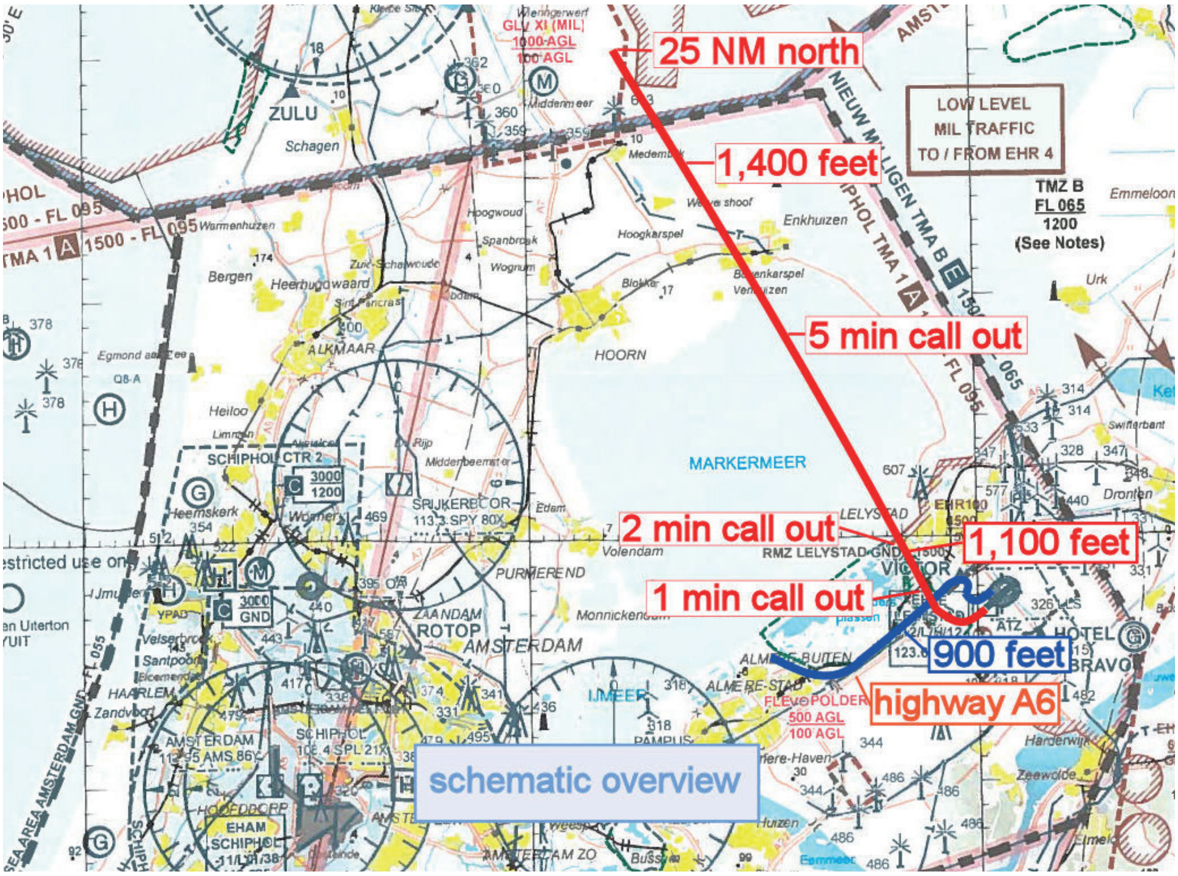

Figure 1: Aeronautical Chart ICAO, The Netherlands: D-IROL in red and PH-4D3 along highway A6 in blue.

Earlier that morning a twin-engine Dornier Do-228-100 turboprop aircraft with registration D-IROL flew from Kassel Calden Airport in Germany (EDVK) to Lelystad Airport. Then four more flights between Lelystad Airport and Texel Airport were carried out. At 17.34, the Dornier took off from Texel Airport (EHTX) for another non-scheduled commercial flight (the fourth flight) to Lelystad Airport with call sign Jump Run 465. The cabin configuration allowed for sixteen seats. These were all occupied by passengers who had attended an air show at Texel Airport. For the two pilots it was the third flight from Texel Airport to Lelystad Airport that day. Like the previous flights, this flight to Lelystad Aiport was operated under VFR and with transponder code 7000 with altitude encoding. The crew stated[3] that anti-collision lights, strobes and navigation lights were on.

The involved Dornier is not equipped with an autopilot. The co-pilot was pilot flying and manually controlling the aircraft. The captain was pilot monitoring and operated the radio. For the flight from Texel Airport to Lelystad Airport the navigation plan gave an 'overhead-overhead' routing. The crew stated they used visual aids with the assistance from a GPS. The crew used aerodrome charts for Lelystad Airport provided by Jeppesen JeppView. The flight crew contacted Lelystad Radio as Jump Run 465 on 123.675 MHz (standard frequency for all aircraft except for microlights), reporting that "… *it was 25 NM*

3 The DSB did not interview the microlight pilot and the pilots of the Dornier. Information from the crew of the Dornier was obtained via the operator. The German Bundesstelle für Flugunfalluntersuchung (BFU) facilitated with obtaining separate comments from the involved pilots and the operator after having reviewed the draft report of the DSB.

north and would like to come in for a straight-in approach[4]*".* Lelystad Radio replied "*… you can come in for a straight-in, call me 5 minutes and 2 minutes prior to touchdown"*, which was acknowledged by the captain, see figure 1. Immediately thereafter, the captain reported that Jump Run 465 was " … 8 minutes, or 25 NM, out." Apart from Jump Run 465, many other flights were in contact with Lelystad Radio and most of them also returned from Texel Airport as well as another company aircraft, a Dornier Do-228-200.

Jump Run 465 approached the aerodrome from the northwest, as shown in appendix A. The flight operated in Class G airspace and roughly halfway from the city of Medemblik the aircraft flew at 1,400 feet. Radar information revealed a ground speed of approximately 200 knots. As previous take-offs and landings at Lelystad Airport had taken place at (paved) runway 05, the crew assumed that runway 05 was still in use.

Jump Run 465 reported that it was 5 minutes out (see appendix A, figure 4) which was acknowledged by Lelystad Radio. Additionally, Lelystad Radio then requested Jump Run 465 to report at 2 minutes out, which was acknowledged by the captain. The crew declared they started landing preparations over lake Markermeer. According to radar information the Dornier started the descent by approximately 100 feet per minute over Markermeer. Once Markermeer had almost been crossed and by using visual aids, the flight crew adjusted the course to the right in order to get southwest of the runway. When just above land, the flight crew made the 2 minutes call to Lelystad Radio.

The co-pilot observed another aircraft at a position to the right and below the Dornier, but he considered this aircraft was not close enough to pose a risk for their flight. A passenger stated that when approaching Lelystad he had not seen any other aircraft nor noticed any disturbance with the flight crew which he could see as the cockpit was open. At about 0,5 NM northwest of highway A6, Jump Run 465 called it was 1 minute out. As for EHLE, the crew explained they aimed for the wind mill as indicated on the JeppView chart for a 3 NM final.

Radar information indicates that by this time the ground speed had reduced to 161 knots. Near highway A6 (see figure 1 and figure 4 in appendix A), at approximately 1,100 feet, the descent rate changed from 100 feet to approximately 650 feet per minute. When starting the descent, the crew extended the landing gear and flaps.

The pilot of PH-4D3 stated that he was approaching reporting point Victor from the southwest on a course parallel to highway A6. At his 10 o'clock position he suddenly noticed a twin-engine aircraft at approximately the same altitude at a close range. The pilot stated that because the Dornier had such a nose down altitude he saw sunlight reflecting on the upper part of the wings of the Dornier. He immediately brought down the nose of his aircraft, after which the twin-engine aircraft passed overhead towards Lelystad aerodrome. According to the pilot, his action prevented a mid-air collision. For the flight paths of both aircraft, see figure 3 in appendix A.

4 This is cited from the recorder of Lelystad Radio and the message from the pilot does not contain the runway in use.

The Dornier aircraft continued its descent and the crew reduced the speed for landing. For the Dornier 228 the final approach speed approximately is 110 knots. The crew made a left turn towards an approximate 1,8 NM final leg and landed uneventfully at 17.50 on the paved runway 05. PH-4D3 continued its track parallel to highway A6 towards the reporting point Victor, performed a left hand circuit procedure and landed uneventfully at 17.57 on grass runway 05.

1.2 Personnel information

The pilot of the Tecnam held a valid recreational pilot licence (RPL) and a valid medical class 2 certificate. Both pilots of the Dornier held commercial pilot licences (CPL) with valid medical class 1 certificates. Licences and indicative flight hours (on type and total) are listed in the table below.

Crew member	Type of licence	Flying experience on type	Total flying experience
Tecnam pilot	RPL(A)	230 hours	370 hours
Dornier captain	CPL(A)	2,000 hours	19,900 hours
Dornier first officer	CPL(A)	1,500 hours	4,800 hours

Table 1: Crew particulars.

1.3 Aircraft information

The involved Dornier Do-228-100 is a twin-turboprop STOL[5] utility aircraft. It has a maximum certified take-off mass (MCTOM) of 5,700 kg and a maximum operational passenger seating configuration (MOPSC) of 18. This type was manufactured by Dornier GmbH in Germany and later by RUAG. No ACAS equipment was onboard nor was this required for this flight.[6]

The Tecnam P92 Echo Super is a two-seater, single strut braced high wing microlight aircraft. It is manufactured by Costruzioni Aeronautiche Technam in Italy.

5 A short take-off and landing (STOL) aircraft is an aircraft with short runway requirements for take-off and landing.
6 AUR.ACAS.1005 of Commision Regulation (EU) No 1332/2011 and/or CAT.IDE.A.155 of Commision Regulation (EU) No 965/2012.

1.4 Airspace structure and flight information service

Based on standardised European rules of the air (SERA) the airspace[7] is divided into segments. They are classified as classes A through G. Each airspace class sets specific requirements to traffic in order to be allowed to fly through it, in terms of aircraft airspeed capabilities, visibility, distances to be kept from clouds, availability of air traffic control (ATC) services, radio use, et cetera. Traffic in class A is subject to the most strict and traffic in class G to the least strict requirements.

Class G airspace
Class G airspace is uncontrolled, meaning that for both VFR and IFR flights ATC does not provide separation between aircraft. Flight information service is available on request. For these flights the pilots can only maintain separation by applying the 'see-and-avoid' principle and only for VFR traffic[8] minimum requirements for visibility exist. Class G airspace usually is from the ground up to a certain altitude or flight level, depending on airspace structure.

For the area in which the near miss occurred, the upper limit of the G-airspace is 1,500 feet AMSL and the minimum allowed altitude for en route traffic is 500 ft.[9] For civil aircraft in this airspace the required visibility is 5 km[10] when the airspeed is more than 140 knots airspeed and the maximum allowed airspeed is 250 knots in order to timely see and avoid other traffic or obstacles.

Lelystad Aerodrome Traffic Zone
The aerodrome traffic zone (ATZ) is an airspace of defined dimensions established around an aerodrome for the protection of aerodrome traffic, see figure 2. As for Lelystad Airport, its ATZ[11] is G-airspace. Two-way radio contact with Lelystad Radio is required.

7 Specifications laid down in the International Civil Aviation Organization (ICAO) annex 11 and Regulation (EU) 923/2012.
8 For IFR traffic minimum Visual Meteorological Conditions (VMC) are not applicable.
9 Minimum altitude is 500 feet above MSL and scarcely populated areas and 1,000 ft above MSL when flying above cities and crowded areas.
10 In Class G airspace the minimum required visibility is 8 km above FL100 and 5 km below FL100. Below 3,000 feet the minimum required visibility for fixed wing aircraft is 1,500 metres under circumstances in which the probability of encounters with other traffic would normally be low and provided airspeed is 140 knots or less.
11 ATZs can also exist in controlled airspaces like military control zones (CTR), for instance in Eindhoven or Leeuwarden.

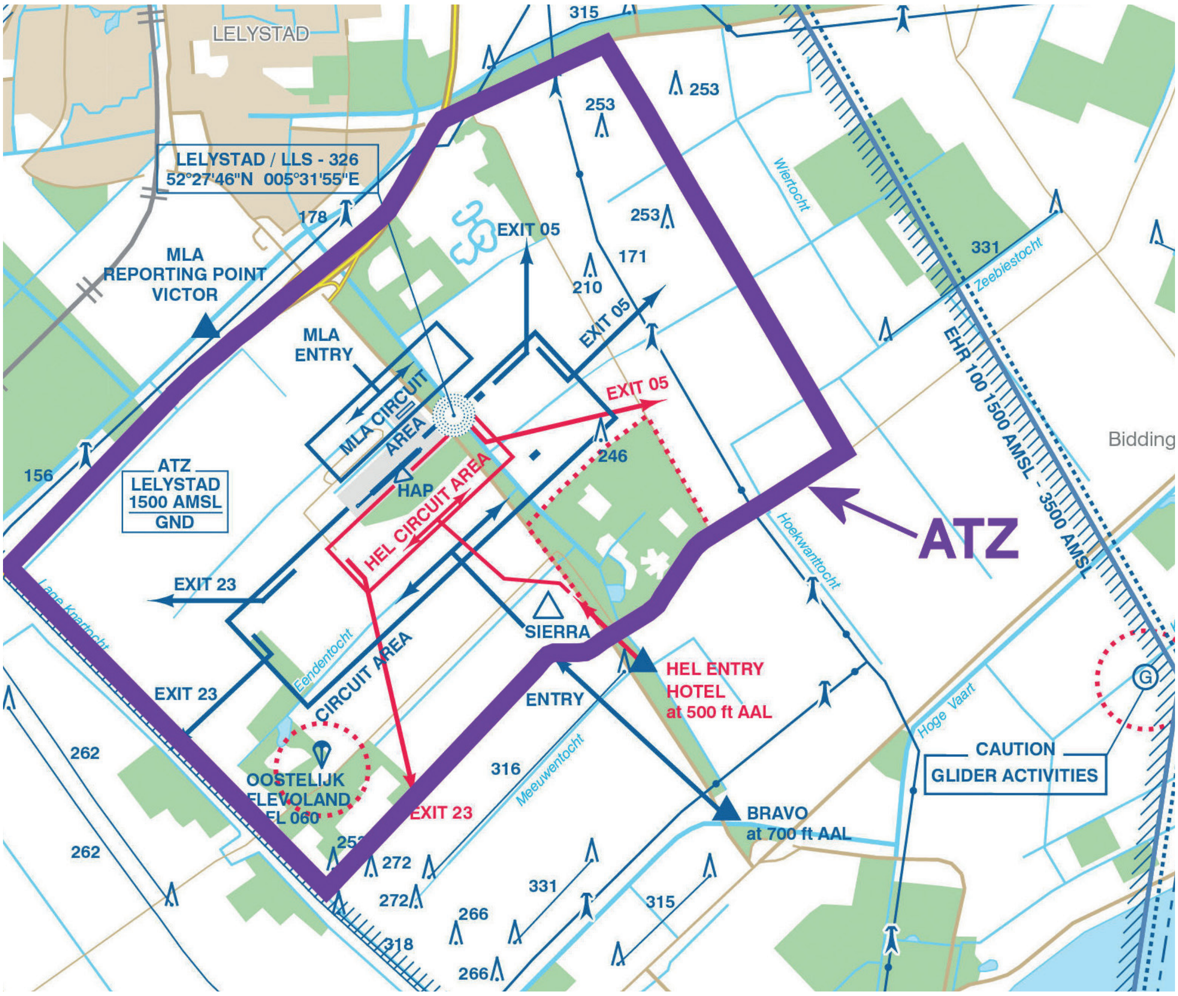

Figure 2: Aerodrome traffic zone (ATZ) in the visual approach (VAC) chart of the Dutch AIP.

Flight information service

By definition there is no radar separation service by ATC in G airspace. For G airspace in the Netherlands, Amsterdam Flight Information Centre[12] (FIC) or Dutch MIL provide flight Information service (FIS) only. Depending upon sufficient altitude, Amsterdam FIC may be able to observe aircraft in the area of Lelystad Airport on radar when their transponders are on.

Lelystad Radio is an aeronautical station at the aerodrome that provides aerodrome flight information service to departing, arriving or to local traffic. The radio operator at Lelystad Airport has no radar information. At the time of the event a different radio frequency[13] existed for microlight aircraft.

Transponders may also communicate with anti-collision systems of other aircraft to warn pilots for conflicting traffic.

12 The radio call sign is Amsterdam Information and it is part of Air Traffic Control The Netherlands (LVNL). Dutch MIL Info is a military provider of flight information service also for civil air traffic.

13 Currently there is one frequency for both microlight aircraft and other aircraft.

1.5 Lelystad aerodrome

Aerodrome description[14]
According to the Dutch AIP the aerodrome is available for national and international civil traffic using any type of aircraft, including microlight aircraft. In daily practice the aerodrome is mainly used by general aviation VFR[15] traffic: training flights by local flight schools, commercial scenic flights and private pleasure flights.

In general, pilots in command have to assure that they have knowledge of all available aeronautical information.[16] Occasionally, larger aircraft like twin-engine turboprop aircraft like the involved Dornier aircraft, or small twin-engine (mostly business) jet aircraft visit the aerodrome. For these aircraft the Aeronautical Information Publication (AIP) of the Netherlands describes a 'straight-in approach' procedure', see appendix C under VFR procedures item 11. Aircraft performance or differences in air speed with other significantly slower traffic in the circuit may be a practical reason to follow a 'straight-in approach'.

The visual approach chart (VAC) of Lelystad Airport in the AIP shows the standard entry and exit procedures (flight path) for general aviation using the depicted circuits, see figure 2. This information has also been incorporated in the JeppView system charts as used by the crew, see appendix B.

Near the points Bravo and Sierra (for circuit traffic) and southwest of runway 05 many wind turbines in clusters are equally spaced.

1.6 Weather information

The Royal Netherlands Meteorological Institute (*Koninklijk Nederlands Meteorologisch Instituut,* KNMI) provided a weather report:

General situation
Due to the proximity of a high pressure system the weather was calm. The present air mass was unstable up to approximately 5,000 feet.
The weather report for Lelystad on 1 August 2015 at 15.47 UTC (17.47 local time) mentioned at least 10 kilometres of visibility and scattered clouds with a cloud base at 25,000 feet. The wind was from the northwest (330 degrees), with wind speeds ranging from 6 knots at ground level to 10 knots at 1,000 feet.

The azimuth position of the sun was 258 degrees and 31 degrees above the horizon.[17]

14 This is applicable at the time of the event in August 2015. As from 2016 the aerodrome is under construction to facilitate commercial air transport operations in the near future.
15 IFR flights are limited in time and number and usually only allowed outside the uniform daylight period.
16 For Dutch law, see the "Act on Aviation (Wet Luchtvaart)", article 5.8". In daily practice flight operations departments of operators usually collect the aeronautical information for flight crews.
17 http://www.tijdgeest.eu/astrologie/zonenmaan/zonnetijdberekening

1.7 Navigation and flight procedures information

Operational information

On 1 August 2015 a German operator executed several flights between Texel Airport and Lelystad Airport with two Dornier Do-228 aircraft.[18] The flight crew of the Dornier involved in this incident used the visual approach charts of Texel and Lelystad Airport from Jeppesen printed from the JeppView system. These charts were valid up to and including 30 July 2015, see appendix B, figure 5. The charts show the reporting points Bravo and Sierra for general aviation traffic southeast of the field and reporting point Victor for ultra-light aircraft northwest of the field. A 'classic' wind mill icon is depicted southwest of runway 05. The used JeppView charts show the frequencies of the DME beacon FRO and the NDB beacon LLS at Lelystad aerodrome.[19]

The operator stated that since 2016 it uses an Electronic Flight Bag (EFB) for both VFR and IFR charts instead of paper charts, which reportedly better assures the validity of used charts

Uncontrolled aerodromes in Germany

According to the operator, approximately 50% of its operations are flown under VFR. In Germany it is common practice for VFR operations – when allowed by the national AIP - that crew fly a 'straight-in approach' to uncontrolled aerodromes. It means not to follow the standard entry and to remain clear of the circuit. It has not been defined[20] in time or distance. As for Lelystad Airport, for the crew a VFR 'straight in' procedure meant that it was not necessary to fly via reporting point Bravo. The point where traffic for a straight-in and circuit traffic may encounter each other is the point on final approach that crosses the base leg of the circuit.

The other 50% of the flights of the operator is under IFR. 'Straight-in approaches' during IFR operations might imply that the published approach procedure turn[21] is skipped. This is independent from the landing procedure.

Coordination

During radio contact the operator of Lelystad Radio thought the crew of the Dornier aircraft might have felt less safe about the (first) approach. He stated that after the first landing he had explained the 'straight-in approach' procedure to the pilots.

According to the operator, its crews routinely discuss with local airport authorities to see how their operations can go together with other traffic when knowing that their aircraft do not quite fit into the prescribed or expected circuit or traffic patterns. This is usually done face to face. The discussion with the aerodrome authority (Lelystad Radio) also occurred after the first landing at Lelystad Airport when arriving from Germany.

18 In addition to chapter 1.3, the sister aircraft has a maximum certified take-off mass (MCTOM) of 6,400 kg.
19 FRO is the identifier name of the Distance Measuring Equipment (DME) beacon and LLS is the identifier name of the Non Directional Beacon (NDB). Though these beacons usually support instrument approaches during IFR operations, they can also be used during VFR operations.
20 In Germany local noise abatement procedures may sometimes require short turns in for VFR traffic.
21 For many instrument approaches to a runway, a procedure turn is prescribed from the Initial Approach Fix (IAF).

It was agreed with the aerodrome authority of Lelystad Airport that for the return flights from Texel the crew of both Dornier 228 aircraft should fly a final leg for runway 05 of approximately 3 NM. The crew involved with the near-miss opted to use a wind mill – as shown in the JeppView visual approach chart - as a visual aid on final for runway 05. During the approach the pilots had to report their position at 2 minutes and 5 minutes out before touchdown.

Radar and radio telephony (RT) information
Radar information and a recording of Lelystad Radio communication indicate that both Dornier 228 aircraft arrived from Germany higher than the standard altitude for the approach via Bravo. From there, they directly flew to the base leg of runway 05 and remained free of the circuit.

For other arriving flights of both Dornier 228 aircraft from Texel Airport, the distance for final varied from approximately 3 NM (two flights) to 2 NM (four flights). During these six flights 5 minutes and 2 minutes radio calls were made and followed by calls from the airport authority that 'straight in approaches' were in progress.

1.8 Previous mid-air collisions in the Netherlands

Since 1999 six comparable mid-air collisions[22] occurred in the Netherlands. The current Dutch Safety Board (DSB) and its precursor founded in 1999, the Dutch Transport Safety Board, issued the reports[23] of these accidents. All but one occurred in uncontrolled airspace. Except two collisions all were fatal.

In 1999 a jet fighter aircraft and single engine aircraft collided in mid-air. The report concludes that due to the difference in airspeed 'see-and-avoid' does not work (title 'Botsing in de lucht, Piper PA-28, General Dynamics F-16, 22 December 1999 near Etten-Leur').

In 2002 a jet fighter aircraft and a microlight aircraft collided in mid-air. The most important causes of the accident were the failure of 'see-and-avoid' and that the F-16 was below its minimum required altitude (title 'Botsing in de lucht, General Dynamics F-16, Comco Ikarus C42, 24 April 2002, Sellingen').

In 2006 a microlight aircraft collided with a banner that was being towed by a Cessna 172 during a commercial operation. The report concluded that 'see-and-avoid' had failed (title 'Botsing in de lucht, Comco Ikarus C42B, Cessna 172N, 22 April 2006, Stadskanaal').

22 These do not include mid-air collisions between aircraft performing formation flights.
23 www.safetyboard.nl or www.onderzoeksraad.nl

In 2007 two single engine aircraft collided during their standard approaches to the circuit of Lelystad Airport. The report concludes that 'see-and-avoid' had failed and non-effective radio use possibly was a factor. The report (title 'Botsing in de lucht, Cessna 172R, Fuji FA-200, 19 October 2007') also refers to the research report issued by the ATSB, see paragraph 1.9.

In 2009 two gliders were on opposite tracks in airspace class C.[24] Evasive actions could not prevent a collision but both pilots made a successful emergency landing. The report concluded the 'see-and-avoid' had failed and hazy conditions possibly affected the distinctness of the aircraft (title 'Botsing in de lucht, ASK-21, LS-3A, 26 April 2009, near glider aerodrome Terlet').

In 2012 a Cessna 172N collided in mid-air with a Christen A-1 which was towing a banner (commercial flight) along the shoreline at Wassenaarse Slag. The Christen made a successful emergency landing on the beach and the Cessna made a safe landing at Rotterdam Airport. The report concluded that the pilot of the Cessna focussed on another aircraft that was being photographed. No technical safety net was present that could have warned for other traffic (title 'Voorkomen van (bijna-)botsingen in de lucht (Preventing (near) mid-air collisions), 8 September 2012').

1.9 See-and-Avoid research and developments

Research by ATSB
In April 1991 the Australian Transport Safety Bureau (ATSB) issued its first Final report[25] of the Limitations of the See-and-Avoid principle. In summary the report elaborates that in the absence of traffic alerts the 'see-and-avoid' principle is subject to serious limitations associated with physical limits to human perception.

Although strobes cannot increase the visibility of an aircraft against bright sky, it is likely that high intensity white strobes would increase the conspicuity of aircraft against a dark sky or ground. There is no evidence that low intensity red rotating beacons are effective as anti-collision lights during daytime.

The small number of mid-air collisions has been in a large part due to low traffic density and chance as much as the successful operation of 'see-and-avoid'. The most effective response to the many flaws of 'see-and-avoid' is to minimise the reliance on 'see-and-avoid'. The complete list of conclusions of the reports has been included in appendix D.

24 For VFR operations class C requires a visibility of 5 kilometre or more. The required vertical distance to the cloud base is 1,000 ft or more and a horizontal distance of 1,500 metres or more.
25 The full reports can be downloaded from: http://skybrary.aero/bookshelf/books/259.pdf.

European Plan for Aviation Safety (EPAS)
The European Plan for Aviation Safety[26] aims to further improve aviation safety throughout Europe. It is developed by the European Aviation Safety Agency (EASA) in consultation with the EASA member states and aviation industry. The plan contains actions in the domain of rulemaking, safety oversight and safety promotion covering all segments of aviation. Both for commercial air transport (aeroplanes) and general aviation the prevention of mid-air collisions has been identified as key risk area that needs to be further addressed.

The latest plan (EPAS 2017-2021) states that in recent years there have been no airborne collisions with commercial air transport aeroplanes. Still, this key risk area has been raised by a number of EASA member states and also by some airlines. A collision risk with aircraft without transponders in uncontrolled airspace is specifically mentioned. This is one specific safety issue that is a main priority in this key risk area.

Regarding General Aviation, the EPAS indicates that statistics show that mid-air collisions affect both novice and experienced pilots and can occur in all phases of flight and at all altitudes. However, the vast majority of them occur in daylight and in excellent meteorological conditions. A collision is more likely where aircraft are concentrated, especially close to aerodromes. The EPAS therefore addresses actions on the subjects of airspace complexity, airspace infringement and the use of technology.

In 2012 EASA published a research study on "Scoping improvements to see and avoid for General Aviation", Research Project EASA2011.07. This study focused both on anti-collision devices for General Aviation (GA) aircraft as well as potential improvements regarding the use of 'see-and-avoid' for GA in uncontrolled airspace.
https://www.easa.europa.eu/system/files/dfu/Final%20Report%20EASA.2011.07.pdf.

Cost-efficient electronic conspicuity devices can be one contributor. EASA is facilitating the voluntary installation of electronic conspicuity devices amongst others via Standard Changes (CS-STAN).

Additional actions part of the EPAS 2017-2021 are:

For commercial air transport:
- Rulemaking task[27]: carriage of Aircraft Collision Avoidance System (ACAS) II equipment on aircraft other than aeroplanes in excess of 5,700 kg or 19 passengers.
- Include mid-air collisions in the national State Safety Plans.[28]

26 The European Plan for Aviation Safety (EPAS) is a document of EASA and is part of the European Aviation Safety Programme (EASP). The document provides a framework for safety at regional level and identifies major safety risks and actions to take.
27 Rule Making Task (RMT).0376
28 Action Member State Task (MST).010 on State level.

For general aviation:

- Promoting safety improving technology.[29]
- European Safety Promotion on mid-air collisions and airspace infringement.[30]

Collision avoidance systems

Commission Regulation (EU) No 965/2012 (Air-OPS) requires ACAS II equipment onboard turbine-powered aeroplanes with a maximum certified[31] take-off mass (MCTOM) of more than 5,700 kg or a maximum operational passenger seating configuration (MOPSC) of more than 19. In addition to ACAS II, a growing number of anti-collision system devices are becoming available.

29 Action Safety Promotion Task (SPT).084
30 Action Safety Promotion Task (SPT).089
31 This applies to commercial air transport (CAT), non-commercial operations with complex-motor aircraft (NCC) and specialised operations (SPO).

2 ANALYSIS

2.1 Circumstances and causes allowing the near miss

General
The pilots of both aircraft were properly licensed and had valid medical certificates.

The validity of the charts that were used by the crew of the Dornier was uncertain, because the note on the JeppView charts indicated that the charts may not be valid after 30 July 2015. However, aeronautical information from the AIP Netherlands showed that the same flight procedures of Lelystad Airport were still in effect on 1 August 2015. Consequently, the potential invalidity of the used Jeppesen visual approach charts was not a factor.

Airspace and requirements
The required VFR conditions for G-airspace were met: a visibility of 10 kilometres or more and a cloud base of 25,000 feet. Air speeds of both aircraft were well below the maximum 250 knots indicated airspeed (IAS). At the moment of the near miss both aircraft were allowed to be there and both were outside the ATZ. It is concluded that through the moment of the near miss the crew of both aircraft complied with the regulations.

See-and-avoid
Reconstruction of the flight paths of both aircraft shows that the relative positions remained constant for an extended period of time as illustrated by the constant bearing lines in appendix A. When composing the ground speed vectors of both aircraft the relative speed approximately appeared to be 3 NM per minute (330 km/hr). For both crew these circumstances were major disadvantages to timely detect conflicting traffic.

Statements from the operator and witness reports from passengers onboard revealed that the crew of the Dornier had not seen PH-4D3 at all. Taking into account the Dornier was much larger than PH-4D3 and that the direction of flight of PH-4D3 was away from the sun, it made sense that the pilot of PH-4D3 was in the best circumstances to detect the conflicting traffic. He could carry out – though in a very late stage – an evasive action. The coincidentally reflected sunlight coming from the wings might have facilitated the visual detection of the Dornier by the pilot of PH-4D3.

It is believed that strobes and anti-collision lights of both aircraft were on. According to the ATSB research report (see paragraph 1.9) it likely was without effect, because it was a bright day. Consequently, the absence of effective visual traffic alerts limited the conspicuity of both aircraft. As a result the effectiveness of the 'see-and-avoid' principle was lost, which impaired the safety of 20 persons onboard of two aircraft.

As seen in paragraph 1.8 the mid-air collisions due to failure of the 'see-and-avoid' occasionally occur and mostly are fatal.

Most commercial air transport flights are IFR operations. Separation with other aircraft is usually established by radar service from ATC. For the passengers onboard the Dornier aircraft the safety level had been less due to a VFR operation in uncontrolled airspace. Consequently, no radar service (separation) was provided. Furthermore, because the Dornier was not equipped with a traffic collision avoidance system, no safety net existed for 'see-and-avoid'.

2.2 Contributing factors near miss

Radio procedures
Based on the prescribed approach procedures of both microlight and 'straight-in' traffic their respective flight paths to the different runways are sufficiently separated. As such no need exists to inform microlight pilots about 'straight-in approaches'.

By listening out Lelystad Radio, information about the positions or directions may enable pilots to become better aware where other traffic might be expected. However, PH-4D3 and the Dornier communicated on their "own" different radio frequencies as required. Now the pilots of both aircraft could not be aware of each other by listening out the radio.

Initial routings and descent to the field
The Dornier roughly followed the GPS 'overhead – overhead' navigation plan routing between Texel Airport and Lelystad Airport. This increased the chance of an encounter with arriving microlight traffic as the routing of the Dornier was close to reporting point Victor. Furthermore, the Dornier flew at low altitude as the crew had started the descent for landing. This undermined the goal of the 'straight-in approach' procedure of Lelystad Airport to keep the various kinds of traffic (turbo twin-engine aircraft from microlight) aircraft separated.

As indicated by the ATSB research report 'see-and-avoid' is an unreliable tool to prevent a (near) collision. Therefore, it is much better to prevent needing it by staying away from areas or locations where encounters might be more expected like mandatory reporting points.

Note:
The near miss was outside the ATZ, but the flight paths of the Dorniers also caused an additional risk for a (near) mid-air collision within the ATZ. The flight paths were not in accordance with any existing approach procedure to enter the ATZ. Therefore, in this near miss investigation also the functionality of the 'straight-in approach' procedure is further considered in 2.3.

2.3 Safety performance 'straight-in approach' procedure

Published aeronautical information
Prescribed flight paths being part of approach procedures, either standard or non-standard like a 'straight-in', form primary information to pilots. However, the VAC of Lelystad Airport (both in AIP and in Jeppesen) does not depict the flight path of the 'straight-in approach' procedure, nor does it refer to the chapter in the AIP where the applicable 'straight-in approach' procedure is described. It is found embedded in the AIP, see appendix C under *VFR Flight Procedures*. This is less effective to safety, for pilots always need the VAC to determine the flight path.

When arriving from Germany, the Dornier crews had the required visual approach chart (here the Jeppesen VAC) of Lelystad Airport at their disposal showing the standard circuit and its flight path procedure.
The rather legal argument that pilots (commanders) have to assure that they have knowledge of all available aeronautical information, could not prevent that the 'straight-in approach' procedure was probably overlooked during the flight preparation.

Non-compliance with agreed approach flight path
Taking into account a final approach speed of 110 knots, the procedure required a 3,7 NM (no wind) final leg from the threshold. When arriving from Germany (first arrivals that day), the crew of both Dornier aircraft followed a similar procedure when flying an approach to uncontrolled aerodromes in Germany (see paragraph 1.7). This, however, was not in accordance with the prescribed flight path at Lelystad Airport.

Radar and radio telephony (RT) analysis revealed that during the following six flights arriving from Texel, 'straight-in approach' procedures were still not flown as prescribed in the AIP. Only two approaches approximately showed a 1,5 minutes final, the other four roughly showed a 1 minute final being aligned with the centreline. It could not be established why the pilots mostly did not to comply with the final leg for runway 05 they had apparently discussed and agreed with the aerodrome authority of Lelystad Airport. Nevertheless, the radio call outs (5 and 2 minutes) by the Dornier pilots and communication by Lelystad Radio (warnings for 'straight-in' traffic) generally complied with the radio procedures of a 'straight-in approach'.

The airport authority believed it had properly explained to the Dornier crew how to fly the 'straight-in approach' procedure. The RT of the event flight shows (see 1.1) that the Dornier crew requested a 'straight-in approach'. Though this had to be co-ordinated, there was no requirement for such a request because the prescribed procedure was likely discussed with the airport authority in the first place. Whatever the Dornier crew believed they had agreed upon, the formal confirmation (maybe interpreted as an approval) of the 'straight-in approach' by Lelystad Radio might have felt themselves relieved from the prescribed procedure. Surely, it resulted in a cut off flight path which was non-compliant. This – together with the other approaches as described above - may indicate that the interpretation of the 'straight-in approach' procedure (still) was ambiguous.

When arriving from Texel Airport at least one Dornier crew reportedly aimed for the 'classic' wind mill. According to the chart it was located at approximately 3 NM from the runway threshold. In contradiction to the chart this visual marker did not exist, which was not helpful in visually establishing an approximate 2 minutes final leg.

On the other hand, navigational aids at Lelystad Airport and GPS equipment onboard the aircraft were available to support professional pilots to determine a 2 minutes final leg on the extended runway centreline.

Contributing factors of different interpretation
About 50% of the flights of the operator are conducted under IFR. As indicated in paragraph 1.7, 'straight-in' approaches are common for IFR operations and usually have the character of a cut off by skipping the procedure turn. 'Straight-in' means a shorter flight path to the runway. As for VFR operations at uncontrolled aerodromes in Germany, as long as they remain clear of the circuit area a more direct routing to the runway or a short turn in are common for the Dornier pilots of this operator.

In the context as described above, the experience of the pilots to fly a shorter distance to the runway was in conflict with the required 2 minutes lasting final, and thus longer distance, for Lelystad Airport. It is likely that this affected the interpretation of the 'straight-in approach' by the Dornier pilots, even after they had been briefed by the aerodrome authority.

Incorrect procedure impairs safety
Compliance with the radio procedures could not prevent a deviation of the 'straight-in approach' flight path. Consequently, the Dornier aircraft intruded the ATZ on the dead side of the circuit of general aviation aircraft where it was not supposed to be and least expected.

Under such circumstances traffic in the standard circuit has more difficulty to timely detect the 'straight-in' traffic thereby increasing the risk of a (near) mid-air collision for landing aircraft in the ATZ. Additionally, landing aircraft have lower airspeed and possibly high bank angle whilst coming closer to the ground. During such conditions evasive actions may promote aerodynamic stall or loss of control which usually are disastrous as well.

The deviation did not interfere with the circuit for microlight aircraft.

3 CONCLUSIONS

The near mid-air occurrence

The pilots of both aircraft were properly licensed and had valid medical certificates. Up to and including the moment of the near miss the crew of both aircraft complied with the regulations.

Both aircraft approached each other with a high relative speed (330 km/hr, 3 NM/minute) without relative motion. Without effective visual traffic alerts the effectiveness of the 'see-and-avoid' principle was lost resulting into a near mid-air collision.

Because of a VFR operation in uncontrolled airspace and without anti-collision system the safety level was less compared to most (IFR) commercial air transport (passengers) flights.

Contributing factors
The flight path of the Dornier close to reporting point Victor increased the risk of an encounter with microlights and by that it increased the necessity to rely more on the 'see-and-avoid' principle.

The use of different radio frequencies for microlight aircraft and other aircraft reduced the probability to detect the other traffic.

The straight-in approach procedure

Indirectly the investigation revealed flaws for a VFR 'straight-in approach' procedure. In particular at uncontrolled aerodromes this may impair flight safety.

Different interpretations of the 'straight-in approach' procedure (description) of Lelystad Airport are possible depending on context. This likely occurred during the Dornier operations resulting into non-compliance with the prescribed flight path.

Prescribed flight paths (procedures) form primary information to pilots. The 'straight-in approach' flight path of Lelystad Airport is not depicted in the VAC leaving room for different interpretations of the 'straight-in approach' procedure.

A correct performance of the radio procedures could not prevent a deviation of the prescribed flight path. Non-adherence to the 'straight-in approach' procedure increases the risk of collision for traffic within the ATZ.

4 RECOMMENDATIONS

To avoid a (near) mid-air collision:
In addition to previous accident and research reports this investigation revealed (again) the limitations of the 'see-and-avoid' principle. Recent developments show the availability of different electronic devices to improve the timely conspicuity of other traffic.

Therefore, it is recommended **to EASA** to:

1. Introduce, as a matter of priority, requirements for commercial air transport aircraft other than with a MCTOM in excess of 5,700 kg or a MOPSC in excess of 19 seats to be equipped with aircraft collision avoidance systems.

To improve safety performance of the 'straight-in approach' procedure:
Adherence to procedures contributes to safety. It requires an unambiguous interpretation of the flight path and an overview of both the standard and 'straight-in' visual presentation of the VFR approach procedures of an aerodrome as primary information to pilots.

Therefore, it is recommended **to the Environment and Transport Inspectorate** (Inspectie Leefomgeving en Transport (ILenT)) to:

2. Visualise (draw) all VFR approach flight paths in Visual Approach Chart(s).

TRACKS AND RELATIVE BEARINGS

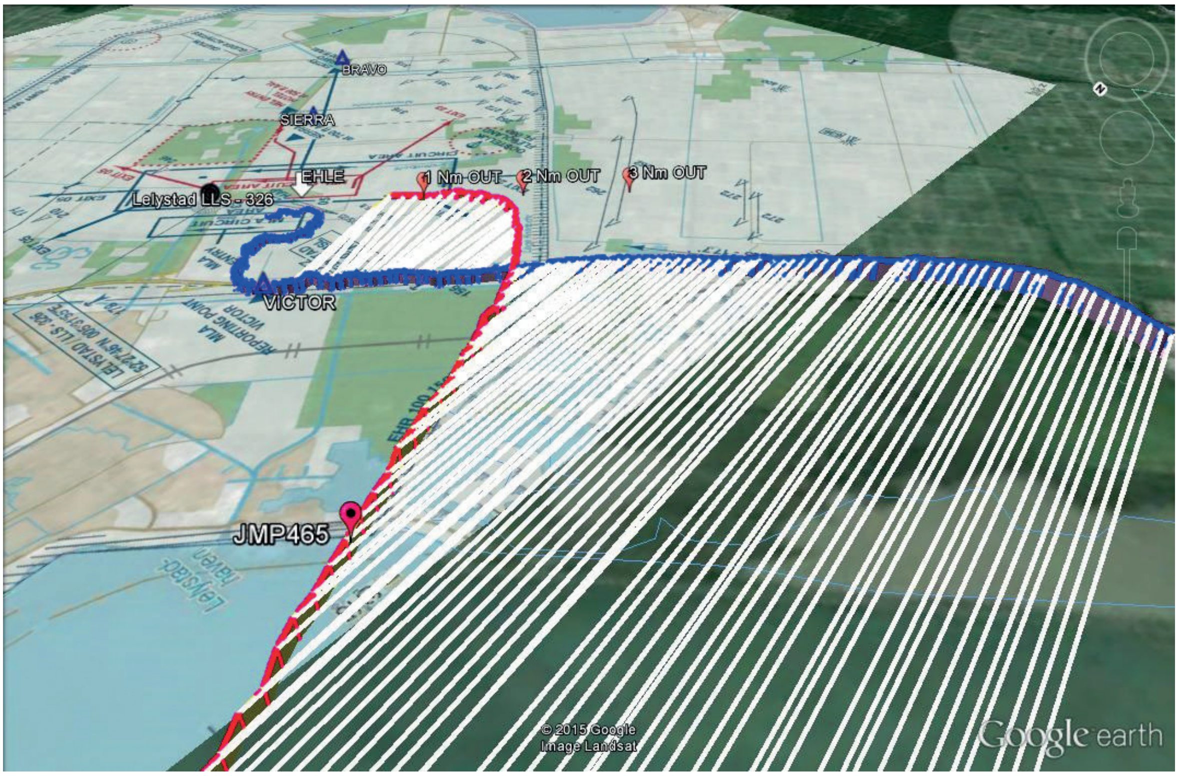

Figure 3: Flight paths relative to aerodrome and ATZ showing relative constant bearing angles (white). The PH-4D3 microlight path is blue, the D-IROL Dornier Do-228 path is red. View is from northwest.

Figure 4: Flight path of Dornier aircraft with call out positions and distances in NM from runway threshold on extended centreline. For orientation, the top of the page is north and the bottom of the page is south.

VISUAL APPROACH CHART

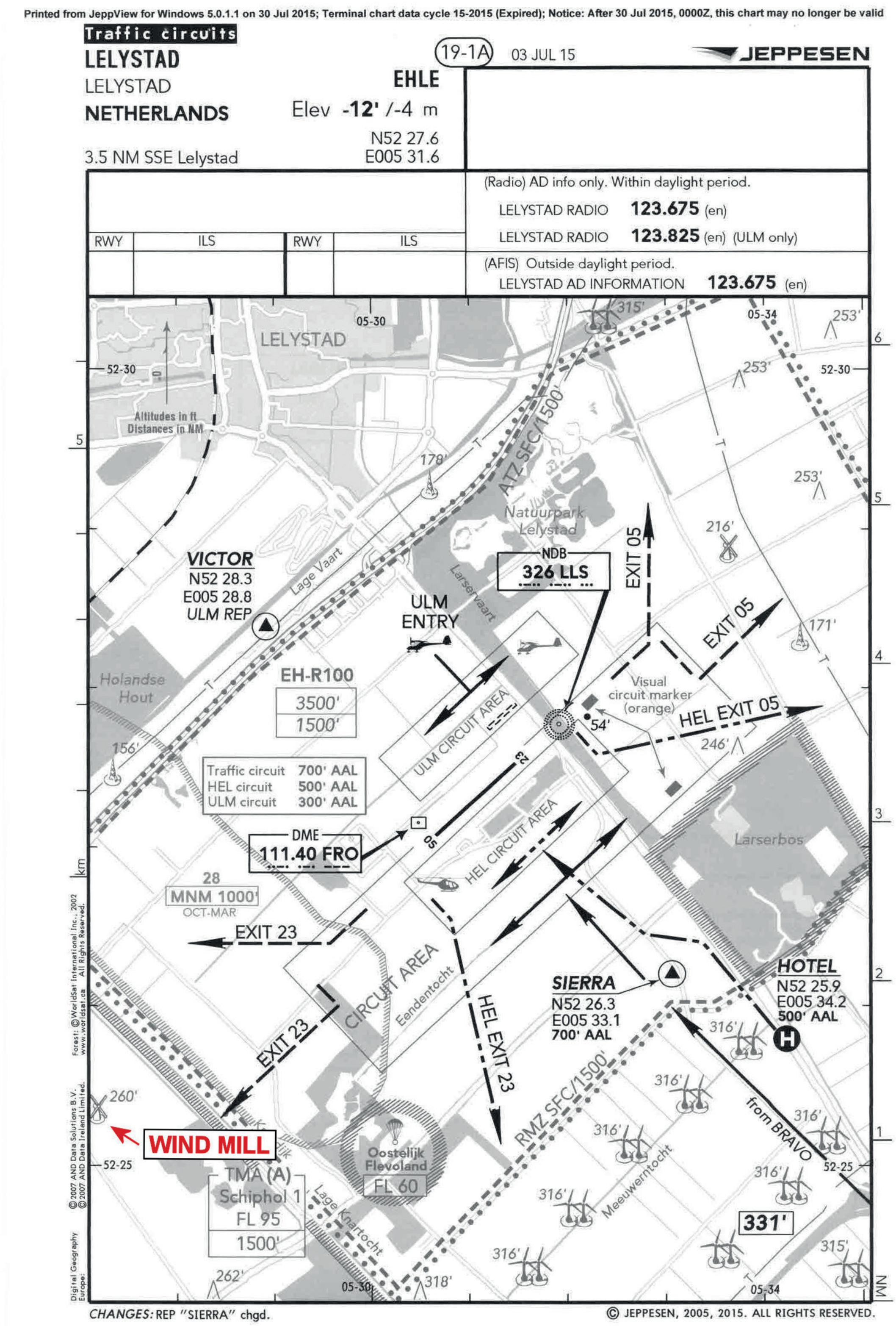

Figure 5: Visual approach chart from JeppView including the wind mill icon.

APPENDIX C

PROCEDURES LELYSTAD AIRPORT

Local flight procedures aim to make sure that arriving and departing traffic is separated and also that the different types of traffic are separated. In order to separate microlight traffic from other traffic, two different runways are used. For the main traffic there is one asphalted runway of 1250 x 30 m. For microlight aircraft operations, there is one dedicated grass runway of 300 x 50 m with a circuit area separated from the other runway and circuit area. Both the asphalt and the grass runway have runway 05 and runway 23 designations. Lelystad Radio[32] uses different radio frequencies for microlight aircraft operations and the other operations.

Radio communication with Lelystad Radio is mandatory for all traffic in the ATZ. As Lelystad Airport is uncontrolled, Lelystad Radio does not provide clearances but is strictly informative and has no radar to monitor traffic. In figure 2 (chapter 1.4) the procedures for the visual approach and departures are depicted. The procedures include compulsory radio position reports at prescribed circuit entry points and for circuit positions.[33] Traffic with comparable performances, and consequently using the same approach procedure and circuit, have to establish adequate separation with other aircraft. The position reports aim to increase pilots' awareness of other traffic to, from or at Lelystad Airport.

Approach and circuit flight procedures

There are two circuit areas on the southeast side of the aerodrome. For fixed wing general aviation traffic, the circuit altitude is 700 ft AAL. The flight procedure prescribes an approach path via the mandatory reporting points Bravo and Sierra at 700 ft AAL to the circuit, see appendix B. A similar circuit and approach procedure exists at 500 feet via mandatory reporting point Hotel for helicopter traffic. Depending on the runway in use (runway 05 or runway 23) the circuit has to be flown with right or left turns.

On the northwest side of the aerodrome, the circuit area for microlight aircraft (MLA) has a prescribed circuit altitude of 300 ft AAL. For MLA traffic, a position report at the reporting point Victor is mandatory, albeit without a specified altitude.

32 123.675 Mhz for the main operations and 123.850 Mhz for microlight operations.

33 'Final full stop' and 'final touch and go' are mandatory reports. Depending on visibility also 'downwind' and 'turning final' calls are prescribed.

Straight-in approach procedure
The Dutch integrated aeronautical information publication[34] (AIP Netherlands) shows the 'straight-in approach' procedure of aerodrome Lelystad under item 11 which was in effect during the event in July 2015:

VFR FLIGHT PROCEDURES AND REGULATIONS
3.1 General

1. Flights to or from Lelystad shall be co-ordinated with the aerodrome authorities.
2. In the ATZ Lelystad only aerodrome traffic is allowed.
3. The ATZ Lelystad is active within UDP, during AD OPR HR. For the lateral and vertical limits of the ATZ Lelystad see AD 2.EHLE-VAC.
4. Contact Lelystad Radio before entering the ATZ Lelystad or before departing Lelystad aerodrome and state your intentions. Lelystad Radio responds with aerodrome information. Lelystad Radio does not issue clearances but is strictly informative.
5. Flights in the ATZ Lelystad shall maintain two-way radio contact with Lelystad Radio. This obligation applies also to pilots without an RTF licence.
6. Report switching off the radio or leaving the ATZ Lelystad.
7. Aircraft, helicopters and MLAs use separated circuits (see AD 2.EHLE-VAC) to establish horizontal and vertical separation.
8. Circuit flights shall be carried out within the lateral limits of the circuit area. The aerodrome authorities can decide that circuit flights are not allowed.
9. Avoid built-up areas and other houses as much as possible.
10. Avoid the marked areas.
11. A 'straight-in-approach' is possible for aircraft unable to follow the standard circuit for performance reasons. A 'straight-in' is only allowed after coordination with the Lelystad Radio. Therefore, report a 'straight-in' well in advance to Lelystad Radio. When established on final report also "final straight in, two minutes out".
12. Report "final full stop" or "final touch and go". If ground visibility, as determined by the aerodrome authority, is <= 3 km also report "downwind" and "turning final".
13. In case of a go-around on RWY 05/23, it is advised to execute it north-west of the runway, in order to stay clear of the helicopter circuit area. Maintain sufficient separation with the MLA circuit area.
14. Banners are picked-up and thrown-off west of and parallel to RWY 05/23, only after coordination with aerodrome authorities.
15. Helicopters shall use the helicopter aiming point (HAP) south-east of RWY 05/23.
16. Entering RWY 05/23 is only allowed at the runway extremities: TWY A and TWY E.
17. Final approach speeds may vary for each type of aircraft and the length of the 2 minutes final segment varies accordingly. This procedure applies to the paved runway in both directions (05 and 23). Permission for the 'straight-in approach' procedure does not imply right of way over the traffic in the standard circuit.

34 In the AIP aeronautical information has been laid down under responsibility of the national service provider Air Traffic Control the Netherlands.

Lelystad Radio informs all other aircraft on the radio frequency in use[35] that 'a straight in approach' procedure is in progress. Visual contact with the 'straight-in' aircraft and the 2 minutes out call are essential information for other traffic in the circuit. Any aircraft on downwind must use it to decide whether safe separation with the straight in aircraft can be maintained. The options are either to turn into base leg and land first, or to extend downwind and land behind the 'straight-in' traffic.

35 This concerns only the general aviation traffic in the southeast circuit, not the microlight traffic in the northwest.

APPENDIX D

RESEARCH 'SEE-AND-AVOID'

Limitations of the See and Avoid principles investigation by the ATSB, the conclusions are:

The 'see-and-avoid' principle in the absence of traffic alerts is subject to serious limitations. It is likely that the historically small number of mid-air collisions has been in a large part due to low traffic density and chance as much as the successful operation of 'see-and-avoid'.

Unalerted 'see-and-avoid' has a limited place as a last resort means of traffic separation at low closing speeds but is not sufficiently reliable to warrant a greater role in the air traffic system. The Bureau of Air Safety Investigation (BASI) considers that see-and-avoid is completely unsuitable as a primary traffic separation method for scheduled services.

Many of the limitations of 'see-and-avoid' are associated with physical limits to humanperception, however there is some scope to improve the effectiveness of see-and-avoid in other areas.

Although strobes cannot increase the visibility of an aircraft against bright sky, it is likely that high intensity white strobes would increase the conspicuity of aircraft against a dark sky or ground. There is no evidence that low intensity red rotating beacons are effective as anti-collision lights in daytime.

Pilots and Air Traffic Services (ATS) personnel should be made aware of the limitations of the 'see-and-avoid' procedure, particularly the psychological factors which can reduce a pilot's effective visual field. Pilots may be trained to scan more effectively and to accommodate to an appropriate distance when searching for traffic. Simply ensuring that the windscreen is clean and uncrazed will greatly increase the chance of sighting traffic.

There are important questions about the operation of 'see-and-avoid' which can be answered by future BASI research. These include the question of how frequently Australian pilots scan for traffic and whether they scan significantly less in controlled airspace due to an over-reliance on ATS. The traffic scan training received by student pilots should be assessed. The visibility from aircraft should also be examined, with particular reference to windows and cabin obstructions.

The most effective response to the many flaws of 'see-and-avoid' is to minimise the reliance on 'see-and-avoid' in Australian airspace.

DUTCH
SAFETY BOARD

Visiting address
Lange Voorhout 9
2514 EA The Hague
T 070 333 70 00
F 070 333 70 77

Postal address
PO Box 95404
2509 CK The Hague

www.safetyboard.nl