DUTCH
SAFETY BOARD

Near mid-air collision between F-16 and Tecnam

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The Hague, October 2025

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The Dutch Safety Board

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

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SUMMARY

On 16 November 2023, a near mid-air collision between an F-16 (hereafter: Shark 1) of the Royal Netherlands Air and Space Force (RNLASF) and a single-engine Tecnam P-Mentor aircraft (hereafter: Tecnam) occurred near Elburg. Shark 1 was the leader of a formation of two F-16s (hereafter: Shark formation), returning from a training exercise at the Vliehors Range (Vlieland) to Volkel Air Base. The Tecnam, with an instructor and student on board, had taken off from Lelystad Airport for a local training flight. After both the Shark formation and the Tecnam changed course and altitude, both aircraft were flying towards each other at the same altitude.

The incident occurred because the flight crews were initially unaware of each other's presence and they did not see each other until the last moment. Only after the air traffic controller had informed the Shark formation on the other aircraft, the pilot of Shark 1 noticed the Tecnam and performed an evasive manoeuvre. The Tecnam's crew only saw the F-16 after it had performed the evasive manoeuvre at close range.

The Shark formation was operating under Instrument Flight Rules (IFR) and the Tecnam was flying under Visual Flight Rules (VFR). The near mid-air collision took place in Class E airspace. In this airspace class, air traffic control does not provide separation between IFR and VFR flights; air traffic control provides only traffic information as far as practical.

At the time of the incident, the Shark formation was in radio contact with the air traffic controller of the Military Air Traffic Control Centre (MilATCC), while the Tecnam was in contact with the Flight Information Service Officer (FISO) of MilATCC. The controller and the FISO were operating on different radio frequencies. Consequently, the air traffic services personnel as well as the flight crews could not hear each other's radio transmissions.

The trajectory of high-speed fighter aircraft via Amerongen and Kampen is a standard route for the RNLASF, but it is not officially published. This trajectory passes the airspace close to Lelystad Airport. If a high-speed fighter aircraft flies at an altitude between 1,200 and 3,000 feet and in the proximity of Lelystad Airport, the chance increases of an encounter between that high-speed fighter aircraft and slow flying general aviation aircraft.

The Dutch Safety Board and its predecessor, the Transport Safety Board (RvTV), have conducted several investigations into (near) mid-air collisions involving high-speed military fighter aircraft, including two fatal accidents. One recurring cause identified in the investigations was the limitations of the so-called 'see and avoid' principle. In airspace where air traffic control does not provide separation, the pilots are responsible for separation with other aircraft. This requires them to visually detect other aircraft and take evasive action if necessary (see and avoid). Studies and investigations have shown

that this principle is a weak safety barrier. This is even more the case when a high-speed fighter aircraft is involved. In the case of unalerted see and avoid, pilots of slow flying aircraft have minimal chances to detect a potential conflict and timely make an evasive manoeuvre due to the high closing speed. Crews of high-speed military fighter aircraft are in a better position to do so, due to their training, skills and on-board equipment.

A mid-air collision between a high-speed military fighter aircraft and a low-speed general aviation aircraft in civil airspace where no separation is provided by air traffic control, is an accident scenario with a low probability, but catastrophic consequences. Despite the measures taken after previous fatal mid-air collisions in the Netherlands, the serious incident near Elburg shows it is a realistic scenario. By accepting the higher speeds of military fighter aircraft in Dutch airspace, overall, the risk of a mid-air collision between a high-speed military fighter aircraft and general aviation is an increased risk in Dutch airspace.

The investigation concluded that there are possibilities to improve the management of risks of proximities between high-speed military fighter aircraft and general aviation. In addition, the risks are changing because of the introduction of the F-35 and new military training areas, as well as the foreseen increase of foreign military forces performing training activities in Dutch airspace. These risks should be assessed and where necessary, mitigation measures should be put in place.

The safe interaction between civil and military air traffic is a shared responsibility between the Ministry of Infrastructure and Water Management and the Ministry of Defence, and therefore requires joint attention. The Dutch Safety Board issues four recommendations.

ABBREVIATIONS

Abbreviation	Description
ACAS	Airborne Collision Avoidance System
ACFT	Aircraft
ADS-B	Automatic Dependent Surveillance – Broadcast
AIC-B	Aeronautical Information Circular series B
AIFF	Airborne Identification Friend or Foe
AIP	Aeronautical Information Publication
AMSL	Above Mean Sea Level
ATC	Air Traffic Control
ATPL(A)	Airline Transport Pilot Licence Aeroplanes
ATS	Air Traffic Services
AVTR	Aircraft Video Tape Recording
CIV	Civil
CMFD	Colour Multi-Function Display
CTR	Control Zone
EASA	European Union Aviation Safety Agency
EPAS	European Plan for Aviation Safety
FCR	Fire Control Radar
FI(A)	Flight Instructor Aeroplanes
FIR	Flight Information Region
FISO	Flight Information Service Officer
FL	Flight Level
ft	feet
GASP	Global Aviation Safety Plan
HUD	Head-up Display
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILT	Dutch Human Environment and Transport Inspectorate
IMC	Instrument Meteorological Conditions
IR	Instrument Rating
IVD	Defence Safety Inspectorate
km	kilometre
KNMI	Royal Netherlands Meteorological Institute
kt(s)	knot(s)
LMFD	Left Colour Multi-Function Display
LVC	Aviation Advice Commission (*in Dutch: Luchtverkeerscommissie*)
LVNL	Air Traffic Control the Netherlands
MAC	Mid-Air Collision

MER	Strategic Environmental Assessment
MIL	Military
MilATCC	Military Air Traffic Control Centre
MLA	Military Aviation Authority
MPL	Multi-Crew Pilot License
MST	Member State Task
NM	Nautical Miles
NOTAM	Notice to Airmen
PPL(A)	Private Pilot Licence Aeroplanes
RMFD	Right Colour Multi-Function Display
RMZ	Radio Mandatory Zone
RNLASF	Royal Netherlands Air and Space Force
RvTV	Dutch Transport Safety Board
SEP(A)	Single Engine Piston Aeroplanes
SFI(A)	Synthetic Flight Instructor Aeroplanes
SSP	State Safety Program
SSR	Secondary Surveillance Radar
STCA	Short Term Conflict Alert
TEM	Threat and Error Management
TMA	Terminal Control Area
TMZ	Transponder Mandatory Zone
UHF	Ultra High Frequency
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions

GENERAL OVERVIEW

Identification number:	2023231
Classification:	Serious incident
Date, time of occurrence:	16 November 2023, around 13:40 UTC[1]
Location of occurrence:	Airspace near Elburg, the Netherlands
Registration aircraft 1:	J-515
Aircraft type:	General Dynamics F-16AM
Aircraft category:	Military fighter aircraft
Type of flight:	Training flight
Phase of operation:	En route
Damage to aircraft:	None
Flight crew:	One
Injuries:	None
Registration aircraft 2:	PH-ZVT
Aircraft type:	Costruzioni Aeronautiche Tecnam S.r.l. P-Mentor
Aircraft category:	Single engine piston
Type of flight:	Training flight
Phase of operation:	En route
Damage to aircraft:	None
Flight crew:	Two
Passengers:	None
Injuries:	None
Other damage:	None
Light conditions:	Daylight

1 All times in this report are expressed in UTC (local time = UTC + 1 hour), unless otherwise specified.

1 INTRODUCTION

1.1 The incident

On 16 November 2023, around 13:40, a near miss between an F-16 of the Royal Netherlands Air and Space Force (RNLASF) and a Tecnam P-Mentor occurred near Elburg, the Netherlands. A formation of two F-16s conducted a flight from the Vliehors range to Volkel Air Base under Instrument Flight Rules (IFR). The Tecnam, with an instructor and a student on board, had departed Lelystad Airport for a training flight under Visual Flight Rules (VFR). The near miss occurred at an altitude of 3,000 feet in class E airspace. In the area, visual meteorological conditions prevailed. Both aircraft continued their flight without any further issues.

1.2 Investigation questions

The training organisation to which the Tecnam belonged, reported the near miss to the Dutch Safety Board on 23 November 2023. The Dutch Safety Board classified the occurrence as a serious incident, because the incident involved circumstances indicating that there was a high probability of an accident. The Ministry of Defence did not report the occurrence to the Dutch Safety Board.

The Dutch Safety Board initiated a safety investigation on behalf of the state of occurrence. The investigation was conducted in accordance with Regulation (EU) No 996/2010 of the European Parliament and Council and the Dutch Safety Board's Kingdom Act.

In addition to investigating the cause(s) of the incident, the Safety Board focussed the investigation on the overall management of the risk of a mid-air collision between military fighter aircraft and general aviation in airspace where no active separation is provided by air traffic control between or from VFR traffic. In Dutch airspace below flight level 100[2], military fighter aircraft may also fly faster than the applicable speed limitation of 250 kts. The risk of mid-air collisions is increased by the high speed of military fighter aircraft. Currently there are measures in place to mitigate the effect of the higher speeds (e.g. the increase of the minimum flight visibility to eight kilometres and the use of transponders).

2 Above transition level, the altitude is expressed in flight level (FL). FL100 corresponds to 10,000 feet above the standard isobaric reference plane of 1013,25 hPa.

The Dutch Safety Board's predecessor, the Dutch Transport Safety Board (RvTV), investigated two fatal mid-air collisions between military fighter aircraft and general aviation aircraft:

- 22 December 1999: collision between an F-16 and a Piper Cherokee, two fatalities.
- 24 April 2002: collision between an F-16 and a Comco Ikarus C42, two fatalities.

The RvTV issued several recommendations in the final investigation reports, published respectively in 2001 and 2004. This report presents an overview of the key actions taken in relation to these recommendations.

With respect to the risk of mid-air collisions between military fighter aircraft and general aviation, the current investigation also considered a number of (ongoing) developments. These include the introduction of the F-35 at the RNLASF, the foreseen growth of the Dutch armed forces, the expansion of military training activities and the redesign of the Dutch airspace (Dutch Airspace Redesign Programme, in Dutch: *Luchtruimherziening*).

This investigation seeks to answer the following questions:

a. What caused the near miss and what factors contributed to the event?
b. What improvements can be identified regarding the management of the risk of a mid-air collision between a military fighter aircraft and general aviation aircraft in airspace where no active separation is provided by air traffic control between or from VFR traffic?

The Board did not investigate the technical reason why the Tecnam was not visible on the radar screen of one of the two F-16s. This radar is a military tactical device, not designed and intended to prevent collisions with civil air traffic.

The Dutch Safety Board collected information from the RNLASF, Air Traffic Control the Netherlands (LVNL), the Royal Netherlands Meteorological Institute (KNMI), and Ministry of Infrastructure and Water Management. The investigators of the Board also conducted interviews with the civil and military pilots and air traffic services personnel.

1.3 Report structure

Chapter 2 presents the relevant factual information. Chapter 3 contains the analysis of the data collected. Findings and conclusions are summarised in Chapter 4. The recommendations are presented in Chapter 5.

2 FACTUAL INFORMATION

2.1 History of the flight

2.1.1 Shark formation

Flight preparation

On 16 November 2023, two F-16s were scheduled for a training exercise at the Vliehors range military training site on Vlieland. The formation – known by the call sign 'Shark Formation' – was based at Volkel Air Base and comprised two aircraft: Shark 1 as the lead and Shark 2 as the wingman.

In the morning, the two pilots prepared for the flight. This included discussing and planning the outbound and return flights in collaboration with ground support personnel. The pilots had performed this training exercise multiple times before and they conducted the flight to and from the Vliehors range via a frequently used route. Therefore, the preparation was relatively simple and all aspects of the flight and the exercise were discussed.

A band of low overcast clouds extended from Volkel to an area south of the Flevopolder. North of this cloud band, Visual Meteorological Conditions (VMC) prevailed. Due to the cloud cover, visual flight was not possible for the first part of the flight trajectory, so the flight to and from the Vliehors range was conducted under Instrument Flight Rules (IFR). For this purpose, the flight operations staff prepared and filed an IFR flight plan. According to the flight plan, the Shark formation was scheduled to take off at 13:00. The outbound flight was planned at an altitude of 2,000 feet with a speed of 420 knots via the route Volkel-Amerongen-Kampen-Vlieland. The exercise on Vlieland was scheduled to last 45 minutes and the total flight duration was estimated at 1 hour and 30 minutes. The return flight would be flown via the same, reversed, route at the same altitude.[3]

Meteorological conditions and flight rules

Flights under Visual Flight Rules (VFR) are subject to specific rules for operations in Visual Meteorological Conditions (VMC). The Standardised European Rules of the Air (SERA, Regulation (EU) No 923/2012) and the national Aeronautical Information Publication (AIP) specify minimum criteria for VMC visibility and distance from cloud. A VFR flight shall only be carried out when flight visibility and distance of aircraft from clouds are equal to or greater than the values specified in the regulations.

3 According to information from the Royal Netherlands Air and Space Force (RNLASF), the standard altitude for F-16s is an altitude between 1,200 and 2,000 feet. Depending on (weather) conditions, higher altitudes may be flown.

Instrument meteorological conditions (IMC) are meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, that are less than the minima specified for Visual Meteorological Conditions. Flights executed in IMC are subject to Instrument Flight Rules (IFR). Pilots of IFR flights depend on flying by reference to instruments in the cockpit and they navigate by reference to electronic signals.

During the flight planning, the crew paid attention to the possibility of dense air traffic, amongst others in the vicinity of Lelystad Airport. Because of the IFR flight plan and the fact that most of the en route flight would take place in class E airspace, air traffic control (ATC) service would be available to ensure separation from other IFR flights. In line with the airspace classification, the crew expected to receive traffic information[4] regarding Visual Flight Rules (VFR) flights.

According to the military pilots, the combination of ATC services and cockpit equipment, such as radar and the Airborne Identification Friend or Foe (AIFF) interrogator[5], provided sufficient capabilities for detecting and avoiding potential conflicts with civil air traffic. The cockpit equipment was configured to display the airspace structure on the navigation screen. The transponder was set on Mode 3/C and Mode 5, so that the F-16s would be visible for ATC and other aircraft equipped with the appropriate receivers. The AIFF interrogator was set on Mode 3 code 7000, so that air traffic with their transponder set to code 7000 would be visible on the F-16 radar screen.

The flight

At around 12:45, the two F-16s took off from Volkel Air Base. The formation flew northeast via the planned route at 2,000 feet. Once the formation left Volkel airspace, Shark 1 contacted Dutch Mil[6] via the UHF[7] frequency 336.325 MHz. The Dutch Mil air traffic controller (hereafter: area controller) confirmed radio contact and cleared the Shark formation to the Vliehors range at 2,000 feet. The weather was as expected: Instrument Meteorological Conditions (IMC) prevailed from Volkel to Lelystad, but north of Lelystad, the weather improved quickly. At around 13:00, the formation reached the Vliehors range, where the weather was clear and Visual Meteorological Conditions (VMC) prevailed. The crew cancelled the IFR flight plan and conducted the exercise at the Vliehors range.

After the exercise, at around 13:30, the Shark formation returned via Den Helder and the Southwest of Friesland towards Kampen, see Figure 1. At 13:34, Shark 1 re-established contact with the area controller from Dutch Mil on frequency 336.325 MHz to activate the IFR flight plan for their return to Volkel Air Base.

4 'Traffic information' means information issued by an air traffic services unit to alert a pilot to other known or observed air traffic which may be in proximity to the position or intended route of flight and to help the pilot avoid a collision. Source: Standardised European Rules of the Air (SERA, Regulation (EU) No 923/2012).

5 This tactical system allows the pilot of an F-16 to interrogate transponders and the corresponding codes of other aircraft. See also Section 2.3.1.

6 Military Air Traffic Control Centre (MilATCC) Schiphol.

7 Ultra high frequency (300 to 3000 MHz): frequencies usually used for military aircraft communications.

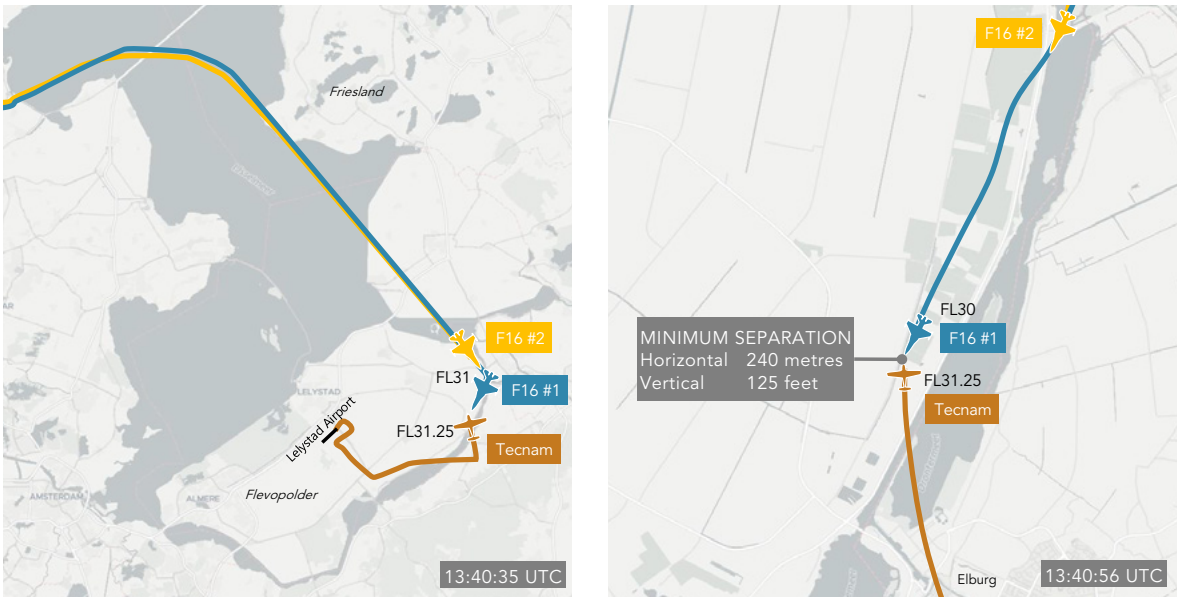
▲ *Figure 1: Approximate aircraft positions at 13:34 and 13:36 (source radar data: ATC the Netherlands).*

At 13:36, the area controller instructed the formation to climb to 3,000 feet due to VFR traffic flying in the area of Lelystad Airport and opposite IFR traffic. The opposite traffic was another F-16 formation that was scheduled to fly at 2,000 feet along the same route from Volkel to Vlieland. At the time of the area controller's instruction, this formation had not yet departed from Volkel Air Base.

Between 13:36 and 13:40, a colleague relieved the area controller of his duty. At 13:40, near Kampen, the F-16s changed course to a southwesterly direction, see Figure 2. At that time, the new area controller informed the pilots of traffic flying two nautical miles (NM) right in front of Shark 1, at the same altitude. Shark 1 observed an aircraft at 3,000 feet on the AIFF interrogator. This aircraft was however not displayed on his radar screen. Shark 2, flying approximately two miles behind Shark 1, did see this aircraft on his radar screen and informed Shark 1, indicating the aircraft was flying two miles directly ahead and slightly above the horizon. Shark 2 also relayed the aircraft's radar track to Shark 1 via datalink.

The pilot of Shark 1, considering the F-16's high speed, decided to focus on visually identifying the traffic. Shortly thereafter, Shark 1 spotted three lights and identified a white propeller aircraft with a tricycle landing gear at close distance. The pilot immediately performed an evasive manoeuvre by making a sharp descending turn to the right.

ATC radar data indicated that Shark 1 and the Tecnam passed each other with a minimum horizontal separation of approximately 240 metres and a vertical separation of 125 feet. The groundspeed of Shark 1 at the time of the manoeuvre was approximately 420 knots.



▲ *Figure 2: Aircraft positions at 13:40:35 (course change near Kampen) and 13:40:56 (near miss) (source radar data: ATC the Netherlands).*

After executing this evasive manoeuvre, Shark 1 instructed Shark 2 to descend immediately, because it was still flying at 3,000 feet - approximately the same altitude as the white aircraft. Shark 2 complied with this instruction, thereby eliminating the risk of a collision.

Following the incident, the Shark formation continued its flight without further issues. Shark 1 reported the near miss to the area controller. Upon landing at Volkel Air Base, the pilots submitted a safety report to their safety department.

2.1.2 Tecnam

Flight preparation

The Tecnam P-Mentor with registration PH-ZVT (hereafter: Tecnam), was scheduled for a VFR training flight from Lelystad Airport. This training flight was part of the Multi-Crew Pilot License (MPL) training program for commercial pilots. The crew consisted of an instructor and a student pilot.

The purpose of this flight was to practice basic flying skills, including stalls and descending and climbing turns. The student completed the flight preparation, which the instructor then reviewed through a question-and-answer session, including Threat and Error Management (TEM). They identified potential risks and discussed measures to manage them. They also addressed the general risk of loss of separation, particularly the importance of looking out for other traffic before practicing manoeuvres, like steep turns. The specific possibility of encountering high-speed military aircraft was not discussed. Both the instructor and the student were aware that ATC does not provide separation services for VFR flights in class E airspace.

The flight
At approximately 13:25, the Tecnam departed from Runway 05 at Lelystad Airport. The flight crew set the transponder to code 7000 with mode C/S and switched on the strobe and navigation lights. Until reaching point BRAVO[8], the crew maintained contact with Lelystad Tower, after which they switched to Dutch Mil on VHF[9] frequency 132.350 MHz. The Dutch Mil Flight Information Service Officer (FISO) confirmed radar contact. The Tecnam flew on a generally easterly course, climbing to 2,000 feet. The aircraft then made a left turn and flew on a generally northerly course towards Elburg. The instructor tasked the student with performing a 'straight and level flight' and the aircraft subsequently climbed to 3,000 feet for this exercise. The student was alternating between monitoring the instruments and visually scanning outside, while the instructor primarily scanned outside.

Suddenly, the crew saw an F-16 executing a descending turn directly in front of them, veering left from their perspective. They saw the underside of the F-16 as it turned away. The event happened so quickly that the crew had no time to take evasive action. They had not noticed the aircraft earlier and were greatly surprised by it. They also saw another F-16 flying to their right.

The crew did not receive traffic information from the FISO about the two approaching F-16s. In addition, the instructor stated that both F-16s were not visible via ADS-B[10], which he was monitoring on a handheld device used for navigation.

After landing, the crew reported the occurrence to the flight safety manager of the training organisation, who reported the occurrence to the Dutch Safety Board.

2.1.3 Dutch Mil
The incident occurred in the airspace Lelystad TMA 4. The responsible air traffic service provider for this part of the airspace depends on the time of day; see Section 2.7.2 for further details. At the time of the occurrence, MilATCC Schiphol, operating under the call sign Dutch Mil, was the assigned air traffic service provider.

Dutch Mil is located at Air Traffic Control the Netherlands (LVNL) at Schiphol Airport. There are seven controller positions, which are not all used simultaneously. The use depends on traffic density and available staff. At the time of the occurrence, two out of seven controller positions were in use: one by the area controller and the other by the FISO. The area controller provides air traffic services (ATS) to all IFR traffic in its area of responsibility, while the FISO provides flight information services to all uncontrolled VFR traffic in its area. The area controller was performing the tasks of two controller positions. He performed the tasks of controller for all air traffic below FL195 (Lower executive for

8 BRAVO is a VFR reporting point and part of the visual departure procedure 'BRAVO Departure' from Lelystad Airport.
9 Very High Frequency (30 to 300 MHz): the frequency band most commonly used in civil aviation.
10 Automatic dependent surveillance - broadcast (ADS-B) is a means by which aircraft, aerodrome vehicles and other objects can automatically transmit and/or receive data such as identification, position and additional data, as appropriate, in a broadcast mode via a data link. Source: ICAO, Doc 4444 Procedures for Air Navigation Services - Air Traffic Management Sixteenth edition, 2016.

two areas EL1 and EL2) and all air traffic above FL195 (Upper executive).[11] In addition to this task, he acted as coordinator. He had to monitor four radio frequencies. The FISO monitored two frequencies.

According to interviews, combining controller positions results from a structural lack of personnel at MilATCC Schiphol. Consequently, not all air traffic control tasks can always be carried out as described in the operations manual.

The three controller workstations between the area controller and FISO were not occupied. The physical distance between the two staff members was about eight meters and communication between them took place via the fixed telephone network. There were no specific procedures or work instructions for coordination between the area controller and the FISO.

The layout of the radar screens for the area controller and the FISO was basically identical. However, the screens and communication options were different. All IFR and VFR traffic were displayed on the radar screens of both the area controller and the FISO. To avoid confusion and overload, both had disabled the option to monitor all radio frequencies. The area controller listened to the IFR frequencies and the FISO to the VFR frequencies. As a result, neither of them was listening to the frequency of his colleague. In case of a potential loss of separation between IFR flights, a Short Term Conflict Alert (STCA)[12] is generated by the system to support controller actions. This STCA functionality had not been implemented for VFR traffic, as there are no defined separation criteria and to avoid an overload of warnings in case of high VFR traffic density.

The area controller instructed the Shark formation to climb to 3,000 feet due to VFR traffic around Lelystad Airport and opposite traffic. He stated that it was his standard procedure to instruct military fighter aircraft to climb when there was a lot of low flying VFR traffic in the area. In addition, although the 'opposite traffic' had not yet taken off from Volkel Air Base, the area controller took preventive action to ensure separation in advance. After issuing the instruction to climb, his colleague relieved him of his duty. Some minutes after the handover, the new area controller saw the Shark formation making a turn near Kampen. This change in course brought the formation into potential conflict with the Tecnam. The area controller immediately warned the Shark formation of this traffic, indicating it was directly ahead at about two miles. About one minute after, Shark 1 reported a 'near miss' to the area controller.

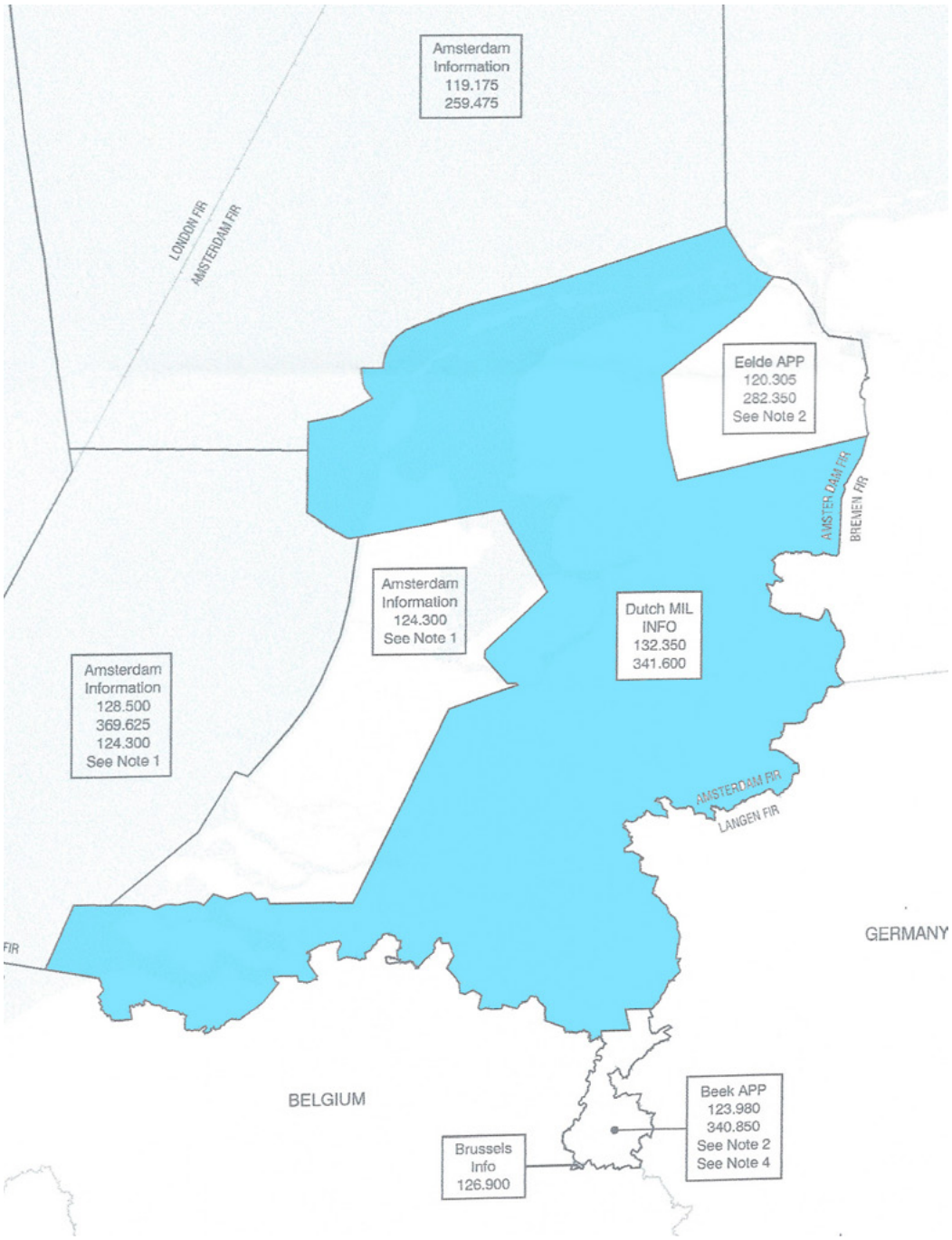
On the day of the incident, the FISO was on duty from 10:00 to 17:00. At the start of his shift, he noticed the Shark formation's flight plan and recalled that the outbound flight to the Vliehors range was over the east of the Netherlands. His belief was that the return flight would be over the North Sea. He paid no further attention to it thereafter. During

11 Area: Nieuw Milligen TMA and CTA North, Amsterdam Upper Control Area (UTA) for air traffic not following the air traffic services (ATS) routes, up to FL 245.

12 The objective of the STCA function is to assist the controller in preventing collision between aircraft by generating, in a timely manner, an alert of a potential or actual infringement of separation minima. Source: ICAO, Doc 4444 Procedures for Air Navigation Services - Air Traffic Management Sixteenth edition, 2016.

his FISO duty, traffic levels were low, with about six aircraft reporting on the VFR frequency for flight information within his area, including the Tecnam. He monitored air traffic generally and found no need to provide additional information to aircraft or pay extra attention to any aircraft.

The FISO did not notice a potential conflict between the Shark formation and the Tecnam and did not see the near miss. He only learned of the incident from the area controller. The FISO stated that he could not explain why he had missed the event, suggesting that, given the large work area he was monitoring (see Figure 3), his attention might have been focused elsewhere, despite his low workload.



▲ *Figure 3: Airspace under responsibility of the Dutch Mil FISO (blue) (source: AIP the Netherlands – blue area highlighted).*

2.2 Personnel information

2.2.1 Shark 1

The pilot of Shark 1 held a valid Military Pilot Licence with an Instrument Rating (IR) Class 1 and a type rating for the F-16. He also held a valid Military Medical Certificate. His total flight experience was around 3,315 hours, including 3,001 hours on the F-16. His most recent flight prior to the occurrence was on 14 November 2023.

2.2.2 Tecnam

The instructor held a valid Airline Transport Pilot Licence Aeroplanes (ATPL(A)) and a Private Pilot Licence Aeroplanes (PPL(A)), with ratings for Single Engine Piston (SEP(A)), Flight Instructor (FI(A)) and Synthetic Flight Instructor (SFI(A)). He also possessed a valid Class 2 Medical Certificate. His total flight experience was around 22,000 hours on both multi- and single-engine aircraft, with 28.45 hours on the Tecnam. The total experience the last three months was 37.50 hours. He worked as freelance instructor for the training organisation.

The student did not yet hold a pilot licence. He started his flight training on 31 October 2023. Until the incident flight, he had made five instructional flights, accumulating around seven hours of flight time, under the supervision of different instructors.

2.2.3 Air Traffic Control

Both the area controller and the FISO had been serving in military ATC for several years. The area controller had been employed since 2007 as an air traffic controller, with experience also as a coordinator and instructor. He held a valid air traffic controller licence for MilATCC with ratings for area control surveillance and area control procedural and coordinator, terminal control and on-the-job training instructor endorsements. The FISO had been working as ground controller/assistant at Eindhoven Air Base since 2000. He worked on average once a week at MilATCC Schiphol as a FISO or assistant to an air traffic controller. He held a valid FISO licence for MilATCC with area rating and radar, clearance delivery and on-the-job training instructor endorsements. He also held a valid air traffic controller license for Eindhoven Air Base with aerodrome ground control rating and ground movement and on-the-job training instructor endorsement.

2.3 Aircraft information

2.3.1 Shark 1

Shark 1, with registration mark J-515, is a General Dynamics F-16AM, a single-seat military fighter aircraft powered by a Pratt & Whitney F100 – PW220E engine. The aircraft is painted in the standard light grey colour scheme and is equipped with standard navigation lights and a strobe light mounted on the vertical stabilizer.

▲ *Figure 4: F-16 with registration J-515 (source: Ministry of Defence).*

In addition to the standard flight and weapon system instruments, the F-16 is equipped with a Fire Control Radar (FCR), which has a tactical function for detecting airborne targets. These targets are displayed on one of the two configurable Colour Multi-Function Displays (CMFDs). The radar detects a target if that target meets two conditions: its ground speed must exceed a pre-set threshold, and it must have sufficient reflectivity or radar cross-section.

The F-16 is also equipped with an Airborne Identification Friend or Foe (AIFF) system, which allows the pilot to interrogate the transponders and codes of other aircraft. This radar is a military tactical device that is not designed or intended to prevent collisions with civil air traffic. The F-16 is not equipped with, nor required to be equipped with an Airborne Collision Avoidance System (ACAS).[13]

2.3.2 Tecnam

The Tecnam P-Mentor is a two-seat, single-engine piston aircraft with a fixed tricycle landing gear. The fuselage is constructed from a steel truss frame, with a mix of alloy and glass fibre-reinforced polymer materials. The aircraft is powered by a Rotax 912iSc3 Sport engine. The aircraft type is certified by the European Union Aviation Safety Agency (EASA) in accordance with the airworthiness requirements for Normal Category Aeroplanes (CS-23) and has a maximum take-off mass of 720 kilograms.[14]

13 An airborne collision avoidance system is an aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders. Source: ICAO, *Doc 4444 Procedures for Air Navigation Services – Air Traffic Management Sixteenth edition, 2016.*

14 See EASA Type-Certificate Data Sheet EASA.A.006.

▲ *Figure 5: Tecnam P-Mentor with registration PH-ZVT (source: Cees Romeijn).*

PH-ZVT was built in 2023 (serial number 1089) and registered in the Dutch aircraft registry on 18 October 2023. Its airworthiness review certificate was valid through 9 October 2024. The main colour of PH-ZVT is white and it is equipped with standard navigation lights and strobe lights on the vertical stabilizer and wingtips.

PH-ZVT has a radio, a transponder, and basic navigation instruments. The aircraft is not equipped with, or required to be equipped with, an ACAS. However, the instructor carried a portable device for navigation purposes, which displayed nearby aircraft that are equipped with a transponder.

2.4 Meteorological information

The Royal Netherlands Meteorological Institute (KNMI) provided a report with the meteorological conditions around the time of the occurrence. The text of this report is provided below.

General situation
On the northern flank of a low-pressure area over northern France, an easterly flow was bringing in transformed polar air. An occlusion front was situated over the southern part of the Netherlands. Light rain occasionally fell near the occlusion. North of the Rotterdam-Deelen line, the cloud base was above 5,000 feet, while to the south, there was broken/scattered stratus cumulus cloud at 1,500 - 2,500 feet and locally broken/scattered stratus cloud at 500-1,000 feet in precipitation, with cloud tops around 9,000 feet.

Weather conditions near Elburg around 13:40
- Dry and no clouds below 10,000 feet, overcast around 16,000 feet
- Visibility more than 10 kilometre (km)
- QNH[15] 1011 hectopascal (hPa)

15 QNH is the local atmospheric pressure. The pilot uses this to set the aircraft's altimeter to ensure that the instrument indicates the aircraft's height above mean sea level.

▼ *Table 1: Wind and temperature under 5,000 feet (source: KNMI).*

Level	Direction (degrees)	Speed (knots)	Temperature (°C)
Ground	050	6	8
250 feet	060	10	7
500 feet	070	12	6
1,500 feet	070	12	4
3,000 feet	070	12	1
5,000 feet	070	12	-1

Weather conditions south of Elburg and around Volkel Air Base
Around 3,000 feet, conditions just south of Elburg at 13:40 were good with a cloud base above 10,000 feet. Further south of the Veluwe, towards Volkel, conditions deteriorated with light rain and drizzle and locally broken/scattered stratus cloud around 700 feet and ground visibility reduced to around 8 km. The slant visibility from the cockpit was likely worse, occasionally, around 3 to 5 km.

2.5 Communications

During the exercise at the Vliehors range, the Shark formation established radio contact with the Vliehors range Control Officer's frequency. After the exercise, the crew established radio contact with Dutch Mil on the UHF frequency 336.325 MHz for the return flight to Volkel Air Base. Internal communication between the two F-16s was via VHF radio.

The flight crew of the Tecnam had radio contact with Lelystad Tower on VHF frequency 135.180 MHz when flying in the Lelystad Control Zone (CTR). Outside this CTR and for the remainder of the flight, the crew established radio contact with Dutch Mil on VHF frequency 132.350 MHz. After the crew signed on, they maintained a listening watch on this frequency. After the initial contact when signing on, there was no further communication with Dutch Mil until the crew informed Dutch Mil of the near miss.

2.6 Data recorders

2.6.1 Shark 1
Shark 1 was not equipped with a flight recorder, but the aircraft had some devices that recorded data of the aircraft and the flight. These are primarily designed for data analysis of normal flight operations and not for accident investigation purposes. One of these devices is the Aircraft Video Tape Recorder (AVTR).

The AVTR recordings of the following components are stored on three videotapes:

- The recording of the head-up display (HUD), which shows the forward view from the cockpit with projected information on altitude, speed, course, and time.
- Left Colour Multi-Function Display (LMFD) and Right Colour Multi-Function Display (RMFD), both with information selected by the pilot.

All internal and external radio communication is also recorded on these videotapes.

The HUD showed the forward view of the pilot including speed and altitude. Shortly after Shark 1 made a right turn to heading 190° at 13:40:30, the area controller warned of traffic in front of the F-16. The LMFD showed symbols of other aircraft. Some of these symbols showed transponder code 7000, but none of them were right in front of the F-16 at the same altitude. Some of the symbols were sometimes visible and sometimes not. None of these symbols could be positively identified as the Tecnam. Shark 2 saw an aircraft on its radar display straight ahead at about 2 miles. A short moment later, Shark 2's radar image that was sent by data link, was visible on Shark 1's LMFD, but the altitude of the symbol varied. Some seconds thereafter, landing lights were briefly visible on the HUD, after which Shark 1 made a sharp descending right turn. At that point, the Tecnam was very briefly visible moving from right to left through the HUD image. The whole scene lasted for about 10 seconds. The RMFD showed the horizontal situation display with the intended course and track.

2.6.2 Tecnam

The Tecnam was not equipped, or required to be equipped, with flight recorders.

2.7 Air Traffic Services

The Dutch State is responsible for managing the Dutch airspace, called the Amsterdam Flight Information Region (FIR), in accordance with international standards and regulations. The State shall determine and ensure the appropriate level of air traffic services to be provided in the different parts of the airspace and at the aerodromes.[16] For this purpose, the airspace is divided into different areas (airspace structure), operational procedures are established and routes are designed. In the Dutch airspace below flight level (FL) 245, air traffic services are provided by either Air Traffic Control the Netherlands (LVNL) or the Military Air Traffic Control Centre (MilATCC), each in their assigned parts of the airspace.

2.7.1 Airspace classification

For airspace standardisation, the airspace classes as established in the Standardised European Rules of the Air (SERA) are used. These classes differ in the services provided:

- Separation services between aircraft provided by air traffic control;
- Speed limitations;
- Radio communication capability requirements;
- Required air-ground voice communication;
- Required clearance to enter the airspace.

16 See Annex 11, Air Traffic Service, International Civil Aviation Organization (ICAO), 15th Edition, July 2018 and Regulation (EU) 2017/373 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight.

Table 2 presents the provided air traffic services and requirements for the for this report relevant airspace classes D, E and G. Class D and E are considered controlled airspace, and class G is uncontrolled airspace.

▼ *Table 2: Air traffic services provided and requirements for airspace class D, E and G (source: AIP the Netherlands).*

Class D	IFR	VFR
Service provided	Air traffic control service; VFR traffic information; Traffic avoidance advice on request	Air traffic control service; VFR traffic information; Traffic avoidance advice on request
Separation provided	IFR from IFR	Not provided
Speed limitation	250 kts below FL100	250 kts below FL100
Continuous 2-way radio communication	Required	Required
Flight plan	Required	Required
ATC clearance	Required	Required

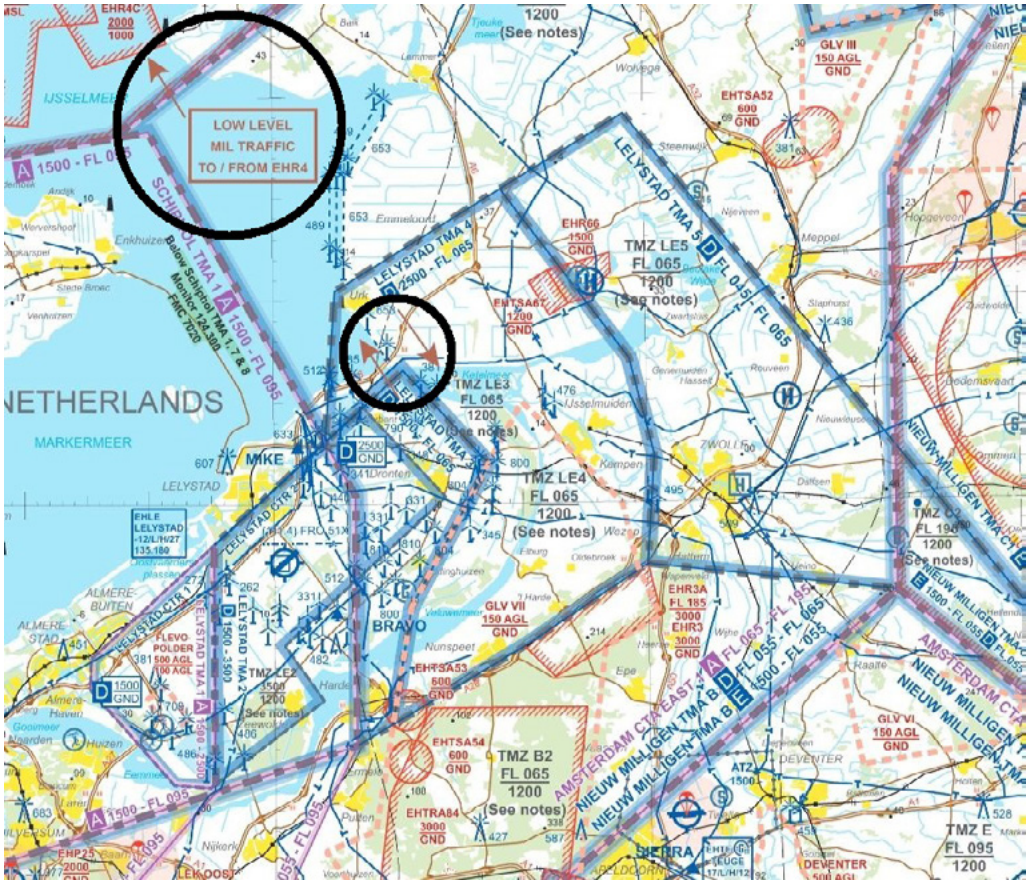
Class E	IFR	VFR
Service provided	Air traffic control service; VFR traffic information (as far as practical)	Traffic information (as far as practical)
Separation provided	IFR from IFR	Not provided
Speed limitation	250 kts below FL100	250 kts below FL100
Continuous 2-way radio communication	Required	Not required
Flight plan	Required	Not required
ATC clearance	Required	Not required

Class G	IFR	VFR
Service provided	Flight information service if requested	Flight information service if requested
Separation provided	Not provided	Not provided
Speed limitation	250 kts below FL100	250 kts below FL100
Continuous 2-way radio communication	Not required	Not required
Flight plan	Required	Not required
ATC clearance	Not required	Not required

The Aeronautical Information Publication (AIP) of the Netherlands further states that for these three airspace classes, the speed limit of 250 knots below FL100 is not applicable to military fighter aircraft, if the flight visibility is more than 8 kilometres.

2.7.2 Airspace near the incident

The incident occurred near Elburg at around 3,000 feet. At this location, the airspace from 2,500 feet to FL065[17] is called 'Lelystad Terminal Control Area 4' (Lelystad TMA 4). The responsible service provider is MilATCC Schiphol. The airspace classification for the Lelystad TMA 4 depends on the time of day. According to the AIP of the Netherlands and published charts, this airspace is classified as class D. However, in AIP Supplement 03/2022[18] it has been determined that from 1 April 2020, this area is classified as class E between 21:00 and 17:00 the next day.



▲ *Figure 6: Part of the aeronautical chart with the 'Low level Mil Traffic' warnings highlighted (source: Aeronautical Chart The Netherlands, Edition 2024, LVNL - warnings highlighted).*

The establishment of Lelystad TMA 4 and airspace class D, where more air traffic services are provided to air traffic compared to class E, is related to the anticipated future use of Lelystad Airport by commercial air transport as an overflow airport for Schiphol Airport. Until this takes effect, the AIP Supplement 03/2022 will remain in force. Airspace class E requires less ATC capacity, i.e. staff and resources, compared to class D.

17 Above transition level, the altitude is expressed in flight level (FL). FL065 corresponds to 6,500 feet above the standard isobaric reference plane of 1013,25 hPa.

18 LVNL, *AIP SUP 03/2022*, Time-Dependent Airspace Classification TMAs, April 2022.

The airspace structure is depicted on the Aeronautical Chart The Netherlands, see Figure 6.[19] This chart shows a warning 'Low Level Mil Traffic to/from EHR4'. The arrows indicate the flight direction of low-level military aircraft flying to and from the Vliehors range.[20]

The cruising level for IFR flights in controlled airspace, including airspace class E, shall be selected from the table of cruising levels specified in the AIP the Netherlands and the Military AIP.[21] This table indicates that 1,000, 2,000 and 3,000 feet Above Mean Sea Level (AMSL) are IFR cruising levels. For VFR traffic, there are no requirements regarding cruising levels when flying in class E airspace below 3,500 feet AMSL.[22]

2.8 See and avoid principle

In class E airspace, the air traffic service provider does not provide separation between IFR-VFR and VFR-VFR flights. For these flights, pilots apply the see and avoid principle to maintain separation. See and avoid is a concept for avoiding collisions: the pilot actively scans the airspace for potentially conflicting traffic. See and avoid is recognised as the main method for avoiding collision when weather conditions permit. It requires that pilots actively search for potentially conflicting traffic, especially when operating in airspace where air traffic services do not provide separation.

Much research has been conducted on the see and avoid principle and its limitations. These limitations include the human visual system, cockpit workload, and various physical and environmental conditions. The causes of these limitations and possible solutions have been extensively described.[23] This investigation report provides a summary of the relevant content of these studies and refers to these documents for further background information.

Unalerted and alerted see and avoid

The overall conclusion of the studies is that see and avoid is an uncertain method of traffic separation. It is important to distinguish between unalerted and alerted see and avoid. Unalerted see and avoid relies solely on the pilot with no other assistance, to visually detect other aircraft. For aircraft without a radio, radio contact or other traffic awareness technical tools, it is the only means to detect possible conflicting traffic.

19 LVNL, *Aeronautical Chart The Netherlands, ICAO 1:500.000*, Edition 2024.
20 The Vliehors range is restricted area EHR4.
21 See section ENR 1.7 in both the AIP the Netherlands and MIL AIP.
22 VFR flights operated in level cruising flight above 3,500 feet AMSL (the transition altitude for VFR flights in the Amsterdam FIR) shall be conducted at a flight level appropriate to the track as specified in the table of cruising levels included in the AIP the Netherlands and Military AIP in section ENR 1.7, except when otherwise indicated in ATC clearances.
23 Sources see and avoid principle used for this section:
- Australian Transport Safety Bureau (ATSB), *Limitations of the See-and-Avoid Principle*, 1991, reprinted 2004.
- EASA, *Collision avoidance – EGAST Safety Promotion Leaflet GA1*, 2010.
- U.S. Department of Transportation, Federal *Aviation Administration, Advisory Circular 90-48D*, 2016.
- Australian Government, Civil Aviation Safety Authority, *Advisory Circular AC 91-14 v1.0, Pilots' responsibility for collision avoidance*, 2021.
- https://skybrary.aero/articles/see-and-avoid [consulted on 12 August 2024].

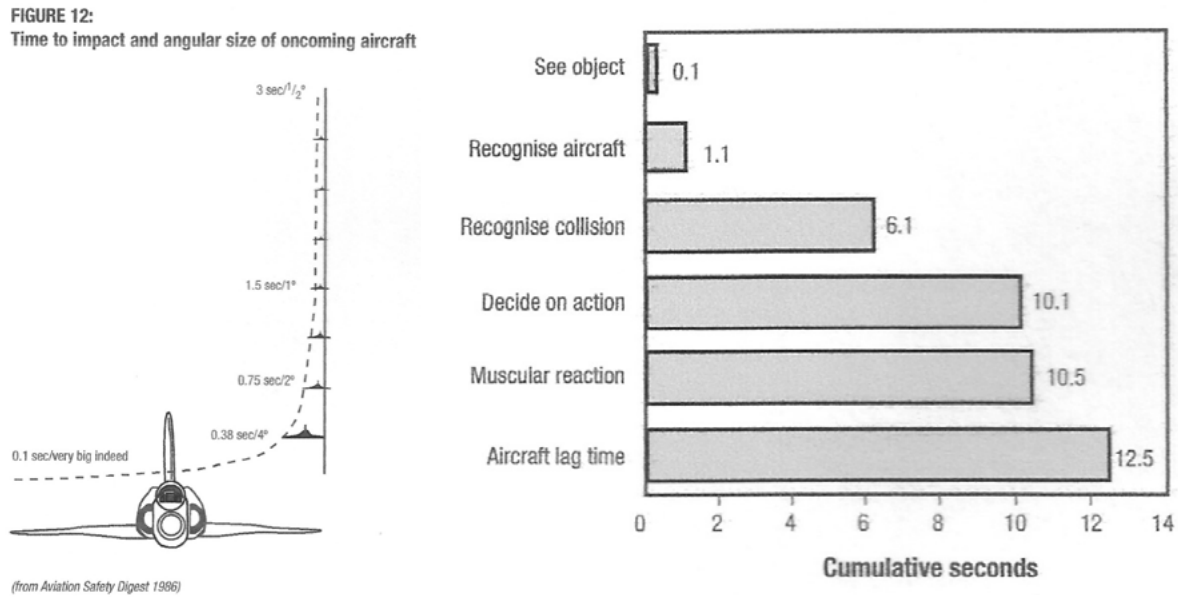
In alerted see and avoid, the pilot is assisted to detect the traffic. The primary tool of alerted see and avoid that is common across aviation is the use of radio communication: radio communications from pilots about their positions or the provision of traffic information to the pilot by ATC. In addition, the use of traffic awareness systems, such as Airborne Collision Avoidance System (ACAS) or other tools using Automatic Dependent Surveillance - Broadcast (ADS-B) and FLARM, a system originally designed for gliders, can assist in increasing the pilot's awareness of other traffic.

According to the literature, the effectiveness of a search for other traffic is eight times greater under alerted circumstances than when only unalerted.[24]

High closing speeds

In order to facilitate the visual acquisition of flights that are not separated by ATC, a speed limitation of 250 knots applies to all flights below FL100.[25] In the Amsterdam FIR, military fighter aircraft are exempted from this speed limitation for operational reasons in case the flight characteristics of the aircraft type concerned or the type of mission to be executed require higher speeds.

The limitations of the see and avoid principle become even more apparent at higher closing speeds, such as in the case of high-speed military fighter aircraft. Research on this subject shows that, given the speed of a military fighter aircraft, it may only take some seconds before a head-on approaching fighter aircraft becomes visible. In general, when a pilot notices the other aircraft, it takes around ten seconds before he decides on action and initiates an evasive manoeuvre. The same is true for the pilot of the high-speed fighter aircraft. Given the speed at which both aircraft are approaching, the military pilot too will have little time to detect a small aircraft and take evasive action.



▲ *Figure 7: Visibility of a military fighter aircraft related to time and reaction time for an evasive manoeuvre (source: Australian Transport Safety Bureau (ATSB), Limitations of the See-and-Avoid Principle, 1991, reprinted 2004).*

24 Australian Government, Civil Aviation Safety Authority, *Advisory Circular AC 91-14 v1.0, Pilots' responsibility for collision avoidance*, 2021.

25 IFR traffic in airspace class A, B and C and VFR traffic in class A and B are exempted from this limitation.

In the Netherlands, to mitigate the effect of a high closing speed between military and civil aircraft, an additional requirement has been put in place, whereby for military fighter aircraft a minimum flight visibility of eight kilometres is required.

Extracts from aeronautical publications regarding speed limitation

AIP - ENR 1.4, 1.2 Speed limitation
Military aircraft cannot adhere to the 250 KT speed limitation below FL 100 as prescribed in the ATS airspace classification. Due to the shortage of space, both civil and military aircraft have to share the same airspaces. The therefore unavoidable mix of low- and high-speed aircraft creates a problem with respect to the principle "detect and avoid", which has been solved by increasing the minimum flight visibility below FL 100 for military jet aircraft from 5 KM to 8 KM, except in the Control Zones.
Source: AIP the Netherlands

MIL AIP - ENR 1.4.1.1 Speed limitation
In the Netherlands CIV, MIL and other State ACFT adhere to the same set of rules derived from the ICAO Annexes. However, most of the MIL ACFT cannot adhere to the 250 KT speed limitation below FL 100 as prescribed in the ICAO ATS Airspace Classification. Due to the shortage of space, CIV, MIL and other State ACFT have to share the same airspaces. The therefore unavoidable mix of low- and high speed ACFT creates a problem with respect to the principle 'see and be seen', which has been solved by:

- Lifting the minimum flight visibility during VFR flights for MIL ACFT in all airspace classes from 5 km to 8 km (except in MIL CTRs), when not able to comply to airspeed restrictions due to ACFT limitations and/or operational purposes;
- Lifting the minimum flight visibility below FL 100 in class G airspace for MIL jet from 5 km to 8 km;
- Additional rules concerning radio communication in class E airspace;
- Additional rules concerning radio communication, SSR transponder and altitude restrictions in class G airspace.

Source: Military AIP, Amendment 13, 2023

2.9 Previous occurrences

2.9.1 Previous occurrences investigated by the Dutch Safety Board

The Dutch Safety Board and its predecessor, the Dutch Transport Safety Board (RvTV), have previously investigated collisions and near-collisions between military and civilian air traffic.

Etten-Leur, 22 December 1999, mid-air collision
A mid-air collision between an F-16 and a Piper Cherokee. The two occupants of the Piper died. The collision occurred at 1,270 feet in uncontrolled airspace (class G). Both

the F-16 and the Piper were conducting a VFR navigation flight. During the phase of flight in which the collision occurred, neither pilot maintained contact with an air traffic service provider.[26]

Sellingen, 24 April 2002, mid-air collision
A mid-air collision between an F-16 and a Comco Ikarus C42. The occupant of the Comco Ikarus and one crew member of the F-16 died. The collision occurred in uncontrolled airspace (class G). The F-16 was conducting a VFR navigation flight. The F-16 formation was in contact with Dutch Mil during the flight, although just before the collision the formation was already switched to the German air traffic service provider. The Comco Ikarus C42 also conducted a VFR-flight and was not in contact with an air traffic service provider.[27]

North Sea, 27 June 2019, near miss
Near miss between an F-16 (VFR traffic) and a helicopter with 17 people on board (IFR traffic). The near miss occurred in class E airspace. Both aircraft were in communication with (different) air traffic service providers. The F-16 pilot was not aware of the helicopter's position.[28]

Recommendations
Following the two fatal accidents in 1999 and 2002, the RvTV made several recommendations. Aspects highlighted in these investigations and addressed in the recommendations, included:

- The limitations of the see and avoid principle;
- The separation between fast-flying military traffic and other air traffic;
- The use of transponders;
- Radio contact between pilots and air traffic service provider.

The RvTV addressed two recommendations to both the minister of Transport and Water Management[29] and the minister of Defence. In summary: on short term to establish a separation between fast-flying military traffic and slow moving civil traffic in uncontrolled airspace. On the longer term, the ministers should investigate whether (new) technical measures can offer a solution to minimize the risk of such collisions.

The RvTV, and later the Dutch Safety Board, did not investigate or report on the follow-up of the recommendations. However, the Sellingen report outlines some developments:

- The introduction of a ban on military fighter aircraft traffic below 1,200 feet AMSL, except for published low-flying routes and low-flying areas;
- Transponder requirements for powered civil aircraft above 1,200 feet AMSL;
- Advice to inform and train private pilots on the use of airspace by fast military traffic, in terms of areas and types of flights.

26 Dutch Transport Safety Board, *Eindrapport 1999142 Botsing in de lucht tussen PH-BLY Piper PA-28-140 J-059 General Dynamics F-16 22 december 1999, nabij Etten-Leur,* March 2001. (Report in Dutch only) https://onderzoeksraad.nl/onderzoek/botsing-in-de-lucht-piper-pa-28-140-general-dynamics-f-16-22-december/
27 Dutch Transport Safety Board, *Botsing in de lucht tussen de FB19/Tiger11 General Dynamics F-16 en de PH-3G8 Comco Ikarus C42 nabij Sellingen op 24 april 2002*, March 2004. (Report in Dutch only) https://onderzoeksraad.nl/onderzoek/botsing-in-de-lucht-general-dynamics-f-16-comco-ikarus-c42-24-april/
28 https://onderzoeksraad.nl/wp-content/uploads/2023/11/kwartaalrapportage_luchtvaart_q4_2020.pdf
29 Now Ministry of Infrastructure and Water Management.

In both the Etten-Leur and the Sellingen report, the RvTV concluded that the combination of both types of air traffic in the same low-altitude airspace poses an unacceptable risk. Additionally, the report stated that the underlying cause of the accident near Sellingen was that, following the 1999 accident in Etten-Leur, insufficient measures were taken by the involved ministries despite the clear recommendation by the RvTV in 2001. Therefore, the RvTV again recommended that the Ministries of Transport and Water Management and Defence take adequate measures for separation in height, time, or location between fast-flying military traffic and other air traffic in those airspace classes where uncontrolled traffic is allowed.

In the report of the near miss over the North Sea, the Safety Board noted that the circumstances of this incident, together with the findings from previous investigations, showed that the need to separate high-speed military air traffic from other air traffic still existed. In that respect, the issues identified in previous investigations had not been resolved.

2.9.2 Other reported near miss occurrences

Apart from the investigated occurrences above, incidents between high-speed military aircraft and civil aircraft have also been reported to the Dutch Human Environment and Transport Inspectorate (ILT) and/or to the Royal Netherlands Air and Space Force (RNLASF). The relevant reported occurrences are mentioned in Appendix B. Due to the way of reporting, there is only limited information on these occurrences. Therefore, it is difficult to determine the actual risk of collision, to establish a probable cause or to identify underlying factors. A number of cases involve military airspace infringements or non-adherence to procedures. In other cases, technical or ATC problems appeared to have played a role.

2.9.3 Main actions taken following previous occurrences

Following the previous mid-air collisions between high-speed military fighter aircraft and civil aircraft, the Ministry of Infrastructure and Water Management and the Ministry of Defence have taken steps to reduce the risk of such collisions. Table 3 presents a summary of the key developments and actions taken.

▼ *Table 3: Main actions taken by the Ministry of Infrastructure and Water Management and the Ministry of Defence.*

Date	Action	Remarks
1996	Discussion about implementation of a general obligation to carry and use a transponder in all civil aircraft.	Not implemented after objections from interest groups.
15 June 2001	Regulation: An aircraft must be equipped with a transponder when executing a VFR flight. Exemptions: • when flying in class G airspace • non-engine equipped (non-powered) aircraft	
28 September 2001	Advice of 'Luchtverkeerscommissie' (LVC) to the ministers involved: 1. Prohibit military fighter aircraft from flying in class G airspace below 1,200 feet AMSL, except within published low-flying routes and areas. 2. Require powered civil air traffic to use radio and transponder for all flights in class G airspace above 1,200 feet AMSL, except from Friday 17:00 to Sunday 24:00 and during recognized public holidays. 3. Inform and train private pilots on the use of airspace by fast military aircraft, regarding the areas and nature of these flights.	Advice to the Ministers of Transport and Water Management[30] and Defence.
30 October 2001	Ministers of Transport and Water Management and Defence agree with the advice of LVC.	
1 December 2001	Regulation of the Minister of Defence: Minimum altitude of 1,200 feet AMSL for fast-flying military aircraft in class G airspace.	Advice 1 of 28-9-2001 implemented, advice 2 and 3 not implemented.
April 2002	Installation 'Etten-Leur Measures Implementation Working Group'	
8 May 2002	Issue of NOTAM: 'All aircraft performing VFR flights and equipped with a transponder must set it to mode S with code 7000 or mode A and C code 7000. All powered aircraft performing VFR flights in class G airspace above 1,200 feet AMSL must be equipped with a transponder. This transponder must be set to mode S code 7000 or mode A and C code 7000 or another code assigned by air traffic control. This does not apply in airspace under the Schiphol TMA'.	LVC's recommendation to mandate radio use for powered civil air traffic in class G airspace above 1,200 feet was not implemented.
25 July 2002	Issue of AIC-B[31] 11/02 to attend pilots to measures against so-called mid-air collisions.	Advice 3 of 28-9-2001 implemented.
December 2002	Decision to postpone the proposed transponder requirement for non-powered aircraft until 1 April 2004.	
3 April 2003	Issue of AIC-B 03/03 to attend pilots again to the risk of mid-air collisions in uncontrolled airspace.	

30 Now Ministry of Infrastructure and Water Management.
31 Aeronautical Information Circular series B.

Date	Action	Remarks
16 October 2003	Issue of AIC-B 10/03 regarding transponders: • Powered aircraft for VFR flights in Dutch airspace must carry and activate an SSR transponder in mode S or mode A/C unless otherwise instructed by air traffic control. • This does not apply to VFR flights in class G airspace below 1,200 feet. If an aircraft is equipped with a functioning transponder, it must also be activated below 1,200 feet. • This does not apply to VFR flights under Schiphol TMA 1 (temporarily). • Non-powered aircraft are exempt from this requirement until 31 March 2004.	Advice 2 of 28-9-2001 implemented, except for radio use.
12 March 2009	Transponder Mandatory Zones (TMZ) in force: • The use of an SSR transponder with mode S/ELS and with automatic altitude reporting in mode C is mandatory in airspace with classification A, B, C, D, E or F, in the North Sea Area and in other airspace with classification G at and above 1,200 feet AMSL, with the exception of the airspace below Schiphol TMA 1.	

The use of on-board transponders enables ATC to receive precise information about an aircraft's position, altitude, and identity. An activated transponder is also necessary for a functioning ACAS system and the transmitted signals could be recognized by military operational devices.

Currently, all aircraft flying in the Netherlands shall be equipped with a mode S transponder with elementary surveillance (ELS) functionality. Exempted are motorised VFR flights in class G airspace below 1,200 feet within Uniform Daylight Period (excluding the North Sea area Amsterdam) and non-motorised aircraft (gliders, hang gliders, paragliders or balloons) and para motors, outside the Transponder Mandatory Zones (TMZs).[32]

Specifications referring to TMZs are described in the airspace catalogue.[33] This document contains criteria determined by the Ministries of Infrastructure and Water Management and Defence that can serve as guidelines for establishing airspace classes. The criteria relevant to this investigation are:

3.1.7.
Within the Amsterdam FIR, with the exception of airspace class G below 1,200 feet, there is a general transponder requirement for motorised air traffic. The basics for identifying a TMZ, is that a TMZ will at least be in an area within which:
(…)
- Daily jet aircraft (civil or military) operate.
(…)

32 Source: AIP the Netherlands, GEN 1.5 Aircraft instruments, equipment and flight documents.
33 Criteria Catalogue Airspace - Assessment framework for airspace classes. https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/publicaties/2023/05/25/wijzigingsproces-luchtruim-en-vliegprocedures/IenW+Criteria+Catalogus+Luchtruim.pdf

5.7.7.
In airspace volumes where high-speed military air traffic operates, the transponder adds value by increasing the visibility of uncontrolled air traffic. A TMZ provides this visibility where non-motorised air traffic is concerned. In cases of greater danger, restricted or danger areas can be established as navigation warnings. In or near these types of areas, a Radio Mandatory Zone (RMZ) where listening on, for example, a Flight Information frequency, may have value because it provides air traffic services with the opportunity to address air traffic that is exhibiting or threatening to exhibit behaviour that may be hazardous.

2.10 Risk assessment of civil-military air traffic interaction

State Safety Programme - Introduction
Regulation (EU) 2018/1139[34] requires that each Member State shall establish and maintain a State Safety Programme (SSP) for the management of civil aviation safety in relation to the aviation activities under its responsibility. Based on the assessment of relevant safety information, each Member State, in consultation with relevant stakeholders, shall identify the main safety risks affecting its national civil aviation safety system and shall set out the necessary actions to mitigate those risks. The national programme shall be based on higher-level plans, such as the ICAO Global Aviation Safety Plan (GASP) and the European Plan for Aviation Safety (EPAS).

This section lists the for this investigation relevant aspects from both the international and national plans on the interaction of civil-military air traffic and general aviation mid-air collision risks.

International framework
The ICAO GASP identifies mid-air collision as one of the global high-risk categories of occurrences.[35] Civil-military air traffic interaction and coordination is not specifically mentioned in the GASP.

The EPAS identifies airborne collision as one of the three key risk areas for general aviation.[36] The EPAS also lists several actions to address the safety issue of deconfliction between IFR and VFR flights. It specifically mentions that 'the ineffective deconfliction of flights adhering to IFR and VFR in an airspace class where at least one of the flights is not under ATC separation has been identified as a strong contributor to airborne collision risk'.[37] The actions focus mainly on promoting iConspicuity[38] solutions and safety promotion. The EPAS mentions civil-military coordination and cooperation as a strategic priority.[39]

34 Regulation (EU) 2018/1139 of the European Parliament and of the Council, see articles 7 and 8.
35 ICAO, *Global Aviation Safety Plan, 2023-2025, Doc 10004*, 2022.
36 EASA, *EPAS 2023-2025 Volume I Strategic priorities.*
37 EASA, *EPAS Volume III Safety Risk Portfolio's*, 2024 Edition.
38 The concept of iConspicuity has to be understood as the 'in-flight capability' to transmit position and/or to receive, process and display information about other aircraft, airspace, weather or support navigation in real time with the objective of enhancing pilots' situational awareness (source: EPAS, Volume II, 2024 Edition).
39 EASA, *EPAS 2023-2025 Volume I Strategic priorities.*

It mentions that 'closer cooperation is needed between the civil and the military aviation stakeholders, including at the level of State safety management, both to reconcile the airspace needs and to achieve a safe and efficient use of airspace as well as to protect fundamental principles such as security or interoperability'. This priority is translated into an EPAS action[40] for all EASA Member States to have due regard for the safety of civil aircraft and establish respective regulations for national State aircraft. One of the recommendations in this respect mentioned is to 'closely coordinate to develop, harmonise and publish operational requirements and instructions for State aircraft to ensure that 'due regard' for civil aircraft is always maintained'.

The State responsibility regarding civil-military coordination is also specifically mentioned in Regulation (EU) 2018/1139. The European regulatory framework is set-up for civil aviation and therefore does not apply to State aircraft. However, article 2 of Regulation (EU) 2018/1139 states that Member States shall ensure that activities and services performed by the aircraft outside the scope of this Regulation (including State aircraft) are carried out 'with due regard to the safety objectives of this Regulation. Member States shall ensure that, where appropriate, those aircraft are safely separated from other aircraft'.

The Dutch National Aviation Safety Plan
As part of the Dutch SSP, the National Aviation Safety Plan (NASP)[41] indicates how the Ministry of Infrastructure and Water Management and the aviation sector will work on the continuous improvement of aviation safety. The NASP lists safety enhancement initiatives and mitigating measures on various facets of the safety system: regulation, approvals, licensing, oversight, and safety promotion. The safety enhancement initiatives from the international GASP and EPAS, including those indicated as state tasks – tasks for which the state is responsible – are internationally mandatory and therefore included in the NASP.

The national safety goal is to continuously improve aviation safety by knowing the greatest national risks and managing them to an acceptable level. To identify the main safety risks at State level, the Ministry of Infrastructure and Water Management periodically conducts a State Safety Analysis.[42]

The most recent State Safety Analysis lists the following risk scenarios related to mid-air collisions and civil-military air traffic interaction:[43]

- Conflicting airspace needs (COM.27) and Complex and fragmented airspace (COM.28, GA.12) (civil, military, general).
- Insufficient separation between aircraft (including consequences of wake turbulence (GA.03).
- Interaction civil-military (GA.39).

The State Safety Analysis includes an assessment of the risks, after which a risk priority is established. Only the top risks are included in the NASP.

40 Action MST.0024 from EASA, *EPAS Volume II 2024 edition.*
41 In Dutch: Nederlands Actieplan voor Luchtvaartveiligheid (NALV).
42 In Dutch: *Nationale Veiligheidsanalyse (NVA).*
43 NLR, *Nationale Veiligheidsanalyse voor de Nederlandse luchtvaart*, NLR-CR-2022-040-PT-1, June 2022.

Appendix C presents an overview of the identified risks, safety enhancement initiatives and mitigating measures included in the NASP. The risk scenario 'Interaction civil-military' – including the mid-air collision risk between military and civil aircraft – is not specifically addressed in the NASP, as it was not identified as priority in the State Safety Analysis based on the risk assessment. In the State Safety Analysis, it is stated that the probability of an accident due to this hazard cannot be determined with the available data and references. Based on expert opinion, the risk is estimated as unlikely (probability) and catastrophic (severity), but it is mentioned that this risk estimate is uncertain.

In an interview for this investigation, the Ministry of Infrastructure and Water Management indicated the following:

- The likelihood of a collision between a fast-flying military aircraft and a general aviation aircraft is currently not assessed as high, as indicated in the State Safety Analysis. The frequency of accidents and serious near misses is so low, that it is not considered feasible to conduct a trend analysis. However, it is unclear if all aircraft proximity incidents are reported to the authorities. In addition, at the time of the interview there was no formal reporting of occurrences from the RNLASF to the civil aviation authorities. This reporting line is expected to be implemented.[44]
- No specific actions have been identified in the NASP on the topic of civil-military air traffic interaction. Through regular awareness campaigns aimed at general aviation organisations, interest groups, and private pilots, there is hope for improved awareness and better compliance with law and regulations. It is considered plausible that the average private pilot has unrealistic expectations of air traffic control: after contacting flight information service, pilots may assume that also separation is provided, which is not the case.
- A regulated physical separation between fast-flying military traffic and general aviation is in the current Dutch airspace not considered as realistic. If such measures were implemented, they would probably impose restrictions on general aviation rather than on military air traffic.
- Mandating ACAS equipment in general aviation would face significant resistance due to cost and feasibility concerns. ACAS in military aircraft is also not considered feasible, as there are limitations to the number of technical systems that these type of aircraft can bring on board.[45] On European level, there are developments ongoing regarding iConspicuity solutions for general aviation, amongst others aiming at enhancing the pilot's awareness of other aircraft. However, it is at this moment not certain if this solution is also capable and effective in detecting military (high-speed) air traffic.

Risk assessment by the RNLASF

The Safety Board did not find evidence that the RNLASF performed an overall risk assessment including identified mitigation measures on the topic of civil-military air traffic interaction or the mid-air collision risk between military and civil air traffic.

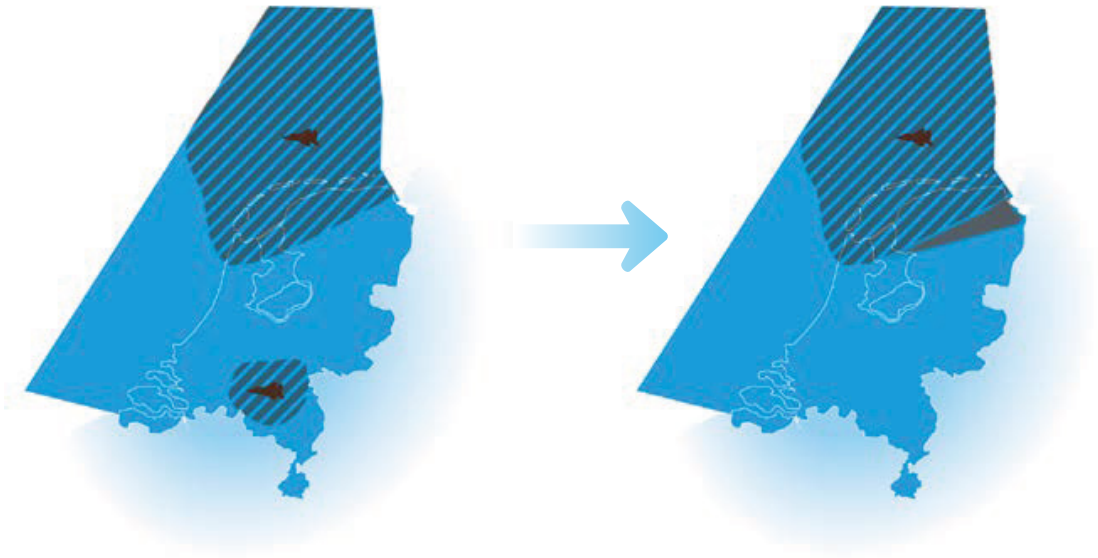
44 A cooperation agreement for exchange of occurrence notifications between the RNLASF and ILT entered into force on 25 April 2025. The implementation of this agreement has not been part of this safety investigation.

45 According to the RNLASF, ACAS is technically feasible but currently not an option for an F-35, amongst others for security reasons.

2.11 Future developments

The Dutch airspace is being used more intensively in the past years, partly due to growth of aviation and to new developments such as unmanned aircraft.[46] In addition, the Dutch government established a need for modernisation and growth of the Dutch armed forces in order to ensure national and international security in light of geopolitical developments. With the expansion of training activities and the introduction of the F-35, the RNLASF is placing new demands on the Dutch airspace.[47] The Ministry of Infrastructure and Water Management, the Ministry of Defence, RNLASF and the involved air traffic service providers, are jointly working on the redesign of the Dutch airspace (Dutch Airspace Redesign Programme, in Dutch: *Luchtruimherziening*).

One of the elements of this joint civil-military project is the expansion of the military training area in the northern part of Dutch airspace. Also, the northeast and southeast part of the Dutch airspace will be redesigned to improve the civil air traffic flows (2026 onwards). Together with Germany, the feasibility of a cross-border area for military training is being explored.[48,49] As a result of these developments, the military training area in the south of the Netherlands will disappear. As some of the military aircraft are based in the south of the Netherlands, it may be expected that there will be more aircraft movements from south to north and vice versa between the air bases and training areas. Overall, account must be taken of intensification of flying activities by fighter aircraft in Dutch airspace, due to both an increase in flying activities by Dutch fighter aircraft as well as an increase of foreign military fighter aircraft performing training activities in Dutch airspace.[50]



▲ *Figure 8: Military training areas before and after the airspace revision (source: Ministry of Infrastructure and Water Management, Factsheet 'Nieuwe indeling luchtruim Noord-Nederland', October 2022).*

46 Ministry of Infrastructure and Water Management, *Verantwoord vliegen naar 2025, Luchtvaartnota 2020-2050*, November 2020.
47 Ministry of Infrastructure and Water Management, *Factsheet Schoner en stiller vliegen door nieuwe indeling van het luchtruim*, October 2022.
48 See documents on the website https://www.luchtvaartindetoekomst.nl/onderwerpen/n/nieuwe-indeling-luchtruim.
49 Ministry of Infrastructure and Water Management, *Factsheet Nieuwe indeling luchtruim Noord-Nederland*, October 2022.
50 Ministry of Defence, *Notitie Reikwijdte en Detailniveau*, December 2023.

None of the associated documents addresses the effect on the risk of collision between high-speed military fighter aircraft and slow-flying general aviation, regardless of airspace classification. According to the Ministry of Infrastructure and Water Management, optimisation of the airspace for general aviation and reduction of near miss/collision risks with general aviation is not formulated as a specific objective in the airspace redesign programme. In any case, before the implementation of the new training areas or other airspace changes, the Ministry of Infrastructure and Water Management and/or Ministry of Defence will need to conduct a detailed safety assessment of the airspace change as part of the procedure 'airspace and flight procedures change'[51].

As part of the airspace redesign, the Ministry of Infrastructure and Water Management commissioned the preparation of an initial high-level strategic environmental assessment (in Dutch: *plan Milieueffectrapportage*, hereafter: plan-MER).[52] This document provides an analysis on the environmental impact of the airspace redesign plans, including safety, as well as the effects on aviation. For the purpose of this investigation, the focus on the plan-MER and its underlying documents was solely to assess the extent to which attention has been given to the shared use of airspace by military and civil aircraft and the risk of collisions. Overall, the airspace review programme uses the criterion accident risk to measure the level of safety. The accident risk between military aircraft and general aviation is not specifically mentioned in the plan-MER.

The Ministry of Defence will also prepare an environmental assessment as part of the 'National Space for Defence Programme'. The Environmental Impact Assessment Committee (in Dutch: *Commissie voor de Milieueffectrapportage*) has provided advice on the content of this future MER.[53] For this purpose, the Committee reviewed the memorandum[54] 'Scope and Level of Detail' (in Dutch: *Notitie Reikwijdte en Detailniveau*) prepared by the Ministry of Defence. One of the potential obstacles identified by the Committee, is the increased risk of collision with high-speed fighter aircraft at speeds exceeding the general maximum allowed speed in those parts of the airspace where the 'see and avoid principle' is the only method of separation.

The Committee advises to:

> 'Initiate an aviation safety study with an explanation and justification of when the airspace is considered safe enough from a Defence perspective. Specifically, address Defence's view on who is responsible for preventing collisions (civil aviation and/or Defence) and why. As far as the Committee could determine, such a starting point or view does not exist yet. However, it is essential for transparent and traceable decision-making.'

51 In Dutch: Wijzigingsproces Luchtruim en vliegprocedures. See also https://www.rijksoverheid.nl/documenten/publicaties/2023/05/25/wijzigingsproces-luchtruim-en-vliegprocedures

52 Royal HasKoningDHV and NLR, *Rapport Plan-MER Luchtruimherziening*, Januari 2021.

53 Commissie voor de milieueffectrapportage, *Nationaal Programma Ruimte voor Defensie – advies reikwijdte en detailniveau van het milieueffectrapport*, May 2024.
See https://www.commissiemer.nl/docs/mer/p37/p3779/a3779rd.pdf.

54 Ministry of Defence, *Notitie Reikwijdte en Detailniveau*, December 2023.

'Assess the consequences of the increase in military air traffic in Dutch airspace for the safety of civil aviation. Present the consequences for those parts of Dutch airspace where the 'see-and-avoid principle' is the only method of separation. Pay specific attention to the collision risk posed by the operation of military aircraft (F-35) at speeds exceeding the general maximum allowed flying speed.'

'In the MER, provide a justification why Defence considers these risks acceptable and give a substantiated overview to further reduce these risks where possible. Pay attention to operational and technical measures, including Airborne Collision Avoidance Systems.'

2.12 Safety reporting and actions

The following safety actions were taken following the serious incident near Elburg in 2023.

In accordance with the classification matrix in Directive SG-005 'Occurrence reporting' from the Ministry of Defence, the RNLASF classified the occurrence as a category 1 event (incident), as there were no injuries or damages. The procedure prescribes that in such case, the relevant Defence units are responsible for investigating the incident themselves. The RNLASF Executive Staff collects all reports from the units and performs an analysis in order to recognize trends in a timely manner.

Serious incident versus incident – classification difference

The RNLASF's Directive SG-005 classification matrix is based on the (potential) consequences of an event in terms of injury, financial loss or environmental damage. The Directive applies to all parts of the Ministry of Defence. Directive SG-005 also contains a chapter on aviation occurrences. This chapter refers to definitions for occurrences as used in civil aviation: incidents, serious incidents and accidents. The chapter states that incidents involving civil aviation should also be reported to the Human Environment and Transport Inspectorate (ILT) and that reports relating to serious incidents and aviation accidents should be submitted to the Dutch Safety Board. The relation between the classification matrix and the aviation occurrence definitions is not further detailed in the directive. As there were no injuries, financial loss or environmental damage, the RNLASF classified the occurrence as a category 1 incident (lowest category).

The Dutch Safety Board uses the occurrence classification from ICAO Annex 13 and Regulation (EU) 996/2010. This classification includes a risk-based approach, whereby the most credible scenario had the incident escalated and the effectiveness of the remaining defences (safety barriers) are taken into account. Taking into the account the actual separation of the F-16 and Tecnam, the evasive manoeuvre and the limited barriers, the Dutch Safety Board classified the occurrence near Elburg as serious incident.

The report of the pilots of the Shark formation was logged in the RNLASF's safety reporting system. The involved unit, the squadron, did not further investigate the incident. However, it was determined that not all fighter pilots were aware that ATC does not provide separation between IFR and VFR flights in airspace classes D and E, but only issues traffic information when relevant or as far as practical. Therefore, following the incident, RNLASF organised safety briefings for all Dutch fighter pilots with the aim to improve the level of knowledge in this area. Since the likelihood of recurrence was deemed low by the RNLASF, the staff considered this action sufficient.

The RNLASF did report the occurrence to the Military Aviation Authority (MLA). As the MLA conducts oversight, it was not involved in the investigation or follow-up of this specific occurrence.

The Defence Safety Inspectorate (IVD) supervises the physical and social safety in the Defence organisation and investigates incidents. The RNLASF did not report the occurrence to the IVD, as the occurrence near Elburg was classified as a category 1 incident. The IVD did not investigate this specific occurrence.

The F-16 is no longer operational in the RNLASF and has been replaced by the F-35 in September 2024. According to RNLASF staff, the operational use of the F-35 has brought several safety enhancements:

- The route from Volkel to the Vliehors range at 2,000 feet will no longer be used. The F-35 mostly flies at medium altitude, above 10,000 feet. However, because of training purposes, the F-35 will also continue operating below 10,000 feet.
- The F-35 has – compared to the F-16 – more advanced on-board sensors and therefore (according to RNLASF) can detect other air traffic much better. It is therefore expected that the likelihood of an airprox with an F-35 is many times lower than with an F-16. However, Dutch airspace is also used for training purposes by foreign military forces that use other aircraft types than the F-35 (e.g. F-16s) and may use lower flying altitudes.

MilATCC Schiphol, the Ministry of Infrastructure and Water Management and the training organisation did not take additional safety actions following the incident.

3 ANALYSIS

This analysis starts with a general overview of the incident. Next, the choice of the flight route and the different barriers are discussed. The analysis concludes with a comparison with previous events and a discussion on the management of the mid-air collision risk.

3.1 The occurrence

The crew members of the Shark formation prepared their flight in a standard and thorough manner. They were aware that they might encounter Visual Flight Rules (VFR) traffic during the en route part of the flight. They expected to receive traffic information from air traffic control. Combined with the equipment in the cockpit, this information would be sufficient to detect other VFR traffic.

The moment Shark 1 checked in with Dutch Mil for the return flight, the formation was flying in the Nieuw Milligen TMA A, which is airspace class E (from 1,500 feet to FL065). By opening the flight plan, the requirements for an Instrument Flight Rules (IFR) flight in class E airspace were met. Therefore, changes in route or altitude were subject to Air Traffic Control (ATC) clearances.

During flight preparation by the crew of the Tecnam, the two crew members had a general discussion about keeping an eye out for other air traffic during the flight. After the Tecnam reported to Dutch Mil Info and remained tuned to this frequency, no traffic information or other communication took place between the aircraft and ATC until after the near miss.

Both flights would, in a large part, operate in the same area with airspace class E. When the Shark formation, in accordance with their flight plan, made a right turn near Kampen, flying at 3,000 feet, the aircraft flew on a roughly southern course. When the Tecnam made a left turn to fly a roughly northern course and climbed to 3,000 feet, the formation and the Tecnam found themselves on more or less opposite courses at the same altitude. At that moment, the formation and the Tecnam were more than 10 kilometres apart. The pilots did not notice each other visually.

Contrary to IFR, for VFR traffic there are no requirements regarding cruising levels when flying in class E airspace below 3,500 feet Above Mean Sea Level (AMSL). The crew must visually scan outside in advance to ensure that no other aircraft is nearby. This scan is made by searching the immediate area around the aircraft for other air traffic, supplemented (if applicable) by information that becomes known to the crew via radio or information from on-board equipment that the position of nearby traffic displays (traffic awareness systems). Because of the large distance between the Shark formation and the Tecnam and because the Tecnam was tuned on a different frequency, the crew

of the Tecnam was not aware of the other traffic. The crew assumed that the change in altitude and course would be safe.

At the moment the area controller warned the Shark formation about the Tecnam, the Shark formation and the Tecnam were more than five kilometres apart, according to radar information. Although Shark 1 saw a contact on its Airborne Identification Friend or Foe (AIFF) system, he had no detailed information of that aircraft. Given the high speed and short distance, the pilot of Shark 1 made the logical decision to look outside. When he saw the Tecnam at the very last moment, he immediately made a sharp evasive manoeuvre and narrowly avoided a collision between the two aircraft. Recordings from the head-up display (HUD) showed that the Tecnam was visible for about one second before the two aircraft passed each other with high speed.

According to the radar information, the interviews with the pilot of Shark 1 and HUD tape from Shark 1, a mid-air collision would have been likely, had Shark 1 not taken evasive action.

The rules applicable in the Dutch airspace and airspace classification allowed the fast-flying F-16s and the slow-flying Tecnam to approach each other at the same altitude and on opposite courses. The pilots did not visually observe the other aircraft. It was only after the warning of the area controller that the F-16 formation was alerted about the aircraft. The Shark 1 pilot saw the Tecnam at the last moment and he was able to successfully execute an evasive manoeuvre. The crew of the Tecnam had no information of the approaching formation and only saw the F-16 after it had performed the evasive manoeuvre at close range.

3.2 Choice of flight route

Depending on the mission, the Volkel based military pilots are free to choose the route to and from Vliehors range. The route via the eastern part of the Netherlands via Amerongen and Kampen is often used. Other options for flying from Volkel to Vlieland are via the North Sea or via the western part of the Netherlands. The North Sea route is longer and has some restrictions due to different airspace classifications. The western part of the Netherlands is not a logical choice, as there is a lot of commercial air traffic to and from Schiphol and Rotterdam airports. For this reason, although not formally published, the flight route via Amerongen and Kampen is more or less a standard military route. The choice of the F-16 pilots for this route is therefore understandable. This route is not published, except for two arrows on the Aeronautical Chart The Netherlands. It is therefore likely that the route is not widely known to general aviation pilots. At the time of the near miss, the course of the F-16 formation was perpendicular to the direction of the arrows.

By choosing this route via Kampen, there is a chance that high-speed fighter aircraft will encounter other, slow flying general aviation aircraft. Conversely, pilots of these slow flying aircraft may suddenly be confronted with high-speed fighter aircraft. Especially

since part of the trajectory passes the airspace around Lelystad Airport. The frequently used exit point BRAVO of Lelystad Airport is located in this area. Consequently, there is a concentration of general aviation aircraft in this area.

The flight altitude used by the F-16s also makes the risk of proximity to civil aircraft real. In class D, E or G airspace, general aviation generally flies between 1,000 and 3,000 feet, depending on what is permitted. Flying at an altitude between 1,200 and 3,000 feet puts high-speed fighter aircraft in the same area as most general aviation aircraft.

In the case of the incident, the F-16s were flying IFR. Although IFR flights receive more air traffic services, IFR flights are also bound by clearances (altitude, heading) and instructions. The pilots of Shark 1 and Shark 2 were bound by the flight plan and the instruction to climb given by the area controller.

The trajectory of the high-speed fighter aircraft via Amerongen and Kampen is a standard route but it is not published. Flying at an altitude between 1,200 and 3,000 feet and in the proximity of Lelystad Airport, increases the chance of an encounter between high-speed fighter aircraft and slow flying general aviation aircraft.

3.3 Conflict avoidance

This section discusses three safety barriers in preventing mid-air collisions: Air Traffic Control, 'see and avoid' and technical equipment on board the aircraft.

Air traffic control (ATC)
In airspace class E, the air traffic controller or Flight Information Service Officer (FISO) of the Dutch Mil, provides VFR traffic information only in as far as practical. The term 'as far as practical' is not further defined in regulation or guidance. ATC is not legally required to provide traffic information to all VFR traffic at all times. This leaves room for local implementation and professional judgement. Traffic information is given as conditions allow. Whether traffic information is provided or not depends for example on air traffic density, workload, or even the availability of a FISO. Therefore, in class E airspace the provision of traffic information is an unreliable or weak safety barrier. However, in the case of the incident, the barrier was effective for the F-16 formation, as the area controller warned the formation for other traffic shortly before the near miss. The Dutch Safety Board could not assess the effect of the change of shift between the two area controllers that took place shortly before the incident on the provision of traffic information, as only limited information about the hand-over was available to the investigators.

One of the consequences of the current way of providing air traffic services by Dutch Mil, was that at the time of the occurrence, the service provision of IFR and VFR traffic was split. Tasks were performed by two different persons using two different radio frequencies.

Because the Shark formation flew under IFR and the Tecnam under VFR, the crews had radio contact with two different air traffic services personnel on different frequencies. Therefore, the pilots of the Shark formation and the Tecnam could not hear each other and it was not possible for either crew to be informed of each other's position via the radio communication they heard (listening watch). This hampered their awareness of other air traffic in their vicinity.

The fact that the area controller and FISO were operating on different frequencies, also meant that the FISO had not been alerted over the potential conflict, because he could not hear the conversation between the area controller and the Shark formation. The physical distance between both workstations (approximately eight metres) hampered direct communication between the two persons. Especially under these circumstances (split of tasks, different frequencies and distance), coordination and communication between the area controller and FISO is required. The operation manual of MilATCC did not contain specific instructions addressing this.

The FISO did not consider his workload to be high. However, since he was responsible for a large part of the Amsterdam FIR, he had to divide his attention among the traffic flying in this area. This gives room to the possibility that the FISO's attention was focused elsewhere (as also assumed by the FISO himself) and he therefore was not aware that the course and altitude changes of the aircraft had created a potential conflict. In addition, his belief was that the return flight would be over the North Sea.

Due to staff shortages at MilATCC, air traffic controller positions and tasks are sometimes combined or even unfilled. In the investigated incident, the area controller was combining two controller positions and monitoring four frequencies. Even though at the time of near mid-air collision it was not extremely busy with air traffic, combining positions increases the number of tasks to be performed and the size of the area to be monitored by the controller. Less attention can be paid to all air traffic movements. This has an effect on the strength of this safety barrier and has the potential to result in an unsafe situation.

Overall, the current way the air traffic services are provided has an impact on the safety level. It is the responsibility of the State to conduct a safety assessment in order to determine if the airspace classification and operational set-up of air traffic services is justifiable or if additional risk mitigation measures are needed.

The occurrence took place in the Lelystad TMA 4. This TMA has an airspace classification D, but only between 17:00 and 21:00.[55] The rest of the day, it is classified as E airspace with Dutch Mil acting as air traffic service provider. The change in airspace classification can create complexity and ambiguity for flight crews. For class D, VFR traffic information is included in the services provided. For class E, ATC provides VFR traffic information only in as far as practical.

55 Time-Dependent Airspace Classification TMAs, AIP SUP 03/2022, publication date 07 APR 2022.

See and avoid
As mentioned above, in class E airspace VFR traffic cannot rely on the provision of traffic information. Therefore, the crew of the Tecnam (flying under VFR) could only rely on the see and avoid principle. However, as indicated in Section 2.8, this principle has many shortcomings and is considered a weak safety barrier. Its effectiveness can be increased if 'alerted' see and avoid is applied.

In this incident, the traffic information from the area controller was effective for Shark 1. The pilot knew in which direction he had to look for the other traffic. When he saw the Tecnam, he was able to make an evasive manoeuvre at the very last moment.

The Tecnam had no information about the approaching high-speed fighter aircraft, and unalerted see and avoid was the only possibility for the crew to notice the Shark formation. Given that the crew had to visually scan the entire airspace around the Tecnam, the high closing speed between the aircraft and the relatively small visible surface of the F-16 flying almost straight ahead at them, it is understandable that the crew did not see the Shark formation. The crew did not notice the fast approaching formation until Shark 1 made the evasive manoeuvre.

Calculations by the Dutch Safety Board show that the closing speed between the two aircraft was approximately 500 knots, equivalent to 257 meters per second. A fighter aircraft approaching head-on, transforms from a small dot into a recognizable aircraft in about three seconds (see Figure 7 in Section 2.8). If a pilot recognizes within that time that the approaching aircraft poses a threat, it will take more than ten seconds before he can initiate an effective evasive manoeuvre. Therefore, the Tecnam crew could not have made a timely evasive manoeuvre to prevent a collision. Conversely, the same is true for pilots of high-speed fighter aircraft. At the same high closing speed, a relatively small light aircraft will also be detected only at the last moment. For Shark 1, the traffic information and his military fighter pilot training allowed the pilot to make an evasive manoeuvre, but only just in time.

In general, the limitations of the see and avoid principle are partly mitigated by airspace rules on minimum flight visibility of five kilometres and a maximum speed of 250 knots. However, this maximum speed does not apply to military fighter aircraft. For military fighter aircraft, the minimum visibility has been increased from five to eight kilometres as mitigation measure for the increased minimum speed. However, the closing speed is so high, that it is questionable whether a military fighter pilot can spot a small general aviation aircraft and execute a successful evasive manoeuvre in time, if 'unalerted'.

Technical equipment on board aircraft
All the aircraft involved had working and transmitting on-board transponders. Interviews with Royal Netherlands Air and Space Force (RNLASF) personnel revealed that equipment on board high-speed fighter aircraft can detect other air traffic, but these devices are primarily designed for tactical purposes. In this incident, the tactical instruments on board Shark 1 provided less added value in detecting the general aviation aircraft than expected by the pilot. The functioning and vulnerabilities of the

F-16's tactical systems in relation to the detection of general aviation aircraft was outside the scope of this safety investigation.

According to the RNLASF, the equipment on board the new F-35 will have better capabilities to detect other aircraft at an early stage, although the specifications were not provided to the Dutch Safety Board due to security reasons. The Safety Board notes, however, that also air forces of other countries, which might use other types of high-speed fighter aircraft (e.g. F-16), use Dutch airspace regularly for training purposes and, for example, will fly to and from the Vliehors range.

The barrier provided by Air Traffic Control was only effective for the F-16 formation, as the area controller provided traffic information. The FISO and the pilot of the Tecnam were however on a different radio frequency, and therefore did not hear this traffic information. Due to the split of tasks of the area controller and FISO, the use of two frequencies and the physical distance between the two staff members, coordination and communication about possible conflicts is required.

The see and avoid principle is a weak safety barrier. This is even more the case when a high-speed fighter aircraft is involved. In the case of unalerted see and avoid, pilots of slow flying aircraft have minimal chances to detect a potential conflict and timely make an evasive manoeuvre due to the high closing speed. Crews of high-speed military fighter aircraft are in a better position to do so, due to their training, skills and on-board equipment.

The tactical systems on board the F-16 were not sufficient to trigger an evasive manoeuvre, despite the fact that the Tecnam's transponder was functioning. The RNLASF expects that the on-board systems of the F-35 have better capabilities, though this was not further substantiated with evidences. In addition, foreign military forces that might use other types of high-speed fighter aircraft, also make use of Dutch airspace for training purposes.

3.4 Comparing previous events

In the last twenty-five years, two fatal accidents between high-speed military fighter aircraft and general aviation aircraft occurred in the Netherlands. Additionally, there have been several reports of aircraft proximities or near collisions between military and civil air traffic.

Both the first fatal accident near Etten-Leur in 1999 and the second accident near Sellingen in 2002 took place in uncontrolled airspace, class G, and in both cases, there was no radio communication with the responsible air traffic service provider. The safety investigation reports concluded that at the given speeds and speed differences, the see and avoid principle does not work, even with visibility of eight kilometres or more.

Other reported occurrences contain too little detailed information to identify a common cause. In several cases, there was a failure to follow airspace regulations or procedures.

Despite the fact that two fatal accidents had occurred within a relatively short period of time, it took a number of years before safety actions were implemented on national level. The actions focussed on introducing a minimum altitude of 1,200 feet in uncontrolled airspace for military aircraft and mandatory use of transponders by general aviation. It is noteworthy that the measures focussed on uncontrolled airspace, whereas for VFR flights the requirements and conditions in class D and E airspace are more or less similar, in particular that no separation is provided by ATC.

The idea behind the minimum altitude of 1,200 feet in uncontrolled airspace for military aircraft was to separate general aviation aircraft from military air traffic. This is partially realised, but general aviation activities also take place between 1,000 and 1,500 feet in uncontrolled class G airspace. Furthermore, most Terminal Control Areas (TMAs) in the Netherlands are classified as class E airspace with a maximum altitude of FL055 or FL065. In this airspace, VFR general aviation traffic is allowed to fly without two-way radio contact, without a flight plan, and without clearance from ATC. These are similar conditions to class G airspace. The only requirement is that above 1,200 feet the transponder must be switched on.

Therefore, between 1,200 feet and FL065, military and civil traffic with completely different characteristics, performance and pilot capabilities, fly intermixed and can encounter each other. In addition, the serious incident near Elburg has shown that the implemented measures – minimum flight altitude and transponder requirement – were not sufficient to prevent the near miss from occurring in class E airspace.

The measures taken following previous events – introducing a minimum flight altitude for high-speed military fighter aircraft of 1,200 feet in uncontrolled airspace and the mandatory carriage of a transponder – could not prevent the serious incident near Elburg from occurring. Also in airspace class E, a collision between a fast-flying military fighter aircraft and other, slow-flying traffic is an existing risk that can have serious consequences.

3.5 Mid-air collision risk management

The National Aviation Safety Plan (NASP) does not contain concrete actions related to the mid-air collision risk between military and general aviation aircraft. The aviation authorities place the responsibility mainly on pilots; current laws and regulations should provide sufficient safeguards. If pilots comply with these, the risk is considered low according to the authorities, although they also recognize that it is impossible to eliminate the risk completely.

This perspective was also confirmed by the RNLASF actions following the incident. Based on the Ministry of Defence's procedures, the event was classified as a category 1 event (lowest category incident) and was handled within the squadron in accordance with procedures. The squadron organised safety briefings for all Dutch fighter pilots with the aim to improve the level of knowledge on the level of air traffic services in airspace classes D and E. The event classification was based on the outcome of the occurrence (the level of injuries and/or damage) and not on the risk. The outcome was forwarded to RNLASF's executive staff that considered it an isolated event. It was not investigated further. The event was also not investigated by the Military Aviation Authority (MLA) or Defence Safety Inspectorate (IVD), nor did these organisations challenge the classification level. In general, the Dutch Safety Board found no evidence that RNLASF has conducted an overall risk assessment on the risk of mid-air collisions with general aviation aircraft. There is no framework to evaluate near miss occurrences based on the risk encountered and monitor mitigating measures.

As mentioned earlier, with the introduction of the F-35, the risk of mid-air collisions or near misses is likely to decrease due to fact that the aircraft is generally flying at a higher altitude and has better on-board sensors to detect other traffic on the radar. However, the RNLASF did not provide evidence to the Dutch Safety Board that show that the effect on the risk of mid-air collisions has actually been assessed. In addition, the F-35 will continue to also fly below 10,000 feet and Dutch airspace is used by foreign military forces with other aircraft types (e.g. with F-16s) for training purposes. These aspects need to be taken into account as well.

Regulation (EU) 2019/1139 requires states to ensure that activities of military aircraft, as these fall outside the scope of civil aviation regulations, are carried out with due regard to the safety objectives of the regulation and military air traffic is safely separated from civil air traffic. There is no evidence that the Dutch aviation authorities (civil and military) have fully complied with this requirement. The authorities consider that, given the low number of incidents, the risk of a mid-air collision is low. However, despite the low probability, the consequences of a mid-air collision are in most cases catastrophic in terms of injuries and damages, as previous accidents have shown. Also, the Standardised European Rules of the Air (SERA) state that an alleviation of the 250 knots speed limitation should be based on a safety assessment and approved by the competent authority.[56] The main measures in place in the Netherlands to mitigate the effect of a high closing speed between military and civil aircraft, is the increased minimum flight visibility of eight kilometres instead of five and the use of transponders. It is questionable, considering the limitations detailed in Chapter 2 and analysis in Chapter 3, if these measures can be considered as an effective mitigation for the increase of the speed limitation of military fighter aircraft. The Dutch Safety Board did not find evidence of the underlying safety assessment.

Until now, the ongoing Dutch Airspace Redesign Programme does not include concrete measures for the safe separation of (high-speed) military and general aviation aircraft

56 AMC1 SERA.6001(a)(4);(5);(6);(7) Classification of airspaces. Acceptable Means of Compliance to the Standardised European Rules of the Air (SERA, Regulation (EU) No 923/2012).

outside military training areas. For airspace below 10,000 feet, the focus is mainly on approach and departure routes for commercial air transport to major airports.

The incomplete substantiation of the state's responsibility to ensure that military air traffic is safely separated from civil air traffic in all parts of the airspace, is also reflected in the Environmental Impact Assessment Committee's advice to the Ministry of Defence of May 2024. The committee advised to conduct an aviation-related safety study to demonstrate that airspace is safe enough from a defence perspective and address Defence's view on who is responsible for preventing collisions between aircraft. From the wording, it may be concluded that the responsibility for a safe use of shared airspace is placed with the Ministry of Defence. However, the Dutch Safety Board considers this an overall state responsibility, involving both civil and military authorities, therefore requiring coordination.
The committee's advice mainly concerns uncontrolled airspace where 'see and avoid' is the only method of separation. This opinion ignores the fact that the risk also exists in class D and E airspace. The response of de Ministry of Defence to the advice of the Environmental Impact Assessment Committee's was not known at the time of this safety investigation.

Although the risk of a mid-air collision is considered a high priority according to international ICAO and EASA documents, the risk is difficult to quantify because of the low number of occurrences. This leads to the result that low priority is assigned in the Dutch State Safety Programme and underlying action plans to the interaction between civil and military air traffic, including high-speed fighter aircraft. At the level of RNLASF, no risk assessment exists on the mid-air collision risk with general aviation aircraft.

In the current documentation for the Dutch Airspace Redesign Programme, routes flown by military aircraft to and from training areas and their high speed are not specifically taken into account.

The interaction between civil and military air traffic is a shared responsibility of two parties, the Ministry of Infrastructure and Water Management and the Ministry of Defence, and therefore requires joint attention.

4 CONCLUSIONS

The near miss between the F-16 and the Tecnam occurred because the flight crews were initially not aware of the presence of the other and they did not visually see each other until the last moment. Only after the area controller had informed the F-16s, the pilot of Shark 1 noticed the Tecnam and performed an evasive manoeuvre. The Tecnam's crew only saw the F-16 after it had performed the evasive manoeuvre at close range.

The occurrence

Both aircraft were allowed to fly in class E airspace. As no active separation between Instrument Flight Rules (IFR) and Visual Flight Rules (VFR) traffic was provided by Air Traffic Control (ATC), both the Shark formation and the Tecnam were largely dependent on traffic information from ATC and looking outside to avoid other air traffic. Because the flight crews were in contact with two different air traffic services personnel working on different frequencies, the crews were not able to hear each other's communication. Shortly before the near miss, the area controller informed the Shark formation about the opposite traffic. In class E airspace, ATC provides traffic information regarding VFR traffic only as far as practical. The split of tasks, use of different frequencies and physical distance between the two air traffic services personnel, require coordination and communication about air traffic and possible conflicts. In addition, the shortage of staff at MilATCC reduces the effectiveness of this safety barrier and potentially creates an unsafe situation.

The chosen trajectory by the Shark formation via Kampen is an understandable route. However, this route passes through a section of airspace near Lelystad Airport where a high density of VFR traffic can be expected. This increases the risk of mid-air collisions.

In addition, the risk of mid-air collisions between military and civil aircraft is increased by the high speed of military fighter aircraft. The see and avoid principle is a weak safety barrier. This is even more the case when there is a high-speed fighter aircraft involved.

Most general aviation and military fighter aircraft are not equipped with technical on-board equipment designed to prevent collisions by timely warning the pilot of converging traffic.

Management of risks

In Dutch airspace, military fighter aircraft may fly faster than the applicable speed limitation of 250 kts. It is questionable if the current measures in place to mitigate the effect of the higher speeds (e.g. the increase of the minimum flight visibility to eight kilometres and the use of transponders) are effective measures for this purpose. Overall, the risk of a mid-air collision between a military fighter aircraft and general aviation aircraft is increased in Dutch airspace by accepting the higher speeds of military fighter aircraft without effective risk reducing measures.

According to European regulations, states must ensure that activities performed by military aircraft are carried out with due regard to the safety objectives for civil aviation and that these aircraft are safely separated from other aircraft. The underlying documents of the Dutch State Safety Programme do not contain specific actions on the topic of civil-military interaction, as this is not considered a priority. At the level of the Royal Netherlands Air and Space Force (RNLASF), the Safety Board did not find evidences that the risk of mid-air collisions with general aviation is explicitly managed. Also, the introduction of the F-35 has not been assessed for its effect on safety in relation to civil-military interaction.

In the case of the investigated incident, all pilots and air traffic services personnel involved were complying with the applicable rules and procedures. Relying solely on see and avoid when high-speed military fighter aircraft are involved, is too vulnerable a barrier. The crew of the Tecnam was not in the position to prevent a mid-air collision and had no idea that something like this could happen to them at that moment.

Although the risk of a mid-air collision is overall low, the consequences are usually catastrophic. The RNLASF classified the occurrence near Elburg as a lowest category incident in accordance with its classification matrix. This matrix does not contribute to a risk-based assessment of occurrences involving aircraft proximities or near misses between military and civil aircraft.

The way the airspace has been designed, (military) air traffic services are provided and military aircraft are operated has an impact on the safety level for aviation. It is the responsibility of the State to determine if the current airspace design, airspace classification and operational procedures and set-up result in an acceptable risk or if additional mitigation measures are needed.

Additional mitigation measures to reduce the risk of mid-air collisions are possible on different levels. For example, separating military and general aviation traffic flows, additional provision of air traffic services, or on-board traffic awareness systems. The Ministry of Defence and Ministry of Infrastructure and Water Management are responsible to actively work together to improve the risk management on civil-military interaction, and the mid-air collision risk in particular, and assess possible additional measures to be implemented. This is especially important in the light of the foreseen expansion of the RNLASF, geopolitical developments and upcoming changes to airspace structures and procedures as part of the Dutch Airspace Redesign Programme.

5 RECOMMENDATIONS

A mid-air collision between a high-speed military fighter aircraft and a low-speed general aviation aircraft in civil airspace where no separation is provided by air traffic control, is an accident scenario with a low probability, but catastrophic consequences. Despite the measures taken following the 1999 and 2002 fatal mid-air collisions in the Netherlands, the serious incident near Elburg shows it is a realistic scenario. The investigation concluded that there are possibilities to improve the management of risks of proximities between military fighter aircraft and general aviation. In addition, the introduction of the F-35 and new military training areas and the foreseen increase of foreign military forces performing training activities in Dutch airspace also changes the risks. These risks should be assessed and where necessary, mitigation measures should be put in place.

Therefore, the Dutch Safety Board makes the following recommendations.

To the Minister of Defence:

1. Assess the risks of the operational use of high-speed military aircraft in Dutch airspace in relation to the safe separation between military and civil air traffic, including general aviation. Include in this risk assessment the deviation of military aircraft from the speed limit of 250 knots, the staffing and operational arrangement of air traffic services by MilATCC Schiphol, future airspace developments, and flights to and from military training areas.
   In addition to the risk assessment, determine risk mitigation measures that are proportional and feasible and implement these measures.
2. Implement measure(s) to improve operational communication between area controller and FISO at MilATCC in order to enhance coordination on potential conflicting (high-speed) military and civil air traffic.

To the Minister of Infrastructure and Water Management:

3. Evaluate, in consultation with the Minister of Defence, how the Dutch State complies with the responsibility to ensure a safe separation between military and civil air traffic (in accordance with article 2 of Regulation (EU) 2018/1139).
   Address specifically the risk of military fighter aircraft deviating from the speed limitation of 250 knots and the use of Dutch airspace by foreign military forces for training purposes. In addition to the risk assessment, determine risk mitigation measures that are proportional and feasible and implement these measures.

To the Minister of Infrastructure and Water Management and the Minister of Defence:

4. Align the classification of aviation occurrence reports and collectively analyse aircraft proximity occurrences between military and civil air traffic in order to draw lessons, monitor the effectiveness of implemented mitigation measures and prevent (near) mid-air collisions.

APPENDIX A

Responses to the draft report

In accordance with the Dutch Safety Board Act, a draft version of this report was submitted to the parties involved for review. The following parties have been requested to check the report for any factual inaccuracies and ambiguities:

- Ministry of Infrastructure and Water Management
- Human Environment and Transport Inspectorate (ILT)
- Ministry of Defence
- Royal Netherlands Air and Space Force (RNLASF)
- Area controller and FISO
- Pilots of Shark formation (F-16s)
- Instructor and student pilot of Tecnam
- Zelf Vliegen
- Transavia
- European Union Aviation Safety Agency (EASA)

The responses received were processed in the following way:

- If the Safety Board decided to adopt responses, they were amended into the final version of the report.
- If the Safety Board did not adopt responses, an explanation is given of why it decided to do so.

The responses received, as well as the way in which they were processed, are set out in a table that can be found on the Dutch Safety Board's website (https://www.safetyboard.nl).

APPENDIX B

List of reported but not investigated civil-military aircraft proximities

22 September 2008 - A formation of 4 F-16s passed a helicopter at a lateral distance of approximately 2,5 NM at the same altitude in de North Sea Area.

22 January 2015 - An F-16 approached an aircraft of the Coast Guard from behind, causing a TCAS alert. The Coast Guard made an evasive action. Closest distance: horizontal 1 NM and vertical 100 ft.

1 September 2015 - Fighter aircraft at low altitude over the North Sea came close to a helicopter flying IFR and that was in contact with Flight Information Service.

9 November 2015 - Near miss between two F-16s and a civil helicopter in G airspace. Altitude 1,200 ft., proximity: horizontal 0 NM, vertical distance around 300 ft. Helicopter's transponder was probably not engaged.

4 May 2016 - Near miss between an F-16 formation and touring motor glider in G airspace during fly by in temporary restricted airspace. TMG's transponder was not engaged. Flight information was not provided due to lack of staff.

23 November 2017 - Loss of separation between a foreign F-16 formation and an Airbus A320 that just took off from Eindhoven Airport. The F-16 formation entered Dutch airspace without clearance and approached the A320 within close range. (Airspace class unknown)

15 August 2018 - Loss of separation between an F-16 and a civil Cessna in G airspace. The Cessna entered a restricted area without clearance. Both Dutch Mil and Amsterdam Info had a complete communication fall out.

18 October 2018 - Loss of separation between an F-16 and a civil Boeing 737 in C airspace. Proximity: horizontal 2 NM vertical distance 900 ft. The B737 had taken off from Eindhoven Airport and was displayed on the radar screen with delay. The F-16 was descending and the B737 was climbing. Instructions of ATC prevented a near miss.

4 September 2019 - Loss of separation between 3 F-16s and a helicopter in E airspace.

12 September 2019 - Loss of separation between an F-16 and a civil aircraft in E airspace. Distance 3,7 NM. The civil aircraft entered a temporary restricted airspace. Instructions of ATC prevented a near miss.

15 April 2021 - In the North Sea Area a formation of F-16s flew in the vicinity of a helicopter at a distance that was too close for comfort.

8 December 2022 - Loss of separation between an F-16 and a civil helicopter in C airspace. Proximity: horizontal 1 NM, vertical 600 ft. The F-16 tried to land the aircraft in low visibility without clearance. After a radio call of ATC the F-16 pilot reported that he had the helicopter in sight.

Source: Dutch Human Environment and Transport Inspectorate (ILT).

APPENDIX C

National Aviation Safety Plan (NASP) for the Netherlands 2023 – 2026

The Dutch National Aviation Safety Plan (NASP) contains the identified risks, safety enhancement initiatives and mitigating measures. The table below presents an overview of identified safety risk and safety enhancement initiatives related to general aviation mid-air collisions and civil-military interaction.

Status Green: indicates that the implementation of the safety enhancement initiative is on track or already (or almost) completed.
Status Yellow: indicates that the issue is being monitored with (continued) extra attention.

▼ *Table C.1: NASP safety enhancement initiatives.*

Identified risk	Source	Explanation	Measures identified in Dutch NASP	Status
Mid-Air collisions	ICAO GASP	Identified as one of the five global high-risk category of occurrences. The types of occurrences considered to be high-risk categories were selected based on actual fatalities, high fatality risk per accident or the number of accidents and incidents. Mid-air collisions involve many contributing factors, including traffic conditions, air traffic controller workload, aircraft equipment, and flight crew training. Requirements for aircraft to be equipped with traffic alert and collision avoidance system/airborne collision avoidance system (TCAS/ACAS) have significantly reduced the number of mid-air collisions. However, when they occur, mid-air collisions often have catastrophic results with very few, if any, survivors. Therefore, there is a high fatality risk associated with these events.	Mitigate contributing factors to MAC (Mid-Air Collision) accidents and incidents.	Yellow
Due regard for the safety of civil traffic	EPAS	Member States must have due regard for the safety of civil aircraft and must have established respective regulations for national State aircraft. Several EU Member States have reported an increase in incidents involving close encounters between civil and military aircraft, and more particularly an increase in non-cooperative international military traffic. One of the recommendations to Member States is to: closely coordinate to develop, harmonise and publish operational requirements and instructions for State aircraft to ensure that 'due regard' for civil aircraft is always maintained	Establish laws and regulations and the system of reporting to EASA on incidents between military and civil air traffic over international waters	Green
Conflicting airspace needs (COM.27) and Complex and fragmented airspace (COM.28, GA.12)	State Safety Analysis	This risk scenario is related to airspace infringements in controlled airspace. The revision of the Dutch airspace structure (in progress) is expected to reduce the risk of both these scenarios, except for general aviation.	Review airspace (GA.12.B.1). Provide information about Dutch airspace to visiting pilots (GA.12.B.2).	Yellow Yellow
Insufficient separation between aircraft (including consequences of wake turbulence (GA.03).	State Safety Analysis	In airspace classes E and G, the 'see and avoid' principle is the only means of protection against collisions in the air. The limitations of that principle have been known for years. The relatively high number of mid-air collisions of general aviation aircraft underlines the urgency. Technical measures are conceivable that would prevent many such incidents.	Introduce a uniform warning system on board aircraft (GA.03.B.1) Provision of operational support before and during flight by air traffic control (GA.03.B.2). Provide information on separation (required distance between aircraft) (GA.03.B.3).	Yellow Green Yellow

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