Accident with Apache during night flight traning
near Rossum, 12 December 2007

The Hague, January 2009 (M2007DE1212-08)

THE DUTCH SAFETY BOARD

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CONSIDERATIONS

Introduction

On 12 December 2007, close to the village of Rossum, an incident[1] occurred during a night flying exercise whereby a Royal Netherlands Air Force helicopter of the type AH 64D Apache (registration number Q-01) collided with a 150 kV high-voltage power line over the river Waal. This caused the high-voltage cables to snap, leaving part of the Bommelerwaard and the Land van Maas en Waal area without electricity for almost 50 hours. Approximately 30,000 households and 7000 businesses were affected by this power outage. The helicopter was severely damaged. In spite of this, the crew was able to land the Apache helicopter to the south of the river Maas.

Further to this incident the Dutch Safety Board launched two investigations: "Apache helicopter power line collision" and "The vulnerability of electricity supplies in catchment zones". This investigation relates to the Apache helicopter power line collision and aims to determine exactly what took place – ascertaining the truth – and to examine whether the incident was the result of any underlying structural safety failings and if so what these failings were, with the sole purpose of learning lessons with regard to safety. Unlike criminal law, which focuses on investigating criminal offences and as an extension of this the question of who is to blame, the independent investigation carried out by the Dutch Safety Board explicitly does not seek to apportion blame.

The incident

On 12 December 2007, two pilots from the 301 Squadron (Gilze-Rijen air base) of the Royal Netherlands Air Force Command were instructed to carry out a night mission within the context of the Annual Training Programme, which would involve a number of exercises including low-level flight. The flight path ran from the Gilze-Rijen air base to a low-level flight zone near to Eindhoven and then to the Maas-Waal low-level flight zone, returning to the Gilze-Rijen air base following a number of exercises.

Apache helicopters have two cockpits in a tandem construction. The aircraft commander sits in the front cockpit (hereinafter referred to as the 'front seater'). He operates the weapons systems and is responsible for navigation. The pilot flying the helicopter sits in the back cockpit (hereinafter referred to as the 'back seater'). It is also possible, however, to fly the helicopter from the front cockpit. During night-flying use is made of infrared systems, including the Pilot Night Vision System and the Target Acquisition Designation System.

The first part of the flight went according to plan. From the Gilze-Rijen air base, the helicopter followed a low-level flight route towards the low-level flight zone at Eindhoven, where it carried out a number of exercises. Following completion of these exercises, the helicopter made for the Maas-Waal low-level flight zone. Once it had arrived in this zone, the aircraft first performed a number of exercises at a higher altitude. These exercises were carried out around 3 km to the east of the village of Rossum. The front seater subsequently instructed the back seater to start a descent. He commenced the descent on a north-westerly course, in the direction of the river Waal. At 122 feet (approximately 37 metres) and at a speed of 116 knots (approximately 215 km/h), the helicopter collided with the high-voltage cables, which stretched above the river. These cables supply the Bommelerwaard with electricity. The so-called cable cutters fitted to the helicopter as standard and the speed of the aircraft meant that the six power lines were cut and/or snapped in two, thus cutting off the power supply and leaving the Bommelerwaard area with no electricity.

Immediately after the collision the back seater had commenced an ascent to 1000 feet (approximately 300 m) and once at this height had been instructed by the front seater to fly in the direction of the Gilze-Rijen air base. As the back seater's night vision equipment was no longer functioning and the front seater had a great deal more experience, the back seater handed over control to the front seater. Although no critical system failures were detected (cockpit alert system) that could indicate reduced airworthiness, the front seater reached the conclusion that the helicopter must have been damaged to such a degree by the collision that it might not be possible to reach the Gilze-Rijen air base safely. He decided to cut short the flight and to look for a suitable location to carry out a precautionary landing. Such a location was found to the south of Maas at Hedikhuizen, where a successful landing was carried out.

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[1] Dutch Safety Board Act, Section 1(1)(f) Incident: an event that causes the death of or injury to a person or damage to an object or the environment, or an event that creates the risk of such an outcome.

The scope of the investigation

The aim of the investigation is to determine the (direct) cause or causes of the incident and any underlying factors. The investigation does not examine the benefit and necessity of low-level flight in a helicopter. This is regarded as an operational requirement.

The (unfulfilled) preconditions of adequate flight preparation, the performance of descent checks prior to low-level flight, the visibility of high-voltage power lines and adequate scanning have been identified as direct causes of the incident. Underlying factors have no direct causal link to the occurrence of an incident, but are factors that create the circumstances that permit unsafe actions and methods that lead to the occurrence of the incident. In the case of this incident, these underlying factors are the type and level of training received, supervision, reorganisation and quality control. The analysis section below deals with the factors examined in greater detail.

Analysis

Technical factors and weather conditions
An inspection of the information on maintenance carried out on the Apache helicopter did not bring to light any issues that could cast doubt on its airworthiness. The maintenance status of the helicopter can be described as normal. There were no technical defects at the time of the incident. The weather conditions did not form an obstacle to the execution of the flight. Once underway, visibility and cloud height actually proved to be better than anticipated (6–8 km visibility with clouds at 4400 feet). It was already dark by around 18:00 hours and the crew was able to make good use of the sensor systems.

Qualifications, training
With regard to the qualifications of the pilots, it emerged that both were qualified, met all of the requirements and can be regarded as being capable of carrying out the mission properly. Although the back seater had not yet attained 'Combat Ready' status, the skills he still needed to acquire in order to achieve this status (for example the requirement to follow the mountain flying course) had no bearing on the incident.

Flight preparations
One of the activities that involve the highest level of risk when it comes to flying during times of peace is flying at a (very) low level. In addition to the normal risks associated with flying, flying at a (very) low level involves an additional hazardous dimension: the risk of colliding with obstacles that rise higher than the altitude of the aircraft and that are sometimes barely visible or only become visible at a very late stage (or too late), such as high-voltage cables. If this type of low-level flight takes place in the dark the risk is even greater, even when using a helicopter that is equipped with all sorts of sensors, due to the limitations of these sensors (see section 2.3.2). This high level of risk involved in low-level flight must be counteracted by means of a flight risk assessment, followed by extremely thorough and meticulous flight preparations and execution.

The crew had one and three quarter hours in which to plan the mission. For the planned training flight, this time is considered sufficient in order to carry out effective preparations for the mission. This means, however, that the best possible use must be made of the time. The investigation revealed that the preparations were insufficient and were not carried out with an adequate level of precision.

The navigation charts for the flight were plotted and prepared by the squadron's navigation division and not by the pilots themselves. This in itself is not necessarily a drawback and is standard procedure, however preparing a route on the charts helps a pilot to identify risks and therefore forms part of the necessary preparations. This can be overcome by carefully studying charts that have already been plotted. Examining the route on the chart in advance ensures that the pilots are aware of any prominent landmarks and potential obstacles, and each obstacle can be entered into the navigation system or alternatively a so-called point of ascent and point of descent can be determined for each obstacle.[2]

The low-level flight section of a flight must also be discussed in the necessary depth (briefed). It emerged that despite the fact that the pilots did not prepare the charts themselves, a limited

[2] A prominent point in the vicinity of an obstacle at which the aircraft must ascend to a safe altitude and at which it can descend again to the low-level flight altitude if the obstacle is not visible at that time.

amount of time was spent studying the charts and examining the route in advance of the flight. Proper examination of the charts and investigation of the route would have increased the chance of identifying the high-voltage cables, which, after all, intersected the route to be followed, as a safety risk and taking appropriate measures in order to prevent a collision with the cables.

The flight preparations were rounded off with a crew briefing. Inquiries have revealed that the crew briefing lasted three minutes. In view of the fact that flying at a (very) low level is one of the most high-risk activities during times of peace, such a short briefing in combination with the manner in which the preparatory tasks were implemented must be described as inadequate.

The manner in which the preparation time was spent means that there was no longer sufficient time available to fully and properly prepare for the flight. The Apache crews are accustomed to very short preparation times as a result of their operations in Afghanistan. It goes without saying that even if there is only a limited amount of time (left) available in which to prepare for a flight, whether this is self-diagnosed or otherwise, a proper risk assessment must still be carried out in order to guarantee safety. Certainly in the case of training flights during times of peace, it is the individual responsibility of each pilot to make it known if the conditions for the successful execution of a flight are, in reality, inadequate or insufficient. In the case of an aircraft commander, there should also be consequences attached to this. After all, the commander is ultimately responsible for deciding whether or not to take off in an aircraft. It is to be expected that responsibilities in respect of flight preparations will be duly met. However, this did not take place to a sufficient extent in this case.

In conclusion, it can be stated that responsibilities in relation to preparations for the flight were not met to an adequate extent.

Execution of the flight
At a basic level, the division of tasks and responsibilities between the front seater and the back seater is simple. The front seater is the commander and is responsible for determining where and how (high, low, etc.) the aircraft should fly, navigating and operating the weapons systems. The back seater merely flies the aircraft on the basis of the instructions issued by the front seater. This means that on commencing and during low-level flight, the front seater must inform the back seater of any obstacles to be anticipated so that both he and the back seater can identify these obstacles in good time, and the back seater can avoid them.

At the time that the front seater instructed the back seater to descend to a lower altitude with a direction, he should have made certain that the flight path was safe. It is self-evident that aspects that must be checked prior to and during a descent, such as a safe flight path, form part of good airmanship. At the start of the descent, the front seater still did not have the correct chart in front of him. The exercises at higher altitudes were carried out using a 1:250,000 chart, whilst the low-level flight was to be carried out using a 1:50,000 chart. The front seater was not able to provide an explanation as to why he failed to switch the charts in good time. It is impossible for the Dutch Safety Board to investigate the reasons behind poor airmanship. One possible explanation is failure to still appreciate the full extent of the risks associated with low-level flight in relation to the missions carried out during deployment.

During the descent, the front seater was occupied within the cockpit with activities such as switching the flight charts and finding his bearings on the chart. The tandem design of both cockpits means that the crew members are not able to see one another. When flying under Visual Flight Rules, it is important that the crew members know whether the other member's attention is focused inside or outside of the cockpit. If one of the crew members focuses his attention inside the cockpit for an extended period of time, he must declare this by saying: '*I am inside*' . The other crew member must confirm receipt of this message. The issuing of warnings is important in order to ensure that both crew members are on the same level in terms of awareness of potential hazards or restrictions with regard to the normal execution of a flight. This is particularly essential during low-level flight and night flying. In these situations the back seater is intently focused on flying with the help of the Pilot Night Vision System. He must put his trust in the fact that, if there is no need to operate the weapons systems, the front seater will actively participate in the safe execution of the flight by assisting with observation and issuing warnings with regard to obstacles (marked on the chart). If the back seater had been aware that the front seater was occupied in the cockpit, he may have paid greater attention to avoiding obstacles.

Crew resource management
The front seater had a great deal of experience with many periods of deployment, whilst the back seater had not yet achieved Combat Ready status. This disparity had an effect on the teamwork between the two crew members, namely that the front seater was acting as an instructor and a coach to a certain degree. This was also encouraged by the fact that the front seater had intentionally omitted certain elements in the communication regarding the mission, without informing the back seater, in order to create an element of surprise for the latter. The aim of this was to increase the learning effect for the back seater. The flight was a training mission for the crew, however, and not a training flight for the back seater.

The danger of this coaching is that it does not take the original teamwork discipline of the Apache crew concept, which is based on equality, into consideration. The front seater spent more time on the transfer of knowledge and the issuing of instructions, whilst the back seater focused his attention on absorbing the information he was receiving. This means that the back seater subconsciously fell more into the expectation pattern of someone who is being coached than that of a crew member of equal standing. As this relationship was not recognised during the flight, both of the crew members assumed that the other was carrying out his tasks in accordance with the standard teamwork procedures.

Training and training capacity
Investigations have revealed that training capacity is under pressure. Activities within the context of peace-keeping operations, for instance the operation in Afghanistan, are given highest priority. The tasks required for the mission are therefore subject to more intensive training. Examples of this are the so-called mission qualification training programmes.

The number of hours flown by a pilot in principle each year if he is not deployed is set down in the so-called Annual Training Programme. In 2001, the Annual Training Programme was reduced from 180 flight hours to 140 flight hours. An advanced tactical flight simulator was to be purchased in order to compensate for this reduction in hours. This has not yet taken place. The reduction in the number of flight hours available has therefore had a direct negative effect on training and the available training capacity. This reduction of training capacity was recognised by the Commander of the Royal Netherlands Air Force. In consultation with those in charge at the Gilze-Rijen air base, a considered decision was therefore taken to cut back on or omit exercises involving a number of tasks that bore no relation to the current missions.

The statistics for the 301 Squadron show that pilots flew an average of 153 hours in the Apache helicopter in 2007. A large proportion of these hours were flown in Afghanistan, however, where the same missions were flown relatively often. A percentage of these hours can be identified as training hours as defined in the Annual Training Programme, however as a result of the one-sidedness of the missions a further percentage cannot be classified as training hours. This means that the deployment in Afghanistan led to a loss of training capacity (for low-level flight, for instance).

Training focuses on those aspects that are important to ensure safe operations in Afghanistan. Less attention is therefore paid to low-level flight, as this is rarely carried out in Afghanistan due to the threat from ground weapons (small arms and infrared rocket systems). The Dutch Safety Board finds it understandable that the focus is placed on operations in Afghanistan, however it is necessary to realise that this is at the expense of training in other areas. On return to the Netherlands, pilots must acknowledge that low-level flight, and certainly low-level flight in the dark, is one of the most dangerous flight activities. Attention to the safety risks associated with low-level flight in the Dutch flight zone, such as high-voltage cables, must be guaranteed. In order to limit the risks as far as possible there must be effective and effectively functioning safety nets in place, such as a proficiency training programme specifically aimed at pilots for the purpose of practicing certain general flight skills that were rarely or not required during the mission upon return from a deployment mission and to bring these skills back up to the required standard. Other safety nets include adequate and active supervision and checks in the form of audits etc. in order to identify any shortcomings in good time.

It can be stated that the limited capacity with regard to training hours and the one-sided implementation of these hours has placed the practising of general (basic) skills by Apache pilots under pressure.

Supervision
It has become clear that it is difficult for the squadron commander of the 301 Squadron to give substance to a well-founded supervision policy. The squadron’s obligations and the training cycle followed means that two of the five flight commanders are absent on a regular basis. In addition,

one of the flight commanders is recuperating following a period of deployment and is occupied with arranging outstanding administrative and private matters, and consequently only two of the five flight commanders are present within the squadron on a daily basis. As a result, management tasks are delegated to pilots who may be experienced, but who are not (yet) properly prepared for such activities, to the detriment of the task of supervision. This situation means that the desired standard of supervision and quality, and therefore the desired standard of safety, is not guaranteed.

Amongst other things, the flight commander must examine whether flights carried out within the context of the Annual Training Programme have been executed correctly. He can do this by holding post-flight discussions with the crew and by listening and viewing the flight data (audio and visual). If certain skills are not being practised or are not being practised to a sufficient extent (for example stealth flight, terrain flight, low-level flight, chart reading, general preparations etc.), these themes must be addressed during later flights. It did not appear to the Dutch Safety Board that this is demonstrably taking place on a regular basis in relation to general aspects of flight skills.

A number of the supervisory activities in respect of daily flight preparations and the execution of a (training) mission in accordance with the flight plan are delegated to the so-called Duty Officer. He is responsible for "*supervising proper and comprehensive flight preparations and execution of the flight in accordance with the flight order issued*" and he authorises the flight. An important point at which the Duty Officer must fulfil his obligations with regard to supervision is the time at which the flight is booked out and the crew make their way to the helicopter.

The shortcomings with regard to the preparations did not come to light on the so-called booking out of the training flight. Investigations have revealed, however, that the supervisory activities carried out by the Duty Officer consist of checking in an automated system whether the pilots still meet the specifically required skills (currency), checking whether the flight preparations were carried out in full and that the pilots have been provided with the latest (flight) information. A substantive check with regard to the (quality of the) flight preparations (including the crew briefing held) was not carried out, or not carried to a sufficient extent. A substantive review of the execution of the flight did not take place with the Duty Officer after the flight. The Dutch Safety Board is of the opinion that the Duty Officer failed to duly fulfil his responsibility to "*supervise proper and comprehensive flight preparations and execution of the flight in accordance with the flight order issued*", as set out in the Royal Netherlands Air Force Flight Order Book.

Audits and reviews
Audits, as part of the safety management system, play an essential role in providing the management of an organisation with an insight into safety. The investigation into quality control therefore focused on auditing by the central level of the Ministry of Defence and within the Royal Netherlands Air Force Command.

At the highest level within the Ministry of Defence, the Military Aviation Authority [MLA] is charged on behalf of the Minister with quality control and assurance in relation to military aviation. The Military Aviation Authority has given priority to the introduction of military aviation requirements in the field of aircraft maintenance in a broad sense. The Military Aviation Authority has not yet been able to implement the regulations in respect of military flight operations as a result of a delay in the elaboration of these regulations by the operators (which include the Commander of the Royal Netherlands Air Force). The Military Aviation Authority has not yet conducted any audits in the field of flight operations either. On the one hand, this is due to the fact that the Authority does not have sufficient manpower to develop regulations at the same time as conducting audits, and on the other hand, because it believes that it is not possible to conduct audits until the new regulations have been agreed on and implemented. The Military Aviation Authority does not enforce or carry out audits on the basis of the current (old) regulations. This means that as the supervisory authority, the Military Aviation Authority does not have an effective insight into the extent to which flight safety is currently guaranteed within the Royal Netherlands Air Force Command.

Audits in respect of flight safety must examine both the process (is flight safety properly organised?) and the product (does flight safety actually exist?). Investigations have revealed that at the time of the incident, proper audits in respect of (flight) safety that examine the abovementioned aspects were not being carried out, whilst no audits had as yet been conducted within the Ministry of Defence Safety Management System.

Although the MLA carried out inspections and quick scans, these were mainly reactive and focused on the execution of mission-related tasks. Furthermore, these activities did not relate to Apache operations. The quick scans carried out in January and September 2007 related to the deployability posture of the 298 and 300 squadrons (equipped with Chinook and Cougar helicopters respectively). The inspections carried out in May and September 2008 in relation to unmanned flight operations took place in Afghanistan and therefore also focused on mission-related activities. The inspections were also carried out in response to safety incidents or warnings in response to unsafe situations. The Dutch Safety Board is forced to conclude that the inspections and quick scans carried out by the MLA and the Royal Netherlands Air Force Command (on behalf of the MLA) were predominantly reactive, limited in depth and focused on the execution of mission-related training.

The Royal Netherlands Air Force Commander does not conduct any audits that focus on flight safety. He takes the view that the monthly and quarterly reports drawn up by the units should state whether the tasks assigned have been carried out properly. If the unit is not or no longer able to carry out the tasks properly or it is anticipated that this may be the case in the future, this must be clearly stated in the reports.

The Commander of the Gilze-Rijen air base and his staff were busy with the amalgamation of two air bases and a naval airbase and the formation of the Ministry of Defence Helicopter Command prior to and at the time of the incident. Investigations have revealed that no audits were conducted by or on behalf of the air base commander. This means, for instance, that the activities of the squadron commanders, flight commanders, Duty Officers etc. were not being reviewed on a regular basis.

Previous incidents
An alarming point to note is that incidents involving helicopters have occurred within the Ministry of Defence over the past few years in which the aforementioned factors also played a role. The investigation into one of these incidents was carried out by the Dutch Safety Board, whilst the remaining investigations were carried out by investigation committees set up by the Air Force Command or (in part) by the Ministry of Defence Temporary Committee for the Investigation of Defence Incidents.

One of these incidents involved the crashing of a AH 64D Apache helicopter (registration number Q-20) during a period of deployment in Afghanistan in July 2004. The direct cause of this incident was miscommunication. The mission was relatively easy, with a low task load which caused a failure in the transfer of control. During the deployment, the front seater fulfilled a dual function. This dual function placed the supervision structure under pressure.

In October 2005, a further incident took place in Afghanistan involving a CH-47D Chinook (registration number D-104) during a transport flight, whereby the aircraft deviated from the planned route. The pilots had not sufficiently prepared the flight in order to foresee the consequences of taking a different route. The flight was regarded as a routine flight, and consequently one with a low task load. The crew’s confidence in the aircraft commander (an experienced mountain flight instructor) and the technical capabilities of the helicopter also led to a more passive attitude than desired (complacency). In addition, the aircraft commander was also acting as an authorising agent (Head of Operations and detachment commander) in this instance, which affected the supervision structure when he himself was flying.

In June 2007, a serious incident occurred involving a Lynx SH-14D from the Royal Netherlands Navy Command[3] . In the case of this incident, agreements and discussions of procedures (preparation) were insufficient at a detail level to guarantee the necessary level of safety and the professional competence of one of the individuals involved was not guaranteed, who had not yet actually carried out a specific, crucial operation and exercise. The fact that he was charged with these activities nonetheless indicates that supervision was lacking. Again, there was no external supervision by the Military Aviation Authority of compliance with general preconditions as no such preconditions had been established at this time.

General considerations

The Ministry of Defence is a self-regulatory organisation and there is little to no direct external supervision. The manner in which safety is achieved is largely an internal matter. This means that a great deal of responsibility rests with all of the units of the Ministry of Defence involved not only with regard to fulfilling their own responsibilities, but also monitoring this themselves internally as the party responsible.

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[3] On 4 July 2008, the helicopters of the Royal Netherlands Navy Command and the de Kooy Marine Naval Airbase were placed under the Ministry of Defence Helicopter Command [DHC].

All those involved must have a clear understanding of their own responsibility when it comes to safety. This also applies to their expectations of and the obligations that they place on others. All this must lead to coordinated internal auditing processes that enable the units of the Ministry of Defence to contribute internally and towards each others' safety in order to guarantee the end product, in this case flight safety.

Quality control and assurance of safety by the higher levels within organisations must take place in accordance with the five general safety principles set out in Chapter 3.4 (Assessment framework for safety management) and that come together in a safety management system.

In a letter dated 4 August 2006 the Minister of Defence stated, in response to recommendations made by the Ministry of Defence Temporary Committee for the Investigation of Incidents, that the Ministry of Defence would implement a "Defence Safety Management System" (VMS DEF). Some time after this, it was stated during a presentation that the documentation in this regard had been certified and that implementation was set to commence. In addition, the Military Aviation Authority is charged at the highest level with quality control and assurance in relation to military aviation.

Nevertheless, the Dutch Safety Board sees the same underlying factors come up time and again in the case of incidents within the Ministry of Defence. What is disappointing is that it has been stated for years now that work is being carried out on the introduction of a safety management system and the implementation of supervision, internal checks and audits, however concrete steps to ensure that these safety nets play a (more) effective and significant role are (still) not visible. The Military Aviation Authority is still busy introducing regulations but, given that certain operational quality requirements have not yet been implemented, appears to lack sufficient drive.

In addition, it appears that although the Ministry of Defence is taking certain well-considered measures and is attempting to offset the risks of these as far as possible, it is no longer doing sufficiently aware of the impact of the total of those measures and the total of the risks that are ultimately being run. This is bringing the Ministry of Defence into territory that is known as 'operational drift' or 'drift into failure', which is presently regarded as a major risk in aviation. The term 'operational drift' refers to a gradually increasing movement of work and safety systems towards the limit of the zone within which it is still possible to operate at a safe level. This movement occurs under pressure from all kinds of factors, such as a shortage of funds or resources. These factors exert a subtle influence on the many decisions made every day by implementers and management. Operational drift is difficult to recognise and acknowledge because it concerns normal people who are carrying out their normal work within a (seemingly) normal organisation, rather than clear failures, defects or errors.

In the event of operational drift, there is an increasing risk of an incident occurring as a normal by-product of normal work under (normal) pressure from shortages and competition. No (safety) system is immune to this pressure. In the structures and systems used within the (military) aviation sector, there is often more than enough inbuilt protection against the effects of one isolated failure. These protective structures can ultimately contribute towards the occurrence of an accident, because they help to disguise 'operational drift', as it were. These structures provide adequate protection in the first instance, however under pressure the structures are always gnawed away to a greater or lesser degree. Although they may appear to continue to exist, their protective effect is reduced, which constantly pushes the risk of an incident, which was effectively limited, further towards the limit of the zone within which it is still possible to operate at a safe level, until this limit is reached and the incident occurs. Because it appears as though the protective structures continue to exist, the 'operational drift' passes unnoticed, or is paid little attention.

This incident and the previous incidents cited above also involved normal people carrying out their normal work within a (seemingly) normal organisation, with no clear failures, defects or errors.

One example of this is the fact that the number of flight hours for training purposes was reduced from 180 hours to 140 hours for financial reasons, and an advanced tactical simulator was to be purchased in which the remaining 40 hours would be 'flown'. This simulator was not acquired, which meant in practice that there was and is less opportunity for training. An attempt was made to offset this problem by carrying out targeted training for the deployment mission and by omitting training in specific tasks that are regarded as being less important for the purpose of executing the mission. A number of the hours flown during deployment missions are also regarded as training hours. These are all separate and well-considered decisions, appropriate within the structure, but which mean that there is effectively much less time available for training. The result is that considerably less training is carried out. Training is still considered to be very important, however there has in fact been a (significant) reduction in training capacity, resulting in a situation whereby certain skills fall short of requirements. Although this problem is occasionally recognised, it is ‘glossed over’ with the comment: “We are achieving a 5.5 instead of an 8, but a 5.5 is still a pass”.

Supervision is also built into the safety structure. Supervision is therefore carried out, however occasionally the roles of supervisor and implementer are combined in one individual. Furthermore, flight preparations are still monitored, however only on the basis of checklists and no longer at a substantive level. Supervision therefore does indeed take place in practice, but whether or not this supervision is effective enough is open to doubt.

As a result of reorganisations, tasks and responsibilities are shifted and the capacity available for the conducting of audits etc. is reduced. This leads to a situation whereby audits and reviews are temporarily suspended or not carried out to a sufficient extent pending new regulations or the implementation of further reorganisations. Delays in this regard ensure that defects slowly but surely creep into the safety structures, and are no longer picked up during reviews or audits and subsequently rectified.

All of these, often small, harmful effects on the structures result in ‘operational drift' under the pressure of various circumstances, with the help of all kinds of well-founded decisions and camouflaged by familiar structures, which, over long periods of time, are no longer as effective as once imagined or thought due to all of these adjustments and changes.

The Dutch Safety Board is of the opinion that the various incidents that have occurred over the past few years within the Ministry of Defence highlight the fact that the safety risk and in particular the ‘operational drift’ is not or no longer being recognised to a sufficient extent. This is due, amongst other things, to the absence of proper supervision and safeguarding within the operational management of (high-risk) business operations.

Lessons from previous investigations

The Dutch Safety Board and its predecessor in the case of the Ministry of Defence, the Ministry of Defence Temporary Committee for the Investigation of Incidents [*Tijdekijke Commissie Ongevallenonderzoek Defensie*, TCOD], have already stated several times in their reports and have been forced to reach the conclusion time and again that a sufficient focus is not being placed on guaranteeing (flight) safety. Various recommendations have been devoted to this.

The recommendations issued following the collision between a YPR armoured vehicle and a train near Assen on 17 June 2003 included the implementation of a uniform health and safety management system for the entire armed forces. It was also recommended that Risk Assessment and Evaluation should be carried out in the case of exercises and that performance targets in respect of the execution of health and safety audits should be included at district level. Furthermore, it was recommended that compliance with the safety regulations imposed should be adequately monitored, feedback should be provided with regard to the feasibility of these regulations and an adequate system should be introduced for the purpose of identifying defects in relation to safety by means of carrying out checks, recording such defects and resolving them by taking corrective measures.

The report regarding the fall of a torpedo in the forward torpedo room of a submarine on 16 March 2004 recommended the introduction within the short term of a management system in which feedback and quality assurance, as well as adequate Risk Assessment and Evaluations, are anchored in order to ensure that an insight is gained into safety management aspects at a command and policy level, also via a fully implemented and functioning health, safety and environment management system, audits, checks and inspections, for the purpose of achieving continuous improvements.

The Dutch Safety Board echoed this recommendation following the incident involving chlorine gas intoxication in the “Bever” damage simulator on 4 July 2005. In this instance, an indication of what the Board was referring to when using the term 'safety management system’ was provided for the sake of completeness.

The report entitled “Injuries in Curacao due to the use of a smoke grenade (WP)”, 26 April 2006 also revealed that the checks built into the (ammunition) process were clearly insufficient. One of the recommendations stated that safety must be guaranteed by means of conducting checks at specific points during the process.

Finally, one of the recommendations in the report regarding the abseiling incident during the Army Open Days in Wezep on 2 June 2007 stated that it is essential to ensure that briefings take place prior to high-risk activities, in which the risks and procedures to be followed are discussed in detail.

It is possible to conclude that failure to guarantee safety or to guarantee safety to a sufficient extent, due, amongst other things, to the absence of an effective safety management system, failure to perform proper risk assessments, and insufficient feedback to more senior authorities by means of audits, inspections and checks, is a recurrent theme in these recommendations.

All of these recommendations have been adopted by the Minister of Defence, and he announced that measures would be taken for the purpose of implementing them. The Dutch Safety Board has established, however, that the power line collision was caused by inadequate flight preparations and execution and insufficient supervision. The Board has also established that this was able to take place as a result of failure to conduct regular audits of the Apache squadron up to the level of the Central Staff, which means that (basic) flight safety was not effectively guaranteed. The Board concludes from this that the underlying factors in the present case are the same as those of the previously investigated incidents.

Recommendations

In view of the above and in view of the direct causes and the underlying factors of the present case, the Dutch Safety Board is of the opinion that an insufficient focus was placed on quality control in relation to flight safety.

The Board advises the Minister of Defence to guarantee general (basic) flight skills and flight safety by ensuring:

- that an adequate supervision system is in place, together with the corresponding checks and evaluations
- that a full insight is gained, by means of audits, into (flight) safety and the way in which this is managed.

Prof. Pieter van Vollenhoven — Chairman of the Dutch Safety Board

M. Visser — General Secretary

LIST OF ABBREVIATIONS

AGL	Above Ground Level (altitude calculated from the ground)
AVB	Apache Flight Training Book
BVG	Special Rules Zone
BS	Back seater: responsible for flying the Apache helicopter
CDS	Chief of Defence
C-LSK	Commander of the Royal Netherlands Air Force
CLSK	Royal Netherlands Air Force Command
CML	Centre for Man and Aviation
CRM	Crew Resource Management
CRO	Crisis Response Operations
DHC	Ministry of Defence Helicopter Command
DMO	Defence Materiel Organisation
DTC	Data Transfer Cartridge
DVD	Defence Infrastructure Agency
FLIR	Forward Looking Infrared
FOV	Field of view
FS	Front seater: the aircraft commander and operator of the weapons systems
GLV	Low-level flight zone
GMB	Full Military Licence
HDU	Head Display Unit
HFACS	Human Factor Analysis and Classification System
ICAO	International Civil Aviation Organisation
IHADSS	Integrated Helmet And Display Sighting System
ISAF	International Security Assistance Force
JAR	Joint Aviation Requirements
JOP	Annual Training Programme
JVT	Annual Flight Test
KLu	Royal Netherlands Air Force
LCT	Longbow Crew Trainer
LE	Aviation Requirement
LVV	Royal Netherlands Air Force Air Traffic Regulations
LVR	Air Traffic Regulations
MDR	Maintenance Data Recorder
MilAIP	Military Aeronautical Information Publication
MLA	Military Aviation Authority
MLE	Military Aviation Requirements
NVG	Night Vision Goggles
OBP	Operational Decision-Making Process
OMIS	Royal Netherlands Air Force Operational Management Information System
OPS	Operations
PF	Pilot Flying: the pilot who is actually flying the aircraft at that point in time
PKB	Key Planning Decision
PNVS	Pilot Night Vision System
PVE	Product Centre
RAD ALT/RALT	Radar Altimeter
SMT	Military Terrain Structure Plan
SOP	Standard Operating Procedures
TACSOP	Tactical SOP
STV	Standardisation Training Flight
TADS	Target Acquisition Designation System
THG	Tactical Helicopter Group
TSD	Tactical Situation Display
VFR	Visual Flight Rules
VKAM	Flight Safety, Quality, Health & Safety and the Environment
VOBKLu	Royal Netherlands Air Force Flight Order Book
WAAK	KLU Target Level Analysis Task Force

1 INTRODUCTION

1.1 Immediate Cause

On 12 December 2007, during a night flying exercise near to the village of Rossum, an Apache helicopter belonging to the Royal Netherlands Air Force collided with the 150 kV high-voltage power line over the river Waal. This caused the high-voltage cables to snap, leaving part of the Bommelerwaard and the Land van Maas en Waal areas without electricity for almost 50 hours. Around 30,000 households and 7000 businesses were affected.

The helicopter was severely damaged. In spite of this, the two pilots were able to land the Apache helicopter to the south of the river Maas. The aircraft commander sustained a minor injury to his face from broken glass. The major and relatively protracted power failure meant that this incident had a major impact in one region of the Netherlands and there was a great deal of media attention.

1.2 Purpose of the investigation

The Dutch Safety Board has carried out an independent investigation into this incident. The aim of the investigation is to determine exactly what took place – ascertaining the truth – and to examine whether the incident was the result of any underlying structural safety failings and if so what these failings were, with the sole purpose of learning lessons with regard to safety.

The investigation focuses on the question as to how it was possible for the Apache helicopter to collide with the high-voltage power lines. The following factors are examined:

1. Technical factors: are there any technical factors that played a role in the incident?

2. Human factors: are there any human factors that have a direct or indirect causal link with the incident?

The following sub-questions are examined in greater detail:

   a. Is there a link between the pilots' training and the incident?
   b. What preparations were made for the flight?
   c. Is there a link between the relationship between the pilots and the incident (Crew Resource Management (CRM))?
   d. Are there any other factors that influenced the incident (pressure of deployment, experience of "war", etc.)?

3. Organisational factors: are there organisational aspects within the Royal Netherlands Air Force and the Ministry of Defence, or externally, that played a role in the incident?

   a. These include the following aspects: organisational structure, decision-making process, culture, safety management etc.
   b. Organisation and supervisory structure, both within the Royal Netherlands Air Force and within the Ministry of Defence.

4. External factors: are there factors in relation to the high-voltage power lines outside of the sphere of influence of the Ministry of Defence that influenced the incident (for instance lighting of high-voltage pylons)?

A further aspect of this incident, namely the vulnerability of electricity supplies in recreational zones, will be the subject of a separate investigation and report by the Dutch Safety Board.

1.3 READING GUIDE

The report on the power line collision consists of six chapters. Chapter two presents the facts that are relevant in determining the cause or causes of the incident. Chapter three focuses on the assessment framework. Chapter four describes the parties involved and their responsibilities. Chapter five analyses the facts in relation to the power line collision, using both the TRIPOD method and the Human Factor Analysis and Classification System (HFACS) as the method of analysis. Chapter six repeats the previously formulated partial conclusions, and final conclusions are subsequently reached and recommendations made.

2 RELEVANT FACTS

2.1 INTRODUCTION

This chapter presents the facts that are relevant in determining the cause or causes of the incident. The chapter first examines the Apache squadron, to which the crew of the Apache helicopter belongs. A focus is placed on the composition of the squadron and the development of the flight programme. The chapter then goes on to describe the Apache helicopter, and a number of its specific features and capabilities. Finally, information is provided on the relevant facts of the incident.

The power line collision involving the AH-64D Apache helicopter (registration number Q 01) can be described as an aviation incident. At an international level, reports on aviation incidents are presented in accordance with the format specified in Appendix 13 of the International Civil Aviation Organisation (ICAO) regulations. Appendix 11 (Relevant facts and data) presents the factual information in this format.

2.2 THE APACHE SQUADRON

In order to gain a greater insight into why the incident occurred, this section provides more detailed information on the Apache squadron. Subsection 2.2.1. describes the composition of the squadron. Subsection 2.2.2. provides a brief description of the squadron's tasks and the way the flight programmes are developed. The information provided in this section shows the formal composition of the squadron and how the tasks and training exercises are carried out.

2.2.1 *Composition*

The Royal Netherlands Air Force Command has a number of tools at its disposal for the purpose of carrying out combat activities, including Apache helicopters. These Apache helicopters are kept with the 301 squadron at the Gilze-Rijen air base, with the exception of a number of aircraft that are stationed in the United States for training purposes. The 301 Squadron is made up of around 180 members of staff headed by a squadron commander, divided into the Operations Divisions, the Preparation Division and Maintenance. As the emphasis is placed on Operations in this investigation, further information is provided on this division below.

The Operations division consists of five flights and a number of supporting sections. The division falls under the command of the Head of Operations, who is also known as the Ops Officer (see appendix 6: Royal Netherlands Air Force Command Organisation Chart). A flight[4] consists of around nine pilots, including the flight commander, and is deployed as a unit for the purpose of carrying out specific tasks. One of the supporting sections within the Operations Division is the Navigation section. When carrying out tasks, efforts are made to use the flight structure as far as possible in the schedule. Efforts are made to divide the tasks between the flights as evenly as possible in the annual schedule.

The Ops Officer is responsible for the long-term schedule (around three months and thereafter). Amongst other things, he draws up the annual schedule and divides the various tasks assigned to the squadron for that period between the different flights.

The Ops Officer is supported by the Current Ops Officer, who is primarily responsible for the short-term schedule (up to around three months into the future). The daily schedule is managed by the Duty Officer. The Duty Officer is a flying officer who is responsible for ensuring that the daily schedule runs smoothly and for organising the execution of flights on that day. The position of Duty Officer is an ancillary position and is filled by experienced pilots within the squadron on a rotation basis, in principle changing every week.

2.2.2 *Tasks and training*

The 301 Squadron has three main tasks:

1. Carrying out offensive air operations
2. Carrying out reconnaissance flights

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[4] In this context, the word 'flight' is used to refer to an organisational unit within a squadron. In other places the word 'flight' is also used to refer to travel by air (an air operation).

3. Carrying out security and escort flights.

The squadron is also charged with carrying out flight assignments for the various branches of the armed forces, training its own personnel and maintaining the helicopter fleet.

In order to carry out these tasks, the 301 Squadron is assigned a number of flight hours on the basis of the Regulations in respect of the training programme for the AH-64D attack helicopter THGKLU (see appendix 3). These regulations describe the Annual Training Programme (JOP) for the Apache helicopter. The number of hours flown by a pilot in principle each year if he is not deployed is set down in the JOP. For the JOP of Apache pilots, 140 flight hours are available per pilot. The training programme consists of general flying (GF), continuation training (CT), operations that can be allocated on a flexible basis and Longbow Crew Trainer (LCT) operations[5] (simulator operations).

The aim of the GF part of the JOP is to maintain basic flight skills. The CT is made up of blocks that correspond to the types of missions that the squadron carries out, as well as weapon training. Operations that can be allocated on a flexible basis are the part of the JOP that is used for additional CT operations. The squadron commander allocates the additional CT operations. The LCT supports the flight programme. The LCT operations have the same structure as the flight programme. The JOP in the LCT includes GF, CT and operations that can be allocated on a flexible basis.

Quality control takes place in two areas. In the first instance, quantitative requirements are imposed on the training programme in the form of the JOP. In addition, qualitative requirements are set out in the Apache Flight Training Book (AVB), the Tactical Operation Procedures (TACSOP), and in the Regulations in respect of the execution of artillery missions within the annual training programme of the 301 squadron (AH-64D). These requirements are assessed by means of test flights such as the Annual Flight Test (JVT) and the Standardisation Training Flight (STV) and the arms qualifications. A flight is also assessed as a unit at least once every year in a tactical scenario.

All Apache and simulator (LCT) operations are recorded in the Royal Netherlands Air Force Operational Mission Information System (OMISKLu). The period of validity (currency) is automatically updated in the OMISKLu. The difference between the number of operations that have actually been effectively executed over the past 365 days and the standard imposed in this regard is also shown for each type of operation. In addition to the operations, the Tactics, Techniques and Procedures (TTPs) are also recorded in OMISKLu. There is no currency requirement linked to the TTPs. The recording of this information provides the squadron commander with a detailed insight into progress in relation to training. All operations flown are submitted to the squadron commander via OMIS. He is then responsible for determining whether or not the operation was effective. The qualifications (currencies) are not updated until an operation has been judged to have been effective. The squadron commander is able to delegate this power to the Head of the Operations Division (Ops Officer).

It is the responsibility of the Ops Officer to organise and distribute the operations (and therefore the flight hours) in a manner that ensures that the squadron is trained to carry out the abovementioned tasks safely and effectively. This is the case if the pilots receive sufficient hours to carry out their JOP, so that training in all task areas remains guaranteed.

As one of the measures within the context of the KLU Target Level Analysis Task Force [WAAK], the decision was taken in 2001 to reduce the number of JOP flight hours available to each pilot from 180 to 140. The 40 hours deducted from the JOP were required to be “flown” in an advanced tactical simulator that was still to be purchased[6]. This simulator was to replace the simulator currently in use, the Longbow Crew Trainer, which is not suitable for tactical simulation (mission substitute), but rather just for ‘normal’ flight situations. This tactical simulator has not yet been purchased to date. For the squadron, this means that there has been a change in the composition of the JOP, in which some tactical elements of the squadron's tasks have a lower priority.

Each year, the Ops Officer draws up a schedule assigning the exercises for each flight and each week. This ensures that the flight commanders and flight personnel are notified in good time as to which tasks they will be carrying out at which times.

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[5] For the purpose of the schedule, the JOP is calculated in numbers of operations. The average duration of an operation is 1.7 flight hours, which corresponds to 82 operations per full JOP (140 flight hours).

[6] This arrangement was made in imitation of the US Army Aviation, where each operational pilot is assigned the same number of hours each year.

The current annual schedule includes the following elements, amongst other things: a period of around ten weeks' deployment in Afghanistan, an annual training exercise in the US and a total of around one month's artillery exercises in Germany (two times two weeks).
This schedule is developed in close consultation with the maintenance division, as deployability is also dependent on the availability of helicopters.

The current Ops Officer is responsible for making concrete arrangements for the schedule during the weeks in which the squadron is carrying out flights. These are made a number of weeks in advance in order to effectively coordinate the activities with other units from a supply and demand point of view.

2.3 The Apache helicopter

The incident involved an AH-64D Apache helicopter. The Apache helicopter is a two-person helicopter with cockpits built in a tandem configuration. The crew consists of two pilots, whereby the front seater acts as the aircraft commander. The pilot in the back seat, the back seater, is responsible for flying the Apache helicopter. In order to ensure that he has an uninterrupted view, his seat occupies an elevated position so that he can see over the top of the front seater. The back seater's cockpit is primarily equipped for the use of those systems in the Apache helicopter that have to do with flight, such as starting the engine etc. The front seater is responsible for operating the target acquisition sensors (TADS: Target Acquisition Designation System) and for launching the weapons systems. His cockpit is adapted accordingly and includes features such as the controls for the TADS and an additional screen showing weapons information.

The Apache helicopter is designed to operate under a number of special conditions, including at low to very low altitudes. One of the greatest hazards when doing this is the presence of wires (telephone and electricity cables and high-voltage power lines). The Apache helicopter is therefore equipped with various cable cutters as standard.

A number of specific characteristics of this helicopter played a role in the occurrence of the incident. This section therefore provides a brief explanation of a number of the helicopter's features. First of all, section 2.3.1. provides a description of how the Apache helicopter is deployed. Section 2.3.2. then focuses on a number of sensors and visual systems that were being used at the time of the incident. Finally, section 2.3.3. looks at the composition of and collaboration within the crew (CRM: Crew Resource Management). As the incident took place during an exercise that involved night flying and low-level flight, these will be examined in greater detail when dealing with the collaboration within the crew.

2.3.1 *Deployment of the Apache helicopter*

With the Apache helicopter, the 301 Squadron provides fighting power. The squadron is able to take action during any conflict, from small-scale disturbances to large-scale war. The Apache helicopter was initially built to combat large mechanised units. After the Cold War, the role of the Apache helicopter changed and adapted to current action. This action primarily focuses on operating within 'Crisis Response Operations (CRO)', whereby the threat level can vary from almost negligible to very high.
The Apache helicopter was designed to be flown using the sensors (both during the day and at night). One of the basic principles of the design is that the helicopter is mainly flown at night and at low altitudes. For the purpose of night operations, a great deal of thought went into the design and the ergonomic integration of the night vision equipment and the other sensors on the Apache helicopter. It is however also perfectly possible to fly the Apache helicopter during the day without sensors.

As described in section 2.2.2, the three main tasks of the Apache helicopter involve carrying out offensive air operations, carrying out reconnaissance flights and carrying out security and escort flights. It must be possible to execute all of these tasks both during the day and at night. In view of the method of deployment, the crew of the Apache helicopter must be able to carry out the abovementioned tasks within both a national and an international environment. Within the Netherlands, training is conducted with the army, the air force and navy units.
In addition, international training also regularly takes place with the aim of coordinating and streamlining the techniques and tactics of the various NATO member states. This international training has made it possible for the states to take joint action during the current missions in countries such as Afghanistan.

Since 2004, the Dutch air force has been continuously involved in operations in Iraq and

Afghanistan using the Apache helicopter.

There are two ways in which the Apache helicopter can carry out its tasks, whereby a distinction is made on the basis of the available preparation time.

1. Planned deployment. This type of deployment relates to missions planned in advance, and where there is therefore time to coordinate with the various sub-units that are providing support or being supported during the mission. In addition, the mission is worked out in detail on the chart and prepared in the mission planning system. In this case, all resources can be used for the optimal development of Situational Awareness both before and during the mission. This is the most desirable method of deployment.
2. Urgent deployment. This type of deployment relates to the execution of urgent missions. In this case there is little to no preparation time prior to the actual mission. General briefings are however held before this type of deployment takes place, whereby the various potential deployment scenarios are discussed. During the mission, the general charts for the region will be used, although the data specific to the mission will not be marked on the charts. In this instance, there is also no time to prepare the mission planning system. The data relating to the mission, if available, must be entered into the weapon system during the flight. Development of Situational Awareness during an urgent mission is by definition much more difficult, which is why this is not the preferred method of deployment.

During the current mission in Afghanistan, ± 80 % of missions are flown according to the latter method. In Afghanistan, the Apache helicopter is on stand-by for urgent deployment 24 hours per day. In many cases, this involves so-called ‘Troops in Contact’ support.

2.3.2 *Sensors and visual equipment*

The Apache helicopter features a wide range of sensors that can be used in variety of different ways. The main sensors, which were also being used at the time of the collision, are described below.

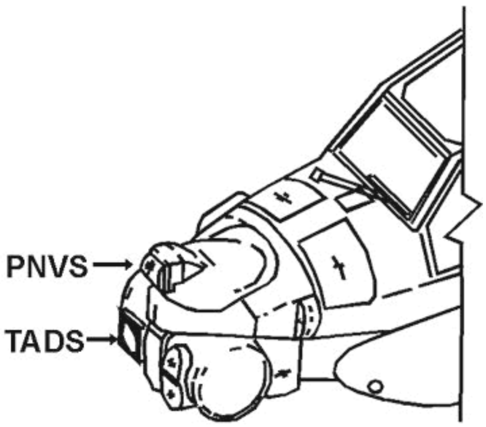

Figure 1: position of the PNVS and the TADS in the nose of the Apache helicopter

Target Acquisition and Designation System (TADS)

The sensors for the TADS are located in the large round 'drum' constructed directly below the nose of the Apache helicopter (see figure 1). The front seater uses the TADS for the purpose of acquisition and target marking during the deployment of weapons. The drum incorporates three sensors: thermal imaging (Forward Looking InfraRed (FLIR)), an optical sensor (Direct View Optics (DVO)) and the daylight camera (Daylight TeleVision (DTV)). The front seater is able to zoom in on all of the sensors several times. The TADS can be controlled by operating a handle or by linking the sensor to the position of the pilot’s helmet.
The latter method means that the sensor can be rapidly moved in the direction of a specific point, and adjustments can then be made using the handle.

Although the TADS was primarily designed to be used in combination with the weapons systems, it can also be used as thermal imaging (Forward Looking Infra Red), to fly and to navigate.

Figure 2: cockpit in an Apache helicopter

Pilot Night Vision System (PNVS)
The sensor for the PNVS is the small protrusion on the nose of the Apache helicopter (see figure 1). The PNVS processes the thermal imaging, which is primarily used at night by the back seater as a visual system. The sensor was developed primarily to be used as a flight sensor. This means that the thermal images provided by this sensor are of a higher quality than those from the TADS. However, the PNVS does not feature a zoom option or any additional sensors. When flying using the thermal images, the back seater also does not have the option to select the data projected via the thermal imaging. He is always presented with the flight data.

Figure 3: monocular optics

Although the PNVS provides high-quality thermal images, there are, however, a number of limitations with regard to visibility during daylight:

1. The resolution of the PNVS means that it may not always be possible to make out small objects.
2. The infrared image is made up of the temperature differences that can be detected in the atmosphere. Objects are therefore only visible if there is a great enough difference between the temperature of the object and the background temperature. If this is not the case, the object will no longer be registered by the sensor and will not be visible in the cockpit.
3. The image is a two-dimensional projection of the thermal images from the sensor, which means that there is no depth perception.
4. The optics are monocular[7], which means that there is no stereo depth perception either, and the pilot may also have to cope with potential symptoms of 'eye dominance[8]'.
5. Thermal cross-over can occur under certain circumstances: i.e. the occurrence of a period in the morning and in the evening, due to the daily rise and drop in temperature, in which the difference in temperature between the foreground and the background is so small that the sensor is not able, or is barely able, to register it. During this period, the crew cannot fully rely on the IR image[9].
6. If the PNVS fails, the back seater can select the TADS as a back-up sensor. When the TADS is being used by the back seater, it is no longer available to the front seater.
7. The field-of-view (FOV) is limited to 30 vertically and 40 degrees horizontally, which reduces the external view. Normal eye movements are no longer sufficient.
8. As the sensor in the nose of the aircraft follows the pilot's head movements, it is still possible to obtain a peripheral view, however to do this he will need to move his entire head. The pilot must therefore get into the habit of actively scanning the outside world by means of moving his head. Fixing on one specific point or object in the direction of flight therefore means that peripheral vision is lost.

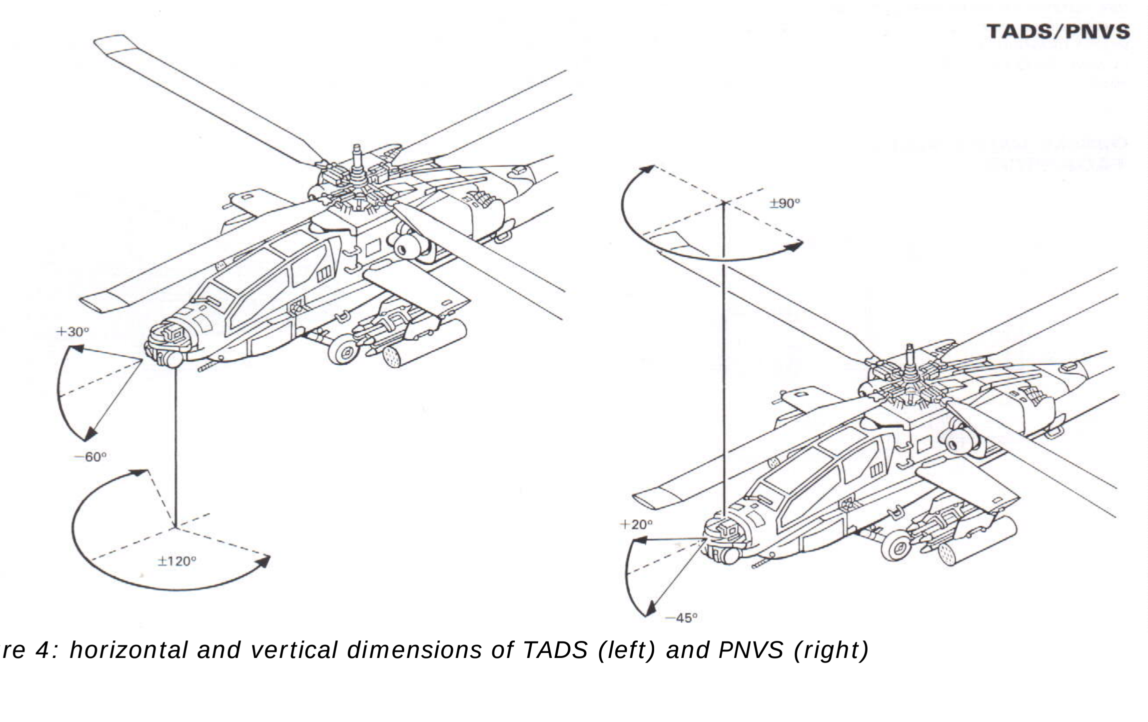

Figure 4: horizontal and vertical dimensions of TADS (left) and PNVS (right)

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[7] The information is observed using equipment that is only situated in front of the right eye.

[8] As what one eye is seeing is slightly different to what the other eye is seeing, the brain must determine which images to process.

[9] This thermal cross-over can be calculated and analysed before the start of the flight in order to determine how this will affect flight safety.

2.3.3 *Composition of and collaboration within the crew*

Composition of the crew

When the company McDonnell Douglas designed the Apache helicopter, the basic principle was that the pilot responsible for flying would sit in the back cockpit. In the case of the US Army[10], this pilot is also the aircraft commander. This basic principle means that in the operating manual, the back seater is referred to as the 'pilot' and the front seater as the 'co-pilot/gunner'.

When the Apache helicopter was introduced within the Dutch air force, the various concepts with regard to the division of tasks within the cockpit used in different countries (such as the US and Israel) were taken into account. The Royal Netherlands Air Force is of the opinion that the deployment of weapons should be regarded as the most important aspect of the Apache helicopter. It is necessary to fly the weapons system in order to get that system to where the weapons need to be deployed. Making the difficult decisions such as those in relation to tactical communication and navigation and the actual deployment of weapons within the applicable tactical regulations, the Rules of Engagement (ROE), is the hardest task on board the Apache helicopter. One of the two pilots must be focused on this at all times. In the opinion of the Air Force, this task should not be combined with flying the Apache helicopter.

The Royal Netherlands Air Force therefore took the decision to arrange for the most experienced pilot to act as the front seater (and aircraft commander) of the Apache helicopter. The role of back seater is fulfilled by the less experienced pilot[11].

Collaboration within the crew

There are three specific elements to the collaboration between the two pilots in the Apache helicopter, which play a role in Crew Resource Management (CRM). In the first instance, the cockpits are physically separated, and there is a distance and height difference between the positions of the cockpits. This separation means that it is not possible to visually monitor the activities of the other pilot. The intercom and, where appropriate, the 'symbology' of systems are the only ways of communicating. The specific element of the CRM is dealt with extensively during the pilots' training.

Secondly, there is not <u>one</u> range of duties that are carried out jointly by the pilots. In fact the difference in tasks between the front seater, who is responsible for tactical communication, tactical navigation and the deployment of the weapons systems, and the back seater, who is responsible for flying the Apache helicopter, is great. Each has his own range of duties, although there are of course many areas of overlap. For instance, the front seater will indicate the direction of flight, the altitude and speed, and the back seater will then be independently occupied with carrying out this task.

A third element is that the pilots do not work in fixed teams: the crew is assigned by the Ops Officer and the pilots are trained to be able to fly in any combination.

In the event of night flying, there are limitations due to the use of night vision equipment. It is not possible to identify all obstacles using the FLIR. If the aircraft is flying at a low altitude, the back seater must spend most of his time looking outside, which means that he has no time to read the chart. This problem is overcome by assigning the front seater responsibility for notifying the back seater of any obstacles situated on or near to the route and that are marked on the chart. The back seater can then use this information to build up a complete picture of the surroundings and manoeuvre the Apache helicopter safely across the terrain. Optimising the avoidance of obstacles therefore also depends on the communication between both pilots.

2.4 THE INCIDENT

On 12 December 2007, two pilots from the 301 Squadron (Gilze-Rijen air base) were instructed to carry out a night mission within the context of the JOP. This section examines the preparations for and the execution of this mission and the events following the collision with the high-voltage cables in greater detail.

[10] In the case of the US Armed Forces, the Apache helicopter is a weapon system of the US Army.

[11] This is also the case within the Israeli Air Force.

2.4.1 *Preparations*

On the day of the incident, both pilots involved arrived at the squadron at around noon. Both of the crew members were aware that they had been included in the flight programme for the evening in question.
They were not yet aware of the crew arrangement, however, or the take-off time. These details were determined on the day itself on the basis of the anticipated weather conditions and current priorities. A final schedule for the evening flight programme was released at around 16.15 hours and the take-off time for the low-level flight night mission was set at 18.00 hours. The two pilots were informed and subsequently commenced their preparations. With regard to preparation time, the mission was not a case of urgent deployment as described in section 2.3.1.

During the planning of the mission, the route to low-level flight zone 5 (GLV5) near Eindhoven was determined and from there to the Maas-Waal low-level flight zone (GLV Maas-Waal), returning to the Gilze-Rijen air base following a number of exercises. The Navigation division was instructed to prepare the charts and to save the digital information relating to the mission planning on the Data Transport Cartridge[12] (DTC), enabling both pilots to have something to eat in the staff restaurant. On their return, there were still a number of adjustments to be made. After a briefing lasting around three minutes (at around 17.30 hours), the front seater made his way to the ops room[13] to obtain the latest information on the flight, whilst the back seater made his way to the Apache helicopter.

2.4.2 *Execution of the flight up until the power line collision*

The first part of the flight went according to plan. From the Gilze-Rijen air base, a low-level flight route was followed in the direction of the GLV 5[14], in order to carry out the first exercises in this zone. Following completion of these exercises, the helicopter took a northerly course towards the Maas-Waal low-level flight zone. Once it had arrived in this zone, the aircraft performed a number of exercises at a higher altitude[15]. The helicopter then started a descent to a lower altitude in order to carry out other exercises. As the collision with the high-voltage cables took place during this descent and at the start of the low-level flight, this part of the flight will be described in greater detail.

The higher altitude exercises were completed around 3 km to the east of the village of Rossum. The front seater subsequently instructed the back seater to start a descent. Using the helicopter's technical/visual equipment, he indicated a roughly north-westerly direction along the Waal, which he confirmed verbally. The back seater understood the instructions and commenced the descent. When he asked how low he should descend, the front seater responded to the effect that he should fly as low as he was comfortable with (so-called 'comfort level').

2.4.3 *Collision*

The back seater commenced the descent on a north-westerly course, in the direction of the river Waal (on a bearing of 324 degrees). At around 122 feet (37 metres) and at a speed of 116 knots (215 km/h), the helicopter collided with the high-voltage cables, which stretched above the river. These cables supply the Bommelerwaard area with electricity. The so-called cable cutters fitted to the helicopter as standard and the speed of the aircraft meant that the six power lines were cut and/or snapped in two, cutting off the power supply and leaving the Bommelerwaard with no electricity (see appendix 11: Relevant facts and data)[16]. The helicopter was able to continue flying. The back seater subsequently started an ascent to around 1000 feet.

2.4.4 *Execution of the flight after the collision*

Both pilots later stated that they had no idea what was happening at the time of the collision. It took some time before they realised that they had hit something. As the windows in the front cockpit had shattered, the front seater was sitting under the glass and in the cold wind. The back seater was no longer able to use the Pilot Night Vision System (PNVS), and so was not able to see anything using his sensors.

The back seater had commenced an ascent to around 1000 feet (300 metres) and once at this altitude had been instructed by the front seater to fly in the direction of the Gilze-Rijen air base. At this time, the front seater made a radio transmission to air traffic control stating that they were in an emergency situation. As the back seater's night vision equipment was no longer functioning

[12] A data carrier used with the computers in the Apache helicopter.
[13] The room occupied by the Duty Officer and where daily supervision takes place.
[14] Low-level flight area near Eindhoven.
[15] Approx. 2000 to 3000 feet = between around 600 and 900 meters.
[16] The two overhead ground wires on both sides of the pylon were not damaged or broken.

and the front seater had a great deal more experience, the back seater handed over control to the front seater. Although no system failures were detected (cockpit alert system) that could indicate reduced airworthiness, the front seater decided that the helicopter must have been damaged to such a degree by the collision that it might not be possible to reach the Gilze-Rijen safely. He decided to cut short the flight and to look for a suitable location to carry out a precautionary landing. A site was found south of the river Maas at Hedikhuizen. Following a successful precautionary landing, a call was placed to the Gilze-Rijen air base and assistance was requested.

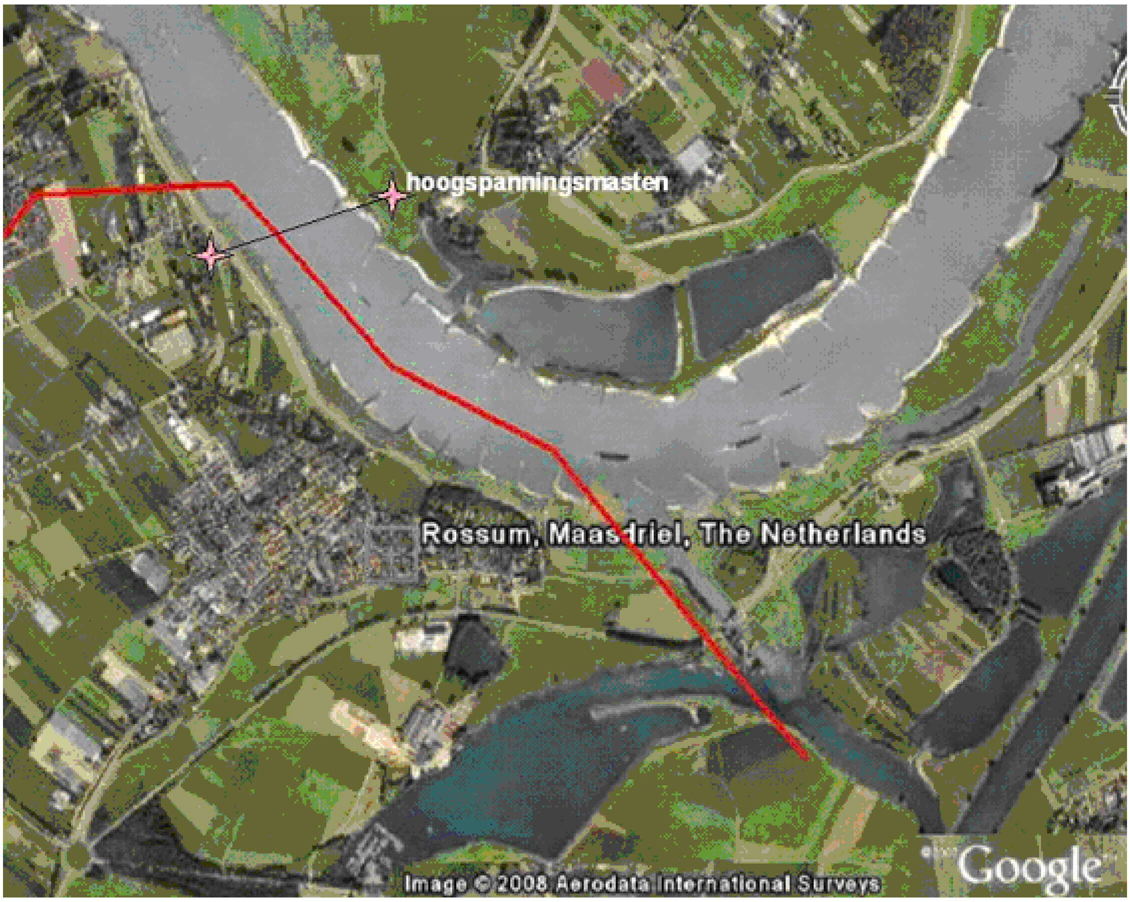

Figure 5: flight path immediately before and immediately after the collision with the power lines

At the time of the collision with the high-voltage power line, there was a second Apache helicopter flying in another part of the low-level flight zone. The crew of that helicopter heard via the radio that the other Apache helicopter had run into trouble. They assisted the crew of the damaged Apache helicopter during the precautionary landing by informing the various authorities.

3 ASSESSMENT FRAMEWORK

3.1 GENERAL

In addition to the task of determining precisely what happened within the context of an incident, the Dutch Safety Board must also establish how it was possible for an incident to occur, so that lessons can be learned for the future. In order to do this, an assessment framework is essential. This chapter describes the assessment framework for the investigation into the Apache helicopter power line collision over the Waal near Bommelerwaard on 12 December 2007.

The Dutch Safety Board uses the assessment framework to analyse the incident and applies the framework to the relevant facts, the determination of the (probable) causes, the scope of the consequences, the identification of structural safety failings and the drawing up of recommendations.

The assessment framework consists of three parts. The first part provides an insight into the relevant elements of (national) legislation and regulations. The second part describes the Ministry of Defence regulations in force that are relevant to the investigation. The final part describes the points for attention drawn up by the Dutch Safety Board in relation to the approach adopted by the parties involved with regard to safety management and their own responsibility for safety.

Appendix 2 sets out the assessment framework in greater detail where necessary.

3.2 NATIONAL LEGISLATION AND REGULATIONS

3.2.1 *Occupational health and safety legislation*

As a framework Act, the Netherlands Working Conditions Act imposes a number of obligations in relation to working conditions, including in the field of policy (Article 3.1a) and the implementation of risk assessment and evaluation (Article 5). The Working Conditions Decree elaborates on the general provisions in the Working Conditions Act and also sets out the special position of the Ministry of Defence (Articles 1.26 to 1.33 inclusive). This is also linked to international obligations and various circumstances (including training exercises).

3.2.2 *Act on Aviation / Aviation Act (WL/LW)*

Aviation legislation is currently undergoing a drastic review. On 1 July 1999, the name Air Traffic Act was changed to Act on Aviation. The Aviation Act is also incorporated into the WL. Chapter 10 of the WL includes a separate chapter dedicated to military aviation. This chapter sets out all of the provisions applicable to the Ministry of Defence that differ from those of civil aviation.

3.2.3 *Air Traffic Regulations [LVR]*

Amongst other things, this Decree dated December 1992 imposes restrictions on the execution of flights involving visual flight (VFR[17]), for instance with regard to flying outside of daylight periods and minimum flight altitudes. It is stated that the Minister of Defence may grant exemptions for military aircraft from the restrictions that apply to VFR flights (Article 44 paragraph 4) and the minimum VFR flight altitude (Article 45 paragraph 4).

3.2.4 *Regulations on VFR night flights and minimum altitudes for military aircraft*[18]

These regulations dated January 1995 are based on the Air Traffic Regulations and set out the rules for, amongst other things, night flying (VFR and IFR) and the minimum VFR altitudes for military helicopters. These regulations create a general exemption and mean that it is not necessary to establish a Special Rules Zone [BVG] for every training exercise or aircraft movement.

In addition to the low-level flight routes for jet planes and transport aircraft (Article 4), these regulations include the “low-level flight zones and routes for military helicopters and propeller aircraft designed for training purposes” (Article 5).
The Maas/Waal low-level flight zone is established here under (i). Article 12 sets down the minimum altitude for VFR night flights.

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17 VFR: Visual Flight Rules

18 Regulations on VFR night flights and minimum altitudes for military aircraft. Date of entry into force: 1 January 1995.

3.3 MINISTRY OF DEFENCE REGULATIONS

3.3.1 *Royal Netherlands Air Force Air Traffic Regulations [LVV]*[19]

The Royal Netherlands Air Force Air Traffic Regulations were laid down by the Commander of the Royal Netherlands Air Force and provide a translation of the aviation legislation and regulations. The LVV must not be inconsistent with the abovementioned primary legislation and regulations.

3.3.2 *Royal Netherlands Air Force Flight Order Book [VOBKLu]*[20]

The Royal Netherlands Air Force Flight Order Book (VOBKLu) serves to implement the provisions established under or pursuant to the Act on Aviation (WL) and the Aviation Act (LVW) as operational regulations for the execution of flight operations.
The VOBKLu also sets down rules in respect of the implementation of the issuing, suspension and withdrawal of military licences and authorisations, as well as the powers and responsibilities associated with these flight operations.
The VOBKLu is split into a number of parts, whereby "*Part III, Helicopters*" exclusively contains provisions that apply to operations with helicopters.
Chapter 2 of this part sets out, amongst other things, the requirements to be imposed on members of the cockpit personnel in relation to proficiency (currency requirements). Chapter 5 deals with preparations for the flight (including flight authorisation, general VFR, night operations). Chapter 6 relates to the execution of the flight.

3.3.3 *Apache Flight Training Book (AVB)*[21]

"The purpose of the AVB is to provide guidelines, parameters and tips for the execution of flight manoeuvres in order to ensure that these are executed in an efficient and safe manner. The AVB therefore constitutes a regulation in respect of the flight and technical training required by Apache pilots. The aim of the AVB is also to ensure that training exercises are standardised wherever possible in order to establish as objective a basis as possible for the assessment of the flight skills of Apache pilots" (Part I, Introduction).
Part III (Flight exercises) of the AVB deals with, amongst other things, the crew concept and crew briefing (chapter 1) and navigating cables (chapter 18).

3.3.4 *Regulations in respect of the training programme for the AH-64D attack helicopter THGKLU*[22]

As part of the primary task of the Royal Netherlands Air Force Tactical Helicopter Group [THGKLu], the attack helicopter is used for specific combat operations and support. In order to be able to perform these tasks and guarantee deployment, pilots of the attack helicopters must constantly keep their general and operational flight skills up to the required standard to ensure that they retain 'Combat Ready' status. These regulations provide detailed guidelines and provisions in relation to the Annual Training Programme (JOP) for pilots of the Apache attack helicopter.

3.4 ASSESSMENT FRAMEWORK FOR SAFETY MANAGEMENT

In principle, the manner in which an organisation meets its own responsibility for safety is tested and assessed from various angles.
Rules with regard to safety aspects are laid down in a multitude of sector or subject-specific laws and regulations, and partly in the form of standards and guidelines. There is therefore no universal handbook that can be applied to all situations, despite the fact that an increasingly large focus has been placed on individual responsibility since the 1990s.

In view of this fragmented method of regulating safety, the Dutch Safety Board applies five general basic safety principles that give an idea of what aspects can play a role (to a greater or lesser

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19 Royal Netherlands Air Force Air Traffic Regulations. 1st edition. Laid down by the Commander of the Royal Netherlands Air Force by order No. 17815 dated 07-07-2007. OC No. 83-6900-104. Pub. No. 062834.

20 Royal Netherlands Air Force Flight Order Book. Laid down by the Commander of the Royal Netherlands Air Force by order No. CLSK 2005 50 29 064. OC No. 83-6100-001. Pub no. 010699. 11th revised edition dated 1 January 2006.

21 Apache Flight Training Book. Laid down by the Commander of the Royal Netherlands Air Force by order No. 15005. Pub. No. 061764. Version 1.3 dated July 2006.

22 Regulations in respect of the training programme for the AH-64D attack helicopter THGKLU. Laid down by the Commander of the Royal Netherlands Air Force by order No. 015211. Pub. No. 061834. 1st edition dated 23 August 2006.

extent) and that are broadly accepted[23].

The five basic principles are as follows:

1. An insight into risks as the basis for a safety policy

   - The starting point for achieving the required level of safety is an investigation into the system, followed by an assessment of the associated risks.
   - This is used as a basis to establish which risks need to be managed and what preventative and repressive measures must be taken in order to achieve this.

2. Demonstrable and realistic safety policy
   In order to prevent and manage undesirable incidents, it is essential to establish a safety policy that is realistic and that can be applied in practice, including the corresponding basic principles. This safety policy must be set out and controlled at management level and based on:

   - relevant legislation and regulations in force
   - available standards, guidelines and 'best practices' within the sector, and
   - the organisation's own insights and experience and safety objectives drawn up specifically for the organisation.

3. Implementation and enforcement of the safety policy
   The implementation and enforcement of the safety policy and the management of the risks identified are carried out by means of:

   - a description of the way in which the safety policy adopted will be implemented, focusing on the concrete objectives, and planning including the resulting preventative and repressive measures
   - a division of responsibilities on the shop floor in respect of the implementation and enforcement of safety plans and measures that is transparent, uniform and accessible to everyone
   - a clear record of the required commitment from personnel and expertise in respect of the various tasks
   - clear and active central coordination of safety activities.

4. Tightening up of the safety policy
   The safety policy must be subject to continuous improvement on the basis of:

   - the prospective implementation of (risk) analyses, observations, inspections and audits on a regular basis and as a minimum in the event of any changes to the basic principles (policy, design, technique, process)
   - a reactive system for monitoring and investigating incidents, near-accidents and accidents, as well as an expert analysis of these.

   On the basis of this, evaluations are carried out and the safety policy is revised by management where necessary. Points for improvement are also identified and actively used as a guide.

5. Guidance provided by management, commitment and communication
   The management of the parties/organisation in question must:

   - *internally* provide clear and realistic expectations with regard to safety objectives, ensure that there is a climate of continuous safety improvement on the shop floor by always setting a good example, and make sufficient people and resources available for this purpose
   - *externally* communicate clearly with regard to the general mode of operation, methods of assessing this, procedures in the event of deviations etc. on the basis of clear and documented agreements with the surrounding environment.

Past experience has shown that the structure and implementation of the safety management system play a vital role in the demonstrable management and continuous improvement of safety. Every organisation must strive to achieve the highest possible level of safety.

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[23] Based on, amongst other things, the ISO 9002, ISO 14011 and OHSAS 18001 standards, but also Section 3 of the Working Conditions Act. See also the letter from the Minister of Justice to the House of Representatives regarding the report on the cell complex fire dated 18 October 2006.

The Dutch Safety Board acknowledges that the assessment of the manner in which organisations meet their own responsibilities in respect of safety depends on the organisation in question. Aspects such as the nature and scale of the organisation can be important in this regard and should therefore be taken into account in the assessment. Although the formation of judgements can vary for each incident, the approach remains the same.

Organisations that potentially face extremely dangerous situations as a result of the nature of their profession can be expected to have a highly developed awareness when it comes to safety. The armed forces are one such organisation. A high priority for safety and the application of state of the art measures to guarantee safety must be standard across the Ministry of Defence. The Dutch Safety Board expects Defence to take a well-considered approach towards the management of risks, so that these risks can be limited as far as reasonably possible under the given circumstances.

4 THE PARTIES INVOLVED AND THEIR RESPONSIBILITIES

4.1 GENERAL

Various parties with various responsibilities were involved in the incident. The overview provided below examines those parties that played a role in the incident, based on the organisation in force at the time that the incident took place. For a more detailed overview of the parties involved in the incident and their responsibilities, please refer to Appendix 4: (Other) parties involved and their responsibilities.

The parties directly involved form part of the Royal Netherlands Air Force Command [CLSK]. In addition, the Military Aviation Authority, as part of the Central Staff, is responsible for the exemption from the prescribed minimum altitude and the designation of a special rules zone, amongst other things.

4.2 THE CENTRAL STAFF

The Central Staff includes the following service units[24]:

- the Office of the Secretary-General
- the Defence Staff
- the Military Aviation Authority.

The Ministry of Defence operates in accordance with an official hierarchical model. The Minister of Defence is (politically) ultimately responsible for the Ministry. All tasks performed by officials come under the political responsibility of the Minister. The Minister's powers are often delegated. For the mutual relationships between the various parties, please refer to appendix 5: Central Staff Organisation Chart.

4.2.1 *The Secretary-General*

The Secretary-General (SG) is officially ultimately responsible for managing all of the units. The SG has been granted the authority to take decisions on behalf of the Minister of Defence (mandate).

4.2.2 *The Chief of Defence*

The Defence Staff is managed by the Chief of Defence [CDS]. The CDS is the Minister's most senior military advisor. He directly manages the (Commanders of the) Operational Commands and has primary responsibility for the execution of military operations. Management of the Operational Commands is carried out by means of the development, transfer, monitoring and evaluation of frameworks and standards, amongst other things.

4.2.3 *The Military Aviation Authority*

The Military Aviation Authority [MLA] is part of the Central Staff of the Ministry of Defence. It guarantees that activities within the Dutch military aviation system are carried out at an acceptable risk level. The MLA has the power to take decisions on behalf of the Minister of Defence and to perform activities for the purpose of implementing the Act on Aviation and the Aviation Act. The MLA is responsible for formulating requirements in respect of military aviation (including by means of imposing military aviation requirements [MLE]) and supervising compliance with these.

4.3 THE ROYAL NETHERLANDS AIR FORCE COMMAND

The Royal Netherlands Air Force Command [CLSK] includes, in so far as relevant, the following organisational units[25]:

- the CLSK Staff, including the Directorate of Operations
- the Gilze-Rijen air base
- the 301 Squadron.

[24] Ministry of Defence General (Organisation) Decree 2005, MP 10-100.
[25] Royal Netherlands Air Force Command Subtask Order 2005. See also the organisation chart in Appendix 5.

4.3.1 *The Commander of the Royal Netherlands Air Force*

The Commander of the Royal Netherlands Air Force [C-LSK] is ultimately responsible for effective training, exercises and preparing of the CLSK units, and therefore also for the use of the scarce resources. The C-LSK also draws up the Annual Training Programme.

4.3.2 *The Director of Operations (CLSK)*

The Director of Operations manages his directorate and his responsibilities include guaranteeing the quality of operational skills and deployability within the Royal Netherlands Air Force Command. He is also responsible for contributing towards the information requirements of the C-LSK[26].

4.3.3 *The Commander of the Gilze-Rijen air base*

The Commander of the Gilze-Rijen air base makes helicopter capacity available on behalf of the C-LSK for the purpose requested by the CDS and for the necessary preparatory activities. The air base commander is responsible for the results of the helicopter capacity (products) to be provided and the way in which this is achieved.
The other responsibilities of the Commander of the Gilze-Rijen air base include the formulation and implementation of policy in respect of the occupational safety, health and welfare of military and civilian personnel employed at the Gilze-Rijen air base.

4.3.4 *The Commander of the 301 Squadron*

The squadron commander is responsible for achieving the objectives set by the air base commander within established preconditions. He is ultimately responsible for the squadron's operational (deployability) posture. For this purpose, the squadron commander has a Squadron Staff Bureau (SSB), a Squadron Operations Division and a Preparation & Maintenance Division at his disposal[27].

The commander of the 301 Squadron is responsible for implementing policy laid down by the C-LSK and further policy based on this, as well as the guidelines set out by the Commander of the Gilze-Rijen air base within his squadron. He provides the head of the Ops division (the Ops Officer) and the head of the Preparation and Maintenance division with guidance in this context.
The Commander of the 301 Squadron is ultimately responsible for the implementation of the Annual Training Programme (JOP) in the case of the pilots in the 301 Squadron.

4.3.5 *The Head of the Operations Division of the 301 Squadron (Ops Officer)*

The Ops Officer of the 301 Squadron manages the Ops Division, which consists of five flights, each with a flight commander, the navigation section and the intelligence section. He is responsible for the long-term schedule (three months and thereafter), drawing up the annual programme and dividing the corresponding tasks assigned to the squadron.

4.3.6 *The flight commander*

The responsibilities of the flight commander include[28]:

- producing individuals and crews that are ready for deployment
- issuing operational and administrative instructions to the relevant flight
- mission debriefing at flight level and below
- monitoring the currencies and JOP obligations of the pilots
- reporting to the Ops Officer with regard to the currencies and operational deployability of the pilots
- advising the Ops Officer in drawing up assessments
- conducting performance interviews with the personnel from the relevant flight
- authorising flight orders
- supervising the daily flight operations and ensuring that the daily flight schedule is kept up to date.

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[26] Royal Netherlands Air Force Command Subtask Order 2005.
[27] Job evaluation of the Commander of the 301 Squadron.
[28] Job evaluation of Flight Commanders with the 301 Squadron.

4.3.7 *The Duty Ops Officer*

The position of Duty Ops Officer is an ancillary position for designated experienced pilots within the squadron. The (daily) Duty Ops Officer (dd Ops) on duty has the delegated power to authorise flights during the actual performance of this role and as authoriser is therefore responsible for[29]:

- supervising proper and comprehensive flight preparations and execution of the flight in accordance with the flight order issued
- ensuring that the flight order is in keeping with the regulations.

[29] Royal Netherlands Air Force Flight Order Book. Laid down by the Commander of the Royal Netherlands Air Force by order No. CLSK 2005 50 29 064. OC No. 83-6100-001. Pub No. 010699. 11th revised edition dated 1 January 2006.

5 ANALYSIS

5.1 Introduction

Chapter two presents the facts that played a role in the incident. These clearly show that the failure by the crew of the Apache helicopter to detect the high-voltage cables and the pylons can be regarded as a direct cause. This chapter analyses the incident in further detail.

The analysis is primarily based on the Human Factor Analysis and Classification System (HFACS). HFACS is a classification and analysis system whereby the human factor is placed in relation to the incident. The TRIPOD method was also used in order to carry out the analysis. This method has been developed for the purpose of tracing the direct causes of an incident back to shortcomings within organisations that are responsible for ensuring the safe operation of the relevant (sub) system. Appendix 7 describes the HFACS in greater detail, while appendix 8 provides information on the TRIPOD method.

In the analysis, a distinction is made between factors relating to the preparations for and execution of the flight (section 5.2) and the underlying factors (section 5.3).

Factors relating to the preparations for and execution of the flight that played a role, or may have played a role, in the incident are:

- the technical state of the helicopter
- the weather conditions
- the qualifications of the pilots
- preparations for the mission
- the commencement of the descent
- the descent and the start of the low-level flight
- crew resource management
- the visibility of the high-voltage cables and pylons
- the boundaries of the Maas/Waal low-level flight zone
- the flight from the power line collision to the precautionary landing.

Underlying factors that played a role or may have played a role in the incident are:

- training capacity and the level of training
- supervision
- reorganisations
- quality control
- operational management in relation to flight safety
- parallels with previous incidents involving helicopters.

5.2 Factors relating to the preparations for and execution of the flight

5.2.1 *The technical state of the helicopter*

An inspection of the information on maintenance carried out on the Apache helicopter did not bring to light any issues that could cast doubt on the airworthiness of this helicopter. The maintenance status of the helicopter can be described as normal, and no issues had been identified that were not permissible. At the time of the incident on 12 December 2007 no signs or incidents, caused by a technical failure, had been detected that could have contributed towards the collision with the high-voltage power line. For detailed information see appendix 9: Airworthiness report.

Sub-conclusion 1: No faults had been detected in the Apache helicopter and the helicopter was in a good technical state at the time of the incident.

5.2.2 *Weather conditions*

On 12 December 2007 at 16:15, the crew received the order to carry out a training mission that evening within the context of the Annual Training Programme (JOP).

Apache helicopters are only permitted to operate under visual conditions (Visual Flight Rules, VFR). This means that they cannot fly in cloud and there are certain limits with regard to visibility. In order to ensure safety during night-time flights, Apache helicopters are equipped with various sensor systems (see section 2.3.2), which mean that visual flight is also possible at night time. The proper functioning of these sensor systems depends on certain meteorological conditions, such as atmospheric humidity and fluctuations in temperature.

It has been established that the weather conditions did not form an obstacle to the execution of the flight. Once underway, visibility and cloud height proved to be even better than anticipated (6–8 km visibility with clouds at 4400 feet). It was dark by around 18:00 hours and the crew was able to make good use of the sensor systems.

Sub-conclusion 2: The weather conditions did not form an obstacle to the safe execution of the flight.

5.2.3 *Qualifications of the pilots*
With a total of 1800 flight hours, 1100 hours of which had been spent in the Apache helicopter, the front seater and aircraft commander can be classed as an experienced pilot. He had also acquired a considerable amount of operational experience during eight periods of deployment in crisis zones, including four in Afghanistan. In the three months prior to the incident, the front seater had flown 12.3 hours in the Apache helicopter, 6.1 hours of which had been during the last month. This is far below the average[30] , however it can be explained by the fact that the front seater was going through a stand down[31] period. Despite this low number of flight hours, the front seater met all of the applicable skills requirements (see appendix 11: Relevant facts and data).

With around 500 flight hours, 240 hours of which had been spent in the Apache helicopter, the back seater can be classed as a pilot with limited experience. He was fully qualified to fly the Apache helicopter (as a back seater), however at the time of the incident he had not yet received sufficient training in order to be able to carry out all operational tasks during a mission. He was still in the Mission Qualification Training (MQT) phase, and still had a number of components to complete before he could achieve Combat Ready (CR) status (mid-2008) and be organically assigned to the 301 Squadron. In the three months prior to the incident, the back seater had flown 23.8 hours in the Apache helicopter, 9.3 hours of which had been during the last month (see appendix 11: Relevant facts and data).

The investigation revealed that the crew met all of the requirements and could be regarded as being capable of carrying out the mission properly. They had flown together previously. Both pilots stated that they felt fit and well rested at the start of the flight and neither of the men were subject to any medical restrictions.

Sub-conclusion 3: The crew met all of the requirements and could be regarded as being capable of carrying out the mission properly.

5.2.4 *Preparations for the mission*
One of the activities that involves the highest level of risk when it comes to flying during times of peace is flying at a (very) low level. On top of the normal risks associated with flying, flying at a (very) low level involves an additional hazardous dimension: the risk of colliding with obstacles that rise higher than the altitude of the aircraft and that are sometimes barely visible or only become visible at a very late stage (or too late), such as high-voltage cables. If this type of low-level flight takes place in the dark the risk is even greater, even when using a helicopter that is equipped with all sorts of sensors, due to the limitations of these sensors (see section 2.3.2). This high level of risk involved in low-level flight must be counteracted by means of a flight risk assessment, followed by extremely thorough and meticulous flight preparations and execution.

The crew received the order to carry out the training flight in question at 16:15 hours. The take-off time was set at 18:00 hours local time, which meant that the crew had one and three quarter hours in which to plan the mission. For this training flight, a period of one and three quarter hours is considered sufficient in order to carry out effective preparations for the mission. This means, however, that the best possible use must be made of the time available.

[30] On average, each pilot flew 153 hours in the Apache during 2007 (including the hours flown in Afghanistan).
[31] This term refers to the period following deployment.

The investigation revealed that the crew arranged for the navigation section to mark[32] the obstacles etc. on the navigation charts. In the meantime, the crew went to have a meal in the staff restaurant. The fact that the pilots arranged for the navigation section to mark the obstacles on the charts in itself is not necessarily a drawback and is standard procedure, however preparing a route on the charts helps a pilot to identify risks and therefore forms part of the necessary preparations. This can be overcome by carefully studying charts that have already been plotted. Examining the route on the chart in advance ensures that the pilots are aware of any prominent landmarks and potential obstacles, and a so-called point of ascent and point of descent can be determined for each obstacle[33]. The low-level flight section of a flight must also be discussed in the necessary depth (briefed). It emerged that despite the fact that the pilots did not prepare the charts themselves, a limited amount of time was spent studying the charts and examining the route in advance of the flight. Proper examination of the charts and investigation of the route would have increased the chance of identifying the high-voltage cables, which, after all, intersected the route to be followed, as a safety risk so that appropriate measures could have been taken in order to prevent the collision with the wires. The high-voltage cables and pylons were not detected, however. This is evidence that the flight was not discussed in sufficient detail and, as this was not picked up on by those in charge, that no substantive supervision took place.

The flight preparations were rounded off with a crew briefing[34]. Inquiries have revealed that the crew briefing lasted three minutes. In view of the fact that flying at a (very) low level in the dark is one of the most high-risk activities during times of peace, the Dutch Safety Board can only describe such a short briefing in combination with the manner in which the preparatory tasks were implemented as inadequate. In conclusion, it can be stated that the crew did not meet their responsibilities in relation to preparations for the flight to an adequate extent.

The manner in which the preparation time was spent means that there was no longer sufficient time available to fully and properly prepare for the flight. The Apache crews are accustomed to very short preparation times as a result of the operations in Afghanistan (see section 2.3.1). It goes without saying that even if there is only a limited amount of time (left) available in which to prepare for a flight, whether this preparation is delegated or otherwise, a proper risk assessment must still be carried out in order to guarantee safety. Certainly in the case of training flights during times of peace, it is the individual responsibility of each pilot to make it known if the conditions for the successful execution of a flight are, in reality, inadequate or insufficient. In the case of an aircraft commander, it is his/her individual responsibility to attach consequences to this. After all, the commander is ultimately responsible for deciding whether or not to take off in an aircraft. It is to be expected that responsibilities in respect of risk assessment will be duly met. However, this did not take place to a sufficient extent in this case.

The Dutch Safety Board concludes that the preparations were insufficient and were not carried out with an adequate level of precision, and that the pilots did not prepare properly for the flight. The flight was approached as a simple mission, which meant there was a low task load, in turn resulting in a certain degree of complacency[35]. This can be accounted for in the case of the front seater in view of the nature of this flight in comparison with the operational missions in Afghanistan and also in the case of the back seater who, due to the presence of an experienced aircraft commander, had the impression that everything was fully under control.

Sub-conclusion 4:
The preparations for the flight were inadequate. Failure to acknowledge the full extent of the risks associated with low-level flight significantly contributed towards the occurrence of the incident.

It emerged that within the Apache squadron, it was no longer a custom to determine points of ascent and points of descent when avoiding obstacles. In the past this was standard practice. With regard to the use of points of ascent and points of descent, a different technique was launched for avoiding obstacles when the Apache helicopter was introduced. As part of this technique, obstacles

[32] In this report, the term 'mark' is understood to refer to the highlighting of all of the obstacles (such as high-voltage cables) indicated on the flight chart and the marking on and highlighting of obstacles that do not (yet) appear on the chart (such as recently constructed high-rise buildings or temporary high objects such as tower cranes).

[33] A prominent point in the vicinity of an obstacle where the aircraft must climb to a safe altitude and where it can descend again to the low-level flight altitude respectively if the obstacle is not visible at that time.

[34] Apache Flight Training Book, Appendix B. See appendix 2.

[35] Complacency is a well-known term within the context of aviation and a general human trait. The term is used to refer to the mental scenario in which a person subconsciously underestimates the degree of complexity and the potential risks and dangers.

such as high-voltage pylons were specifically included as navigation points in the navigation plan, entered in the helicopter's navigation system and shown on the Head Display Unit (HDU) and the Tactical Situation Display (TSD). This means that the attention of the crew is drawn to the obstacle by the navigation and optics systems during the execution of the flight, and to the fact that action must be taken. In principle, therefore, the crew can choose between two techniques. However the navigation system has limited memory space, which means it is necessary to make decisions about what is entered in the system. As obstacles also appear on the flight charts and are 'highlighted', they are not (or no longer) entered. On inspection of the flight data for the Apache helicopter it emerged that the high-voltage power lines and pylons had not been flagged in the navigation system. The investigation also revealed that many Apache pilots (including the pilots involved in the incident) are no longer familiar with the 'old' technique of determining points of ascent and points of descent and that this technique is also no longer taught to pilots.

The comments made demonstrate that those involved are aware that the procedures for entering obstacles into the navigation system are not always followed (to an adequate extent). Partly as a result of this incident, the decision has been taken to reintroduce the 'old technique' of consistently using of points of ascent and points of descent.

Sub-conclusion 5:
The fact that the pilots are not (or no longer) familiar with and no longer apply points of ascent and points of descent to compensate for failure to enter obstacles into the navigation system means that there is an increased risk of collisions.

5.2.5 *The commencement of the descent to the low-level flight altitude*

At a basic level, the division of tasks and responsibilities between the front seater and the back seater is simple. The front seater is the aircraft commander and is responsible for determining where and how (high, low, etc.) the aircraft should fly, for navigation and for operating the weapons systems. The back seater merely flies the aircraft on the basis of the instructions issued by the front seater. This means that on commencing and during low-level flight, the front seater must inform the back seater of any obstacles to be anticipated so that both he and the back seater can identify these obstacles in good time, and the back seater can avoid them.

Exercises at higher altitudes are carried out using a 1:250,000 chart[36], whilst low-level flight is carried out using a 1:50,000 chart. The high-voltage power lines and pylons are clearly indicated on the 1:50,000 chart marked up by the navigation section[37]. The 1:50,000 chart was not examined during the flight preparations and the front seater did not yet have this chart in front of him at the time that the descent was commenced. When the front seater instructed the back seater to descend in the direction of the Waal to a low altitude at which the back seater still felt comfortable (so-called 'comfort level'), he had therefore not yet made certain that the flight path up to and including the first part of the low-level flight was safe.

It is self-evident that aspects that must be checked prior to and during a descent, such as a safe flight path, form part of good airmanship. It was not possible for the Dutch Safety Board to establish the reasons behind this poor airmanship. The front seater subsequently also expressed the opinion that he should have had the right chart in front of him so that he could have alerted the back seater to the high-voltage pylons and cables. He was not able to explain why he had failed to switch the charts in good time. One possible explanation is failure to still appreciate the full extent of the risks associated with low-level flight in relation to the missions carried out during deployment.

The crew was aware of the position of the helicopter and knew exactly where they were flying. Neither the back seater, who resides near to the location of the incident, nor the front seater, who has flown in this area many times in the past, realised that they were flying in the vicinity of the high-voltage power lines and high-voltage pylons. It was also unclear to the crew after the incident that a collision with high-voltage power lines had occurred. Failure to acknowledge the risks or the full extent of the risks associated with low-level flight in this zone meant that this latent knowledge was not activated.

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[36] Although the high-voltage power lines do appear on these charts, they are less detailed and clear. These charts are not suitable and are in principle not used for low-level flight and the identification of obstacles.

[37] Although the charts that were being used by the front seater were for the most part lost during the collision, it is possible to establish on the basis of other charts that the high-voltage power lines and pylons were indicated on the chart. It was not possible to determine whether the navigation section had highlighted the pylons and power lines.

Sub-conclusion 6:
At the time that the front seater issued the instruction from a safe altitude to commence the descent, safety with regard to the last part of the descent and the start of the low-level flight had not been guaranteed to a sufficient extent.

5.2.6 *During the descent and the start of the low-level flight*
As stated in chapter two, the most important sensor for the back seater is the monocular representation of the camera positioned on the nose of the Apache helicopter (Pilot Night Vision System: see section 2.3.2). A characteristic feature of this sensor is the limited field of vision and the lack of a periphery. In order to ensure adequate vision during the flight, the pilot must actually move his head: so-called scanning.
The act of scanning can be broken down into two parts: the head movement and the frequency of movement. The head movement determines the pilot's scan width (field of vision) and the frequency the amount of times that he looks in a specific direction.
Failure to carry out one or both of these parts or to do this to a sufficient extent reduces the chance of detecting hazards.

If the back seater had been informed or had been aware that there were high-voltage pylons and cables in the immediate vicinity of the helicopter, he would usually have displayed an active and wide scan pattern.

On analysing the data from the records present, it appeared that the back seater's scan pattern during the descent was limited (see also appendix 14: Analysis of the scan behaviour of the back seater). The analysis of the scan behaviour of the back seater shows that few head movements were made 30 seconds (a distance of around 1800 metres in view of the flying speed) before the collision and that the scanning frequency was extremely erratic.

The back seater explained that his attention had been drawn by a ship that was travelling in the line of the descent and the low-level flight route in the opposite direction on the Waal. The fact that the high-voltage pylons are positioned far apart means that these pylons disappeared from the back seater's field of vision relatively quickly, and the chance of detecting these pylons therefore decreased the closer the helicopter came to the high-voltage cables[38].

The Dutch Safety Board carried out investigations into whether this method of scanning is standard practice or an exception. In order to determine this, the scanning behaviour of other pilots was analysed on the basis of a number of tapes. Out of the twenty tapes that were available, there were three involving circumstances that were somewhat similar to those at the time of the incident (low-level flight, time/darkness, speed and altitude). This small number did not provide sufficient information in order to draw proper conclusions. The data from these night-time low-level flight missions did reveal, however, that the scan pattern of the pilots involved was wider (and even significantly wider according to the data from after the incident) than that of the back seater at the time of the incident. However, the scan behaviour of the back seater in a comparable situation, around 25 minutes before the power line collision, was indeed similar to the scanning behaviour of the pilots in the cases examined. To illustrate this and for the purpose of comparison, appendix 14 (Analysis of the scan behaviour of the back seater) features a diagram showing the scan behaviour over a period of two minutes (25 minutes before the power line collision).

Sub-conclusion 7:
During the descent and the start of the low-level flight the back seater displayed limited scan behaviour, which reduced the chance of detecting the high-voltage pylons.

5.2.7 *Crew Resource Management (CRM)*
The investigation revealed that the method of collaboration between the crew members may have been a potential factor in the occurrence of the incident.

As stated in section 5.2.3, the front seater had a great deal of experience with many periods of deployment, whilst the back seater had not yet achieved Combat Ready status. Analysis of the

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38 High-voltage cables are not visible from aircraft, at least not until it is too late, either with the naked eye or using the Pilot Night Vision System. In principle, the pilots always look/watch out for pylons in order to avoid cables.

tape[39] has revealed that this disparity had an effect on the teamwork between the two crew members, namely that the front seater was acting as an instructor and a coach to a certain degree. This was also encouraged by the fact that the front seater had intentionally omitted certain elements in the communication regarding the mission, without informing the back seater, in order to create an element of surprise for the latter. The aim of this was to increase the learning effect for the back seater. The flight was a training mission for the crew, however, and not a training flight for the back seater.

The danger of this coaching is that it does not take the original teamwork discipline of the Apache crew concept, which is based on equality, into consideration. The front seater spent more time on the transfer of knowledge and the issuing of instructions, whilst the back seater focused his attention on absorbing the information he was receiving. This means that the back seater subconsciously fell more into the expectation pattern of someone who is being coached than that of a crew member of equal standing. As this relationship was not recognised during the flight, both of the crew members assumed that the other was carrying out his tasks in accordance with the standard teamwork procedures.

The tandem design of the two cockpits means that the crew members are not able to see one another. When flying under Visual Flight Rules, it is important that both pilots know whether the other pilot's attention is focused inside or outside of the cockpit. If circumstances are such that one of the pilots must focus his attention inside the cockpit for an extended period of time rather than outside of the aircraft, he must declare this by using the words: *"I am inside"*[40]. The other pilot must confirm receipt of this message. The issuing of warnings is important in order to ensure that both crew members are on the same level in terms of awareness of potential hazards or restrictions with regard to the normal execution of a flight. The importance of knowing what the other pilot is doing is demonstrated by the incident that took place in 2004 involving an Apache helicopter in Afghanistan, which crashed because both pilots thought that the other was flying as the procedure for transferring control to the other pilot was incorrect (or carried out incorrectly).

During the descent and the start of the low-level flight the front seater was occupied inside the cockpit with, amongst other things, changing over the flight charts and finding his bearings on the 1:50,000 chart. He did not report this to the back seater, even when he was occupied within the cockpit for longer than necessary in order to switch the charts. The back seater was therefore unaware of these activities and thought that the front seater was busy identifying hazards in the flight path and carrying out observations. If the back seater had been aware of this, it is highly likely that he would have paid more attention to avoiding obstacles.

The investigation revealed that the importance of good teamwork between crew members is recognised within the Royal Netherlands Air Force Command. Crew Resource Management has played a demonstrable role in recent incidents involving helicopters. Crew Resource Management training courses are currently and will in the future be organised for the different types of aircraft, in order to eradicate aspects that have a negative effect on effective teamwork, such as seniority or a difference in rank.

Sub-conclusion 8: The coaching approach adopted by the front seater and inadequate communication between the crew members meant that tasks set out in the teamwork concept for an Apache crew were subconsciously neglected or not carried out to a sufficient extent. This contributed towards the occurrence of the incident.

5.2.8 *High-voltage pylons*

The high-voltage pylons on the left and right river banks were not illuminated. The International Civil Aviation Organisation (ICAO) has prescribed a guideline for the marking of high obstacles, which specifies that obstacles higher than 150 metres must be illuminated. However, both of the pylons were between 100 and 150 metres tall, and were consequently not required to comply with this guideline.

The Transport and Water Management Inspectorate [IVW] is seeking to introduce legislation in relation to the illumination of obstacles that specifies that all obstacles with a height of more than 100 metres and that are situated in the vicinity of a river or along a motorway must be illuminated.

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39 Recording from the Target Acquisition Data System with communication between the pilots and external communication.

40 Apache Flight Training Book. See appendix 2: Regulations for the assessment framework.

In accordance with this proposed legislation, the high-voltage pylons at Rossum would therefore need to be illuminated.

Illumination increases the chance of detection with the naked eye, thus reducing the risk of collisions. The chance of detection is limited, however, as pilots largely concentrate on the information obtained via the sensors (PNVS/TADS). In addition, the chance of detecting the pylons depends on the course and altitude of the helicopter in relation to the pylons.
Even if the pylons were illuminated, there would be no change in the visibility of the high-voltage power lines, and pilots would need to consciously realise that there is a high-voltage power line in between the two lights positioned far apart.

Sub-conclusion 9:
The high-voltage pylons on the left and right river banks were not illuminated. The chance that the pilots would have noticed the pylons if they had been illuminated is thought to be limited.

5.2.9 *Additional questions*
Two additional questions arose after the incident and during the investigation. Did the descent actually take place in the Maas/Waal low-level flight zone? And did the crew continue to fly for too long after the power line collision?

The boundaries of the Maas/Waal low-level flight zone
The investigation revealed that some debate had arisen with regard to the boundaries of the Maas/Waal low-level flight zone. This debate focused on the question as to whether the river Waal forms part of the low-level flight zone. On the pilots' charts, the boundary of the Maas/Waal low-level flight zone was situated above the centre of the Waal. This means that the power line collision would have taken place within the low-level flight zone. Investigations have revealed that the accepted view within the 301 (Apache) Squadron was that the Waal formed part of the low-level flight zone. The Dutch Safety Board concludes that the crew's decision to descend above the Waal was consciously made as being a descent inside the low-level flight zone. It should also be noted that this decision was also prompted by the desire to limit excessive noise levels for the residents of the low-level flight zone as far as possible.

The flight from the power line collision up to the precautionary landing
After the power line collision, the Apache helicopter continued to fly for around 6 minutes before the precautionary landing. The crew were confused for a while as they did not know exactly what had happened. In addition, the front seater had to get rid of all the shards of glass that had landed on top of him. As a reflex, the back seater had ascended to around 1000 feet (the collision took place at 122 feet, or 37 metres) immediately after the collision and the front seater had instructed him to fly a course in the direction of the Gilze-Rijen air base.

Apart from the broken window and the failure of the Pilot Night Vision System, the crew had no indication that there was anything wrong with the engine power and/or the controls. Returning to the Gilze-Rijen air base was therefore seen as a good option in the first instance. There was, however, a clearly audible recurrent deep/low noise (at a frequency of around 5 Hertz) that could have indicated damage to the main rotor blade.[41] The crew subsequently took the correct decision to carry out a precautionary landing.

5.3 UNDERLYING FACTORS

5.3.1 *Training capacity and level of training received*
Investigations have revealed that training capacity is under pressure. Activities within the context of peace operations, for instance the operation in Afghanistan, are given highest priority. The tasks required for the mission are therefore subject to more intensive training. Examples of this are the so-called mission qualification training programmes (MQTs).

The number of hours flown by a pilot in principle each year if he is not deployed is set down in the so-called Annual Training Programme. As already stated in section 2.2.2, the Annual Training Programme was reduced from 180 hours to 140 hours in 2001. An advanced simulator was to be purchased in order to compensate for this reduction of hours. This did not happen, however. The reduction in the number of flight hours available has had a direct negative effect on the available

[41] See appendix 10: Damage to the helicopter, item 3.1 the main rotor blades and also appendix 11: Relevant facts and data, item 4.2.4. Audio data.

training capacity. This was recognised at staff level within the Royal Netherlands Air Force Command. In consultation with those in charge at the Gilze-Rijen air base, a considered decision was taken to cut back on or omit exercises involving a number of tasks that bore no relation to the current missions.

The statistics for the 301 Squadron show that pilots flew an average of 153 hours in the Apache helicopter in the last year. A large proportion of these hours were flown in Afghanistan, however, where the same types of missions are flown relatively often.
A percentage of these hours can be identified as training hours as defined in the Annual Training Programme, however as a result of the one-sidedness of the missions a further percentage cannot be classified as training hours. This means that the deployment in Afghanistan led to a loss of training capacity (also for night flying and low-level flight).

The limited number of training hours available and the mission-focused implementation of these hours with respect to the current operation in Afghanistan has placed the practising of basic skills by the Apache pilots under pressure. It has been recognised that many aircraft commanders (front seaters) are flying despite the fact that they have not received adequate training to ensure that they are sufficiently proficient in various techniques and tactics, such as low-level flight, air assault, etc. This also applies to the front seater involved in the incident.
As stated in section 5.2.3, he did in fact have all of the qualifications required in order to fly, however he had only flown 12.3 hours during the last three months (this is an average of 1 hour per week), 5.1 hours of which took place at night. Before this he had spent four months in Afghanistan, where flying mainly takes place at a high altitude, out of the reach of small arms. His recent experience of low-level flight during night-time was therefore limited.

Sub-conclusion 10:
The reduction in the number of Annual Training Programme hours available, the mission-focused training and the deployment within the context of peace operations has placed training and training capacity for flight skills that are not related to this deployment under pressure.

5.3.2 *Supervision*
In addition to the execution of the training flight and guaranteeing competencies (see appendix 12), explicitly also including the formation and monitoring of attitudes, the supervision structure is responsible for ensuring that preconditions are met (such as those relating to people, resources, structure, location, opportunity and administrative framework) and monitoring the quality of operational management. This also includes running through the ORM (Operational Risk Management) cycle as part of the planning procedure and formulating the required contingency plans in preparation for all eventualities.

With regard to supervision within the line, it is possible to distinguish between the following categories:

- *Supervision of the training flight*.
  This is carried out entirely within the squadron and mainly by the flight commander and the Duty Officer.
- *Supervision of competencies (knowledge, skills and attitude)*.
  Responsibility for supervision in relation to competencies chiefly rests with the flight commander, the Ops Officer (together with the Current Ops Officer) and the squadron commander.
- *Supervision of fulfilment of preconditions (people, resources, structure, location, administrative framework and quality of operational management)*.
  This must take place within the line Ops Officer, squadron commander, air base commander and by the Royal Netherlands Air Force Command Director of Operations on behalf of the Commander of the Royal Netherlands Air Force.

Supervision of the training flight
The flight commander is charged with supervising the pilots placed under him. He is also responsible for implementing the Annual Training Programme and enforcing professional competence (currency) amongst his pilots. The flight commander is therefore also the one who determines which training missions within the Annual Training Programme must be flown and what aspects/techniques need to be practised. In doing this, he consults with the squadron's Head of Operations with regard to flight planning.

A number of the supervisory activities in respect of daily flight preparations and the execution of a (training) mission in accordance with the flight plan are delegated to the Duty Officer. He is responsible for "*supervising proper and comprehensive flight preparations and execution of the* *flight in accordance with the flight order issued*" (see 4.3.7) and he authorises the flight. An important moment where the Duty Officer must fulfil his obligations with regard to supervision is when the flight is booked out and the crew make their way to the helicopter.

The shortcomings with regard to the preparations did not come to light on the so-called booking out of the training flight. Investigations have revealed, however, that the supervision carried out by the Duty Officer consists of checking in an automated system (currently: the Royal Netherlands Air Force Operational Management Information System [OMISKLu]) whether the pilots still meet the specific requirements in terms of skills (currency). He checks whether the flight preparations have been carried out in full and that the pilots have been provided with the latest (flight) information. The Duty Officer does not carry out a substantive check of the (quality of the) flight preparations (including the crew briefing held) or a substantive review of the execution of the flight after the flight.
He also does not do this by means of random checks. The Dutch Safety Board is of the opinion that the Duty Officer is therefore structurally failing to duly comply with his responsibility to "*supervise proper and comprehensive flight preparations and execution of the flight in accordance with the flight order issued*", as set out in the Royal Netherlands Air Force Flight Order Book.[42]

The flight commander must examine whether flights carried out within the context of the Annual Training Programme have been executed correctly. He can do this by holding post-flight discussions with the crew and by listening and viewing the flight data (audio and visual). If certain skills are not being practised or are not being practised to a sufficient extent (for example stealth flight, terrain flight, low-level flight, chart reading, general preparations etc.), these themes must be addressed during later flights. It did not appear to the Dutch Safety Board that this is demonstrably taking place on a regular basis in relation to general aspects of flight skills.

Supervision of competencies
'Competencies' is a catch-all term. The essence of competencies consists of the required knowledge, the necessary skills and attitude (see appendix 12). The supervision structure must ensure that competencies are guaranteed. These are closely related to the manner in which the Annual Training Programme is implemented. The flight commander must obtain and maintain an insight into how the pilots within his flight are executing their training flights. Consultation and coordination with fellow flight commanders, the Squadron Commander and the Head of Operations is essential to ensure that the supervision structure operates effectively.

The system for guaranteeing competencies incorporates various assessment points for the players within the supervision structure.

Emergency procedures and the standardisation of procedures are mainly carried out and kept up to date in the Longbow Crew Trainer. Each pilot also takes part in a standardisation training flight [STV] with an instructor every year. This flight is also used to practise emergency procedures, and to standardise procedures. Furthermore, each pilot must sit an Annual Flight Test [JVT] in which his technical flight skills are assessed and fire missions are carried out.

At flight level, a so-called 'challenge week' takes place every year in order to assess the (tactical) deployability of a flight. The evaluation is carried out by an officer who does not belong to the squadron. Another point at which deployability can be measured is during the three-week training period in Fort Hood (USA). Here too, pilots are assessed at flight level in a tactical scenario.

It has become clear that it is difficult for the squadron commander of the 301 Squadron to provide a framework for the task of supervision. The squadron's obligations and the training cycle followed mean that two of the five flight commanders are absent on a regular basis, while one of the flight commanders is recuperating following a period of deployment and is occupied with arranging outstanding administrative and private matters. Consequently only two of the five flight commanders are present within the squadron on a daily basis. As a result, management tasks are delegated to pilots who may be experienced, but who are not properly prepared for such activities, to the detriment of the task of supervision. This situation means that the desired standard of supervision and quality, and therefore the desired standard of safety, is not guaranteed.

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[42] The comments made reveal that during the reorganisation to create the DHC, the 301 Squadron was extended to include extra personnel in the operations section and there was a change in the internal structure of the squadron. It has been stated that as a result of this, the task of supervision within the squadron can be translated into more concrete terms.

It has been established that training focuses on those aspects that are important to ensure safe operations in Afghanistan. Less attention is therefore paid to low-level flight, as this is rarely carried out in Afghanistan due to the threat from ground weapons (small arms and infrared rocket systems). This means that less attention is in turn paid to the safety risks associated with low-level flight in the Dutch flight zone, such as high-voltage cables. The flight hours accrued during actual deployment in the mission zone (Afghanistan), where applicable, partly count towards the obligatory number of flight hours in accordance with the Annual Training Programme (see appendix 3, item 3.4.1). However, the structure of these (relatively large numbers of) hours only cover a relatively small part of the total obligations under the Annual Training Programme.
A programme specifically aimed at pilots for the purpose of practising certain basic skills that were rarely or not required during the (preparations for the) mission upon return from a deployment mission and bringing these skills back up to the required standard, is not standard practice. The flight commander should recognise this and incorporate such exercises when implementing the Annual Training Programme.

Supervision of the fulfilment of preconditions
A third element within the supervision structure is responsibility for fulfilling the preconditions (people, resources, structure, location, administrative framework and the quality of operational management). In addition to the squadron commander, the commander of the air base and the Commander of the Royal Netherlands Air Force (C-LSK) and his staff also play a major role in this context. After all, they establish the frameworks at their respective levels and set priorities with regard to the allocation of the (scarce) resources. Supervision is closely linked to flight safety, and it is precisely at the level of the air base and the CLSK that this aspect is organically incorporated into the organisation (flight safety officer, Flight Safety, Quality Assurance, Occupational Safety and Environmental Affairs [VKAM] Staff Group).

In the monthly and quarterly reports issued by the Commander of the 301 Squadron to the Commander of the Gilze-Rijen Air Base and subsequently by the air base commander to the Commander of the Royal Netherlands Air Force, account is rendered for the change and task performance targets imposed for that year in the form of a dashboard display[43] . If the indicators of the dashboard instruments appear in green, this shows that no extra attention is required. The performance target to comply with the implementation of the Annual Training Programme is only met in a quantitative sense (hours). The Air Force Commander is not able to exercise supervision in relation to flight safety on the basis of data presented in this way. The dashboard report focuses more on operational deployability than on the level of (individual) operational training received.

As the Royal Netherlands Air Force Command Subtask Order 2005 states that there is a direct link here with the formulation or refining and monitoring of operational quality standards, this is examined in further detail in the section entitled 'quality control'.

Reorganisations
In the past five years, there have been two reorganisations that have affected operations carried out using the Apache helicopter. 2004 saw the merger of the two Apache squadrons (301 and 302 squadron) to become the 301 Squadron. In 2006, a reorganisation across the entire Ministry of Defence was launched whereby the decisions taken included that to introduce a new Ministry of Defence Helicopter Command (DHC), which would also include the Apache squadron. This second reorganisation had not yet been completed at the time of the incident[44].

Both reorganisations have had an effect on the functioning of the Apache squadron. The merger of two squadrons led to the loss of mainly executive positions, resulting in an increase in the workload in relation to supervision. The process for the setting up of the Ministry of Defence Helicopter Command also reduced the capacity available to executive staff for the performance of their normal duties.

Furthermore, the Flight Safety, Quality Assurance, Occupational Safety and Environmental Affairs audit carried out at the Gilze-Rijen Air Base in March 2007 stated that the various reorganisations had implications in terms of workload, the overview of activities and clarity in the division of tasks. Although the audit report does not specifically examine quality control in respect of the flight process, it clearly states that the various reorganisations and the delay in the merger with the

[43] A brief overview (with colour codes) of the deployability status and the targets imposed.
[44] The DHC has been functioning since 4 July 2008.

Soesterberg air base mean that the implications (including the workload) are not being regularly assessed for risks (absence of proper risk assessments)[45].

Sub-conclusion 11: Supervisory activities are being neglected at squadron level. As supervision is biased towards competencies required for the International Security Assistance Force missions in Afghanistan, sufficient attention is not being paid to the level of training in other areas, such as low-level flight. There is no targeted programme for the purpose of bringing all competencies back up to the required standard.

5.3.3 *Quality control*

Supervision and the safeguarding of supervision have a direct link to quality. Within the context of both supervision and quality control, every pilot takes part in a Standardisation Training Flight (STV) with an instructor each year. This flight is used to practise emergency procedures, and to standardise procedures. Pilots are also subject to an annual flight test, which assesses the pilot's technical flight skills.

As stated above, a so-called ‘challenge week’ takes place at flight level every year in order to assess the (tactical) deployability of a flight. This week, which takes place at the Gilze-Rijen Air Base, is used to assess whether a flight can be deployed for the mission in Afghanistan. Deployability is also assessed during the training period in Fort Hood (USA). Here too, pilots are assessed (again as a flight) in a tactical scenario. Examination of the evaluations, both of the pilots involved and the flights, did not reveal any points related to the occurrence of the incident. These types of evaluations are not carried out at squadron and air base level.

Quality control and assurance of safety by the higher levels within organisations must take place in accordance with the five general basic safety principles set out in Chapter 3.4 (Assessment framework for safety management) and that come together in a safety management system.

In a letter dated 4 August 2006 the Minister of Defence stated, in response to recommendations made by the Ministry of Defence Temporary Committee for the Investigation of Incidents, that the Ministry would implement a “Defence Safety Management System” (VMS DEF). Some time after this, it was stated during a presentation that the documentation in this regard had been certified and that implementation was set to commence.

In addition, the Military Aviation Authority is charged with quality control and assurance in relation to military aviation. The Royal Netherlands Air Force Command has a Flight Safety, Quality Assurance, Occupational Safety and Environmental Affairs Management System (VKAM management system), which incorporates safety in line with the basic principles referred to above.

Audits, as part of the safety management system, play an essential role in providing the management of an organisation with an insight into safety. The investigation into quality control therefore focused on auditing by the central level of the Ministry of Defence and within the Royal Netherlands Air Force Command. Audits in respect of flight safety must examine both the process (is flight safety properly organised?) and the product (does flight safety actually exist?). Investigations have revealed that at the time of the incident, proper audits in respect of (flight) safety that examined the abovementioned aspects were not being carried out, whilst no audits have as yet been conducted within the Ministry of Defence Safety Management System.

The Military Aviation Authority has granted priority to the introduction of military aviation requirements [MLE] in the field of aircraft maintenance in a broad sense. The Military Aviation Authority has not yet conducted any audits in the field of flight operations[46]. On the one hand, this is due to the fact that the Authority does not have sufficient manpower to develop regulations at the same time as conducting audits, and on the other hand, because it believes that it is not possible to conduct audits until the new regulations have been agreed on and implemented. The Military Aviation Authority does not enforce or carry out audits on the basis of the current (old) regulations. This means that as the supervisory authority, the Military Aviation Authority does not have an insight into the extent to which flight safety is currently guaranteed within the Royal Netherlands Air Force Command.

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45 VKAM: Flight Safety, Quality Assurance, Occupational Safety and Environmental Affairs. Report of the VKAM audit at the Gilze-Rijen Air Base on 19-23 March 2007, version number 2 dated 11 April 2007

46 The State Secretary for Defence has stated that the launch of the MLEs will mark the introduction of a structured system, including audits at various levels (air base, CLSK staff and MLA)

The Commander of the Royal Netherlands Air Force does not conduct any audits that focus on flight safety. He takes the view that the monthly and quarterly reports drawn up by the units should state whether they have carried out the tasks assigned to them properly. If the unit is not or no longer able to carry out the tasks properly or it is anticipated that this may be the case in the future, this must be clearly stated in the reports. In addition, priority is granted within the Royal Netherlands Air Force Command to the introduction of Military Aviation Requirement 145, the military aviation requirement in relation to maintenance, and not to conducting audits in relation to flight safety. The investigation did reveal, however, that the Commander of the Royal Netherlands Air Force is working on introducing an Integrated Quality Management System.
Two of the steps that have been taken are the appointment of an audit coordinator (March 2008) to conduct previews and the introduction of an integrated audit system technique within the Royal Netherlands Air Force Command. In response to the Court of Audit's criticism of the Ministry of Defence, the Commander of the Royal Netherlands Air Force launched the project 'Q' with the aim of 'improving the improvement cycle'. However, it is not clear to the Dutch Safety Board how these developments can achieve and safeguard an improvement with regard to insights into flight safety in the short term.

The Flight Safety, Quality Assurance, Occupational Safety and Environmental Affairs Staff Group of the staff of the Royal Netherlands Air Force Command conducted an audit at the Gilze-Rijen air base between the 19th and the 23rd of March 2007.
This was a general audit with the aim of informing the Commander of the Royal Netherlands Air Force with regard to the degree of control in relation to the aspects of flight safety, quality assurance, occupational safety and environmental affairs and the extent to which these aspects are integrated into the operational management of the Gilze-Rijen air base. A particular focus was placed on the following question: "*To what extent is the basis for a VKAM management system, the improvement cycle, demonstrably present at the Gilze-Rijen air base?*"[47]. The audit examined all activities carried out at the Gilze-Rijen air base and that fall under the responsibility of the Commander of the Gilze-Rijen Air Base. The unit's Flight Safety, Quality Assurance, Occupational Safety and Environmental Affairs Management System served as a basis for this, in addition to requirements from the applicable flight safety, quality assurance, occupational safety and environmental standards.

With regard to the Flight Safety, Quality Assurance, Occupational Safety and Environmental Affairs audit in March 2007, it is possible to state that no specific points were raised in the audit report in respect of the 301 Squadron. The response to the question posed in the audit was that the management and integration of the flight safety, quality assurance, occupational safety and environmental affairs aspects varies significantly between each squadron or division, focuses almost exclusively on occupational safety and environmental aspects and is generally reactive in nature. There is also no integrated overview of all outstanding actions for improvement.

The audit carried out by the Flight Safety, Quality Assurance, Occupational Safety and Environmental Affairs Staff Group mainly related to the state of affairs within the occupational safety and environmental affairs system. The audit report does however state that the aspect of flight safety is not being managed on a structural basis. This comment regarding the structural manageability of flight safety mainly has to do with the fact that planned reorganisation(s) were behind schedule and as a result of this there was still no full-time Unit Flight Safety Officer [OVVO], and less to do with the manner in which the current regulations and procedures are being implemented. As this position was to be filled with the introduction of the Ministry of Defence Helicopter Command, this observation did not result in any action[48].

The Commander of the Gilze-Rijen Air Base and his staff were busy with the amalgamation of two air bases and a naval airbase and the formation of the Ministry of Defence Helicopter Command prior to and at the time of the incident. Investigations have revealed that no audits were conducted by or on behalf of the air base commander. This means, for instance, that the activities of the squadron commanders, flight commanders, Duty Officers etc. were not being reviewed on a regular

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47 Report of the VKAM audit at the Gilze-Rijen Air Base on 19-23 March 2007, version number 2 dated 11 April 2007.
48 A full-time unit safety officer has now been appointed within the DHC. It should be noted, however, that the appointment of this officer does not mean that flight safety is automatically and structurally guaranteed.

basis. The Commander of the Ministry of Defence Helicopter Command has recognised this and has stated that an audit programme is currently being developed[49].

Sub-conclusion 12: Within the Ministry of Defence in general and specifically within the Royal Netherlands Air Force Command and the Gilze-Rijen Air Base, failure to carry out audits means that quality control in relation to flight safety is being neglected.

5.3.4 *Operational management in relation to flight safety*

If there is no insight into how the procedures are being dealt with, there is also no insight into the level of risks being run. This causes (basic) flight safety to become an issue. As stated in sub-conclusion 11, it has emerged that, particularly within the Royal Netherlands Air Force Command and the Gilze-Rijen Air Base, quality control in relation to flight safety is inadequate as a result of failure to conduct audits.

Despite the fact that flying is the core business of the Royal Netherlands Air Force Command and flight safety forms part of the name and the objective of Flight Safety, Quality Assurance, Occupational Safety and Environmental Affairs, there is not a sufficient focus on flight safety. As a result of this, qualitative flight safety is not being managed.

For the purpose of managing flight safety, the Dutch Safety Board expects there to be a (flight) safety approach or (flight) safety policy, which is realistic and can be applied in practice, established within the Royal Netherlands Air Force Command and therefore also within the Gilze-Rijen Air Base and the 301 Squadron, including the corresponding basic principles. With regard to flight safety, the Board has established that the current (flight) safety policy is not being implemented effectively.
While the tasks, powers and responsibilities in relation to flight safety have indeed been set out in regulations, organisation decrees and subtask orders, the practical implementation of these has not been provided for to a sufficient extent and has not been systematically incorporated into the operational management.

During the investigation, the new structure of the Ministry of Defence Helicopter Command came into effect (4 July 2008). The Dutch Safety Board acknowledges that as a result of this and of the incident, there has been a greater focus on flight safety and the qualitative implementation of the Annual Training Programme. One example of this is that it was stated during a regular meeting of squadron flight safety officers (SVVO) within the 301 Squadron that the flight commanders will be taking a more critical approach when examining the implementation of the Annual Training Programme flights, complacency during the execution of basic flight skills and tactics in particular, and that the supervision carried out by the Duty Officer is not adequate.

Sub-conclusion 13: As a result of inadequate implementation of current (flight) safety policy, the risks and therefore qualitative flight safety are not being managed and systematically safeguarded.

5.3.5 *Parallels with previous incidents*

During the investigation, the Dutch Safety Board examined the question as to whether it is possible to draw parallels with previous incidents involving helicopters. To this end, three other helicopter incidents that took place within the Royal Netherlands Air Force during the past four years were looked at in greater detail. The incidents included one involving an Apache in 2004 and two involving a Chinook in 2005, all in Afghanistan. The incident involving a Lynx helicopter belonging to the Royal Netherlands Navy Command that took place during the Army Open Days in 2007 was also taken into consideration.

During a period of deployment in Afghanistan in July 2004, an AH 64D Apache helicopter (registration number Q-20) was involved in a crash. The direct cause of this incident was that, as a result of miscommunication and failure to fully adhere to the procedures for transferring control to the other pilot, the aircraft was unpiloted for a few seconds and consequently crashed into the ground at a high speed. The mission was relatively easy and had a low task load, involving the transport of a number of units to another air field. The low task load was the reason behind failure to transfer control correctly. During the deployment, the front seater fulfilled a dual function. As a

[49] It has now been announced that an integrated quality management system was/will be introduced within the DHC as of January 2009, whereby flight safety audits have been scheduled and will be carried out on a regular basis.

pilot he was fully operationally deployable and was deployed in a standard manner, however he was also the Head of Operations and therefore the chief supervisor within the context of flight operations. This dual function placed the supervision structure under pressure.

On 27 July 2005, a CH-47D Chinook (registration number D-105) was involved in an accident in Afghanistan during a landing within the context of a night-time tactical transport flight. Partly as a result of mental pressure, communication between the crew members regarding decisions in relation to the landing was not effective. It also emerged that the level of training received by the crew had been placed under pressure. The huge demand for transport helicopters and activities outside of the national borders at that time meant that the number of flight hours available for training was limited.

On 31 October 2005, a further incident took place in Afghanistan again involving a CH-47D Chinook (registration number D-104) during a transport flight, whereby the aircraft deviated from the planned route. The pilots had not paid sufficient attention to the planning for the flight in order to foresee the consequences of taking a different route. The flight was regarded as a routine flight, and consequently one with a low task load.

As the aircraft commander was the former mountain flight instructor of the pilot flying the aircraft, the pilots unconsciously drifted into an instructor/student relationship during this flight, which had a negative effect on the attentiveness of the pilot flying the aircraft. The crew's confidence in the aircraft commander (an experienced mountain flight instructor) and the technical capabilities of the helicopter also led to a more passive attitude than desired (complacency). In addition, the aircraft commander was also acting as an authorising agent (Head of Operations and detachment commander) in this instance, which affected the supervision structure when he himself was flying.

In June 2007, a serious incident occurred involving a Lynx SH-14D belonging to the Royal Netherlands Navy Command[50]. In the case of this incident, agreements and discussions regarding procedures (preparation) were insufficient at a detail level to guarantee the necessary level of safety. In addition, the professional competence of one of the individuals involved was not guaranteed (he had never before actually carried out a certain crucial operation and exercise). The fact that he was charged with these activities nonetheless indicates that supervision was lacking. There was no external supervision by the Military Aviation Authority of compliance with general preconditions as no such preconditions had been established at this time.

It is striking that (lack of) supervision, a low task load, limited training capacity and inadequate crew resource management (CRM) are regularly cited as underlying factors of incidents. The conducting of proper audits and a greater focus on guaranteeing flight safety would make these weaknesses in the system visible and help to avert potential incidents in which these underlying factors play a leading part. The investigations into these incidents, with the exception of the incident involving the Lynx helicopter, were not carried out by the Dutch Safety Board, but by investigation committees set up by the Royal Netherlands Air Force Command and (in part) by the Ministry of Defence Temporary Committee for the Investigation of Incidents.
Following the two incidents involving the Chinook helicopter, the State Secretary informed the House of Representatives with regard to the relevant facts in January 2007, providing background information and answering questions posed[51]. A general indication of the measures that have now been taken was also provided.
The Royal Netherlands Air Force Command places a greater focus on mission qualification training (MQT) and quick scans have been carried out for the purpose of guaranteeing flight safety during periods of deployment, amongst other things. The importance of Crew Resource Management has been acknowledged in the form of Crew Resource Management courses and additional attention is being paid to this aspect.

Despite the measures taken, it appears that the same underlying factors played a role in the occurrence of the incident involving the power line collision. Lack of supervision, a low task load, CRM and limited training capacity are underlying causes that contributed towards the occurrence of this incident. The Dutch Safety Board therefore concludes that there are structural safety failings.

Sub-conclusion 14: The shortcomings identified can be regarded as structural failings.

[50] On 4 July 2008, the helicopters of the Royal Netherlands Navy Command and the de Kooy Marine Naval Airbase were placed under the Ministry of Defence Helicopter Command [DHC].
[51] Letter from the State Secretary for Defence dated 18 January 2007, no. HDAB2006026874

6 CONCLUSION AND RECOMMENDATIONS

6.1 SUB-CONCLUSIONS

The following sub-conclusions are identified in the analysis.

1. No faults had been detected in the Apache helicopter and the helicopter was in a good technical state at the time of the incident.

2. The weather conditions did not form an obstacle to the safe execution of the flight.

3. The crew met all of the requirements and can be regarded as being capable of carrying out the mission properly.

4. The preparations for the flight were inadequate. Failure to acknowledge the full extent of the risks associated with low-level flight significantly contributed towards the occurrence of the incident.

5. The fact that the pilots are not (or no longer) familiar with and no longer apply points of ascent and points of descent to compensate for failure to enter obstacles into the navigation system means that there is an increased risk of collisions.

6. At the time that the front seater issued the instruction from a safe altitude to commence the descent, safety with regard to the last part of the descent and the start of the low-level flight had not been guaranteed to a sufficient extent.

7. During the descent and the start of the low-level flight the back seater displayed limited scan behaviour, which reduced the chance of detecting the high-voltage pylons.

8. The coaching approach adopted by the front seater and inadequate communication between the crew members meant that tasks set out in the teamwork concept for an Apache crew were subconsciously neglected or not carried out to a sufficient extent.

9. The high-voltage pylons on the left and right river banks were not illuminated. The chance that the pilots would have noticed the pylons if they had been illuminated is thought to be limited.

10. The reduction in the number of Annual Training Programme hours available, the mission-focused training and the deployment within the context of peace operations has placed training and training capacity for flight skills that are not related to this deployment under pressure.

11. Supervisory activities are being neglected at squadron level. As supervision is biased towards competencies required for the International Security Assistance Force missions in Afghanistan, sufficient attention is not being paid to the level of training in other areas, such as low-level flight. There is no targeted programme for the purpose of bringing all competencies back up to the required standard.

12. Within the Ministry of Defence in general and specifically within the Royal Netherlands Air Force Command and the Gilze-Rijen Air Base, failure to carry out audits means that quality control in relation to flight safety is being neglected.

13. As a result of inadequate implementation of current (flight) safety policy, the risks and therefore qualitative flight safety are not being managed and systematically safeguarded.

14. The shortcomings identified can be regarded as structural failings.

6.2 MAIN CONCLUSION

The power line collision involving the Apache helicopter was caused by poor flight preparation, poor flight execution and inadequate supervision. This was able to take place as a result of failure to conduct regular audits which meant that, from the level of the Apache squadron to the level of the Central Staff, (basic) flight safety was not guaranteed.

6.3 RECOMMENDATIONS

In view of the recommendations in the reports produced by the Dutch Safety Board and its predecessor in the case of the Ministry of Defence (the Ministry of Defence Temporary Committee for the Investigation of Incidents) following incidents that have previously been investigated within the Ministry of Defence and the direct causes and the underlying factors of the incident in question, the Dutch Safety Board is of the opinion that an insufficient focus is being placed on quality control in relation to flight safety. The Board advises the Minister of Defence to guarantee general (basic) flight skills and flight safety by ensuring:

- that an adequate supervision system is in place, together with the corresponding checks and evaluations

- that a full insight is gained, by means of audits, into (flight) safety and the way in which this is managed.

Administrative authorities to which a recommendation is addressed must state their position with regard to compliance with this recommendation to the relevant Minister within six months of the date of publication of this report. Non-administrative authorities or individuals to whom a recommendation is addressed must state their position with regard to compliance with the recommendation to the relevant Minister within one year. A copy of this response should be submitted simultaneously to the chairman of the Dutch Safety Board and the Minister of the Interior and Kingdom Relations.

APPENDIX 1 EXPLANATION OF THE INVESTIGATION

Notification of and investigation by the Dutch Safety Board
The Ministry of Defence notified the Dutch Safety Board of the incident on Wednesday 12 December 2007 at 19:30 hours. This concerned an incident involving an Apache helicopter belonging to the Royal Netherlands Air Force Command (CLSK). Investigators from the Dutch Safety Board immediately travelled to the location of the precautionary landing. On 18 December, the Board decided to proceed with the investigation and on 20 December, the Board agreed to the investigation proposal. On 12 February 2008, the Board approved the plan of approach.

In accordance with Article 14 of the Dutch Safety Board Act and the Ministry of Defence-Dutch Safety Board coordination protocol[52], the Ministry of Defence was asked on 20 December 2007 to provide specific expertise. This was the subject of a verbal undertaking on 7 January 2008 and was subsequently confirmed in writing[53].
The support consisted of a technical flight expert, a technical expert and a pilot psychologist. These individuals operate in accordance with and under the protection of the Dutch Safety Board Act. One of the consequences of the fact that the Ministry of Defence was making a number of the few experts that they have at their disposal available to the Dutch Safety Board was that the Ministry did not carry out a comprehensive investigation of its own. The CLSK did, however, carry out a so-called ORM (Operational Risk Management) investigation in order to examine whether, and if so which, short term measures needed to be taken in order to prevent the recurrence of this type of incident. On the basis of this ORM, the Ministry of Defence resumed low-level flight in the Maas/Waal region (subject to conditions).

Scope
The investigation carried out by the Dutch Safety Board focused on determining the causes or probable causes, the underlying factors and the potential structural safety failings that formed the basis for the incident.

The investigation did not examine the benefit and necessity of low-level flight with a helicopter during night-time. This is regarded as an operational requirement when using attack helicopters. The same applies to the presence and locations of low-level flight zones in the Netherlands.

Shortly after the power line collision, the decision was taken not to include the crisis management aspects in the investigation into this incident. This decision was primarily based on the fact that the Dutch Safety Board did not have any indication on the basis of the information initially gathered that the manner in which the parties involved implemented the crisis management processes led to safety issues for the population. The evidence that problems had occurred in the field of communication did not on its own form sufficient grounds to launch an investigation into the entire crisis management process. The Board did, however, decide to launch a separate investigation into the vulnerability of electricity supplies in recreational zones.
The present investigation therefore does not take either of the abovementioned aspects into consideration.

Other investigations
The Royal Netherlands Marechaussee has launched a criminal investigation into this incident.
As the Public Prosecution Service had impounded the helicopter, the Royal Netherlands Air Force was not able to conduct a (technical) examination of the helicopter in the first instance. This was carried out by the Dutch Safety Board (see appendix 9: Airworthiness report and appendix 10: Damage to the helicopter).

Operational Risk Management (CLSK)
Following the incident, the CLSK suspended low-level flight using Apache helicopters in the Bommelerwaard low-level flight zone. The risks were identified and control measures determined during an 'Operational Risk Management (ORM)' meeting.

During this risk analysis, it was established that the aim of the existing control measures, set out in flight order books, procedures and syllabuses, is partly to minimise the risks associated with low-level flights and flights during night-time as far as possible. Under the notion that risks can never be completely excluded, the conclusion was reached during the risk analysis that all the existing control measures result in a level of risk at which it was acceptable to resume low-level flight at

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[52] Signed on 14 December 2007.
[53] Letter from the Director of Operational Readiness dated 11 January 2008, No. S 200800376.

night-time.

The Commander of the Royal Netherlands Air Force therefore advised the Chief of Defence[54] to introduce a temporary measure, focused on the avoidance of the abovementioned high-voltage pylons and cables, until the investigations into the relevant facts of the incident had provided clarity.

This risk analysis also led to a number of recommendations for the purpose of further reducing the remaining risks. This involved making improvements in relation to the marking of obstacles on flight charts in the Amsterdam FIR (Flight Information Region) and the production of flight charts on a scale of 1:100 000 and 1:50 000 on the basis of the existing staff charts that feature all vertical obstacles over 150 feet AGL (above ground level) in the Amsterdam FIR. The order has now been issued within the CLSK to implement these improvements.

The Commander of the Royal Netherlands Air Force also recommended that, in consultation with the administrator of the high-voltage grid, the visual marking of high-voltage cables supported by poles that are situated far apart should be improved (potentially by means of illuminating obstacles over 150 AGL in Amsterdam FIR).

In mid February 2008, the Ministry of Defence lifted the ban on low-level flight in the Bommelerwaard, in response to the results of the ORM meeting, whereby the high-voltage pylons and cables were to be avoided until the publication of this report.

Interviews
Interviews were conducted with those directly involved and a number of individuals in charge within the CLSK within the context of the investigation. Partly in view of the protocol with the Public Prosecution Service, the Dutch Safety Board has access to more than just the interviews that it conducts itself, and it took advantage of this right during this investigation.

Analysis
The analysis focused on the reconstruction of the incident and the direct and underlying causes. Once it had been established during the initial analysis of the incident (TRIPOD) that the human factor had played a predominant role in its occurrence, use was also made of the Human Factors Analysis and Classification System (HFACS) in the analysis. HFACS is a classification and analysis system whereby the human factor is placed in relation to the incident (see appendix 7: Human Factors Analysis and Classification System).
An additional advantage is that this method of analysis is well known and is also used within the aviation sector and the CLSK. This meant that it was possible to make optimal use of the additional specialists provided by the CLSK.

Project team
The project team was made up of the following individuals:

J.W. Selles **:** Investigation manager (Secretary of the Defence Sector up until 1 February 2007)
J. Heerink**Fout! Er is geen naam opgegeven voor de eigenschap.** **:** Project leader
G.L. de Wilde **:** Senior investigator (up until 1 November 2008)
C. van Antwerpen **:** Senior investigator (from 25 August 2008)
M. Schuurman **:** Technical investigator
K.N.R. Verhoeve **:** Analyst

The project team also included the following individuals from the Royal Netherlands Air Force, acting under the management and responsibility of the Dutch Safety Board:

Major H.G.S. Boekholt **:** Technical flight expert
Major G.J.P. van den Elzen **:** Pilot psychologist
Captain G.J.P.M. Rekkers **:** Technical expert

Drafts
The draft final report (minus the consideration and the recommendations) was submitted to those in charge of the Ministry of Defence units involved as well as those individuals directly involved in the incident so that it could be checked for factual inaccuracies. The Dutch Safety Board has received responses from the State Secretary for Defence (also on behalf of the Secretary-General,

[54] Letter from the Royal Netherlands Air Force Command dated 8 January 2008, no. CLSK2008000418.

the Military Aviation Authority and the Chief of Defence), the Commander of the Royal Netherlands Air Force, the Commander of the Ministry of Defence Helicopter Command (also on behalf of the Commander of the 301 Squadron) as well as the two pilots involved. These responses have been incorporated into the report where relevant; where comments that were made have not been incorporated, the reasons for this are explained below.

Comments made on the draft report that have not been incorporated into the final report

The explanations in relation to the comments that were not incorporated into the final report follow the structure of chapter 5 (Analysis) as far as possible.

1. Preparations for the mission (5.2.4)

Comments
The preparation time was not in fact one and three quarter hours (as stated in the report) as the aforementioned period also had to include time to get something to eat, carry out pre-flight activities, book out the bus and take-off, amongst other things. It was also stated that, in view of the time available, although the flight preparations may not have been optimal they were not inadequate as claimed by the Dutch Safety Board. Furthermore, nothing was deliberately passed over or omitted during the planning process and the crew therefore made the best possible use of the very short planning time available.

Response of the Dutch Safety Board
The investigation revealed that, with the exception of the meal, the aforementioned aspects form part of the flight preparations as a whole and that in principle, one and three quarter hours is sufficient time in which to carry out these activities properly provided that effective use is made of this time. In addition, it can be expected that if the scheduled time between receiving the order and the take-off is insufficient, for instance because the crew still need to have something to eat, this should be made known. If the crew considered the time available to be too short for the purpose of carrying out more thorough preparations, they could have postponed the take-off time. Certainly in the case of training flights during times of peace, it is the individual responsibility of each pilot to make it known if the conditions for the successful execution of a flight are inadequate or insufficient. In the case of an aircraft commander, there should also be consequences attached to this. After all, the commander is ultimately responsible for deciding whether or not to take off in an aircraft. If the crew felt that they did not have sufficient time in which to carry out the flight preparations, they should have taken appropriate action. The manner, as described in the report, in which the crew carried out the preparations is regarded by the Dutch Safety Board as inadequate.

Comments
The comment was made that during the Apache pilot training in Fort Hood, a risk assessment is carried out prior to a flight order. The completion of a so–called risk assessment sheet is common practice there. This means that the risks associated with the flight are assessed by means of checking off all sorts of aspects. A duly authorised individual must then approve the completed sheet.

Response of the Dutch Safety Board
The assessment of risks in advance whereby aspects such as the preparation time required, the level of training received by the crew, the weather conditions, nature of the flight, route etc. are examined should take place as standard during the preparations for a flight. The Board did not investigate why the procedure described – the completion of a risk assessment sheet – is not applied here.

2. Commencement of the descent (5.2.5)

Comments
The report states that it is self-evident that aspects that must be checked prior to and during a descent, such as a safe flight path, form a self-evident part of good airmanship. These aspects to be checked are not set out in writing in the Apache documents.

Response of the Dutch Safety Board
The Board is of the opinion that good airmanship means that pilots have a certain situational awareness on the basis of their experience and that it should not be necessary for activities that are self-evident, such as checking the flight path before commencing low-level flight, to be put down in writing in order for pilots to carry these out.

3. During the descent (5.2.6)

Comments
It was requested that the plots of the scan behaviour during other flights examined by the Dutch Safety Board, as referred to in section 5.2.6, be included in the report.

Response of the Dutch Safety Board

The inclusion of all of these plots has no or very little added value as the circumstances were not identical. The issue at hand is to determine the scan behaviour shortly before the power line collision. A plot of 2 minutes of the scan behaviour of the back seater (pilot flying) during another period of the flight has, however, been included in appendix 14 for the purpose of comparison. This took place around 25 minutes prior to the power line collision. During this period, the back seater displayed a broad scan pattern that shows similarities with the other scan patterns examined. This is explained in greater detail in section 5.2.6.

4. CRM (5.2.7)

Comments

It is stated that the term 'complacency' has severely negative connotations within the context of aviation and even appears to imply deliberate intent. The literal translation of the word in the report also conjures up the wrong image.

Response of the Dutch Safety Board

While the report states that a certain degree of complacency had developed, it is not the intention of the Dutch Safety Board to imbue this claim with overly strong connotations. In the case of road traffic too, even simply driving too close to the vehicle in front can be regarded as complacency within the sense of a (subconscious) underestimation of the risks that can be associated with such behaviour. On the basis of the comments made, the term complacency has been described more accurately (section 5.2.4, footnote 35).

Comments

The call 'I am inside' is a courtesy call and not obligatory as stated in the report.

Response of the Dutch Safety Board

See the Apache Flight Training Book, part III, section 1.5.4 Crew communication (Appendix 2).

5. High-voltage pylons (5.2.8)

Comments

It was requested that an indication be provided of the evidence that the high-voltage cables were clearly indicated on the marked up 1:50,000 charts, as these charts were blown out of the cockpit and cut into pieces.

Response of the Dutch Safety Board

Although the charts that were being used by the front seater were for the most part lost during the collision, it is possible to establish on the basis of other 1:250,000 and 1:50,000 charts in standard use that the high-voltage power lines and pylons were indicated on those charts as standard. It was not possible to determine whether or not the navigation section had also highlighted the pylons and power lines on the 1:50,000 chart, however this is indeed standard procedure.

Comments

The conclusion that the chance of detecting the high-voltage pylons would be limited even if the pylons were illuminated is incorrect. 'Unaided' scanning is carried out with the left eye precisely for the purpose of identifying these types of illuminated objects.

Response of the Dutch Safety Board

The Board recognises that illumination increases the chance of detection. However in this specific situation, in which the masts were not anticipated, amongst other things, the chance that the pylons would have been detected or identified as high-voltage pylons by the pilots using the equipment available or with the naked eye is limited.

6. Training capacity and level of training received (5.3.1)

Comments

With regard to training capacity and the level of training received (section 5.3.1), the text wrongly creates the impression that the pilots are not properly trained. This is due to the fact that the text states that the reduction in the available Annual Training Programme hours (JOP) and deployment within the context of peace operations means that training and training capacity for flight skills that are not related to this deployment have been placed under pressure. As stated in the report, the reduction in the number of hours has been accompanied by well-considered decisions with regard

to the number of tasks. Training primarily focuses on the tasks required for the mission and where necessary, a greater number of flight hours are allocated to the pilots.
Furthermore, well-considered decisions have been made when adapting the tasks, whereby flight safety forms the key element. Examples of this are the so-called Mission Qualification Training programmes (MQTs). These programmes also focus on flight safety aspects.

Response of the Dutch Safety Board
When the number of flight hours was reduced, decisions were made with regard to the number of tasks and a focus was placed on the tasks required for the deployment missions during training. The problem behind this incident, however, is that it occurred during training in general (basic) flight skills (low-level flight) that are not practised or are practised less frequently and that are not kept up to date during the mission, or are only kept up to date to a limited extent. It is therefore also stated in section 5.3.1 that the limited number of training hours available and the partly one-sided implementation of these hours have placed the practising of basic skills by the Apache pilots under pressure. The mission-focused training, the flight safety aspects that play a role in this and the level of training received for the deployment missions were not investigated. It is now stated more clearly in section 5.3.1 that there are programmes for the purpose of keeping the level of training received for periods of deployment up to the required standard (MQTs).

Comments
It has been stated that the reduced availability of JOP hours in combination with the emphasis on the range of tasks required for actual deployment has meant that a number of tasks have been assigned a lower priority. The corresponding tactics and techniques, such as low-level flight, are therefore practised less than is set out in the regulations drawn up for the purpose of bringing the level of training received by aircraft crews up to the required standard and keeping it there. However, it is not possible to automatically conclude from this that there is a structural failure to recognise the risks associated with low-level flight. The reduced opportunity for practising has in fact led to a situation whereby a specific focus is placed on the various high-risk aspects of low-level flight during activities such as daily briefings and the complexity and degree of difficulty of these types of missions has been adjusted downwards. The mission, as described in the report, was in line with the policy implemented.

Response of the Dutch Safety Board
The Board agrees that it is not possible to automatically conclude from the abovementioned facts that there is a structural failure to recognise the full extent of the risks associated with low-level flight.

7. Supervision (5.3.2)

Comments
In section 5.3.2 it is incorrectly asserted that there is no targeted programme for the purpose of bringing all competencies back up to the required standard. During the ISAF mission, a conscious decision was made to opt for a number of tasks that focus on the tasks required for ISAF. Working towards achieving operational readiness of the organic tasks following completion of a mission is standard practice and set out in books and readiness orders.

Response of the Dutch Safety Board
Information received shows that the reduced availability of the number of JOP hours has meant that a number of tasks have been granted a lower priority and that certain tactics and techniques, such as low-level flight, are therefore practised less frequently than set out in the regulations. The complexity and degree of difficulty of such low-level flight missions has therefore been adjusted downwards in anticipation of this. This did not prevent the incident from occurring, however, and highlights the importance of practising general (basic) flight skills. Information has also shown that it has been recognised that many aircraft commanders (front seaters) are flying despite the fact that they have not received adequate training to ensure that they are sufficiently proficient in various techniques and tactics, such as low-level flight, air assault etc. Individual gaps with regard to the level of training received must be identified by means of supervision and subsequently incorporated into a specific training programme. The Annual Training Programme established as standard is not sufficient in this respect. From a structural point of view, there are no programmes specifically aimed at the pilot for the purpose of practising general (basic) flight skills that were rarely or not required during the mission upon return from a mission.

8. Quality control (5.3.3)

Comments

It is stated in section 5.3.3 of the report that failure to carry out audits means that quality control in relation to flight safety is being neglected. However, a structured system (analogous to the EASA) including audits at various levels (air base, CLSK staff and MLA) is in fact being introduced in the form of the Military Aviation Requirements (MLEs). This involves the key areas of Operations, Technology and Air Traffic Management. The aim of the MLEs is to increase flight safety and guarantee quality. In addition, the MLA conducts inspections following safety incidents or warnings of unsafe situations. These types of inspections have been scheduled and are already being carried out. Examples of this include the performance during January and September 2007 of quick scans in the field of operations and training with Chinook, Cougar and Apache helicopters. In May and September 2008, activities included inspections of unpiloted aviation operations in the deployment zone in Afghanistan.

It is recognised, however, that the implementation of the MLEs has not yet been completed, and that the introduction of an MLE for Specific Military Operations is essential in the present case. Further work is also underway on improving the integrated quality system, which covers more than just flight safety.

Response of the Dutch Safety Board
The Board acknowledges that the developments described in this comment may contribute towards increasing flight safety in general, however it also wishes to note the following.
The MLA was set up on 1 July 2005. As also stated in section 5.3.3, the investigation revealed that since this date, the MLA has specifically focused on formulating and introducing MLEs. The report concerns an incident within the key areas of Operations. At the time of the incident, although the operational framework directive Military Aviation Requirements Operations Volume I (MAR-OPS Volume 1) regarding 'basic and general operations' may have been declared effective (since August 2006), the operational implementers, such as the Royal Netherlands Air Force Command, were not yet required to comply with this (this was to take place as of 1 January 2008, however in August 2008 the implementers still did not comply despite two years' preparation time). MAR-OPS Volume II sets out rules for 'Special military operations' such as the use of Night Vision Systems and has not yet been introduced or declared effective.

The investigation also revealed (as stated in section 5.3.3) that the MLA has not conducted any audits. The inspections and quick scans referred to in the comment are no substitute for these audits. The quick scans carried out in January and September related to the deployability posture of the 298 and 300 squadrons (equipped with Chinook and Cougar helicopters respectively). The inspections in relation to unpiloted aviation operations took place in Afghanistan and therefore also concerned mission-related activities. Furthermore, the inspections were carried out in response to safety incidents or warnings in response to unsafe situations.
The Dutch Safety Board is forced to conclude that the inspections and quick scans carried out by the MLA and the C-LSK (on behalf of the MLA) were predominantly reactive, limited in depth and focused on the execution of mission-related training (such as the MQTs). These activities did not relate to Apache operations. They are also not audits as intended and referred to in section 5.3.3 of the report.

The report does not address the training and skills required for a mission but rather those aspects required in order to be able to operate safely using helicopters during times of peace. The Board is not concerned with the (quality of the) mission-focused training programmes and their implementation, but with non-specific mission-focused training, such as in low-level flight, which is carried out less frequently as a result of the emphasis on mission-focused training. These skills, such as low-level flight, are not addressed to a sufficient extent in the current training programmes, and audits at various levels within the organisation that could have potentially led to the identification of this problem are not being carried out.

Comments
A number of examples are provided to show that there is indeed a structured system in relation to flight safety and quality within the CLSK. It is also stated that measures for improvement were taken following the earlier Chinook incidents. Examples provided include the improvement of the Mission Qualification Training and Crew Resource Management Training and the supervision of the implementation of these measures for improvement by the MLA.

Response of the Dutch Safety Board
The Board is concerned with the fact that the risks referred to in the report in relation to keeping (basic) flight skills up to date and guaranteeing flight safety are not being managed on a structural basis (see also the previous response).

9. Operational management and flight safety (5.3.4)

Comments

It is stated in section 5.3.4 of the report that as a result of inadequate implementation of current (flight) safety policy, the risks and therefore qualitative flight safety are not being managed and systematically safeguarded. However, although the safeguarding of the flight safety system has not been introduced in full within the Ministry of Defence, quality assurance in relation to flight safety is being properly structured, as this is taking place in conjunction with the comprehensive introduction of the military aviation requirements.

The assertion that qualitative flight safety is not being managed is therefore factually incorrect. There is in fact a structured system in relation to flight safety and quality. Examples include Flight Safety Awareness days and structural feedback in relation to safety with all of the personnel involved.

Response of the Dutch Safety Board

The Board welcomes efforts by the Ministry of Defence to achieve a structured system and to provide a proper structure for quality assurance in relation to flight safety, however the Board believes that the management and safeguarding of flight safety can only be achieved once the five general basic principles that are set out in Chapter 3.4 (assessment framework for safety management), and that come together in a safety management system, have been met. The reports produced by the Dutch Safety Board and its predecessor in the case of the Ministry of Defence, the Ministry of Defence Temporary Committee for the Investigation of Incidents, since 2004 have stated that the Ministry of Defence lacks this type of structured system. It will not be possible to safeguard (basic) flight safety until supervision is carried out and audits are conducted on a structural basis at the various levels within the organisation. As long as this safeguarding does not actually take place on a structural basis, there will be no control mechanism, which means that deviations may go undetected. Audits, as part of the safety management system, play an essential role in providing the management of an organisation with an insight into safety (management). As these audits are not being carried out and the flight safety system has not yet been introduced (in full), there is insufficient insight and safeguarding, and therefore no structural management of flight safety.

Comments

Within the context of the gaps in the knowledge of and the demonstrable (visible) application and safeguarding of the quality system, reference is once again made to the report submitted by the State Secretary for Defence to the House of Representatives in January 2007. This report provided information on measures for improvement that had been taken following the two Chinook incidents (in Afghanistan). The MLA subsequently investigated this situation (at the start of 2007) and concluded that all of the measures had been implemented.

Response of the Dutch Safety Board

The measures referred to in the abovementioned report primarily relate to readiness for deployment and safeguarding (flight) safety during periods of deployment. This was also the focus of the investigations carried out by the MLA. The report does not address the training and skills required for a mission but rather those aspects required in order to be able to operate with helicopters safely during times of peace. The Board is not concerned with the (quality of the) mission-focused training programmes and their implementation, but with non-specific mission-focused training, such as in low-level flight, which is carried out less frequently as a result of the emphasis on mission-focused training. These skills, such as low-level flight, are not addressed to a sufficient extent in the current training programmes, and audits at various levels within the organisation that could have potentially led to the identification of this problem are not being carried out.

Comments

It is stated that the formation of the Ministry of Defence Helicopter Command also remedied a number of the failings identified in the report, or that these failings are being remedied in the short term. One example of this is the appointment of a full-time unit flight safety officer within the DHC. During the reorganisation to create the DHC, the 301 squadron was also extended to include extra personnel in the operations section, and there was a change in the internal organisational structure of the squadron. As a result of this, the task of supervision within the squadron can be translated into more concrete terms. As of January 2009, an integrated quality management system will be introduced in which flight safety audits are scheduled and carried out on a structural basis.

Response of the Dutch Safety Board

The Board is pleased that action has been and is being taken within the DHC to address the shortcomings within the quality and safety system in advance of the publication of the report.

10. Parallels with previous incidents (5.3.5)

<u>Comments</u>
The report makes the assertion that there are structural safety failings, which is substantiated by the establishment of a link with the incidents involving an Apache in 2004 and the Chinooks in 2005. It is stated that there was a lack of supervision in all of these cases. However, in these previous incidents there was a situation whereby the crew was responsible for the (daily) management of the detachment and the execution of flights. This did not apply in the case of the power line collision. The types of supervision are not comparable and it is therefore impossible to draw a parallel between this incident and the previous incidents with regard to (a lack of) supervision.

<u>Response of the Dutch Safety Board</u>
On the basis of these previous incidents, the Board concluded that the same background factors (a low task load, limited training capacity, inadequate Crew Resource Management and a lack of supervision) that played a role in these incidents also played a role in the occurrence of the power line collision. The Board acknowledges the fact that the circumstances and the manner in which supervision was implemented are not identical. However, the Board is not drawing a comparison between these types of supervision, but merely stating that supervision was partly or entirely lacking in all of these incidents. The Board acknowledges that measures for improvement have now been taken in relation to CRM and training for missions (MQTs), however on the other hand it is forced to conclude that these background factors played a role once again in the present incident. It is therefore possible to assert that there are structural safety failings.

APPENDIX 2 REGULATIONS FOR THE ASSESSMENT FRAMEWORK

Chapter 3 describes the assessment framework. This appendix examines the content of the various regulations in greater detail.

Second Military Terrain Structure Plan (SMT2)
The SMT2 is a key planning decision (PKB), which describes government policy in respect of the indirect claim on space. The SMT2 sets out the low-level flight zones in the Netherlands. The SMT2 is going through an approval procedure involving both the House of Representatives and the Senate. The low-level flight zones in the Netherlands also have a basis in legislation (the Act on Aviation and the Aviation Act).

Act on Aviation [*Wet Luchtvaart*]
Act of 18 June 1992, containing general rules in relation to aviation.

- Section 5.7(2)
  Regardless of whether or not he is actually operating the controls, the aircraft commander is responsible for ensuring that the flight is executed in accordance with the rules established pursuant to this act. It is only possible to deviate from the rules referred to in the first sentence if circumstances mean that this is an urgent necessity in the interest of flight safety.

Regulations on VFR night flights and minimum altitudes for military aircraft[55]

- Article 3 lays down the minimum VFR altitude.
- Article 5(1)
  The provisions of Article 3 do not apply to aircraft commanders of military helicopters or of propeller aircraft designed for training purposed belonging to or used by the Dutch or allied armed forces in so far as they are carrying out, subject to due observance of the rules set out in paragraph 2, VFR flights within the following zones and routes:
  (..)
  i. Maas/Waal
  51 43 N – 004 53 E (Keizersveer)
  51 43 N – 005 03 E (Drongelen)
  51 44 N – 005 08 E (Heusden)
  51 45 N – 005 16 E (Hedel)
  51 43 N – 005 22 E (Rosmalen)
  51 46 N – 005 32 E (Oss)
  51 48 N – 005 39 E (Ravenstein)
  51 53 N – 005 37 E (Druten)
  along the river Waal to:
  51 49 N – 005 00 E (Woudrichem)
  51 49 N – 004 56 E (Sleeuwijk)
  along the A27 motorway to:
  51 43 N – 004 53 E (Keizersveer)
  (..)
- Article 5(2)
  During the flights referred to in paragraph 1, the aircraft commander must comply with the following, more detailed, conditions:
  a. The minimum altitude must be at least 30 metres (100 feet) above obstacles or lower than this if required for the purpose of the flight.
  b. Connected buildings, hospitals, sanatoriums and suchlike must be avoided.
  c. Any aircraft commander who deviates more than 926 metres (½ NM) from the route or travels outside of the zone, must first reach the applicable minimum altitude before continuing the flight on the route or within the zone.
  (..)
  f. Prior permission from the Commander of the Royal Netherlands Air Force College/Woensdrecht air base must be obtained for flights within the zones referred to in paragraph 1(i) and (j) and the route referred to under point 1.
  (..)

- Article 5(30

[55] Regulations on VFR night flights and minimum altitudes for military aircraft. Date of entry into force: 1 January 1995.

Aircraft commanders of helicopters or propeller aircraft designed for training purposes belonging to allied armed forces shall be granted permission for each exercise by the State Secretary for Defence under conditions to be agreed, with the exception of exercises carried out jointly with Dutch units.

- Article 6
  Aircraft commanders of military aircraft shall be granted an exemption from the prohibition set out in Article 45(1) of the LVR and Article 3 of this regulation, on the condition that the provisions referred to in Articles 7 to 12 inclusive are observed.
- Article 8
  The exemption referred to in Article 6 shall be granted to aircraft commanders of military helicopters belonging to or used by the Dutch or allied armed forces for the purpose of carrying out a VFR flight during which the following minimum altitudes are observed:
  a. Above areas with connected buildings, including industrial areas and port areas, or above gatherings of people: at least 210 metres (700 feet) above the highest obstacle situated within a distance of 600 metres of the aircraft, in so far as necessary in accordance with the purpose of the flight.
  b. In areas not included under a: at least 50 metres (150 feet) above ground or water.
- Article 12
  The exemption referred to in Article 6 applies to aircraft commanders of military aircraft belonging to the Dutch armed forces and of aircraft belonging to allied armed forces to be designated by the State Secretary for Defence for the purpose of VFR night flights provided that the following minimum altitudes are observed:
  a. Above areas with connected buildings, including industrial areas and port areas, or above gatherings of people: at least 300 metres (1000 feet), in the case of helicopters 210 metres (700 feet), above the highest obstacles within a distance of 600 metres from the aircraft.
  b. In areas not included under a:
     1st In the case of fixed-wing aircraft:
     a. at least 300 metres (1000 feet) above ground or water
     b. at least 150 metres (500 feet) above ground or water in the case of flights referred to in Article 2(2)
     c. at least 100 metres (300 feet) above water or lower than this if required for the purpose of the flight.
     2nd In the case of helicopters:
     a. at least 30 metres (100 feet) above ground or water or lower than this if required for the purpose of the flight, in the case of flights referred to in Article 2(5)
     b. at least 75 metres (250 feet) above obstacles on the routes from and to the training zones referred to in Article 2(5)
     c. at least 100 metres (300 feet) above ground or water or lower than this if required for the purpose of the flight.

Royal Netherlands Air Force Traffic Regulations (LVV)[56]

Part A: Organisation of air traffic control; A1: General

1. The LVV sets out rules for the implementation of air traffic control by the military air traffic control service in the Netherlands. The LVV contains procedures, rules and regulations required by operational personnel in order to carry out their task in a safe and efficient manner.
2. The target groups are LVL personnel, combat leaders and pilots within the Ministry of Defence.
3. The LVV is a regulation. Its content is based on ICAO regulations, national regulations and Ministry of Defence regulations.
4. Commanders are able to lay down additional local regulations and procedures, however under no circumstances may these be in conflict with the regulations in force.
5. It is only possible to deviate from the provisions of the LVV if circumstances mean that this is an urgent necessity in the interest of safety.

[56] Royal Netherlands Air Force Traffic Regulations. 1st edition. Laid down by the Commander of the Royal Netherlands Air Force by order No. 17815 dated 07-07-2007. OC No. 83-6900-104. Pub No. 062834

Part D: Flight rules; D1: Flight rules

4. If a flight is being carried out with due observance of the general and visual flight rules, this is referred to as a VFR flight. If the fight is being carried out in accordance with general and instrument flight rules, this is referred to as an IFR flight.

Part J: Special arrangements; J4: Low-level flight and VFR night flights

2. Aircraft commanders of military helicopters and propeller aircraft designed for training purposes belonging to or used by the Dutch armed forces are permitted to carry out VFR flights within the zones and routes referred to in the Military Aeronautical Information Publication for the Netherlands, ENR 3.3.
3. The following rules must be observed during the flights referred to in paragraph 2.
   a. The minimum altitude must be 100 feet (30 metres) above obstacles or lower than this if required in connection with the order.
   b. Connected buildings, hospitals, sanatoriums etc. must be avoided.
   c. Any aircraft commander who deviates more than ½ NM (926 metres) from the route or travels outside of the zone, must first reach the applicable standard minimum altitude, return to the route or the zone, and may then continue the flight at the minimum altitude as referred to under (a).
   d. In the case of flights within the low-level flight zones I to VIII inclusive, Maas/Waal zone, the islands Voorne-Putten and Hoeksche Waard (excluding the beaches), prior permission must be obtained from or in the name of the Commander of the Gilze-Rijen Air Base.

   (..)
8. Aircraft commanders of military helicopters belonging to the Dutch and allied armed forces and of propeller aircraft designed for training purposes belonging to or used by the Dutch armed forces are permitted to carry out VFR flights within the context of training with non-flying units and within the borders of the training zone, provided that the following rules are observed.
   a. Minimum altitude must be at least 100 feet (30 metres) above obstacles or lower than this if required in connection with the order.
   b. The requirements in respect of VFR flights apply with regard to flight visibility and cloud base.
   c. Connected buildings, hospitals, sanatoriums and suchlike must be avoided.
   d. Prior permission must be obtained from the local competent authorities on the basis of the Air Traffic Regulations for flights within a control zone, a special rules zone or in the vicinity of a civil airfield.
   e. Prior permission must be obtained from or in the name of the Commander of the Gilze-Rijen air base for flights within the zones referred to in paragraph 3 (d).
10. Aircraft commanders of military aircraft belonging to the Dutch armed forces and of aircraft belonging to allied armed forces to be designated by the CLSK/DO on behalf of the State Secretary for Defence are permitted to carry out VFR flights outside of the uniform daylight period (UDP) provided that the following regulations and provisions are observed.
    a. The flights must be carried out in accordance with the rules that apply to controlled flights, on the understanding that it is possible to deviate from these conditions in the case of flights with helicopters involving the use of night vision equipment that take place in a zone with horizontal and vertical borders (for information on these zones see the Military Aeronautical Information Publication for the Netherlands, ENR 3.3).
    b. Zones with connected buildings, hospitals, sanatoriums and suchlike must be avoided during the flight.
    c. The flights must be carried out with due observance of the applicable visual meteorological conditions and minimum altitudes.
14. Minimum altitudes for VFR night flights
    a. If flying above the zones referred to in paragraph 10 (b) is unavoidable, the minimum altitude is: at least 1000 feet (300 metres), in the case of helicopters 700 feet (210 metres), above the highest obstacles within a distance of 2000 feet (600 metres) from the aircraft.
    b. In areas not included under a:
       (1) in the case of fixed-wing aircraft:
           (a) at least 1000 feet above ground or water
           (b) at least 500 feet above ground or water in the case of flights using aircraft classified within the Royal Netherlands Air Force, on routes established for the purpose of aerial reconnaissance
           (c) at least 300 feet above water or lower than this if required for the purpose of the flight.
       (2) in the case of helicopters:
           (a) at least 300 feet above ground or water or lower than this if required for the purpose of the flight
           (b) at least 100 feet above ground or water or lower than this if required for the

purpose of the flight in the case of flights in the training zones referred to in paragraph 10(a)

(c) at least 250 feet above obstacles on the routes from and to the training zones referred to in paragraph 10(a).

Royal Netherlands Air Force Flight Order Book (VOBKLu)[57]

Part IA: General

Applicability of the VOBKLu

- 1.4.1. General
  The provisions of the VOBKLu apply at all times and must be strictly observed during the execution of flight operations using aircraft belonging to the Royal Netherlands Air Force within the broadest sense. Where regulations such as the LVV and applicable orders and instructions from the C-LSK fall short within a specific situation, action must be taken in line with the VOBKLu. Flight safety is a driving force within this context, in addition to compliance with provisions set out by or pursuant to the WL. Failure to comply with the provisions of the VOBKLu constitutes failure to comply with flight orders. Commanders will judge this as such.
- Exceptional circumstances
  Under exceptional circumstances, which specifically includes times of crisis/war, it may be necessary to extend the provisions in relation to specific elements of the VOBKLu. The C-LSK has exclusive authority to order such an extension.
- 1.6. Additional flight orders
  Subcommanders are able to issue additional flight orders. Additional flight orders must not be in conflict with the provisions of the VOBKLu.
- 1.7. Deviations from the VOBKLu
  It is only possible to deviate from the provisions of the VOBKLu if this is essential within the context of flight safety.
- Responsibility of the authoriser
  The authoriser:
  a. Is responsible for supervising proper and comprehensive flight preparations and execution of the flight in accordance with the flight order issued.
  b. Ensures that the flight order is in line with the regulations.
  c. Issues an ancillary order in addition to the actual flight order where applicable, if it is impossible to carry out the actual order due to unforeseen circumstances.
  Specific requirements to this effect are formulated in parts II to V inclusive where required.

PART III: HELICOPTERS

Operational competencies

- 2.3.2. Aircraft commander (PIC)
  A PIC is able to independently manage a helicopter crew during the preparations for and execution of an operation. In order to be eligible for assignment to the role of PIC, a pilot must have at least acquired the qualification of first pilot (FP) with CR status. The candidate must have at least 250 flight hours' experience in the specific type of aircraft or a grand total of 500 flight hours of helicopter experience, of which at least 125 flight hours must have been spent in the specific type of helicopter. If having been assigned this role a pilot no longer meets the requirements for CR status, the qualification will be maintained by means of the submission of a recommendation by the Squadron Commander to the Air Base Commander (CVB), stating the 'readiness-status'.

Night operations

- 2.7.1. General
  The term 'night operations' is used to refer to flights outside of the Uniform Daylight Period (UDP), whereby a distinction is made between IFR and VFR flights. With regard to VFR night flights, a distinction is made between 'unaided' and 'aided' night flying.
  'Aided' night flying is carried out using Night Vision Goggles (NVG) or Night Vision Systems (NVS).
  Local regulations in relation to night flying are set out in permanent orders [OBAs] and LOPs.

[57] Royal Netherlands Air Force Flight Order Book. Laid down by the Commander of the Royal Netherlands Air Force by order No. CLSK 2005 50 29 064. OC No. 83-6100-001. Pub No. 010699. 11th revised edition dated 1 January 2006.

- 2.7.2. Night flight qualification
  In order to carry out night flights, both the aircraft commander and the first pilot must have a valid night flight qualification. This rule does not apply to flights within the context of training and flights for the purpose of regaining 'current' status. These flights are carried out under the guidance of an authorised flight instructor or in accordance with the provisions regarding the requirements in respect of experience of night operations.
- 2.7.3 Use of NVG during AH-64D operations
  The main aim of the use of NVGs in the AH-64D is to use these as a sensor for the purpose of target acquisition and identification, in combination with the use of IR pointers where necessary. The NVGs can also be used by front seaters for the purpose of assisting back seaters during adverse FLIR conditions. The NVGs may only be used as a “hands-off device” (i.e. the “Pilot Flying” does not use NVGs). The NVG currencies as referred to in requirements in respect of experience of 'aided' night flying therefore do not apply. The decision to fly with NVGs can only be made during the execution of a flight for reasons of flight safety (in emergencies). A front seater can obtain qualified status by flying at least two missions with an NVG trained flight instructor. These flights must focus on the use of NVGs as described above, including a number of basic ATM manoeuvres.
- 2.7.5. Requirements in respect of experience (Currency)
  Regulations in relation to the training programme for operations outside of UDP are set out in the OBAs TL/OPS/H-040 to H-044 inclusive. The following conditions must also be met:
  (..)
  b. ‘Aided’ night flying
  (1) Currency requirement for aided night flying: the currency will cease to be valid if there are more than 90 days between two 'NVG' flights, or 45 days in the case of 'NVS’ flights
  (2) if no more than 120 days have passed since the last flight, the currency can be regained by means of carrying out an 'aided' night flight under the guidance of a current ‘aided' category 1 aircraft commander. NVS pilots can also do this by means of carrying out a ‘bag-flight' under the guidance of a current instructor
  (..)

Flight preparations

- 5.1.1. Power to authorise flights
  In addition to the provisions of Part IA, the power to authorise flights is delegated (in hierarchical order) to:
  a. The Air Base Commander (CVB) or his deputy
  b. The Head of the Operation Coordination Centre (H-OCC) of the air base in question and the officers of an assigned OCC (provided that they are members of the cockpit personnel)
  c. The Squadron Commander or his deputy
  d. The Head of PVE-OPS (H-OPS) and the squadron flight commanders
  e. The ‘Duty Ops Officer’ (dd Ops) during the actual performance of this role
  f. Instructors for flights within the context of a training syllabus
  g. Unit test pilot for all FCF or test flights and FCF pilots with regard to their own functional check flights
  h. An officer specially designated for this purpose by the CVB by written order.
- 5.1.3. Responsibilities
  In addition to the provisions of Part IA, the following conditions also apply to officers who have the power to authorise flights:
  a. These officers must have a good knowledge of the relevant regulations and documentation
  b. Flight authorisations within the context of (flight) exercises must be formulated in as much detail as possible. If this is not feasible for practical reasons, the authorisation register can be partly completed after the flight. Where this is the case, the details provided must at least include the operation zone and the minimum altitude
  c. It may be sufficient to state the basic combat techniques [BGTs] and/or route numbers in the case of orders within the context of maintaining flight skills, the training programme or set/standard routes. In the case of training and conversions it may be sufficient to state the order number in accordance with the syllabuses.
  (..)
- 5.1.4. Authorisation of altitude
  The minimum altitude for which no separate authorisation is required in the authorisation register is 500 feet AGL. All flights involving flight at altitudes lower than the aforementioned height must be recorded in the authorisation register as follows: place-name – altitude – place-name - (place-name) – altitude – place-name. The description of the order in the authorisation register must be sufficiently clear to ensure that no misunderstandings can arise between low-level flight within the meaning of the law (the Air Traffic Regulations) and flying below an altitude of 150 feet AGL within the context of terrain flight.

Flight preparations for aided (NVS/NVG) night operations

- 5.5.1. Weather limits
  In accordance with the provisions of the LVR 3044a:
  a. If meteorological visibility is at least 3 km and the lowest cloud (1/8 or more) is at 500 ft or higher, there are no additional restrictions
  b. Visibility using NVGs must be at least 1.5 km with a view of the ground or water, whereby the amount of residual light must be at least 0.5 mLux.
  c. If the weather conditions do not meet the requirements set out in section 5.5.1.a., 'IFR recovery' must be possible, whereby all of the IFR regulations imposed must be met.

Reconnaissance for night operations

- 5.6.1. General
  In the case of 'unaided' and 'aided' night operations, routes (and/or zones) and landing areas must be explored in advance of the flight.
  a. 'Unaided'
  (1) Routes (and/or zones) must be explored within 14 days prior to the flight
  (2) A landing area must be explored within one day prior to the flight, by means of a ground or aerial reconnaissance mission, and a taxi plan must also be drawn up.
  b. 'Aided'
  (1) Routes (and/or zones) along which flight takes place at an altitude of at least 300 ft AGL must be examined within 31 days prior to the flight
  (2) Routes (and/or zones) along which flight takes place at altitudes lower than 300 ft AGL must be examined within 14 days prior to the flight
  (3) A landing area must be explored within two hours prior to the flight, by means of a ground or aerial reconnaissance mission.
- 5.6.2. Deviations
  Reconnaissance activities may only be omitted in the following cases:
  a. In the event of landings on an open air field during which the standard approach procedures are followed
  b. If during a landing in a landing area it is possible to follow the 'unexplored landing site at night' procedure for operational reasons; see the relevant SOPs
  c. In the case of zones and routes in which or along which operations are carried out on an almost daily basis, a so-called 'hazards map' may suffice. This must be drawn up in advance of the operations on the basis of a zone or route reconnaissance. The chart must subsequently be amended after each flight, as part of the debriefing, and new information distributed where appropriate. Provided that this procedure is followed and operations are carried out on an ongoing basis in the zone or along the route, the 'hazards map' can suffice for a maximum period of 31 days.
  d. In the case of aided night flights involving flight at a minimum altitude of 500 ft AGL and a minimum of 200 feet above obstacles indicated on the flight chart situated within 5 Nm.
  e. In the case of unaided night flights involving flight at a minimum altitude of 1000 ft AGL and a minimum of 500 feet above obstacles indicated on the flight chart situated within 5 Nm.

Execution of the flight

- 6.1.12. Terrain flight
  The term 'terrain flight' is used to refer to operations that make use of the terrain, the cover and man-made obstacles in order to increase the operational survival probability. Terrain flight is carried out almost entirely below 150 ft AGL with the 'hover' altitude as the minimum altitude and includes the following techniques:
  a. General low-level flight
  General low-level flight is (usually) carried out between 150 ft AGL and the obstacles situated on the terrain. Unless the weather, load or suchlike dictate otherwise, flight is carried out at a constant speed, along straight lines and at a steady altitude.
  b. Contour flight
  Contour flight is carried out at a low altitude, following the contours of the terrain. The flight speed is as constant as possible and is determined by the flight visibility and surveyability of the terrain, whereby the power surplus must also be sufficient to ensure that obstacles can be avoided at all times. The altitude is such that it is only necessary to deviate from this altitude in the case of dominant obstacles. The aircraft always passes *above* high-voltage cables and bridges.
  c. Stealth flight
  Stealth flight is a flight technique in which the speed is made entirely subordinate to the primary requirement to remain under cover. Obstacles can be passed under where necessary. The altitude is such that the helicopter does not stand out against the horizon, or only stands out to a minimal extent. The aircraft does *not* pass below bridges.

- 6.1.13. Limiting noise levels
  In addition to the provisions of the LVVKLu in relation to low-level flight and the limiting of noise levels an additional focus must be placed on avoiding excessively high noise levels during the execution of flight operations. (..)

Apache Flight Training Book [*Apache Vliegoefeningenboek*, AVB][58]

PART III FLIGHT EXERCISES

Crew concept & crew briefing

- 1.5.1. Standard division of tasks during flights:
  - Pilot Flying (usually the back seater): operation of the bus, radiotelephony in relation to Air Traffic Control
  - Pilot Not Flying (usually the front seater): navigation and setting up of NAV page, Tactical radiotelephony
  The aircraft commander can of course decide to deviate from this standard division of tasks. (For example: as the PNF, the aircraft commander takes over R/T with ATC)
- 1.5.4. Crew communication
  If circumstances mean that one of the crew members must focus his attention inside the cockpit for an extended period of time instead of monitoring the situation outside of the bus, he must declare this by issuing the call: "I am inside" so that the other crew member can move his focus 'outside'. This is particularly important if it concerns the PF. The issuing of warnings is important in order to ensure that both crew members are on the same level in terms of awareness of potential hazards or restrictions with regard to the normal execution of a flight. Warnings are issued in the event of:
  Potential hazards (cables during low-level flight, other aircraft in the vicinity)
  (..)
- 1.5.7. Crew briefing:
  The crew briefing concentrates on checking whether the division of tasks between the crew members is clear with regard to:
  - all preparations
  - the execution of the mission
  - crew concept
  - mission equipment
  A sample crew briefing check list can be found in Appendix B.

Navigating cables

- 18.1. Objective
  To learn how to pass below cables safely.
- 18.2. Theory
  The height of the bus is 20 feet. Allow for 10 feet above and below the bus. The lowest cable must not be lower than 40 feet. The altitude can be determined by hovering at the same height as the lowest cables and reading the radio altimeter. It is possible to determine whether you are at the same height at the cables as follows: if the cables become 'one' you are at the same eye level. Just like the eyes of the front seater and the back seater, the FLIR sensors are positioned higher than the radar altimeter. This means that you should always make conservative estimates when determining the height of the cables. However, this method is not always tactically advisable.
- 18.3. Limitations
  If it is not possible to make out the cables using the FLIR when negotiating cables at night-time, it will be necessary to carry out a reconnaissance during daylight.
- 18.4. Basic principle
  The aircraft is hovering near to the high-voltage cables to be negotiated. It is (tactically) impossible to pass over the top of the cables.
- 18.5. Execution
  Make a reconnaissance stop
  Determine the point at which the aircraft will pass the cables; near to the pylon (the greatest distance between the lowest cable and the ground) and at a safe distance.
  Determine the height of the lowest cable.
  Examine the terrain below and beyond the cables. Watch out for secondary cables, steep terrain, obstacles, drifting sand etc.

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[58] Apache Flight Training Book. Laid down by the Commander of the Royal Netherlands Air Force by order no. 15005. Pub no. 061764. Version 1.3 dated July 2006.

Take PIDV ('fly-to point').
Fly to a maximum of 10 feet on the radar altimeter at a crawl towards the passing point. Check the distance between the passing point and the pylon.
If this distance is sufficient, do not look at the cables again, but move at a crawl (hover-taxiing) below the cable. Take the PIDV to check the bearing.
Continue to observe the terrain situated beyond the high-voltage cables whilst passing below the cables. Move forward slowly, until you are sure that the whole helicopter has passed the cables. The PNF must state that the cables are clear. Slowly accelerate after passing the cables, so that the tail does not lift up too high.

- 18.6. Airmanship
  High-voltage cables can become dangerous obstacles. Telephone cables can be even more dangerous. During stealth flight, be constantly prepared for these cables. Cables can be hidden between trees, behind slopes or can be difficult to make out against a natural background.
  The direction of the pylons indicates the course of the cables. The pylons generally follow the relief of the terrain.
  Never remain hovering in the vicinity of a high-voltage cable for a long period of time, as these are often used by ground patrols as a line reference. You should also never follow a high-voltage cable for this reason.
  Once a high-voltage cable has been spotted there is a risk that the pilot will concentrate (too) intensely on the cable, therefore missing a second, smaller cable or branch.
  Not every high-voltage cable is negotiated in the same way. This depends on the tactical situation, the height of the pylons and the surrounding terrain.

NVG (Night Vision Goggles)

- 36.1. Objective
  To be able to fly the Apache back safely using Night Vision Goggles (NVG) from the front seat in an emergency situation, during adverse weather conditions and/or in the event of defective sensors (possibly as a result of generator failures) and if a climb-out is not an option.
- 36.3. Limitations
  - In principle, NVGs are only used in the front seat to help to identify targets.

  (..)

Appendix B of the Apache Flight Training Book

CREW BRIEFING CHECK LIST

<u>MISSION PREPARATION</u>
1. Diplo clearances, PPR nos., Accommodation, FP measures, Travel orders
2. WX, Notams, Hazards
3. Performance planning, W&B
4. Flight plans
5. Mission Planning & Briefing
6. Flight Ops checkout, crew currency & status
7. Intell checkout
8. SBB briefer
9. Walk around

<u>MISSION</u>
1. Mission purpose
2. Mission cycle
3. Special duties of front seater & back seater
4. Time Line

<u>CREW CONCEPT</u>
1. Deviations from standard crew concept
- Crew duties
- Checks
- Transfer of controls
- Crew communication
- Two challenge rule
- Emergencies (crew duties, rally point, ICS Failure)
2. Crew specific issues
3. Flight Instruction: Simulated E.P.s

<u>MISSION EQUIPMENT</u>
1. Nomex flightwear ID tags, ID cards, bloodshits
2. Helmet, survival vest, flash lights, batteries
3. Special survival equipment (dry-suits, dinghies),
water, grab packs, weapons & ammo
4. Authorisation book, crew relief bags, sickness bags

5. Msn data, maps, pubs, PPR nos, Diplo nos.
6. Code lists, DTC, Video tapes, TDC
7. GSM, Sat-tel
8. NVGs
9. Combat gear

QUESTIONS / SUGGESTIONS

Rules in respect of the training programme for the AH-64D attack helicopter THGKLU

These rules form the basis for the Annual Training Programme (JOP) and can therefore be found in full in Appendix 3.

Gilze-Rijen catchword file
Catchword A-4[59]
It is possible to practise passing below high-voltage cables at the following locations:
- Hulshorst – 31U FU 8455 0545
- Entire high-voltage cable between 31U FU 8900 1965 and 31U GU 0000 1945

At all locations, aircraft are only permitted to negotiate cables if:
The cables are negotiated at a distance of at least 500 metres from any buildings.
The cables are negotiated at a distance of at least 500 metres from any people and/or livestock present.
There are no clear potential sources of complaints about noise and/or claims for compensation.
If there are crops on the land, a different location should be used, or the aircraft should return to the site after harvesting. The following coordinate in particular has been found to be very problematic 31U FU 9219 (East, South/East of Dronten).

[59] Gilze-Rijen catchword file, catchword A-4. Subject: negotiating cables. Date of entry into force 16-11-99

APPENDIX 3 RULES IN RESPECT OF THE TRAINING PROGRAMME FOR THE AH-64D ATTACK HELICOPTER[60]

References
A - VOB KLu 11th Revised edition
B - Flight hour reduction card WAAK STL2001.032.419, dated 16 July 2001
C - DRPTHGKLu/GZR, B2005.004646, dated 15 Feb 2005
D - Defence Strategic Plan 1998 (DSP-98)
E - Rules in respect of the standardisation of instruction, training and evaluation of Royal Netherlands Air Force helicopter units,
Pub No. 030099

Appendix (appendices)
A - Overview of general flying and continuation training
B - Qualification and tactics, techniques and procedures (TTP)
C - Minimum LTC training requirements
D - List of abbreviations used

1. Information

1.1. Introduction

1.1.1. As part of the primary task of the Royal Netherlands Air Force Tactical Helicopter Group [THGKLu] the attack helicopter [GH] is used for specific combat operations and support. In order to be able to perform these tasks and guarantee deployment, the crew members of the GHs (hereinafter referred to as pilots) must constantly keep their general and operational flight skills up to the required standard to ensure that they retain ´Combat Ready´ status (CR status) or are able to achieve this within a reasonable period of time.

1.1.2. The information in the Dutch-language rules contains various English language terms that are difficult to translate or that are assumed to be generally known. These terms have been reproduced literally for the sake of readability. Appendix D contains a list of abbreviations used.

2. Objective

2.1.1. To lay down more detailed guidelines and provisions in respect of the Annual Training Programme (JOP) for pilots of the AH-64D attack helicopter.

3. Execution

3.1 Missions

3.1.1. The resources of the Royal Netherlands Air Force can be deployed for the purpose of ‘allied defence’, ‘crisis management', ‘military humanitarian emergency aid’ and ‘national duties' (reference D). In this context, it must be possible to take action across the entire spectrum of force. Pilots must be able to carry out the tasks assigned and offered to them within the context of this deployment both during daylight and in darkness.

3.1.2. <u>Missions.</u>
Missions that must be carried out by the Apache pilots are:
a. Attack missies
   (1) Deliberate attack
   (2) Hasty attack
   (3) Close Air Support (CAS)
   (4) Close Combat Attack (CCA)
b. Security missions
   (1) Screen

[60] Rules in respect of the training programme for the AH-64D attack helicopter THGKLU. Laid down by the Commander of the Royal Netherlands Air Force by order No. 015211. Pub No. 061834. 1st edition dated 23 August 2006.

(2) Guard
(3) Aerial escort
(4) Convoy escort
c. Reconnaissance missions
(1) Area Reconnaissance
(2) Route Reconnaissance
(3) Zone Reconnaissance
d. Surveillance
e. Airborne FAC[61] (ABFAC)
f. Personnel recovery/Combat Search and Rescue (PR/CSAR)[62]
g. Support[63]

3.2. General training programme

3.2.1. Available flight hours

140 flight hours are available per pilot per year for the JOP of Apache pilots (reference B). A number of the preconditions in respect of the reduction in the number of hours from 180 to 140 have not yet been met. This has had an impact on the quality of the programme, however this effect cannot be overcome for the time being. For the purpose of the schedule, the JOP is calculated in numbers of operations. The average duration of an operation is 1.7 flight hours, which corresponds to 82 operations. In addition to the flight hours, 35 Longbow Crew Trainer (LCT) hours or 23 LCT operations are allocated.

3.2.2. Allocation of operations

Squadron pilots are allocated a full JOP consisting of 82 operations. The pilots in the squadron staff are assigned a half JOP consisting of 41 operations. Instructors from the Apache Instruction and Training Service [BOT-AH] are also allocated a half JOP. Visiting pilots are allocated a minimum JOP of 29 operations. Twenty LCT operations are available on an annual basis for squadron pilots, squadron staff pilots and visiting pilots.

3.2.3. Structure of the programme

The training programme consists of general flying (GF), continuation training (CT), operations that can be allocated on a flexible basis and LCT operations. Support operations do not form part of the JOP. The various categories are explained in greater detail below. Appendix A contains a detailed overview of the GF, and CT flight training. A detailed overview of the LCT operations can be found in appendix C.

a. General Flying
The aim of the GF part of the JOP is to maintain basic flight skills. The Apache Flight Training Book (AVB) describes the flight manoeuvres and techniques that the pilot must have mastered. The method of execution is also set out in the AVB. In this part of the training, a number of operations are also reserved for the purpose of meeting the currency obligations pursuant to reference A (JVT and STV). The GF operations are carried out single ship.

b. Continuation training
The CT is made up of blocks that correspond to the types of missions that the squadron carries out, as well as weapon training. The complexity is built up per mission type in the CT programme. The aim is for this structure to act as a basis for the squadron's planning. The complexity can be selected for each training period, depending on the level of training received and the training facilities available.

c. Operations that can be allocated on a flexible basis
The operations that are not used for GF, CT and SUP are used as additional CT operations. The squadron commander allocates the additional CT operations. Pilots with an ABFAC qualification must be allocated at least three operations in order to retain their ABFAC currency.

d. Support
Those missions that must be flown but that provide little or no value in terms of training are recorded in the SUP category. This includes external support, such as Open Days and Air Power Demos. Self-deployment and ferry operations are also grouped in this category if they cannot be classed under GF navigation. The aim is to limit the number of SUPs to a minimum.

e. LCT operations
The LCT supports the flight programme. The LCT operations have the same structure as the flight programme. The JOP in the LCT includes GF, CT and operations that can be allocated on

[61] Only a limited number of pilots have an ABFAC qualification.
[62] Only a limited number of pilots have a CSAR mission leader qualification.
[63] For an explanation, see section 3.2.3.d.

a flexible basis. Support operations are also flown in the LCT. These support operations do not fall under the JOP LCT.

3.2.4. Longbow Crew Trainer (LCT)

The LCT programme includes 23 operations, 13 of which are assigned to fixed categories. The squadron commander assigns the remaining 10 operations in order to tailor the level of training received to each pilot. The average duration of an operation in the LCT is 1.5 hours. The LCT is a crew trainer in the first instance. Tactical training is only possible to a limited extent. It is, however, also possible to practise a number of TTPs in the LCT. Appendix B provides an overview of this.

3.2.5. Additional provisions

a. ABFAC
Only a limited number of pilots are ABFAC qualified. ABFAC operations are therefore not included in the CT training. Pilots with an ABFAC qualification must meet the STANAG 3797 ´minimum qualifications for forward air controllers´ currency requirements. Operations that can be allocated on a flexible basis must be used in order to meet this currency requirement.

b. CSAR rescue commander
Only a limited number of pilots are able to act as a CSAR rescue commander. All other pilots are able to take part in CSAR missions, however they are not able to independently lead the missions.

c. Supervision
The supervision qualifications Section Leader (SL), Flight Leader (FL), Mission Leader (ML) and Air Mission Commander (AMC) must be practised. Pilots must meet the obligation described in appendix B on an annual basis in order to be able to act as SL, FL, ML and AMC during deployment.

d. Weapon Training
The details of the weapon training part of the CT operations are set out in the OBA TL/ OPS/H-046.

e. TTPs
The pilot must have mastered various tactics, techniques and procedures (TTPs) in order to qualify as CR. On setting up the training programme, these TTPs must be incorporated into the CT. TTPs that have been practised are recorded in order to provide an insight into the level of training received. A number of TTPs can be practised in both the Apache and the LCT. The list of TTPs can be found in appendix B.

3.3. Requirements in respect of CR status

3.3.1. Once they have passed the MQT, pilots are awarded CR status. Squadron pilots retain their CR status by meeting the JOP obligation. A pilot must fly a minimum number of CT operations in order to retain CR status. In this context, a distinction is made between experienced and inexperienced pilots. Experienced pilots are able to retain their CR status with less CT training than inexperienced pilots. A pilot who has more than two years' experience as an aircraft commander is classed as experienced. First pilots are inexperienced by definition.

3.3.2. Appendix A provides an overview of the type and number of CT operations that experienced and inexperienced pilots must fly as a minimum in order to retain CR status. If the CR requirements are not met, the pilot's status will lapse to LCR. In order to work their way back up from LCR to CR, pilots must eliminate their CT backlog. A pilot who has LCR status can, however, be deployed for those types of missions for which the CT requirements have in fact been met. The status of pilots who meet the GF and CT requirements, but who have not flown 140 hours, is determined by the air base commander based on the recommendation of the squadron commander.

3.3.3. Visiting pilots do not have a sufficient number of operations available to meet the requirements imposed in respect of CR status. Pilots from this category therefore have LCR status. Based on the recommendation of the squadron commander, the air base commander determines the number and type of operations that must be flown by visiting pilots in order to work their way up to CR status. The proficiency training programme is tailor-made to suit each pilot and is carried out under the supervision of a flight instructor and a weapons instructor. Once the proficiency training has been completed, the visiting pilot is put forward by the squadron commander to the air base commander for CR status.

3.4. JOP training versus deployment

3.4.1. Level of training received

Operations flown during actual periods of deployment count towards the CT JOP obligation. The operations are recorded under the most appropriate CT operation. If all of the mission types are not carried out during actual periods of deployment, the requirements in relation to the level of training received may not have been met. Where appropriate, the pilot's status will lapse to LCR. A pilot who has LCR status can only be deployed for those types of missions for which the requirements in relation to the level of training received have in fact been met.

3.5. Records

3.5.1. Period of validity

Each obligatory GF and CT operation has a period of validity of 365 days. If an operation must be flown more than once, this period of validity applies to each separate operation. The requirement in relation to the level of training received and therefore the CR status lapses after 365 days.

3.5.2. OMISKLu

All Apache and LCT operations are recorded in the OMISKLu. The period of validity is automatically updated in the OMISKLu. Operations for which the period of validity has been met are shown in green. Operations for which the period of validity has expired are shown in red. The difference between the number of operations that have actually been effectively executed over the past 365 days and the standard imposed in this regard is also shown for each type of operation (see appendix A). Types of operations that meet the standard imposed are shown in green. Types of operations that do not meet the standard imposed are shown in red.

In the case of ABFAC qualified pilots, an up-to-date record of the number of runs effectively controlled is maintained in the OMIS. Expired currencies are shown in red. In the case of CSAR rescue commander qualified pilots, an up-to-date record of the number of operations during which this role was fulfilled is maintained in the OMIS.
In the case of pilots with the qualification SL, FL, MC and AMC, an up-to-date record of the number of operations during which the role in question was fulfilled is maintained in the OMIS. Expired currencies are shown in red.
In addition to the operations, the TTPs as shown in appendix B are also recorded in the OMISKLu. There is no currency requirement linked to the TTPs. These records provide the squadron commander with a detailed insight into the progress made in relation to training. All operations flown are submitted to the squadron commander or detachment commander via the OMIS. He is then responsible for determining whether or not the operation was effective. The currencies are not updated until an operation has been judged to have been effective. The squadron commander or detachment commander may delegate this power to his H-OPS or S3 Air.

3.6. Waivers

3.6.1. GF and CT waivers

A pilot's status is automatically updated by the OMIS. The air base commander is authorised to deviate from this status. He can do this by issuing a waiver. The reason for issue and period of validity must be stated on issuing the waiver.

3.6.2. Weapon training waiver

The authority to issue waivers in respect of weapon training is set out in the Regulations in respect of the execution of fire missions within the annual training programme of the 301 squadron (AH-64D)

3.7. Quality control

3.7.1. Quality control takes place in two areas. In the first instance, quantitative requirements are imposed on the training programme in the form of the JOP. Qualitative requirements are also imposed in respect of the execution of the programme. The qualitative requirements are set out in the AVB, the TACSOP and the Regulations in respect of the execution of fire missions within the annual training programme of the 301 squadron (AH-64D). These requirements are tested by means of test flights such as the JVT and the STV and the arms qualifications. A flight is also assessed as a unit at least once every year in a tactical scenario. This assessment must be recorded by the squadron commander.

3.8. Administrative provisions

3.8.1. CLSK/DO/H-AHO is responsible for maintaining these rules.

3.8.2. These rules must be reviewed during September of each year.

Appendix A to the Rules in respect of the training programme for the AH-64D attack helicopter THGKLu

Overview of general flying and continuation training

See appendix D for a list of abbreviations used.

GENERAL FLYING (GF)				
NO.	IDENTIFIER	DESCRIPTION	EXPERIENCED PILOT	INEXPERIENCED PILOT
1	JVT	SS	1	1
2	STV	SS	1	1
3	AV 1	SS	1	2
4	AV 2	SS N	1	1
5	AV 3	SS HVY	1	2
6	NV 1	SS	1	2
7	NV 2	SS N	1	1
8	IF 1	SS	3	4
			10	14

ATTACK (CT)				
NO.	IDENTIFIER	DESCRIPTION	EXPERIENCED PILOT	INEXPERIENCED PILOT
1	DB 1	SE D/N	1	2
2	DB 2	FLT D	1	1
3	DB 3	FLT N	1	1
4	HS 1	SE D	1	2
5	HS 2	SE N	1	1
6	HS 3	FLT D/N	1	1
7	CA 1	SE D LO&HI	1	2
8	CA 2	SE N LO&HI	2	2
9	CC 1	SE D	1	2
10	CC 2	SE N	1	2
			11	16

RECONNAISSANCE (CT)				
NO.	IDENTIFIER	DESCRIPTION	EXPERIENCED PILOT	INEXPERIENCED PILOT
1	AR 1	SE N	1	1
2	RR 1	SE	1	1
3	ZR 1	FLT	1	1
			3	3

SECURITY (CT)				
NO.	IDENTIFIER	DESCRIPTION	EXPERIENCED PILOT	INEXPERIENCED PILOT
1	SG 1	SE	1	1
2	SG 2	SE/FLT N	1	1
3	CV 1	SE	1	2
4	CV 2	SE N	1	1
5	AE 1	SE	1	2
6	AE 2	FLT N	1	1
			6	8

PERS. RECOVERY/ COMBAT SEARCH &RESCUE (CT)				
NO.	IDENTIFIER	DESCRIPTION	EXPERIENCED PILOT	INEXPERIENCED PILOT
1	PR 1	SE	1	1
2	PR 2	SE N	1	1
3	PR 3	FLT	1	1
			3	3

SURVEILLANCE (CT)				
NO.	IDENTIFIER	DESCRIPTION	EXPERIENCED PILOT	INEXPERIENCED PILOT
1	SU 1	SE/FLT D/N	0	0

WEAPONS (CT)				
NO.	IDENTIFIER	DESCRIPTION	EXPERIENCED PILOT	INEXPERIENCED PILOT
1	WP 1	Table 1	1	1
2	WP 2	Table 2	1	1
3	WP 3	Table 3	1	1
4	WP 4	Table 4	1	1
			4	4

Appendix B to the Rules in respect of the training programme for the AH-64D attack helicopter THGKLu

Qualifications and tactics, techniques and procedures (TTP)

The list below shows the qualifications and TTPs that must be incorporated into the CT. There are currency requirements linked to ABFAC and supervision level. There are no currency requirements linked to the TTPs. The method of execution of the TTPs is set out in the TACSOP AH.

a. Qualifications with currency[64]:
  (1) ABFAC: currency requirements in accordance with STANAG 3797
  (2) Supervision levels:
    (a) SL: at least 8 operations per year
    (b) FL: at least 4 operations per year. One FL operation is equal to 2 SL operations
    (c) ML: at least 1 operation per year. One ML operation is equal to 1 FL operation and 2 SL operations
    (d) AMC: at least 1 operation per year. One AMC operation is equal to one ML, one FL operation and two SL operations.

b. TTPs with no currency:
  (1) Air Assault *(These TTPs are not recorded in the LCT)*
  (2) NVG targeting *(These TTPs are not recorded in the LCT)*
  (3) Low-level Dynamic Operations
  (4) High Level Dynamic Operations
  (5) Stationary Operations
  (6) Evasive Manoeuvring (EVM)
  (7) Operations in Electronic Warfare (EW) Conditions
  (8) Radar Threat Handling
  (9) IR Threat Handling
  (10) Tactical IIMC procedures
  (11) Battle Handover
  (12) FARP Operations
  (13) Arty request
  (14) Heavy Load *(These TTPs are not recorded in the LCT)*
  (15) Brown Out Landing *(These TTPs are not recorded in the LCT)*
  (16) Mountain flying *(These TTPs are not recorded in the LCT)*

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[64] These operations cannot be flown in the LCT

(17) Hill flying *(These TTPs are not recorded in the LCT)*
(18) Close Formation Flying *(These TTPs are not recorded in the LCT)*

Appendix C to the Rules in respect of the training programme for the AH-64D attack helicopter THGKLu

Minimum LCT training requirements

LONGBOW CREW TRAINER (LCT)				
NO.	IDENTIFIER	DESCRIPTION	EXPERIENCED PILOT	INEXPERIENCED PILOT
GENERAL FLYING				
1	EP 1	D/N	4	4
2	IF 1		2	2
CONTINUATION TRAINING				
3	AT 1	D	1	1
4	AT 2	N	1	1
5	AT 3	D	1	1
6	RA 1	D/N	1	1
7	SA 1	D/N	1	1
8	WP 1	D	1	1
9	WP 2	N	1	1
			13	13

Appendix D to the Rules in respect of the training programme for the AH-64D attack helicopter THGKLu

Abbreviations

ABFAC	Airborne Forward Air Controller
AE	Aerial escort
AHO	Helicopter Operations Division
AGI	Additional joint instruction
AMC	Air Mission Commander
AR	Area Reconnaissance
AT	Attack
AV	Apache Flight Training Book
CA	Close Air Support
CC	Close Combat Attack
CLSK	Royal Netherlands Air Force Command
CV	Convoy Escort
CR	Combat Ready
CSAR	Combat Search and Rescue
CT	Continuation Training
DB	Deliberate Attack
DSP98	1998 Defence Strategic Plan
EVM	Evasive Manoeuvres
EW	Electronic Warfare
FARP	Forward Arming and Refuelling Point
FL	Flight Leader
FLT	Flight
GF	General Flying
GH	Attack helicopter
HAHO	Head of the Helicopter Operations Division
HS	Hasty Attack
HI	High-altitude operations
HVY	Heavy Load
IF	Instrument Flying
IFR	Instrument Flight Rules
IR	Infra Red
JOP	Annual Training Programme

JVT	Annual Flight Test
KLu	Royal Netherlands Air Force
LCR	Limited Combat Ready
LO	Low-altitude operations
ML	Mission Lead
NV	Navigation
NCR	Non Combat Ready
NVG	Night Vision Goggles
OMISKLu	Royal Netherlands Air Force Operational Mission Information System
OBA	Permanent Order
PR	Personnel Recovery
RA	General recce
RR	Route Reconnaissance
SA	General security
SC	Screen
SE	Section
SG	Screen and/or Guard mission
SL	Section Leader
SS	Single Ship
STV	Standardisation Training Flight
SU	Support Operation
TACSOP	Tactical Operating Procedures
TAK THG	Activities calendar
THGKLu	Royal Netherlands Air Force Tactical Helicopter Group
TTP	Tactics, Techniques and Procedures
VOBKLu	Royal Netherlands Air Force Flight Order Book
WAAK	Royal Netherlands Air Force Target Level Analysis Task Force
WP	Weapon training
ZR	Zone Reconnaissance

APPENDIX 4 (OTHER) PARTIES INVOLVED AND THEIR RESPONSIBILITIES

This appendix provides a description of the parties involved referred to in Chapter 4, as well as a description of the other parties involved.

THE CENTRAL STAFF

For the mutual relationships between the various parties please refer to appendix 5: Central Staff Organisation Chart.

The Ministry of Defence
The Ministry of Defence includes the following units[65]:
- the Office of the Secretary General
- the Defence Staff
- the Military Aviation Authority.

The Ministry of Defence operates in accordance with an official hierarchical model. This means that the Secretary-General, Director-Generals, Directors and Commanders have a hierarchical responsibility for all results of all matters relating to the Ministry, their Directorate-Generals, Directorates, units and commands respectively.

The Minister of Defence
The Minister of Defence is (politically) ultimately responsible for the Ministry. All tasks performed by officials stand in the light of the political responsibility of the Minister. The Minister's powers are often delegated. In principle, all powers in respect of the primary processes and operational management are delegated to the overall manager (general mandate), with reservations (special mandate) or otherwise.

The Secretary-General
The Secretary-General (SG) is officially ultimately responsible for managing all of the units. The SG is granted the power to take decisions on behalf of the Minister of Defence (mandate), to carry out legal acts under private law (power of attorney) and to carry out other acts (authorisation). The SG has delegated some of these powers. The Office of the Secretary-General is managed by the Secretary-General.

The Chief of Defence
The Defence Staff is managed by the Chief of Defence (CDS). The CDS is the Minister's highest placed military adviser, corporate planner, needs assessor and corporate operator. The CDS is in command of the three Operational Commands (OCs) of the armed forces. In his role as corporate operator, he is charged with and has overall responsibility for managing the deployment and preparatory process of the Operational Commands. The CDS directly manages the (Commanders of the) Operational Commands and has primary responsibility for the execution of military operations. He does this within the frameworks created by the defence policy of the Central Staff. Management of the Operational Commands is carried out by means of the development, transfer, monitoring and evaluation of frameworks and standards, amongst other things.

The Military Aviation Authority
The Military Aviation Authority (MLA) is part of the Central Staff of the Ministry of Defence. It guarantees that activities within the Dutch military aviation system are carried out with an acceptable risk level.

The Military Aviation Authority is managed by the Head of the Military Aviation Authority, who is charged with:
- the official management of his staff, subject to due observance of the instructions and guidelines issued by the Secretary-General
- guaranteeing that the activities in relation to Dutch military aviation are carried out within the applicable legislation and regulations
- advising the political and administrative leaders on aspects of military aviation, formulating guidelines and requirements in this respect and supervising implementation and execution in this regard

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[65] Ministry of Defence General (Organisation) Decree 2005, MP 10-100.

- assessing whether individuals or organisations meet the requirements imposed and granting permission on the basis of this for the performance of activities in relation to aspects of military aviation, or issuing further relevant guidelines
- responding to requests for information from the (deputy) Secretary-General, in relation to his own areas of responsibility
- the effective organisation, operational management and internal management of the military aviation authority
- taking decisions and carrying out other activities for the purpose of implementing the Aviation Act and the Act on Aviation.

THE ROYAL NETHERLANDS AIR FORCE COMMAND

For the mutual relationships between the various parties please refer to appendix 11: Relevant facts and data.

The Commander of the Royal Netherlands Air Force[66]
The CLSK is managed by the Commander of the Royal Netherlands Air Force (C-LSK), whose responsibilities include:
- managing the Royal Netherlands Air Force Command, subject to due observance of the instructions and guidelines issued by the Chief of Defence
- the effective organisation, operational management and internal management of the Royal Netherlands Air Force Command
- executing the tasks of the Royal Netherlands Air Force Command, i.e. preparations for deployment, maintenance, aftercare and recovery of operational capacity
- providing advice on defence policy on the basis of his responsibility for executing the tasks of the Royal Netherlands Air Force Command
- drawing up demands and quality requirements in respect of the products and services to be provided by the Support Command and the Defence Materiel Organisation, within the frameworks imposed.

The C-LSK is also responsible for and charged with the formulation and implementation of policy in respect of the occupational safety, health and welfare of military and civilian personnel employed by the CLSK. This policy must comply with defence policy.

The Directorate of Operations[67]
The Directorate of Operations is managed by the Director of Operations, whose responsibilities include:
- the official management of the Directorate of Operations, subject to due observance of the instructions and guidelines issued by the Commander of the Royal Netherlands Air Force
- guaranteeing the quality of operational skills and deployability within the Royal Netherlands Air Force Command. This includes drawing up or refining and monitoring operational quality standards, and periodically assessing the extent to which these are being met, as well as initiating the required corrective actions
- responding to requests for information from the Commander of the Royal Netherlands Air Force, in relation to his own areas of responsibility.

The Commander of the Gilze-Rijen Air Base[68]
The Commander of the Gilze-Rijen air base makes helicopter capacity available on behalf of the C-LSK for the purpose requested by the CDS and for the necessary preparatory activities. The air base commander is responsible for the financial results of the helicopter capacity (products) to be provided and the way in which this is achieved. The brief consists of two main elements.
Firstly, the provision of helicopter capacity for the purpose of continuing the current ISAF operations using attack helicopters, until the middle of 2010, potentially continuing as part of the assistance during the phasing-out stage. This also includes organising preparatory activities required for the deployment, performing other activities within the context of the further improvement of operational management and accounting for the products delivered and the manner in which this has been carried out. This includes the performance of reconnaissance, security and attack missions using attack helicopters. In order to achieve this main task, the air base must fulfil its supporting task of providing regional support.
The CLSK units, other armed forces units and national staff at the Gilze-Rijen air base and in the region must be provided with general, technical, logistical and administrative support.

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[66] Ministry of Defence General (Organisation) Decree 2005, MP 10-100.
[67] Royal Netherlands Air Force Command Subtask Order 2005.
[68] Definitive brief for 2008-2009, Gilze-Rijen Air Base.

The second main task is to implement the Ministry of Defence Helicopter Command (DHC) reorganisation plan. The transition includes the further implementation of the organisation and corresponding operational management. The transition pathway will be primarily determined by external factors, namely the introduction of the NH90 helicopter and the accompanying phasing out and disposal of other helicopters. In addition, the actual merger of the Gilze-Rijen and Soesterberg air bases to become the new DHC organisation will be carried out.

The Commander of the 301 Squadron[69]
The squadron commander is responsible for achieving the objectives imposed by the air base commander within established preconditions and is ultimately responsible for the squadron's operational (deployment) posture. For this purpose, the squadron commander has a Squadron Staff Bureau, a Squadron Operations Product Responsibility Unit (PVE) and a Preparation & Maintenance PVE at his disposal.

The main tasks of the squadron commander are:
- optimising operational management of the squadron
- promoting the squadron's interests
- ensuring continued deployability as the operational aircraft commander of the AH 64D
- managing the 301 Squadron.

The Operations Officer of the 301 Squadron[70] *(Ops Officer)*
The Operations (Ops) Product Responsibility Unit (PVE) is charged with providing sufficient aircraft crews with operational status for the execution of a mission. The Ops PVE is managed by the Head of the Operations PVE (the Operations Officer (Ops Officer)) and includes five operational flights and a Navigation section.

The Ops Officer is responsible for:
- achieving and maintaining the required operational status by implementing the scheduled JOP programme
- planning and implementing the operational component of the OBP process
- drawing up the JOP programme on the basis of the standard JOP (incl. ferry hours) the training schedule (tactess) and not combining the JOP (orders).
- the Head of the Operations PVE implements 'Planned Flying' in consultation with the Preparation & Maintenance PVE
- managing PVE operations
- ensuring good working conditions (atmosphere, order, recognition, rules etc.) with the aim of optimising the safety, health and welfare of his personnel
- implementing the THGKLu environmental management system at PVE level and ensuring "Good-housekeeping" within the PVE
- the regulations, documentation and MAS items provided to him on loan
- the operational deployment and operational readiness of the Operations PVE
- the deployment readiness of the materials made available to him.

The Duty Ops Officer[71]
The (daily) Duty Ops Officer (dd Ops) on duty has the delegated power to authorise flights during the actual performance of this role and as authoriser is therefore responsible for:
- supervising proper and comprehensive flight preparations and execution of the flight in accordance with the flight order issued
- ensuring that the flight order is in line with the regulations.

Flight Commander of the 301 Squadron[72]
The flight commander is responsible for:
- producing individuals and crews who are ready for deployment
- OBP at flight level for the purpose of executing missions
- the planning, implementation and supervision of missions
- the operational and administrative management of the flight in question

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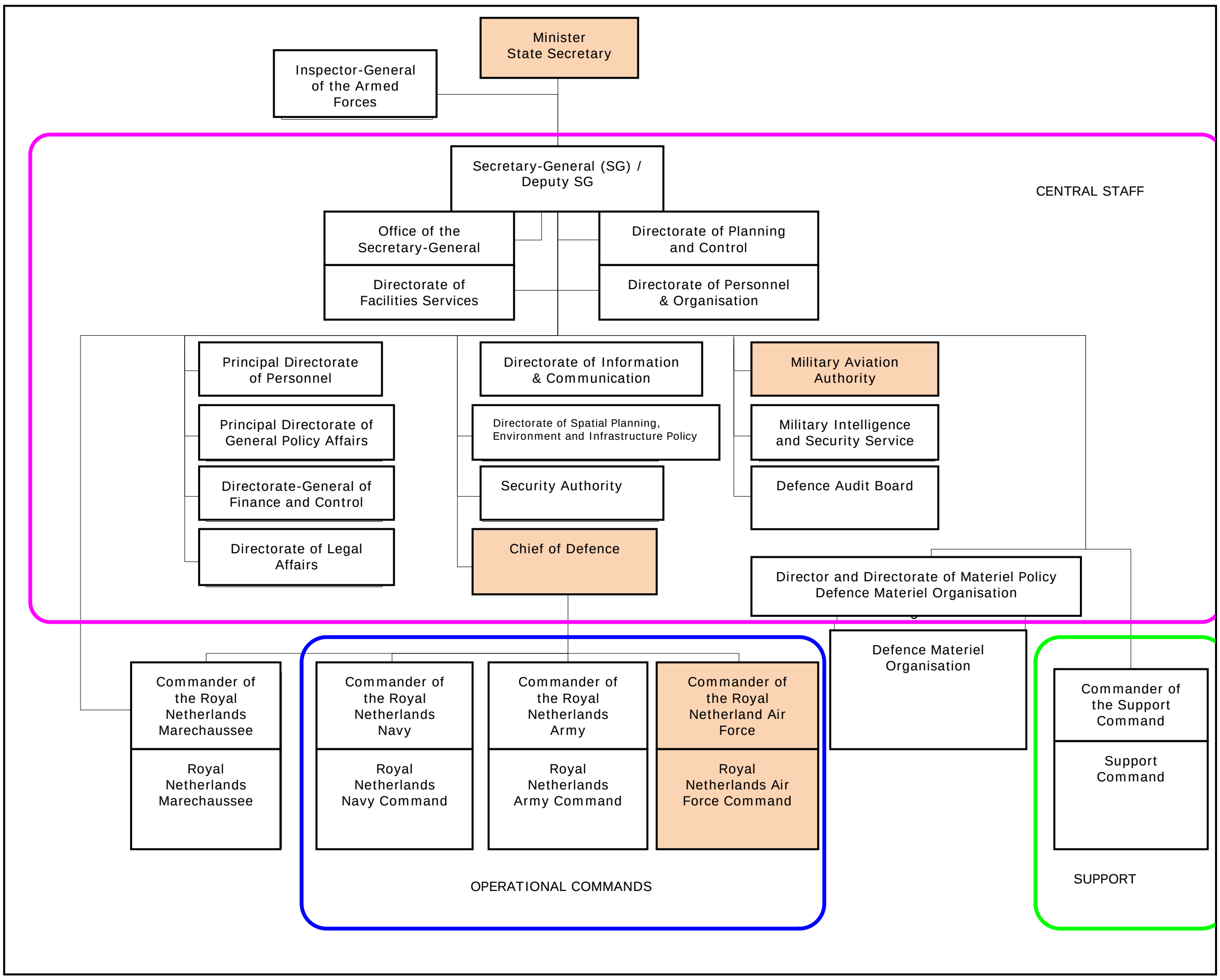
[69] Job evaluation of the Commander of the 301 Squadron.
[70] Job evaluation of the Ops Officer of the 301 Squadron.
[71] Royal Netherlands Air Force Flight Order Book. Laid down by the Commander of the Royal Netherlands Air Force by order No. CLSK 2005 50 29 064. OC No. 83-6100-001. Pub No. 010699. 11th revised edition dated 1 January 2006.
[72] Job evaluation of Flight Commanders with the 301 Squadron.

- submitting requests for information to the supporting bureaus within the squadron, to support the flight OBP
- the debriefing of missions at flight level and below
- monitoring the currencies and JOP obligations of the pilots
- reporting to the Ops Officer in relation to currencies and the operational deployability of pilots
- advising the Ops Officer in drawing up assessments
- advising and assisting the Ops Officer in drawing up the annual/quarterly/monthly/weekly schedule
- making suggestions for the purpose of realising the weekly schedules
- assisting the Ops Officer in the planning and execution of projects
- advising the Ops Officer in respect of the Evaluation and Standardisation of pilots
- the deployability, maintenance and monitoring of the material resources made available to him
- providing guidance to new personnel
- conducting performance interviews with personnel from the flight in question
- authorising flight orders
- supervising the daily flight operations and updating the daily flight schedule
- organising rosters and ensuring that working hours are recorded using Rostaflex.

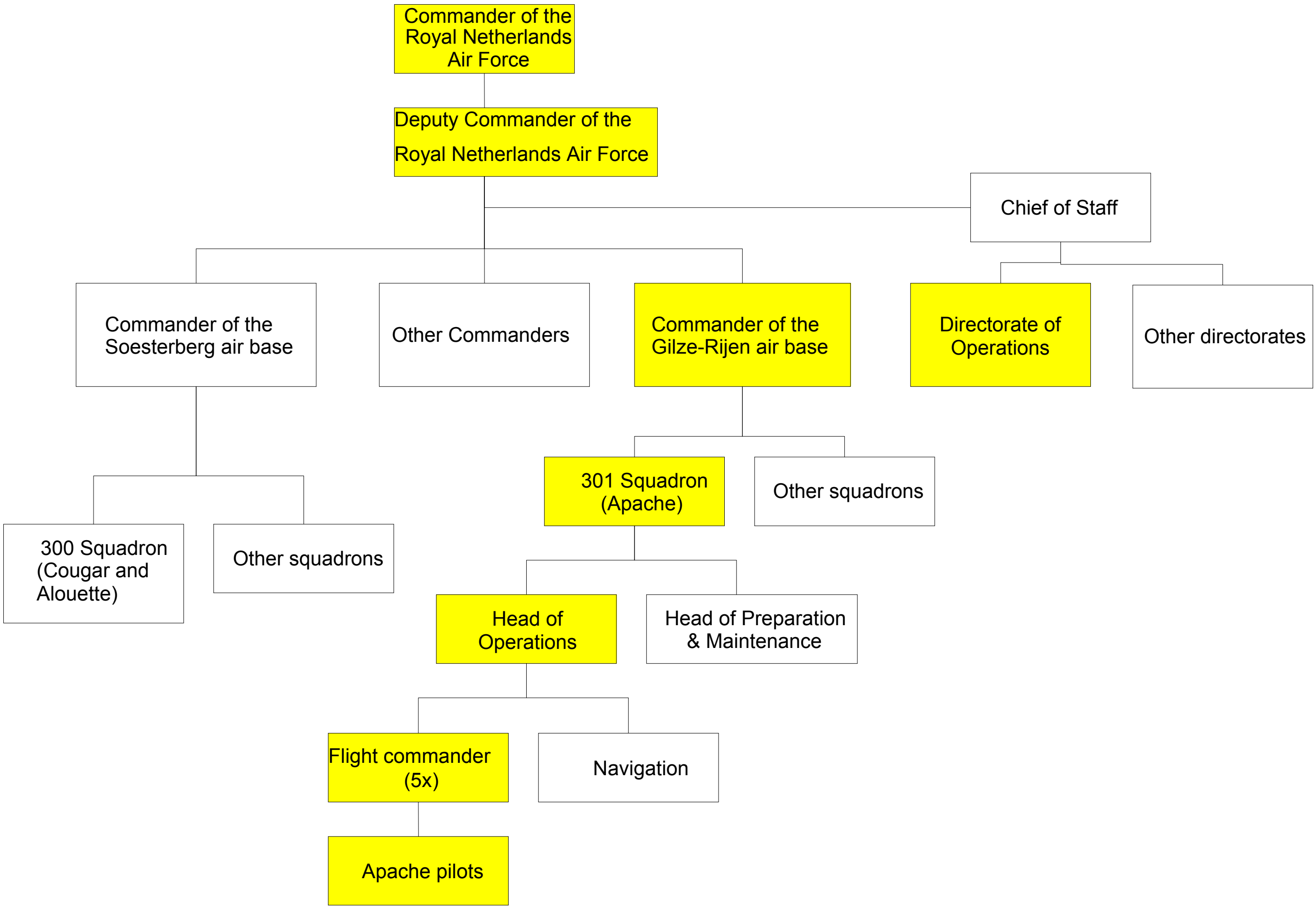
The flight commander is responsible for the operational management of:
- the deputy flight commander
- the flight pilots
- the personnel from the Operations, Support and Navigation sections, if individuals from these sections have been (temporarily) transferred to the flight to support the flight OBP.

APPENDIX 5 CENTRAL STAFF ORGANISATION CHART



APPENDIX 6 ROYAL NETHERLANDS AIR FORCE COMMAND ORGANISATION CHART

(situation as at 12 December 2007)



APPENDIX 7 HUMAN FACTORS ANALYSIS AND CLASSIFICATION SYSTEM (HFACS)

The Human Factors Analysis and Classification System (HFACS) is an analysis and classification system whereby the human factor is placed in relation to the incident. The system is founded on the model developed by James Reason and is based on the principle that human error is not an isolated cause, but rather is the result of underlying (human) factors. The system examines all perspectives of the human factor. Four different levels, which are also subdivided into further elements, are used to categorise these perspectives, so that the basis of the same human factor can be identified for different incidents. By clarifying the underlying factors, it is possible to reach accurate conclusions and issue effective recommendations.

The first level shows the human acts that were the immediate cause of the incident (unsafe acts). A distinction is made here between errors and violations.
The second level examines the circumstances that paved the way for the errors and/or violations. These are subdivided into environmental factors, the condition of the crew (conditions of operators) and/or the way in which the crew members carried out and/or were able to carry out their task and the associated responsibilities (personnel factors).
The third level examines supervision in relation to the incident (supervision).
The fourth level describes the organisational factors that influenced the incident (organisational influences), focusing on aspects such as resource management, governance climate and operational management.

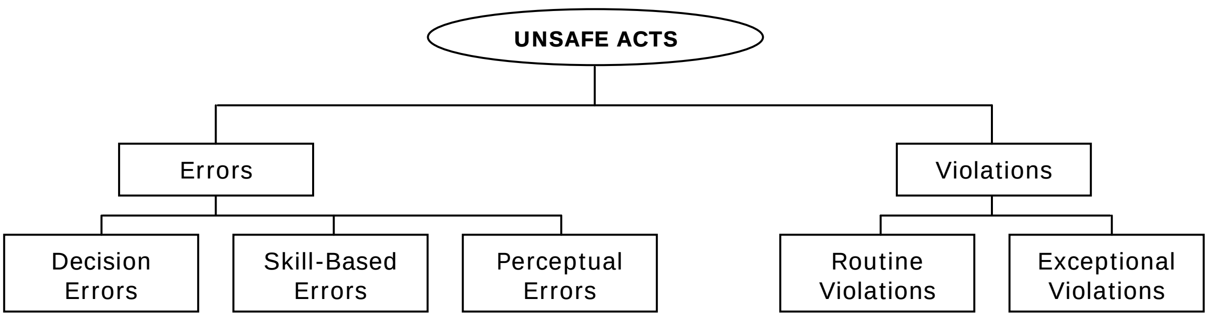
1 first level: unsafe acts

1.1 Introduction

The HFACS starts with the unsafe acts that were the immediate cause of the incident. In the case of the Apache helicopter power line collision, these acts can be described as:
'The commencement of the descent from a safe altitude to low-level flight at an unspecified altitude'.

This act was unsafe because:
- there were high-voltage cables situated in the proposed flight path
- neither the front seater nor the back seater were aware of the presence of these high-voltage cables
- it was not possible for the crew to visualise the high-voltage cables (unlike the pylons) using the visual systems present in the Apache helicopter under the existing conditions
- the front seater had not yet explicitly determined that there were no obstacles to be anticipated in the proposed flight path using the required 1:50,000 chart at the time the descent was commenced
- the flight preparations had been inadequate.

At the first level, a distinction is made between errors and violations.



1.2 Errors

Decision Errors are intentional (decision) errors based on the available information. A decision error is not a conscious violation of the rules.

- The decision by the front seater to delegate part of the flight preparations to the navigation section so that he could have something to eat and his subsequent failure to check the preparations carefully together with the back seater.
- The decision by the front seater to limit the flight preparations to a summary briefing on radio frequencies and navigation points.
- The decision to descend to a lower altitude without having checked the position of obstacles.

Skill-based errors are unintentional errors relating to the incorrect application of skills that may not have been addressed during training or follow-up training to a sufficient extent or in the correct manner.

- The back seater adopted a limited scanning pattern during the descent.
- The front seater was occupied with locating the 1:50,000 chart and finding his bearings on this chart at a critical stage during the flight.
- The flight preparations were inadequate.

Perceptual errors relate to the distortion of situational awareness as a result of a lack of perception. In the case of this incident, no aspects were identified that relate to these conditions.

1.3 Violations

Routine Violations relate to conscious acts contrary to procedures and/or regulations that are the result of the gradual development of bad habits in operational practice. It is not inconceivable that such acts are accepted by the management within an organisation.

- The preparations were inadequate due to the fact that a number of preparatory activities were carried out by others, in combination with a short crew briefing.
- On approaching the river Waal at approx. 1500 feet, the front seater took the decision to descend to a lower altitude without having explicitly checked on the chart that this was safe.
- The front seater had focused his attention inside the cockpit immediately before the power line collision, without reporting this by issuing the call: "I am inside"[73].

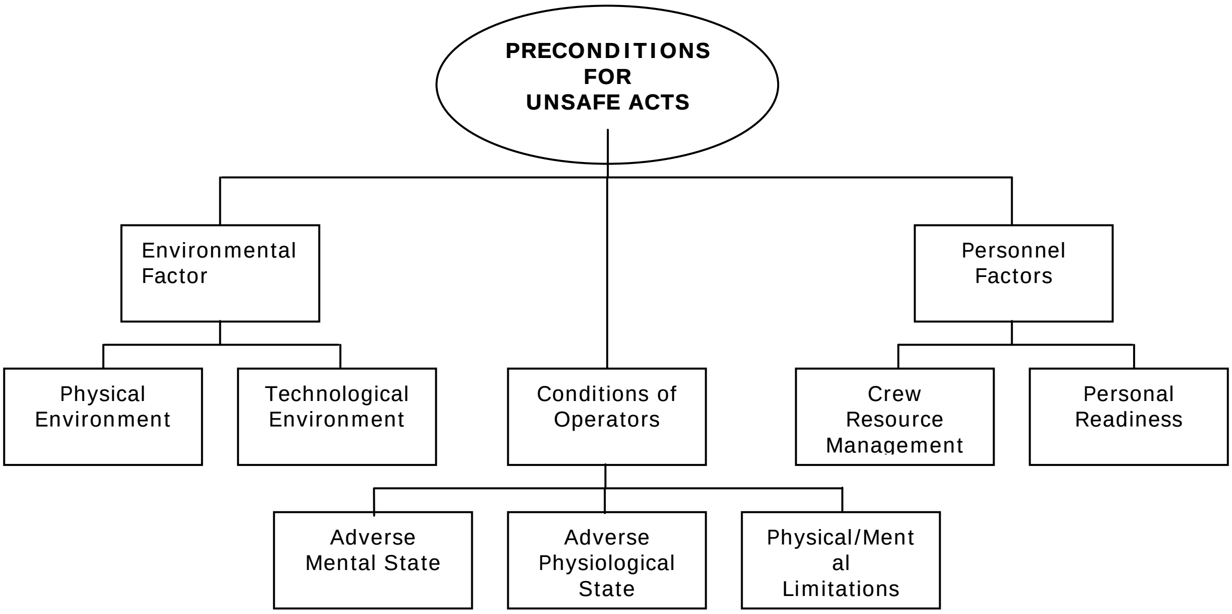
Exceptional Violations relate to exceptional conscious acts contrary to procedures and/or regulations. These types of acts (for instance intentionally flying under the cables) are not tolerated by management. No exceptional violations were identified in the case of this incident.

2 second level: preconditions for unsafe acts

2.1 Introduction

The second level examines the circumstances under which the unsafe acts took place and the potential (negative) influence of these circumstances on the acts. These are subdivided into environmental factors, the condition of the crew (conditions of operators) and/or the way in which the crew members carried out and/or are able to carry out their tasks and the associated responsibilities (personnel factors).

[73] Apache Flight Training Book (AVB), Part III: Flight exercises, section 1.5.4. Crew communication



2.2 Environmental factors

Physical Environment relates to the environmental conditions under which the incident took place.

- The flight took place under night-time conditions, shortly after nightfall.
- FLIR was used for external vision. With this system, the visibility of objects is determined by the difference in temperature (the temperature delta). If the delta is small, the contrast of the projection is also small. If the delta is too small, the object in question is not registered by the sensor. This delta partly depends on the time of day. Shortly after nightfall and shortly before sunrise, the delta is still comparatively small and omissions can easily occur.
- The weather conditions did not form an obstacle to the execution of the flight.

Technological Environment relates to technical and/or material aspects that may have influenced the incident.

- The night vision system optics are monocular (in one eye), which means that the pilot must consciously decide which images will be processed by the brain (eye-dominance, see section 2.3.2).
- Flight charts were used for the purpose of executing the flight.
- The electricity pylons between which the cables were suspended were not illuminated.
- The Apache helicopter was in an airworthy condition at the start of the flight.
- The limited resolution of the night vision system and the limitations of FLIR mean that it would have been very difficult or impossible to see the high-voltage cables.

2.3 Condition of operator

Adverse Mental State relates to the mental state of the crew and the potentially negative influence that this may have in terms of information processing and acts.

- The flight was approached as a simple mission, which can lead to complacency[74].
- The front seater had a relatively low task load during the part of the flight in which the power line collision occurred.
- After the power line collision, there was a brief period of confusion.

Adverse Physiological State relates to the physiological state of the crew and the potentially negative influence that this may have in terms of information processing and acts.
In the case of this incident, no aspects were identified that relate to these conditions.

Physical/Mental Limitations relates to certain physical or mental limitations that may have restricted the crew in the given situation.
In the case of this incident, no aspects were identified that relate to these conditions.

2.4 Personnel factors

[74] See the footnote in section 5.2.4.

Crew Resource Management relates to the communication and teamwork between the crew members during the flight.

- Despite the fact that this was not a training flight, the front seater made the conscious decision during the flight not to inform the back seater with regard to a number of elements of the flight/mission in order to introduce an element of surprise during the flight.
- The communication between the pilots appears to show that there was an authority gradient that was fostered by both crew members: the back seater took on a submissive role whilst the front seater assumed the role of a coach, despite the fact that this is not his official role and the flight in question was not a training flight. The implicit relationship between the two crew members influenced the critical communication.
- The crew members were not fully aware of one another's activities: the back seater was not aware of the fact that the front seater had been focusing inside rather than outside of the cockpit during (part of) the descent.

Personal Readiness relates to the extent to which the crew were mentally and/or physically prepared for the flight (for instance: whether or not they had had enough sleep, whether they were subject to any medical restrictions etc.).
No aspects in relation to personal readiness were identified that applied to the incident.

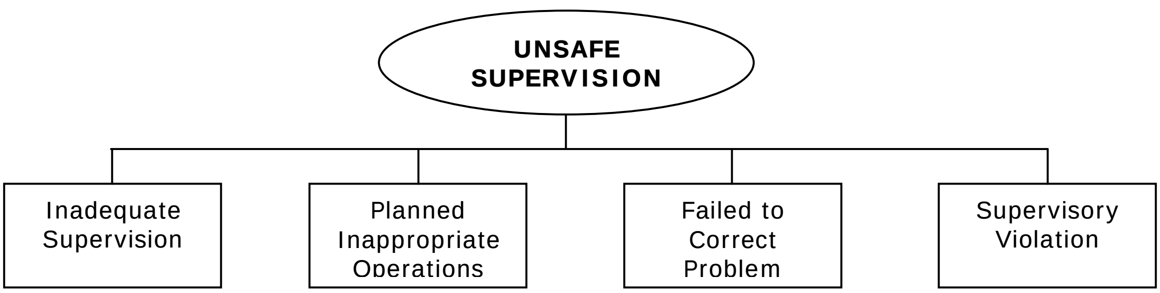
3 third level: unsafe supervision

3.1 Introduction

The third level examines the supervision structure present and the effectiveness of the supervision offered. The responsibility of those charged with supervision (hereinafter referred to as "managers") includes realising and guaranteeing the competencies[75] of the personnel. Within the supervision structure, it is essential to ensure that the competencies of the personnel are adjusted to meet and continue to meet the requirements imposed on the unit on the basis of the brief. This is carried out by means of instruction, training and coaching, taking into account the individual level. In addition to developing new competencies, it is also important that existing competencies are maintained by means of continuation training. Failure to practise skills on a regular basis leads to a deterioration in these skills: the skills level is secured through maintenance and regular testing of the various skills. Finally, managers must ensure that any skills that are specifically required for the operations are identified and the personnel are trained accordingly.

In this investigation, the following supervisors were identified:

- the Commander of the Gilze-Rijen air base is responsible for the results of the helicopter capacity to be provided (products) and the way in which this is achieved, including the implementation of the JOP
- the Squadron Commander of the 301 Squadron is ultimately responsible for the implementation and the quality of the implementation of the Annual Training Programme (JOP) for the pilots in the 301 Squadron
- the responsibilities of the Ops Officer of the 301 squadron include achieving and maintaining the required operational status by means of implementing the JOP programme, as well as drawing up the JOP programme for the 301 Squadron
- the responsibilities of the flight commanders of the 301 Squadron include monitoring the currencies and JOP obligations of the pilots within their flight and the debriefing of missions at flight level
- the responsibilities of the Duty Officer include supervising proper and comprehensive flight preparations and execution of the flight in accordance with the flight order issued.



[75] See appendix 12 for further information in relation to the term 'competencies'.

Within the third level, the role of the supervisor is assessed as a manager. A distinction is made here between Inadequate Supervision, Planned Inappropriate Operations, Failed to Correct Problem and Supervisory Violations. In this investigation, Unsafe Supervision was only identified in the form of Inadequate Supervision.

3.2 Inadequate supervision

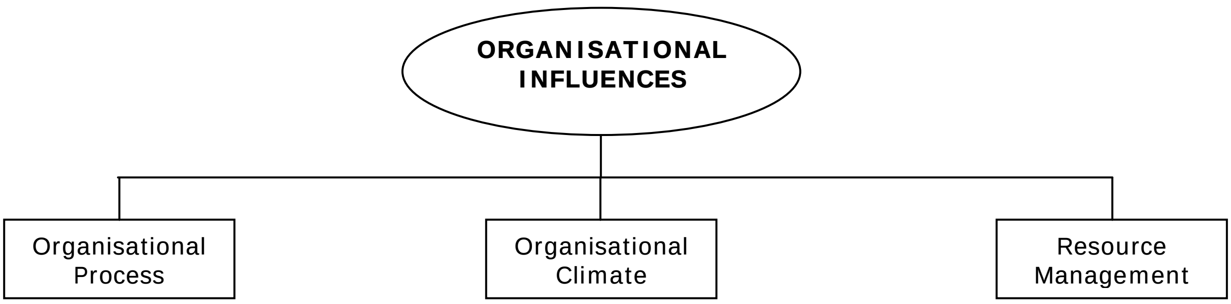
Inadequate Supervision relates to the supervisor's direct role as a manager.

- The large number of deployments and obligations abroad renders consultation between the aforementioned supervisors /managers more difficult.
- As operational priority was entirely given to the International Security Assistance Force (ISAF) in Afghanistan and training is mission-focused, less attention is paid to basic skills and these are also practised less frequently. The demands placed on the pilots as a result of the ISAF mission means that a greater focus is placed on the tactical aspects of flying with a view to the preservation of life, amongst other things, at the expense of addressing more basic skills.
- The Duty Officer is not able to look into whether or not flights have been prepared for and executed in a proper and comprehensive manner or is not able to do this to a sufficient extent, which means that there is limited supervision.

4 fourth level: organisational influences

4.1 Introduction

The fourth level examines the organic environment within which the operations in question took place. The organic environment determines the responsibilities, issues the order, provides the resources required for executing the order and directly and indirectly determines the limits and conditions within which the direct supervision structure implements the order issued. In terms of preconditions, therefore, the direct supervision structure is dependent on this organic environment.



4.2 Organisational process

The Organisational Process relates to the manner in which an organisation carries out its activities. In this context, a distinction is made between operations, procedures and supervision.

- Almost all operations involving Apache helicopters focus on the ISAF mission in Afghanistan. As a result, the emphasis during training is placed on those aspects that are of direct importance in Afghanistan and less attention is paid to basic skills and flying within Dutch territory.
- When operating with Apache helicopters, there are no fixed procedures that must be followed on commencing a descent (for instance the 'descent checks').
- Supervisory measures such as audits and safety inspections are not carried out within the organisation.

4.3 Organisational climate

Organisational climate relates to the influence that the prevailing operational climate can have on the organisation, such as corporate culture and interpersonal relationships.

Communication between the CLSK staff and the Gilzen-Rijen air base is not optimal. Both parties have indicated that the limited transfer of information has an influence on operational management.

4.4 Resource management

Resource management relates to the manner in which the organisation manages its various resources and the influence that this can have on the feasibility of the brief.

- The Annual Training Programme for Apache pilots has been reduced from 180 to 140 hours.
- The Ministry of Defence is under pressure in the labour market.
- The Defence organisation has been faced with various reorganisations both at squadron level and across the organisation over the last few years. This has resulted in a great deal of upheaval and additional workload.

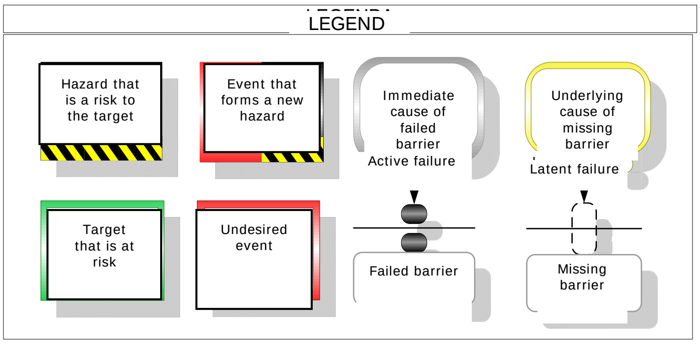
APPENDIX 8 TRIPOD

The incident was also analysed according to the TRIPOD method. This method has been developed for the purpose of tracing the direct causes of an incident back to shortcomings within organisations that are responsible for ensuring the safe operation of the relevant (sub) system. The TRIPOD theory on which the analysis method is based assumes that people in specific situations act and behave in a particular way because the system allows them to do so (consciously or subconsciously) and that it is easier to influence circumstances than it is to influence people. The circumstances under which the active error was able to take place subsequently lead to the latent factors that are regarded as being the (indirect) cause of the incident

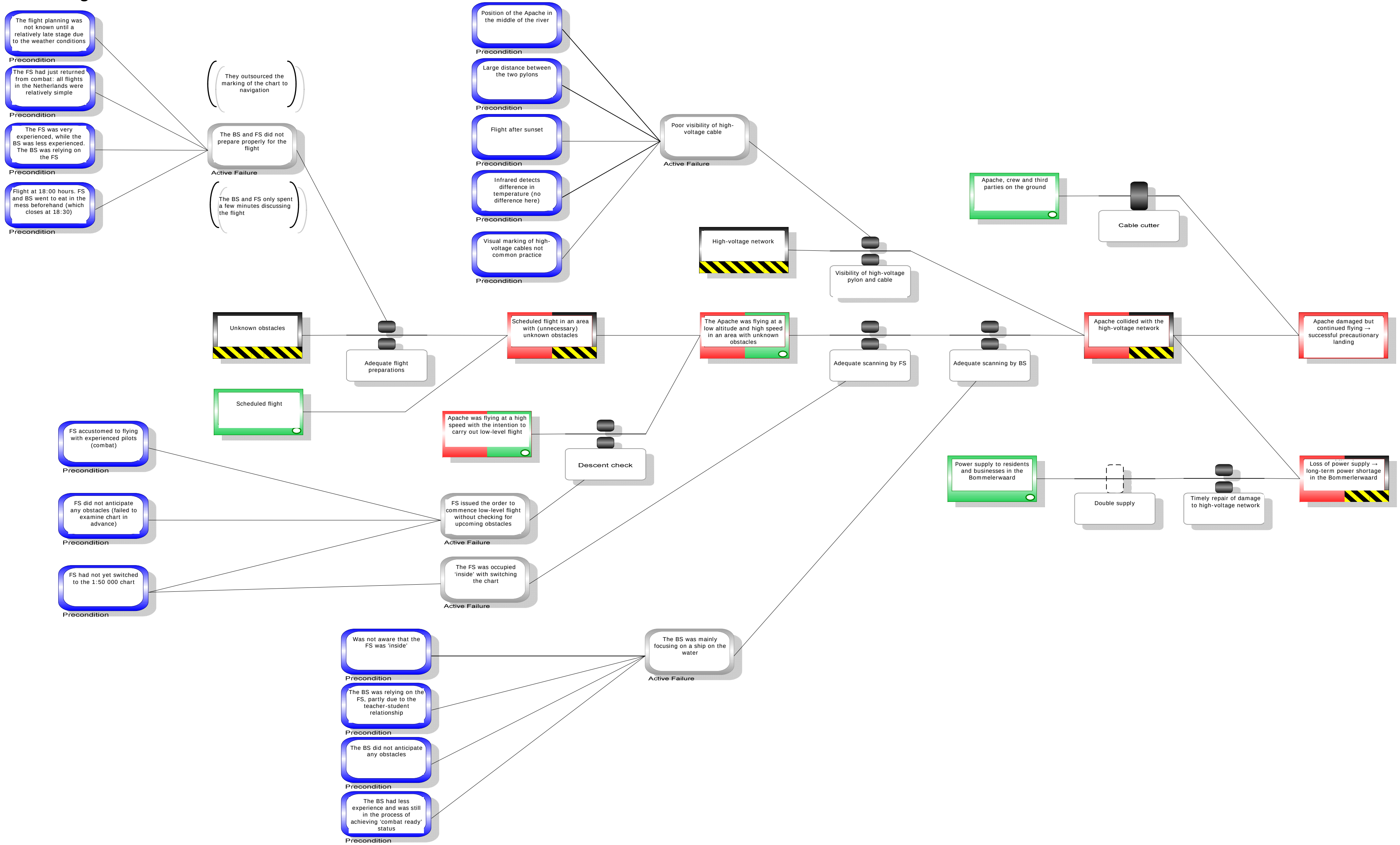
According to the TRIPOD theory, undesired events/incidents occur due to a loss of control over the (operational) processes. In other words, an incident/undesired event takes place because the barriers that should regulate the process are either missing or have failed. Missing barriers are the result of latent errors, whereas failed barriers are the result of active errors. These active errors can be explained by the context in which they take place. The context is established by means of errors at system level (underlying factors or latent errors). By naming the hazards, the event and targets and subsequently identifying barriers, active errors, context and underlying factors, it is possible in turn to identify areas that require investigation.

As stated, the basis of TRIPOD is formed by a HET (Hazard Event Target) diagram. In the diagrams, hazards are indicated with yellow/back hatching, events/incidents appear in red and targets in green (see the legend). TRIPOD assumes that by taking measures (barriers) it is possible to control the hazard, thus preventing the event from taking place, or – if the measures fail – to protect people and equipment from the effects of an incident.

TRIPOD makes a distinction between failed barriers, inadequate barriers and missing barriers. A failed barrier is a barrier that is originally present and has always worked. However, something failed at the time of the event or incident, leading to the failure of the barrier as a whole. An inadequate barrier is a measure that the owner or user of an installation believes to offer sufficient protection. A missing barrier is a barrier that could have been set up in order to offer sufficient protection, but that was not set up.



HET Diagram



The flight planning was not known until a relatively late stage due to the weather conditions
Precondition
The FS had just returned from combat: all flights in the Netherlands were relatively simple
Precondition
The FS was very experienced, while the BS was less experienced. The BS was relying on the FS
Precondition
Flight at 18:00 hours. FS and BS went to eat in the mess beforehand (which closes at 18:30)
Precondition
They outsourced the marking of the chart to navigation
The BS and FS did not prepare properly for the flight
Active Failure
The BS and FS only spent a few minutes discussing the flight
Position of the Apache in the middle of the river
Precondition
Large distance between the two pylons
Precondition
Flight after sunset
Precondition
Infrared detects difference in temperature (no difference here)
Precondition
Visual marking of high-voltage cables not common practice
Precondition
Poor visibility of high-voltage cable
Active Failure
Apache, crew and third parties on the ground
Cable cutter
High-voltage network
Visibility of high-voltage pylon and cable
Unknown obstacles
Adequate flight preparations
Scheduled flight in an area with (unnecessary) unknown obstacles
The Apache was flying at a low altitude and high speed in an area with unknown obstacles
Adequate scanning by FS
Adequate scanning by BS
Apache collided with the high-voltage network
Apache damaged but continued flying → successful precautionary landing
Scheduled flight
Apache was flying at a high speed with the intention to carry out low-level flight
Descent check
FS accustomed to flying with experienced pilots (combat)
Precondition
FS did not anticipate any obstacles (failed to examine chart in advance)
Precondition
FS had not yet switched to the 1:50 000 chart
Precondition
FS issued the order to commence low-level flight without checking for upcoming obstacles
Active Failure
The FS was occupied 'inside' with switching the chart
Active Failure
Power supply to residents and businesses in the Bommelerwaard
Double supply
Timely repair of damage to high-voltage network
Loss of power supply → long-term power shortage in the Bommelerwaard
Was not aware that the FS was 'inside'
Precondition
The BS was relying on the FS, partly due to the teacher-student relationship
Precondition
The BS did not anticipate any obstacles
Precondition
The BS had less experience and was still in the process of achieving 'combat ready' status
Precondition
The BS was mainly focusing on a ship on the water
Active Failure

APPENDIX 9 AIRWORTHINESS REPORT

APQ-01 & airworthiness

Report: airworthiness of APQ-01

Status	Final
Date	11 February 2008

Contents

1. Introduction:

1.1 Reference sources:

A number of reference sources were consulted in order to obtain an insight into the maintenance work that had been carried out on/to the APQ-01 at the time of the collision with the high-voltage cables on 12 December 2007. With the aid of these references, it was possible to obtain an insight into the maintenance status/airworthiness of the APQ-01. The following documents were consulted:

- Military Type Certificate Holder Organisation Exposition (MTCHOE) version 1, dated 12 October 2007.
- Military Aviation Requirements for maintenance organisation (MLE-145) version 2, dated 1 September 2007.
- Maintenance Management Exposition & Maintenance Organisation Exposition (MME&MOE) amendment 3 dated 1 August 2007.
- Royal Netherlands Air Force TM 1-1520-Longbow/Apache AH64D (IETM) version 9.1, dated 13 December 2005.
- Royal Netherlands Air Force supplement bundle No. 18 in IETM dated 18 December 2007.
- Integrated Maintenance Data System (IMDS) edition 6, dated 20 December 2007.
- Regulations regarding helicopter maintenance activities (VOA helicopters) 2nd revised edition, dated 26 March 2007.
- Regulations regarding general maintenance activities, 4th revised edition, amendment 2, dated 31 March 2004.
- Configuration Management Regulations (VCM) 4th revised edition, dated 6 March 2006.
- Minimum Equipment List RNLAF AH-64D Apache 1st revised edition, dated 27 April 2006.
- Scheduled inspections and maintenance requirements Royal Netherlands Air Force TM AH-64D-6 (“dash 6”) 1st revised edition, dated 20 November 2007.
- TM 55-1500-342-23: weight and balance 3rd revised edition, dated 01-03-2005.

The IMDS database[76] was consulted for the purpose of obtaining the correct data in relation to maintenance work carried out, the deferral of complaints, the correct configuration and modification standard.
These sources of information show that the APQ-01 helicopter was technically sound and had been released as an airworthy helicopter in accordance with the MAR requirements[77] for the flight on 12 December 2007.

[76] Royal Netherlands Air Force Maintenance/configuration database, aircraft and helicopters.
[77] Military aviation requirements.

2. Records of maintenance work

2.1 IMDS database

All maintenance work carried out is recorded in a database known as IMDS.
We found the following maintenance history in this database:
Periodic maintenance carried out.
Complaints/faults dealt with.
Complaints/faults deferred.
Modifications carried out, modification standard.
Configuration of the helicopter.

This IMDS data must correspond with the information that can be found in the aircraft log. The log documents from the aircraft log must be retained for 24 months in accordance with the VOA helicopters[78] .

2.2 Deferred complaints

The IMDS database showed 11 deferred complaints. These complaints had been deferred for various reasons. The two main reasons were: no capacity available or no parts available. The nature of the complaints can be described as minor.
One deferred complaint stands out, namely the complaint '*temporary repaired wires of stab actuator #1'*. This deferred complaint will be discussed in greater detail as a separate topic in this report (see section 3.2).

2.3 Inspections

No striking issues in relation to inspections or parts or components to be inspected were identified on the basis of the information in the IMDS database. Inspections can be classified as follows:
Periodic: calendar inspections (daily, weekly, monthly or annually).
Flight hours related (every flight hour, 10, 25, 50, 125, 250, 500 flight hours etc.).

No inspections had been carried out too late or were overdue with regard to the date or the flight hours ('due'[79]) on the APQ-01 on 12 December 2007.

2.4 Modifications

The modification standard of the APQ-01 corresponded with the schedule for the modifications to be carried out to the APQ-01 helicopter. On 12 December 2007, the APQ-01 was configured to the authorised modification standard (IMDS).

2.5 Configuration

Configuration: prescribed parts and components present on the helicopter in the correct construction. Any deviations from the permitted configuration mean that the helicopter is not airworthy at that point in time.
A check of the IMDS database in relation to the permitted configuration for the Apache helicopters revealed that the APQ-01 did not feature any deviations from the permitted configuration (VCM[80]).

3. Maintenance status

3.1 Deferred complaints

As already stated in section 2.2, 11 complaints had been deferred at the time of the incident. The deferral of complaints is bound by regulations. These regulations are described in the VOA helicopters (Part C: corrective maintenance).
Within the unit, it is the support unit that determines when corrective maintenance is carried out. Depending on the scheduled deployment of the helicopter, the operational user is able to permit a situation whereby systems on the helicopter and/or or operational and emergency equipment do

[78] Regulations regarding helicopter maintenance activities.
[79] Exceeding of the period or number of hours for the inspection.
[80] Configuration management regulations [VCM].

not function or only function to a certain degree, within certain established limits (in accordance with the MEL). On behalf of the operational user, the support unit determines whether corrective maintenance will be postponed.
The aim of the MEL is to assess whether the helicopter is (partly) deployable for operations even with non-functioning systems. This can be restricted to a specific time period within which the corrective maintenance must be carried out.
The basic principle is that the maintenance work must be carried out at the next available opportunity.
The postponed maintenance work must be recorded in the aircraft log in accordance with the VOA. The postponed maintenance work must also be recorded in the IMDS in accordance with the VCM.

3.2 Deviation from authorisation

Section 2.2 specifically cites the deferred complaint: 'temporary repaired wires of stab actuator #1'. It is true to say, however, that this concerned a critical part of the helicopter (the controls). The wiring was faulty in this part of the helicopter. The maintenance book specifies that the entire wiring must be replaced in the case of a failure in this component, as it concerns a critical part of the helicopter's control system.
At the time the fault occurred this wiring was not in stock (AWP[81]) and the decision was taken to fully rectify the fault at a later point in time. Following consultation with DMO/LU/WS&B/BTHE-B[82], the decision was taken to temporarily repair the break and to replace the wiring as soon as possible once the new parts had been received.
The temporary solution (emergency repair of the wiring) became a deviation in the configuration as of this point in time. A special procedure in respect of flying with a deviating configuration is described in VOA helicopters, part E section 3.
A deviation authorisation form (AAF: Lu-form 0019) must be included in the aircraft log.

Incidentally, in the case of this complaint a number of conditions were imposed on the AAF (AAF 07-03 dated 19 January 2007, BTO/Gilze-Rijen). The main condition was: definitive repair work must be carried out as soon as possible once the two missing parts have been received!
The delivery date of both parts was stated on the AAF in question. There was a backlog in the case of the last missing part: 9 June 2007.
Further enquiries revealed the following: both items were delivered on the date (Gilze-Rijen) stated on the AAF.
On signing the AAF as authorised, the following instructions were issued: the emergency repairs must be rectified as soon as possible following delivery of both types of original wiring materials required.
Despite the fact that the parts were delivered on the dates stated on the AAF, nobody took action to rectify the temporary situation (deviation in configuration) in order to fully remedy the fault (AAF in the aircraft log)!

4. Specific helicopter systems

4.1 Critical systems

The Apache helicopter has a number of important systems that are essential to ensure the proper and safe functioning of the helicopter. These systems must be regarded as critical because the inadequate functioning of these systems can lead to dangerous situations, which in turn can lead to potentially fatal incidents. The following systems on the Apache helicopter are to be regarded as critical:

- rotor systems
- motors
- pneumatic and hydraulic system
- pilot system[83]
- navigation system
- fuel system
- control system
- air conditioning system
- electronics system
- drive system.

[81] Awaiting parts
[82] Maintenance engineering AH64 helicopter
[83] Air data system

Investigations into the status of the maintenance data relating to the abovementioned systems revealed that the APQ-01 helicopter did not have any faults/complaints before the take-off for the last flight on 12 December 2007. The helicopter was safe to fly at that time.

4.2 Other systems

The remaining systems on the helicopter that can be described as non-critical are:
- APU system (power generator)
- arms system
- communication system
- data-management system
- lighting system
- landing gear
- visual system (TADS/PNVS).

These systems are present on the helicopter as additional systems. Investigations into the status of the maintenance data relating to these systems also revealed that the APQ-01 did not have any complaints/faults before the take-off for the last flight on 12 December 2007. The APQ-01 was safe to fly at that time.

5. Weight and Balance of the APQ-01[84]

5.1 Weighing of the helicopter

Every two years, a check is carried out to determine the base weight of the helicopter. This two-yearly inspection: '24 month scheduled inspection: helicopter weighing' is monitored in the IMDS database. The data obtained on weighing the helicopter is entered in the AWBS system[85]. This system then calculates the weight and balance of the helicopter on the basis of the data entered. The data includes all changes as a result of modifications or new configurations that apply to the helicopter at that time.

5.2 F-chart

In accordance with the VOA helicopters, an F-chart[86] is always included in the aircraft log as evidence that the weight and balance have been determined correctly. In the event of each change that may influence the weight and balance of the aircraft, a new F-chart must be drawn up and used to replace the old F-chart in the aircraft log.
The F-chart drawn up for the APQ-01 shows that the weight and balance (centre of gravity, C.G.) were within the limits. However, there was one thing that did stand out: the check-off pad!
The check-off pad was signed as follows:
Computed and W&B authority: by one and the same person.
Pilot signature: not signed.

This is no reason to assume that the helicopter was not airworthy with regard to weight and balance, however it is strange that the right people had not signed the check-off pad. Each check-off pad should be completed by a different person and all check-off pads must be signed.

6. Final conclusion

An inspection of the information on maintenance carried out on the APQ-01 did not bring to light any issues that could cast doubt on the airworthiness of this helicopter.
The maintenance status of the APQ-01 can be described as normal, and no issues had been identified that were not permissible. At the time of the incident on 12 December 2007 no signs or incidents, caused by a technical failure, had been detected that could have contributed towards the collision with the high-voltage power line.

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[84] Weight and balance of the helicopter.
[85] Programme for the automatic calculation of the weight and balance of the helicopter.
[86] Form from AWBS program: certificate of helicopter weight and balance.

APPENDIX 10 DAMAGE TO THE HELICOPTER

Damage to the helicopter (Q-01)

Contents

1. Introduction

During a low-level flight exercise using an Apache helicopter in the early evening of 12 December 2007, the Apache flew into a high-voltage power line. I will provide a brief description of the damage sustained by the helicopter during this incident, accompanied by explanations where required. The visible damage will be presented in chronological order. The Apache helicopter is equipped with special cable cutters[87] (CCs) to protect against obstacles in the form of cables etc. The CCs cannot, however, prevent damage from occurring. Broadly speaking, the parts of the helicopter that were damaged can be classified as follows:

- Airframe[88]
- Main rotor blades[89]
- Tail rotor blades[90]
- Engines.

2. Airframe

2.1 Front of the helicopter:
The pilot night vision system[91] (PNVS) is located on the nose of the helicopter. The top of the system was hit, causing a considerable amount of damage. The glass plate had completely disappeared from the front. At the back of the PNVS, the plastic housing had been knocked off (see photos 1 and 2).


Foto 1

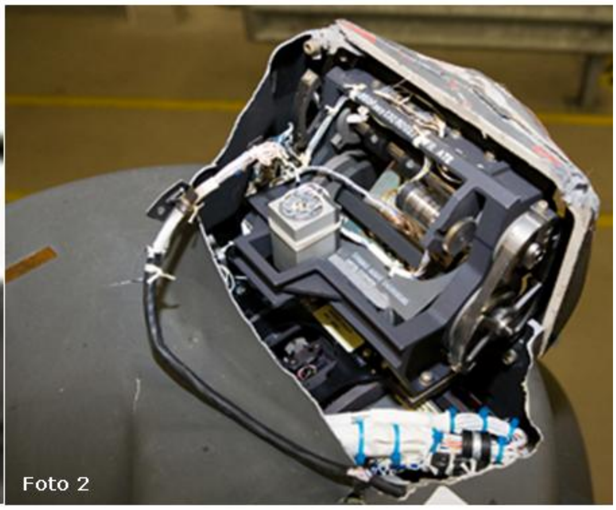
Foto 2

2.2 Front right side
On the front right side of the airframe in the region of the front of the CPG station[92] , severe damage was caused by the impact of the high-voltage power line. The impact starts directly below the right window stile, and the windscreen wiper and windscreen wiper motor were completely removed. The right window stile was crushed to such an extent during the collision that there was severe distortion of the nose section of the helicopter right at the transition between the nose section and the front cockpit (CPG). The 'front seater 57.50'[93] frame was entirely ripped through at this position.

[87] Cable cutters
[88] Helicopter frame
[89] Main rotor blades
[90] Tail rotor blades
[91] Pilot night vision system
[92] Co-pilot gunner cockpit
[93] Frame at the point 57.50" from the front.

This caused the frame of the nose section to buckle a few centimetres on the right side. The sheet metal work was distorted, and a number of rivets had completely disappeared (see photos 3 and 4).

Foto 3

Foto 4

2.3 Co-pilot gunner cockpit (CPG)

At the CPG station, the stile of the window on the right was pushed right in, shattering the windshield[94] of both the CPG station (co-pilot) and the PLT station[95] (pilot). It is also clear to see that the high-voltage power line moved upwards over the cockpit during the collision. The left window stile was hit, however it was not pushed in. The bending of the window stile caused the co-pilot's door (right side) to warp (see photo 5).

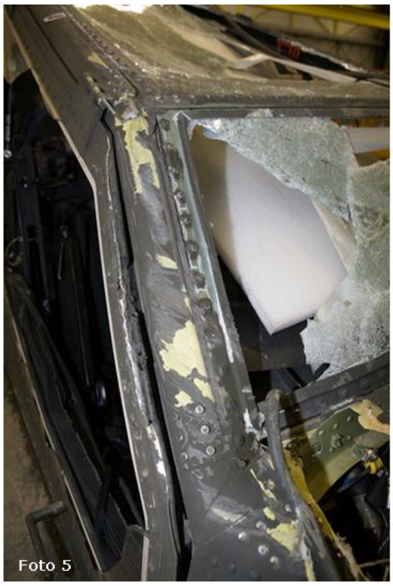

Foto 5

2.4 Cockpit damage

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[94] Co-pilot's (front) window

[95] Pilot (seated directly behind the co-pilot)

The impact of the high-voltage power line caused both pilots' windows (windshield) at the front to smash into lots of small pieces. The window in the front cockpit door was completely removed. The door buckled and material from the front frame was largely pulled away (see photos 5 and 6).

2.5 Top of the airframe

The cable cutter is situated immediately to the left behind the cockpit. No damage to the CC has been identified as yet. The panel known as the dog-house[96], which starts immediately behind the cockpit, sustained a considerable amount of damage as a result of the incident. One of the causes of this damage was debris, which was found in a number of places, including part of the helicopter known as the cat-walk[97]. The debris mainly consisted of small pieces of hard foam, glass and some fragments of synthetic resin fibre. The small pieces of hard foam came from the dog-house panel (source: BOEING, see photos 7 and 8).

2.6 Nacelle on the right

The nacelle on the right side of the helicopter sustained mild damage in the form of some small tears in the protective hood of the engine exhaust directly above the navigation light.
The HADS probe[98] was hit and completely twisted during the collision with the high-voltage power line.
Underneath the nacelle in the region of the engine exhaust, there were traces of an imprint but no further damage was found. There was also a small hole (ø 2cm) on the bottom of the nacelle in the region of the secondary air inlet (see photos 9, 10 and 11).

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96 Panel that has been given this nickname due to its shape, situated on top of the helicopter immediately behind the cockpit.

97 Work platform behind the main rotor.

98 Helicopter Air Data Sensor.


Foto 9


Foto 10


Foto 11

2.7 Horizontal stabilator

There was damage to the top of the horizontal stabilator in the form of a minor dent measuring around 25 cm in length behind the centre of the helicopter's tail. There was also minor damage to the top right. On the front left, there was a heavy-impact dent measuring a few centimetres in depth (see photos 12 and 13).

Foto 12

Foto 13

2.8 Tail rotor

On the tail rotor it is possible to see damage to the protective cover (cover L546/L547) mounted around the outgoing axis of the tail rotor gear box. There was no further damage to the outgoing axis.
The tail rotor head (head and swashplate[99]) did not show any damage, however there was some damage to the tail rotor blades. Damage to the tail rotor blades is discussed separately in this report (see photos 14 and 15).

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[99] Tail rotor controls

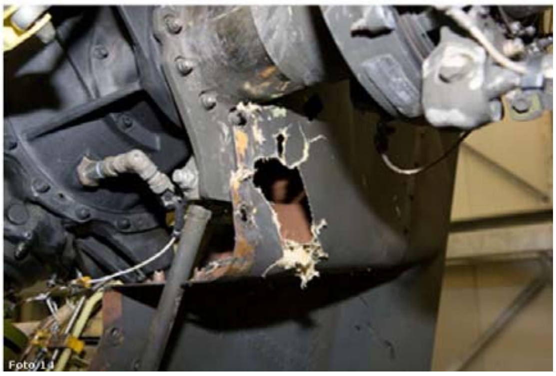


Foto 14 Foto 15

2.9 Vertical tail boom
The vertical tail boom starts at the back of the helicopter at the end of the tail. A protective hood is mounted along the entire length of the back of this vertical tail boom. There were a number of small holes in the top part of the hood, on both the left and the right (see photo 16).

Foto 16

2.10 Left side of the helicopter
There is not much further damage to the left side of the helicopter to report!
There are two points to note, however: the HADS probe on the nacelle was also twisted on the left side. This bending of the probe had damaged the protective hood of the engine exhaust. The damage is visible just above the navigation light. Immediately behind the navigation light there was a hole measuring ø 2 cm in the protective hood at a distance of 5 cm from the back edge. The window in the left side of the PLT station had a scorch mark immediately below the position where the cable cutter is attached (see also photo 7).

3. Rotor blades

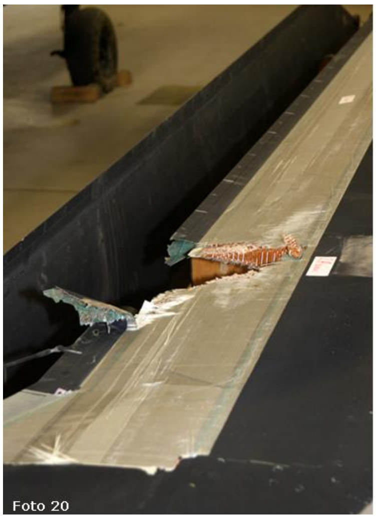
3.1 The main rotor blades
The main rotor is built of a number of components, including four rotor blades. The rotor blades are mounted in a fixed order: nos. 1 to 4 inclusive.
Each main rotor blade is identified with a unique serial number. The damage in this report is stated for each position and the corresponding serial number.

Blade at position no. 1, serial number C10-5721:
Minor damage (4x) to the top.

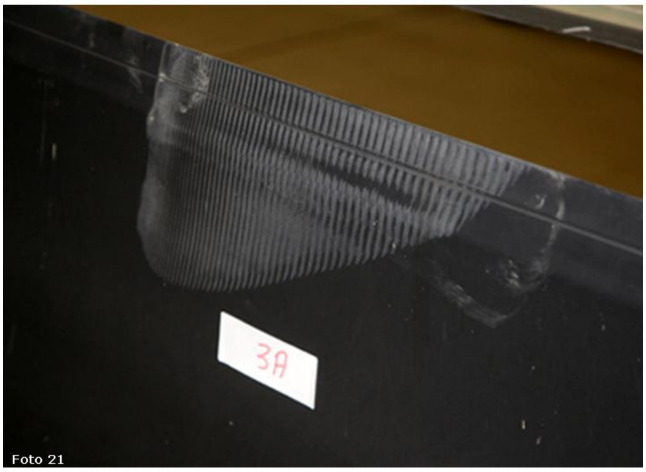
Leading Edge (L.E.)[100] damage as a result of F.O.D.[101] at around 1.20 metres from the base of the blade.
Trailing Edge (T.E.)[102] damaged at around 1 metre from the tip, 2.5 cm deep and delamination[103] over an area measuring around 50 cm in length (see photo 17).

Blade at position no. 2, serial number C10-5275:
Severe damage to the L.E. at a distance of 1 metre from the tip (possibly due to severe impact over an area measuring 40 cm in length against the front frame). The damage continues to the underside and at a distance of 5 cm from the L.E. there is a hole of around ø5 cm and also 5 cm in depth. Immediately after the hole, a triangular piece of the honeycomb[104] section was removed (estimated dimensions: 20x20x20 cm).
A part measuring around 40 cm in length of the rear frame was removed on the T.E. at a distance of ± 80 cm from the tip.
On the top of the blade, the fibreglass reinforced shell was removed from 50% of the surface area (see photos 18, 19 and 20).

[100] Front frame/front.
[101] FOD: Foreign object damage, damage from debris etc.
[102] Rear frame/rear.
[103] Peeling off of the top layer.
[104] Honeycomb structure.



Blade at position no. 3, serial number C10-5715:
It is possible to see an imprint on the underside of the L.E. at a distance of 2 metres from the tip: 10x20 cm (see photo 21).



Blade at position no. 4, serial number C10-5701:
Damage to the front frame of the L.E. at a distance of ± 1.2 metres from the tip as a result of F.O.D.
The entire rear frame had disappeared from an area measuring ± 3 metres in length on the T.E., with large burn/singe marks visible in two places.
The base of the blade on the T.E. also had a major singe mark, with delamination of the connection at the base of the blade. The top layer was missing from the end of the blade (see also photos 22, 23 and 24).


Foto 22

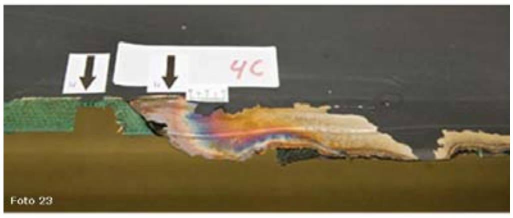


Foto 23

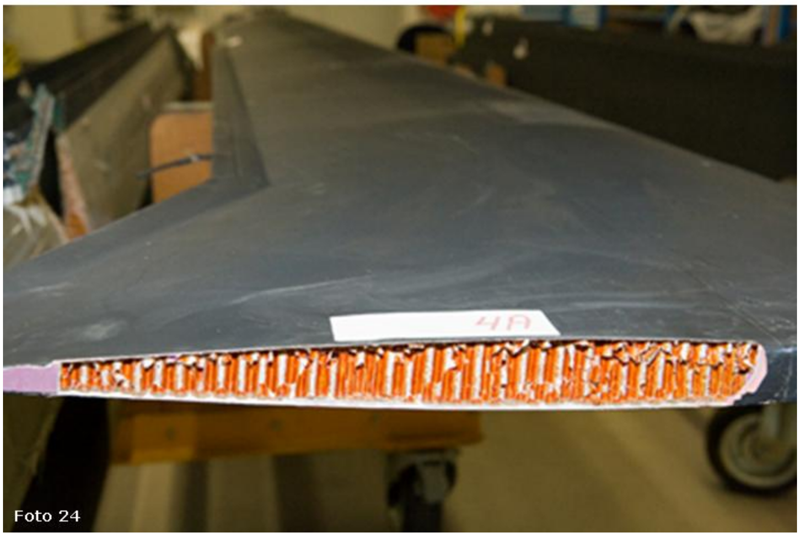


Foto 24

3.2 Tail rotor blades
Like the main rotor blades, the tail rotor blades (T/R blades) are mounted in order. A brief description of the damage is provided below for each blade position.

T/R blade no. 1 serial number C12-D969
An imprint can be seen in the front frame in the centre of the blade.
From the imprint in the front frame, a sharp imprint (scratch) runs along the inside of the blade in the direction of the blade's rear frame.
Two large dents can be seen in the rear frame at the same level (see photo 25).

T/R blade no. 2 serial number C12-A506:
In the front frame at a distance of 15 cm below the tip of the blade two deep impressions: one impression ± 1 cm and one slightly smaller impression (see photo 26).

T/R blade no. 3 serial number C12-D985:
On the underside of the blade (on the inside) at a distance of around 5 cm from the tip there are two small holes in the blade (see photo 27).

Foto 27

T/R blade no. 4 serial number C12-D981:
At the base of this tail rotor blade, the wiring (anti-ice wiring) was warped and crushed (see photo 28).

Foto 28

4. Engines

4.1 Right engine
The right engine, serial number ET 306, was damaged by flying debris. This damage can be seen in the first stage of the compressor. In the first stage of the compressor, all of the blades showed severe damage on the front frame (see photos 29, 30 and 31).

Foto 29

Foto 30

4.2 Left engine
There was no discernible damage to the left engine, serial number ET 278.

5. Summary

The front right side of the helicopter showed the most damage. No damage could be seen on the underside of the helicopter. It is clear to see that the collision initially took place at the nose of the helicopter, where the PNVS is located. From here, the high-voltage power line moved to the back of the aircraft via the nose and the cockpit during the collision, causing the abovementioned damage.

Three of the main rotor blades were severely damaged. Evidence of electric discharge can clearly be seen on one of the blades. The damage is characterised by an image that is in keeping with a discharge following a lightning strike on an aircraft.

A large amount of debris, such as glass, hard foam and synthetic resin fibre, was found. The maintenance platform (cat-walk) immediately behind the main rotor contained a considerable amount of debris. The large amount of debris may also explain some of the small holes that can be seen in a number of places, as stated in this report.

It is likely that a major electrical charge passed through the helicopter during the collision with the high-voltage grid. Possible secondary damage, which is not yet visible, must therefore also be taken into account.

APPENDIX 11 RELEVANT FACTS AND DATA

1. Crew particulars

The crew of the Apache helicopter consists of two pilots who sit one behind the other in separate cockpits. The set-up is as follows:

- Front seat : aircraft commander, who also acts as co-pilot and gunner
- Back seat : first pilot (flies the helicopter)

1.1 Front seater

Aircraft commander	: male, aged 40
Flight medical examination	: 03-12-2007 valid until 30-06-2008
Proof of competence	
GMB	: 07-05-1998
AH-64D	: 15-08-2001 valid until 10-01-2012
Currency of CRM course	: 1061 days

Flight experience in hours	All types	Incident type	Instruction
Total/of which during night-time	1724.9/379.4	1074.0/351.0	n/a
Last 90 days/of which during night-time	12.3/5.1	12.3/5.1	n/a
Last 30 days/of which during night-time	6.1/3.3	6.1/3.3	n/a
Last 24 hours/of which during night-time	1.2/1.2	1.2/1.2	n/a

1.2 Back seater

Pilot	: male, aged 23
Flight medical examination	: 21-05-2007 valid until 31-05-2008
Proof of competence	
GMB	: 21-04-2006
AH-64D pilot's licence	: 15-09-2006 valid until 24-10-2011
Currency of CRM course	: 918 days

Flight experience in hours	All types	Incident type	Instruction
Total/of which during night-time	426.1/70.6	236.5/52.0	n/a
Last 90 days/of which during night-time	23.8/8.1	23.8/8.1	n/a
Last 30 days/of which during night-time	9.3/2.9	9.3/2.9	n/a
Last 24 hours/of which during night-time	1.2/1.2	1.2/1.2	n/a

2. Information on the helicopter

2.1 General

The versatile Apache AH-64D attack helicopter can be used for a wide range of tasks. This helicopter features advanced detection and navigation equipment, which means that it is ideal for carrying out reconnaissance activities. The various weapons offer protection to ground forces or transport helicopters. This helicopter can also be deployed offensively for the purpose of eliminating armoured vehicles, tanks or targets such as command and radar posts, artillery deployments and deployments of guided missiles. The Apache helicopter is able to carry out these activities both during the day and at night, as well as during adverse weather conditions.

Type	: Apache AH-64D
Manufacturer	: Boeing Defense & Space Group, Helicopter Division
Serial number	: 98-0101
Certificate of registration	: 29 May 1998 No. 1449 (Royal Netherlands Air Force Defence Materiel – Air. Form 0009)
Registration number	: Q-01
Total number of flight hours	: 1301 hours
Engine	: two, type General Electric T700-GE-701 C 1301 flight hours (both engines)
Main rotor	: four blades, diameter 14.63 m 292 revs per minute 388.8 flight hours

Tail rotor	: four blades, diameter 2.79 m 1417 revs per minute 111.7 flight hours
Capacity	: maximum 1765 hp (with 1 engine) continuous 1685 hp per motor
Speed	: cruising speed 222 km/hr maximum speed 366 km/hr
Range	: 460-485 km or approx. 2.5 hours

2.2 Weight and position of centre of gravity

Empty weight : 5,662 kg
Maximum tactical weight : 9,190 kg
Maximum weight : 10,433 kg
Every two years, a check is carried out to determine the base weight of the helicopter. This two-yearly inspection: '*24 month scheduled inspection: helicopter weighing*' is monitored in a database. The data obtained on weighing the helicopter is entered in a specific program. All changes as a result of modifications that apply to the helicopter at that time are taken into account. The (new) weight and balance are eventually calculated.
Previous weighing of Q-01 helicopter: 2007-11-13 (Weight and Balance Clearance Form F-Tactical)

2.3 Technical state of the helicopter

The helicopter has a Certificate of Airworthiness dated 22 December 2000, No. 1449 (Royal Netherlands Air Force Defence Materiel – Air. Form 0010). The maintenance database revealed 11 deferred complaints: these were deferred for various reasons (including lack of capacity and lack of available parts) and can be described as minor. One of the deferred complaints concerned a critical part of the helicopter (the controls), however, and according to the regulations this should have been rectified as soon as possible following delivery of the required parts (June 2007). This did not take place.
However, the failure to permanently rectify this temporary repair did not play a role in this incident.
All of the prescribed maintenance inspections had been carried out on 12 December 2007.

3. Meteorological data

3.1 Data for 12 December 2007 from the KNMI (Eindhoven weather station)

Average temperature	: 2.3 ℃
Maximum temperature	: 5.1 °C
Minimum temperature	: -1.9 ℃
Precipitation	: none
Average wind speed	: 1.2 m/s = 1 Bft
Prevailing direction	: 1° = north
Average cover	: 7 eighths (= severely overcast)
Minimum visibility	: 0.3 km
Average atmospheric pressure	: 1037.5 hPa

3.2 Forecast at Gilze-Rijen Air Base

TAF AMD EHGR 121815Z 121904 VRB02KT 6000 BR MIFG BKN050 BECMG 1921 3000 TEMPO 2204 1200 PROB30 TEMPO 0004 0500 FG SCT012 BKN050[105]

4. Flight recording equipment and main data

4.1 *The helicopter is equipped with the following recording equipment, amongst others:*

4.1.1 *DTC (Data Transfer Cartridge)*

[105] The TAF is a weather forecast for the area immediately surrounding an airfield. The information is presented in a standard format and in Zulu time (UTC). The line means: a specially adapted TAF for the Gilze-Rijen Air Base, issued on 12 December at 18:15 hours, valid from 19 to 04 hours, variable wind at 2 knots, visibility 6000 metres, mist, slight fog, semi-overcast at 5000 ft. Forecast from 19 to 21 hours: visibility 3000 metres, temporary change from 22 to 04 hours: visibility 1200 metres. 30% chance of a temporary change between 00 to 04 hours: visibility 500 metres, fog, scattered cloud at 1200 ft, and semi-overcast at 5000 ft.

The Apache helicopter is equipped with a Data Transfer Cartridge (DTC). This is a memory module onto which data can be placed that the pilots can see on their navigation display. It is possible to enter the main points (route, targets and hazards) during the flight planning, and to display these via a map projection during the flight.
After the power line collision, the DTC data was recovered and analysed.

4.1.2 Video (TADS). See Chapter 2: section 2.4.2.1.
As well as images of the entire flight, accompanied by the presentation of the main flight data, the internal and external communication is also recorded.

4.1.3 MDR (Maintenance Data Recorder).
The Apache AH-64D is equipped with a 'maintenance data recorder' (MDR).

In addition to flight data, this recorder also stores information on the exceeding of use levels and maintenance errors. The data is generally used for maintenance purposes. The data from the MDR can, however, also be used for the purpose of investigating incidents. The MDR is designed to be able to resist fire and impact damage during an incident. The flight data is recorded asynchronously via a data bus (MIL-STD-1553). The maximum amount of data that can be stored is equal to around 10 hours. The data stored in the MDR was downloaded for the purpose of analysis following the power line collision.

In addition to flight data, two 30-minute sound fragments were also available. As the audio (from the MDR) is recorded in a loop, only the last 30 minutes of a flight are available. The sound recordings are of good quality and the communication between the crew members is clearly audible.

4.2 Main data

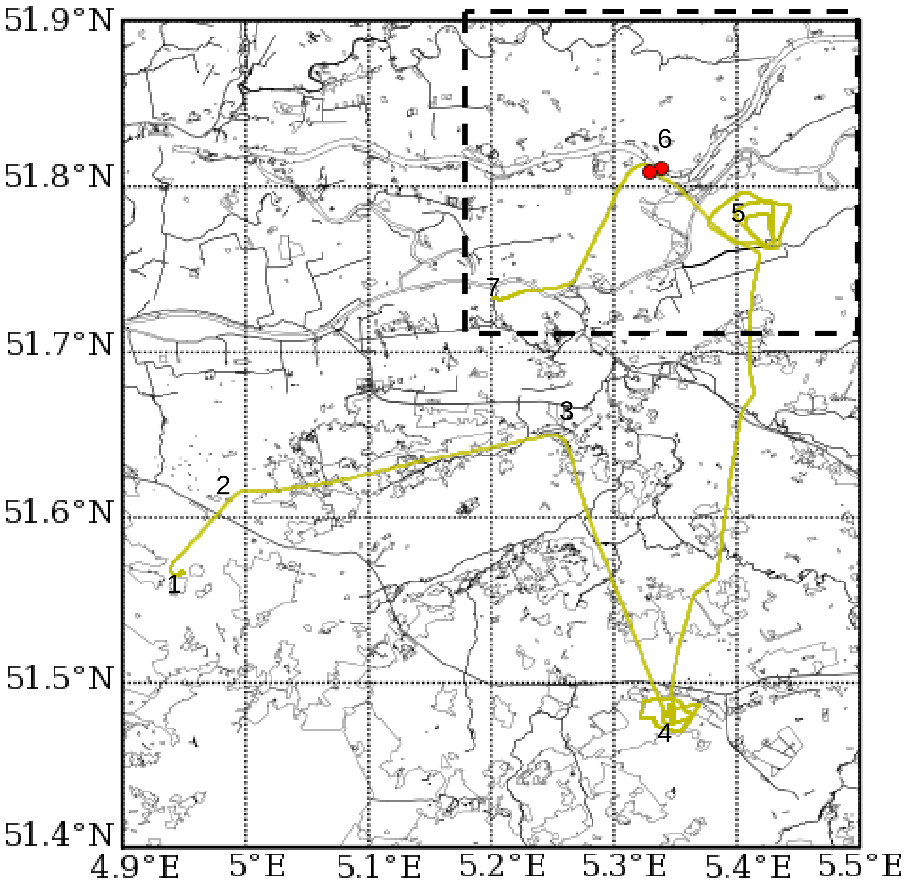
4.2.1 <u>Flight data</u> in Zulu time (Z = local time minus 1 hour)

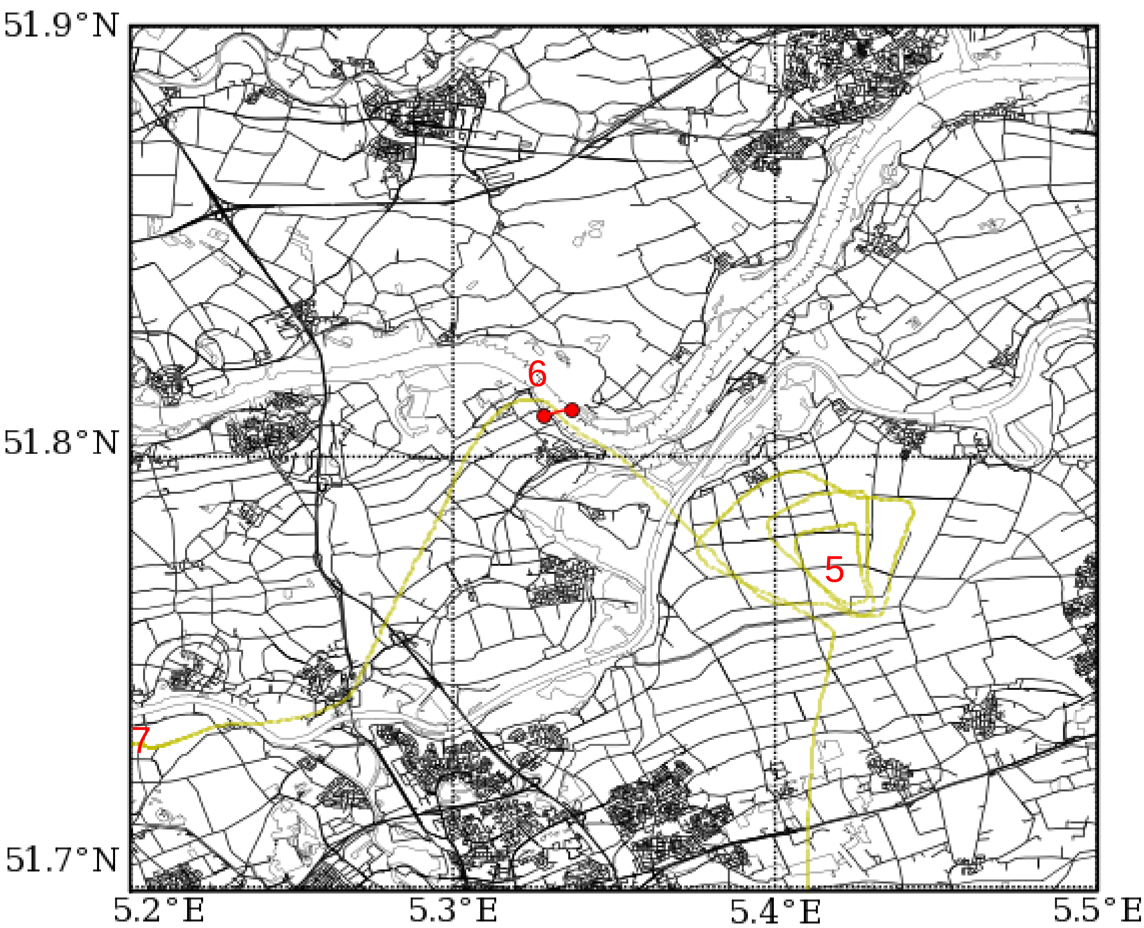
Time (Z)	Action	Comment
16:56:33	Starting of engines and performance of checks	Point 1 on the chart
17:05:01	Increase in altitude and travel in a northerly direction	On arrival at point 2, a course was set in an easterly direction (towards point 3) and after carrying out exercises in a southerly direction (point 4)
	Performance of exercises at point 4	Travel in a northerly direction towards point 5
	Performance of exercises at point 5	After carrying out exercises, a course was set in a north-easterly direction with a decreasing altitude.
18:04:30	Reduction in speed from 116 to 113 knots: radio altitude of 122 feet.	Point 6, power line collision
18:04:30	Warning: “Canopy open”	The cockpit door was open
18:04:31	Increase in the pitch angle of the Apache helicopter up to a maximum of 14 degrees	
18:04:31	Increase in the roll angle of the Apache helicopter	
18:04:32	Roll angle at a maximum of 10 degrees	
18:04:35	Commencement of left turn and increase in altitude	A course was set in a south-westerly direction
18:04:42	Warning: “Pitch Yaw Error”	
18:04:45	Warning: “PNVS FAIL”	Failure of the back seater's night vision system
18:04:45	Warning: “HIADC FAIL”	
18:04:45	Warning: “SSU FAIL”	
18:07:50	Commencement of descent	
18:10:28	Landing of the Apache helicopter	Point 7

Please note: no warnings were recorded in relation to the engine power or the helicopter's controls following the power line collision.

4.2.2 *Overview of the flight route*

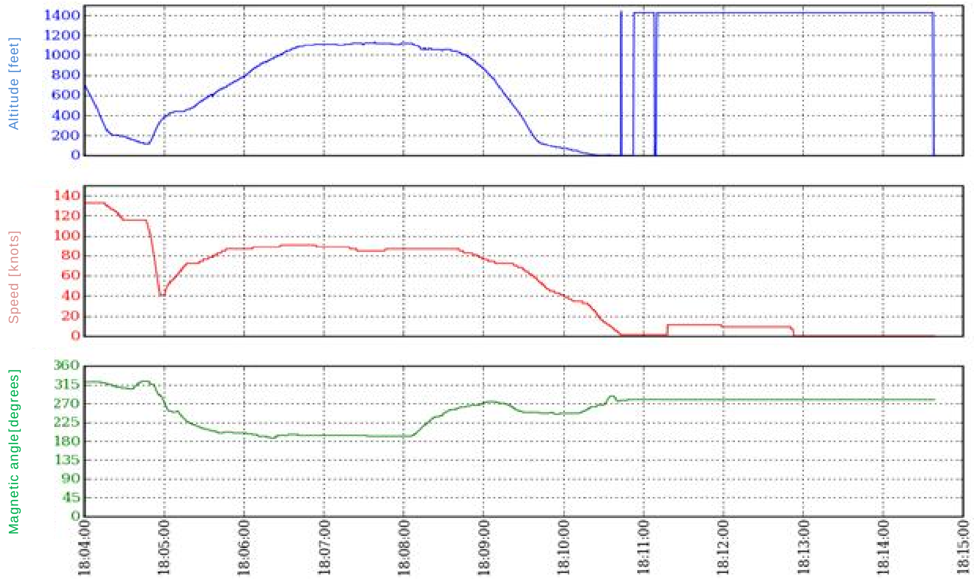
1. Gilze-Rijen
2. “Waypoint” flight route
3. Exercise
4. Exercise
5. Exercise
6. Power line collision
7. Landing

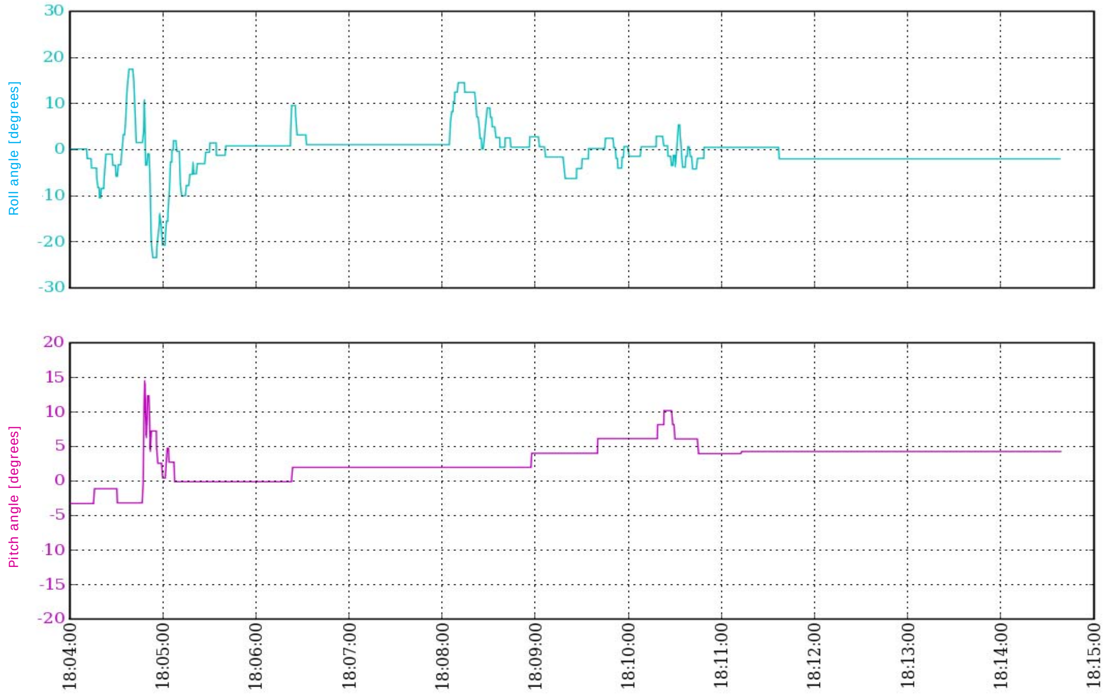




4.2.3. Other flight data (from the power line collision to the landing)

Relating to: altitude (feet), speed (knots), magnetic angle, roll angle and pitch angle (all three in degrees).

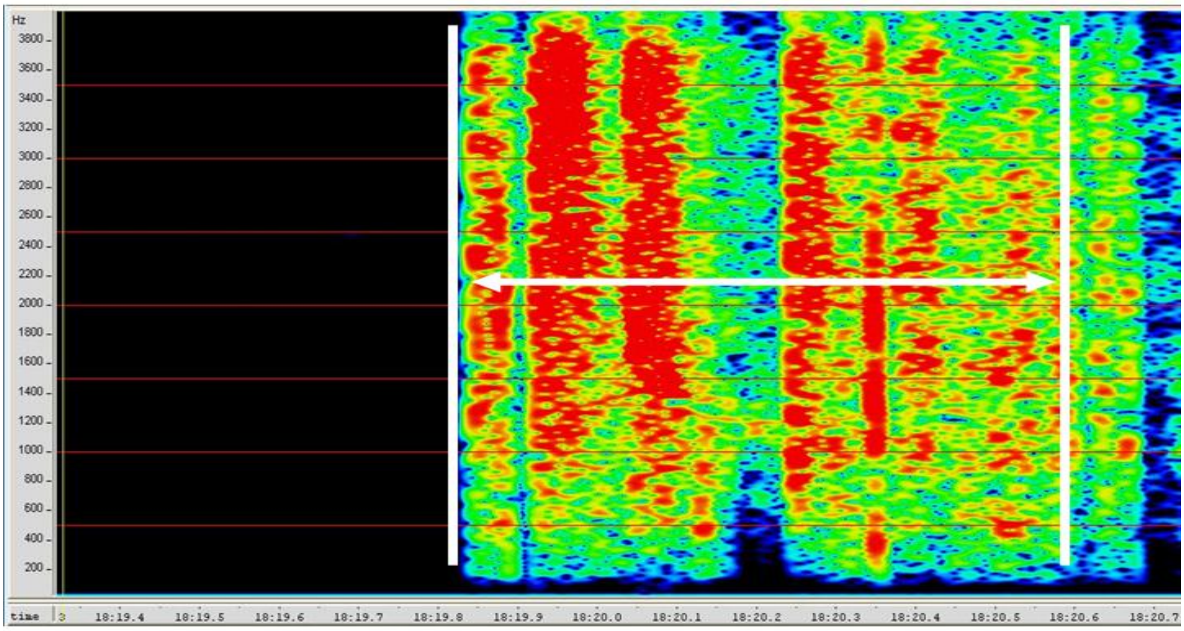




4.2.4 Audio data

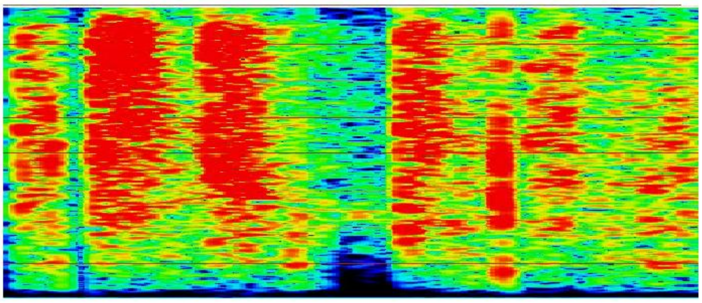
At 18 minutes and 19 seconds (of the 30 minutes available from the MRD), a noise was recorded that sounds like an impact. After this the sound changes, and a rattling noise was also recorded in addition to the communication between the two crew members. Both audio fragments were analysed in greater detail by means of spectral analysis.

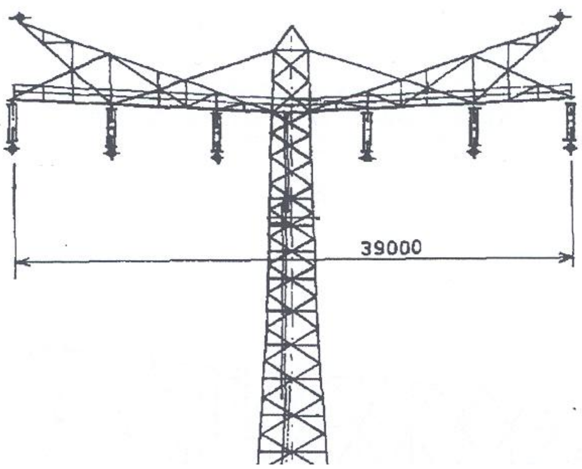
Spectral analysis of the sound at the time of the power line collision produces the following image:



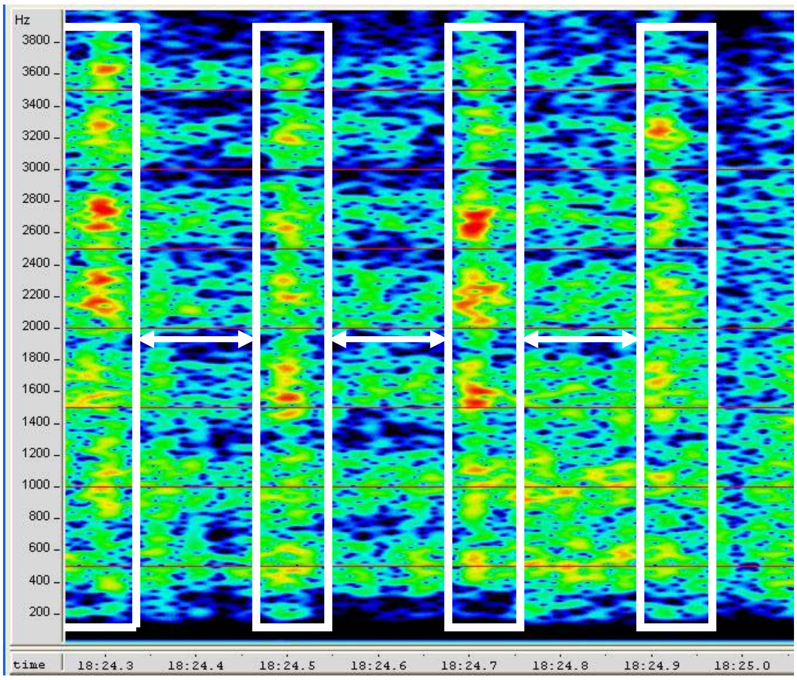
Frequency – Time: spectral analysis of the 'impact noise' recorded at 0:18:19. It is possible to distinguish between six signals with similar frequencies within the total duration of the noise (0.76 sec).

Unravelling the available audio data within a specific frequency range makes it possible to see the impact noise at a specific point in time, followed by a noise that recurs at regular intervals until the end of the flight.
Calculations on the basis of the speed of the Apache and the distances between the wires show that this was the point at which the Apache actually collided with the six power lines (See the adjoining illustration).





After the noise of the impact, another, repetitive noise was recorded. The noise has a recurrent pattern and stops at the end of the flight. The frequency of the noise is 5 Hz (repeated every 0.02 seconds).

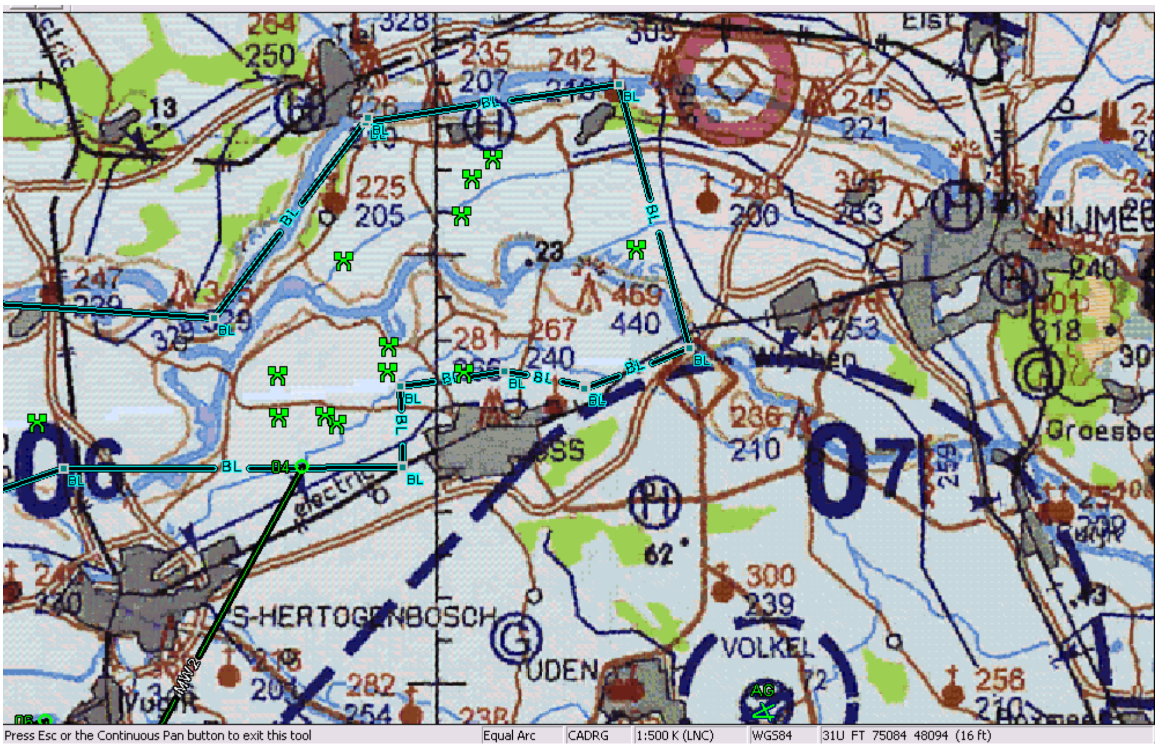


Spectral analysis of the repetitive noise following the power line collision. The time difference between each of the fragments is 0.02 seconds

The repetitive noise with a frequency of approx. 5 Hz corresponds with a rotational speed of 300 revs per minute. A likely explanation for this noise is the impact damage to the main rotor blade, as this rotates at a speed of 296 revs per minute. This type of damage would theoretically produce a repetitive noise at a frequency of 5 Hz. See also Appendix 10: Damage to the helicopter, section 3.1.

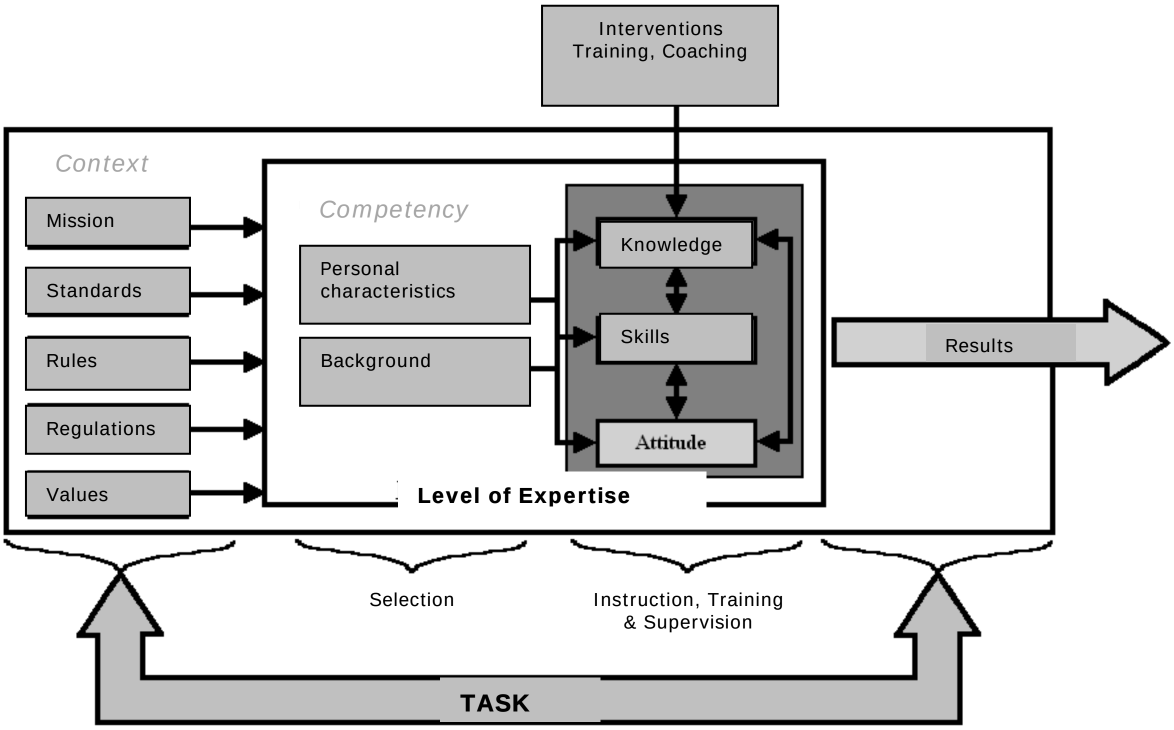
4.2.5 Navigation data

Various points were entered on the DTC (see chart). Obstacles (such as high-voltage power lines) are not entered on the DTC separately.



APPENDIX 12 THE TERM 'COMPETENCIES'

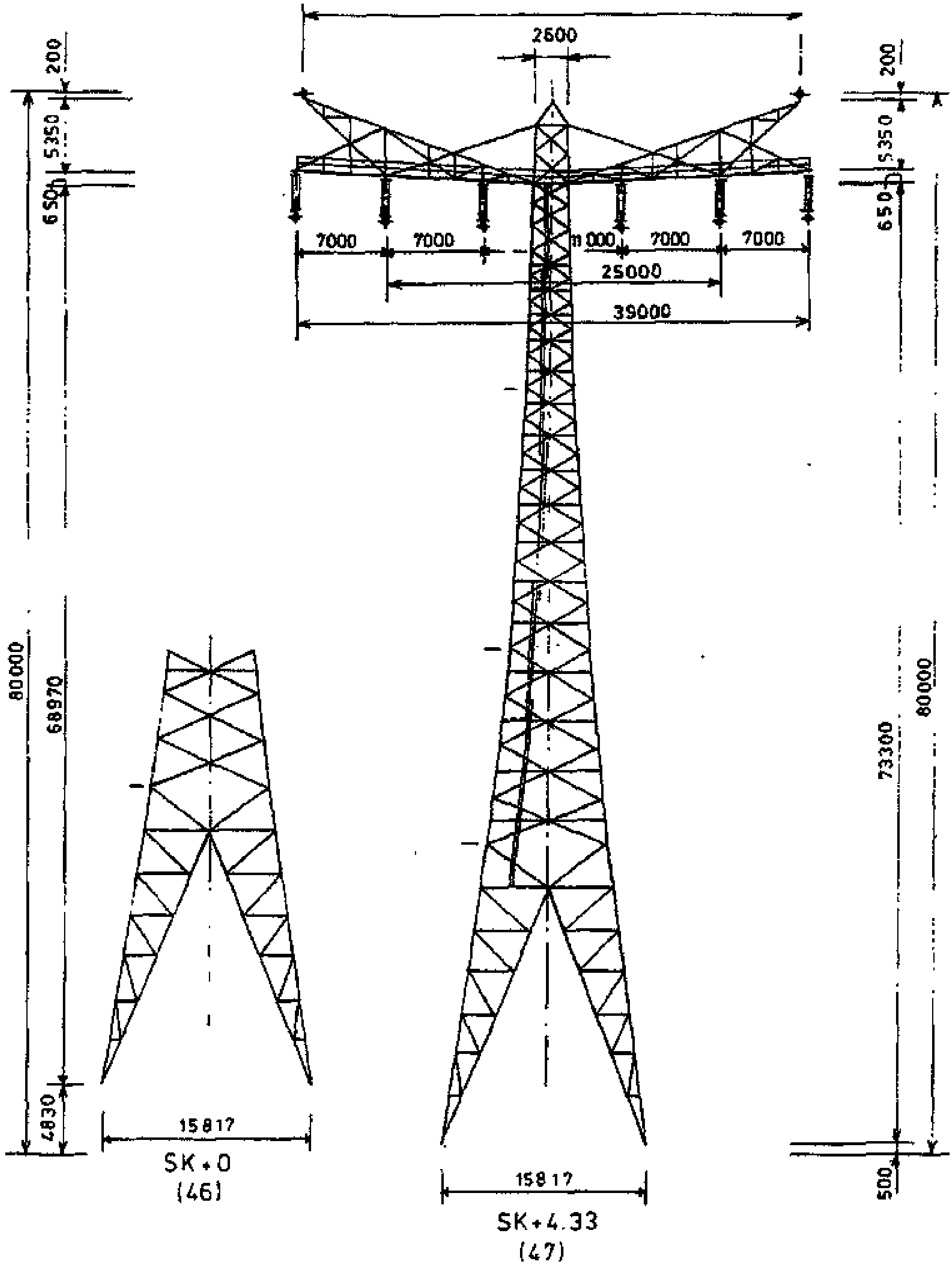
The term 'competencies' is a catch-all term, within which it is possible to distinguish between various aspects. The diagram below outlines the relationships between the various aspects. Competencies are task-related: after all, the task determines the competencies required of the person who is to carry it out. On the one hand, the task includes the required performance (result) and on the other hand, the context within which the performance must be delivered (mission, standards, rules, regulations, values). The core of the competencies consists of the required knowledge (knowledge of the system, knowledge of the rules, procedures etc.), the required skills (general and applied skills) and attitude (ability to correctly apply the knowledge and skills according to the requirements at the time in question). The personal characteristics and background of the person involved are also contributing factors.



In addition to guaranteeing competencies, explicitly also including the formation and monitoring of attitudes, the supervision structure is responsible for ensuring that preconditions are met (such as those relating to people, resources, structure, location, opportunity and administrative framework) and for monitoring the quality of operational management. This also includes performing the Operational Risk Management cycle as part of the planning procedure and the formulating the required contingency plans in preparation for all eventualities.

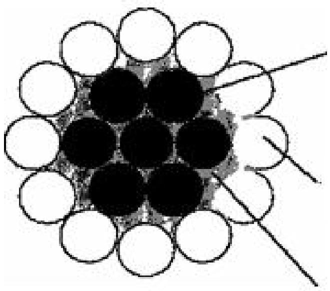
APPENDIX 13 CONFIGURATION OF THE HIGH-VOLTAGE PYLON AND POWER LINE

High-voltage pylon



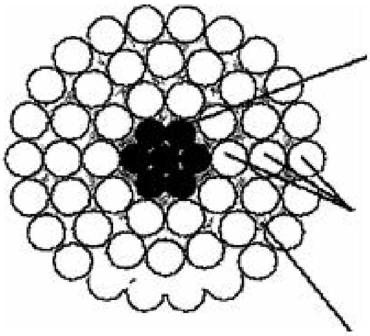
High-voltage power line and ground wire

Structure of the ground wire



Ground wire
- cross-section: 88.9 mm^2
- diameter: 12.20 mm
- weight of cable: 0.41 kg/m

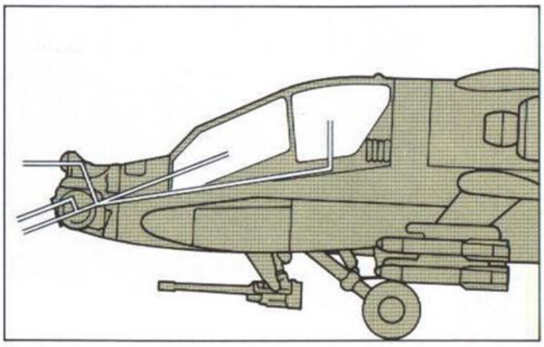
Structure of the phase wire



Phase wire
- cross-section: 495.8 mm^2
- diameter: 29.98 mm
- weight of cable: 1.59 kg/m

APPENDIX 14 ANALYSIS OF THE SCAN BEHAVIOUR OF THE BACK SEATER

The Apache helicopter features night vision equipment: the Integrated Helmet and Display Sighting Sensor (IHADSS) system makes it possible to fly under night-time conditions. Two sensors are positioned on the nose of the Apache helicopter for this purpose: the Target Acquisition Data System (TADS) for the crew member in the front (front seater, aircraft commander) and a Pilot Night Vision System (PNVS) for the crew member in the back (back seater, pilot). The night vision equipment shows an image of the direction in which the pilot is looking. The image is projected to the crew member in question via a sight-glass mounted on the helmet. In order to direct the sensor, the position of the helmet is registered. When the helmet (crew member's head) turns, the night vision sensor moves in the same direction and subsequently shows the image in the direction in which the pilot is looking.

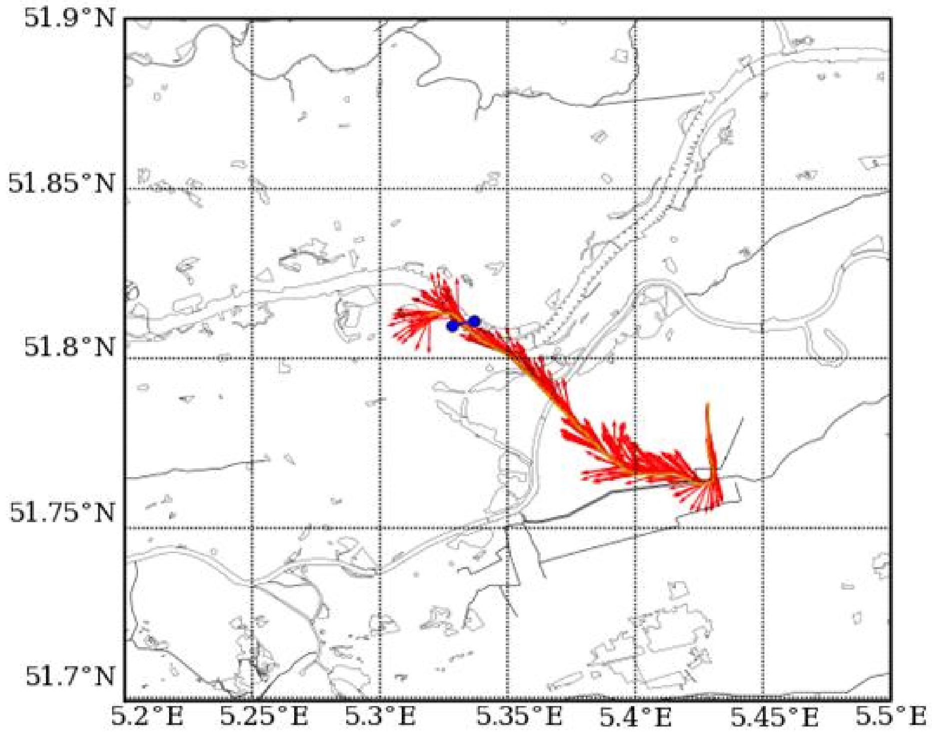


As well as flight data, the maintenance data recorder (MDR) also records data relating to the position of the helmet. Using a program specially designed for this purpose, it is possible to gain an insight into which direction the pilot (may) have been looking in on the basis of the MDR data, and to show this in a diagram or on charts.

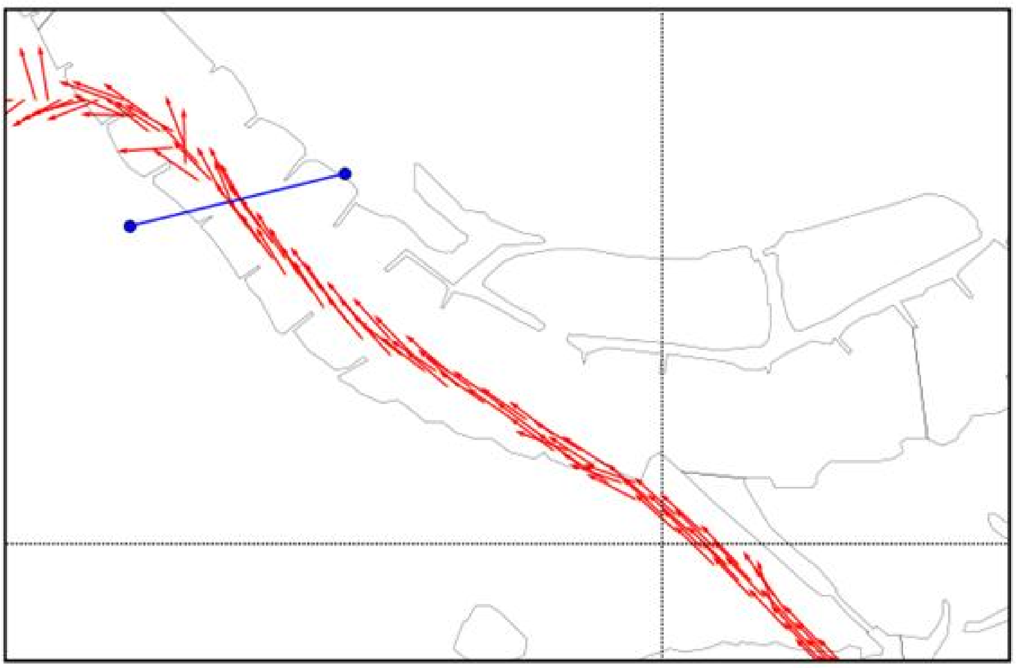
The pilot is able to look below or to the sides of the display mounted on the helmet. These eye movements which involve little or no movement of the helmet take place if the pilot quickly looks at a chart or instrument.

The data from the MDR is recorded asynchronously. The 'direction of view' data is therefore not recorded continuously. The direction of view may have changed without this change being registered by the recorder. As stated above, it is also possible for the pilot to look below or through the side of the projection screen.
Both of these variables must be taken into account in the analysis.
The position of the helmet (direction of view) can be calculated and displayed over a period of time. A number of successive points produce a picture of the scan pattern.

The illustrations and diagrams below show the scan behaviour of the back seater (the pilot flying).

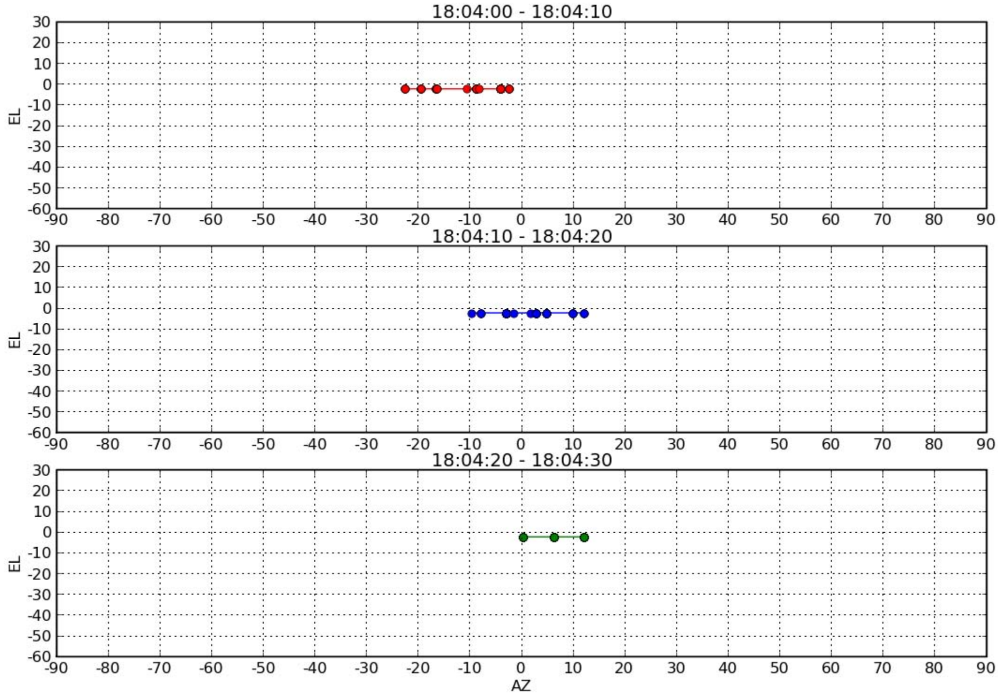


Direction of view of the back seater shown at GPS positions as recorded by the MDR.

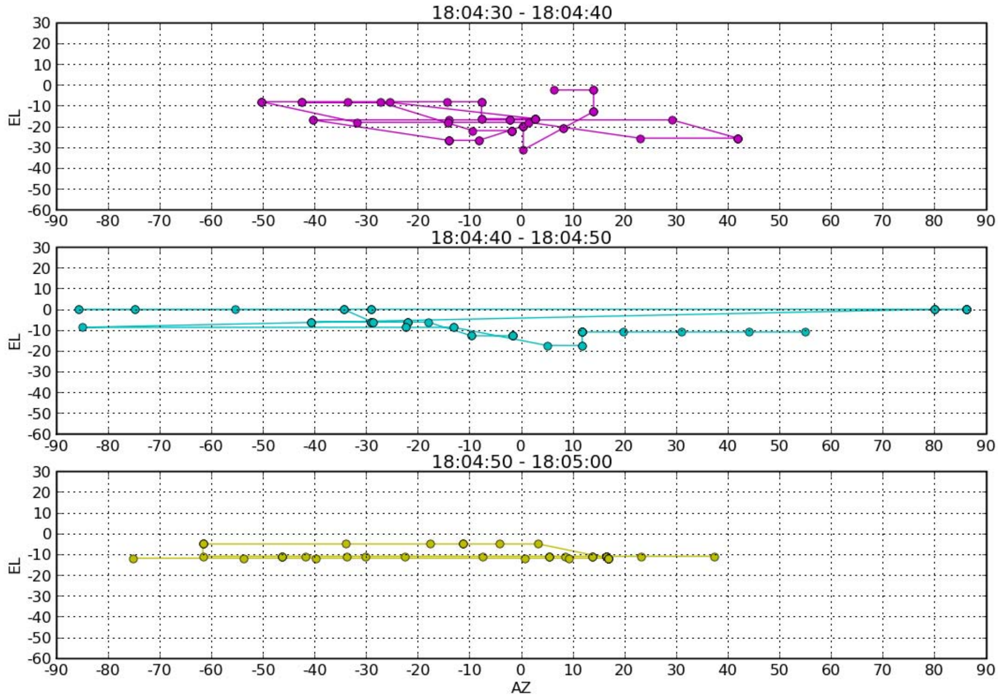


Direction of view of the back seater (red) immediately before, during and after the collision with the high-voltage cables. The interval of the direction of view shown is 0.16 seconds.

Direction of view of the back seater (altitude [el] and azimuth [az]) for a period of 30 seconds prior to the power line collision.



Direction of view of the back seater (altitude [el] and azimuth [az]) at the time of the power line collision (18.04.30) and up to 30 seconds after the collision.



The scan pattern of the back seater at around 25 minutes prior to the power line collision does not differ, however, from the scan patterns in the three other flights investigated (see section 5.2.6).

The diagram below shows the (broad) scan pattern of the back seater over a period of two minutes by way of illustration.

Position of the back seater's head 25 minutes before the power line collision [2 MINUTES]