Inadvertent loss of altitude during approach

Sikorsky S-61N, PH-NZG, Waddenzee near Den Helder, 30 November 2004

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DE ONDERZOEKSRAAD VOOR VEILIGHEID

The Dutch Safety Board has been established with the responsibility to investigate and establish what the causes or probable causes are of individual or categories of incidents in all sectors. The sole aim of such an investigation is to prevent future accidents or incidents and if the results of this should give cause to do so, to attach recommendations to this. The organization consists of a Board with five permanent members and has a number of permanent committees. Specific advisory committees are formed for specific investigations. A staff that comprises investigators and secretarial reporters as well as a support staff support the Dutch Safety Board.

The Dutch Safety Board is the legal successor to the Dutch Transport Safety Board. The present investigation is initiated and partly carried out by the Transport Safety Board but published under the auspices of the Dutch Safety Board.

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In accordance with Annex 13 to the Convention of Chicago as well as Directive No.94/56/EC of the Council for the European Communities, which established the fundamental principles governing the investigation of civil aviation accidents and incidents, the investigation of the Dutch Safety Board is not intended to apportion blame or liability.

N.B:
This report is published in the Dutch and English languages.
In the event of conflict in interpretation, the Dutch text will be deemed binding.

CONSIDERATION

On 30 November 2004 a Sykorsky S-61N of Schreiner Northsea Helicopters (SNH) with registration PH-NZG conducted a return flight from platform L10A in the North Sea to the aerodrome Den Helder Airport. It had three crew members and twelve passengers on board. The first officer was at the controls of the helicopter, 'pilot flying', the pilot in command was the 'pilot non flying'. During the approach, over the Waddenzee, the speed of the helicopter dropped back slowly which was not noticed by the crew. At that moment the helicopter flew in clouds. Since the decreasing speed was not compensated for by adding power, the helicopter lost altitude as well. The more the forward speed decreased, the rate of descend increased. It took approximately 20 seconds before the pilot in command noticed the speed reduction and the rapid decrease in altitude. He immediately took over control of the helicopter and tried to stop its high rate of descent. Though the rate of descent reduced, still the helicopter touched the water of the Waddenzee. After touching the water, the helicopter immediately could climb again and subsequently the aircraft executed a landing at Den Helder Airport a few minutes afterwards. The contact with the water did not result in injuries or substantial damage. The occurrence has been investigated by the Safety Board because it had been classified as a serious incident.

Causes of the occurrence
The Safety Board did not succeed in establishing a single cause of the occurrence. A direct technical cause is ruled out, though it cannot be excluded that the performance of the stabilizing system (AFCS) did play a role in the occurrence. In the course of the investigation several factors were revealed that had an effect on the development of the occurrence. Human factors could be identified as the direct cause of the incident, though the circumstances that enabled these factors to realize, were in particular of an organizational nature.

Human Factors
The speed reduction and the subsequent high rate of descent went unnoticed by both pilots during rather some time, approximately 20 seconds. This may be called remarkable since the manuals of SNH specify the coordination of duties in the cockpit of the helicopter in such a manner that, if this crew coordination is observed, a similar situation cannot occur. During an instrument approach the pilot flying concentrates his attention on monitoring the flight instruments and does not look outside. The duty of the pilot non flying is to monitor the pilot flying, as well as the instruments, and to look outside the cockpit for visual clues, such as approach- and runway lights and the runway coming in sight. At that instance he gives a call accordingly, after which the pilot flying looks outside as well and completes the last part of the approach and the landing visually. This procedure is in use in the entire transport aviation sector and is detailed accordingly in the operators operations manuals.

A sound explication why this procedure did not materialize could not be found. It is plausible that circumstances affecting the pilot flying as well as the pilot non flying caused them to deviate from this procedure. To indicate a single cause appeared not possible. Consequently, on several occasions, this report refers to probable causes and likely causes.

The pilot flying
Initially the pilot flying reduced the speed of the helicopter on purpose because its speed was higher then the 70 knots which would be maintained during the approach. However, this speed reduction was not stopped; the air speed of the helicopter continued to decrease. Because the reducing speed was not compensated for, by increasing engine power, the rate of descent of the helicopter increased.

The probable causes of the pilot flying not observing the decreasing air speed and the increasing rate of descent are, fatigue, lack of recent experience flying this type of helicopter, attending to a problem with the AFCS and executing an instrument approach with a speed of 70 knots, which was a non standard procedure[1].

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[1] This relatively low speed of the helicopter combined with a weight close to the maximum allowed, resulted in operating the helicopter close to the so called transition point of the power curve. In such circumstances an uncorrected decrease in speed can result in a quickly increasing rate of descent.

In addition the pilot non flying urged the pilot flying, four times within a short period of time, to allow the helicopter to descend in order to fly below the glide path. This was done in the assumption that in that way the runway lights could be detected earlier. It is likely that therefore the pilot flying concentrated in particular his attention to the instrument that indicates the position of the helicopter in relation to the glide path.

The pilot non flying
With regard to the pilot non flying it is established, that the monitoring inside and looking outside in order to detect the runway lights, has not been divided in an evenly manner. Probably he looked outside for a longer period of time, in order to detect the runway lights in a stage as early as possible. This probably was inspired by the urge to land at Den Helder Airport. With a view to the deteriorating weather situation it could have been possible that the helicopter would have to divert, because the visibility of Den Helder Airport would drop below limits. The conditions allowing for the execution of a landing are: a minimum horizontal visibility of 500 meters and runway lights in sight at a minimum altitude of 200 feet. The actual conditions were: a horizontal visibility of 700 meters and the runway lights visible at 250 feet. It was forecasted that these visibility values would deteriorate rapidly. All things considered it was found that the crew sought to prevent that a diversion to another airport would be required.

Crew Resource Management
Prior to the inadvertent altitude loss the flight was operated in a routine manner. It was found that during the flight, the crew did not make use of the checklists and that procedures were not (completely) followed. The investigation revealed that this had occurred more often on previous occasions and that this habit had developed because both crew members also operated “pilot flights” from the Maasvlakte. Similar “pilot flights” are of such a deviating character that checklists were not, or scarcely used and procedures not, or hardly applied.

Furthermore, during the many take offs and landings that are executed per day in the regular North sea operations, an abbreviated “shuttle checklist” is utilized, during the take offs from- and the landings at the platforms. In the course of time, this causes a routine to develop resulting in a reduction in the strict usage of the complete checklists and the application of procedures.

It was found that during trainings and check flights the procedures were executed and the checklists utilized. Also all crew members follow the mandatory CRM[2]-courses that among other things emphasize the significance of communication between crew members and the application of procedures. It is therefore remarkable that during this regular flight there was also a lack of discipline to follow the procedures and utilize the checklists. In particular during an approach under aggravated circumstances, such as low visibility, the application of procedures and utilization of checklists is of utmost significance. It may be concluded that the crew had the knowledge and competence to execute the approach according to the procedures, but that they failed to do so.

The Safety Board endorses and emphasizes the significance of Crew Resource Management but also concludes that, in the case under consideration the CRM training offered by SNH appeared insufficiently effective. This is a source of concern to the Board, in particular since it appears from the investigation history of the Safety Board and of foreign sister organizations that inadequacies in the field of CRM are a prominent factor in the causation of safety related occurrences.

Authority gradient
During the flight a flat authority gradient existed with hardly any difference in authority between pilot in command and First Officer. To a large extend this can be explained by the crew concept (division of duties and responsibilities in the cockpit) applied by SNH. In this concept the pilot flying always occupies the right hand seat and makes all decisions, while the pilot non flying is following, even if he is the pilot in command. The danger of a similar division is that no clear structure exists and no division of responsibility, whereas the pilot in command legally is responsible at all times. During a standard flight this crew concept will not immediately pose any problems but in particular at deviating situations, uncertainty and confusion can develop. This is illustrated by the pilot in command, being pilot non flying, giving instructions to the pilot flying, to fly below the glide path indication. This caused his role to change from “following” pilot non flying, to the role of “deciding’’ pilot in command.

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[2] Crew Resource Management.

Organizational factors
From the investigation emerged that indications, that the operational process needed improvement had reached the management at several occasions, from inside the company as well as from outside. Examples of this are observations made as a result of audits and inspections, observations made during meetings and, last but not least, the recommendations made in investigation reports of the company itself. These indications concerned, amongst others, the lack of training, but also deviating flying habits of some helicopter pilots, operating “pilot flights” from the Maasvlakte. The management was aware of the fact that part of the pilots force did not follow the crew concept.

Within the company the emphasis that was laid on the operational process was to the detriment of safety. Thus, the planning for the pilots scheduling was not optimal, causing a lack of proper assessment for the composition of crews. The combined function of flight operations and crew training within the organization of SNH hampered an objective balancing out between operational return and safety. It appeared that in some situations operational interest prevailed over the realization of training.

This creates the impression that SNH reconciled to a manner of managing the company that complied with the legal requirements, without any intention to raise the performance to a higher level. As a result, insufficient attention was given to the inherent dangers that ensued from this level of management. In the opinion of the Safety Board, the management of SNH did put insufficient effort into the implementation of effective improvements in response to the above mentioned observations.

The Transport and Water Management Inspectorate
The Transport and Water Management Inspectorate (IVW) did not succeed in adjusting the management of SNH. As a result of audits and inspections, IVW observed various inadequacies. The gravity of these inadequacies did not require corrective action, but IVW did make an agreement with SNH with regard to safety improvements. However IVW failed to verify the actual implementation of these safety improvements sufficiently. Furthermore IVW is not authorized to demand a higher level of safety then that which is required by legislation; typical in this connection is the statement: *“Compliance with the rules makes a score of six, but we do not have the authority to demand for an eight. This is the companies own prerogative.”*

Lack of valid flight data
Initially the investigation was hampered by a lack of valid flight data. Only after an extensive test, that required the utilization of the helicopter itself and calculation of conversion factors, a representative reconstruction of the flight turned out to be possible.

Reconstruction of the flight data was possible because the helicopter was not lost in the incident. If the helicopter would have been destroyed, then the data would have been useless. Flight recorders primarily serve to facilitate an investigation body such as the Safety Board, in retrieving the cause of an accident in a quick and accurate manner. Insufficient or incorrectly recorded flight data can seriously hamper the investigation of the accident or incident.

The predecessor of the Safety Board did, after a previous accident with a helicopter that crashed into the North Sea, issue a recommendation to equip helicopters that are utilized for passenger transport, with flight recorder equipment. This recommendation has been complied with by implementation in JAR-OPS 3. With regard to the maintenance of the recorders no further requirements are implemented however, resulting in the regulation being not very effective.

In the meantime it has turned out that this is not an isolated fact; with regard to other accidents and serious incidents that occurred within the Netherlands, also it was found that flight data recorder records were incorrect or not recorded at all. That this is not a problem limited to The Netherlands emerges from the report of the French Bureau d’enquetes et d’analyse pour la securite de l’aviation civile (BEA). In that report it is concluded that investigation bodies that are involved in the investigation of aviation accidents often do experience problems with the quality of recorded flight data, in particular if it concerns the smaller operators.

ICAO Annex 6 part 1 recommends among other things that flight recorder equipment be maintained on a yearly basis and the correct operation and the validity of data is being verified. This recommendation however is not implemented in European, nor in national legislation. It is the Boards opinion that this ICAO recommendation must be adopted in mandatory legislation because this will increase the possibility of correct operating flight recorder equipment considerably. The Board asked the IVW for a response to the question why the ICAO recommendation has not been implemented in Dutch legislation. Until the time of publication of this report, no response has been received however. As far as is known, within Europe only in the United Kingdom such legislation is implemented.

Recommendation to CHC
In the course of writing this report, SNH has been merged into CHC Helicopter Corporation Nederland. In this process, part of the management has been changed, but the majority of the management employees and all the pilots that were employed by SNH during the time of the occurrence, are now employed by CHC. It may therefore be expected that the safety risks that have been observed with regard to SNH, still are existing in the operation of CHC. The recommendation in question therefore is directed to CHC.

RECOMMENDATIONS

It is recommended to CHC Helicopter Corporation Nederland (former SNH):

- To put the management of the company to a critical test and implement revisions in order to achieve an operational performance as safe as is reasonably possible. In this context at least the next issues must be taken into consideration
  - Training of helicopter pilots
  - Applying the procedures as laid down in the operations manuals
  - Crew resource management
  - Crew scheduling
  - Response to the findings as a result of audits, inspections and observations made within the company itself.

It is recommended to the Minister of Transport, Public Works and Water Management

- To develop legislation, in cooperation with the European Aviation Authorities, providing for mandatory maintenance of flight recorder equipment on a structural basis and for verification of its operation and the validity of data, in accordance with the ICAO recommendation.

- To record the agreements made with companies as a result of audits and inspections properly and strictly verify the compliance with these agreements in order to observe incomplete- or non compliance in a timely manner.

Prof. Pieter van Vollenhoven
Chairman of the Dutch Safety Board

Mrs. M. Visser
General Secretary

SYNOPSIS

On 30 November 2004 the helicopter PH-NZG, a Sykorsky S-61N conducted a flight from Den Helder Airport to oil platform L10A in the North Sea. After landing on the platform it took off again at 14:59 hours for the return flight. On board were three crew (two pilots and one cabin attendant) and twelve passengers.

The weather in Den Helder was characterized by low clouds and a restricted visibility. The cloud base and the visibility were just above the required minima to allow for the execution of a landing at Den Helder Airport.

During the ILS approach, that was flown in clouds, the speed of the helicopter dropped back slowly from the initial 70 knots to approximately 20 knots. This was not noticed by the crew of the helicopter. Since the forward speed reduction was not compensated for by adding power, a high rate of descent developed. The pilot in command, who did not control the helicopter personally, observed this only at the last moment and took over the controls. In order to stop the high rate of descent he pulled maximum collective. However this action did not prevent the helicopter touching the water of the Waddenzee. Because the pilot in command kept the collective in the pulled up position, the helicopter climbed rapidly out of the water again. Subsequently the helicopter proceeded slowly to Den Helder Airport where a landing was executed. No persons were injured in this occurrence. The gearbox of the helicopter had been overloaded and had to be replaced.

LIST OF ABBREVIATIONS

	Abbreviations	Afkortingen
AFCS	automatic flight control system	automatisch stabilisatiesysteem
AIP	aeronautical information publication	luchtvaartgids
AOC	air operator certificate	vergunning tot vluchtuitvoering
ATC	air traffic control	luchtverkeersleiding
ATL	aircraft technical log	vliegtechnisch logboek
ATPL(H)	airline transport pilot license (helicopter)	bewijs van bevoegdheid als verkeersvlieger (helikopters)
AVAD	altitude voice alerting device	gesproken hoogtewaarschuwingssyseem
BEA	Bureau d'enquêtes et d'analyses pour la sécurité de l'aviation civile	Franse onderzoeksraad voor luchtvaartveiligheid
BECMG	becoming	geleidelijke verandering (van het weer)
Bkn	broken	half bewolkt (5/8 t/m 7/8 bedekkingsgraad)
Br	broom	nevel
C	Celsius	Celsius
CA	cabin attendant	cabinepersoneel
CB	cumulonimbus	cumulonimbus bewolking
CI	cirrus	cirrus bewolking
CHC	CHC Helicopter Corporation	CHC Helicopter Corporation
CPL(H)	commercial pilot license (helicopter)	bewijs van bevoegdheid als beroepsvlieger (helikopter)
CRM	crew resource management	crew resource management
CU	cumulus	cumulus bewolking
CVFDR	cockpit voice and flight data recorder	gecombineerde cockpit voice en flightdatarecorder
CVR	cockpit voice recorder	cockpit voice recorder
DA	decision altitude	beslissingshoogte
DME	distance measuring equipment	voorziening die de afstand tot een VOR weergeeft
DFDAU	digital flight data acquisition unit	digital flight data acquisition unit
ECAC	European Civil Aviation Conference	European Civil Aviation Conference
EGSH	Norwich airport	vliegveld Norwich
EHKD	Den Helder airport	vliegveld Den Helder
FCL	flight crew license	bewijs van bevoegdheid als vliegtuigbestuurder
FDAU	flight data acquisition unit	verzamelcomputer van gegevensbronnen
FDR	flight data recorder	vluchtdatarecorder
FEW	few	weinig bewolking (1/8 t/m 2/8 bedekkingsgraad)
FL	flight level	vluchtniveau, hoogte t.o.v. 1013,2 hPa referentievlak in voeten, gedeeld door 100
FLIDRAS	flight data replay and analyses system	flight data replay and analyses system
G	gusting	windstoot
GMT	Greenwich mean time	Greenwich mean time
GTP	ground test procedure	grondtest procedure
HEMS	helicopter emergency medical services	helikoptervluchten met medische noodzaak
HUMS	health and usage monitoring system	systeem dat trillingen en onderhoudsgegevens registreert
IAS	indicated air speed	aangewezen luchtsnelheid

ICAO	International Civil Aviation Organization	internationale organisatie voor de burgerluchtvaart
ILS	instrument landing system	instrument landingssysteem
IR	instrument rating	bevoegdverklaring instrumentvliegen
IVW-DL	Transport and Water Management Inspectorate the Netherlands, Flight Operations Inspectorate	Inspectie Verkeer en Waterstaat, divisie Luchtvaart
JAA	Joint Aviation Authorities	gemeenschappelijke Europese luchtvaartautoriteiten
JAR	Joint Aviation Requirements	gemeenschappelijke Europese luchtvaarteisen
JAR-OPS3	Joint Aviation Requirements-operations (commercial air transportation, helicopters)	regeling inzake commercieel luchtvervoer met helikopters, opgesteld door de JAA
KIAS	knots indicated airspeed	aangewezen luchtsnelheid in knopen
KNMI	Royal Dutch Meteorological Institute	Koninklijk Nederlands Meteorologisch Instituut
Kt	knot(s)	knopen (1 kt is 1.852 km/u)
Lb(s)	pounds	pond (0.4536 kg)
MDA	minimum decision altitude	minimum beslissingshoogte
MEL	minimum equipment list	minimum equipment lijst
NOTAM	notice to airmen	bericht aan luchtvarenden
OAT	outside air temperature	buitenluchttemperatuur
Ovc	overcast	geheel bewolkt
Pilot flying	pilot flying	bestuurder
Pilot non flying	pilot non flying	assisterende bestuurder
QNH	pressure setting to indicate elevation above mean sea level	atmosferische druk op het aardoppervlak, herleid tot gemiddeld zeeniveau in de ICAO-standaardatmosfeer
RVTV	Dutch Transport Safety Board	Raad voor de Transportveiligheid
RVR	runway visual range	horizontaal zicht langs de landingsbaan
SCT	scattered	verspreide bewolking (3/8-4/8 bedekkingsgraad)
SNH	Schreiner Northsea Helicopters	Schreiner Northsea Helicopters
SOP	standard operating procedure	standaard operatie procedures
SRB	Safety Review Board	Safety Review Board
ST	stratus	stratusbewolking
TAF	terminal aerodrome forecast	luchtvaartterreinweersverwachting
TEMPO	temporarily trend	tijdelijke (weers)verandering
T/TD	temperature/dew point	temperatuur/dauwpunt
TWR/APP	tower/approach	toren- en naderingsverkeersleiding
UTC	coordinated universal time	gecoördineerde wereldtijd
VFR	visual flight rules	vluchten onder zichtvliegomstandigheden
VNV	Dutch Airline Pilots Association	Vereniging van Nederlandse Verkeersvliegers
VOR	VHF omnidirectional radio range	een radiobaken t.b.v. de navigatie
Z	zulu time	gecoördineerde wereldtijd

1 FACTUAL INFORMATION

Place	:	Waddenzee near Den Helder, position 52°56'1''N en 04°47'6''E.
Date and time	:	30 November 2004 approximately 15:23[3]
Aircraft	:	Helicopter Sikorsky S-61N (SK61)
Registration	:	PH-NZG
Flight number	:	03A
Operator	:	Schreiner Northsea Helicopters (SNH)
Crew/passengers	:	3/12
Type of flight	:	Passenger flight
Phase of flight	:	Approach
Classification	:	Serious incident
Type of occurrence	:	Loss of altitude during approach followed by touching the water surface

1.1 HISTORY OF FLIGHT

1.1.1 Preparation

On 30 November 2004 helicopter PH-NZG was scheduled to operate one or more flights from Den Helder Airport (EHKD) to oil- and production platforms in the North Sea. The purpose of these flights was, to transport employees to the platforms and to bring the employees that were relieved, back to EHKD.

Both (cockpit) crew members had left their homes at approximately 06:00 hours in order to proceed to Den Helder. They reported at Operations at 08:00 hours. The visibility was below limits because of fog and therefore no air traffic in or out of Den Helder was possible. The crew did wait until in the afternoon before the weather situation allowed the flight to be operated.

At approximately 13:00 hours the weather had improved sufficiently to allow for flying operations from EHKD again. With a view to the available time and the development of the weather situation Operations had produced a fresh flight scheduling. Around that time the helicopters of Schreiner North Sea Helicopters (SNH) were prepared for departure. De PH-NZG was scheduled to depart behind all the other helicopters, for a flight to platform L10A in the North Sea. In order to comply with the alternate criteria and the fuel planning, for the flight from EHKD to the L10A, a diversion from L10A to Norwich was accounted for. For the return flight the possibility of a diversion to EGHS, if required after a go-around at EHKD, was accounted for.

1.1.2 The outbound flight

The crew of the PH-NZG was composed of a pilot in command (pilot non flying)[4] occupying the left seat of the cockpit, the first officer (pilot flying)[5] occupying the right seat and a cabin attendant in the cabin. Thirteen passengers were on board. According to the flight plan that was prepared for the flight, the available fuel quantity was 2.567 lbs[6]. According to the flight plan/flight log that, before flight, was downloaded by the crew into the on board computer, the fuel quantity was 2.367 lbs. The information that it is loaded into the on board computer can be adjusted during flight and intermediate stops at the platforms, to allow for entering of data regarding passengers, cargo and fuel. After flight a print out is produced of these data.

After flight preparation, fuelling and inspection of the helicopter, the PH-NZG took off from Den Helder with call sign ''Schreiner 3'' at 14:27 hours.
According to the pilot flyings statement, he needed some time searching for the correct stabilization while lifting the helicopter into the hover before take off.

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[3] All times in this report are local times (UTC+1 hour) unless otherwise indicated.
[4] Nowadays this is called the pilot monitoring. In connection with the terminology used in various documents, in this report the term pilot non flying has been chosen.
[5] In situations involving an authority relationship or decision making, the terms Pilot in command and first officer are used, on other occasions pilot flying and pilot non flying.
[6] Lbs is a unit of mass corresponding with 0,4536 kg.

During the flight to the L10A, the pilot flying made the remark that the system for the longitudinal stabilization (component of the automatic flight control system, AFCS, see 1.6.5) lagged slightly behind; the 'pitch channel was sloppy', as he called it. He made a remark about this to the pilot in command twice and referred to his probably "rusty flying''. The pilot in command did not take further notice and the issue did not turn up any more during the remainder of the flight.

In the course of the flight, the request came in from the L10A how many extra passengers could be carried to EHKD. As a result of this question the take off weight from L10A as well as the fuel planning had to be recalculated. Twice, the pilot flying suggested to the pilot non flying to let the L10A know about the return load, in order to allow those responsible on the platform, to determine the number of return passengers. This idea also was proposed by the L10A, but the pilot non flying did not react.

The pilot non flyings request for the so called "deck clearance'' on the L10A was not understood by the radio operator and he requested Schreiner 3 to repeat the message. The pilot non flying did not respond. Therefore the required confirmation from the radio operator that the landing deck was clear remained forthcoming.

From the transcript of the Cockpit Voice Recorder (CVR) it was found that the pilot in command expected the helicopter to have 2.100 lbs of fuel on board after landing. In connection with the possibility that the helicopter would have to divert as a result of the expected weather situation at EHKD (visibility and cloud base), he decided to have the helicopter refuelled with 300 lbs of fuel. As a result the total fuel quantity at departure from the L10A would be 2.400 lbs. Before the landing no crew briefing was given. The "final checklist'' was complied with.

The pilot flying landed the helicopter on the platform L10A at 14:51 hours, after a flight of 24 minutes. On request of the customer one extra passenger was loaded for the return flight, bringing the total number of passengers to twelve. After receiving the manifest, the weight of the passengers and the baggage was entered in the board computer.

At the platform the pilot in command decided to refuel 500 lbs of fuel. In the navigation plan/flightlog that is recorded after the flight it is noted however that that the refuelled quantity was 430 lbs. and the departure fuel quantity was 2.081 lbs. (also see 1.6.2). From the CVR emerged that the pilot in command indicated to have difficulties in calculating weight and fuel quantities all the time and that he did not need all these kind of alterations; *"that would give him a whole in the head''* (translated).

1.1.3 The return flight

At 14:59 hours the Schreiner 3 took off for the return flight. Also on this flight the first officer was pilot flying and the pilot in command the pilot non flying. From the CVR information it emerged that the "before–" and "after take off'' checklists were not used.

After take off the helicopter climbed to 3.000 ft. where the flight was operated above clouds. From CVR information it was found that at 15:04:46 hours the pilot non flying called SNH operations. Subsequently he exchanged information regarding the flight and the weather with Operations and with crews of other helicopters. On the basis of this information the crew concluded that the visibility and the cloud base were above minimum required and that a landing could be made at EHKD.

After receiving the weather from SNH Operations the pilot in command assumed that a "full ILS''[7] would be executed. The first officer suggested that he would fly the ILS with a speed of 70 knots (kt), arguing that if done so, there would be more time available to "observe everything properly'' (transl.) The pilot in command advised (as appeared in a later stage with regard to the glide path), to "stay just a bit below it''(transl.). The consequences of the choice to maintain a relatively low approach speed were not discussed.

After the Schreiner 3, near reporting point "Marin'', was transferred from air traffic control station "Amsterdam Information" to approach control station "De Kooy Approach" (Approach), the crew received instructions to proceed direct to reporting point "Tango'' at 3.000 feet. They received the information to expect an ILS approach on runway 22 at EHKD. Also Approach provided the

[7] An approach during which the Instrument Landing System is utilized.

Schreiner 3 with the latest weather situation of EHKD: ''visibility 700 meters in fog patches, scattered at 100 feet, broken at 200 feet and the wind 130 with 6''.

From the crew of the Schreiner 5, that just had landed, the crew of Schreiner 3 received the information that the approach lights came in sight at an altitude of 250 feet. Approach provided the instruction to proceed direct to Tango and to descend from 3.000 feet to 2.000 feet and after Tango to fly a heading of 130 degrees.

During the initial approach (as appeared afterwards, approximately 8 minutes before the incident) the pilot flying requested the pilot non flying to take over the controls for a while. A short discussion developed regarding the AFCS pitch channel, which did not result in an unambiguous analysis. The "sloppy'' behaviour of the pitch channel, mentioned in an earlier stage, was observed in particular after pressing the trim release button. At 2.000 feet the pilot non flying transferred the controls again to the pilot flying. The emergency checklist was not consulted and possible consequences were not reviewed.

At 2.000 feet and with a heading of 130 degrees, the Schreiner 3 received instructions from Approach to descent further to 1.200 feet and fly a heading of 140 degrees. This heading and altitude would result in a "short line-up''. This "short line-up'' was initiated by the EHKD air traffic control without further consultation with the crew and also was not disputed by the crew.

At 15:19:07 hours the Schreiner 3 approached the altitude of 1.200 feet and the pilot in command gave the instruction to the first officer to follow exactly the instrument flight indications, (transl.: to fly "on the little pins''). At 15:21:03 hours the Schreiner 3 reached the glide path and started descend from 1.200 feet altitude. After confirmation to Approach that the helicopter was established, at 15:21:31 hours Schreiner 3 was transferred to the local air traffic control station ''De Kooy Tower'', which at 15:21:40 cleared the helicopter to land.

From the CVR it cannot be heard that during the approach a crew briefing was given or that the "approach-" and "final checklist'' were read. Items of these were called out though, such as the kind of approach, the approach speed, the "localiser call'', the lowering of the landing gear and the confirmation of the landing clearance.

1.1.4 The occurrence

- 15:22:14 the pilot in command gave the first instruction *"just descend a bit''*
- 15:22:31 this was followed by the second instruction *"descend"*
- 15:22:37 the pilot in command announced that the altitude of 500 feet was reached and they were cleared to land
- 15:22:46 again the pilot in command gave the instruction *"descend''* followed by: *"yes exactly….just a bit more below''* at 15:22:54 hours.

The only thing regarding the onset of the incident that could be heard from the CVR is the pilot in command calling: *"ho ho''* at 15:23:09 hours. Immediately after that the increase in revolutions of the engines is audible.

- 15:23:13 the Altitude Voice Alerting Device (AVAD) calling *"Check Height''* could be heard.
- 15:23:19 the warning *"100 feet''* sounded
- 15:23:20 the pilot in command called out *"approach lights''*

Shortly after that, faintly, a splash could be heard. During and shortly after the occurrence no audible communication between the pilots was exchanged.

15:24:35 hours the pilot flying contacted air traffic control. He indicated that a mishap had occurred, that in the meantime everything was under control and that they wished to have the landing gear checked visually from the tower. After the air traffic control operator had indicated that no irregularities could be observed at the landing gear, the Schreiner 3 landed at 15:26 hours.

At 15:27:24 hours the pilot flying indicated that according to his opinion the "faulty AFCS'' had caused this situation. The crew informed Schreiner Operations and some officials of SNH about the occurrence. Subsequently the crew provided the passengers with an explanation regarding the incident.

The pilot flying stated that while flying the ILS he received several times the instruction from the pilot in command to follow the glide slope[8]. During the approach, which was flown in clouds, he observed the speed of the helicopter reaching slightly above 70 kt, which was corrected by raising the nose of the helicopter a bit, by clicking the “coolie hat'' (see 1.6.5) and a slight decrease in power (torque). He stated that after that action he had observed the rate of descent indicator and the ''horizontal situation indicator'' and checked the pitch attitude of the helicopter. Some time after that he observed a rapid decrease in speed on the airspeed indicator, till below 20 kt and that the helicopter had obtained a pitch high attitude of approximately 15 degrees. He stated that he did not understand the reason of this behaviour and before he realized what happened he noticed the pilot in command taking over control of the helicopter and applying full collective[9]. Because the helicopter flew in clouds he did not have any visual references. He noticed the helicopter coming below clouds and, in an almost vertical attitude, descending steeply and subsequently touching the water of the Waddenzee. Initially he thought that the pilot in command had landed the helicopter on water by purpose. After he noticed that the helicopter took off from the water again he realized that the landing had been made inadvertently.

The pilot in command, pilot non flying, stated that initially the ILS approach went normal. During the approach he had pointed out several times to the pilot flying that he was flying just above the glide slope. At 350 feet he looked outside in order to observe if the approach lights of runway 22 already were visible. After some time he looked at the instruments inside the cockpit again to check their indications. At that moment he noticed the speed being decreased to almost 0 kt and in the same time the glide slope indicator moving up fast. From this the pilot non flying understood that the helicopter was in a fast, vertical descent. He realized that this was a dangerous situation and took over control immediately. The pilot non flying pulled up the collective as far as possible, in order to obtain maximum power and check the steep rate of descend. This however was too late to prevent the helicopter touch the water of the Waddenzee.

Because maximum power was maintained, the helicopter could be lifted out of the water rapidly again. The pilot flying as well as the pilot non flying stated that during the incident they had not noticed the AVAD warning.

The cabin attendant stated that during flight he had had the impression that the helicopter moved up and down slightly. He had noticed the pilots having a discussion about this, but that it did not present a problem. During the approach to De Kooy he had noticed no particulars until he felt the helicopter suddenly starting to shake and vibrate and subsequently moving down fast. The passengers and himself had adopted the “brace position'' and shortly afterwards he felt the helicopter touch the water with a bounce and almost immediately thereafter fly up again. Subsequently the helicopter proceeded slowly towards the airport.

1.2 INJURIES

There were no injuries

1.3 DAMAGE TO THE HELICOPTER

The fuselage of the helicopter was not damaged, the gear box had to be replaced.

From the health and usage monitoring system (HUMS) was found that the following values had been recorded:

- Maximum power (torque) engine #1 : 115% for 1 second
- Maximum power (torque) engine #2 : 128% for 3 seconds
- Maximum combined load on the gear box[10] : 251.01% for 3 seconds

8 The glide slope is part of the ILS and represents a line of descent of 3°, that is followed by the aircraft, beginning at the starting point of the ILS untill the point of touch down.

9 The collective is a control lever that controls vertical movement of the helicopter by selecting the blade angle of the rotor blades simultanouesly and the corresponding power.

10 The gearbox is the transmission system that transmits engine power to the rotor.

Specifications of the manufacturer indicate that the gear box must be replaced if the combined load has been over 235%.

1.4 OTHER DAMAGE

None

1.5 CREW INFORMATION

Pilot in command	:	Male, Dutch, 54 years of age
Licence	:	ATPL (H)
Type qualifications	:	SK61 en SA365/365N
Proficiency check S-61N valid till	:	31 March 2005
Line check S-61N valid till	:	1 December 2004
CRM training valid till	:	6 November 2004
Medical certificate valid till	:	5 March 2005
Employed by SNH since	:	29 January 1986
Flying experience total	:	8958:07
Helicopter experience total		8333:07
On type	:	2757:43
Last 90 days	:	36:06
Last 30 days	:	31:10
Last 24 hours	:	1:08
Rest time before duty	:	35:00

The pilot in command operated flights for SNH with the Sikorsky S-61N from EHKD to platforms in the North Sea on behalf of oil- and gas companies. Besides he performed flights from the Maasvlakte with the SA365N3 (Dauphin) on behalf of the pilot service. This includes letting of pilots, at ships that require pilot service.

The pilot in command had not flown from 23 August till 27 October 2004. His first flight again, of 4:56 hours, was made with the S-61N on 27 October 2004. During the month of November, previous to the incident flight, he had completed eleven flights, with a total of 30:02 flying hours. Ten of these flights were conducted on the SA365N3 during which a total 27:36 flying hours were made, and one flight of 2:26 hours on the S-61N. This last flight on the S-61N, before the occurrence, was made on 3 November 2004.

The pilot in command was employed as a helicopter pilot since 1977. He started flying with SNH in 1998 operating the SA365 from the Maasvlakte. Flights from the Maasvlakte are mostly conducted as VFR flights. He started training for a type qualification on the S-61N on 9 March 2003. In the past he had been in the possession of this qualification but it had expired because he had operated other types of helicopter for some years. On 20 March 2003 he passed the test for the second time, with good results.

From training-, test- and check flight reports covering the period 2000-2005 it turned out that the pilot in command in general showed a standard flying performance. Regarding some of these flights it emerged that the instructors had made remarks with regard to instrument flight performance, coordination, crew concept and standard phraseology.

First officer		Male, Dutch, 35 years of age
Licence	:	CPL (H)
Qualifications	:	SK61 and SA365/365N
Proficiency check S-61N valid till	:	30 November 2005
Line check S-61N valid till	:	30 September 2005
CRM training valid till	:	4 March 2005
Medical certificate valid till	:	1 July 2005
Helicopter experience total		1582:27
On type	:	1445:44
Last 90 days	:	107:45
Last 30 days	:	20:25
Last 24 hours	:	1:08
Rest time before duty	:	21:30

The first officer also operated flights for SNH with the S-61N from EHKD to platforms in the North Sea. Also he operated flights from the Maasvlakte with the SA365N3 (Dauphin) on behalf of the pilot service. The training for this type of helicopter was completed 2½ month before the occurrence with the PH-NZG.

In the month of November, before the incident flight, he had completed seven flights with the SA365N3 with a total flying time of 13:10 hours. In the month of October he had completed six flights with a total time of 25:15 hours. Five flights of these were conducted on the S-61N with a flying time of 24:43 hours and one flight of 0:32 hours with the SA365N3. The last flight with the S-61N before the occurrence was made on 29 October 2004.

From interviews and records it was found that he was employed as a helicopter pilot by SNH in January 1999. From several training reports and test- and check flight reports it emerged that the first officer in general performed standard or slightly above standard. No remarks were made regarding his instrument flight performance and crew communication.

Cabin attendant		Male, Dutch, 32 years of age
Medical certificate valid till	:	31 August 2007
Employed by SNH since	:	1 September 1999
Last line check	:	5 Ocober2004
Duty time last 90 days	:	12:18
Last 30 days	:	12:18
Last 24 hours	:	1:08
Rest time before duty	:	103:00

The cabin attendant was employed in this quality since two years. In the week before the incident he had completed four flights with a total flying time of 12:18 hours. Before that week he had not flown during three months because of an illness.

1.6 INFORMATION ON THE HELICOPTER

1.6.1 General

The Sikorsky S-61N is a twin engined helicopter suitable for commercial transport. The design and construction allows the helicopter also to land on the water and stay afloat. The helicopter has a landing gear existing of a main landing gear that can be raised in wheel bays at the side of the helicopter, which also serve as stabilization floats, and a tail wheel. It has a crew of two pilots and one person as a cabin attendant. A maximum of 28 passengers can be transported dependant upon the type of construction.

Figure 1: PH-NZG (source M. de Bruijn)

Type	:	Sikorsky S-61N
Year of construction	:	1975
Registration	:	PH-NZG
Serial number	:	61753
Certificate of airworthiness	:	Valid till 16 December 2005
Total flying hours	:	28295:22
Maximum certified Take off weight	:	20.500 Lbs
Engines	:	General Electric CT58-2-140
Engine #1		
Serial number	:	295226C
Total number of hours	:	23840:38
Hours since overhaul	:	439:57
Date of installation	:	20 May 2004
Hours since installation	:	16283:30
Engine #2		
Serial number	:	295228C
Total number of hours	:	24280:35
Hours since overhaul	:	972:21
Date of installation	:	30 August 2004
Hours since installation	:	16041:00

1.6.2 Weight and balance

The empty weight of the helicopter was 14.775 lbs. After calculation of the fuel uplift, the fuel used, the weight of the occupants and baggage, the helicopters take off weight from L10A was approximately 20.139 lbs. The maximum allowed take off weight from L10A as calculated by the crew, was 20.100 lbs. This weight varies with wind, temperature and take off location. At the time of the occurrence the weight of the helicopter was approximately 19.706 lbs. Because the passenger distribution over the cabin was not known, to the best ability, a reconstruction was made. It turned out that at the moment of the occurrence the position of the centre of gravity was at approximately 268 inches. According to the flight manual the position of the centre of gravity must be between 258 and 275,8 inches.

1.6.3 *Technical condition of the helicopter*

The certificate of airworthiness of the helicopter was valid until 16 December 2005. After the last inspection, which had been performed on 11 November 2004 a maintenance release was issued on 19 November 2004. It had no outstanding technical complaints. Before the flight the daily inspection was completed by a ground engineer.

1.6.4 *Manuals*

Sikorsky Aircraft Manual

With the helicopter goes a "Sikorsky S-61N flight manual" endorsed by the American authorities. This manual contains i.a. a description of the helicopter, the normal and emergency procedures and the performance data.

The speed/power curve in the flight manual shows the relation between the flying speed and the power required at sea level, in a horizontal flight, at various weights. This curve shows a hollow parabola with its lowest point at approximately 70 kts (at a total weight of the helicopter of 19.000 lbs). The curve shows that if flying at a speed requiring minimum power, a change in speed, be it an increase or a decrease in speed, requires a progressive increase in power (see appendix B).

It must be noted in this connection, that the curve as is shown, applies to a helicopter with a different type of engine. According to the helicopter manufacturer, the performance of the type of engines installed on the PH-NZG will be equal or better.

SNH Operations Manual Part A

In the Operations Manual Part A, paragraph 1.4 the responsibilities of the crew are specified. It is stated i.a.:*''It is obvious that safety is the primary factor to be taken into consideration. Crew members must always be alert to preserve the safety of the aircraft and the passengers and they must ensure that established standards and procedures for safe operations are maintained at all times".*

These responsibilities are stated again in the same part where the specific duties of the pilot in command and the first officer are mentioned.

In the Operations Manual part A paragraph 4.4 the division of duties on board the helicopter is specified, the crew concept. From this concept follows that the pilot flying, who occupies the right hand seat at all times, is to assume all (flying) duties. *"These will include making decisions affecting the routine operation of the helicopter and its systems in accordance with standard operating procedure. When the PF is not the pilot in command (PiC), instructions to the PNF should be considered advisory, also if unsure of or making a decision contrary to SOP then he is to receive the PiC's approval before actioning them."*

"In an emergency the PF continues to fly the helicopter and calls for the immediate and subsequent actions from the PNF. The PiC retains overall responsibility for the helicopter whilst acting as PNF and may revert to PF at any time by taking control from the co-pilot in the normal way."

Information from SNH shows that this crew concept has been developed in the 1970's and deviates from the concepts in use with most other airlines. It is common practice that a decision of the pilot flying, if he is not the pilot in command, needs approval from the pilot in command being the overall responsible person.

SNH Operations Manual Part B S-61N

The Operations Manual part B specifies i.a. limitations, normal- and emergency procedures, performance, loading and systems of the S-61N, utilized by SNH. Chapter 03, 'Normal Procedures' specifies i.a. the technique of executing an approach and landing.

In chapter 02 of the 'Approach and Landing' part it is stated:
"The crew briefing shall be completed, normally by the PF, as soon as the type of approach and landing runway has been decided upon" The crew briefing on-shore will cover:

- *type of approach*
- *circuit and approach speeds*
- *initial approach altitude*
- *outer marker altitude*
- *minimum decision altitude and threshold altitude*
- *missed approach;*
- *crew coordination*
- *All other items of operational interest*

The item crew coordination specifies the duties of the pilot flying and those of the pilot non flying at several set positions during the approach. Following this system, one of the pilots calls for a prescribed action or check whereupon the other pilot performs this check or action and subsequently confirms accomplishment.

CREW CO-ORDINATION

FLIGHT PHASE / EVENT	PNF	PF
Initial / Intermediate approach	Monitor PF	
At first positive inward motion of appropriate needle / pointer	Call: **'Localizer/Radial alive'** and if applicable **'Glide slope alive'**	Confirm needle/pointer movements, respond **'Check'**
Approaching FAP / FAF (1 dot or 1 NM)	• Call: **'Approaching FAP / FAF'** • Select and announce: **'Gear down'** • Perform and announce: **'Final Checklist completed'**	Command: **'Gear down, Final Checklist'**
At FAP / FAF	Call: **'FAP / FAF'** Respond: **'Check'**	Call: **'Descending'** Start descent
100 ft above MCA and level off is necessary	Call: **'Approaching MCA'**	Respond: **'Levelling off'** Level off
At OM	Call: **'OM'** Check Altitude	Respond: **'Check'** Check Altitude
500 ft above THR elevation	Call: **'500'**	Respond: **'Cleared'** or **'Standby'** (if landing clearance not yet received)
100 ft above DA or MDA	Call: **'Approaching minimum'**	Respond: **'Check'**
When approach lights visual	Call: **'Approach lights'**	Respond: **'Check'**
When visual clues associated with the runway are unmistakable	Call: **'Runway'**	Transfer to head up status. Call: **'Visual'**

Figure 2: Duties of pilot flying/pilot non flying according to the crew coordination

Chapter 04 specifies the on shore instrument approach procedure. Some prescribed actions are as follows:

- *Complete the approach checklist at least 5 minutes prior starting the ILS approach*
- *Approach speeds of 70 to 100 kt are recommended*
- *The pilot flying exclusively scans his instruments ('head down status') till the call 'runway' is announced.*
- *Complete the 'final checklist' at the start of the ILS approach*

BEFORE TAKE OFF

1. CREW BRIEFING .... COMPLETED
2. AFCS .... ON
3. WARNING LIGHTS .... OFF
4. TEMPS AND PRESSURES .... IN THE GREEN

IN TAKE OFF POSITION

5. TAIL WHEEL .... LOCKED
6. HEADING .... CHECKED WITH RWY
7. ANTI-ICE .... AS REQUIRED
8. TAKE-OFF CLEARANCE .... RECEIVED
9. ATC TRANSPONDER .... ON

AFTER TAKE OFF

1. COMPASS (off-shore only) .... SYNCHRONISED
2. LANDING GEAR .... UP
3. GROUND INVERTER .... OFF
4. ANTI ICE .... AS REQUIRED

CLIMB / CRUISE / DESCENT

1. N_R .... SET
2. ANTI ICE .... AS REQUIRED
3. AFCS .... CHECKED
4. FUEL SYSTEM .... SET
5. V_{NO} .... CHECKED
6. MAIN BATTERY (when DC GEN load permits) .... ON

APPROACH

1. ALTIMETERS .... SET
2. CREW BRIEFING .... COMPLETED
3. PAX BRIEFING .... COMPLETED

FINAL

1. LANDING GEAR .... DOWN
2. GROUND INVERTER .... ON
3. ANTI ICE .... AS REQUIRED
4. RADAR .... STANDBY
5. TAIL WHEEL .... AS REQUIRED
6. PARKING BRAKE .... AS REQUIRED
7. LANDING CLEARANCE .... RECEIVED

Figure 3: checklist for different phases of flight

Neither the ‘Sikorsky S-61N Flight Manual’ nor the ‘SNH Operations Manual part B S-61N’ specifies a specifically determined approach speed. From interviews emerged that during training of on shore approaches always an approach speed of 100 kt is observed. A speed of 70 kt is not unsafe but, according to the instructors the margins, with a view to redressing the helicopter from unusual situations, are becoming very small.

In the above mentioned manuals also no reference is made to flying an ILS approach while maintaining a glide slope below the glide path. Interviews with instructors learned that no training regarding such a technique is provided and a valid reason for flying an approach below the glide path does not exist.

1.6.5 Some components

Helicopter control levers
The cyclic is the lever to control the helicopter in forward- aft- and sideways directions. If the cyclic is moved forward the nose of the helicopter will move downwards and its speed will increase. Moreover the helicopter will descent if no extra power is selected. If the cyclic is moved backwards these movements will be in a reverse direction.

The cyclic trim system enables the helicopter to be trimmed, enabling the attitude of the helicopter vis à vis the air stream remain constant without having to manipulate the cyclic continuously. If small adjustments are required they can be made by clicking the stick trim switch, the ‘coolie hat’ in the desired direction. The trim system can be temporarily switched off by pressing the trim release. The trim switch as well as the trim release are situated on the cyclic grip and can be manipulated with the thumb.

The collective is the control lever enabling to manipulate the attitude of the rotor blades simultaneously in combination with the application of engine power. In the same time the rotor RPM remains constant automatically. If the collective is moved upwards the blade angle of the rotor blades will increase and engine power will increase as well, resulting in an increase of lift. If the collective is moved downwards, these movements will be in reverse; de rotor blade angle decreases and engine power decreases.

Automatic Flight Control System (AFCS)
The AFCS is a stabilization system rendering assistance to the pilot in controlling the helicopter. AFCS operates in the three control directions, the yaw channel in the top axis, the pitch channel in the cross axis and the roll channel in the longitudinal axis. The system does not take over control of the helicopter but corrects inadvertent changes caused f.i. by wind, change in heading, attitude or altitude of the helicopter relative to those as selected by the pilot. Furthermore it attenuates the control inputs made by the pilot. The system can be switched on, as well as switched off. Controlling the helicopter can be accomplished normally if the AFCS has been switched off though redressing disruptions requires more attention. A description as depicted in the Flight Manual has been attached in Appendix C.

According to the requirements of the Minimum Equipment List (MEL) [11], flying with a known defect in the AFCS exclusively is allowed in VFR conditions. It must be repaired within three days after the defect has been identified. From the Aircraft Technical Log of the PH-NZG it was found that since the year 2000 complaints regarding this system had been reported eleven times. These complaints differed in nature and all were repaired. The last complaint regarding the AFCS was reported at 3 March 2005. On that occasion one click of the stick trim switch appeared to result in an unexpected attitude change of approximately 20 degrees nose up. This movement could be stopped by the pilot flying pressing the trim release switch. During flight testing the stick trim switch it turned out that one click backwards or forward resulted in an attitude change of approximately 5 to 15 degrees nose up or nose down. This was repaired by replacing the AFCS amplifier and the AFCS control panel.

Altitude Voice Alerting Device (AVAD)
AVAD is a warning system providing the pilot with a voice warning if the helicopter descents below a preset altitude. The system provides a warning call *'one hundred feet'* when this altitude is past in descent. Furthermore it provides the warning *'check height'* if descending beyond an altitude preset by the crew. In accordance with the SNH procedures this altitude was preset at 200 feet.

1.7 METEOROLOGICAL INFORMATION

1.7.1 General situation

The KNMI had provided the following information:

The weather over The Netherlands is determined by a ridge of high pressure. Humid and stable air is supplied by a light south easterly flow. Mist occurs on a wide scale and local fog (patches) conditions; also extensive areas of low overcast are observed. The tops of the clouds are at approximately 700 to 800 feet.

Natural light conditions	:	Day light.
Visibility	:	Between 200 and 400 meters.
Cloud base	:	Initially between 300 ft and 700 ft. In fog patches cloud base between ground and 100 ft.
0° Celsius level	:	3.000 ft.
Icing	:	Nil.
Turbulence	:	Nil.
Thermal up current	:	Nil.

[11] The MEL (Minimum Equipment List) is a document that indicates if and when and in which circumstances operation of an aircraft with defective components or equipment is allowed.

1.7.2 Observations

Station	Time	Wind	Visibility	Weather	Clouds	T/TD	QNH
EHKD	13:55	120/05	2.200	BR	Few003;bkn 005	07/07	1015
EHKD	14:25	130/06	2.200	BR	Bkn003;bkn0 04	06/05	1015
EHKD	14:55	130/05	1.600	BR	Bkn002	05/05	1014
EHKD	15:02	120/06	1.000	BCFG	Sct001;bkn0 02	05/05	1014
EHKD	15:25	130/07	450	FG	Few001;ovc0 02	05/04	1014
EHKD	15:55	110/06	200	FG	Ovc001	04/04	1014

"Notes: Thick fog patches travelled from the south to the north and the cloud base decsended to 100 ft. The fog conditions also could be observed over the Waddenzee."

1.7.3 Forecast of De Kooy

TAF AMD EHKD 301204Z 301322 Vrb03kt 2000 BR Sct004 Bkn005 Tempo 1317 3800 Few005 Bkn007 Prob40 Tempo 1322 1500 Sct003 Bkn005[12]

TAF AMD EHKD 301336Z 301322 Vrb03kt 2000 BR Sct004 Bkn005 Tempo 1317 3800 Few005 Bkn007 Prob40 Tempo 1322 0500 FG Sct002 Bkn004

1.7.4 Actual situation

According to statements the horizontal visibility was below limits from early in the morning till around 13:00 hours. After 13:00 hours the visibility gradually improved till it became above limits.

Approximately 15 minutes prior the occurrence the air traffic control of EHKD provided the crew with the next weather report: *"visibility 700 meters in fog patches, scattered at 100 feet, broken at 200 feet, wind 130/6. RVR[13] 800 meter."*
A helicopter that had landed just prior to the PH-NZG reported that the runway lights came in sight at an altitude of 250 ft.

The SNH limits to execute an ILS approach and landing with a S-61N are: RVR 500 meters and a decision altitude (DA) [14] of 200 ft.
The limits of EHKD for a landing at runway 22 with a fully operational ILS system are: RVR 550 meters and a DA of 200 ft.

1.8 NAVIGATIONAL AIDS

Runway 22 of EHKD is equipped with a category 1 Instrument Landing System (ILS) and a VOR/DME approach system. Shortly after the occurrence an integrity test has been performed on the ILS system. No irregularities were observed. The initial approach altitude for a full ILS-procedure is 2.000 ft. The published approach plate of the ILS approach to runway 22, which is inserted in the SNH Operations Manual part C, shows the altitudes and distances to be observed (see Appendix D).

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[12] The TAF is a weather forecast concerning the close environment of the airport and is presented in a standard format. The denotation of the line is: amended forecast for airport De Kooy, issued on 30 November at 12:04 hours, valid from 13 till 22 UTC, variable wind with 3 knots, visibility 2000 meters, mist, scattered clouds at 400 feet, broken clouds at 500 feet. Temporary changes between 13-17 hours: visibility 3800 meters, scattered clouds at 500 feet, broken clouds at 700 feet. A 40% chance of a temporary change between 13-22 hours in: visibility 1500 meters scattered clouds at 300 feet and broken clouds at 500 feet.

[13] RVR, Runway Visual Range, is the visibility along the runway, measured electronically.

[14] DA, Decision Altitude, is the minimum altitude at which the runway lights must be in sight. If the runway lights are not in sight a go-around mudt be executed.

1.9 RADIO COMMUNICATION

In the course of the flight to EHKD, radio contact was maintained with “Amsterdam Information’”, SNH Operations, approach control “De Kooy Approach” and the local air traffic control station “De Kooy Tower”. The communication went without technical problems. From the radio transcript it turned out that the air traffic control of “De Kooy Approach” offered the helicopter crew a “short line up” in stead of a full ILS approach, on its own initiative. From information it emerged that this procedure is followed by helicopters on almost every occasion. The reason for this is, that this procedure provides a time saving and the island of Texel is avoided by flying traffic. The communication transcript between the PH-NZG and De Kooy approach and De Kooy Tower has been attached in Appendix E.

1.10 AIRPORT INFORMATION

EHKD is an aerodrome open to military as well as civil air traffic. The military part is utilized by the Royal Navy as ‘Naval Air Station De Kooy’; the civil part is in use as Den Helder Airport. The Air Traffic Control service is provided by Royal Navy personnel. EHKD is equipped with a take off/landing runway which can be used in two directions, runway 04-22. The runway is strengthened and has a length of 1.395 meters of which 1.275 meters is usable and it is 30 meters wide. On the runway, four helicopter landing spots have been situated. Runway 22 is equipped with a category 1 ILS together with a category 1 precision approach lighting system. This lighting system consists of a row of lights put up in line, in front of the runway. The lights consist of a number of lamps that are positioned side by side. The first cross row of lamps is positioned at a distance of 720 meters from the runway threshold.

1.11 FLIGHT RECORDERS

The helicopter is equipped with a combined cockpit voice and flight data recording system (CVFDR). The CVFDR is a Penny & Giles Data Recorders Ltd (later Teledyne), type 9000/D51508 recorder. This recorder was undamaged and after the incident the recorder records has been read out. Also the helicopter is equipped with a Health and Usage Monitoring System (HUMS).

1.11.1 CVR

The voice recording on the CVFDR has been copied and stored in files. The sounds on the CVFDR were recorded in three sections: the microphone sound of the pilot flying, the pilot non flying and the sound of the cockpit area microphone. The sound quality was good and useful for the investigation. Essential dialogue during the flight has been utilized in paragraph 1.1.

1.11.2 FDR

The flight data of the CVFDR has been read out after the incident and stored in a file. In an early stage of the investigation it was found that a problem existed in converting the flight data into usable data for a proper analysis. The stored data appeared to be unreliable and unfit to analyse the incident flight properly. Paragraph 1.16 describes the tests and investigations that were required in order to obtain representative flight data. Paragraph 1.17.7 describes the background of this problem.

The FDR data were converted into representative flight data. It must be noted in this connection that the tests and investigations were performed ultimo December 2005. At the time the helicopter PH-NZG was already in use again. It is possible that this has caused differences to occur in the relation between the position of the flight controls and their recording sensors. This only goes for the position of the collective, the cyclic and the pedals. In that case, there could be a slight difference in the absolute value, the relative value however (the diagram) remains the same.

From the data the next information could be derived:

- Approximately one minute prior to the incident the airspeed indicator fluctuated just above 70 kt. As from 15:22:45 hours, at an altitude of approximately 400 feet, this speed decreased gradually to approximately 20 kt until at 15:23:10 hours the pilot non flying intervened.

- The helicopter proceeded above the glide path at 15:22:50 hours and arrived below the glide path at approximately 15:22:55 hours.
- At approximately 15:22:50 hours the longitudinal cyclic pitch decreased from approximately 25% to a value between 0% and 10%. As from that moment the nose of the helicopter moved up slowly, the pitch attitude increased slowly.
- At approximately 15:22:50 hours the collective pitch decreased from an almost constant value of -15 to -40 and continued to decrease.
- The power (torque) was selected at around 35% until 15:22:50 hours. As from that moment it decreased to around 20% at 15:22:55 hours. At 15:23:10 hours the power increased to above 120%
- The altitude (radio altitude) was just above 700 ft at 15:21:55 hours. Thereafter the altitude decreased slowly to 0 ft at 15:23:25 hours.

The longitudinal cyclic pitch indicates the position of the control lever to control the helicopter in a forward or aft direction. The pitch attitude indicates the attitude of the helicopter in longitudinal direction. The collective pitch indicates the position of the control lever that controls the attitude of the rotor blades simultaneously.

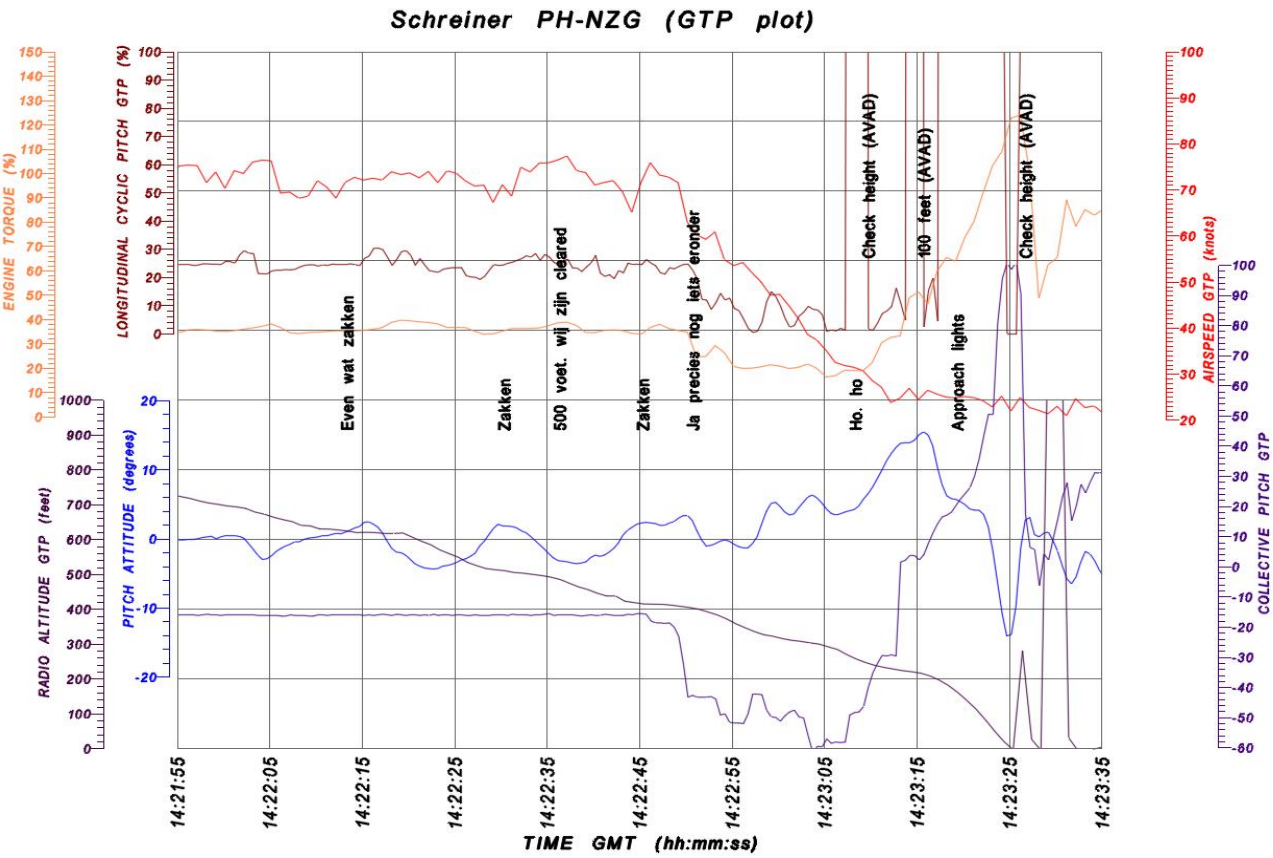

Figure 4: Diagram with the most important FDR-records

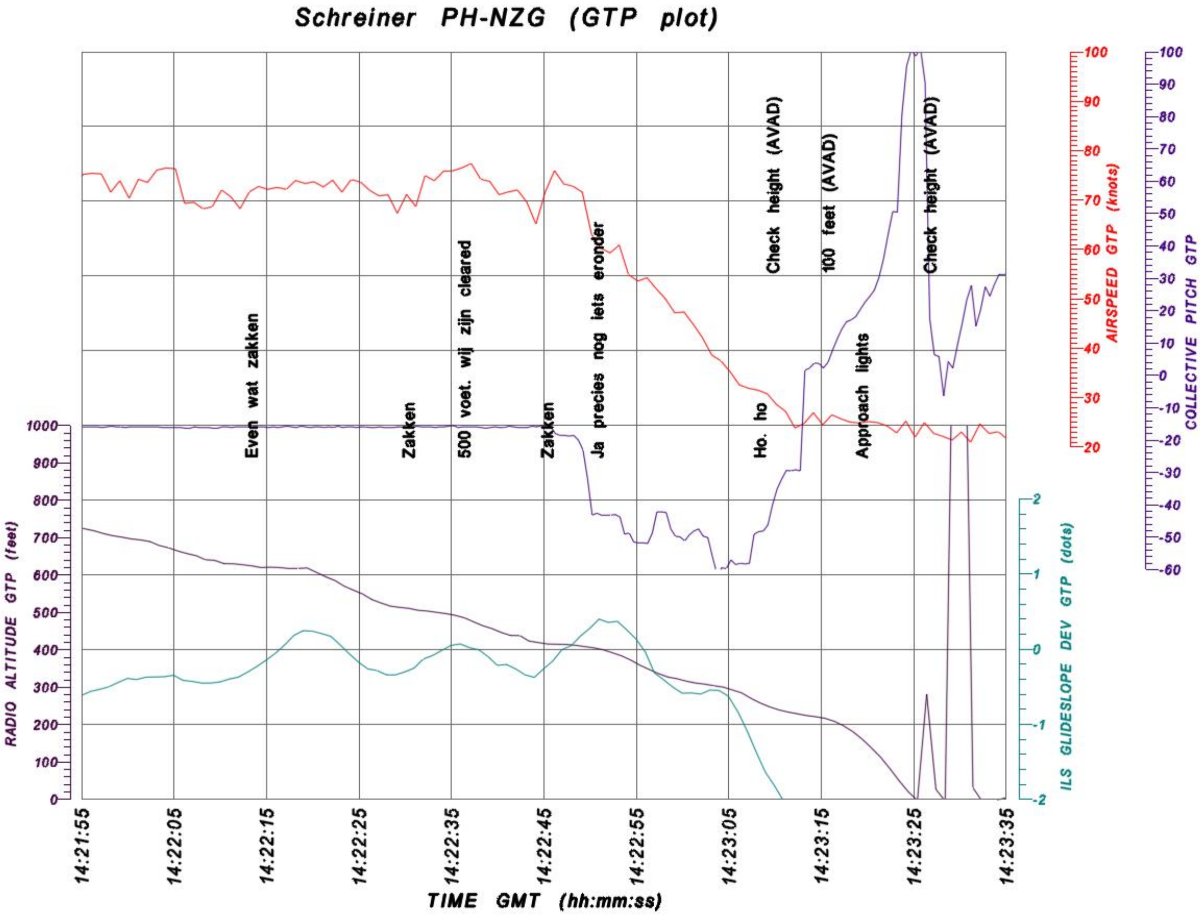

Figure 5: Second diagram with a.o. glide slope deviations

1.11.3 HUMS

Together with two other helicopters of a similar type, the PH-NZG was equipped with a Health and Usage Monitoring System (HUMS) in 1995. The purpose of this system is to monitor the condition of the power train. By utilizing a.o. vibration sensors, possible problems in power components are detected before they actually fail. Furthermore the system records exceeding of limits and the hours of operation of components in order to enable an effective maintenance. The HUMS data are stored in the helicopter. These data are downloaded at a ground station by ground- or maintenance personnel and subsequently analysed.

The HUMS system works separate from the CVFDR system. Both systems are connected however with the same flight data acquisition unit (FDAU), the central computer for all sources of information. In some instances the HUMS and the CVFDR utilize the same information sources (sensors). Furthermore the HUMS also utilizes separate sensors for data recording.

1.12 INVESTIGATION OF THE HELICOPTER

Immediately after the occurrence the glide slope indicator, the AVAD, the AFCS and the pitot static system were tested by technicians of SNH. No deviations were detected regarding any one of these instruments. During examining the helicopter, after the occurrence, no indications could be found that the helicopter had touched the water; safety equipment that is activated at a landing on water was not activated.

After the occurrance the gear box was replaced. After this replacement two test flights were performed with the helicopter during which all relevant systems were tested. Apart from the required replacement of gear box components, the helicopter was in the same condition as it was during the occurrence. At the second flight the weight of the helicopter was the same as during the occurrence. During these flights no particulars or deviations could be detected.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

After the incident none of the crew members was medically or psychologically examined. Since the occurrence, the cabin attendant did not return to work because of medical complaints that could be related to the occurrence. Because no medical examination had been performed the cause of the complaints cannot be established with certainty. Causes not related to the occurrence cannot be excluded: the cabin attended resumed his work after three months of absence due to an illness, just one week before the occurrence happened.

1.14 FIRE

Not applicable

1.15 SURVIVAL ASPECTS

Not applicable

1.16 TESTS AND RESEARCH

1.16.1 Ground Test Procedure PH-NZG

On a flight data recorder (FDR) raw data from the sensors are stored in a binary format. These raw data must be translated into usable data (engineering units) by a special program. Subsequently the usable data can be utilized for analysis. Translation from binary data to engineering units is accomplished utilizing documentation provided by the operator or manufacturer. Since in an early stage of the investigation it was found that a number of recorded data appeared not to be representative for the occurrence flight, the Safety Board requested the manufacturer Teledyne and the Operator SNH to provide them with the correct conversions.

The manufacturer and the operator did try to provide the correct conversion factors but this could not be accomplished within an acceptable time frame. Therefore the investigators of the Safety Board decided ultimo 2005 to perform a Ground Test Procedure (GTP)in order to retrieve the correct conversion factors concerning the PH-NZG.

In the course of the GTP, various observations were made that were incorporated in a table. The table describes various parameters together with the observed problem and includes a conclusion. For a comprehensive report regarding performing the GTP, reference may be made to appendix F.

1.17 ORGANIZATION AND MANAGEMENT INFORMATION

1.17.1 Description of the organization[15]

Schreiner North Sea Helicopters (SNH) provides helicopter services to oil- and gas companies and the pilot services and is one of the providers of these specific aviation services. At the time of the occurrence SNH had thirteen helicopters to its disposal. Apart from the Sikorsky S-61N, SNH also utilized the Sikorsky S76 and one SA365N3 Dauphin, which was positioned at the Maasvlakte. This helicopter exclusively is used to perform "pilot flights" and is operated by a permanent group[16] of pilots. The company employs approximately 230 personnel including 45 helicopter pilots of which ten pilots are also employed as an instructor/examiner.

The flight operations on the North Sea as well as the Maasvlakte are controlled from the location 'De Kooy' (Den Helder Airport). The investigation has been performed at the location Den Helder. Since 2005 the company has been transferred to CHC Helicopter Corporation and reorganizations are in progress. Information laid down in this paragraph has been derived from the Operations Manual Part A as well as from interviews.

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[15] The description of the organization is conform it was operated at the time of the occurrence.
[16] This operation was abandoned in 2005.

The management team at the location ‘De Kooy’ is composed of the next functionaries (Organization lay out refer to appendix G)

- General Manager, also Accountable manager;
- Operational Manager;
- Quality Manager;
- Technical Manager[17];
- Financial Controller.

Chairman of the Management Team is the General Manager. The General Manager is also the Accountable Manager according to JAR-OPS[18] 3.175
According to the Operations Manual the General Manager is responsible for:
- performing the general leadership with a view to ensuring a continuous profitable development of the company
- development and realization of annual planning, marketing and making contracts
- set targets in order to ensure the continuous improvement of the companies safety- and efficiency performance

In the absence of the General Manager the Operational Manager takes over his position. The Operational Manager furthermore is responsible for discharging the duties delegated to him by the General Manager; as a minimum but not exclusively these concern the following items. The Operational Manager:
- has complete responsibility for the implementation of ground- and flight training that is required to comply with legislation and intern company regulations
- authorized to take corrective action
- is responsible for the performance of all North Sea operations according to company manuals and furthermore responsible for crew training, -planning and -discipline
- ensures that the General Manager and clients immediately are informed in case of any incidents
- is responsible for the administration of documents and registrations.
- is responsible for the maintenance of equipment and tools under his control

The Operational Manager, in his quality as Postholder Flight Operations manages the flight operations (pilots), ground operations and flight scheduling. Furthermore, in his quality as “Postholder Crew training”, the flight instructors operate under his direction. Finally he acts as an instructor and in his quality as a pilot also conducts regular flights
According JAR-OPS 3.175 (J) more then one post holder positions occupied by one person is allowed. This however needs approval of the authorities (IVW) and if a company employs more then twenty personnel, as a minimum, two post holders are required. From the investigation it emerged that IVW approved the combination of post holder positions. (See paragraph 1.17.8)

The Chief Instructor reports directly to the Operational Manager and performs the duties delegated to him by the operational manager such as (selected):
- a safe and efficient management of the training department
- be responsible for informing the Operational Manager regarding possible detrimental effects on the safe and efficient discharge of company directives.
- Inform the Operational Manager as soon as possible if any training being conducted under his supervision, is not conform company standards.

Quality System.
In accordance with JAR-OPS 3.035, an airline (operator) must establish a described and approved Quality System that contains procedures to assure a safe operational practice and airworthy aircraft. Furthermore a Quality Manager must be designated who is responsible for the realization of the quality system. The Quality Manager reports to the Accountable Manager who is responsible for implementing corrective action if required.

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[17] The responsibilities of the Technical Manager and of the Financial Controller are not specified in this report because they are not considered to occupy key positions with regard to this investigation.
[18] JAR-OPS3: Joint Aviation Requirements-operations, European requirements regarding commercial air transport with helicopters.

The quality system of SNH is specified in part A of the Operational Manual. This document contains a description of what SNH understands to be quality and how the company verifies this quality. The Accountable Manager is i.a. ultimately responsible for the quality within SNH. Furthermore he acts as Chairman of the Safety Review Board (SRB).

Monitoring the quality system has been delegated to the Quality Manager. His duties and responsibilities are (selected):

- coordination of the QHS&E-Management System
- perform company audits regarding compliance with JAA and national regulations
- is member of the Safety Review Board (SRB)

The most important functions of the Safety Review Board are:

- support and advice the General Manager and SNH personnel
- initiate and formulate rules and procedures
- verify the implementation of policy, programmes and plans
- coordination of liability issues with the applicable authorities
- suspension of activities if a potential or actual safety threat exists for human life, company assets or the environment.

The SRB convenes every month and during its meeting, discusses the quality system and its results. Apart from the Accountable Manager, the heads of flight operations, maintenance, training, flight technical department, the quality manager and the flight safety officer are a member of the SRB.

From the minutes of the SRB meetings it emerged that all current flight safety issues were discussed. On the occasion of an incident with a helicopter from the Maasvlakte hitting a ships antenna (see 1.18) one of the members made the observation that the pilots from the Maasvlakte were very casual in using the checklists. As a result of this observation, a meeting of all pilots from the Maasvlakte was arranged with an aim to:

- restructure the culture of not applying the procedures;
- to make a start with changing the attitude and the conviction which is generated by a similar culture.

Furthermore a new working protocol was established for the Maasvlakte and the project "Anchors away'' was started. The aim of this project was to improve communication and to improve integration of the Maasvlakte crews with the Den Helder pilots in order to create a larger mix of pilots and reach an improvement in assuring that the crew concept would be applied.

Structure and responsibility

At SNH the position of post holder Flight Operations as well as post holder Crew Training is occupied by one functionary. This was approved by IVW some years in advance of the occurrence. From interviews with various employees it emerged, that within SNH this practice of a combined post holdership is not considered as a very successful solution. According to these employees conflicting interests can arise: the flight schedule easily could become deciding, and training of secondary importance. Furthermore the situation with the combined post holdership is of a structural nature. The functionary occupying the combined positions, also was involved in the staff employment policy and did not find a suitable candidate to take over the position of post holder Crew Training. He indicated that he did not experience any problems in occupying both positions.

Culture

From interviews with the management emerged that the overall company culture had changed over the years. SNH has evolved out of KLM ERA Helicopters in 1998. According to the present management, initially some sluggishness could be observed with regard to operating according to market requirements.

At the time another noticeable feature was that English pilots were employed to rather some extent, resulting in a so called punitive safety culture. This was to the contrary of the non punitive climate the present management wishes to propagate. A 'non punitive' safety culture is footed on the principle that errors are an indication of the performance of the organization as a whole and not of the participating individuals. One of the consequences is that after reporting an error that has been made no punitive action will be taken.

Furthermore within the flight operations of SNH the so called 'Crew Resource Management' (CRM) concept is applied according to JAR-OPS 3. This CRM-concept has been developed in order to provide for an optimal utilization of all available means (equipment, procedures, and human recourses) in the cockpit. It is aimed at minimizing errors originating from the coordination and communication between pilots (see paragraph 1.17.5).

From interviews with the management it emerged that it was familiar with the fact that part of the pilots force did not adhere to the 'crew concept' (the prescribed division of duties and responsibilities that crews are to observe in the cockpit). On being asked the Operational Manager himself regarded the crew concept, as part of the CRM, more as a 'fundament' then as a standard practice: 'it can be utilized as a back up if everything goes wrong'. Consequently compliance of the pilots with the crew concept was not strictly verified by the management.

Safety awareness
From interviews with the management emerged that some pilots on the Maasvlakte did not adhere strictly to checklists and procedures and that on the Maasvlakte a culture developed that deviated from the culture in Den Helder. This was a consequence of the relatively short flights operated from the Maasvlakte and the nature of the operations, requiring to let off pilots on ships, which differed from the operations to and from the platforms in the North Sea. In order to help this group of pilots to adhere to the procedures and because the supply of work on the Maasvlakte deteriorated, the management of SNH decided to have the Maasvlakte pilots also operate out of Den Helder.

According to those who were interviewed the consequence of this decision was that this group of pilots had to learn to fly on a second type of helicopter. When Maasvlakte pilots were on duty in Den Helder, the Den Helder pilots were confronted with pilots having a different manner of operations. On being asked the General Manager recognized the existence of the 'Maasvlakte attitude' but did not consider this as a safety problem because these pilots, during training- and check flights, complied with the requirements. Also flying two types of helicopter was not considered a safety risk.

Proficiency
From an interview with the General Manager it was found that the general understanding within the organization is that part (approximately 10%) of the pilots do not perform according to the required proficiency in the cockpit. Notwithstanding the fact that their performance in the simulator is good. In particular some of the older pilots would be less motivated, show less vigilance and would follow the procedures inadequately.

Usually the pilots complete the proficiency checks on the simulator with a positive result. On being asked, the management recognized however that "some pilots show a difference between simulator- and cockpit performance". Furthermore it appeared from meeting reports that it was observed that some combinations of pilots resulted in a lower performance then others, sometimes by lack of attention, others by having excessive conversations with no relation to flying the helicopter at all.

Training organization
The instructors have meetings with a frequency of approximately two times a year, in stead of the internal aim to meet four times a year,. The meetings are chaired by the Manager Crew training. The meetings are well attended by the instructors. The records report (period November 2000 till March 2005) in particular the exchange of opinions. A standard framework (such as establishing the points to be discussed in advance, take relevant decisions, establish a list of actions to be taken and the verification of their progress) is not consequently applied. In the meeting records some issues in connection with the investigation at hand could be identified; they are reproduced below:

- It was reported that a line trainer was appointed for the Maasvlakte. He was i.a. supposed to conduct 'line checks' and coach Pilots in Command. It was established that *"unfortunately there has been no time yet to provide him with the required training"*. One of the instructors stated that according to the Operations Manual (Part D) the person in question must be provided with the required training and he wondered how this would be accomplished. The response of the Operational Manager was that in connection with the busy schedules on the Maasvlakte no time was available to accomplish this. (meeting 2001)

- A proposal was made to plan a line check twice a year in stead of once a year. The Operational Manager responded that he was willing to take this into consideration. In subsequent meetings however this proposal was not reconsidered any more. From interviews with several instructors it was found that they consider line-checks of much more significance then the prof-checks. In their opinion it is only then that the real performance of a pilot can be observed. A line-check[19] once a year was in their opinion not enough. (meeting 6-2002).

- Instructors observed that in certain circumstances (pilots approaching the end of their duty, pilots who just previously operated another type of helicopter or with certain combinations of pilots) inadequacies in the communication between pilots occurred. There is too much, or too less communication, or conflicts arise. It was noted that action should be taken by further discussing of this issue with the Operational Manager. In the subsequent meetings this issue was not reconsidered any more. (meeting 6-2004).

- Instructors wondered if the S-61 incident under investigation could have been caused by operating on two types of helicopter. One instructor indicated that he did not wish to operate more then one type and certainly did not wish to give instruction on two types. The Operational Managers response was that he was willing to leave this decision to each pilot individually. Furthermore it was proposed that a line captain for one type, perform a line-check as third crew member on another type in order to reach a cross over effect. All attendants to the meeting agreed but according to the records: *"this will be very difficult for the time being, in connection with the high work load"* (meeting 3-2005).

Risk assessment and policy
On company level, the management performed a risk assessment on company level in order to obtain an understanding of the possibility of safety incidents to occur and their possible sub sequential effects. The latest risk-assessment (a bow-tie analyses), that was found during the investigation of the company, was two years old. Actual risks such as the keen competition, the reorganization, the proficiency of the pilots were not included. The General Manager was working on a policy statement that would also cover these items; the statement was available in concept. Actions to improve the operational safety did take place though, but emerged in particular from discussions within the Safety Review Board with regard to reports and (near)incidents.

Monitoring the safety performance
In the course of the investigation the files of the pilots involved in the incident, and of some other pilots were examined. It was found that the trainers, apart from the actual assessment, also expressed their more emotional point of view regarding the performance of the pilots, by means of writing their comments on the training utilization and proficiency check sheets. It appeared from interviews that no internal procedure exists to collect such, primarily emotional, information and the criteria that should apply in further assessing this information.

Adjustment by the management
From interviews emerged that the management tried to adjust the cockpit performance of the pilots on several occasions. For instance a day of discussion has been devoted to the issue and the General Manager issues regularly publications regarding safety awareness. Apart from that, all pilots were invited by the management for a bilateral exchange of views. Only a limited number of pilots reacted and subsequently these interviews were discontinued.

From interviews it appeared that within the company the general feeling is that these actions of the management were not effective. On being asked the management indicated nevertheless the wish to continue this kind of actions and, for the time being, to refrain from implementation of disciplinary action on a structural basis. The management indicated that a fundamental reason to do so was that it wished expressly to advocate the “non punitive culture” within SNH. A second, more practical, reason was that the General Manager assumed that disciplinary action would not be accepted by the pilots and their unions if taken on the basis of the relatively “soft” information emerging from the prof- and line-checks. (see the finding ‘monitoring of the safety performance’)

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[19] A line-check is a yearly test at which the pilots performance during a normal flight is assessed. During the biannual proficiency-check the pilots proficiency in normal, abnormal and emergency situations, is assessed. Mostly the prof-check is conducted in a simulator.

1.17.2 Dual type pilots
Operating on more then one type of helicopter is specified in JAR OPS 3.980 ('Operation on more then one type or variant') with reference to the Operations Manual of SNH. Flying more then one type of helicopter is allowed under conditions. Some conditions according to JAR OPS 3.980 as mentioned and AMC OPS 3.980 read as follows:
The operator should in the Operations Manual:

- establish a minimum required experience for the pilots
- establish the process of training and qualification from one type to the other type
- eventually establish additional requirements to proficiency
- establish the minimum number of flights for each type within three months

Furthermore i.a. the following requirements apply:

- a proficiency check-flight on one of the types of helicopter should be completed every six months, whilst on every type of helicopter a proficiency check-flight must have been completed every 12 months.
- during operations with helicopters with a maximum allowed take off weight of more then 5.700 kg or a cabin configuration for more then 19 passengers:
    - the pilot is allowed to operate maximum two different types of helicopter
    - the pilot must have a flying experience of minimum 3 months and 150 hours before being allowed to start a conversion to another type of helicopter
    - the pilot may not be scheduled for more then one type of helicopter within one scheduling period.

These requirements are adopted by SNH in the Operations Manual part A, with the addition that during the conversion the pilot is allowed to operate a minimum of 28 days and 50 hours on the second type of helicopter only. Furthermore three take-offs, three circuits and three landings must have been conducted on each type, within a period of 90 days. These flights may be performed on a helicopter or in a simulator. Furthermore, under condition, it is allowed to request a crew member, for operational reasons, to operate on more then one type of helicopter within one duty period on one day.

From the investigation it appeared that during the operations on the Maasvlakte an evenly division between duties to perform on the Maasvlakte and from Den Helder was not established. Maasvlakte pilots operated sporadically out of Den Helder. According to one of the pilots this sometimes caused problems with regard to the proficiency in operating the different type helicopter.

1.17.3 Pilots scheduling
It was found from interviews that flight planning and crew scheduling is accomplished at the Operations department manually. The number of flights to be operated every day is established by the customers and is known in advance. These customers provide SNH with the times, destinations and the desired type of helicopter. With reference to these requests the planner designs combinations of helicopter crews; a pilot in command and a First Officer (and a cabin attendant). Composition of these combinations is at random. The sole restriction to this is a list of restrictions indicating the pilots who are not allowed to operate together. This i.a. depends on experience and qualifications.

Crew scheduling for each helicopter is accomplished at random and depends on the customers request regarding the type of helicopter to be used. The only condition is that the pilots must have operated on both type of helicopter on which they are qualified, within a period of 90 days. Consequently the situation can occur that a pilot operates one type of helicopter during a considerable number of weeks but in other situations one pilot operating two different types of helicopter on one day occurs as well. In the pilots combination the recent experience of the pilots on one of the two helicopters is not accounted for. For scheduling no computerized system is available and the planner keeps personally account of all relevant information manually. No registration is made of which pilot operates as pilot flying or pilot non flying.

Furthermore the expiry dates of check flights, training and courses the pilots must attend to, are registered by the administration department. This is registered in Excel format. This program provides a warning two months in advance of the expiry date. Also exceedence of the expiry date is indicated. Within SNH from time to time it occurs however that this does not work out conveniently with regard to the planning and that inspection or training is deferred for some days.

Reports of IVW show that the system is not water tight and it has been found that in all fields training intervals were exceeded.

1.17.4 Differences S-61N and SA365

Considerable differences exist between the two types of helicopter. The most important differences are:

S-61N	AS365
First certification in 1963	First certification in 1975
American design	French design
Max. Take off weight 20.500 lbs	Max. Take off weight 7.715 lbs
Max. nr. of passengers 19-27	Max. nr. of passengers 9
Left-turning rotor	Right-turning rotor
No autopilot	Autopilot

There is an essential difference in the arrangement of the instruments in the cockpit of both helicopters. Most instruments are located in different positions. Also the basic engine instruments are located differently.

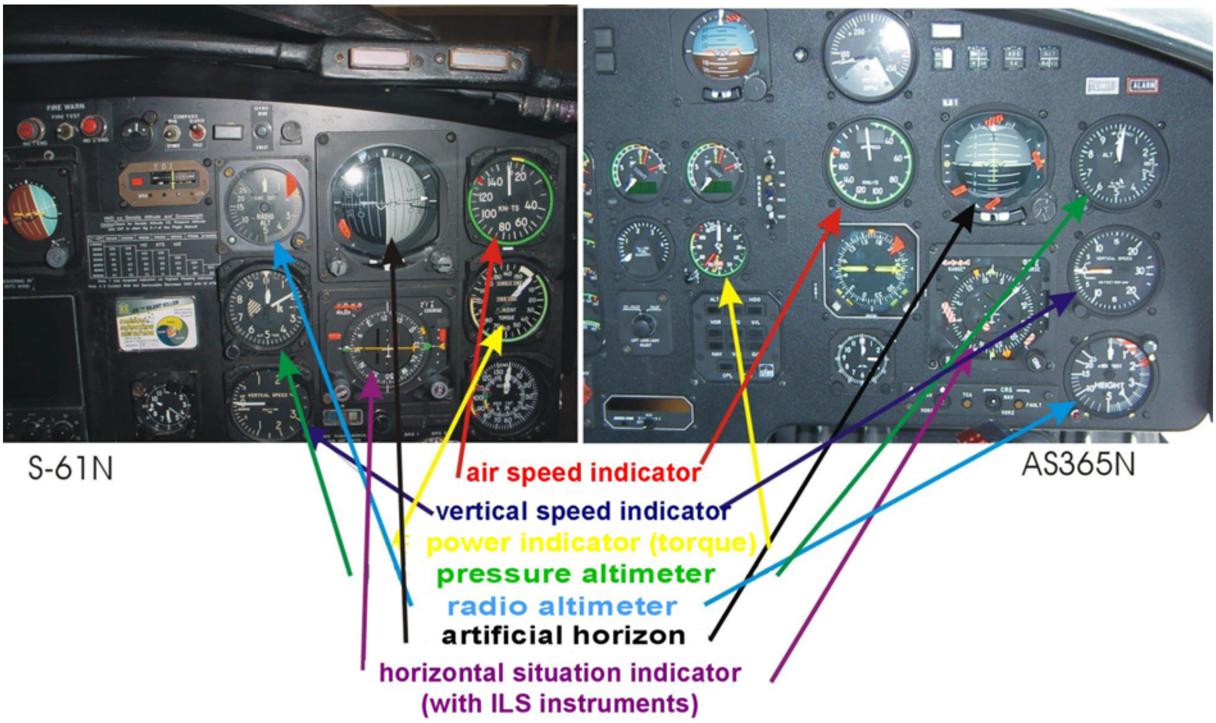

Figure 6: the instrument panels of the S-61N and the AS365N

Some pilots indicated during interviews that they did not experience any difficulties in flying both types of helicopter. The cockpit arrangements differ to such an extend that pilots were well aware of the type of helicopter they operated on and therefore mistakes were excluded. Other pilots indicated they did experience difficulties flying both types. They experienced occasionally that some time was required to find the correct instrument or operated the wrong buttons when flying a helicopter type they did not operate on for some time previously. A small number of these pilots therefore operated only one type of helicopter. The two pilots involved in the incident did indicate to experience no difficulties flying two types of helicopter.

1.17.5 Crew Resource Management

According to JAR-OPS 3.943 (Initial Operator's Crew Resource Management (CRM) training) each cockpit crew member of an airline operator must have followed an initial CRM training. According to JAR-OPS the purpose of a CRM training is: 'to improve the communication and management capabilities of the crew members concerned. The non technical aspects of operation of the cockpit crew members are emphasized.'

Within three years, each cockpit crew member must undergo CRM refresher training courses dealing with the most important topics of the initial CRM training. Furthermore during training sessions and tests, an assessment of the application of the CRM principles by crew members is made.

Part D of the Operating Manual of SNH (training rotary wing) specifies the topics that are included in the CRM training course, when to undergo the initial- and when the conversion training. The training items are:

- human error and reliability, error chain, error prevention and detection;
- company safety culture, SOP's, organized factors;
- stress, stress management, fatigue and vigilance;
- information, acquisition and processing, situational awareness, workload management;
- decision making;
- communication and coordination inside and outside the cockpit;
- leadership and team behaviour synergy;
- automation, philosophy of the use of automation (if relevant to the type);
- specific type related differences;
- case based studies.

The initial CRM training is conducted in two days and is taken by fresh crew members within a year after appointment. Apart from the refresher training courses, CRM training is undergone during a conversion to another type of helicopter, when changing operators and during a captains upgrade. In the course of the line- and proficiency checks also the CRM application of pilots is assessed. Instructors are trained accordingly.

From interviews was found that crew members experience the CRM training in different ways. In general the purpose of similar training is recognised but, in particular the older pilots, consider it mainly as being a constraint.

The background of CRM training in the cockpit has been elucidated by an aviation psychologist. (in appendix H).

1.17.6 Intern SNH report

In the framework of the above mentioned quality system and JAR-OPS 3, SNH also did investigate the incident and finalized a report. The investigation report does not clearly indicate the cause of the occurrance.

The investigation commission did indicate some circumstances that could have affected the incident to occur

- the crew could have suffered a momentary or a complete failure of a proper division of attention.
- the S-61N was operated with a speed that impeded the redress from unusual attitudes or inadvertent (control)inputs.
- the possibility exists that operating two different types of helicopter adversely affects flight safety under specific operational and meteorological circumstances.

1.17.7 Lack of calibrated recorder records

PH-NZG

On request of the oil companies the PH-NZG was equipped with a HUMS-system, on 29 June 1995. On that occasion also the Digital Flight Data Acquisition Unit (DFDAU) was replaced.

To allow the HUMS-system to function properly, new sensors and equipment were required. For the installation a procedure was utilized of a Scandinavian operator which already operated a S-61N with a HUMS-system. During installation a GTP-test has been performed to verify correct installation. Furthermore the GTP-test was part of the certification process for this system.

Because some avionica components used in the helicopter of SNH differed from those of the Scandinavian operator, it appeared that some conversion factors did not match up. Following instructions of Flight Data Company (now Teledyne) some conversion factors in the Flight Data Replay and Analyses System (FLIDRAS) were adjusted. Notwithstanding these adjustments, not all conversion factors appeared to be correct. Some adjustments that were incorporated in the FLIDRAS-system in 1996 were not incorporated in the original translation documentation provided by Teledyne.

Furthermore the records of the GTP test that was conducted in 1995 show with regard to some parameters a clear deviation between the expected and the detected values.

After the installation, tests and acceptance flights have been conducted but it could not be found that after that, the data have been properly validated.

SNH has the possibility to read out, convert and analyse FDR data. The FDR data can be transferred to a computer on which the FLIDRAS-system has been installed. According to SNH procedures CVFDR data were downloaded on a yearly basis and the flights analysed. In that way also the operation of the recorder was verified. The computer program that was utilized in FLIDRAS to translate the raw (binary) data to usable data was produced in 1996. From correspondence with the manufacturer it was found that between the installation in 1995 and 1996 some parameter conversions were changed.

Legislation
Rules and regulations with regard to the installation and maintenance of flight recorder equipment (FDR+CVR) is provided for at different levels. The International Civil Aviation Organization (ICAO) provides in Annex 6 part 3 the Standards and Recommended practices regarding flight data recorder equipment in helicopters. These standards and recommendations can be adopted in European legislation. As far as this investigation is concerned, the sole requirement regarding flight data recorder equipment that applies in European as well as Dutch legislation is, that aircraft (which include helicopters) equipped with turbine engines and an allowed Take off weight of more then 5.700 kg must be equipped with flight data recorder equipment. The organization Eurocae[20] issues minimum specifications with regard to the performance of electronic aircraft equipment. This includes flight data recorder equipment. These requirements are considered to be outside the scope of this investigation.

In the course of several investigations conducted, domestically and abroad it emerged that in particular data recorded by the FDR are not always usable. This i.a. is caused by inadequate maintenance and inadequate verification of the correct operation of the FDR's.
From the paper "*Flight data recorder read-out, technical and regulatory aspects*" conducted by the French Bureau d'enquêtes et d'analyses pour la sécurité de l'aviation civile (BEA)[21] i.a. the next information could be extracted:

- ICAO recommends that FDR systems are maintained and their correct operation and the validity of the data be verified, on a yearly basis.
- ICAO recommends that the wiring and connections of the system are verified every five years
- The above mentioned recommendations have not been adopted in the European requirements of JAR-OPS.

Also these recommendations are not adopted in Dutch aviation legislation. On being asked IVW could not explain why this has not (yet) been accomplished.

1.17.8 Supervision
Supervision of SNH was provided by several parties. Supervision is accomplished by performing inspections and audits. These parties are:

- Inspection of Transport and Public Works
- Gas- and Oil Companies
- Quality Assurance & Flight Safety Department of SNH

Inspection of Transport and Public Works
Supervision of SNH as a holder of an Air Operators Certificate is accomplished by Inspection of Transport and Public Works (IVW). Supervision is exercised in various ways:

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[20] European organization for civil aviation equipment.
[21] www.bea-fr.org

a) inspection of training- and check flights
b) inspection of regular flights
c) company audits

From interviews was found that audits and inspections are conducted according to a regular schedule. The inspections are conducted by a regular inspector-pilot who in his portfolio is assigned to SNH. Audits are performed minimum once a year, inspections more often. Guideline for the inspections and audits are the requirements of JAR-OPS 3, Commercial Air Transportation (Helicopters). It is impossible to verify all JAR-OPS 3 requirements. Therefore the items that will be assessed are determined prior to an inspection/audit. In that connection the items and results of previous inspections/audits are taken into consideration. The regulations of JAR-OPS 3 are minimum requirements a company has to comply with. According to IVW compliance with these requirements 'makes a score of six'. IVW can stimulate companies to raise their performance to a higher level, however this cannot be enforced. If a company does not comply with the requirements, administrative action may be taken. With regard to SNH this has not been considered.

In the past IVW provided SNH with an approval for a combined post holdership. The present policy is that a similar approval will not be provided to companies employing more then 20 personnel.

With regard to the inspections as mentioned under a) and b) the reports of 2002, 2003 and 2004 were selected for further examination. The reports included some remarks with regard to the performance of individual pilots as well as to the organization. Some general observations, being relevant in the context of this investigation, were:

- The inspector wrote in his report that there is a keen competition between helicopter companies in order to secure contracts with the oil- and gas companies or to retain them. Therefore, according to the inspector, flights are operated against cost price. He wrote that it was possible that keeping the costs low received more attention from the helicopter companies then the quality and safety of the operations. A number of helicopter companies had urged IVW to interfere and establish clear standards (2002).

- It had occurred that in the course of one flight, changes in schedule were assigned. This resulted in four, in stead of two landings to be executed on platforms. Furthermore, on the return flight fourteen passengers were on board in stead of operating the flight without passengers. This caused a rise in workload for the pilots. Such changes, made on request of the oil- and gas companies, occurred frequently (2003).

- The inspector observed several times that some pilots who operated two different types of helicopter, the SA365N3 included, had little flying experience on one of the types. This was caused by occasionally operating from the Maasvlakte executing just short flights. Also flying performance under IFR conditions was inadequate in some cases. This was a result of too little operating experience under IFR conditions. According to the inspector, for these pilots provision of extra training should be considered. (2003 and 2004).

Under the item 'actions' it was noted that these observations would be discussed with the operator (SNH). This was accomplished during the so called company consultation meetings, a meeting between IVW and SNH occurring every trimester. As a result SNH promised that pilots having too little experience flying a certain type of helicopter would qualify for extra check-flights. Qualification would be assessed by the Head of Training (the post holder flight operations). Investigation did not reveal that pilots received extra training or undergo extra check flights.

The observations with regard to the safety of the helicopter operations did a.o. result in setting up the 'Task force North Sea'. This task force consists of representatives from the various stake holders involved in helicopter operations on the North Sea. The task force identified seven points of particular interest, being:

- radio coverage over the North sea
- radar coverage over the North sea
- air space structure over the North sea
- air traffic control over the North sea
- awareness of helicopter pilots
- fatigue and work load of helicopter pilots

- guide lines for Search and Rescue

One of the changes that are realized in the meantime is that SNH, though allowed by legislation, does not apply duty times of twelve hours any more.

The ‘Task force North Sea’ will not be further elucidated in this report.

With regard to the company audits as mentioned under c) the reports of 2002, 2003 and 2004 were examined. General observations, relevant to this investigation, were:

1. It was observed that SNH on several occasions did not comply with the planning schedule for the internal audits. Furthermore the follow up with regard to the ‘corrective actions’ is inadequate. (2002)
2. It was possible that personnel was deployed after exceedence of training intervals.(2002)
3. At the Maasvlakte weight and balance calculations were not accomplished for every flight.(2002)
4. Some exceedences of maximum duty time were observed. Investigation revealed that this was a result of scheduling pilots for the legally maximum allowed duty time.(2004)
5. After an audit on 19 May 2004 the JAR-OPS 3 approval of SNH was extended. On that occasion it was observed that the audit planning for 2003 and 2004, as well as the realisation of audits performed, could not be shown.
6. The planning and execution of refresher training and –checks is not a closed system.

From information provided by IVW it was found that these observations have been discussed during the company consultation meetings. The promises and actions of SNH to eliminate these inadequacies satisfied IVW to such an extend that no action was taken.

Gas- and Oil companies
On some occasions the application of additional requirements are demanded by the Gas and oil companies which utilize the helicopters of SNH. These requirements are laid down in a.o. the Aircraft Management Guide of the ‘International Association of Oil and Gas producers’ (OGP) and may have a wider scope then is required by legislation. To verify application of these requirements the oil- and gas companies perform audits within SNH on a regular basis. Within the framework of this investigation, reports of three audits performed by these companies in 2003, were examined.

Some relevant observations and comments are:

- All pilots flying two types of helicopter do undergo a simulator training once a year
- The planning system enables pilots to make more flying hours per month then is established by the companies.
- Training flights for pilots operating more then one type, would have to be conducted on each type of helicopter every six months in stead of every six months in rotation on one type of helicopter.
- Training results are underutilized for the detection of poor performance of pilots or trends.
- Not all incidents are included in the appropriate data base.
- Actions to be taken after a (serious) incident (corrective action reports) are deferred for a too long period of time.

Apparently the actions that were taken by SNH as a result of these observations satisfied the companies to such an extend that SNH was allowed to operate the flights for these companies.

SNH
The assurance that SNH-standards are applied is a.o. accomplished by performing audits. In this respect it is established that a planning scheme for audits must be designed for each calendar period. These audits are focussed primarily on flight- and ground operations, maintenance and training and are conducted by a group of auditors. All operational aspects must have been assessed within a period of twelve months. Extension of this period only is allowed with the approval of the authorities. An extension to more then 24 months is not acceptable.

From the auditplan 2004-2005 of SNH it was found that a large number of audits in the field of Flight Operations has been performed. In the relevant reports nothing was brought up that could have been brought into relation with this occurrence. The planned audit for 2004 in the field of Training has not been conducted because of lack of capacity.

1.18 ADDITIONAL INFORMATION

Similar occurrences
In December 1997 an accident occurred with a helicopter of KLM ERA Helicopters that crashed into the North Sea during an approach to a production platform. The cause of the accident was a large power reduction causing the rate of descent to increase rapidly, without the crew noticing it. When this was observed it was too late to redress the high rate of descent and the helicopter entered the water. KLM ERA Helicopters was merged into SNH in 1998 and all personnel and helicopters were transferred to SNH.
Also during this accident the visibility was low because it was dark. Furthermore the power was reduced to a considerable extend by the pilot flying after an advise of the pilot in command to continue the approach, regardless the pilot flyings opinion that the helicopters position as well as its speed, were too high. There was inadequate communication, probably caused by the lack of formal CRM-training at the time.
Two relevant recommendations out of the report of investigation[22] are:

1. *The RLD (at present IVW) should require that helicopters operated in the Public Transport category (Passengers) are equipped with flight data recorders.*
2. *"The RLD should require that helicopter operating companies introduce CRM training to form an integral part of crew training. This is especially important when within the pilots community there is a great difference between back ground and experience between individual pilots.*

These two recommendation in the mean time are adopted and laid down in JAR-OPS3

In December 2003 an incident occurred involving a SNH helicopter from the Maasvlakte. In the course of letting of a pilot on a ship, the rotor blades of the helicopter touched the antenna of the ship. The occurrence has not been reported to the Transport Safety Board at the time. An intern investigation was conducted by SNH. As far as relevant to the investigation at hand, the conclusions in the report are (briefly worded):

- The standard procedures are not observed by all crew members in the same manner
- The standard procedures in Part A do not cover all categories of operation conducted from the Maasvlakte.
- There is a concern amongst crew members regarding the lack of training and lack of experience in emergency situations and hoist operations.
- Deviation from the guide lines are typical for the underlying organizational problems concerning lack of supervision, support and leadership of the management.
  This culture suggests a lack of attention from the management and absence of adequate procedures with regard to the supervision of employees, to be developed by the management.
- On a higher level IVW, in its role as supervisor in the field of flight safety, did not succeed in revealing the organizational problems.

From the investigation it was found that as a result of these conclusions, the management of SNH developed some initiatives with regard to the procedures. These initiatives can be found in paragraph 1.17.1.

1.19 NEW INVESTIGATION TECHNIQUES

For the investigation a.o. the Tripod-Beta analysis method was utilized. The Tripod-Beta theory has been developed in order to be able to explain and control the occurrence of human error. In this technique after the initial investigation results, the various successive events are identified. Every event has been caused by the joining of energy (hazard) and an object (target, damaged object). For each event the energy and the object must be determined.

The events could occur because certain barriers that could have prevented the energy and the object to join, were broken or absent. These barriers must be identified. Subsequently, for each broken or missing barrier, the reason (technical/human error), the context of the event and the

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latent failure being responsible for the creation of the relevant context must be determined. The diagram of the Tripod analyses is depicted in appendix I of this report.

2 FRAME OF REFERENCE

2.1 GENERAL

In this chapter the scope and assessment framework are presented with regard to the investigation of the occurrence in Den Helder on 30 November 2004. The scope of the investigation indicates the subjects that are covered by the investigation en consequently indicates the extend of the investigation. An assessment framework is an essential item of the investigation because it is very important to indicate the criteria that has been utilized. In utilizing this assessment framework for the analysis of the occurrence, the Safety Board applies it to the circumstances of the occurrance, in establishing the (probable) causes, the extend of the consequences, in determining the structural safety deficiencies and making the recommendations.

2.2 SCOPE

The aim of the investigation of the Safety Board is to determine the actual cause of the occurrence and to determine the underlying factors that contributed to this occurrence.

The occurrence concerns an inadvertent loss of altitude followed by a contact with the water of the Waddenzee by the helicopter PH-NZG, a Sikorsky S-61N. It was caused by the loss of forward speed of the helicopter which went unnoticed by the crew. The crew did not compensate for the loss of speed by selecting an increase in power. As a consequence the rate of decsent increased.

The investigation focussed on several points. Firstly the reason of the decreasing airspeed was investigated and the question why the crew failed to observe this. In this connection the investigation focussed on the performance of the helicopter, the information recorded by the flight data recorder equipment and the performance of the crew. The performance of the crew was examined vis à vis the specified duties and responsibilities and the extend the established procedures were followed.

Apart from the performance of the helicopter and the crew, in particular the organization has been examined. In that connection the investigation focussed on the duties and responsibilities of the management. The extend to which the performance of the management of SNH affected the occurrence has been investigated.

Finally, in the course of the investigation the performance of supervision by the authorities has been examined.

In the course of the investigation it emerged that the flight data recorder equipment, in particular the FDR, did not operate adequately. It was found that this was probably a structural problem that also was recognised in other European countries. Therefore also the lack of maintenance and the inadequate operation of flight data recorder equipment has been included in the investigation.

2.3 ASSESSMENT FRAMEWORK

The assessment framework of the Safety Board is divided in three parts, being:

I. a specification of the relevant applicable legislation in the relevant sector the occurrance took place.
II. a description of additional guide lines, directives and views that are applicable within the sector, as well as
III. a description of the general assessment framework for safety management.

The first two items of the assessment framework are specific for the sector and very much depend on the nature of the occurrence. The third item of the assessment framework is a general section. This section describes the assumptions of the Board with regard to how the parties involved should address the personal responsibility for safety.

I. Legislation
The assessment framework based on the (inter)national aviation legislation is outlined below. The actual contents of the legislation and guide lines are detailed under the relevant subjects in chapters 1 and 3.

International legislation
The applicable international legislation is:
- ICAO Annex 6 en 8
- JAR-OPS3

ICAO Annexes
Though not being formal legislation the ICAO annexes can be considered as such. By ratifying the Chicago convention, a contracting state is committed to the Standards and Recommended Practices provided by ICAO. These requirements are not legally binding but the contracting states are expected to incorporate at least the standards in to their national legislation. If a state decides not to adopt the standard, then that state must give notification to the other states and ICAO immediately. The requirements mentioned in the 'Recommended Practices' are qualitate qua recommending of character.
The Annex of particular interest for this investigation is Annex 6 (Operation of Aircraft), Part 3 (international commercial air transport, helicopters) and chapter 6, containing recommendations with regard to flight data recorder equipment. Furthermore Annex 8, (Airworthiness of Aircraft) is applicable.

JAR-OPS
JAR-OPS3 contains the requirements in the field of helicopter operations. These requirements are implemented by the JAA, a joint venture between European aviation authorities. This legislation is footed on the ICAO annexes. JAR-OPS may contain specific requirements, but can require also the stake holders to adopt the general JAR-OPS requirements and work them out in further detail, in their manuals. In the framework of this report the next parts of JAR-OPS3 are of particular interest:
- JAR-OPS 3.035 Quality system;
- JAR-OPS 3.175 General rules for Air Operator Certification;
- JAR-OPS 3.200 Operations manual;
- JAR-OPS 3.720 Flight data recorders-2;
- JAR-OPS 3.943 Initial operators CRM-training;
- JAR-OPS 3.945 Conversion training and checking.

National legislation
The national legislation provides requirements in all fields of aviation, varying from rules of conduct to maintenance requirements. A major part of the Dutch legislation refers to the European JAR requirements.

II. Additional guide lines and directives of the sector
These include:

- The Operations Manual of SNH. This manual describes all aspects of the helicopter operations within SNH. According to JAR-OPS3 an operations manual must be approved by the authorities (IVW). The operations manual of SNH is divided in:
    - Part A: General/Basic;
    - Part B: Helicopter operating matters;
    - Part C: Route/Role/Area and heliport instructions and information;
    - Part D: Training.

The relevant contents of the operations manual are detailed under the relevant subjects in chapters 1 and 3.

Documentation of the manufacturer
This includes the S-61N flight manual. This manual contains the description, limitations and operational requirements of the S-61N. According to Dutch legislation an aeroplane must be operated according to the flight manual of the manufacturer.

Directives of the gas- and oil companies.
The gas- and oil companies dictate their own requirements to the helicopter operators that transport their employees. These requirements are indicated in the Aircraft Management Guide of the International association of Oil and Gas producers (OGP). They may include an extension to the legal requirements. Verification of the application of these requirements is accomplished by performing audits of the helicopter operators conducted by the gas- and oil companies.

III. Assessment framework for safety management
Over the years it has turned out that the structure and implementation of the safety management system does play a crucial role with regard to controlling and continuously improving safety. This goes for all organizations, private as well as public, being involved, actively or indirectly, in activities that may cause a public safety hazard.

Basically the manner of addressing the personal responsibility for safety by an organization can be tested and assessed from different perspectives. Therefore a universal manual that can be referred to in each situation does not exist. Consequently the Board did select five points of particular safety interest that provide an indication of the aspects which, in various degrees, may play a role. The points of interest selected by the Board are implemented in (inter)national legislation and in a large number of standards accepted and implemented on a wide scale.

The next points of interest are selected:

Risk awareness as a basis for safety approach
- Starting point for reaching the required safety is an exploration of the system and thereafter
- an inventory of the corresponding risks

This forms the basis for establishing the risks to be controlled and the required preventive and repressive measures.

Evident and realistic safety approach
To prevent and control undesirable occurrences, a realistic and practicable safety policy must be established with the corresponding starting points included. This safety approach must be established and controlled at management level. This safety approach is based on:
- relevant applicable legislation
- available standards, directives and 'best practices' applied within the sector
- Understanding and experience from within the organization itself and safety objectives specifically established for the organization

Implementation and enforcement of safety approach
Implementation and enforcement of the safety approach and controlling the identified risks is applied by:
- a description of how the applicable safety approach is realized, with attention to the concrete objectives and plannings, including the resulting preventive and repressive measures.
- A transparent, unambiguous and general accessible division of responsibility on the shop floor for the purpose of realisation and enforcement of safety plans and actions.
- establishing with clarity the required personal effort and experience that is required for the various duties
- A clear and active central coordination of safety activities

Improving the safety approach
The safety approach must be improved continuously on the basis of:
- periodically, and at least after each change in starting points, proactive implementation of (risk)analyses, observations, inspections and audits;
- A reactive system of monitoring and investigation of incidents, near accidents and accidents, with a subsequent professional analysis included.

On this basis evaluations are made and the safety approach is adjusted by the management. Also points of correction are revealed that can be utilized for further active control.

Management control, involvement and communication
The management of the parties/organization involved must

- *internally,* provide for clear and realistic expectations with regard to the safety ambition, provide for a climate of continuous improvement of safety on the shop floor by at least setting a good example and finally provide for sufficient personnel and finances.
- *externally*, communicate clearly on the basis of distinct and established agreements with the environment regarding to the general mode of operation, the manner of testing that, procedures in case of deviations etc.

2.4 PARTIES INVOLVED AND THEIR RESPONSIBILITIES

The next parties are directly or indirectly involved in the occurrence with the PH-NZG

- Schreiner Northsea Helicopters (SNH);
- International Civil Aviation Organization (ICAO);
- Joint Aviation Authorities (JAA);
- Inspectorate Transport and Public Works (IVW);
- The Royal Navy (KM);
- Sikorsky Helicopters;
- Teledyne.

SNH
The company is responsible for all aspects of the helicopter operations. This concerns material- and personnel issues as well as flight operations. The requirements that are established in this regard stem from various sources, such as national and international legislation, internal procedures and requirements of the manufacturer. To that end SNH performs internal audits.

ICAO
The International Civil Aviation Organization (ICAO) is a specialized organization of the United Nations aimed at establishing principles and standards for international civil aviation in order to improve international air transport. It endeavours to reach this by:

- Establish Standards and Recommended practices, SARPs.
- Establish Procedures for Air Navigation Services, PANS.
- Research regarding possible improvements in international civil air transport
- Establish recommendations with regard to design and performance of aircraft and a large part of the equipment; qualification of airline pilots, crew members, air traffic controllers and ground- and maintenance personnel; safety requirements and –procedures for international airports.

These rules must be implemented in national and European legislation as much as is deemed possible.

JAA
The Joint Aviation Authorities is an organization that is connected to the European Civil Aviation Conference (ECAC). The JAA represents a large number of the national aviation authorities of European countries which agreed to cooperate in the field of aviation safety and procedures. This cooperation is aimed at a high and consistent standard of safety. The focus is on operations, maintenance and standards for the design and certification of all categories of aircraft.

National legislation in these fields is, conform the agreements made to that effect, replaced by European legislation, the Joint Aviation Requirements (JARs).

IVW
IVW is responsible for the supervision of the correct application of national and international legislation by approved companies. This is accomplished by performing inspections and audits. Deviations may be the reason of administrative action in extreme cases.

The Royal Navy (KM)
The Royal Navy is responsible for air traffic control within the air traffic area of De Kooy. Furthermore it is the manager of all navigation- radar- and runway equipment on the airport.

Sikorsky Helicopters
Sikorsky Helicopters is as manufacturer of helicopters responsible for the provision of manuals and operational requirements with regard to helicopters that they delivered. Furthermore Sikorsky is

responsible for distribution of temporary maintenance directions and amendments of manuals and operational requirements.

Teledyne
Teledyne is, as supplier of the flight data recorder, responsible for the correct installation and operation of the flight data recorder at delivery of the helicopter. Furthermore the company is, together with the owner of the helicopter, responsible for the implementation of the correct conversion table.

3 ANALYSES

3.1 THE CREW

3.1.1 General
Both pilots possessed current licences required to operate the flight. Both operated from the Maasvlakte as well as from Den Helder Airport. Thus they operated on two different types of helicopter. This was allowed and the legal requirements in this regard, were complied with

It emerged that the pilot in command operated flights whilst the validity of the CRM-training had expired since 24 days. Therefore he was not allowed to operate commercial flights. The Safety Board does not consider it likely however that exceedence of the term of validity had any affect on the occurrence.

3.1.2 Experience
From the investigation was found that the pilot flying conducted five flights on the S-61N in the month of October and that the last of these flights took place on 29 October. In the month of November he exclusively had operated on the SA365. Consequently he had not operated the S-61N for a period of 31 days. It is therefore possible that he did not feel very comfortable when he operated the S-61N again for the first time after this period. This is confirmed by the statement of the pilot flying, concerning his 'rusty flying'. He made this statement when during departure he experienced some difficulties in keeping the helicopter stabilized. The extend of the role of the inoperative pitch channel during this manoeuvre has not emerged.

During the interviews the pilot flying indicated that he experienced no difficulties in flying by turns two types of helicopter. Because he started his training with SNH on the S-61N and the majority of the flying hours he had collected was on that type, he was very familiar with this helicopter. Also his training results indicate that there is no reason to assume that he was not proficient on the helicopter.

Also the pilot in command, the pilot non flying, did not operate on the S-61N for a longer period of time. On 27 October he had made his first flight again with this helicopter. After that he had operated just one flight on the S-61N; on 3 November. This means that he did not operate on the S-61N during a period of 27 days. From training reports was found out i.a. that the pilot in command during flight mixed up both types from time to time.

From the investigation emerged that the small amount of flying hours on the S-61N was caused by an unbalanced division between flights on the S-61N and the SA365N3. The majority of flying hours collected on the SA365N3 were during operations from the Maasvlakte.

Consequently the cockpit crew of the helicopter was composed of two persons who did not operate on the type of helicopter S-61N, for a longer period of time. The requirement to have executed three take-offs, three circuits and three landings with this type of helicopter within 90 days was complied with. Also with a view to the different instrument lay out of both type of helicopter it cannot be excluded that the lack of recent flying experience of both pilots on this type of helicopter has affected the cause of this occurrence.

3.1.3 Fatigue
From the interviews was found that the pilot flying and the pilot non flying left home on the day of the occurrence at around 06:00 hours and that they had reported at Operations in Den Helder at 08:00 hours. From that point in time they had been waiting until approximately 13:00 hours, since flight operations were not possible due to fog. They waited, together with other crew members, in the crew room until the flights could be operated. In general when staying in similar quarters there can be no question of rest and relaxation. More often then not they are noisy and no resting facilities are provided.

The combination of an early rise, a car trip of two hours driving through foggy conditions followed by five hours of waiting, does not represent an optimal flight preparation. Consequently it may be expected that some fatigue may exist already before the flight is commenced. This will, in particular when the flight will be conducted under more difficult conditions, have some effect on crew performance. Therefore it is possible that fatigue played a role in the cause of the occurrence.

3.1.4 The problem with the AFCS

From the recorded conversation between the two pilots turned out that during flight the performance of the AFCS was discussed several times.

On the outbound flight the problem with the AFCS was discussed twice and on the return flight, just before the instrument approach into EHKD was commenced, again attention was given to the AFCS. During the descent for the initial approach, control of the helicopter was transferred to the pilot non flying in order to learn his opinion with regard to the performance of the AFCS. Together the crew members concluded that indeed the stabilization system did not perform correctly. The problem did not appear continuously and did not have a direct affect on flight safety. From the fact that the emergency checklist was not consulted, it can be concluded that the crew did not consider this problem as serious. By transferring controls the pilot flying requested confirmation of his findings from the pilot non flying. No decision was made how to deal with this problem.

The AFCS is a stabilizing aid and is not essential for a safe conduct of flight; the helicopter also can be operated when the AFCS is switched of though this requires more correctional control from the pilot flying. Controlling the helicopter with the AFCS switched off is one of the required skills of a S-61N pilot.

Because the problem did not result in an analysis, the performance of the AFCS kept being a subject of discussion. The result of this was that relatively much attention was paid to the performance of the AFCS and that just before the initial approach the control of the helicopter was transferred temporarily to the pilot non flying, causing a proper preparation of the approach and landing to suffer.

Much attention was paid to the performance of the AFCS which affected the attention paid to flight operations.

3.1.5 Crew resource management

In analysing the aspects of CRM, distinction must be made between:

- CRM: the total system of applying crew communication and -management skills in the cockpit
- Crew concept: division of duties and responsibilities of both cockpit crew members during flight
- Crew coordination: the specified duties of the pilot flying and the pilot non flying during a specific phase of flight.

In the case under consideration, a routine conduct of flight was exercised during which standard procedures for a greater part were not applied, checklists rarely utilized and crew coordination procedures not followed.

Also communication regarding flight execution was relatively scarce. This can be explained by the crews statements, that the S61 pilots group was small and consequently they often operated flights together. They therefore made a good team and most of the time half a word or a gesture was enough to make each other understood.

The problems with the AFCS figured largely in this situation, without resulting in a clear analysis or making a decision. Furthermore on some occasions the pilot flying had to draw the pilot in commands attention to radio calls and the pilot in command did not react to various observations made by the pilot flying. Consequently the impression arises of the pilot in commands awareness not being optimal.

These developments can be the result of the crew concept that is applied within SNH during flight execution. Accordingly the pilot flying, regardless the fact that he is not the pilot in command, takes all operational decisions and he communicates with air traffic control.

During the standard flight execution the pilot flying fulfils a leading role in the cockpit and the pilot in command as the pilot non flying is following the pilot flying. Only if a deviation of standard operational procedures occurs approval of the pilot in command is required.

According to SNH this crew concept deviates from the concept that is in use with other airlines. When comparing with crew concepts of other airlines it appears that indeed they require the consent of the pilot in command for each operational action, but in practice this line of procedure is not followed at all times. Routine actions or compliance with air traffic control directions regularly is accomplished tacitly. Only in special circumstances, as also is specified in the crew concept of SNH, approval of the pilot in command will be requested. The sole deviation of the crew concept is the 'fixed seat policy' requiring the pilot flying always occupy the right hand seat. The deviating crew concept of SNH could encourage the pilot in command, when he is not the pilot flying, adopt a more passive attitude then is desired. This could result in a so called "laisser-faire" cockpit with a flat authority gradient. (see also Appendix G, Crew Resource Management).

During the approach a change in the coordination of duties occurred, that deviated from the above mentioned crew concept. During this approach the pilot in command took over the initiative and, four times within a short period of time, instructed the pilot flying to allow the helicopter to descend below the glide path. The role of the pilot in command as pilot non flying changed, from a passive role according to the crew concept of SNH, into an active role.

An explanation of the impression that until the occurrence, the conduct of flight is routine which apparently is considered being normal practice, can be that this type of operations involve a very high frequency of flight cycles. Within the requirements according to the work- and rest regulations, crews operate, on an almost daily basis, between Den Helder Airport and the production platforms in the North Sea. This involves operating more then one flight per day including the execution of a large number of take offs and landings. This can result in a certain routine, leading to a reduction in consequent checklist discipline and compliance with the procedures. This reduction in discipline can have an adverse affect on flight safety. It is the Safety Boards opinion that in general the hazard of routine must be recognised at all times and that crews must be aware of this hazard.

The flight under consideration cannot be considered a normal routine flight because circumstances prevented that. It was a delayed flight; visibility conditions were marginal; according to the crew the AFCS was not performing properly; both pilots did not have recent experience on type etc. etc. These circumstances could exactly have been the reason for a stricter application of procedures, checklist discipline and the crew concept. Apparently the crew did not recognize the significance of applying the crew concept properly. This could mean that this manner of flight conduct possibly could be of a structural nature, which could be an indication that this is inspired by a certain company culture.

Reviewing the above the Safety Board therefore takes the view that during the flight the CRM-philosophy, which includes an open communication and interaction, has not been followed completely. The company culture may have been instrumental in this.

It must be emphasised that it was the pilot in command who did notice (too late) the high rate of descent. His extensive flying experience and quick reaction was the last barrier to prevent an accident. As a result of his actions an accident has been prevented.

3.1.6 Procedures

Part B of the Operations Manual of SNH specifies the duties of the crew during flight. These include the use of checklists and crew briefing items. The investigation revealed that the crew hardly used the checklists and no crew briefing was given. As a result also the crew coordination, which is an item of the crew briefing, was not applied. The last part of the checklist could not be carried out because by that time the helicopter already was in its high rate of descent. The required communication between the pilot flying and the pilot non flying according to Part B S-61N, including the questions and answers back and forth, was not applied.

Also this practice can be explained from the high frequency of flight cycles that are operated by the crew. The number of take offs and landings that are executed during one flight is to such an extend that consequent utilization of checklists and application of the crew briefing, apparently is experienced as being superfluous. The items being considered by the crew as the most significant are completed by heart. Also operating from the Maasvlakte where checklist discipline and application of procedures was not standard may have affected this crew.

One particular deviation of the procedures was the decision of the pilot in command to fly below the ILS glide path.

The investigation revealed that the crew had some apprehension concerning a likely go-around. It is plausible that the pilot in command by flying a little below the glide path expected to get the approach lights in sight in an earlier stage and therefore the likelihood of a go-around would reduce.

With regard to the instructions to fly below the glide path the following observations can be made:

At 15:22:14 hours, at an altitude of approximately 600 ft, the pilot in command provided the first instruction *"just descend a bit"* and again he gave the instruction *"descend"* at 15:22:31 hours. At 15:22:46 again the pilot in command gave the instruction "descend" followed by the observation at 15:22:54 *"yes exactly... just a bit lower"*. The pilot in command did not explain the reason for this instruction and how much the pilot flying was to descend the helicopter. This should have raised questions with the pilot flying but he did not challenge the instructions given by the pilot in command.

The pilot in commands behaviour at this point deviated from his behaviour during the major part of the flight during which a "laisser-faire cockpit" situation had developed. Within a period of forty seconds, four times an instruction was given to fly below the glide path. This instruction therefore developed into an order with a more imperative character.

Secondly the observation to *"stay just a bit below it"* was unclear. The reason to fly lower and any specification of the amount of deviation from the glide path was not provided.

Thirdly the instruction of the pilot in command *"to stay just a bit below"* increased the complexity of the operation. With a view to the instrument scanning it is less complex to exactly follow the ILS according to the indications of glide path and course, then to follow it with a planned deviation.

Fourthly flying an ILS below the glide path on purpose is not in accordance with the procedures of SNH as well as the published approach plate. It reduces the obstacle clearance margin that is established for similar instrument approach procedures. It also therefore reduces the time available to correct a deviation below the glide path.

Finally flying below the glide path is never practiced during training. From interviews emerged that flying below the glide path was not a usual practice in the operation of SNH. Flying operations that include deviating from the usual procedures include an unnatural element, in that the urge to redress the situation, and return to the desired situation, the glide path, continues. This is confirmed by the fluctuating pattern of the flight path that is shown on the glide path deviation diagram (paragraph 1.11.2, figure 4 and 5). The sequence of the repeated instructions of the pilot in command resulted in a deviating glide path indication whilst initially the indication was centred and according to the desired picture. A similar practice can cause fixation, confusion and doubt.

Flying below the glide path and the demanding instructions of the pilot in command could have had a negative affect on the scanning pattern of the pilot flying. It is therefore likely that these instructions did result in fixation to the glide slope indicator.

From the discussions in the course of receiving the weather information during the return flight, it appeared that the pilot in command was of the opinion that a full ILS-approach would be executed. However, the instructions provided by air traffic control resulted in a shortened ILS-approach procedure (short line up). These instructions for a short line up were provided unrequested. From interviews emerged that this was a normal procedure for air traffic control as well as for the crews with regard to SNH-helicopter operations to Den Helder Airport.

With good visibility values a shortened ILS approach will not cause any problems, but if the approach must be performed under instrument flight conditions it is essential that the crew has ample time to enable the aircraft to stabilise on the glide path. The reason why the crew did not request for a full ILS-approach might have been that a short line up was a normal procedure. And therefore, receiving a similar clearance was within the crews expectations.

The pilot flying indicated to wish to maintain 70 kt in order to enable them to observe everything properly. Consequently it appears that apparently there is a need to take ample time to be able to execute the approach well stabilized on the ILS. This need is contrary to the tacit acceptance to execute a shortened ILS-approach.

Operating according to the procedures, systematic completion of the checklists and giving crew briefings as is practiced during training, results in minimizing the crews work load. All prescribed actions and checks will be completed and there is little chance that something will be overlooked. If these duties are not discharged properly, then all these items must be completed by heart. These results on the one hand in a rise in work load of the pilots, in particular the pilot flying; on the other hand the danger arises of overlooking something. By not applying standard procedures, checklists and crew briefings during the approach, the crews work load increased unnecessarily.

The actions taken by the management of SNH to improve adherence to the procedures, in particular with regard to the Maasvlakte pilots, apparently did not reach the desired effect.

3.1.7 Speed

The suggestion by the pilot flying to maintain 70 kt was elucidated with the observation: *"we will have ample time then to observe everything"*. From this can be derived that he considered the usual approach speed of 100 kt too high in relation to the low visibility conditions. Two observations require further attention:

According to the statement of the instructors on the S-61N, the on-shore instrument approaches in the simulator and helicopter training always are practiced with a speed of 100 kt IAS. Flying an instrument approach with a speed of 70 kt results in significant differences in selected power, rates of descent, reactions to control inputs, and correction angles on the localizer. Because this is not practiced during training, it is likely that insufficient routine exists amongst the pilots to enable them to execute an on-shore instrument approach maintaining that speed. It must be noted in this connection that the Operations Manual Part-B of the S-61N at the description of 'on-shore instrument approaches' indicates an approach speed of 70-100 kt and in general off shore approaches are executed maintaining a speed of 70 kt. These off-shore approaches however are conducted following a different procedure.

Furthermore the maintained speed is close to the transition point of the so called power curve. (Refer to appendix B). As a result a reduction in speed to below the 70 kt, without correcting power, can result in a fast increasing rate of descent. The circumstance that the weight of the helicopter was near the maximum allowed operational weight added to an unfavourable affect.

In conclusion it can be stated that by deciding to execute the approach with a speed of 70 kt, the crew created themselves unnecessarily a more difficult situation.

3.1.8 Personal responsibility

The Safety Board expects professional helicopter pilots to apply all the rules and all procedures designed to preserve the safety on board, as specified in the operations manual of SNH. In particular if a high frequency of a series of flights threatens the operation to become a routine performance, it is their duty to preserve the above mentioned rules and procedures. A continuous awareness is required accordingly and they must do their utmost to prevent deviation in order to ensure that safety is not jeopardized.

It is the Safety Boards opinion that the crew was insufficiently aware of the deteriorating affect of their routine practice operating the flight.

3.2 THE OCCURRENCE

3.2.1 Introduction

It was found from the investigation that during the approach the forward (air)speed of the helicopter reduced slowly from approximately 70 kt to approximately 20 kt IAS. This gradual decrease in speed lasted for approximately 20 seconds and was not observed by both crew members. Since this decrease was not noticed, no correction was applied in time. Consequently the rate of descend increased. This increase in rate of descent could have been arrested by selecting an increase in power. This was not accomplished and subsequently the helicopter developed a very high rate of descent resulting finally in contact with the water.

Though from the technical investigation as well as the failure of deployment of the safety system could be concluded that the helicopter did not touch the water the Safety Board is convinced that it did so. This is based on the CVR records which reproduce the sound of touching the water. Furthermore all three crew members state that they felt the helicopter touch the water.

The interviews revealed that the crew was confronted with a totally unexpected situation. According to FDR-data, at approximately 250 feet radio altitude an aggressive increase of collective power was selected. At that point in time the speed had reduced to approximately 20 kt with a torque value of approximately 20%. The helicopter reached a rate of descent of approximately 1.000 feet per minute which is confirmed by the AVAD warnings recorded by the CVR, and the FDR data. According to the FDR data the forward speed of the helicopter was approximately 25 kt at that moment and the torque value was increasing rapidly. The point in time of the final recognition of the safety threat was late to such an extend, that the margins to prevent an accident proved to be extremely narrow.

The contact with the water did not result in injuries or damage. This is owed to a number of facts. Firstly the pilot in command after observing the descent, was able to reduce the high rate of descent by selecting a large increase in power. Furthermore the S-61N has been designed to float on the water which enabled the helicopter to remain in a stable attitude. Also the contact with the water was of a short duration in time. Thanks to the design of the helicopter and the interference of the pilot in command no further serious consequences occurred.

The occurrence raises two questions. The first question is why the speed of the helicopter decreased till below the approach speed of 70 kt which was agreed with. The second question is why the gradually decreasing speed was not observed by at least one of the crew members.

3.2.2 The decrease in speed

The FDR data show the helicopter being stabilized at the start of the ILS approach; the data regarding the pitch attitude, the power and the altitude, show values which are normal for a similar approach. The speed indicated slightly above the planned 70 kt. At the moment the pilot in command for the fourth time provided the instruction 'just a bit lower', the cyclic was moved slowly backwards and the power, the collective pitch, reduced. These actions were accomplished in order to reduce the speed of the helicopter. Also it could be observed that the nose of the helicopter moved up slowly. As from this very moment the airspeed of the helicopter decreased. This can be explained by the above elucidated changes in pitch and power. After the helicopter had reached the desired speed however correction of pitch and power was neglected. In this process the further decrease in speed and increase in rate of descent was not observed.

The helicopter is liable to speed instability when its speed decreases below a certain value. This means that, a decrease in speed requires an increase in power in order to maintain altitude. If extra power is not selected the speed will further decrease requiring even more power to return to the original speed and/or altitude. If no extra power is selected the helicopter will descend in an ever increasing rate.

The fact that the cyclic was moved backwards and the collective downwards, confirms the conclusion that the speed reduction was initiated by the pilot personally. It is likely that the performance of the AFCS played a role in the sequence of these events.

The duties of the crew and actions during an ILS approach are clearly specified in the manuals of SNH and also are trained as required. The design of the crew coordination during an ILS-approach, results in scanning of the instrument indications by the pilot flying as well as the pilot non flying, on a regular basis. During the approach, the pilot flying exclusively observes the instruments (head down). His attention will be focussed primarily on the six basic instruments. He will not look outside until the moment the pilot non flying reports that the landing runway is in sight. The duty of the pilot non flying i.a. is to monitor the pilot flying as well as, in turn, scanning of the instruments and looking outside in order to observe the approach lights coming in sight. The crew failed to observe the gradual decrease in speed of the helicopter regardless this coordination of duties.

A combination of factors could have contributed to an extensive increase in mental workload for the pilot flying during flight. These factors are:

- lack of recent experience
- fatigue
- attention to the AFCS
- no application of CRM and cockpit procedures (flying below the glide path included)
- executing the approach with a speed of 70 kt

The above mentioned items resulted in a large mental workload for the pilot flying. As a consequence probably the instrument scan was not conducted properly or the instrument indications interpreted incorrectly.

From the conversation that is recorded by the CVR can be concluded that the crew had some urge to make a landing at EHKD and prevent a go-around due to the weather. It is likely that therefore the pilot non flying had the urge to get the approach lights in sight in an early stage as possible. As a result his attention was not divided in an evenly manner and less attention was paid to monitoring of the instruments and of the pilot flying.

Furthermore it is likely that the pilot non flying was too much fixated on flying just below the glide path. This had a detrimental effect on his own instrument scan and therefore the speed reduction, the increasing rate of descent and the low torque-settings were not observed in time.

Because also the pilot flying failed to observe the speed of the helicopter decrease gradually, it can be concluded that the performance of the monitoring duties and the instrument scans was inadequate.

3.3 THE HELICOPTER

3.3.1 General

The helicopter had a valid certificate of airworthiness and was maintained according to the requirements. Weight and balance was within limits though it must be noted that some lack of clarity exists with regard to the amount of fuel that was carried and the corresponding weight of the helicopter.

The first discrepancy exists with regard to the amount of fuel before commencing the flight. There was a difference of 200 lbs (2.567 lbs vs. 2.367 lbs) between the navigation plan/flight log that was prepared before flight and the one that was printed out by the board computer after the flight.

The second difference can be observed between the intention of the pilot in command to refuel 500 lbs on the L10A and the navigation plan/flight log indicating that 430 lbs has been refuelled. A clarification could be that some time elapses between refuelling and the actual take off. After refuelling passengers and cargo are loaded. The fresh figures are used to update the board computer and at that moment the actual fuel quantity is loaded.

The calculation of the take off weight has been based on the most unfavourable (largest) fuel figures. This resulted in a weight of the helicopter at departure from L10A of approximately 20.139 lbs. This is near the maximum allowed take off weight at departure from L10A that was calculated by the crew to be 20.100 lbs. With a view to the lack of knowledge of the correct amount of fuel aboard no further conclusions can be attached. As a result of fuel consumption the weight of the helicopter at the time of the occurrence was approximately 19.706 lbs. As a result of this relatively high total weight a large amount of power was required to arrest the high rate of descent of the helicopter.

3.3.2 Problems with the AFCS

After the occurrence, attempts have been made to discover if the performance of the AFCS played a direct or indirect role in the causation of the occurrence. Firstly, after the occurrence some components of the helicopter, including the AFCS, were examined which revealed no discrepancies. Furthermore two test flights were conducted with the helicopter. The sole alteration in the helicopters condition was the replacement of the gear box, for the rest the helicopter was in the same condition as it was at the time of the occurrence. During these test flights no discrepancies were found regarding the AFCS. On 3 March 2005 a failure was observed regarding the AFCS in that an input from the trim switch resulted in inadvertent pitch changes. These changes could easily be redressed by the pilot. A clear single cause could not be found, but after replacement of some components the complaint was resolved and a similar failure did not occur any more.

Therefore a failure of the AFCS could not be retrieved and during the test flights and further operation of the PH-NZG a similar failure did not occur. Only the failure of 3 March 2005 was of a similar nature, though at that time an immediate and significant pitch change was observed and not a ‘sloppy’ behaviour the crew had discussed during the incident flight.

Nevertheless it is the Boards opinion that it cannot be excluded that the AFCS played a role in the cause of the occurrence.

3.3.3 Problems with the flight recorder equipment

Flight recorder equipment (CVFDR) is installed in order to facilitate an investigation body such as the Safety Board, in retrieving the cause of an accident in a quick and accurate manner. Insufficient or incorrect conversion documentation can seriously hamper the investigation of the accident or serious incident.

In the course of the investigation it was found that for some parameters three different conversion factors were current. This rendered the use of flight data for the investigation impossible. The Board therefore, together with the operator and the manufacturer had to draft a new conversion document in order to enable analyses of the flight data. Drafting of the conversion document could be facilitated because the helicopter was not lost in the incident. If the helicopter would have been destroyed, then the data would have been useless.

As a result and following similar problems with the read out of flight data recorder equipment experienced during the investigation of other occurrences, on 11 July 2006 the Board requested the IVW, in writing, to respond to the observed developments. Until now no response has been received from the IVW.

3.3.4 Inadequacies

During the ground test procedure (GTP-test) different observations have been made that are summarized in paragraph 1.16.1. Two kinds of inadequacies have been observed. The first inadequacy concerns the installation and certification of the HUMS-system and the accompanying sensors. The second inadequacy concerns the maintenance of the sensors and other components of the helicopter.

Discrepancies after installation

The investigation revealed that after installation of the HUMS, testing of the correct operation of the CVFDR has been inadequate. Though tests and acceptance flights were conducted these apparently only served to verify the operation of the CVFDR and the HUMS. It could not be found that also the validity of the recorded data was verified. Though this resulted in compliance with the requirement to have a HUMS installed, the purpose of the use of flight recorders, recording of correct flight data to facilitate the incident- or accident investigation, was not reached.

From the examination of certification documents was found that differences existed between the PH-NZG and two other helicopters that were equipped with the same HUMS system in 1995. Not merely a discrepancy exists between the expected values and the required documentation but also between the values of the three individual helicopters. Therefore during the GPT-test of the PH-NZG also another S-61N has been examined. This resulted in similar discrepancies as found with regard to the PH-NZG.

Discrepancies as a result of maintenance

The GTP-test of 2006 has been compared with the certification test in 1995. Differences were found in the observed values recorded by the sensor of the flight controls. A possible explanation for this discrepancy is the result of maintenance actions during adjustment of the flight controls. After adjustment of the controls the sensors were not done as well or recalibrated in order to indicate the correct zero value again. This can result in the sensors to generate a discrepancy in the course of time.

The Safety Board concludes that during the installation of the flight recorder (CVFDR) SNH provided inadequate supervision in connection with the assurance of the integrity of the flight data.

Furthermore SNH failed to verify the correct operation of the CVFDR after maintenance of the helicopter.

3.3.5 Detection of problems.

SNH performs a flight analyses on a yearly basis and utilizes the FLIDRAS system to analyse the flight data. The FLIDRAS system utilizes a conversion program that has been produced in 1996. The GTP-test revealed that this file is not suitable to analyse the flight data of the PH-NZH. Furthermore individual differences are observed between the two S-61N helicopters owned by SNH. Since SNH utilizes one conversion file for flight data analyses, observation of differences should be possible when comparing flight data. During the flight data analyses conducted by SNH, these differences were not detected. Therefore the flight data analysis conducted by SNH is regarded as inadequate.

3.3.6 Assurance and verification of flight data.
Inadequacies in the field of flight data recording are observed in the study, Flight Data Recorder Read-Out Technical and Regulatory Aspects, of the French investigation authority for aviation accidents, BEA. One of the recommendations made in this report is to formalize the verification and calibration of flight data and sensors. Also, the sensors must be calibrated after the performance of major maintenance actions or after the FDR system is modified. In France it is found that middle classed and small flight operators lack the knowledge and competence to adequately perform a flight data analyses. The observations made in the course of this investigation confirm these findings.

The recommendation that helicopters utilized in passenger transport must be equipped with flight data recorder equipment, published in an earlier investigation report has been complied with by implementation in JAR-OPS3. Since no requirements are implemented with regard to the maintenance of these recorders, this requirement has little effect if the recorder is not maintained correctly and is not tested on a regular basis.

Though ICAO Annex 6 part 3 provides as recommendation, that flight recorder equipment must be tested on a yearly basis, this recommendation has not been adopted in a European directive (JAR-OPS) or national (aviation)legislation. Since no legal requirement exists, assurance of flight data is left to the individual operators. This is also the reason why this is not included in the audit- and inspection programmes of IVW. Because flight data recorder equipment basically only is used for accident investigation, no economic challenge exists for an operator to verify and assure flight recorder data. This is the reason that the Safety Board takes the opinion that it is the responsibility of the aviation authorities to adopt the ICAO- recommendation in national legislation.

It is the Safety Boards opinion that the ICAO recommendation providing that flight data recorder equipment must be maintained on a yearly basis and checked on proper performance and the validity of data, must be adopted in European legislation.

3.4 THE WEATHER

The morning fog caused all flights to be delayed resulting in the crews being forced to wait in the crew room during approximately five hours, for the weather to improve. As mentioned earlier this could have possibly caused an increase in fatigue.

After the weather had improved above limits, all scheduled flights had to be dispatched within a short period of time, which affected flight preparation.

Finally it was forecasted that the ceiling and visibility would deteriorate during the afternoon. Though initially the forecast of 12:04 hours UTC indicated a probability of a temporary slight deterioration between 13:00-22:00 hours UTC, it appeared that the revised forecast of 13:36 hours UTC indicated that this probable temporary deterioration would be considerably worse. Visibility would decrease to 500 meters and the cloud base would go down to 200 ft. These values are the minimum limits to allow for the execution of an approach and landing at Den Helder Airport (EHKD). During the return flight the crew continuously was kept abreast of the weather, by Operations as well as by other crews. The deteriorating weather apparently caused the crew to worry about the likelihood of a diversion.

From the investigation it is found that the weather played a role in the cause of the occurrence.

3.5 THE ORGANIZATION

3.5.1 Manning and resources

Structure and responsibility
Within SNH during some years the position of post holder ‘Flight Operations’ as well as post holder ‘Crew Training’ was occupied by one functionary, the Operational Manager. Discharging these

combined duties of post holdership ‘Flight Operations’ and ‘Crew Training’ by one functionary (the operational manager) could affect an independent balance between operational result and safety. Though this official indicated that he personally did not experience any problems in occupying both positions, employees who were interviewed did have a different experience. According to these employees conflicting interests could arise.

From the investigation was found that in some situations, such as with regard to the items that were raised at the instructor meetings, operations prevailed over training. Another example is the fact that the pilot in command conducted flights with the validity of the CRM training expired. A balanced assessment between operations and training was even more difficult since the same official also was active as an instructor and as well as pilot.

Though this was allowed according to JAR-OPS and approved by IVW, within a company of the size of SNH both duties should be separated. Besides the fact that this is a heavy duty, the danger of conflicting interests is clearly imminent. This is endorsed by the fact that IVW does not approve a combined post holdership for organizations with more then 20 employees any more.

Culture
SNH’s management supports the crew concept but also is aware of observations that part of the pilots force did not comply with the crew concept. The managements reaction to this was that the crew concept is meant rather to serve as a ‘fundament’ then as standard practice, in other words: *"it can be utilized as a back up if everything goes wrong"*. This statement cannot be considered to be a strong appeal to the pilots to adhere the crew concept. It must be noted that the CRM philosophy as well as the crew concept has been incorporated in the Operations Manuals A and B of SNH.

It was found that the management of SNH apparently underestimated the significance of a good crew concept. The company culture at hand allowed part of the pilots force not to comply with the crew concept.

At the Maasvlakte checklists, were not adhered to and procedures not followed strictly. The easy style of flying or –attitude during the Maasvlakte operations therefore could, if operations were to be performed together with North Sea pilots, result in tension between each other. The management did not regard this as a safety hazard. Though indirectly this could be so.

Proficiency
The proficiency checks are conducted in a simulator. In general the results of these checks are adequate. However the performance in the simulator only then is the right predictor of cockpit performance, if the pilot is motivated to discharge his duties in practice with the same proficiency as accomplished in the simulator. On being asked, it was indicated that this did not occur on every occasion; this is underlined by the estimation that 10% of the pilots force structurally shows inadequate proficient cockpit performance.

From the above mentioned observations it can be concluded that the actual results of the prof-checks does not provide for a realistic picture of cockpit performance of the pilots on every occasion.

During their periodical meetings the instructors observed that on several occasions deviations occurred from the desired level of proficiency of the pilots. Examples of this are: inadequacies in communication between pilots and the problems some pilots experience flying two types of helicopter. The possible solutions that were raised by the instructors such as increasing the frequency of line–checks from once a year to two times a year, was not acted upon by the management. It was evident from the records of the instructors meetings that an area of tension existed between the trainings effort desired by everyone and which was feasible in connection with the tight flight schedules. In that connection the double role played by the operational manager was prominent; in his position as Post holder Crew Training he should have substantiated the proposed solution but in his position as Post holder Flight Operations he will emphasise the priority of flight operations.

It is concluded that in the period of time that has been under examination, SNH appeared unable to raise the pilots cockpit performance to the desired level of proficiency.

3.5.2 Safety management

Risk assessment and policy
The latest risk assessment performed by the company had been conducted two years prior the occurrence. Therefore the actual risks such as the combination of keen competition, a reorganization and the proficiency level of the pilots force were not included in the assessment.

An in depth periodical (for instance every year) risk assessment and a subsequent adjusted policy accordingly would enable SNH to formally recognize these risks and anticipate to it with a widely supported and coherent policy. At present, actions primarily emanate from the Safety Review Board discussions, with regard to reports of (near-)incidents and therefore are on hind sight and without further coherence. It seems that within SNH the methodology to estimate the risks in advance and subsequently take preventive action is absent.

Monitoring the safety performance
From the analyses of the information regarding the prof- and line checks, it follows that the "emotional" judgement of the instructor on some occasions is much more negative then the actual assessment. It is this 'soft information' that can be of primary significance to the management. By discussing this information with the particular pilot the management could be enabled to improve the safety performance of the company, by taking general action or action tailored to the individual pilot. However an internal procedure how to deal with this soft information and the criteria how to collect this information, are absent. Therefore this information does not serve any purpose if further prior agreements with instructors and pilots are not made. Consequently the management denies the possibility to take advantage of the use of this valuable information. Therefore SNH should develop a system that allows the use of 'soft information' regarding the pilots performance in order to improve the safety performance.

Previous incidents
The two accidents as mentioned above, the accident on the North Sea in 1997 and the rotor blades touching the ships antenna in 2003 do raise some issues requiring further consideration.

The accident in 1997 indeed involved a helicopter of KLM ERA but because this company shortly afterwards was merged into SNH and on that occasion all personnel and the helicopters were transferred, there is some reference to SNH as well. In the course of the investigation of this accident the significance of adequate communication between both crew members and with that, the significance of an adequate CRM training, emerged. CRM training now is legally required and also conducted, but from the investigation nevertheless emerges that the significance of this training is not recognised by all stakeholders.

After the latest occurrence in 2003 SNH developed various actions. These actions were aimed at the operations from the Maasvlakte and the pilots involved in these operations. The purpose of this project, "Anchors away" was to improve communication and to improve the integration of Maasvlakte crews with Den Helder pilots in order to create a larger mix of pilots and consequently enable an improved assurance of the crew concept.

These actions provided a follow up to the inadequacies that were observed and primarily covered the compliance with the procedures on the Maasvlakte. During the investigation it could not be established if also actions were taken to improve the observed lack of supervision and support by the management.

Adjustment by the management
Via written and oral communication the management indicated to have the intention to improve the cockpit performance of its pilots. These actions had not yet reached any effect in the period of this investigation. This can be concluded from the fact that only a limited number of pilots reacted to the invitation of the management for a bilateral exchange of views. Apparently the problem is not recognized by the target group.

The management declares to refrain, for the time being, from the implementation of disciplinary action on a structural basis in order i.a. to keep up the 'non punitive' culture. This however may not serve as an excuse for the management not to take action if it is of the opinion that safety is at issue. The 'non punitive' culture should be a means to improve the safety performance and is not an aim in itself. Otherwise an unbalance is created between the relatively large ultimate responsibility the management must bear and the relatively small authority it actually claims to achieve it.

The management claims likely disagreement with the pilots union as an argument not to utilize the relatively ‘soft’ information emerging from the prof- and line checks (refer to the finding ‘monitoring of safety performance’). However the management did not take any evident action in order to try to objectify this information and come to an agreement with the pilots, instructors and unions to utilize this information.

Summarizing it can be concluded that until now the actions of the management are lacking any clout and that the management does not succeed in adjusting the cockpit performance of the SNH pilots effectively.

Scheduling
The Safety Board is in the opinion that the crew composition contributed to the cause of the occurrence. Since both pilots did operate two different types of helicopter and did not have recent experience on the S61-N. Both belonged to the group of pilots operating from the Maasvlakte (the pilot flying 2 1/2 months) that was known for their inadequate use of the checklists and procedures.

The composition of the crew stems from the method of planning. Scheduling is accomplished under the responsibility of the Postholder Flight Operations. The policy that is pursued exists in practice of merely establishing a list of restrictions. It appeared that the actual scheduling was accomplished by one single person manually. No planning policy exists or a computerized planning system that takes a pilots recent experience per type or his background into consideration.

Furthermore it is not recorded if a crew member acted as pilot flying or pilot non flying. In this connection it should be noted that legally it is allowed to conduct one prof check per year for each type. This creates the theoretical possibility of two pilots who for a long period of time both did not operate as pilot non flying on one type of helicopter and did not undergo a prof check, together as a crew are operating on another type of helicopter.

The legal requirements of JAR-OPS3 regarding crew composition were complied with. Nevertheless SNH could endeavour to establish a crew composition as optimal as may be possible.

It is the Safety Boards opinion that if two different types of helicopters are operated the organization should assure that the period of time of operation on one type of helicopter is as short as possible. Therefore SNH should develop a system to optimize crew scheduling.

3.5.3 Personal responsibility
Legislation is established in an international framework to an increasing extend. In this connection Dutch legislation is established mainly within the framework of JAA. The state of registration is responsible for supervision of flight operations. Pilots and managements of airline companies however also have a personal responsibility with regard to complying with the regulations and for taking actions that are required in the interest of flight safety. Therefore, apart from the established rules and regulations the personal responsibility is an integral part of the aviation safety system. When government intervention decreases, the role to play by the personal responsibility in the aviation sector will increase to a larger extend then previously was accomplished.

With a view to the analyses as laid down in the chapters above, the Safety Board is in the opinion that SNH addressed the personal responsibility inadequately. Indications from outside the company as well as from within, that several aspects of the operational process needed improvement, were addressed by the company inadequately. A number of examples can be provided:

During the company meetings between IVW and SNH it was agreed that pilots with a moderate performance during training flights would receive supplemental training in order to raise their level of proficiency. It could not be established that this actually was accomplished.

Suggestions from the instructors group, such as to appoint a line trainer for the Maasvlakte, improve communication, division of duties between the instructors on the various types and the increase of the frequency of line checks, were partly adopted and did not have the desired results.

Also the observations made after the audits conducted by the oil companies, are conform the findings in this report. No investigation has been conducted with regard to the actions taken by SNH in follow up of these observations. However, various findings, such as regarding the frequency of training sessions and the planning system, still were current at the time this investigation was conducted. These observations should have been an indication for the management that improvements were inevitable.

In some cases, such as regarding the easy style of flying on the Maasvlakte, a solution was found, but after it appeared that this solution did not come up to expectations no further effort was made in finding another, better solution.

The inspections and audits performed by IVW did result in a picture that SNH did comply with the requirements of JAR-OPS3. Some observations were made, but these were not of such a serious nature that (administrative)action was required. This can result in the impression that no further action with a view to raising the standard within the company is required. In this connection it must be realized that JAR-OPS3 establishes minimum requirements. According to IVW, complying with these requirements 'scores a six'. Compliance with these requirements does not exclude that improvements would not be possible or necessary, however IVW can do no more then give the company the advice to improve from a 'six' to an 'eight'. The drive to improve must come from the company itself. The impression that resulted from this investigation is that SNH's management laid the emphasis on the operational process, on some occasions resulting in a lack of the correct balance between operations on the one hand and safety on the other.

Too much attention to flight operations could be detrimental to (flight)safety. In particular since most of the time this safety is reached with actions taken outside the field of daily operations, such as sufficient training and the emphasis on the primary importance of procedures. It is the management's responsibility to assure the balance. Since the impression is established that within SNH this balance was applied inadequately, the Safety Board takes the opinion that SNH did not address its personal responsibility in an adequate manner.

3.6 SUPERVISION

Supervision of SNH is performed by the Transport and Water Management Inspectorate the Netherlands, Flight Operations Inspectorate (IVW-DL). In connection with issuing the air operators certificate IVW must apply the norms as established by JAR-OPS3. The requirements that are established by JAR-OPS3 provide for a minimum limit for a reliable helicopter operation. The question arises, if the legislation as established provides for a sufficient margin to assure a safe operation on every occasion. IVW however does not have opportunities at its disposal to establish additional requirements, even if additional requirements would result in a significant safer flight operation. It goes without saying that IVW can formulate recommendations for a safer flight operation. In that way an appeal is made to an operators personal responsibility to heed to these recommendations.

Though after the audits and inspections at SNH, observations were made, IVW never saw a reason to take (administrative)action. The observations made in the reports were discussed during company meetings and relevant agreements were made. From the investigation did not emerge however that IVW did verify the actual compliance with the agreements. In any case this was not accomplished with regard to the agreed extra training flights for some pilots flying two types of helicopter, but also with regard to other promises of SNH, the Safety Board has doubts about its follow up. Thus the planned audits with regard to training were not conducted and still procedures were not followed at the Maasvlakte, though these findings were mentioned in reports of 2002.

From this investigation conducted by the Safety Board emerges that in general SNH operated according to the rules but also that the safety of the operation was subjected to pressure. The findings of IVW regarding the work load and commercial pressure became issues adopted by the Taskforce North Sea.

All things considered the Safety Board concludes that the governments supervision was accomplished according to existing requirements but nevertheless verification of follow up- and redressing actions was insufficient and indications that the safety of flight operations was under pressure, were not recognized.

4 CONCLUSIONS

4.1 FINDINGS

The crew

- The crew possessed valid flying licences and medical certificates required to operate the flight
- The crew was authorized to operate on two types of helicopter. The established legal requirements in this regard were complied with.
- The date of validity of the CRM training of the pilot in command was exceeded.
- The crew had not operated on the S-61N for a longer period of time. The requirements of JAR-OPS3 were complied with.
- It cannot be excluded that lack of recent experience of both pilots on this type of helicopter affected the cause of the occurrence.
- Since the crew got up early, had a long travelling time and had to weight in Den Helder for approximately five hours, it is likely that fatigue played a role in the cause of the occurrence.
- Much attention was paid to the performance of the AFCS adversely affecting the attention to flight operations.
- The conduct of the flight was routine in which procedures and checklists were not followed.
- The crew had encumbered itself unnecessarily by not applying the standard procedures, checklists and crew briefing, during the approach.
- The crew accepted the shortened approach procedure that unrequested was assigned by air traffic control.
- During flight the crew did not comply with the crew concept. This was a consequence of the company culture within SNH.
- By deciding to execute the approach with a relatively low speed of 70 kt, the crew created a difficult situation to deal with.
- The approach was conducted below the glide path on purpose.
- The pilot flying received the instruction to descend, from the pilot non flying, four times within 40 seconds. The nature of this instruction changed into an order.
- The crew was insufficiently aware of the affect their routine conduct did have on flight operations.

The occurrence

- The forward (air)speed of the helicopter decreased during the approach from approximately 70 kt to approximately 20 kt. This gradual decrease in speed occurred in a period of approximately 20 seconds.
- Contrary to the required coordination of duties, both pilots failed to observe the decrease in speed.
- Since the cyclic was moved backwards and the collective downwards, it can be concluded that the pilot flying personally initiated the speed reduction.

- As a result of a large mental load, the pilot flying probably failed to conduct the instrument scan or to assess the instrument indications properly. As a result the decrease in speed, the increasing rate of descent and the power being too low was not observed.
- As a result of the urge to have the approach lights in sight in a stage as early as possible the pilot non flying failed to divide his attention in an evenly manner
- The pilot non flying failed to discharge his duty to monitor the pilot flying and scanning of the instruments during approach properly.
- The decrease in speed resulted eventually in an increase of the rate of descent of the helicopter to 1.000 feet per minute.
- When the pilot non flying noticed the high rate of descent he intervened by selecting maximum power
- The helicopter touched the water of the Waddenzee
- The intervention of the pilot non flying prevented a serious accident
- The weather played a role in the cause of the occurrence
- It cannot be excluded that the AFCS played a role in the cause of the occurrence

The helicopter PH-NZG

- The PH-NZG had a valid certificate of airworthiness and had been well maintained.
- Weight and balance of the PH-NZG was within limits.
- In the two flight logs a different fuel quantity was indicated rendering an exact calculation of the total weight impossible.
- As a result of the relatively high weight a high power setting was required to stop the high rate of descent of the PH-NZG
- There are no indications that the occurrence would have been caused by a technical defect
- The gear box was overloaded by the occurrence and had to be replaced
- During the installation of the flight data recorder (CVFDR) inadequate supervision was exercised to assure the integrity of the flight data.
- SNH failed to verify the correct operation of the CVFDR after maintenance of the helicopter.
- Prior to the occurrence with the PH-NZG the operator nor the manufacturer were familiar with the correct conversion factors.
- The performance of the yearly flight analyses by SNH was inadequate to enable detection of deviations between recorded data and actual flight data.
- The flight recorder records would have been useless if the helicopter would have been destroyed in the occurrence.
- ICAO recommends the yearly maintenance of flight recorder equipment as well as verification of the correct operation and the validity of records.
- These recommendations are not adopted in European legislation JAR-OPS nor in Dutch legislation.

The organization

- The combined discharge of duties of the post holder ‘Flight Operations’ and ‘Crew Training’ by one functionary (the Operational Manager) hindered an impartial balancing out of safety and operational return.
- The company culture within SNH allowed part of the pilots not to comply with the crew concept
- The actual result of the prof-checks did not provide a realistic impression of the pilots cockpit performance on all occasions.
- The management of SNH failed to succeed in raising the pilots cockpit performance to the intended level of proficiency.
- The management of SNH failed to adopt possible solutions of the instructors group
- The tension existing between the SNH-trainings program and the flight schedule caused the flight schedule to prevail
- It seemed that within SNH the methodology to estimate the risks in advance and subsequently take preventive action was absent.
- The management lacked useful information with regard to the safety performance of pilots.
- The management failed to effectively adjust the SNH’s pilots cockpit performance.
- SNH lacks a planning policy or a computerized planning system that takes the recent flying experience per type and the pilots back ground into consideration.
- Indications from outside the company as well as from within, that several aspects of the operational process needed improvement, were inadequately recognised by the company.
- The impression that resulted from this investigation is that SNH’s management laid the emphasis on the operational process, resulting in a lack of the correct balance between operations on the one hand and safety on the other, on some occasions.
- SNH failed to address the personal responsibility adequately.

Supervision

- Findings of IVW as a result of audits and inspections prior to the occurrence caused no reason for (administrative) action.
- The observations made in the inspection- and audit reports were discussed during company meetings.
- The findings of IVW regarding work load and commercial pressure became issues for the Taskforce North Sea
- Government supervision has been exercised according to the requirements but failed to result in adequate verification of compliance with agreements and follow up actions.

4.2 CAUSES

The occurrence was caused, because the airspeed of the helicopter decreased unnoticed as a result of a high pitch attitude without taking timely corrective action.

The causal factors were:

- Deviation of cockpit procedures and failure to use checklists
- Inadequate monitoring and instrument scan of both pilots

The underlying factors were:

- Failure of the management of SNH to give safety priority when balancing out flight operations against safety.
- Inadequately addressing the personal responsibility by the management of SNH.
- Inadequate verification of the follow up of agreements and observations by the Transport and Water Management Inspectorate the Netherlands, Flight Operations Inspectorate

5 RECOMMENDATIONS

It is recommended to CHC Helicopter Corporation Nederland (former SNH):

- To put the management of the company to a critical test and implement revisions in order to achieve an operational performance as safe as is reasonably possible. In this context at least the next issues must be taken into consideration
  - Training of helicopter pilots
  - Applying the procedures as laid down in the operations manuals
  - Crew resource management
  - Crew scheduling
  - Response to the findings as a result of audits, inspections and observations made within the company itself.

It is recommended to the Minister of Transport, Public Works and Water Management:

- To develop legislation, in cooperation with the European Aviation Authorities, providing for mandatory maintenance of flight recorder equipment on a structural basis and for verification of its operation and the validity of data, in accordance with the ICAO recommendation.

- To record the agreements made with companies as a result of audits and inspections properly and strictly verify the compliance with these agreements in order to observe incomplete- or non compliance in a timely manner.

The governmental bodies towards which a recommendation has been issued must take a stance regarding the follow-up of this recommendation within 6 months of publication of this report to the minister concerned. Non-governmental bodies or individuals towards which a recommendation has been issued must take a stance regarding the follow-up of this recommendation within a year of publication of this report to the minister concerned. A copy of this reaction must simultaneously be sent to the Chairman of the Dutch Safety Board and to the Minister of the Interior and Kingdom Affairs of the Netherlands.

APPENDIX A: JUSTIFICATION OF THE INVESTIGATION

General
Initially the investigation was conducted by an investigator of the Dutch Transport Safety Board (RvTV), aviation chamber. On 1 February 2005 the RvTV has been transferred into Dutch Safety Board. After that date the investigation was continued by the same investigator in cooperation with the Accident Investigation Group (AIG) of the Dutch Airline Pilots Association (VNV).

Reporting
The occurrence was reported on 30 November 2004 at approximately 17:30 hours. After it had become obvious that there were no casualties and the helicopter was parked in a hangar on Den Helder Airport in the mean time, it was decided to start the investigation the next day.

Investigation
The investigation was conducted according to the European- and ICAO Annex 13 directives that apply to the investigation of aviation accidents[23]. The Safety Board established a committee to provide support to the investigation. This advisory committee initially was composed of two, and in a later stage, of one member of the aviation committee of the Safety Board.

The investigation was started in Den Helder on 1 December 2004. A short interview by telephone was held with the cockpit crew and, in cooperation with technical staff of Schreiner Helicopters (SNH), a technical examination of the helicopter and some components was conducted. Furthermore the Cockpit voice Recorder was secured and a read out was made with an investigator of the Board in attendance.

The cockpit crew has been interviewed on three occasions; the first time, the day after the occurrence, a short telephone interview was held, the second time an extensive interview was held by investigators of SNH and the VNV in attendance of an investigator of the Safety Board as an observer and the last time the crew has been interviewed extensively by investigators of the Dutch Safety Board. The cabin attendant has been interviewed once by investigators of SNH and the VNV. A copy of the report of this interview has been received by the Safety Board. Further interviewing has been abandoned in connection with the medical condition of the cabin attendant. The pilot in command did write a statement personally which also was placed to the Boards disposal.

After replacement of the gearbox two test flights were conducted with the helicopter in attendance of an investigator of the Board. During these test flights the helicopters systems were tested under similar circumstances as during the occurrence.

In order to establish the line of questioning a Tripod analyses and a time frame analyses was made by the Analyses Department of the Safety Board.

On request of the Safety Board a report regarding the meteorological conditions at the time of the occurrence was provided by the KNMI. The Royal Navy provided information regarding the available radio communication, available radar data as well as the results of a test of the ILS-system conducted shortly after the occurrence. SNH put all documentation with regard to the flight as well as all parts of the Operations Manual and the Flight Manual of the S-61N to the Boards disposal for the purpose of investigation.

After the initial investigation all management employees and various other employees, including instructors and helicopter pilots of SNH were interviewed, during two days, by four investigators, two of the Safety Board, one of the AIG of the VNV and one specialist in business administration hired from KPMG. Statements of interviewees are reproduced anonymous as much as possible. With regard to the management team, on some occasions the position has been mentioned. This has been done when apparently a personal view or statement was involved. On the remaining occasions reference is made to the management team.

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[23] Directive 94/56/EG of the Council of the European Union establishing the fundamental principles governing the investigation of civil aviation accidents and the International Standards and Recommended Practices of Annex 13 “Aircraft Accident and Incident Investigation” of the International Civil Aviation Organization (ICAO).

It must be emphasized that the description of the SNH-organization was made as existed during and shortly, after the investigation. In the course of the investigation SNH was merged into CHC-Helicopters and a reorganization was implemented. Also various procedures were changed.

Further investigation and formulating the report has been accomplished by an investigator of the Safety Board and another investigator of the VNV. This investigator also was a member of the AIG of the VNV and in the past has been an S-61N pilot. The AIG acts independent of the remaining activities of the VNV. All external investigators acted under the responsibility of the Dutch Safety Board.

Apart of examination by the Safety Board investigators involved, the CVR data also have been presented to an aviation psychologist. This psychologist had an extensive experience as an operational helicopter pilot in the Dutch Royal Air Force.

GTP-test
After it was found out that the data originating from the FDR-part of the CVFDR were unreliable, a Ground Test Procedure (GTP) was performed in a period of three days, by an investigator of the Safety Board in cooperation with the manufacturer of the CVFDR. On that occasion the errors were identified and by means of these figures conversion factors calculated that enabled the determination of reliable data. The conduction of this test has been detailed in this report.

On request of the investigators of the Safety Board, the Transport and Water Management Inspectorate the Netherlands, Flight Operation Inspectorate (IVW-DL), put the copies of audit- and inspection reports regarding SNH to the boards disposal. In connection with these reports some employees of IVW were interviewed.

Draft report
The draft report regarding this occurrence has been presented to the Aviation Committee of the Safety Board in various stages. Following the observations made, further investigation has been conducted and the report amended.

After the Aviation Committee had approved the draft report it has been assessed by the management team and the members of the Dutch Safety Board.

Perusal
In accordance with the legal requirements, the draft report, excluding the consideration and recommendations, subsequently has been sent to the persons involved for perusal. Persons involved were: both pilots, CHC (former SNH), the Minister of Transport and Public Works, Transport and Water Management Inspectorate, and the Commander of Naval Air Station “De Kooy”.

Comment on the draft report
The Safety Board did incorporate the comment of the persons involved in the definitive final report if appropriate. With regard to the comment that not has been adopted by the Safety Board the parties involved received a motivation in writing.

The actual comment that not has been incorporated, addresses the issues as outlined below:

The pilot in command
- The pilot in command indicated that he exclusively conducted radio conversation with radio operators of the oil companies. This conversation is less formal and by listening out to various radio stations at the same time it is possible that a call will be missed. Furthermore he indicates that usually radio traffic is so intense that from time to time a message could be missed and that this has nothing to do with casualness. Furthermore he has doubts about the competence of the psychologist with regard to off shore flights.

  Reaction Safety Board
  The aviation psychologist did listen to and analyzed the radio conversation and came to the conclusions that are detailed in the report. In the analysis of the investigation report these conclusions are differentiated by incorporating them in the general description of the flight execution. The Safety Board has no reason to dispute the competence of the psychologist.

- The pilot in command challenges the view point that he failed to take initiative after the occurrence

  Reaction Safety Board
  The report indicates that the pilot in command fails to provide instructions aimed at actions dealing with the incident properly and that the first officer provides suggestions which are approved by the pilot in command. This is not a conclusion but a description of the conversation that was held. In the analysis is concluded that this partly stems from the crew concept that is utilized by SNH.

The first officer

- The first officer indicates that approaches with 70 kt are conducted.

  Reaction Safety Board
  This argument has not been adopted because it concerns off shore approaches having a different profile compared to on shore approaches, which are discussed in the report.

- The first officer indicates, that in his opinion procedures and checklists were followed. His personal experience was that the manner how to deal with procedures and checklists differed with each person.

  Reaction Safety Board
  Failing to follow procedures and checklists was observed frequently during interviews. This was one of the reasons why Maasvlakte pilots also had to operate in Den Helder. Furthermore it emerges from the CVR-conversations that, during the flight under consideration, deviations were made from procedures and checklists not followed.

Schreiner Northsea Helicopters (SNH)

- SNH made a lot of comment as a result of its perusal of the report. These observations concerned the text as well the substance of the report. A large part of these items has been adopted. The most significant observations that were not adopted in the report are specified below:

- SNH questions if the helicopter touched the water.

  Reaction Safety Board
  Both pilots stated definitely that the helicopter touched the water. Furthermore the light splash can be heard on the CVR tape. Interviewing fishermen at the Waddenzee is considered to be irrelevant

- SNH opposes the view that the validity of the CRM training of the pilot in command was exceeded because of a transitional arrangement. As a result, the term of validity of the CRM would have been extended with a year. This could be concluded from a letter provided by IVW. Furthermore SNH indicates that the pilot in command was planned to undergo his CRM training before 1 December 2004.

  Reaction Safety Board
  According to the schedule provided by SNH during the investigation, the validity of the CRM training of the pilot in command was exceeded as from 6 November 2003. The letter from IVW could not be retrieved. Nevertheless the Safety Board accepted the existence of a transitional arrangement. In that case the validity of the CRM training would be exceeded as from 6 November 2004, as is indicated in the report. Since the accident occurred on 30 November 2004, at that moment the validity of CRM training was exceeded.

- SNH indicates that IVW had approved the organization of the post holderships.

  Reaction Safety Board
  The report indicates that IVW approved the double post holdership but that afterwards it considered it undesirable.

Transport and Water Management Inspectorate the Netherlands, Flight Operation Inspectorate (IVW)

- IVW observes that air traffic control played a role because they failed to offer a full ILS-procedure but assigned a shortened approach procedure.

  Reaction Safety Board
  Air traffic control indeed offered unrequested a shortened approach whereas the crew assumed to execute a 'full ILS'. As described in the report, conducting a shortened approach was a normal procedure and therefore within the crews expectations. Under the existing weather conditions a full instrument approach would have been preferred but in the Safety Board's opinion the final decision is with the crew; if they had preferred to conduct a full instrument approach a request could have been made to do so.

- IVW considers the fact that the validity of the CRM training of the PNF was exceeded, a matter of high significance. The line check appeared to be valid.

  Reaction Safety Board
  It is the Safety Boards opinion that the exceedence of the validity of the CRM training with 24 days probably did not affect the cause of the occurrence. The conclusion that the PNF formally was not allowed to fly, is correct.

Navy Air station 'De Kooy'

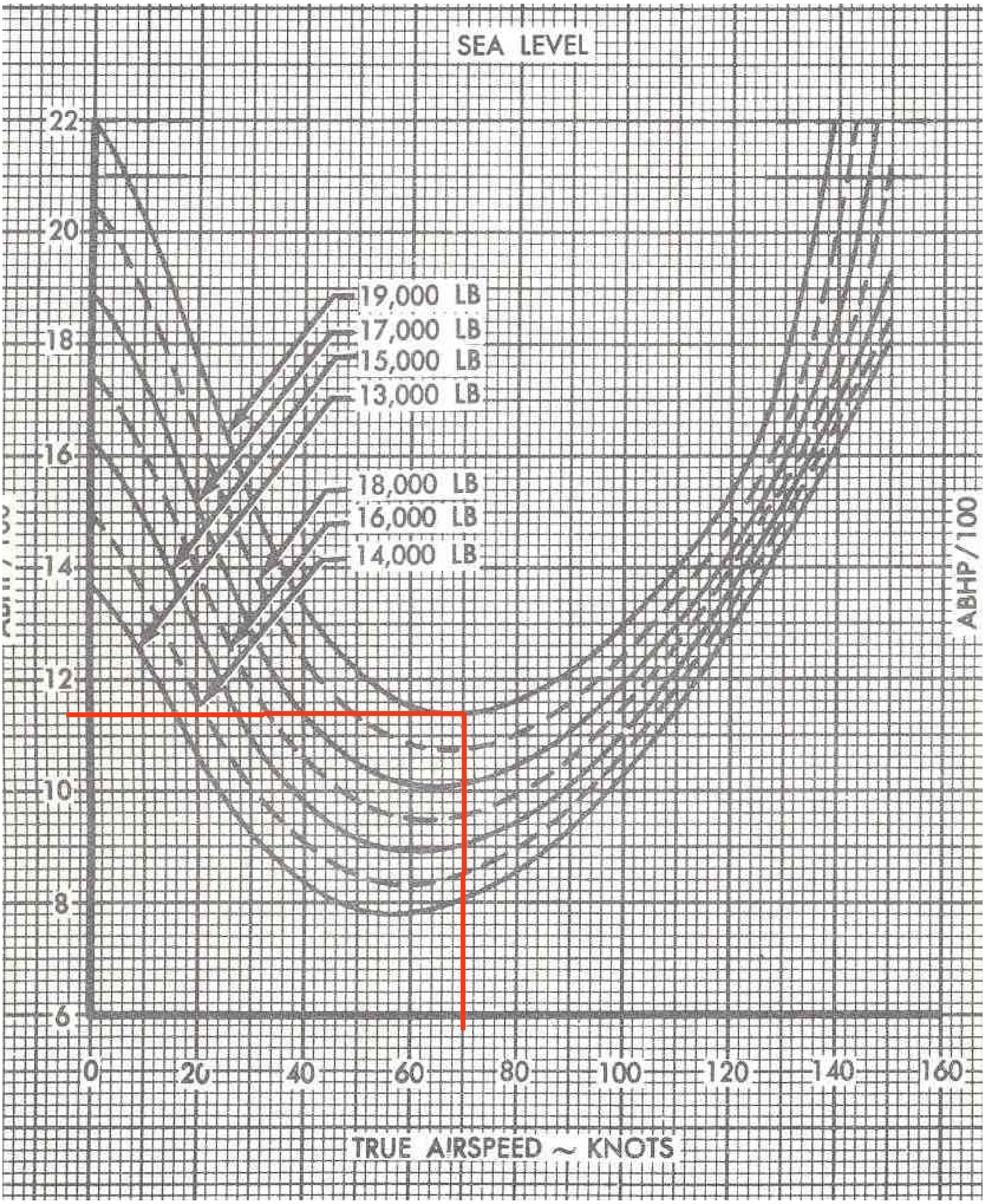
From the commander of Navy Air Station 'De Kooy' no response was received.

Subsequently after the amended report was assessed again by the Aviation Committee it was, after incorporating some alterations, finally presented to the members of the Board. After incorporating the comment of the members of the Board subsequently the report was published.

From various sides criticism was received with a view to the time that was needed for processing the report. The Safety Board is aware that the publication of the report kept a long time. This is a result of various factors.

The investigation had been initiated by the Transport Safety Board. As noted earlier this Board was transferred into the Dutch Safety Board on 1 February 2005. This reorganization took a large amount of time and energy which was to the detriment of current investigations. Furthermore a large back log of investigations of aviation accidents and –incidents to be finalized has built up which, as a result of fresh incidents and accidents and the limited investigation capacity, hardly could be eliminated. Finally the investigation of the fire accident at Schiphol took a large amount of personnel capacity of the Safety Board. This capacity could not be utilized for other investigations such as the investigation of SNH. Consequently the investigation was conducted for the greater part by one investigator and for another part assistance was received from an investigator of the VNV.

APPENDIX B: POWER CURVE S-61N



APPENDIX C: DESCRIPTION OF THE AFCS-SYSTEM

AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS).

The automatic flight control system (AFCS) is designed to maintain the stability of the helicopter in its reference pitch and roll attitudes about the reference directional heading. The automatic flight control system used in this helicopter differs from the autopilot used in fixed-wing aircraft in that it may be engaged at all times, has less authority than the primary flight control system, and is easily overridden through normal use of the flight controls. The pilot has direct control of the system at all times and can engage or disengage the entire system by switches located on the control panel and the cyclic stick grips, or engage and disengage individual channels by switches located on the channel monitor panel. Attitude and directional stabilization is controlled through the pitch, roll, and yaw channels. In the pitch and roll channels, the fuselage attitude is held constant by means of signals received from the vertical gyro. Automatic pitch and roll attitude stability correction occurs any time the helicopter is displaced from the reference attitude. In the yaw channel, the helicopter heading is held constant by signals received from the compass system. While the pilot establishes a reference heading by use of the tail rotor pedals, the yaw channel is placed in a synchronizing mode (no heading correction signal is developed) until pedal pressure is relaxed. During the synchronizing mode, the yaw rate gyro develops a signal proportional to the heading displacement rate of the helicopter. This signal initiates an open-loop spring condition that produces a proportional feedback force at the rotary rudder pedals. As the helicopter turns, the pilot will have to exert a pedal force proportional to the rate-of-turn to overcome the feedback force opposing the applied tail rotor pedal pressure. The feedback force remains until the pilot has established the new reference heading and pedal pressure is relaxed. Heading stability correction occurs any time the helicopter is displaced left or right from the desired reference heading. The system utilizes both AC power from the AC essential bus and DC power from the DC bus. Both AC and DC circuits are protected by appropriately marked circuit breakers.

AUTOMATIC FLIGHT CONTROL SYSTEM CONTROL PANEL.

The automatic flight control system control panel, marked AFCS CONT, is located on the cockpit console between the pilot and copilot. Controls consist of an engage button marked AFCS ENG, a null indicator, a yaw trim knob marked YAW TRIM, a meter selector switch with marked positions P, R, and Y, and a cg trim knob marked CG TRIM. The A position is inoperative as only provisions are made for altitude stabilization. The BAR ALT ENG and OFF buttons are also inoperative for the same reason. The AFCS ENG button is equipped with a light to indicate engagement, and is depressed to engage the pitch, roll, and yaw channels. Once engaged, the entire automatic flight control system can be disengaged by depressing the button marked AFCS REL located on the pilot's and copilot's cyclic control stick grips. The null

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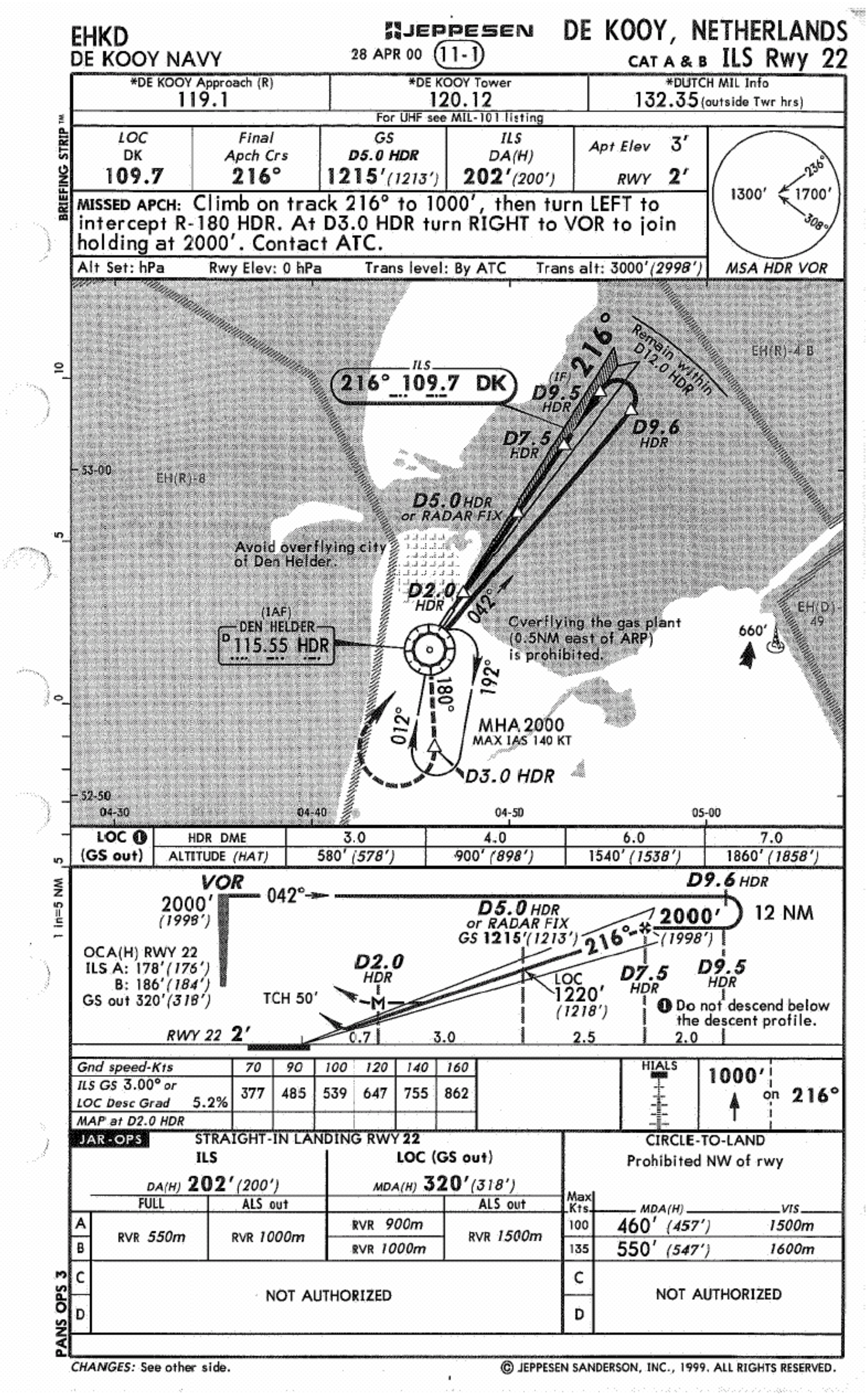
indicator provides visual reference of the channel selected (P, R, Y) on the meter selector switch. The YAW TRIM knob permits the pilot to accurately trim the heading of the helicopter, provided the pedal pressure is less than 2 pounds. One rotation of the knob turns the helicopter 72 degrees. The channel selector knob is used to select a channel to provide signals to the null indicator for visual references. During flight, the channel meter switch should be in the P position to aid in adjusting the CG trim knob for actual cg location. The CG trim knob is used to null the indicator after the pilot has corrected with cyclic trim for CG shift.

CHANNEL MONITOR CONTROL PANEL.

The channel monitor control panel, marked CHANNEL MONITOR, is located on the cockpit console. The controls consist of four toggle switches marked PITCH, ROLL, COLL, and YAW, under the general heading CHANNEL DISENGAGE, with marked position ON and OFF. The guarded toggle switch marked COLL is inoperative as provisions are only provided for barometric altitude stabilization. These toggle switches permit individual disengagement of the pitch, roll, and yaw channels of AFCS. They are usually left in the ON position except when the pilot wishes to disengage a malfunctioning channel. Directly below the toggle switches are guarded three-position switches, under the general heading HARDOVER, that are only used to check system authority during a ground operational check-out. The PITCH switch has marked positions FWD and AFT, and the ROLL and YAW switches have marked positions LEFT and RIGHT. Each switch may be placed in a position to check the corresponding PITCH, ROLL, or YAW channels of AFCS. When the switch guards are closed, the switches are held in a center position and the hardover system is inoperative. The switch guards must be lifted before override checks can be accomplished.

APPENDIX D: APPROACH PLATE RUNWAY 22



APPENDIX E: CVR TRANSCRIPT BETWEEN PH-NZG AND "DE KOOY"

TRANSCRIPT INCIDENT SCHREINER03
datum : 30 november 2004

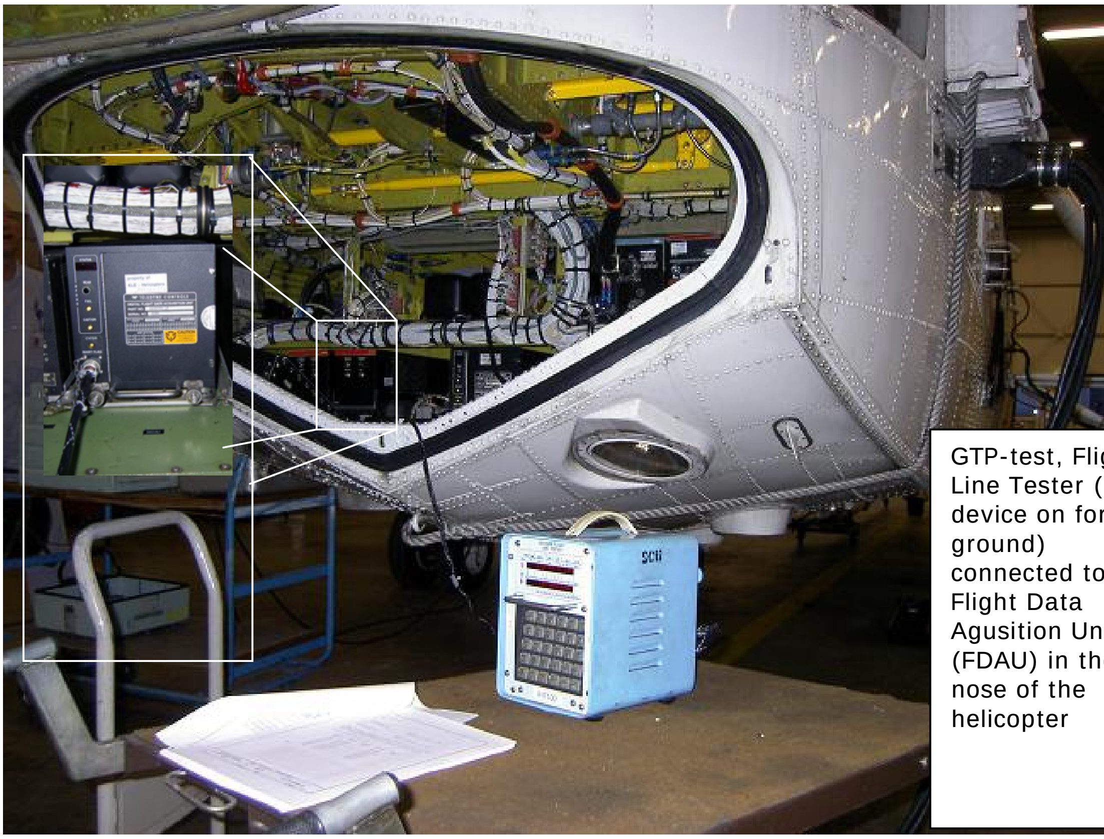
Lokale-tijden:

15.10.10	Schreiner03	: Approach , hello Schreiner 03.
15.10.15	De Kooy Approach	: Schreiner 03 goedemiddag, proceed to Tango 3000 feet, the QNH 1014, expect ILS runway 22.
15.10.20	Schreiner03	: Proceeding to Tango, expecting ILS runway 22 Schreiner 03.
15.10.25	De Kooy Approach	: Schreiner 03, how many persons?
	Schreiner03	uh That is uh 15.
15.10.30	De Kooy Approach	: Roger, the weather at the Kooy:The visibility is 700 meters in uh fogbanks , scattered at 100 feet, broken at 200 feet and the wind 130 with 6.
15.10.40	Schreiner03	: That's copied Schreiner 03.
15.15.25	De Kooy Approach	: Uh, Schreiner 03, descent to altitude 2000 feet and after Tango fly heading 130.
15.15.30	Schreiner03	: Descending to 2000 feet after Tango heading 130. Schreiner 03.
15.16.00	De Kooy Approach	: Schreiner 03, RVR runway 22 is 800 meters.
	Schreiner03	: That's copied Schreiner 03.
15.18.00	De Kooy Approach	: Schreiner03, descent to 1200 feet and stear heading 140.
15.18.05	Schreiner03	: Stear heading 140, descent to 1200, Schreiner03.
15.18.10	De Kooy Approach	: RVR is 700.
	Schreiner03	: Copied.
15.19.25	De Kooy Approach	: Schreiner03, over right heading 190 to intercept, cleared for the approach report established.
15.19.30	Schreiner03	: Right 190, cleared approach. Roger Schreiner 03.
15.20.25	De Kooy Approach	: Schreiner03, in event of a missed approach climb straight ahead 1000 feet, standby further instructions.
	Schreiner03	: In event of a missed approach straight ahead 1000,standing by.
15.21.20	De Kooy Approach	: Schreiner03 is established?
	Schreiner03	: Affirm established.
15.21.25	De Kooy Approach	: Schreiner03, roger call the tower 120.12.
15.21.30	Schreiner03	: 120.12, bye bye.
	De Kooy Approach	: Bye.
15.21.35	Schreiner03	: Tower, hello, Schreiner03, established ILS 22.
15.21.40	De Kooy Tower	: Schreiner03 goedemiddag, the wind 130/8, cleared to land runway 22, taxi approved.
15.21.45	Schreiner03	: Cleared to land 22, taxi approved,Schreiner03.
15.24.35	Schreiner03	: uh Tower, Schreiner uh 03 we are having a mishap and uh we uh coming in for landing. Everything is oke. We do, we like to have uh the gear checked.
15.24.50	De Kooy Tower	: 03 approved in front of the tower.
15.24.55	Schreiner03	: In front of tower.
15.25.25	De Kooy Tower	: 03, Tower*
	Schreiner03	Yeh 03?
15.25.30	De Kooy Tower	I observe uh 3 uh wheels.
	Schreiner03	Ok that's copied.

APPENDIX F: PERFORMANCE GTP-TEST

CONDUCT

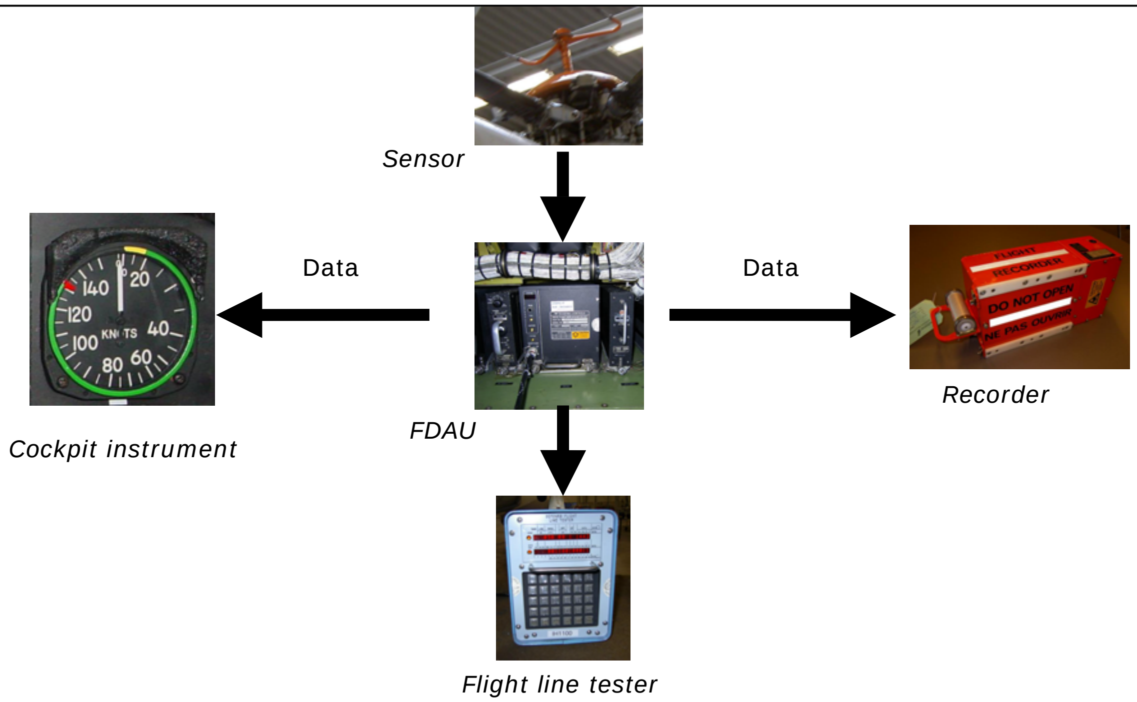
The primary purpose of the GTP-test, conducted by the Safety Board was to establish the relation between recorded data and reality. What did the instruments indicate and which movements were made by the helicopter. Since SNH did not have any experience in conducting a GTP-test, on request of the Safety Board assistance was provided by Teledyne.



GTP-test, Flight Line Tester (Blue device on fore-ground) connected to the Flight Data Agusition Unit (FDAU) in the nose of the helicopter

Totally 63 parameters are recorded by the CVFDR including 25 discretes (on or off). Some of the 63 parameters are required by legislation. Within a period of three days all recorded parameters have been checked.

The GTP-test is conducted utilizing a device (Flight Line Tester) that is connected to the Digital Flight Data Acquisition Unit (DFDAU) the so called mother computer. The flight line tester visualizes the binary data that are delivered by the DFDAU to the flight data recording equipment. Because the deflection of the instrument is known, a relation can be made between the observation by the pilot in the cockpit and the registration of the flight recorder. With this relation a conversion for each parameter can be produced. All conversions are together registered in a document, Engineering Unit Conversion (EUC) document and used to analyse the flight recorder data.



Schematic overview of the relation between sensor, cockpit instrument, FDAU and the recorder (CVFDR). De flight line tester visualizes the data the FDAU delivers to the CVFDR. This enables establishing a representation conversion for the particular cockpit instrument that can be used to analyze the recorder data.

GTP-TEST OBSERVATIONS AND CONCLUSIONS

Indicated airspeed (IAS)
The conversion of the IAS appeared not to match with EUC documentation of Teledyne. This applied for the PH-NZD as well.

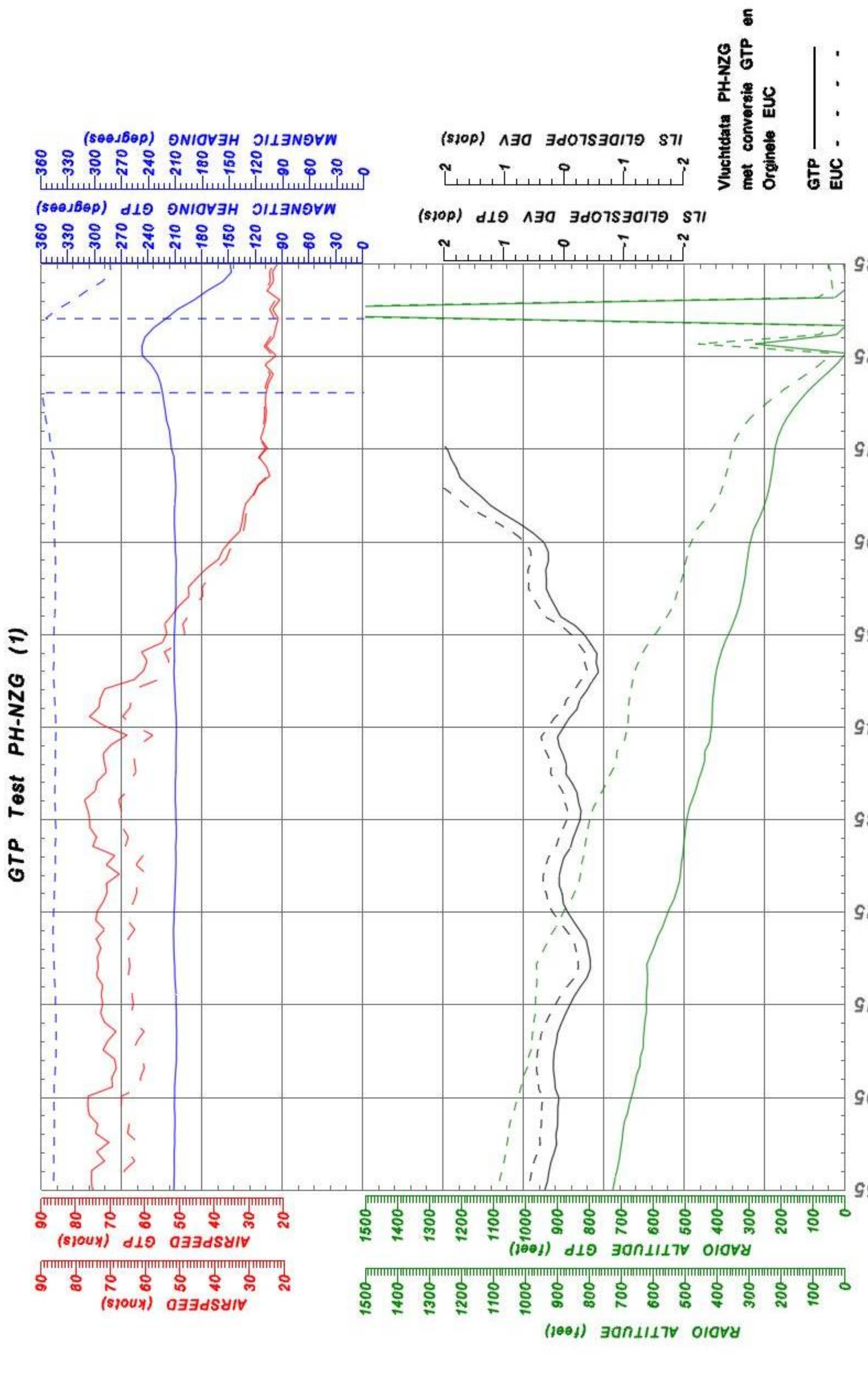
Controls
The extend of the range of the sensor for the lateral Cyclic as well as the Tail rotor pedal appeared to be too large, the EUC conversion for this parameter appeared not satisfactory. The signals of the Collective Pitch appeared to be reversed. This had been observed already after scrutinizing the certification documentation and comparing the movements of the collective with the movements of the helicopter. This confirms the conclusion that the wiring of the sensor had been connected incorrectly as from the time of its installation. Furthermore the GTP-test showed that the range of the sensor failed to match up to the conversion documentation.

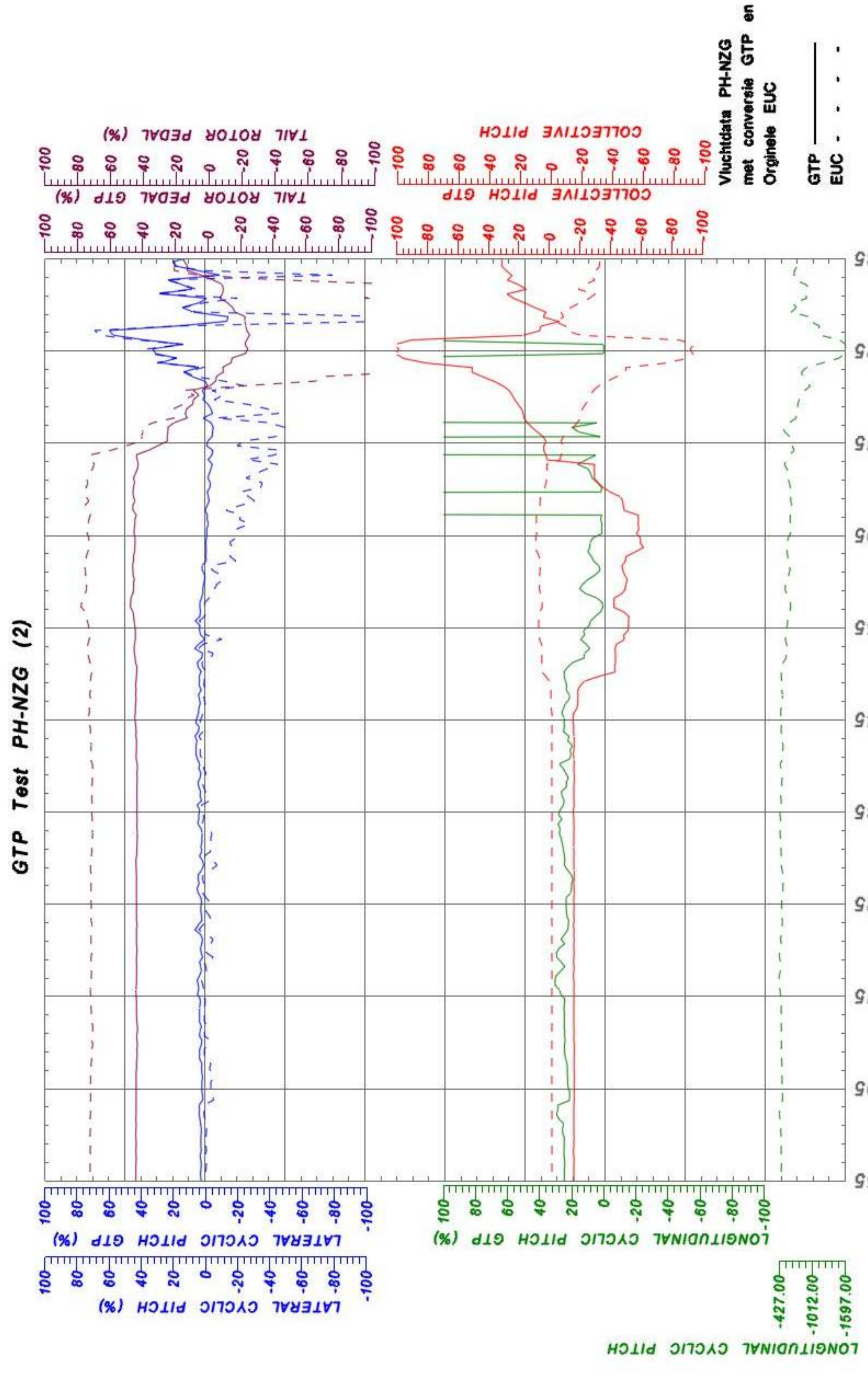
Radio Altitude (RA)
During the GTP-test the radio altitude conversion appeared not to be linear.

Yaw rate gyro (YRG)
During the GTP-test, the Yaw Rate Gyro appeared to fail and was repaired. Subsequently the sensor operated according to specifications.

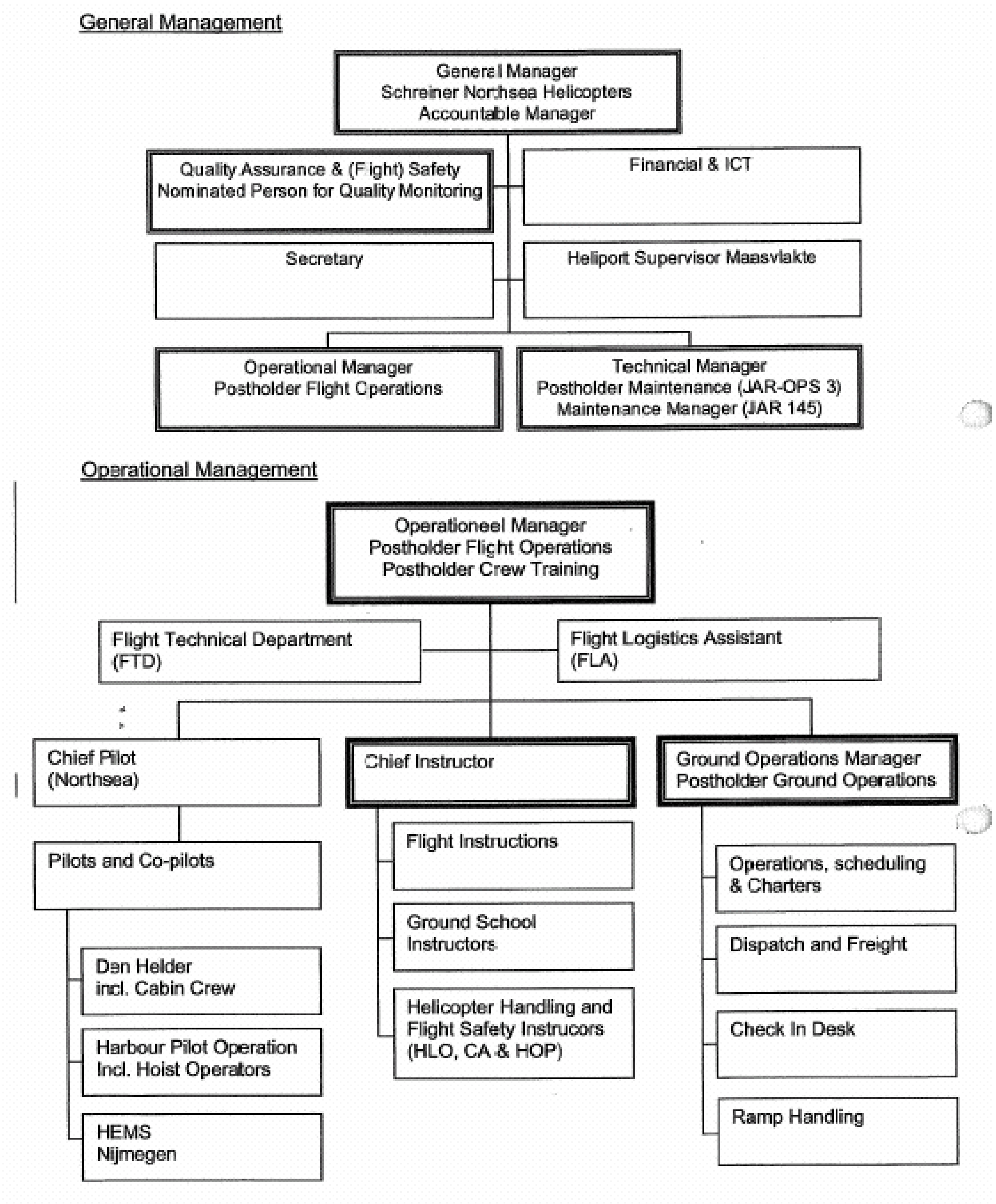
Discretes (on/off)
Three discretes, landing gear in transit, bleed air #1 and #2 appeared to be connected incorrect. An overview of the observed indications are shown in a table. Furthermore a diagram of the differences between the original (EUC) and the actual (GTP) conversion is attached.

Parameter	Problem	Conclusion
IAS	Sensor recorded lower values then required by documentation	Conversion incorrect
Radio Altitude	Sensor recorded the altitude change, however the conversion was not linear as required by documentation	Conversion incorrect
Yaw rate gyro	Sensor failed to operate during GTP test	Defect
Lateral Cyclic	Sensor range larger than required	Defect, conversion incorrect
Longitudinal Cyclic	Deflection of cyclic was outside range of sensor	Defect
Tail rotor pedal	Sensor range larger then required	Defect
Collective Pitch	Deflection reversed. Sensor range differed	Defect, conversie incorrect
Heading	Conversion in original documentation of Teledyne incorrect, SNH had the correct conversion	Conversion unclear
ILS	Visual representation to pilot not matching up with conversion	Conversion incorrect
OAT	Conversion in original documentation of Teledyne incorrect, SNH had correct conversion	Conversion unclear
Landing gear in transit	Discrete reversed, wiring connected incorrectly	Conversion incorrect
Engine #1 Bleed air valve	Discrete reversed, wiring connedted incorrectly	Conversion incorrect
Engine #2 Bleed air valve	Discrete reversed, wiring connedted incorrectly	Conversion incorrect


GTP Test PH-NZG (1)
MAGNETIC HEADING (degrees)
MAGNETIC HEADING GTP (degrees)
ILS GLIDESLOPE DEV (dots)
ILS GLIDESLOPE DEV GTP (dots)
Vluchtdata PH-NZG
met conversie GTP en
Orginele EUC
GTP
EUC
AIRSPEED GTP (knots)
AIRSPEED (knots)
RADIO ALTITUDE GTP (feet)
RADIO ALTITUDE (feet)
14:21:55
14:22:05
14:22:15
14:22:25
14:22:35
14:22:45
14:22:55
14:23:05
14:23:15
14:23:25
14:23:35
TIME GMT (hh:mm:ss)


GTP Test PH-NZG (2)
Vluchtdata PH-NZG met conversie GTP en Orginele EUC
GTP
EUC
TAIL ROTOR PEDAL (%)
TAIL ROTOR PEDAL GTP (%)
COLLECTIVE PITCH
COLLECTIVE PITCH GTP
LATERAL CYCLIC PITCH GTP (%)
LATERAL CYCLIC PITCH (%)
LONGITUDINAL CYCLIC PITCH GTP (%)
LONGITUDINAL CYCLIC PITCH
-427.00
-1012.00
-1597.00
14:21:55
14:22:05
14:22:15
14:22:25
14:22:35
14:22:45
14:22:55
14:23:05
14:23:15
14:23:25
14:23:35
TIME GMT (hh:mm:ss)

APPENDIX G: ORGANIZATIONAL DIAGRAM OF SNH



(Source: Operations Manual Part a SNH)

APPENDIX H: CREW RESOURCE MANAGEMENT (CRM)

Purpose of Crew Resource Management
Human failure can be accounted for in 70% of all aviation accidents. The purpose of Crew Resource Management is to improve safety and efficiency aboard an aircraft with a multi crew cockpit and prevent human error to cause an accident. By means of courses the topics of human behaviour are clarified. The courses must be adapted to the company culture and the nature of operation of the airline company. By means of theory, examples from actual practice and case studies, persons engaged in air transportation are stimulated to implement these topics in daily practice. It goes without saying that during test- and check flights, the actual implementation of CRM by crews during flight operation, is assessed.

CRM is not effective if only one crew member is motivated to implement a good CRM practice. It must be supported by all crew members during flight operation. Furthermore it is the companies prerogative to create an atmosphere that also includes CRM on the shop floor, before and after flight. CRM does not stop after shutting down the engines. CRM affects all aspects of flight operation, and therefore includes flight preparation and administration and also all management levels which primarily are engaged in flight preparation -execution and -administration.

Contents of Crew Resource Management training
Operating aboard an aircraft/helicopter where duties are divided between more then one crew member, requires an accurate cooperation and harmonization. The major part of a crew members training put an emphasis on flying skills and knowledge of procedures, on board as well as in the air. However operating aboard an aircraft/helicopter not merely concerns the managing of technique and procedures, but just as much, the interaction with colleagues. This plays a major role in the large percentage of aviation accidents that are caused by human behaviour. It concerns the wrong interpretation of information, making the wrong decision, too late recognition of errors, conflicts between colleagues that are declared or not etc.. During Crew Resource Management courses the factors affecting our daily performance are clarified. By means of providing theoretical knowledge, discussing previous accidents and the exchange of experiences, the students learn how they, as a crewmember, affect the safety on board.

During a Crew Resource Management Course the next issues are clarified:

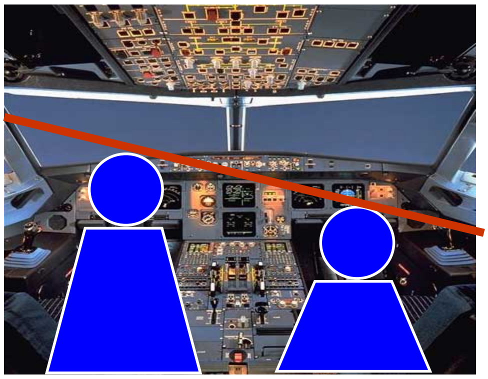
- Situational awareness. An extensive introduction of the limitations of the human brain and the consequences of these limitations in daily practice.
- Human error. What is the reason of people causing errors during their work. Can human error be categorized. Can they be counteracted. All these questions are answered.
- Communication. Communication is sometimes characterized as the cement of CRM. Communication affects all other issue's. The do's and don'ts of communication inside the cockpit and outside, are clarified extensively.
- Stress. What exactly is stress. How does it affect your body, what does it mean to your performance. What to do about it and how to prevent it.
- Group dynamics. Each individual lives in an environment affecting each others behaviour to a certain extend. A small selection of some sociological theories.
- Leadership. What is the leaders role and how essential is leadership in aviation?
- Decision making. Each decision is the result of a process. Sometimes this decision making process is allowed the time it requires, however aviation is distinguished by an ever present time pressure. This could have a negative effect on the quality of your decision unless you are trained to manage it in stressful situations.

CRM and the company culture
The way the crew deals with CRM is merely an expression of how the company deals with CRM. CRM is not about competence. CRM is about an approach, a style of work with an interpersonal character. A style of work is affected by company culture to a considerable extend. Style of work and company culture are interconnected inextricably. For further clarification, the theory of Edgar H. Schein can be utilized. This theory will be elucidated below.

*Authority gradient and style of leadership**

The figures depicted below clarify the meaning of the authority gradient. With a view to this authority gradient, three different situations are distinguished:

- autocratic cockpit
- laisser-faire cockpit ;
- Synergetic cockpit (ideal situation)



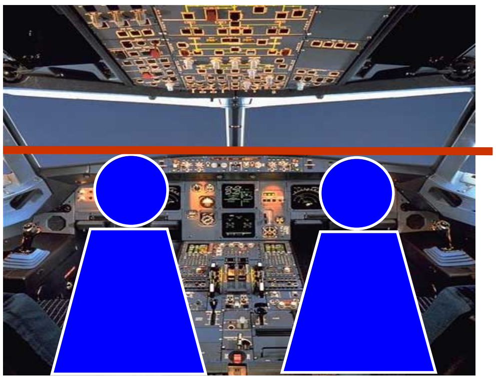
The autocratic cockpit

The autocratic cockpit is identified by the pilot in command:

- deciding and proposing decisions without consultation
- not considering the opinions and points of view of the rest of the crew
- delegating rarely
- making irrelevant observations
- not listening to and isolating from the rest of the crew.
- considering suggestion of others as critique or insubordination
- creating a tense and non-communicative atmosphere in the cockpit

This scenario can occur if:

- the pilot in command seeks to camouflage his/her uncertainty
- a large gap exists between the seniority and knowledge of the pilot in command and the first officer
- the pilot in command has a dominant character and the first officer cannot cope with it



The laisser-faire cockpit

* Extract from Oxford Aviation Services ATPL Training Manual “Human Performance and Limitations” issued by Transair (UK) Ltd, Shoreham, England, 2004.

The laisser-faire cockpit is the other extreme. This situation is identified by the pilot in command:

- staying passive
- leaving other crew memberst to take decisions
- providing little suggestions
- making positive nor negative observations
- encouraging a relaxed atmosphere by discussing irrelevant subjects
- who has the objective to accommodate the rest of the crew

This situation threatens to occur if a pilot in command cooperates with competent pilots and flight engineers. The consequences of the laisser-faire cockpit are clear. Either the vacuum is filled up by another crew member, taking the role of leader, or everyone continues to operate individually, according to one's own plan, without informing each other. From this a "self-centred" cockpit originates creating the least synergy. In this context this cockpit situation is identified as the most dangerous.

The synergetic cockpit

The synergetic cockpit is the ideal situation. In this situation the pilot in command will:

- be a leader
- motivate other crew members
- recognise the need for development of skills for the rest of the crew
- aim for cooperation
- communicate clearly regarding purpose and expectations
- monitor the discharge of duties and give advice if required
- act in coordination during simultaneous occurrences
- listen to the rest of the crew members and consider every suggestion welcome
- make decisions with assistance of, and active participation of, other crew members.
- delegate duties and responsibilities
- exchange information and explains decisions taken
- will not exaggerate in involving people in order to prevent the need to show all their capabilities
- works on a positive and professional atmosphere in the cockpit during the entire flight
- openly compliment good performance
- discuss the flight afterwards with the complete crew and encourages everyone to provide suggestions for improvement.

APPENDIX I: TRIPOD ANALYSES