THE DUTCH SAFETY BOARD

Emergency landing Bristow AS332L2 search and rescue helicopter

North Sea, near Den Helder, 21 November 2006

EMERGENCY LANDING BRISTOW AS332L2
SEARCH AND RESCUE HELICOPTER
North Sea, near Den Helder, 21 November 2006

The Hague, (project number M2006LV1121-07)

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

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CONSIDERATION

Introduction

On the evening of Tuesday 21 November 2006 at 11.28 p.m. a helicopter of the Eurocopter AS332L2 "Super Puma" type, registration number G-JSAR, was forced to make an emergency landing in the North Sea, approximately ten nautical miles to the north-west of Den Helder. The four crew members and thirteen passengers were rescued from the sea after approximately 1 hour and carried to Den Helder using different means of transportation. One passenger was admitted to hospital with mild hypothermia symptoms but discharged after a few hours; the remaining occupants were uninjured.

The passengers came from production platform K15B belonging to the Nederlandse Aardolie Maatschappij (NAM). Because of a prolonged power outage ("black out") - which had started at 08.00 p.m. that day - they had transferred to the drilling platform adjacent to the K15B, the Noble George Sauvageau (hereinafter referred to as the Noble George). After the power outage on the K15B the work on the Noble George had been halted for some time, but was resumed when it became clear that no fire had broken out on the K15B - all the safety provisions on the Noble George were functioning properly. It was decided to take anyone not needed to work on fixing the power outage to the mainland, for which the Search and Rescue (SAR) helicopter G-JSAR was deployed. On the return flight the crew reported fluctuations in the engine revolutions, and there were also problems with the steering, following which the crew decided to make an emergency landing. The Coast Guard organised and coordinated the successful rescue operation.

In its investigation the Dutch Safety Board has divided the incident into three parts that are interrelated but required a different approach. These three parts are:
1. The removal of persons from the K15B production platform and the evacuation using the G-JSAR.
2. The flight of the G-JSAR and the emergency landing.
3. The evacuation of passengers and crew from the G-JSAR and the subsequent rescue action.

This investigation has taken too much time. However, the Board feels that its findings in this matter are of such a nature that, irrespective of the measures the parties involved have already taken, publication of its investigation report is still advisable. The recommendations the Board makes to the various parties involved remain relevant.

The removal of persons from the K15B production platform and the evacuation using the G-JSAR
If there is a power outage on the K15B a number of safety provisions, including the fire extinguishing system, will not function. To reduce the risk of fire in such cases an "Emergency Shutdown" is effected, which means full isolation of the platform and the release of the pressure. After 90 minutes the backup generators for, among other things, the emergency lighting, will also stop. In a power outage lasting more than three hours the fire and gas detection equipment will also cease to function. Under these circumstances the responsible officials of the NAM felt it was not safe to leave employees on the K15B that night. In view of the fact that both fire detection and fire fighting facilities on the K15B would eventually become unavailable the Safety Board supports this decision. The Board notes that the NAM had not assessed the risks for the employees in the event of a long-term power outage on the K15B in combination with the continuation of the work on the Noble George. The Board therefore makes a recommendation regarding this aspect to the NAM.

The fact that the decision to evacuate the K15B was justified does not automatically mean that the deployment of the G-JSAR rescue helicopter for this evacuation was also justified. The civil G-JSAR helicopter, hired from company Bristow by a number of offshore companies to perform rescue operations for personnel employed on the Dutch Continental Shelf, was specifically equipped for Search and Rescue (SAR) work. To perform these Search and Rescue activities the helicopter was also allowed to take off and land outside the regular daily transport hours. Not only was it equipped to operate and rescue people from the sea or evacuate people from ships or offshore installations under heavy weather conditions, it was also equipped to carry stretchers, for instance, for which some of the seating had been sacrificed. As a result the G-JSAR cabin only had four seats.

Search and Rescue operations tend to carry much higher risks than regular transport flights and are therefore only justified in true emergency situations. This elevated risk level was also the basis on which Bristow had obtained the flight licence for the G-JSAR from the British Civil Aviation Authority (UK CAA). In this licence the - conditional - risk-increasing exceptions to the normal rules for the SAR work (and for associated training flights) were formulated. For instance, for SAR missions a higher number of people were allowed on board than there were seats available.

The competent authority with regard to the British registration of the G-JSAR, the UK CAA, has confirmed that SAR situations within the definition of the licence must be considered to be acute emergency situations, as described in the definitions of "Search" and "Rescue" in Annexe 12 with the Chicago Convention. If, despite being specifically outfitted for SAR work, the G-JSAR were used for situations other than such acute emergency situations, the aforementioned exceptions to the normal rules would not apply and the normal rules for passenger transport would be in force.

The Safety Board has ascertained that on 21 November 2006 there was no emergency situation on the K15B and the Noble George that justified an SAR flight. There were no life-threatening conditions, nor was there an acute medical situation. In this case there was even the possibility of an overnight stay on the Noble George - but even if the latter had not been the case, the situation would not have demanded Search and Rescue, but regular transport. In view of the number of passengers to be transported alone (thirteen) it was not possible to realise such a normal transport flight with the use of the SAR-equipped G-JSAR. A "night reserve" helicopter for regular transport that could be deployed from Norwich Airport *would* have been able to carry out such a transport flight

Both the NAM and the Coast Guard have contributed to the unjustified deployment of the G-JSAR. The NAM was the formal requester of the assistance: the ultimate decision about the deployment of Search and Rescue is and remains the preserve of Coast Guard, even when it concerns the deployment of a civil helicopter hired by the NAM itself, like the G-JSAR. The NAM officials involved were not aware of the possibility of using a "night reserve" helicopter: they assumed that the only transport option at that time was a Search and Rescue transport. This is an important shortcoming on the side of the NAM organisation. With the unjustified SAR request the NAM acted in violation of agreements with fellow offshore companies and with the Coast Guard, according to which the deployment of the G-JSAR must remain limited to "emergency" situations, a term that corresponded with the aforementioned limitation to acute emergency situations and, in addition, only included medical evacuations. In its own investigation into the cause of this incident the NAM has already reached a similar conclusion, which has resulted in the fact that the agreements within the NAM regarding the deployment of SAR have been clarified and updated.
With regard to the Coast Guard, which was responsible for the formal decision to deploy Search and Rescue, the Safety Board has been forced to conclude that an evaluation as to whether this was in fact an emergency situation was not made at all. This contravened a number of rules and evaluation procedures, which required an actual mapping out of the need to use SAR. In this context the Board notes that in the case of a possible acute emergency situation it is of course not possible to postpone the Search and Rescue tasks until such time as the regulatory evaluations and associated bureaucratic actions have been completed. In many cases it will therefore only be possible to complete these evaluations once the mission is underway, after which it can be recalled if necessary. However, in this case there was no verification of the extent of a possible emergency situation at all - not even after the flight had departed. This means the Coast Guard has in fact reduced its function to that of a "middle man" between the NAM and Bristow, which does not correspond with its role of competent authority with respect to the deployment of Search and Rescue. It was the decision of the Coast Guard that was the determining factor as to whether the aforementioned exceptions for SAR flights (in acute emergency situations and medical evacuations) associated with Bristow's licence, applied in this case. This makes the approach of the Coast Guard, which may be classed as passive, even more conclusive. The Board must conclude that the Coast Guard did not handle the situation on the K15B responsibly and adequately. The Board recommends that the Minister of Defence ensures that henceforth the Coast Guard Centre complies with the evaluation procedures for the deployment of Search and Rescue.

The Board wants to make a further comment about the role of Bristow and the crew members of the flight in question. As the operator and the holder of the flight licence, Bristow was the official responsible party for ensuring that flights with the G-JSAR were realised in compliance with this licence. However, this responsibility must be clearly distinguished from the question whether it can be said that the captain of the G-JSAR, when faced with the decision of the Coast Guard to deploy the G-JSAR, should have refused to make the flight. The Board feels that the latter is not the case. After all, it is the task and the jurisdiction of the Coast Guard to evaluate the need for Search and Rescue. If the Coast Guard deems this need to exist then the Commander who is realising the flight is only authorised to make decisions in the interest of the safety of the flight within the framework of the Coast Guard's evaluation. The Commander was therefore not authorised to ignore the view of the Coast Guard with respect to the need for Search and Rescue. At a later stage the need for a flight *can* be evaluated.

The flight of the G-JSAR and the emergency landing

At 10.35 p.m. the G-JSAR left De Kooy Airport with the Commander, the co-pilot and the "rear crew", consisting of the winch driver and the winch man, on board. The outbound flight to the Noble George progressed normally. During the return flight the co-pilot was flying the aircraft. Shortly after the start of the flight the crew was experiencing a discrepancy between the engine revolutions of the two engines of approximately 5%, which both the Commander and the co-pilot experienced as abnormal and threatening. In practice the differences in engine revolutions do not normally exceed 1%.The Operations Manual of the Super Puma stipulates that only in the case of engine revolution discrepancies of 7.5% and higher a warning will be sounded, after which the intervention of the crew is necessary. Although there was no warning the crew members were of the opinion that action was needed. The co-pilot therefore deactivated a number of functions of the automatic pilot - the so-called upper modes - and took the aircraft down to a lower altitude. During the flight the discrepancy in the engine revolutions increased further and after some time warning signals sounded because the discrepancy exceeded 7.5%. Based on data analysis the Safety Board has determined that this increase was the result of the malfunctioning of the synchronisation systems of the engines. The Board was unable to establish a technical cause for this malfunctioning. It is clear, however, that together the engines were still supplying sufficient power to continue the flight, even after the discrepancy in the engine revolutions had increased. The Board therefore feels that it would have been preferable for the cockpit crew to continue the flight normally in the first instance. By descending they changed the stable flight situation and it became more complicated to evaluate the discrepancies in the engine revolutions.

In this context the Board observes that the Bristow Operations Manual does not provide adequate information about the situation that occurred at the moment the co-pilot decided to descend: a situation in which discrepancies in engine behaviour are observed that are greater than usual, but where there is not (yet) any question of a discrepancy in engine revolutions that is so high that a warning signal is sounded (between 1% and 7.5%). Eurocopter says that such small discrepancies in engine revolutions can still be considered normal system behaviour. The Board is of the opinion that Bristow should have ensured that the cockpit crew had access to this system knowledge. Without the aforementioned system knowledge, discrepancies between 1% and 7.5% may cause alarm among the cockpit crew, which can influence the decisions about the way the flight is continued. The Board recommends that Bristow should make an addition to the Operations Manual with respect to this point.

As the co-pilot continued to descend he reported problems with the steering. From that moment on the crew - logically so - did not pay further attention to the engine problems. Some minutes after he first noticed the steering problems the co-pilot reported that he was making an emergency landing because he was losing control of the helicopter. The Commander inflated the pontoons, which he had primed previously. The G-JSAR landed on the water. The Safety Board conducted a comprehensive investigation of the steering problems, but this investigation did not reveal any technical cause for these problems. No link with the abnormal engine behaviour was established. An expansion of the parameters for the flight data recorder of helicopters to include the steering forces, as used in some categories of fixed wing aircraft, could possibly provide more clarity in future regarding the cause of these kinds of problems. The Board makes a recommendation to this effect to the European Aviation Safety Agency (EASA).

At the moment when steering problems revealed themselves in addition to the problems with the engines, the crew of the G-JSAR was faced with a complex situation. The fact that it was night, and the weather conditions, also contributed to this situation. Although when taking all these factors into account the Board considers it understandable that the crew experienced a feeling of losing control of the situation, it is still of the opinion that the decision that an emergency landing was inevitable was made too quickly. There were only four minutes between the time the problems were first reported and the actual landing. In hindsight it cannot be ruled out that the quick decision to make the emergency landing impeded a proper evaluation of the situation. For instance, an attempt to reactivate the upper modes of the automatic pilot might have re-established control. Furthermore, a co-ordinated exchange of the steering between both cockpit crew members might have been valuable to determine the seriousness of the problem. All in all, the Board is of the opinion that the cockpit crew, although ultimately having made a successful emergency landing, did not show enough understanding of the situation. In this context the Board emphasises that the cause of this shortcoming can, to a large extent, be blamed on the training and instructions the crew received from Bristol.

The Board also notes that, not just with regard to training but also in a broader sense, it may be said that the quality and safety management with regard to the G-JSAR flight realisation within Bristow was not functioning adequately.

In this context the Board refers to the lack of sufficient feedback and evaluation of flight information, and the fact that there is too much overlap in the procedures for public transport on the one hand and Search and Rescue on the other hand. Audits performed by the UK CAA confirmed this picture. The Board therefore recommends that Bristow improve its safety management system.

The Board also notes that the training for abnormal procedures and emergency procedures in a realistic environment that the crew received was limited, both in scope and in quality. This training is provided using a simulator of French company Helisim. The Board notes that there are differences between the simulator and the actual type AS332L2 helicopter that are not permitted under European guidelines. The Board therefore questions the validity of the approval of this specific simulator for the highest level ('level D'), by the French Direction Générale de l'Aviation Civile (DGAC). The Board recommends that the DGAC reconsider this approval.

The technical investigation also made it clear that the guaranteeing of the permanent airworthiness of the Super Puma was not adequate. Eurocopter proved to be unable to recover past data on two similar steering problem incidents in helicopters destined for the Dutch Royal Air Force[1]. The Board therefore has some doubts about a system for the worldwide resection, registration and analysis of reports of incidents with Eurocopter products. In addition it also became clear that Eurocopter's own investigation capacity for the Super Puma is insufficient. The Board makes a recommendation to Eurocopter with respect to the point of incident investigation.

The evacuation of the G-JSAR and the rescue operation

The passengers only received limited communications regarding the evacuation of the G-JSAR. The cockpit crew did not notify the passengers of the emergency landing by means of the Tannoy system. The rear crew members, who were in touch with the cockpit crew via the intercom system, *were* aware of the imminent emergency landing, but were unable to inform the passengers verbally because of the engine noise. Attempts by the rear crew to inform the passengers by means of, among other attempts, hand gestures, were not successful. As a result of all this the passengers were unable to put on their full survival kit in advance and neither were they able to prepare themselves for the actions required to evacuate the helicopter. The Board feels that, irrespective of the problems with the audibility of the Tannoy system, it is incomprehensible that no warning about the emergency landing was issued via that system at all. In the Board's opinion a brief warning is always helpful, and especially a briefly worded signal, provided it was pronounced loudly and clearly, was likely to have been heard in the cabin. This would have given the passengers more opportunity to prepare for the emergency landing and evacuation.

After the emergency landing the rear crew was concerned that, as a result of the strong winds and heavy seas, the helicopter would quickly capsize. Consequently the rear crew urged the passengers to jump into the water immediately, and the crew did the same. In fact, the evacuation was started even before the main rotor of the helicopter had come to a complete standstill, and without the Commander having authorised this course of action. According to the Bristow Operations Manual the conditions were such that a landing without capsizing was still just within the operational parameters (among others, category-4 seas). In fact, the helicopter remained afloat for a further eight hours. If there is no direct danger of capsizing after a landing on water there is sufficient time to leave the helicopter in the prescribed manner immediately into the life rafts, which considerably increases the chances of survival at sea. However, the Board recognises that in this case, in view of the absolute darkness, it was not easy for the rear crew to predict with any certainty that the helicopter would not capsize. The Board is of the opinion that estimating whether or not a situation is within the operational parameters, even in special circumstances, is a subject that requires further attention in the form of information and training. Consequently the Board suggests that the British Civil Aviation Authority consider including information regarding the application of the aforementioned operational parameters in its guideline "Review of Helicopter Offshore Safety and Survival"[2], so that crews are better able to evaluate the chances of capsizing after a successful emergency landing.

The G-JSAR was equipped with two life rafts which were stored in the stabilisation floats and which, prior to the evacuation, could be launched with the aid of levers, so that passengers could leave the aircraft without getting in the water. These life rafts were the main contribution to improving the chances of survival of those involved. The G-JSAR was fitted with levers to launch the life rafts

1 Translator's note: It is assumed that the source refers to the Dutch Royal Airforce and 'Dutch' has been inserted to avoid any confusion for the reader.

2 The *Review of Helicopter Offshore Safety and Survival* (Civil Aviation Publication 641) incorporates all aspects relating to safety and survival for the occupants of offshore helicopters, in order to optimise the chances of survival after a helicopter accident at sea.

in three places: in the cockpit, on both sides of the exterior of the fuselage and in both stabilisation floats. None of the crew members used any of the levers prior to the evacuation. Once most of the passengers were in the water and the main rotor had come to a halt, the crew could still have launched the life rafts, but this didn't occur to them. Later attempts on the part of the rear crew to still launch the life rafts failed. The Board notes that the training the cockpit crew and the rear crew had received was not sufficiently focused on an evacuation like this one. Bristow has now revised and expanded the training programmes on this point. The fact that the life rafts were not launched is a point of concern to the Board: the consequences could have been serious. In retrospect the investigation by the Board also brought to light the fact that the mechanism for launching the left life raft was showing serious defects. The Safety Board has made interim recommendations to the EASA, the authority responsible for the certification of products fabricated by Eurocopter, about this fact. These recommendations were followed in the main outlines, after which Eurocopter took the appropriate measures.

The Board notes that the use of other rescue devices, such as the immersion suits, gloves, hoods and life jackets was not without problems either. This was partly the result of the lack of preparation for the evacuation and the hasty realisation thereof. The recommendations the Board makes to Bristow and the UK CAA are partly aimed at improving the use and handling of these rescue devices.

The Board has a final comment about the rescue operation. At the time of the accident there was a ship, the Arca, which was sailing by order of the Coast Guard, in the vicinity of the accident location. The ship arrived at the accident site approximately 30 minutes after the emergency landing. After the emergency call directly preceding the landing it took 32 minutes before the first Westland Lynx helicopter of the Royal Marine Corps took off for the location of the accident; it arrived seven minutes later. A second Lynx helicopter took off after 50 minutes and arrived six minutes later. A vessel of the Koninklijke Nederlandse Redding Maatschappij (KNRM), the Dorus Rijkers, departed 10 minutes after the emergency call and arrived at the site after 65 minutes. However, all the units involved managed to stay within or very close to the target arrival time of 60 minutes for these air and water-based units. Within one hour and 15 minutes after the emergency landing all 17 occupants of the G-JSAR had been taken to safety. This means the duration of the stay in the water of those involved was well within the maximum period of two hours accepted by the NOPEGA. The fact that the accident location was not very far from the De Kooy Airport, the closeness of the ship Arca and the fact that the G-JSAR could be located using its emergency transmitter contributed to the quick rescue.

Proportioning and acceptance of liability

The international regulations impose an obligation on member states to provide for Search and Rescue for aviation and seafaring, but do not lay down specific rules for the realisation of this obligation. In the Netherlands this task comes under the responsibility of the Coast Guard via the SAR Services Scheme 1994. The Scheme expressly also covers Search and Rescue tasks for the offshore industry. This means the realisation of Search and Rescue in the Netherlands formally comes under the government, also with respect to the offshore industry. Although the public Coast Guard joint venture does not realise this task on its own, the partners it works with are generally participants in the joint venture - one exception is the KNRM -, which means the task realisation does remain directly related to the Coast Guard. For instance, the Coast Guard generally uses helicopters from the Department of Defence. In this kind of situation it is, in principle, clear what everyone's task is, the coordinating role of the Coast Guard Centre speaks for itself and the lack of specific (international) regulations for the realisation of Search and Rescue activities and the associated supervision are not an immediate problem.

This is different when it comes to the phenomenon of "civil SAR". The G-JSAR, owned by private operator Bristow, was hired by the offshore companies. However, in the Netherlands the realisation of Search and Rescue activities is and remains a government task, and a phenomenon like "civil SAR" does not change the formal and exclusive authority of the Coast Guard on this point. The Coast Guard therefore had obtained the operational control of the G-JSAR. Such a situation, as we have seen in this case, results in two types of obstacles.

In the first place there is the *use* of SAR. As stated previously, this remains the formal preserve of the Coast Guard, but in the various agreements between the parties involved a provision had been made for the assessment on this point by the offshore companies, as they are closely involved. This active participation on the part of the offshore companies makes them, as it were, the simultaneous provider and receiver of the assistance: the attitude of the Coast Guard in this case, which may be considered passive with respect to this point, confirms this picture. Formally the handling of a request for Search and Rescue, other than the remaining transport for which the offshore companies are of course responsible themselves, is and remains the responsibility of the Coast Guard. In practice, however, the "civil SAR" did and still does find itself in a kind of vacuum, in which nobody appears fully and directly accountable for its use.

When we come to the actual deployment of SAR, the subject matter becomes the *realisation*. Here we encounter a second obstacle. For this aspect as well, the Coast Guard continues to have the formal full and final responsibility, but once again this was a case of a kind of "gap" in the acceptance of this responsibility - albeit that it was not the offshore industry but Bristow that played a role in this instance. After all, the actual Search and Rescue activities were performed by this company. The Board has concluded that the training Bristow provided for the crew fell significantly short, both with respect to the flight realisation and with respect to the subsequent evacuation. This has had serious consequences, resulting in the fact that those who were sent on a rescue mission ultimately had to be rescued themselves. It is the Board's opinion that in the case of an organisational structure like this one it is up to the Coast Guard, as the ultimate responsible party for the realisation of Search and Rescue activities, to verify the quality of the task realisation on the part of the party that is charged with the actual realisation of the Coast Guard's SAR task. The Board is aware that such involvement is in fact expressly excluded in the agreement the Coast Guard signed with another private party, the KNRM. Although in the case of the KNRM this exclusion has never resulted in problems, the Board remains of the opinion that the Coast Guard should not evade its responsibility for the quality of the realisation of Search and Rescue activities in this way. This is why the Board recommends that the Minister of Defence ensure that the Director of the Coast Guard can fulfil his responsibilities by ensuring that the Coast Guard has an evaluation system for the tasks it has been allocated and that are being performed by private third parties or otherwise. The Ministry of Transport, Public Works and Water Management has indicated that in 2009 steps have been taken to introduce a quality system for the Coast Guard.

The Board notes that during the investigation no procedures or reports were found in respect of the supervision of the Coast Guard by the responsible Ministries of Transport, Public Works and Water Management and of Defence. The results of the audit of the civil aviation industry that the International Civil Aviation Organisation (ICAO) completed in the Netherlands in 2008 have confirmed that the supervision, when it comes to SAR work, had not been given sufficient shape even with the coming into effect of the Decree Establishing a Coast Guard on 1 January 2007 and the associated appointment of a Board for the Coast Guard. On this point the Board makes a recommendation to the jointly responsible Ministers of Defence and of Transport, Public Works and Water Management. The Ministry of Transport, Public Works and Water Management has indicated that the supervision of the SAR tasks of the Coast Guard as part of the quality system is currently under development.

Recommendations

The Minister of Defence
The Board recommends that the Minister of Defence:
1. ensure that the Coast Guard Centre complies with the evaluation procedures for the *use* of Search and Rescue;
2. ensure that the Director of the Coast Guard accepts responsibility for the *realisation tasks* of the Coast Guard by providing a system for the evaluation of the quality thereof.

The Minister of Defence and the Minister of Transport, Public Works and Water Management
The Board recommends that, in line with the relevant finding from the audit conducted by the International Civil Aviation Organisation, the Minister of Defence and the Minister of Transport, Public Works and Water Management give shape to the supervision of the Dutch Search and Rescue activities and the realisation of these activities by the Coast Guard Centre.

Nederlandse Aardolie Maatschappij (NAM)
In addition to the evaluation of the risks of short-term power outages on offshore installations the Board recommends that the NAM map out and manage the risks of long-term power outages.

Bristow Helicopters Limited (Bristow)
The Board recommends that Bristow:
1. expand and optimise the training programme of (Search and Rescue) pilots with regard to the simulator training, the use of the "autoflight" system, evacuation and the use of rescue equipment;
2. describe in the Operations Manual how the cockpit crew should handle discrepancies of the engine revolution counts that do not result in a warning signal, as well as include a procedure for the use of the automatic pilot in non-standard situation;
3. adapt its safety management system in view of the shortcomings described in this report.

UK Civil Aviation Authority (UK CAA)
The Board recommends that the UK CAA consider including information regarding the application of the aforementioned operational parameters in its guideline "Review of Helicopter Offshore Safety and Survival", so that crews are better able to evaluate the chances of capsizing after a successful emergency landing. In addition it is advisable that this guideline provides solutions with regard to the smoothness of survival suits in combination with inflated lifejackets, so that survivors can be retrieved from the water more quickly.

Eurocopter
The Board recommends that Eurocopter ensure that all incidents involving its own products are reported to Eurocopter, that these reports are documented in a structural manner and analysed for the purpose of continued airworthiness, and that the company's own investigation capacity is focused on these tasks.

European Aviation Safety Agency (EASA)
The Board recommends that EASA consider expanding the parameters for the flight data recorders of helicopters to include the forces of the steering (*"control forces")*, as is the case in some categories of fixed wing aircrafts.

Direction Générale de l'Aviation Civile (DGAC)
The Board recommends that the French DGAC reconsider its approval for the use of the Helisim AS332L2 simulator for training helicopter crews to the highest level, 'level D', as the simulator differs from the type AS332L2 helicopter, which means it does not comply with the European requirements on this point.

Prof. Pieter van Vollenhoven
Chairman of the Dutch Safety Board

M. Visser
General Secretary

LIST OF ABBREVIATIONS AND EXPLANATIONS

A	Abbreviation	Explanation
	AAIB	Air Accident Investigation Branch
	ADELT	Automatically Deployable Emergency Locator Transmitter
	AFCS	Automatic Flight Control System
	AJS	Joint venture of Amec, Jacobs Engineering and Stork (contractors)
	ALARP	As Low As Reasonably Practicable
	AMC	Acceptable Means of Compliance
	ANO	Air Navigation Order
	AOC	Air Operator's Certificate
	AP	Autopilot
	ASC	Air Crew Safety Check
	ASR	Air Safety Report
	ATC	Air Traffic Control
B	BEA	Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile
	BHL	Bristow Helicopter Limited
C	CAA	Civil Aviation Authority
	CAC	Cabin Attendant Check
	CAP	Civil Aviation Publication
	CASEVAC	Casualty evacuation
	CAT	Commercial Air Transport
	CHC	Canadian Helicopter Corporation
	CO	Concurrent Operations
	COS	Concurrent Operations Script
	CRM	Crew Resource Management
	CRS	Certificate of Release to Service
	CS	Certification Specifications
	CVR	Cockpit Voice Recorder
D	DALPA	Dutch Airline Pilots Association
	DDP	Daily Drilling Program
	DECU	Digital Engine Control Unit
	DIFF NG	Engine RPM Rotor Difference
	DGA	Dangerous Goods Awareness
	DGAC	Direction Générale de l'Aviation Civile
E	EASA	European Aviation Safety Agency
	EBU	European Business Unit
	EC	European Commission
	ECAC	European Civil Aviation Conference
	ECT	Emergency Coordination Team
	EEJ	Emergency Exit Jettison
	ELT	Emergency Location Transmitter
	EMS	Emergency and Safety Equipment
	EOPs	Emergency Operating Procedures

	EP	Eurocopter Procedures
	EPE	Shell Exploration and Production Europe
	ERC	Emergency Response Coordinator
	ERT	Emergency Response Team
	ESD	Emergency Shutdown
F	FCU	Fuel Control Unit
	FDR	Flight Data Recorder
	FFLB	Free Fall Life Boat
	FSU	Flight Scheduling Unit
	ft	feet
G	GHOR	Regional Emergency Response Organisation
	GM	Guidance Material
	GOV	Governor
H	HAZOP	Hazard and Operability Study
	HCO	Head of Concurrent Operations
	HEMP	Hazard and Effect Management Process
	HSE	Health, Safety and Environment
	HUET	Helicopter Underwater Escape Training
	HUMS	Health and Usage Monitoring System
I	IAMSAR	International Aeronautical and Maritime Search and Rescue Manual
	ICAO	International Civil Aviation Organization
	IFR	Instrument Flight Rules
	IMC	Instrument Meteorological Conditions
	IMO	International Maritime Organization
	IRP	Incident Review Panel
J	JAA	Joint Aviation Authorities
	JAR	Joint Aviation Requirements
	JAR-OPS	JAR Operations
	JRCC	Joint Rescue and Coordination Centre
K	KNMI	Royal Netherlands Meteorological Institute
	KNRM	Royal Netherlands Sea Rescue Institution
	km	kilometre
L	LAPP	Life jacket Air Pocket Plus
	LJ	Life jacket
	LPC	License Proficiency Check
M	MCW	Manual Control Warning
	MEDEVAC	Medical evacuation
	MOPO	Matrix of Permitted Operations

N	NAM	Nederlandse Aardolie Maatschappij B.V.
	NCG	Netherlands Coastguard
	Ng	Engine gas turbine rotor RPM
	NM	nautical mile
	NMD	Navigation and Mission Display
	NOGEPA	Netherlands Oil and Gas Exploration and Production Association
	NOPs	Normal Operating Procedure
O	OCP	Offshore Contingency Plan
	OGP	International Association of Oil & Gas Producers
	OEI HI	One Engine Inoperative HIGH
	OEI LO	One Engine Inoperative LOW
	OIM	Offshore Installation Manager
	OPC	Operator Proficiency Check
	OPITO	Offshore Petroleum Industry Training Organisation
	OPPLAN-SAR	Operational Plan Search and Rescue
P	PFD	Primary Flight Display
	PKHN	Permanent Contact Group Enforcement North Sea
	PLB	Personal Locator Beacon
	POB	Persons on board
	POSO	Periodical Operational SAR Deliberation
	PPE	Personal Protective Equipment
Q	QNH	Pressure setting to indicate elevation above mean sea level
R	RIB	Rigid Inflatable Boat
	RI&E	Hazard Identification and Analysis
	RNLAF	Royal Netherlands Air Force
	RPM	Revolutions Per Minute
S	SAFA	Safety Assessment Foreign Aircraft
	SAR	Search and Rescue
	SART	Search and Rescue Transponder
	SDC	Smoke Drill Check
	SMD	Smart Multimode Display
	SMS	Safety Management System
	SNH	Schreiner Noordzee Helicopters
	SOLAS	International Convention for the Safety of Life at Sea
	SOP	Standard Operating Procedure
T	T4	Exhaust Gas Temperature
	THM	Training helicopter manual
	TRE	Type Rating Examiner
	TRI	Type Rating Instructor
U	UHF	Ultra High Frequency
	UK	United Kingdom

V	VFR	Visual Flight Rules
	VGM	Health, Safety and Environment
	VHF	Very High Frequency
	VOR	VHF Omnidirectional Radio Range (navigation aid working in the VHF band)
W	WDD	Wet Dinghy Drill

1 INTRODUCTION

1.1 Synopsis

On 21 November 2006 at 23.28 hours[3] a Bristow search and rescue helicopter, a Eurocopter AS332L2 Super Puma, with registration G-JSAR made an emergency landing in the North Sea, approximately 10 nautical miles North West of Den Helder in the Netherlands. The 4 crew members and 13 passengers were rescued out of the water after approximately one hour and were transported ashore to Den Helder. One passenger suffered from light hypothermia and was taken to hospital, but was discharged within a few hours. The other occupants were not injured.

The passengers were staff from the offshore installation K15B, which is owned by NAM. Because of a blackout that had started at 20.00 hours that day, they had walked over to the Noble George Sauvageau, a drilling rig located next to the K15B, via a bridge. It was decided to take these non-essential staff from K15B ashore with the search and rescue helicopter G-JSAR . During the return flight of the G-JSAR, the cockpit crew reported engine speed fluctuations and experienced controllability problems and decided to make an emergency landing. All occupants evacuated the helicopter, but the life rafts located in the sponsons were not used during the evacuation. The Netherlands Coastguard organized and co-ordinated the rescue operation.

1.2 The investigation

This final report contains the results of the Board's investigation into the causes of the emergency landing of a Super Puma search and rescue (SAR) helicopter in the North Sea on 21 November 2006. The Safety Board conducted a coherent investigation that was extended to all the events and conditions concerning the mission, including those regarding the decision to use this particular helicopter for the transport of personnel, the decision to make an emergency landing as well as to the evacuation and the subsequent rescue actions. These results provided additional value to the internal investigations performed by the individual parties involved.

1.3 Objective and questions of the investigation

The objective of the independent investigation is to find the direct and underlying causes of the occurrence to:

- Provide all interested parties, including Bristow SAR crew and passengers involved, offshore oil and gas operators, offshore aviation transport operators, helicopter manufacturer and operators, and agencies involved with search and rescue in the Netherlands with pertinent information regarding the occurrence on 21 November 2006.
- Make recommendations with an aim to prevent similar occurrences.

The investigation is divided into 3 parts:
Part 1: the down-manning of the production platform K15B and the activation of the G-JSAR.
Part 2: the G-JSAR flight and the emergency landing.
Part 3: the evacuation of the G-JSAR and the rescue operation after the emergency landing of the G-JSAR.

The main question for each part, respectively, is:

- Why was the decision taken to down-man the offshore installation by means of a search and rescue helicopter?
- What were the events and conditions that resulted in the decision to make an emergency landing?
- Did all the life-saving appliances and procedures function as planned? If not, why did they not function properly?

In accordance with the Kingdom Act, which is supported by EU Directive 94/56 and Annex 13, the purpose of this investigation is not to apportion blame or liability. According to the Kingdom Act, article 69, the reports of the Dutch Safety Board cannot be used in criminal, disciplinary or civil proceedings, nor can a disciplinary measure, an administrative sanction or an administrative measure be based on the reports of the Dutch Safety Board.

3 All times in this report are local times.

1.4 Investigation approach and procedure

On 21 November 2006, the Dutch Safety Board was notified of the accident with the SAR helicopter. The emergency landing of the helicopter, which will be dealt with in part 2 of the investigation, initiated this investigation.

As a result of the incident, the Nederlandse Aardolie Maatschappij B.V. (NAM) and Bristow Helicopters Limited (Bristow) performed their own internal investigations. The conclusions and recommendations of these investigations are summarized in the factual information. The French Bureau d'Enquêtes et d'Analyses produced the readouts and analyses of the flight recorders and several helicopter components that contained recorded data. Eurocopter performed tests on the G-JSAR helicopter and its components at its facilities in Marignane, France. Turbomeca performed tests on the engines and some of its components. The UK Air Accident Investigation Branch contributed to the investigation and the analysis in parts 2 and 3 in general and on the personal survival equipment of the G-JSAR occupants in part 3 in particular. Bristow provided information regarding the company, the SAR operation, the aircraft, training and personnel. The Royal Netherlands Air Force assisted in a simulator test and provided a static test and a test flight on the Cougar, the military version of the Super Puma. A test flight with a SAR Super Puma helicopter for the analysis of specific sounds on the cockpit voice recorder was provided by Bond Offshore Helicopters Limited. The Royal Netherlands Navy and the Netherlands Coastguard provided information regarding the search and rescue service. The final report will be published in the Dutch as well as in the English language.

1.5 Outline of the report

The report has 9 chapters. Chapter 2 contains the factual information. Chapter 3 contains the scope and the frame of reference of the investigation. Chapter 4 describes the parties involved and their responsibilities. In Chapters 5, 6 and 7, the facts relating to part 1, part 2, and part 3 respectively of the investigation are analyzed, sub-conclusions are printed in boxes, and the respective research questions are answered. The Tripod analysis is used for the analysis of part 3. Chapter 8 contains the analysis of the safety and quality management systems of the parties involved and supervision. Chapter 9 contains the conclusions and recommendations. Quotations are printed in italic and footnotes are used for explanation or context.

The International Civil Aviation Organization has issued standards and recommended practices for the investigation of civil aviation accidents and serious incidents. These can be found in Annex 13 "Aircraft Accident and Incident Investigation". The final report of the Dutch Safety Board has the same structure as the Annex 13 report: factual information, analysis, conclusions and recommendations. The Annex 13 report defines the factual report in a specific template only.

The scope of this investigation is not limited to (civil) aviation safety, but also includes safety in the oil and gas industry and passenger safety during rescue operations.

The Dutch Safety Board did not separate the Annex 13 investigation from the other investigations into this incident by publishing a stand-alone 'Annex 13 report' because the interface problems between aviation and non-aviation problems cannot be presented clearly when two separate reports are published. A specially for the offshore helicopter operations such as the investigated commercial search and rescue operation.

2 FACTUAL INFORMATION

This chapter presents the factual information that is of primary importance for the analysis of the incident. It describes the events that resulted in the dispatch of the SAR helicopter, the emergency landing, the evacuation of the SAR helicopter and the rescue operation of its occupants. Section 2.1 provides a description of the situation. Section 2.2 contains the sequence of events. Section 2.3 contains information about the technical investigation on the helicopter and its survival equipment. Section 2.4 contains a summary of relevant information. Section 2.5 contains relevant audit information from the parties involved. Section 2.6 contains information regarding Bristow's crew training. Finally, Section 2.7 contains information regarding the investigations performed by the individual parties involved and the actions that are taken as a result.

2.1 Description of the situation

This section provides an introductory overview of the parties involved as well as the processes involved.

2.1.1 Introduction of NAM and K15B

NAM is the licence holder for the exploration and production of minerals in the geographically indicated block "K15" located on the Dutch Continental Shelf in the southern part of the North Sea (see illustration 1). The installations for production in the K15 field are the offshore installation K15-FB-1 (K15B), which is normally manned, and the satellite installations K15-FC-1 (K15C) and K15-FK-1 (K15K), which are connected by gas pipelines to the K15B and are not normally manned. All three installations are set out with a helicopter landing deck (heli deck). The offshore installation K15B is located at 53°16' 35" North 3°52' 23.8" East, 70 kilometres (approximately 40 nautical miles) North West of Den Helder.

The K15B installation produces natural gas and condensate from the K15-FB-1 field and processes natural gas from K15C and K15K. Furthermore, the installation is the riser station for natural gas from K14-FA-1P (K14A). Auxiliary facilities on K15B are a glycol regeneration unit, a water treatment facility, two gas generators and a diesel generator for emergency energy supply.

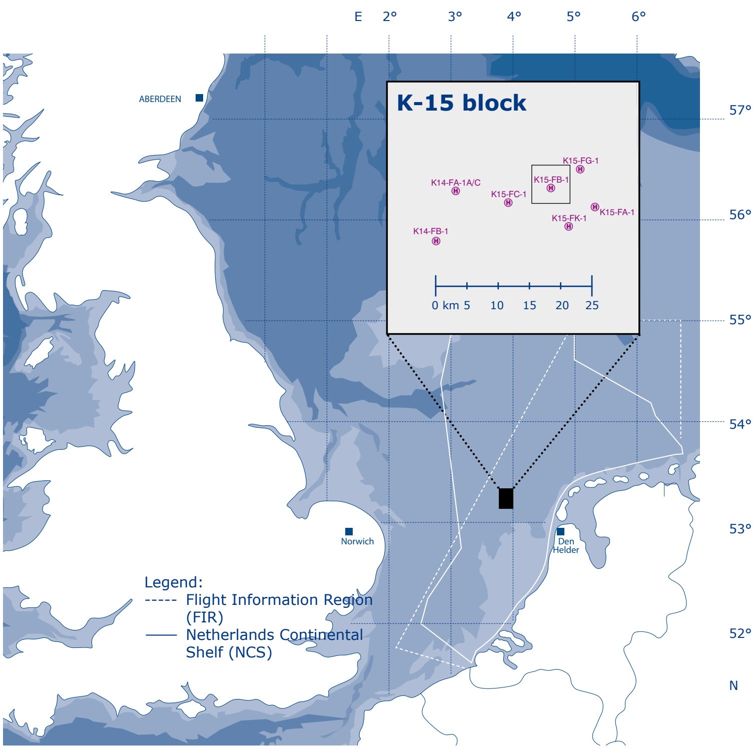

Illustration 1: location of the K15-FB-1 platform in the K15 block of the Dutch Continental Shelf 10

2.1.2 Concurrent operations of K15B and Noble George Sauvageau

On the night of the incident, a drilling rig, the Noble George Sauvageau (Noble George), was located next to the K15B (see illustration 2). Once located next to the K15B, the derrick of the rig was moved over the K15B wellhead area and connected to K15B by a footbridge. Both K15B and the Noble George are equipped with a heli deck. However, the heli deck of K15B was out of operation for the duration of the concurrent operations with the Noble George.

To carry out the work, 20 persons were on board the K15B and 74 persons on the Noble George. The K15B installation can accommodate 22 people and the Noble George has accommodation for 82 people. The K15B Offshore Installation Manager is in charge of the K15B and an acting Offshore Installation Manager is assigned as a backup. Furthermore, the Noble George Rig Manager is in charge of the Noble George. Because of the concurrent operations with the Noble George, the K15B Offshore Installation Manager is also Head of Concurrent Operations and has overall responsibility as well as being responsible for coordinating the emergency response for both the K15B and the Noble George in case of an emergency. All helicopter flights to and from the K15B and the Noble George require approval by this official.

Illustration 2: K15B platform (left) and the Noble George Sauvageau rig (right) [source: NAM].

2.1.3 Transfer by helicopter

The regular helicopter public transport operations to and from NAM's offshore mining installations on weekdays between 07.00 - 21.00 hours and at weekends between 08.00 - 20.00 hours have been contracted out by NAM to Bristow Helicopter Limited (Bristow) and DanCopter S.A.. For the transfer by helicopter in the southern part of the North Sea, one DanCopter helicopter and two Bristow helicopters are stationed at Aerodrome De Kooy (the Netherlands), and three Bristow helicopters at Norwich Airport (UK), including a night emergency standby helicopter at Norwich.[4]

The NAM Flight Scheduling Unit (FSU), which was located in Amsterdam and Den Helder,[5] the Netherlands at the time of the occurrence, scheduled all helicopter offshore flights for ONEgas UK and ONEgas NL.[6] Every day, flight schedules for the following day were distributed to all installations. The schedule for the next day was decided upon at 13.00 hours. In emergency situations, the OIM (or in this case the HCO) approved changes to the schedule in the last 24 hours. Changes for operational reasons have to be approved by the Operations Manager onshore.

4 Norwich-based aircraft are not restricted to flights in the UK sector and Den Helder-based aircraft are not restricted to the Dutch sector. The aircraft are used where they are most needed, irrespective of where a particular aircraft is based.
5 The NAM Flight Scheduling Unit is currently located in Amsterdam only.
6 The Dutch NAM offshore operations were merged with the British Shell offshore operations in ONEgas asset.

NAM schedules its flights to be conducted between 07.00 and 21.00 hours. After office hours, all flight requirements for the NAM offshore operations are organized and controlled from K14C, because its radio room is manned 24 hours per day. Between 21.00 and 07.00 hours, no flights are available for the purpose of transportation and/or crew changes. However, for public transport operations outside of office hours, a 'night standby' Bristow helicopter, based at Norwich Airport, can be activated.

2.1.4 Civil search and rescue helicopter sharing agreement

Legislation of EU countries around the North Sea provides a risk-based approach that requires hazards to be identified, risks to be assessed and minimized and risk-reducing measures to be described. In the Netherlands, the result of this continuous process must be laid down in safety cases that describe the safety status of an offshore installation. The decision made by the responsible company whether and under what conditions the installation is safe to operate must be based on the safety cases. This process is set down in legislation.[7]

Part of these safety cases deal with the subject of survivability of persons entering the water in an emergency or as a result of helicopter ditching. Following a study by the UK Health and Safety Executive,[8] the basic principle of survivability adopted is that if people wearing survival suits could be brought to safety within 2 hours, the probability of survival is acceptable. As a result, rescue capability on the Dutch Continental Shelf was considered to be inadequate by the Netherlands Oil and Gas Exploration and Production Association (NOGEPA).[9] For helicopter flights to remote installations, in particular, the rescue of all passengers within 2 hours could not be guaranteed.

To mitigate this risk, a number of the offshore operators who were members of the NOGEPA hired a commercial (civil) SAR helicopter. This initiative was taken in order to provide a solution during a period of investigations and discussions between various governmental organisations and departments in the Netherlands, concerning offshore SAR capability. This SAR helicopter, a Eurocopter Super Puma AS332L2, was used for this task from 17 November 2003, operated by Bristow and placed under the operational command of the Netherlands Coastguard. The group of companies hiring the civil SAR helicopter is known as the Company Group.

2.1.5 Bristow commercial search and rescue operations

Bristow Helicopters Limited is a British helicopter operator with its registered office in Redhill, England. Bristow has been involved in dedicated SAR helicopter operations for over 30 years. At the time of the accident, Bristow operated 4 SAR bases in the UK (Stornoway, Sumburgh, Lee on Solent and Portland) and was contracted to support the UK Maritime and Coastguard Agency.[10]

The G-JSAR was the only type of AS332L2 operated by Bristow and was stationed at the Bristow Den Helder SAR unit at Aerodrome De Kooy (illustration 3). The Bristow SAR operation, including its crews, operates separately from the (normal) Bristow helicopter transportation operations, as mentioned in section 2.1.3.

Illustration 3: G-JSAR [source: Netherlands Coastguard]

7 Dutch Occupational Health and Safety Decree section 3 part A.
8 *Review of probable survival times for immersion in the North Sea,* D.H. Robertson and M.E. Simpson, Health and Safety Executive report OTO 95 038, January 1996.
9 *Rescue at Sea of people working in the Mining Industry on the Dutch Continental Shelf,* revision 8, NOGEPA.
10 Bristow has not carried out SAR operations within the UK since April 2008.

2.1.6 Netherlands Coastguard

Since 1987, the Netherlands Coastguard is responsible for a number of operational and enforcement activities in the Netherlands, including the search and rescue services on the Dutch Continental Shelf. The Netherlands Coastguard uses an Operational Centre in Den Helder and several air and sea SAR units for this purpose. The Royal Netherlands Navy is responsible for the operational command of the Den Helder Operational Centre. The Operational Centre is manned 24 hours a day and acts as a central reporting, information and co-ordination centre, as well as being the national Maritime and Aeronautical Rescue Centre (Joint Rescue and Coordination Centre - JRCC). Upon receipt of an alarm call, the Netherlands Coastguard will mobilize SAR units, such as rescue vessels, from the Royal Netherlands Sea Rescue Institution (KNRM) and SAR aircraft for the execution of search and/or rescue activities.

For rescues at sea at some distance from the coast, the Netherlands Coastguard can rely upon the Royal Netherlands Navy Lynx helicopter(s). At least one Lynx SH-14D helicopter with crew[11] is on standby 24 hours per day, and will be operational within a predetermined time depending on the time of day and the day of the week.[12]

2.1.7 Aerodrome De Kooy opening hours

Aerodrome De Kooy is a mixed military (Naval Airstation De Kooy) and civil airport. This airport is the main offshore heliport in the Netherlands for commercial helicopter operators flying within the Dutch Continental Shelf. Its location is close to the oil and gas fields in the central and southern parts of the North Sea. At the time of the accident, the Royal Netherlands Navy provided air traffic services, i.e. the terminal approach control service and aerodrome control service, and provided fire brigade services at the airport.[13]

During weekdays, Aerodrome De Kooy is closed from 22.00 to 07.00 hours and at weekends and during public holidays from 11.00 to 15.00 hours and from 20.00 to 07.00 hours. When the airport is closed for commercial flights, air traffic services, runway lighting, and the fire brigade are not available and departure and arrival of (commercial) helicopters is not permitted.

The Royal Netherlands Navy Lynx SAR helicopter(s)[14] and the Bristow SAR helicopter each have their own facilities at the airport. The Bristow SAR helicopter is allowed to take off for a SAR mission, recovery of casualties or medical evacuation when the airport is closed. After departure of the SAR helicopter, air traffic services and the fire brigade are alerted so that the airport is operational for the return of the helicopter.

2.2 Sequence of events

This section describes the sequence of events. The section is divided into the three parts of the investigation as indicated in section 1.3: (part 1) the down-manning of the production platform K15B and the activation of the G-JSAR, (part 2) the G-JSAR flight and the emergency landing and (part 3) the evacuation of the G-JSAR and the rescue operation following the emergency landing of the G-JSAR.

The down-manning of the production platform K15B and activation of the G-JSAR

2.2.1 Blackout of the K15B

On the evening of Tuesday 21 November 2006, close to 20.00, a blackout occurred on the K15B production platform. The sun had set more than three hours earlier and it was dark. All personnel were located in the living quarters of the installation. The K15B platform was fully operational when the blackout occurred. A new well was being drilled simultaneously by the Noble George.

A remote shutdown facility was operational on the Noble George. This facility enables the Noble George Rig Manager to shut down the K15B platform from the drilling rig in the event of an

11 Two flight crew, one hoist operator, one rescue operator and normally one physician.
12 Twenty minutes during weekdays between 08.00-16.30, 45 minutes on weekdays between 16.30-08.00, 45 minutes at weekends during daylight hours and 60 minutes outside of daylight hours, *OPPLAN-SAR*, Netherlands Coastguard.
13 During the investigation, the command of Naval Airstation De Kooy was taken over by the command of the Royal Netherlands Air Force.
14 During the investigation, the command of the Royal Netherlands Navy helicopters was taken over by the command of the Royal Netherlands Air Force.

emergency on the rig. During a routine muster drill on the Noble George the day before the blackout, the remote shutdown facility of the K15B platform was accidentally activated, causing an emergency shutdown (ESD) of the K15B.

In the event of an emergency shutdown, all wells and incoming risers (feeding the installation with gas from the satellite installations) are shut off from the installation using valves. The pressure of the installation is relieved by opening the valves to the vent stack. Also, the two gas generators that normally supply the power to the platform are shut down. The backup diesel generator will automatically start to feed emergency systems including the firewater[15] pumps. To start up the installation again, the gas generators had to be restarted.

After the restart, one of the gas generators was not running smoothly. The Head of Concurrent Operations decided to use one gas generator together with the backup diesel generator in order to solve the problems with the gas generator.

On 21 November 2006, at around 20.00 hours, the diesel generator automatically switched off and could not be restarted.[16] This caused an emergency shutdown of the installation, as programmed in the safety logic. The attempts to restart the diesel generator caused a great deal of smoke to come from the exhaust. Seeing the smoke and hearing the noise[17] of the shutdown, the Rig Manager was under the impression that there was a fire on the K15B. He therefore stopped the drilling operations to bring the Noble George into a safe mode.

Troubleshooting the situation, engineers of the K15B, together with engineers from the drilling rig, concluded that an external specialist was required to repair the fault to the diesel generator. This specialist would have to be flown in the following day. The Head of Concurrent Operations and the acting K15B Offshore Installation Manager concluded that the power supply would not be restored on K15B that night. According to them, a closed and depressurized installation was in a safe failure mode and offered safe accommodation. The Head of Concurrent Operations and Rig Manager discussed the situation, together with the NAM Drilling Supervisor. K15B staff could move to the Noble George, but only 7 beds were available.[18] The Noble George Rig Manager was against this option but accepted that staff could stay overnight in the rig's lounge. This option was abandoned, however, because the drilling operations would be resumed and the lounge also would have to be used by Noble George personnel. Without proper rest, K15B personnel would probably not be able to work the next day.

Although the K15B was in total platform shutdown mode, drilling operations by the Noble George over the K15B wellhead were resumed.

2.2.2 Decision to evacuate non-essential personnel

At approximately 21.00, the Head of Concurrent Operations contacted the NAM Operations Coordinator (onshore) to discuss the situation. The Operations Coordinator believed the situation would become unsafe, as fire and gas detection would be lost upon depletion of power from the battery backup and firewater would not be available. It was therefore decided that the best way out would be to accommodate 7 'essential staff' overnight on the Noble George required for the start-up of the K15B installation and for whom sufficient beds were available on the Noble George, and to take the remaining 13 'non-essential staff' ashore. At around 21.20, this option was also discussed with the NAM Operations Manager, who supported the decision.

From post-accident interviews with directly and indirectly-involved NAM staff it became clear that the decision to use the civil SAR helicopter was not based on a commonly shared view concerning the safety condition of an installation during a blackout, the availability of transport and SAR helicopters in general and the alternatives to transport helicopters in particular. They also had different views with regard to the number of seats available in the G-JSAR.

At approximately 21.30 hours, the radio operator on the K14C platform received a request from the Head of Concurrent Operations that 13 non-essential crew of the K15B needed to be evacuated-[19]with the G-JSAR and added that there was no life-threatening situation. The radio operator

15 The term *firewater* is used instead of *fire extinguishing water* in the oil and gas industry mainly because water is used for fire suppression or cooling rather than extinguishing fire.
16 It was discovered later that the diesel generator tripped on overspeed due to a malfunction in the accelerator of the diesel engine.
17 The pressure relief of gas to the vent stack causes a loud rumbling noise.
18 The Noble George has accommodation for 82 persons. With 74 persons on board the Noble George, including a female employee who used one room with two beds, only 7 beds were available.
19 The verbal form of *to evacuate* was probably used.

consequently contacted the NAM Flight Scheduling Unit (FSU) representative in Den Helder requesting a helicopter for the evacuation. The FSU representative responded stating that in the event of an evacuation, the only option for a flight was a search and rescue flight, as Aerodrome De Kooy closes at 22.00 hours during weekdays. The FSU representative did not challenge the need for evacuation but treated the request for evacuation as such. Appendix B contains an organisation chart with the persons involved in the decision-making process regarding the evacuation of non-essential staff from K15B.
The K14C radio operator then contacted the Netherlands Coastguard at its Joint Rescue and Coordination Centre in Den Helder and informed the duty officer of the request to dispatch the G-JSAR. The Netherlands Coastguard was also informed that the helicopter needed to land on the Noble George because of the concurrent operations. This message was forwarded to the crew of the G-JSAR. The call from the K14C radio operator was recorded in the Netherlands Coastguard log at 21.57 hours and logged in their database as "to evacuate the K15B".[20] The Netherlands Coastguard dispatched the G-JSAR from its base at Aerodrome De Kooy. After the accident, the Netherlands Coastguard stated that it did not categorize the request for evacuation.[21]

At around 22.00 hours, all K15B staff moved to the Noble George. The 'essential staff' were to stay overnight on the Noble George. The 'non-essential staff' took their packed bags with them and waited for the helicopter.

The G-JSAR flight and the emergency landing

2.2.3 The outbound flight

The on-duty captain of the Bristow helicopter accepted the request from the Netherlands Coastguard duty officer. Since the G-JSAR was equipped with only four cabin seats, the captain verified the need to 'evacuate' 13 persons with the K14C radio operator. The radio operator replied that the evacuation was requested by the K15B Offshore Installation Manager, who was backed up by the NAM Operations Manager, and added that there was no need to take a medic on board since there was no life- threatening situation. Due to the absence of a life-threatening situation, the captain initially questioned the validity of the SAR mission with the G-JSAR, but accepted the mission eventually. The captain subsequently briefed the co-pilot and the rear crew, which consisted of the winch operator and the winchman, about the mission. The captain and the co-pilot verified the weather conditions for the flight. The terminal aerodrome forecast indicated thunderstorms and rain showers but weather radar pictures indicated that these had already passed. The G-JSAR had about 2900 pounds of fuel on board at take-off, which was sufficient for the outbound flight and the return flight.

At 22.35, the G-JSAR departed from Aerodrome De Kooy. During the pertinent radio communications, the flight was referred to as "Coastguard Rescue Alpha Romeo", the call sign to be used for SAR missions. The flight was conducted under instrument flight rules. The captain was the pilot in control of the flight and sitting in the right-hand seat. The co-pilot was in the left-hand seat. The flight was conducted at 2000 feet on a direct route to the Noble George.

During the course of the flight, the cockpit voice recorder (CVR) recorded the flight crew informing the Noble George radio operator that the passengers could not take luggage with them because the G-JSAR was not equipped for stowing luggage for so many passengers and because it was an evacuation. The Noble George radio operator confirmed this message. Later on the crew briefly discussed the validity of the SAR call out. The captain concluded that the only reason for using the G-JSAR was the closure of Aerodrome De Kooy for regular transport operations. Although an exemption is provided for the G-JSAR operations, for its passengers to carry life jackets during SAR missions, a discussion developed between the crew as to whether the required number of passenger life jackets was on board. An answer to this question initially remained forthcoming. The rear crew counted twelve life jackets for thirteen passengers. The remainder of the flight to the Noble George was uneventful.

At 23.00, the G-JSAR landed on the helideck. The captain and co-pilot stayed on board while the engines and the rotors were kept running. After the landing, one of the rear crew members informed the flight crew that thirteen life jackets had been found on board.
The rear crew members left the helicopter and met the passengers who were waiting beside the helipad with their bags. The winch operator took them to the radio room to brief them and told

20 *Rig Incident - 008471-21112006* at 22.02 (translated and reported concisely): *due to total blackout, evacuation from K15B requested with G-JSAR: 7 crew walked to the adjacent Noble George Sauvageau, 13 crew went with G-JSAR.*

21 See sections 3.3.5 and 3.3.6 for information about the different forms of categorization of SAR requests.

them that bags would not be allowed. The passengers were all wearing their survival suits. Earplugs were also available. Thirteen life jackets of three different types (Beaufort Mk 15, Beaufort Mk28 and Shark LAPP) were distributed among the passengers. According to the winch operator, the passengers were asked if they understood the briefing and no questions were asked either about the briefing or the operation of the life jackets used. He was under the impression that the passengers were not listening very attentively. The crew members accompanied the passengers back to the G-JSAR. During interviews following the accident, the rear crew members explained that they had briefed the passengers on the use of the different types of life jackets. However, several passengers indicated that there was some confusion about the life jackets, due to the mixture of the three different types and that they did not fully understand the design of the survival aids contained in the individual jackets. One passenger explained that he did not understand most of the briefing and about his lack of understanding of the English language.

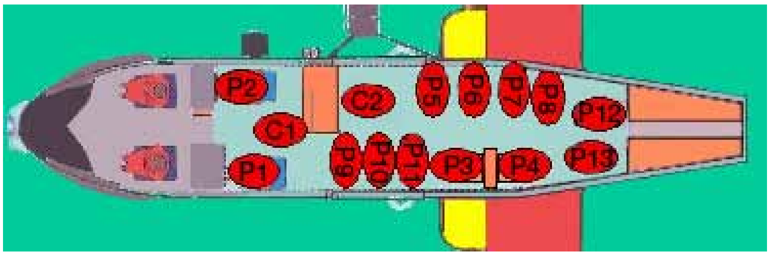

Illustration 4: rear crew (C) and passenger (P) seating G-JSAR

The passengers boarded the G-JSAR on the right-hand side. Illustration 4 shows that four passengers (P1-P4) were seated on the available passenger seats and nine of them (P5-P13) were seated on the floor. The two rear crew members (C1, C2) attached themselves to the dispatcher harnesses and kneeled down in the middle of the cabin. They were wearing headsets and were able to communicate with the pilots.

During preparations for the return flight, the co-pilot expressed his unfamiliarity with the contents of a commercial air transport offshore take-off crew briefing. The captain allowed him to give this briefing and confirmed its adequacy. The captain also confirmed the need for more training in offshore operations. The crew noted that 2470 pounds of fuel were present and estimated the take-off weight to be 20,000 pounds.

2.2.4 The return flight

The captain's briefing on the public address system to the passengers was recorded on the Cockpit Voice Recorder (CVR). The captain informed the passengers that the flying time to De Kooy was about 25 minutes and instructed them to remain seated during the entire flight and to follow the instructions of the crew during an emergency. During interviews, several passengers indicated that they did not receive an emergency or evacuation instruction in the helicopter, but none of the passengers had mentioned this to the crew.

The G-JSAR departed the Noble George helicopter deck at 23.13 hours with the co-pilot piloting the flight. The aircraft climbed to 3000 feet and followed a direct track to Den Helder's radio navigation beacon. During the climb, the crew checked the flight conditions for possible icing. No signs of ice were detected. When levelling off at 3000 feet, the captain observed an outside air temperature of 4 degrees Celsius and the anti-icing was switched on.

At 23.20 hours, the CVR recorded the captain's first remark of a "huge" difference between the two engines.[22] The crew observed that the gas turbine rotor speed[23] of engine number 1 was unstable. Approximately 20 seconds later, they observed a difference in the exhaust gas temperatures. Both pilots agreed that engine number 1 indications showed fluctuations. They discussed the variations of some other parameters. At 23.21 hours, the captain made contact with air traffic control 'De Kooy Approach' (ATC) and reported the return of the helicopter with 17 persons on board at 3000 feet.

One minute after the first remark about the 'difference' between the engines, the co-pilot announced his intention to slow down. The captain then responded straight away with an urgency

22 The AS332L2 helicopter has 2 gas turbine engines.
23 Engine rotor speed is presented in revolutions per minute (RPM).

message[24] on the radio and requested ATC for permission to descend to 1000 feet. ATC provided this clearance. The co-pilot disconnected the autopilot upper modes,[25] asked the captain to get out the Emergency Operating Procedures and initiated a slow descent. There was little communication about the use of the autopilot during the flight in general. The captain announced that she had no idea where to look in the Emergency Operating Procedures; no applicable procedure existed for this situation. She instructed the co-pilot to maintain a slow descent whilst noting the present rate of descent of 900 feet/minute. The captain confirmed that both fuel flow control levers were "in the gate".[26] She asked the co-pilot to move the collective slowly. After a short ATC communication, the captain confirmed that both engines were responding to the changes in power demanded.

The co-pilot continued his descent. The airspeed indicated remained approximately the same. The rear crew informed the cockpit of the bearing and distance to Texel. The captain announced that her first reaction, bearing in mind the absence of a governor[27] light, would be that this could be a minor or major failure of the governor.

The captain reported to the crew that they had 20 nautical miles to run to the field and she instructed the co-pilot to descend to 1000 feet. She asked the co-pilot twice if he was still happy to remain at the controls. The co-pilot confirmed this after the second request. The captain then observed that both engines were looking normal, there were no indications on the central warning panel or any warning lights indicating a difference between the two engines, and the main rotor was functioning normally.

At 23.24:43 hours, there was a short warning indicating a difference between both engines' speed for the first time. During the remainder of the flight, eleven short activations of this warning light were recorded on the flight data recorder. The captain announced the warning and instructed the co-pilot to get as close to De Kooy as possible and to continue with the slow descent. The captain again confirmed that both engines were responding to the collective.[28] At the same time she observed the 'one engine inoperative high'[29] armed light turning on and off. Thereafter, this light illuminated simultaneously with the above-mentioned warning indicating different engine speeds. The captain disarmed the one engine inoperative high and confirmed that the light for one engine inoperative low[30] was on. When the co-pilot mentioned that the exhaust temperature of engine number 1 was increasing, the captain instructed him to continue to proceed to the destination and to correct the heading by 10 degrees.

At this moment, which was approximately one minute after the first warning, the co-pilot announced that there were some restrictions to his use of the controls and that he had some problems with steering. According to his observations, the control problems seemed to increase. During his observations, the rear crew reported that the island of Texel was the nearest part of the mainland. At 23.26 hours, 30 seconds after the start of the control problems, the captain transmitted a MAYDAY[31] on the radio indicating that the aircraft had steering and engine problems and that they were diverting to Texel. Shortly after the distress message, the co-pilot announced he was going to ditch the aircraft because he was losing control. The captain responded straight away with a radio transmission in which she explained that the G-JSAR was going to ditch. The co-pilot announced

24 *PAN PAN* (three times), an international urgency signal indicating that the calling station has a very urgent message to transmit concerning the safety of a mobile unit or person.

25 The AS332L2 is equipped with an automatic flight control system (AFCS) that acts as an autopilot. The AFCS is a stabilization system that lends assistance to the pilot in controlling the helicopter. The 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. Stabilization is provided in the basic operating mode. Speed, altitude and navigation modes are available in the upper modes.

26 In the appropriate position for the flight, also called 'flight detent'.

27 A governor is a device used to measure and regulate the speed of the engine.

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

29 One engine inoperative high (OEI HI) selection: in normal twin engine operation, engine power is automatically limited to transient take-off rating, but following an engine failure, when DIFF NG illuminates, OEI HI is automatically armed because, during low speed flight, more power is required of the remaining engine than during normal flight. Use of the associated super contingency power rating must not last longer than 30 seconds. Arming of the one engine inoperative high (OEI HI) is indicated by illumination of an LED, and a caption "OEI HI" appears on the screens. Actual use of this power is indicated by a further red symbol.

30 One engine inoperative low (OEI LO) selection: in the event of an in-flight engine failure at higher speed, this contingency power rating is selected by the pilot after the system has armed OEI HI, by using a button under the collective. Its use must be limited to 2 minutes, after which the collective must be lowered to the OEI continuous power rating. There are similar LEDs and captions as for OEI HI.

31 International distress signal: a condition of being threatened by serious and/or imminent danger and requiring immediate assistance.

twice that he could not “fight the controls anymore”. Aware of the predicament, the winch operator requested the cockpit crew members to slow down. At that moment, the ground speed was 150 knots and the radio altitude 500 feet.

At 23.27 hours, there was an altitude voice alert and the co-pilot announced that he flared the helicopter. The CVR also recorded the voice alert, caused by the high nose attitude whilst slowing down. The captain commanded the co-pilot to keep the aircraft in the air. Eventually the G-JSAR slowed down. The captain inflated the floatation gear, which she had previously armed. At 23.27, the rear crew transmitted a MAYDAY using its own radio on the frequency of the Netherlands Coastguard. The distress message did not include the position of the G-JSAR. The estimated ditching time of the G-JSAR was 23.28. This was also the time that both the CVR and the flight data recorder (FDR) recordings stopped.

The evacuation of the G-JSAR and the rescue operation

2.2.5 The evacuation of the G-JSAR

The flight crew did not use the public address system to announce that the aircraft was going to ditch. Because all four crew members were connected by the intercom system, the rear crew was aware of the situation. The rear crew were able to inform some of the passengers in their direct vicinity verbally or by using hand signals, because of the engine noise. In post-accident interviews, all the passengers reported experiencing unusually severe turbulence prior to the ditching. This caused some of them to suspect that the aircraft was experiencing a problem. The winchman used hand signals in an attempt to explain that the aircraft was about to ditch but this was not correctly interpreted by the passengers. Several passengers were able to see the water outside, through the window, but many believed it was a normal landing until the sliding door was opened and water entered the aircraft. Once in the water, the helicopter emergency exit lights automatically activated. The flood lights, strobe lights and navigation lights were switched on before the ditching. The landing lights were not used. The cabin lights which had been on throughout the flight remained on. After the helicopter ditched, the emergency locator transmitter (ADELT) deployed automatically and started transmitting.

Once floating, the winchman opened the helicopter right-hand sliding cabin door using the normal opening method. The door jettison system was not used.[32] Both rear crew members shouted to the passengers to jump into the water, which they did.[33] The captain heard the evacuation initiated by the rear crew and ordered them to wait because the rotor blades were still turning. She subsequently switched off the engines and used the rotor brake to bring the rotor blades to a halt. The winch operator explained that he ordered the evacuation, because he was sure at that time that the aircraft would capsize immediately and secondly, because 9 unstrapped/unsecured passengers were in the back of the aircraft who would stand little chance of escaping if the aircraft capsized as they were not trained for this situation. The flight crew did not use the life raft deployment handles in the cockpit (see illustration 5).

When the captain shouted “everybody out” she looked behind into the cabin and noticed that most passengers had already left the cabin. Both pilots exited the aircraft through their respective doors and jumped over the floatation bags into the sea. The captain was wearing her gloves during the whole flight, but did not don her hood. The co-pilot did not don his hood and gloves prior to leaving the G-JSAR. A few passengers stated that the main rotor blades did not turn during their evacuation and one passenger stated that the rotor blades completed a final turn before coming to a standstill during his evacuation.

The G-JSAR is equipped with life raft deployment handles, located externally on the fuselage and within reach at both sides of the doors. The rear crew did not use these handles after opening both cabin doors. The winch operator stated that he entered the water after evacuating the last passenger from the cabin and found the winchman working on the right-hand sponson life raft.

The passengers attempted to inflate their life jackets as they entered the water but several of them experienced difficulties in doing so because they were wearing a type of life jacket that they were not familiar with. None of the passengers had time to don gloves or hoods prior to the evacuation. Once the passengers were evacuated, both rear crew members also entered the water and the winchman attempted to manually deploy the right-hand sponson life raft. He spent several minutes unsuccessfully trying to locate the deployment cable/handle within the sponson housing and

32 In the Operations Manual Part B, it is stated that the hoist assembly will trap the right-hand door if jettisoned.

33 Several of the passengers commented later that the lack of seating in the helicopter cabin improved the speed of the evacuation.

eventually gave up. The winch operator, observing the winchman's predicament and assuming that he had already attempted to use the right-hand external life raft deployment handle, decided to swim around the helicopter to inflate the left-hand sponson life raft.
This proved to be problematic, however, due to the high sea conditions with wave heights between 2-3 metres, so he returned to the right-hand cabin door area.

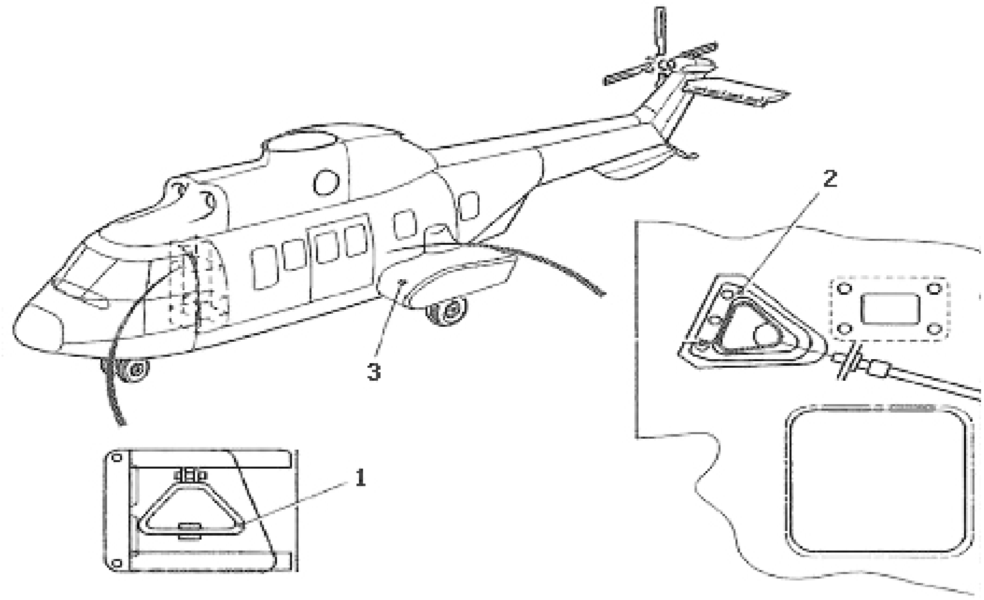

Illustration 5: for each life raft, 3 inflation systems/release handles are in operation. One is installed in the cockpit (1), one is installed externally on the fuselage aft of the main door (2), the third handle is installed in the sponson stowage (3).

The co-pilot, who was the only person to evacuate on the left-hand side of the aircraft, moved rearwards to the left-hand cabin door and entered the cabin to verify that all the occupants had evacuated. Whilst he was in the cabin, the winch operator shouted to him to evacuate, out of fear of the aircraft capsizing, and he consequently joined all the others in the sea holding onto the right-hand side of the aircraft. He managed to find the captain in the water. The captain was not wearing a life jacket. Afterwards the captain stated that in the course of her evacuation she had become detached from her life jacket. However, she had no recollection of how or as a result of what. The co-pilot stayed with the captain and assisted her in keeping afloat.

The winch operator then climbed back into the cabin and pulled the right-hand door emergency jettison handle, which had been operated by the winch man a moment earlier. This action had no effect because the right-hand door was already open. He then retrieved the air deployable life raft (maximum capacity approximately 10 persons) and went back into the sea with it. While the winch man held onto the bag, the winch operator pulled out the retrieval or mooring line, which was 150 feet long and designed to be dropped from the air. Before it was all pulled out, the winch operator got entangled. He decided to cut the bag's lace housing with his knife and pulled directly on the inflation bottle, which inflated the life raft. During this operation, the rear crew had released their grip on the helicopter's side and by the time they climbed aboard the dinghy, they had lost sight of the G-JSAR, because the helicopter had drifted away due to the heavy wind. The winch man attempted to swim back to the helicopter whilst tied to the life raft's rope, but did not succeed and returned to the dinghy.

In the meantime, in addition to the two crew members in the dinghy, the pilots and the passengers had formed several small groups, out of which two distinct groups were eventually formed.
A group of four passengers initially attempted to swim back to the G-JSAR, which had drifted away. However, they decided that saving their energy would be a better option. One passenger within this group was unable to recall the life jacket briefing and required the assistance of a colleague in order to inflate his life jacket. A second group of four passengers joined up with the first four, to form a group of eight, and they formed a circle. This group was joined at a later stage by the captain and the co-pilot. Rather than risk losing contact with the group, some passengers chose to refrain from putting on their gloves and hood when they were in the water.
Several passengers stated that the lights on their life jackets did not work. None of the life jacket

buddy lines[34] were deployed in this group. Five of the passengers were hanging on to the grab rope fitted to the right-hand side nose float of the G-JSAR and formed the group of five. Within this group, the opinions about the potential for the floating helicopter to capsize differed. However, one of the passengers in this group who wanted to climb back inside the helicopter's cockpit in order to reduce heat loss was advised against doing so by the rest of the group. The group decided to hang on to the helicopter for as long as possible.

The group of ten became detached from the helicopter, which, in the strong wind, drifted away rapidly. The co-pilot, who was a member of this group, and two other members of the group had mini-flares in their life jackets. The co-pilot's hands were too cold to manipulate the flares, because he was not wearing gloves. However, when a ship proceeding in their direction was sighted, the captain, who had no life jacket but was holding onto the co-pilot, was able to get the flares, following which several flares were fired by the co-pilot.

The passengers reported having difficulties in donning their gloves whilst in the water and being deprived of proper lighting conditions. They also found it difficult to don the hood whilst the waves were breaking over them, although some managed to do so by getting assistance from others in the group. Post-accident interviews revealed that many passengers reported that survival suits were leaking to a limited extent, which had an adverse effect on their mental state. Several passengers and crew commented that remaining together as a group significantly improved their mental state. Several passengers were seasick whilst awaiting rescue.

2.2.6 The rescue operation

Following the MAYDAY transmitted by the G-JSAR flight crew at 23.26 hours, ATC transmitted a SAR-alarm. One minute later, the crew of the standby Royal Netherlands Navy Lynx SAR helicopter was alerted. Because of the number of G-JSAR occupants, a second Lynx-helicopter was asked to be put on standby. At approximately 23.29 hours, the Netherlands Coastguard Duty Officer logged the MAYDAY from the rear crew - he was unaware of the first MAYDAY on the ATC radio frequency.[35] He activated the "Aircraft Emergency" action plan at the same time. The Royal Netherlands Navy co-ordinated the respective alarms from ATC and the Netherlands Coastguard to the Lynx SAR helicopter crews.

From 23.30 onwards, the following rescue assets were assigned to and directly involved in the rescue operation:

- Two Navy Lynx SAR helicopters
- The KNRM[36] rescue craft Dorus Rijkers from Den Helder;
- The Arca, a vessel belonging to the Ministry of Transport, Public Works and Water Management and sailing under the command of the Netherlands Coastguard, in the vicinity of the G-JSAR landing spot.

Other resources assigned to the incident included lifeboats from Texel and Callantsoog, the KNRM vessel De Waker and the Royal Netherlands Air Force SAR helicopter from Leeuwarden, but their assistance in the actual recovery of persons from the sea appeared to be redundant.

At 23.46, the Arca reported receiving a signal from the G-JSAR's emergency locator transmitter at a distance of about three to four nautical miles. Subsequently, upon moving in, the Arca reported having flares in sight. The Arca arrived on scene at around 23.59 hours and reported visual contact with all three groups of survivors. The Arca moved towards the group of ten people drifting in the water and put a rigid inflatable boat (RIB) overboard to pick up the survivors. The G-JSAR had drifted 500-800 meters away from the group of ten.

At the first sign of rescue boats and helicopters, the rear crew in the dinghy fired flares and were able to direct the helicopters using hand signals onto the survivors who were still in the water.

At 00.01 hours, the first Royal Netherlands Navy SAR helicopter was airborne, to arrive on scene approximately 7 minutes later. The helicopter crew spotted the G-JSAR and the Arca as well as the life raft. Proceeding to the raft first, the helicopter was directed to the G-JSAR by the group of two in the life raft. The group of five, hanging onto the side of the G-JSAR, were difficult to spot from the air and could only be seen after the winchman was lowered into the water.

34 A buddy line is a cord which is used to securely connect two persons to one other.
35 There are different frequencies for ATC and the Netherlands Coastguard.
36 Royal Netherlands Sea Rescue Institution (KNRM).

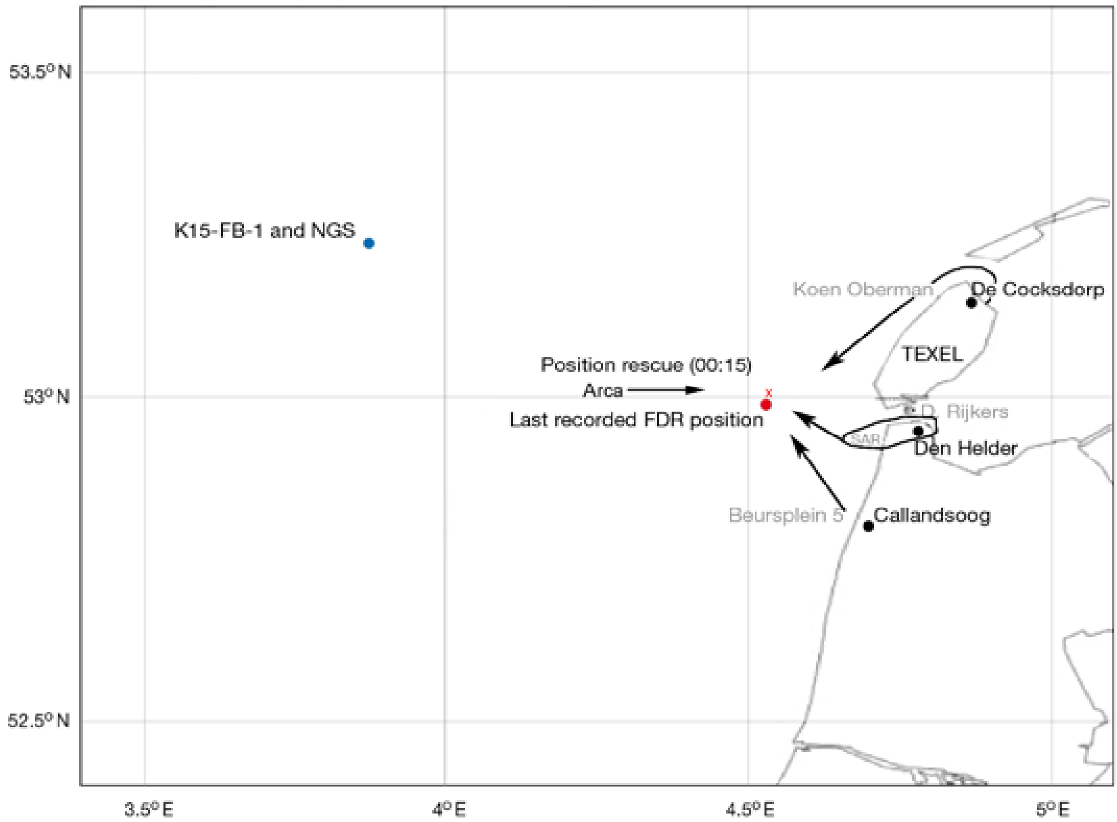

Illustration 6: the G-JSAR ditched approximately 10 nautical miles North West of Den Helder. About 3 to 4 nautical miles West of this location, the Arca was performing Netherlands Coastguard duties. The dispatch of other rescue assets is shown.

At 00.06, the Arca reported that the group of ten had been retrieved. At 00.10, the Navy SAR helicopter started lowering the winch man into the water. The winch man instructed the group of five to swim towards his position (some 30 metres from the helicopter) as the winch could not be lowered to the nose of the helicopter due to potential interference with the rotor blades of the G-JSAR. At 00.12, the Arca reported that the group of ten was aboard the Arca. Due to unfavourable weather conditions the RIB was damaged after contact with one of the wooden rungs of the pilot ladder that was used for climbing from the RIB onto the Arca and could not be used anymore. At 00.20, a second Navy Lynx SAR helicopter departed from Aerodrome De Kooy and arrived on scene in approximately six minutes. At around 00.35, the KNRM rescue craft Dorus Rijkers arrived on scene and picked up the group of two in the life raft.

Meanwhile, the first Navy SAR helicopter transferred two survivors, together with the doctor of the Navy SAR helicopter, to the Arca. The second Navy SAR helicopter hoisted another survivor from the group of five, who was also transferred to the Arca. At around 00.38, the rescue craft Dorus Rijkers arrived at the G-JSAR to pick up the last two survivors from the group of five. These two survivors were towed on board with a line, because the vertical movement of the helicopter rotor blades prevented the Dorus Rijkers from getting close to the G-JSAR. The ships' crews on board the vessels stated that it was not easy to bring the passengers onto deck. The survival suits were wet and therefore slippery and the inflated life jacket made man-handling difficult.

The original plan to transfer all the survivors to the Arca was abandoned due to the unfavourable weather conditions. It was therefore decided that both vessels, Arca and Dorus Rijkers, would sail to Den Helder and transfer the survivors to the naval base. On board the vessels, immediate medical attention was provided by the doctor from the first Navy SAR Lynx, who was lowered to the Arca first and then later transferred to the Dorus Rijkers. One of the survivors picked up by the Dorus Rijkers who originated from the group of five was diagnosed as suffering from mild hypothermia. He was therefore airlifted to Den Helder, together with the doctor, and was subsequently transferred to the hospital in Alkmaar by ambulance. The Dorus Rijkers, with three remaining survivors on board, arrived at the naval base at 02.10. The Arca, with thirteen survivors on board, arrived at the naval base at 03.03.

In the initial phase of the rescue operation, the Netherlands Coastguard informed the Common Emergency Centre, which in turn had alerted the Regional Emergency Response Organisation (GHOR). Seventeen ambulances were directed to Aerodrome De Kooy to pick up any injured survivors, should they have been brought in by helicopter. Later, when it was confirmed that all but one survivor were in good health, the GHOR stepped down. Upon arrival in Den Helder, the rest of the survivors were transported to the Navy hospital. The pilots provided the survivors with a debriefing. Arrangements were made to be seen by a doctor, to be provided with food and drinks, and for relatives and company representatives to be hosted.

According to the NAM Drilling Supervisor, no passenger list was made of the G-JSAR return flight to Aerodrome De Kooy. After the ditch, he was requested to send the passenger list to the K14C.

Illustration 7: G-JSAR washed ashore the day after the incident.

2.3 Technical investigation of the G-JSAR

2.3.1 Investigation of the helicopter components and systems

The flight data recorder and cockpit voice recorder information were retrieved and analysed. The data provided an insight into the technical details of the event and the crew's actions. The data did not reveal a cause to the reported engine behaviour and control problems. The aircraft and its systems were subjected to a detailed examination. Special attention was given to the engine control and the flight control systems. A connection between the differences in engine speed and the reported control problems could not be found. It has been concluded that both engines were still running and that sufficient engine power was available to continue the flight. The recorded data neither qualified the nature of the control problems nor quantified the extent of them.

During the course of the investigation, a theory was developed that the autopilot hydraulic system could have caused an intermittent increase in control loads. Further investigation revealed that after the accident, one of the autopilot hydraulic on/off switches contained salt. If this had been present before the accident, it could have caused inadvertent switching of the autopilot hydraulic system. Because the inside of the switch did not show signs of corrosion, it was concluded most likely that seawater was not present in the switches before the accident. No other failures were found in the autopilot hydraulic system. Because there is no proof that the switch was free of salt before the accident, Eurocopter concluded it may have caused the intermittent switching of the autopilot hydraulic system, causing an intermittent increase of control loads. This scenario is also considered plausible by the French Bureau d'Enquêtes et d'Analyses (BEA). Based on flight data, cockpit voice recorder information and examination of the autopilot hydraulic system, it has been concluded that insufficient evidence is available to support the theory that an intermittent autopilot hydraulic failure occurred. Furthermore, the investigation did not reveal substantial evidence to back the theory that intermittent switching of the autopilot hydraulic system can cause such a control problem.

The Safety Board has not identified a technical cause for the control problems experienced by the G-JSAR crew.

Information from two Royal Netherlands Air Force control problem incidents in 1996 involving the same type of aircraft was used in this investigation. Appendix C contains the results of the above-mentioned technical investigation, presented in Annex 13 format.

2.3.2 Investigation of survival equipment

The standard equipment of the G-JSAR includes a detailed equipment list of rescue, medical and emergency equipment to be carried specifically for its search and rescue role.
Of particular interest for this investigation, the G-JSAR helicopter:

- carried two 18-person life rafts with an overload capacity of 27 persons mounted in the sponsons outside of the cabin
- carried an additional deployable life raft (air droppable) with a maximum capacity of ten persons inside the cabin for potential emergency use during hoist activities
- carried ten Beaufort Mk28 (passenger) jackets, two Beaufort Mk15 (rear crew) jackets and one additional Beaufort Mk15 crew jacket large size, two Beaufort Mk44 (flight crew) jackets and two Shark LAPP jackets
- was approved to operate in (limited) icing conditions
- was equipped with four seats in the cabin
- was not equipped with one or more handholds for the use of passengers outnumbering the number of seats.

The investigation of the accident under consideration presents an opportunity to assess the performance of the survival equipment. To examine the correct operation of the survival suits, three parallel activities were undertaken:

- A questionnaire was sent to the thirteen passengers and the four crew members requesting information regarding the performance of their immersion suits, life jackets and accessories, as well as about their physical condition.
- The passenger suits were taken to the manufacturer, visually inspected and tested for leaks.
- The crew suits (different manufacturer to the passenger suits) were also taken to the manufacturer, visually inspected and tested for leaks.

Fourteen of the 17 occupants reported having had the sensation of being wet or moist inside their suits, and many had reported leaks from the wrist and neck seals. With the exception of one passenger, who only wore 2 layers of clothing under his immersion suit, all the passengers and all the crew reported to have been wearing appropriate (winter) clothing under their suits. The inspection of the suits revealed that most of the neck seals had been trimmed, and many of these had been trimmed in excess of the manufacturer's recommended values vis-à-vis the neck sizes of the individual suit wearers.

The absence of a warning of the ditching gave the passengers hardly any opportunity to don hoods and gloves prior to their evacuation. Once in the water, many passengers helped each other to put on their gloves. Ten passengers reported having used their gloves and these worked effectively. Only one passenger reported having used a hood which could only be donned with the assistance of other passengers. None of the crew had hoods available in the dedicated pockets in their suits, and only one had gloves available. One of the suit manufacturers explained that the use of a hood can significantly improve the performance of the neck seal on the immersion suit.

The G-JSAR carried ten passenger life jackets. To provide a life jacket for each passenger, the addition of two spare aircrew life jackets and one stretcher life jacket was required. These life jackets were of three different types and some passengers reported that they were not familiar with handling an unknown type of life jacket. The emergency appliances contained within the jackets varied with the different types. Two passengers reported difficulty in inflating their jackets during the subsequent evacuation. Apart from the captain, who lost her jacket during the evacuation, the life jackets for the remaining sixteen occupants were all successfully inflated. None of the occupants used the available buddy lines. An elaborate description of the questionnaire, immersion suits, gloves and hoods, and life jackets is presented in Appendix C, sections 1.16.6.1 to 1.16.6.4.

2.3.3 Life raft release mechanisms

During the investigation, the life raft release mechanisms of the life raft stowed in G-JSAR's left-hand sponson were tested. It was found that this life raft could not be released using either the exterior or the interior release handles. Initially, the cable grip of the release control cable (see

Appendix C, section 1.16.6.5) was suspected to have slipped, but detailed investigation of the cable proved that not to be the case. It turned out that the control lever angle was too large in relation to its horizontal axis and prevented the control lever from functioning in its normal operating range. The Safety Board did not extend its investigation to other helicopter types. Eurocopter stated that the AS 332L2 is the only type that is equipped with this life raft activating mechanism. Based on these findings, the Dutch Safety Board issued three recommendations on 29 March 2007, addressed to the certifying authority for the Eurocopter products, the European Aviation Safety Agency (EASA), advising it to take necessary actions as deemed appropriate. EASA responded to the three recommendations on 29 May 2008. An elaborate description of the test and its results and the recommendations and EASA-responses can be found in Appendix C, section 1.16.6.

2.3.4 Captain's life jacket

The captain lost her life jacket during the evacuation. The captain stated that she was wearing the life jacket during the flight and could not recall when it was lost. During a test in a similar helicopter, it was concluded that the scenario in which the life jacket could have been unsecured while releasing the safety belt after ditching and subsequently lost during the captain's exiting through the cockpit door was most probable. The life jacket was not retrieved after the accident.

2.4 Relevant occurrences

2.4.1 NAM offshore installation blackouts

NAM provided information regarding blackouts that lasted longer than one hour and that had occurred over a 5-year period preceding the G-JSAR occurrence. The information revealed that about 6 weeks before the emergency landing of the G-JSAR, K15B suffered a blackout as well. All staff had stayed on board the installation. In 5 years prior to the G-JSAR occurrence, 5 blackouts lasting longer than one hour occurred on NAM installations that were normally manned. Of these blackouts, 3 occurred within half a year prior to the blackout on K15B. During previous blackouts, personnel stayed on board the installation. Previous blackouts had occurred during the day, late at night or early in the morning. These blackouts were logged as operational downtime.

2.4.2 G-JSAR 'evacuation' flights

Both the Netherlands Coastguard and the Bristow crew stated that 'evacuation' flights similar to the accident flight with the G-JSAR on 21 November 2006 had been executed before. A total of 140 missions for SAR ('operational flights')[37] were executed with the G-JSAR, including the accident flight.
The Safety Board examined the following information:
- 139 SAR reports, excluding the accident flight.[38]
- Netherlands Coastguard annual reports from 2003 to 2006 inclusive.
- Minutes of Periodical Operational SAR Deliberations (POSO).[39]

The SAR reports did not contain any crew comments regarding procedures, equipment or training related to non-emergency evacuation flights. The minutes of the POSO meetings did not contain any issues related to the G-JSAR operation with regard to dispatch, call-out procedures, evacuations of offshore mining installations or the functioning of the Steering Committee, which is responsible for the operational supervision of the G-JSAR dispatch.[40]

Table 1 presents a history of the number of G-JSAR operational flights, SAR training flights, type of operational flights (SAR/MEDEVAC/RIB[41]), and number of reported 'evacuation' flights. There has been a total of six evacuation flights, including the accident flight during the G-JSAR operation.

37 An operational flight is a flight authorized by the Netherlands Coastguard for search and rescue.
38 No SAR report was made of the accident flight.
39 The function of the POSO meetings is described in section 4.8.
40 See the description of the Steering Committee in section 4.3.
41 The 2005 annual report also included hours for RIB: *Rampen en Incidenten Bestrijding (Disasters and Incidents Suppression)*.

Number of G-JSAR flights	2003[42]	2004	2005	2006
SAR operational and training (in total)	41	428	416	655
SAR operational	2	25	64	48[43]
SAR/RIB MEDEVAC	2	8 17	22 42	20 28[3]
Reported platform evacuation flights	1	0	1	4

Table 1: G-JSAR dispatch and reported evacuation flights [source: Netherlands Coastguard annual reports, Bristow Operations logbook information and Bristow SAR reports].

Table 2 presents a summary of the six reported and documented G-JSAR evacuation flights, including the last flight, the accident flight. The Netherlands Coastguard database did not provide information regarding the different emergency phases of the recorded SAR-incidents. [45] The Netherlands Coastguard stated that they follow their Operational plan Search-and-Rescue (OPPLAN-SAR) procedures[46] with the different emergency phases, but could not demonstrate the categorization of the state of emergency phase of SAR-incidents, because it is not recorded in the incident files. The Safety Board's assessment on the basis of the available information, as to whether an emergency situation existed, is presented in the last column.

Mission number	Date	Description of the evacuation flights	Emergency
2	15 December 2003	Seven persons were transported from L9FF to L5-FA1 platform, due to a drifting vessel in close proximity. The 7 persons remained at the L5-FA1 due to the unavailability of a suitable public transport helicopter for their return flight.	yes
31	28 January 2005	Eight persons were transported from the normally unmanned K7-FA1. Public transport helicopters were not allowed to land on the platform due to defective lighting on the helideck combined with poor flight visibility. Four persons were transported to the K14 and the other 4 persons were taken along to Aerodrome De Kooy.	unclear
93	6 January 2006	Nineteen persons from the K5EN, K6D and L4PN were transported to the L7Q due to a lack of water and heating for about 1½ days. Public transport was not available due to icing conditions.	unclear
95	8 January 2006	Three persons were transported from the Q8A. They had been on the platform without food for 3 days. Public transport was not available due to icing conditions.	unclear
138	16 November 2006	Five persons were transported from the Q8B platform because public transport helicopters were not available.[47]	no
140	21 November 2006	Thirteen persons were transported from K15B/Noble George to Den Helder during the night due to a blackout on K15B.	no

Table 2: summary of reported G-JSAR evacuation flights.

42 The G-JSAR operation started on 17 November 2003.
43 The Netherlands Coastguard annual report in 2006 mistakenly reported 47 flights instead of 48.
44 The Netherlands Coastguard annual report in 2006 mistakenly reported 28 SAR/RIB and 18 MEDEVAC flights.
45 See section 3.3.5.
46 See section 3.3.5.
47 This flight was mistakenly left out the Netherlands Coastguard 2006 annual report, because it was not recorded in the Netherlands Coastguard's database for SAR-incidents.

The SAR reports of the five evacuation flights that had been executed prior to the accident flight are presented in Appendix D. Detailed information about these flights was provided by the Netherlands Coastguard. This information revealed that:

- The Netherlands Coastguard categorized all evacuation flights, except mission 138, as 'SAR-incidents'. Mission 138 was not recorded in the Netherlands Coastguard's database.
- It could not be determined whether missions 31, 93 and 95 were executed under emergency conditions on the basis of the information available.
- Mission 2, which concerned the evacuation of personnel to a nearby platform, was executed under emergency conditions. When the emergency situation was discontinued, the G-JSAR returned to Aerodrome De Kooy and left the evacuated personnel on the nearby platform.
- Missions 93 and 95 were performed because the available public transport operators did not have helicopters at their disposal that were approved to operate in icing conditions.
- The G-JSAR is the only AS332L2 helicopter in the Bristow fleet and its operational capabilities exceed those of the other helicopter types in use for offshore transportation from Aerodrome De Kooy considerably. Because of its SAR role, the G-JSAR is equipped with only 2 passenger seats and 2 seats for the rear crew.
- On all flights, the number of occupants in the cabin exceeded the number of available seats.
- The discussions between the offshore oil and gas operators and Bristow via the Netherlands Coastguard concentrated on the issue as to whether the situation was serious enough to allow transportation of all the passengers on one flight or a maximum of two per flight due to the number of available passenger seats.
- In general, the requesting offshore oil and gas operator made the decision that an operation under SAR was allowed without having direct communication with the Bristow crew. In mission 138 and the accident flight (mission 140), communication had taken place between the oil and gas operator and one of the Bristow crew members.
- In one mission, the decision to limit the number of passengers in one flight was abandoned during the mission.
- Missions 2 and 31 originated from a request from NAM to the Netherlands Coastguard for the evacuation of offshore personnel.
- The captain of the flights in missions 31 and 93 was the line check pilot of the Bristow Den Helder SAR base. His co-pilots were the pilot who subsequently acted as captain on the G-JSAR accident flight and the deputy chief pilot of the Bristow Den Helder SAR base. The captain during the flight in mission 95 was the chief pilot for Bristow SAR Operations; his co-pilot was again the pilot being the captain on the accident flight. The co-pilot of mission 138 was also the co-pilot on the accident flight.

A more elaborate summary of the information about the five evacuation flights other than the accident flight is presented in Appendix E.

2.4.3 Bristow Super Puma incidents

Bristow's Flight Safety System includes the reporting of incidents through Air Safety Reports (ASRs) that can be filed by crews after incidents have taken place during flights. Air Safety Reports are stored in the company database.

The Bristow company database was searched for ASRs relating to incidents with Bristow Super Pumas (AS332L and AS332L2) preceding the accident flight, as well as in relation to more recent incidents. The following information was retrieved:

- An accident that took place on 19 January 1995, during which the helicopter ditched in the North Sea under rough sea conditions as a result of a lightning stroke. The helicopter remained upright, enabling the passengers and crew to evacuate with a life raft, from which they were subsequently rescued. There were no injuries. A summary of the investigation can be found in Appendix C, section 1.18.2.
- 42 reported G-JSAR (AS332L2) company incidents[48] over a period of 20 months prior to the accident. An investigation of the relevant ASRs, including a detailed examination of 12 engine- related ASRs, indicated that none could be related to the G-JSAR accident. The same 42 ASRs were checked by Bristow for crew comments regarding procedures, equipment or training related to non-emergency evacuation missions, but none were found.
- A further 41 AS332L company incidents over a period of 20 months prior to the G-JSAR accident were reviewed with similar results.
- An incident that took place on 15 October 2007, during which the flight crew experienced controllability problems in the course of an offshore flight in the UK with an AS332L

48 A *company incident* is an occurrence, other than a reportable accident, or (serious) incident, associated with the operation of an aircraft, which may affect the safety of operations.

helicopter.[49] The aircraft returned safely to its base. A summary of the investigation can be found in Appendix C, section 1.17.1.

Note: events that are not incidents can be filed under Pilots Operations Report. Bristow indicated that no relevant pilots operations reports were filed relating to issues such as procedures, equipment and training related to SAR flights.

2.4.4 Eurocopter AS332L2 controllability incidents

Eurocopter, the manufacturer of the AS332L2 helicopter, was requested to search its database for related incidents that have occurred in the past. Eurocopter informed the Safety Board that they had no record of reported incidents with control problems with the AS332L2 (Super Puma or Cougar; the latter is the military version of the Super Puma). According to Eurocopter, the Super Puma Mk1 and Mk2 version fleet hours as of 31 December 2007 comprised a total of 3,512,000 flight hours. No flight control-related incidents were reported, except the ones mentioned by the Safety Board (see below).

Since the Royal Netherlands Air Force (RNLAF) operates Cougars, the RNLAF was asked to search their database for similar controllability-related incidents that occurred in the past. It turned out that there were two reported cases relating to controllability problems during flights of the first Cougar (S400 with serial number 2400) built for the RNLAF in France in 1996.

When confronted with the 2 RNLAF 1996 incidents, Eurocopter responded saying that these problems had been solved by rerouting an electrical wire. This rerouting was carried out following an incident in 1995 with the same aircraft, flown by a member of Eurocopter crew. During the 1996 RNLAF incidents, a Eurocopter test pilot was the captain. Eurocopter had no information available relating to the two 1996 RNLAF incidents and could not provide the Safety Board with any documentation relating to an internal investigation. According to Eurocopter, it was a misunderstanding, as they did not recover the document relating to the two 1996 incidents. The answer could be found in the known case of the 1995 incident.

Unlike Eurocopter, the RNLAF was able to produce the Eurocopter internal report of the incidents that occurred in 1996. According to the RNLAF, the helicopters were operated under a French civil registration. In both cases, a short cyclic[50] control restriction occurred during the flight of the S400. The RNLAF flights were conducted in daylight and in visual meteorological conditions, with a Eurocopter Super Puma test pilot in command, who returned to base immediately. After the last incident, Eurocopter conducted an investigation but could not find the cause of the cyclic control restriction. After several tests and the replacement of several components (roll damper, trim actuator and the hydraulic unit), no reoccurrence occurred during the following test flights.

An investigation by the RNLAF bureau for technical support revealed 5 technical reports regarding problems related to control systems in Cougar helicopters during the period 1996 - 2005. Four events were related to the automatic flight control system computers (AFCS) and trim actuators. In 2 of these cases, sounds coming from the hydraulic cabinet[51] were recorded. Information from the RNLAF revealed that these AFCS computers and trim actuators had been modified. The Eurocopter internal report concluded by stating that the investigation will be continued. Further information about the RNLAF incidents and the Eurocopter report can be found in Appendix C, section 1.17.3.

2.4.5 Other relevant helicopter incidents

Several databases were checked for similar incidents in the past, including the database from the Dutch Safety Board's predecessor(s), the International Civil Aviation Organization (ICAO) and the International Association of Oil & Gas Producers' (OGP) databases, and other databases from aircraft accident investigation authorities abroad with offshore operations. The relevant information assembled revealed that:

- As a result of a fatal accident in the North Sea (UK) in 1992, in which a helicopter inverted and sank within about 2 minutes after it struck the sea, helicopter airworthiness requirements were amended to include, as a minimum, the facility for automatic deployment of floatation systems upon water entry. All but 5 of the occupants managed to escape from the helicopter before it sank. Of the 12 survivors in the sea, only 6 were recovered alive; the others perished in the hostile sea environment, some of them having survived for a considerable time. The UK Civil Aviation Authority (UK CAA) published the document

49 The incident was reported during the ongoing G-JSAR investigation.
50 The cyclic is the lever used to control the helicopter in forward, aft and sideways directions.
51 Helicopter compartment near the cockpit that contains the main hydraulic components.

Review of Helicopter Offshore Safety and Survival,[52] which addressed all aspects of offshore helicopter safety and survival in the context of an integrated system, with the intention of maximizing the prospects of occupants surviving a helicopter accident at sea. It does not address the causes or prevention of helicopter accidents.

- As a result of an accident with a Bristow helicopter in the North Sea in the UK in 1995, the UK CAA completed a review of the operations manuals of (British) North Sea helicopter operators in 1997 to ensure that they contain the necessary procedures for accomplishing a successful evacuation from a floating helicopter following a ditching or alighting on the sea.
- As a result of an accident in the North Sea in the Netherlands in 1997, the following improvements have been made to offshore helicopter operations:
  - To equip helicopters with a flight data recorder and a cockpit voice recorder and to introduce Crew Resource Management (CRM) training in helicopter companies (in accordance with European regulation)
  - Mandatory Helicopter Underwater Escape Training (HUET) for offshore passengers
  - New survival suits, better neck seals and protective clothing
  - Mandatory offshore passenger pre-flight safety briefings.
- As a result of a serious incident with a Super Puma in the North Sea in Norway in 1998, in which the flight crew inadvertently reduced power on the wrong engine after one of the engine readings became unstable, it was believed that such situations could best be handled by flight crews using theoretical knowledge combined with practical experience acquired on a flight simulator.
- As a result of a serious incident in the North Sea in the Netherlands in 2004, the significance of providing CRM training for helicopter crews was stipulated.

A more elaborate summary of the information concerning the aforementioned investigations is presented in Appendix C, section 1.18.

2.5 Safety study and audit information

2.5.1 Safety study G-JSAR operation

Bristow indicated that the commencement of search and rescue operations at the Bristow Den Helder base was regarded as a progression of established operations at an established company base. Bristow could not provide information as to whether a safety case study or a risk assessment and analysis had been performed for the G-JSAR operation.

2.5.2 Company Group audits

The scope of the investigation was limited to the G-JSAR (Search and rescue) operation. The Safety Board was informed by NAM that the G-JSAR operation had been audited once by one of the operators of the Company Group prior to its operation. After that, individual Company Group operators did audit their respective offshore air transport operator(s) (regularly), but these audits did not include the Bristow Den Helder SAR base during the G-JSAR operation that took place between December 2003 and November 2006.

2.5.3 Bristow audits

Bristow provided information about the internal audits of the Den Helder SAR base performed by their SAR Training and Standard audit team over the years 2004 - 2006. The investigation did not carry out a review of the airworthiness or maintenance part of these audits. A concise summary of relevant details of findings during this period is presented below:

- The performance of the Steering Committee was not checked after the initial meeting
- There seems to be a high turnover of aircrew, requiring constant training remit
- A number of training issues were revealed relating to documentation, requirements and initial, recurrent and simulator training.

A more elaborate summary of the findings can be found in Appendix F. The last audit before the accident flight was held in October 2006. In the summary concerning the observed flying, the following comments were made about the standard of Crew Resource Management:

"All observed flying was of a high standard. Adherence to Standard Operational Procedures was above-average and all crews witnessed, demonstrated a real enthusiasm for the work.

52 *Civil Aviation Publication 641 (CAP 641)*, Civil Aviation Authority 1995.

Safety was considered paramount in all flights. Emergency briefings were comprehensive and realistic. The standard of Crew Resource Management (CRM) exhibited by all was generally good. Because of the mix of nationalities, and the variation in 'mother tongues', there is some potential for misunderstanding within crews. It is, therefore, particularly important that CRM skills are above-average. The unit's approach to the new re-currency targets is positive and dynamic."

2.5.4. Civil Aviation Authority audits

The G-JSAR was operated by a British company and had a British registration. Regulatory oversight of the Bristow operations and its maintenance at the Bristow Den Helder (SAR) base and the G-JSAR are conducted by the Civil Aviation Authority in the United Kingdom (UK CAA). The UK CAA provided information about the audits of the Bristow Den Helder SAR base and Bristow headquarters in Aberdeen performed over the years 2004 - 2006. In addition to performing audits, the UK CAA Flight Operations Inspector responsible for the Bristow oversight was familiar with the Bristow operation through performing as a Bristow first officer/co-pilot.

Relevant findings are presented below (reported concisely):

- Audits of Bristow Den Helder SAR base and Bristow's responses:

May 2005:

- The recording and checking of whether the pilot's qualifications are up to date did not go too well.

Bristow introduced a new system and was confident that this situation would not occur again.

- Line Check Forms were not being annotated as SAR line checks.

All Bristow SAR Line Training captains were informed of the need to state clearly on Line Check Forms that the check was for SAR.

June 2006:
Significant evidence of the fact that the company Quality System was not being applied (level 2 finding[53]):

- A number of pilots did not receive CRM training
- The Den Helder base was not aware of the findings of the Bristow internal audits
- No plans available to resolve these problems.

Bristow responded, stating that:

- All Quality and Health, Safety and Environment policies form an integral part of the company Safety Management System and are documented in a variety of company procedures available at the base and on the intranet
- An audit and Quality briefing to Operations Management is scheduled for 8/9 August 2006. All audits have been reported to the base. The company Flight Safety Officer has issued a reminder to all the bases of the need to hold regular Flight Safety Briefs.
- CRM training will be completed in October/November 2006.

UK CAA responded as follows: UK CAA considered it appropriate to follow up this issue during the visit to Aberdeen in October and closed these findings with the remark that the Quality system would be discussed further during the annual inspection in October 2006.

- Audits of Bristow Aberdeen (headquarters) and Bristow's responses:

October 2006:
The Quality and Safety part of the company was neglected, especially Operations.
Bristow acknowledged this weakness and reported that with the addition of two new personnel since the previous audit in 2005 and by utilising existing lead auditor experience, the internal audit programme for 2006 had been recovered. Ongoing training and development of staff and a closer working relationship with training pilots used in Flying Standards audits has enhanced the scope and depth of audits conducted to date. In addition, training is actively being sought in the JAR-OPS field to be concluded during early 2007, together with the development of a closer working relationship with Operations management.
UK CAA's response: with the replacement of Bristow's Quality and Safety manager and the employment of additional staff to address the issues raised, the CAA accepted this as a positive action and over the next year it was evident that Bristow was making progress and conducting comprehensive internal audits of its operation. This response was considered sufficiently robust by the CAA to close the finding.

53 There are three levels. A level 2 finding means that the deficiency must be resolved within a predetermined time.

September 2007:
A further finding was raised against the Quality System. The Quality Assurance system, procedures and programmes have not been published in any visible form and there is evidence that internal quality audit findings are not being correctly addressed by the individuals nominated to follow up and action the findings.
Bristow responded with reference to the adoption of the top level Quality System manual for Bristow Eastern Hemisphere, which includes the top level Quality processes and procedures.

A more elaborate summary of the findings can be found in Appendix G.

2.6 Information regarding Bristow

2.6.1 Information regarding operational procedures

As mentioned in section 2.2.4, during the return flight, the crew noticed a difference between the two engines. Minutes later, the crew experienced control problems, resulting in the decision to land in the water. The Bristow procedures relating to the handling of the engine behaviour are discussed in this section.

By design, a split engine condition in the AS332L2 is a normal system response for dual engine operation if the performance of one engine or its governing system degrades. In accordance with the AS332L2 flight manual (see section 3.3.2 - Eurocopter), a correct engine alignment following engine or module replacement means an 'engine gas turbine rotor RPM difference' (gas turbine rotor speed difference - Ng difference) equal to or less than 1%. During transit at the Nobel George, the flight data recorder recorded a gas turbine rotor speed difference of approximately 3% for a short time and with an intermittent character. Before the return flight to De Kooy, the difference was below 1% Ng. Flight data recorder data indicate that the first gas turbine rotor speed differences observed by the captain are of a magnitude of approximately 5%. According to the aircraft and engine manufacturers, gas turbine rotor speed differences of less than 7.5% are considered as normal operation. However, in accordance with the aforementioned alignment criteria, Bristow encouraged pilots to report 'splits' of more than 1% to engineering staff for maintenance purposes. Procedures dealing with engine problems published by Eurocopter (in the AS332L2 Flight Manual) and Bristow (in the Operating Manuals and procedures checklists) do not contain a procedure or instruction for engine readings that do not exceed 7.5% difference in Ng.

The AS332L2 Emergency Operating Procedures contain six procedures to be used when the ALARM and DIFF NG captions are illuminated in the cockpit. Except for the sixth Emergency Operating Procedure 'ENGINE MINOR GOVERNOR FAILURE', they all start mentioning these captions as the first indications that the Emergency Operating Procedure is applicable. The first four Emergency Operating Procedures deal with engine failures. The fifth procedure is called 'ENGINE MAJOR GOVERNOR FAILURE'.

2.6.2 Information regarding crew training and checking

General
Table 3 presents an overview of the number of G-JSAR operational flights and the number of SAR training hours and operational flight hours (SAR/MEDEVAC) during its operation in 2004 - 2006, based on information derived from the Netherlands Coastguard annual reports and information from Bristow Operations.

G-JSAR operation from Aerodrome De Kooy	2003[54]	2004	2005	2006
Number of flights (SAR operation and SAR training)	41	428	416	655
SAR training in flight hours	46.5	515.5	464	407
SAR operation in flight hours	5.3	40.7	76.5	32.1
MEDEVAC operation in flight hours	not available			36.5

Table 3: G-JSAR operation [source: Netherlands Coastguard annual reports and Bristow Operations].

54 The G-JSAR operation started on 17 November 2003.

Information relating to Bristow's training requirements can be found in the Training Manual (Operations Manual Part D) and in the Supplement to the Training Manual for the Conversion Training of the Super Puma AS332L2 (Supplement to Operations Manual Part D).[55] A summary of the relevant training information can be found in Appendix H. A list of the most recent training and checking performed by the G-JSAR crew members is contained in Attachment 1 to Appendix C.

The Training Manual requires that the training programme covers all major failures of helicopter systems and associated procedures within a three-year period. The training and checking of emergencies may be conducted in a practical manner and combined with the proficiency check. During checking, the candidate should be able to demonstrate competence in identifying a system failure and satisfactory conduct in carrying out actions straight away from memory and subsequent actions from the Emergency Operating Procedures, without first requiring helicopter/simulator training. Subsequent recurrent training should be used to address any failures noted during checking and/or enhance understanding of the systems and increase confidence in handling abnormal and emergency procedures.

The Training Manual refers to the different training requirements for flight crew and rear crew, but there is no specific program for all the necessary SAR training and checking of rear crew. The manual states that the training program may be combined with emergency and safety equipment training conducted on the helicopter. The Den Helder Base Instructions for SAR[56] state that role training shall be performed while crews are on SAR standby, provided that sufficient flying training hours are available.

Relevant subjects for this investigation with regard to training and checking for the Den Helder SAR base unit are:
- Helicopter training
- Simulator training
- Emergency and Safety Equipment training
- Crew Resource Management training
- Flight crew checking

Helicopter training
The vast majority of the annually programmed training hours for G-JSAR flight crews are used for hands-on training of SAR flight manoeuvres on the aircraft itself. The total number of actual flight hours to be used for SAR training forms part of the contract between Bristow and the Company Group. During the initial contract period, to maintain the required level of SAR expertise (for UK Bristow SAR units providing 24 hours a day/7 days a week SAR operational cover) 45 hours per month of flying training was allocated. From 1 January 2005, the training requirements were reduced to 38 hours/month.

According to Bristow, the reduced hours for the Den Helder SAR unit reflected the lower number of SAR tasks in the Netherlands, i.e. no mountain flying training. However, in order to allow for a reduction in time for SAR crews to get accustomed to their tasks, additional training hours were provided at the start of the contract. The 38 hours per month in the contract resulted in an average of around 60 hours of SAR aircraft training as the control pilot per pilot per year (based on a SAR unit of 8 pilots).

Simulator training
The use of flight simulators is not compulsory and Bristow accepts classroom training as an alternative procedure for training on simulators. Bristow used an AS332L2 simulator at Helisim in Marignac, France, for the training of its G-JSAR crews. This simulator has a cockpit layout similar to the Royal Netherlands Air Force Cougar. The layout of the centre console differs from that of the G-JSAR. Moreover, the visual cues near the ground are poor and some of the emergency procedures for this simulator do not correspond with those in use for the G-JSAR. Bristow stated that, although this simulator has some shortcomings, it is still a very valuable training aid. Despite these shortcomings, the French Direction Générale de l'Aviation Civile (DGAC) qualified the simulator for level D training in accordance with the Joint Aviation Requirement for synthetic training devices (JAR-STD 1H).[57] The UK CAA granted Bristow approval to use the simulator for License Skill Tests.

Simulator training was not included in the G-JSAR contract with the Company Group. Simulator training was added to the training program about 2 years prior to the accident at Bristow's expense.

55 See section 3.3.3.
56 See section 3.3.3 - *Den Helder Base Instructions*.
57 Level D is the highest level of simulator performance in accordance with JAR-STD 1H.

The Bristow training department provided the Safety Board with copies of all available records of training, checking and qualification prescribed in JAR-OPS 3 undertaken by the G-JSAR crew members since the date they completed their initial qualification on the AS332L2. Information extracted from these files is summarized below.

The captain passed her first License Skill Test for the AS332L2 on 17 November 2003. Entries in the captain's personal logbook indicated that since this test, she spent an initial six-hour session in a simulator on 29/30 December 2003, where half of the time was used for instrument (IFR) training and the other half for visual (VFR) training. A second session of six hours was held on 13-14 November 2006 and this time only IFR training was mentioned. The training records at Helisim in Marseille indicated that this last 6-hour simulator session was used by a Bristow crew of two pilots (including the captain) and an instructor.

Some training information, dated 17 November 2006, can be found on one of the captain's Bristow training sheets, This information demonstrates that attention was paid to flight procedures using the cockpit instruments and visual cues from outside generated by a visual system, as well as some selected emergency procedures.

The co-pilot has received one session of simulator training since he undertook his qualification training, which was completed one year before the accident. Information obtained from the simulator company (Helisim, France) showed that this six-hour session took place on 5-6 June 2006 and that the participating crew consisted of two pilots (including the co-pilot) and an instructor. The session was used for the training of flight procedures using the cockpit instruments and visual cues from outside generated by a visual system, for the training of some selected emergency procedures and for proficiency checking.

Emergency and Safety Equipment training
The flight crew was not trained hands-on in the use of the life raft launching procedure and the rear crew members were not trained to perform the role of a line cabin crew member in case of a ditch with passengers. All crew members followed the Helicopter Underwater Escape Training (HUET) programme. This programme provides the training to escape from a mock-up of a cabin with passenger seats, invertly positioned on the bottom of a swimming pool.

Crew Resource Management training
Bristow AS332L2 crews received training on Crew Resource Management (CRM) items during winch training sessions on the aircraft itself. The captain's training file indicates that she satisfactory attended classroom CRM recurrence training in October 2005 and September 2006. The co-pilot also attended such training for the last time in September 2006. There are no records relating to the content of these courses.

According to Bristow procedures, the captain may take over controls from the co-pilot. The flight crew stated that within the Bristow SAR operation, it was common practice that:

- The captain does not take over the controls in an emergency situation; and
- The autopilot upper modes are switched off as soon as non-standard situations develop during flight.

The Bristow management added that prior to a decision to ditch due to control problems, it would be expected that the captain would confirm the problem by taking control. The Bristow procedures on this subject leave the decision-making to the captain. See Operations Manual Part A - paragraph 4.6 First Officer Handling the Aircraft (Appendix I - Crew flying duties).

Flight crew checking
In accordance with European requirements, the G-JSAR flight crew had an Operator Proficiency Check every six months and a SAR line check every year. The purpose of the Operator Proficiency Check is to demonstrate the flight crew's competence in carrying out normal, abnormal and emergency procedures. The line check shall be held on the helicopter to demonstrate competence in carrying out normal line operations described in the Operations Manual. As described in the Bristow Operations Manual, to qualify for SAR operations, Bristow pilots dedicated to SAR units are not required to complete a commercial air transport line check. However, pilots at a SAR unit who are required to undertake commercial air transport operations must complete a Commercial Air Transport line check. Both the captain and the co-pilot of the G-JSAR had recently successfully completed a line check for SAR operations.

2.7 Actions taken and investigation performed by involved parties

2.7.1 Actions taken by NOGEPA

After the accident with the G-JSAR, a representative of the aviation working group of the Netherlands Oil and Gas Exploration and Production Association was appointed as coordinator of the Steering Committee. The Steering Committee currently holds an average of three meetings per year, or more when necessary, with representatives from the Netherlands Coastguard and Bristow. The NOGEPA coordinator reports to its aviation working group. The working group holds about five meetings per year. All offshore operators that are members of NOGEPA are represented in this aviation working group.

2.7.2 Actions taken and investigation performed by NAM

Because of the accident with the G-JSAR, the SAR performance capacity for the oil and gas operators was degraded. NAM therefore took precautions by flying transport flights to remote offshore installations with half the usual number of passengers, in order to increase the survivability of passengers and crew in the event of a ditching or water landing. Reducing the number of persons to be rescued from the water allows for taking them to a safe environment within the set time limit. As soon as the G-JSAR was replaced by another SAR helicopter, these precautions were withdrawn. A safety alert was also issued within the Shell Exploration and Production Europe organisation on 8 December 2006 to emphasise to helicopter passengers the importance of ensuring wrist/neck seals are tight and zips are fully closed before boarding a helicopter.

NAM performed its own investigation into the incident. The NAM investigation included the decision to evacuate, performance of safety equipment and emergency procedures, rescue, recovery and emergency response processes. It therefore excluded the power failure on the K15-FB-1 platform (which was investigated in a separate NAM study and is not relevant to this report) and the technical failure of the helicopter. A representative of the State Supervision of Mines joined the NAM investigation team in order to acquire knowledge of the findings of this investigation as soon as possible, to verify that the most important aspects of the incident formed part of the NAM investigation and to prevent interference with the other investigations.

Within the context of the investigation, interviews were carried out with passengers and other involved parties, logbooks and documentation were examined and the safety equipment was inspected. The most relevant conclusions from the NAM report[58] are reported below. The entire list of relevant recommendations and the follow-up actions from NAM can be found in Appendix J.

Decision to evacuate

Conclusions:
- There was no real emergency on K15B (nor on the Noble George Sauvageau) which warranted an evacuation of non-essential staff after 21.00 using the G-JSAR helicopter:
  - Well-being of staff was the main reason for transporting them to shore;
  - The risk of helicopter flying was not taken into account sufficiently in the decision-making process;
  - The specific risk of using G-JSAR for transportation was not understood.
- NAM's infrastructure is dependent on regular flying and flying risks and mitigation measures are included in high-level risk analyses (e.g. as used for Safety Cases and Rescue at Sea analyses). There is, however, limited evidence of trend monitoring or periodic evaluation of the helicopter risks, with the ultimate goal being to confirm ALARP.
- There was insufficient challenge (and intervention) to prevent the use of G-JSAR to transport staff to shore.

Survival at sea and rescue

Conclusions:
- The aircraft carried 3 life rafts, only one of which was deployed successfully. Only 2 out of the 17 passengers and crew managed to board this life raft.
- There are mixed beliefs as to whether a helicopter, landing with floats deployed, will capsize immediately after landing, and a lack of clarity as to whether passengers/crew should remain on board until life rafts are deployed, or evacuate immediately to sea.
- Some Personal Protective Equipment did not perform to, or deviated from, the industry

58 Incident Investigation Report, *Search and Rescue Helicopter (G-JSAR) Emergency Landing at Sea,* Nederlandse Aardolie Maatschappij B.V., 9 February 2007.

standard, or was not used effectively by the survivors:
- The passengers' survival suits ranged from soaking wet through to relative dryness
- The hoods were not used.

2.7.3 Actions taken and investigation performed by Bristow

As a result of the G-JSAR being unserviceable, Bristow initially replaced this aircraft with a Eurocopter AS332L SAR helicopter with a Norwegian registration. In December 2007, this helicopter was replaced by a Sikorsky Sea King S-61 SAR helicopter with British registration that was subject to the same contract with the Company Group.

After the G-JSAR accident, Bristow drafted a Special Bulletin,[59] because significant problems with regard to survivability were revealed in the early stages of its internal investigation, see Appendix K. Bristow made the following recommendations (which are also applicable to other types of aircraft within the Bristow fleet):

1. "It is recommended that the Emergency and Safety Equipment training for rear crew include a cabin evacuation using live persons.
2. It is recommended that, in order to reinforce the academic learning, Emergency and Safety Equipment training be amended to require the candidate to physically pull those handles which would be required to be activated in a real ditching.
3. It is recommended that Emergency and Safety Equipment training in aircraft with sponson mounted dinghies with a means of deployment contained within the stowage, be expanded to require the visual identification (and touch drill) of that deployment handle.
4. It is recommended that all primary deployment handles of sponson mounted dinghies are illuminated whenever the floatation equipment is activated."

Bristow indicated that prior to the accident with the G-JSAR, the Operation Manual Part D (Training Manual) was undergoing amendment, but this was stopped to allow for the lessons learned to be included after the accident. In the meantime, the whole manual has been rewritten. With regard to the Emergency and Safety Equipment training, Bristow indicated that it had accomplished the following:

- A new Aircraft Evacuation drill has become effective.
- Initial, recurrent Emergency and Safety Equipment training and the checking requirements for crew other than flight crew have been clarified and amended.
- Instructions for the conduct of Emergency and Safety Equipment training and checking (applicable to both front and rear crew) have been made more robust, including making the use of touch drills, talk-through and activation of handles/levers compulsory where possible, as well as combined front/rear crew training, especially for the evacuation drill element of the Emergency and Safety Equipment.

More details of the changes to the Training Manual can be found in Appendix H.

2.7.4 Actions taken and investigation performed by Eurocopter

Eurocopter issued an internal accident investigation report on 28 November 2006 following the accident, see Appendix L. Eurocopter stated that during the ongoing (technical) investigation, it kept EASA informed of the possible scenarios of helicopter malfunction and the progress of the investigation. Eurocopter proposed a detailed plan to test the aircraft systems in relation to the control of the aircraft. Furthermore, it was proposed that the relevant components be removed from the aircraft following a system test, in order to perform a detailed component check. The plans were also discussed with the French Bureau d'Enquêtes et d'Analyses and the UK Air Accident Investigation Branch and agreed upon. On the basis of the test results, Eurocopter concluded in its report:

"The investigation performed on the aircraft in accordance with the programme defined by the Design Office did not provide evidence of any direct physical issue that could explain a kind of "blockage" of the controls. However, the observations and facts gathered at different stages of the investigation lead Eurocopter to believe that the collective stick autopilot switch on the pilot side appeared to be the only component that failed. In addition, observations showed that the "beating" of the electro valve was only associated with the switch being in the loop of the electrical system.

Therefore, Eurocopter believes that the switch is the fundamental fact in Eurocopter's probable assumptions. The "beating" of this electro-valve induces a kind of sinusoidal variable hydraulic

59 *Special Bulletin,* Bristow Eastern Hemisphere Flight Safety Office, 22 December 2006.

pressure, which acts directly on the cyclic sticks. Because of its frequency, this phenomenon did not trigger any alarm on the cockpit warning panel and the autopilot hydraulic assistance did not work properly (higher loads on the controls).

The speed of the helicopter, which was close to 155 knots, is an aggrieving factor confirmed by Eurocopter's flight test pilot. The crew's workload increased to control the aircraft carrying higher loads in order to pilot through the autopilot hydraulic block. The aircraft was also experiencing meteorological conditions that were challenging for the instrument. Eurocopter believes that the crew was facing a difficult situation in terms of controlling the aircraft.

Note: An identical incident took place on a Super Puma MK1 (October 2007) and the report reads "the control became stiff", with jerks on the cyclic stick too. If we add the factor of high speed to it, this scenario is very likely to apply to the G-JSAR too ."

In response to the publication of the intermediate report of the Dutch Safety Board on 29 March 2007 in relation to the life raft mechanism (see section 2.3.3), Eurocopter issued two Service Bulletins that apply to AS332L2 helicopters:[60]

- SB 25.01.93 regarding life rafts in sponsons on 7 July 2007. This Service Bulletin contains instructions in order to ensure that the cable grips of the life raft release controls are installed correctly.
- SB 25.01.98 regarding life raft release system improvement on 16 April 2008. This Service Bulletin contains instructions for replacing cable clamps on life raft squib percussion controls.

With regard to the technical investigation to establish the probable cause(s), Eurocopter has not taken corrective measures yet, but issued an operator's message for pilots and maintenance personnel on 11 June 2008 for the AS332L series. The information in the message is to warn flight crews about the (remote) possibility of controllability problems during a flight, on the basis of the G-JSAR accident and the incident with a Super Puma (AS332L) that took place on 15 October 2007 in the UK, and refers to procedures in the respective Flight Manuals for proper rotor flight control (see Appendix M).
At the end of 2008, Eurocopter announced that it had taken the Safety Board observations from the G-JSAR investigation into account. The newly set-up Fleet Safety organisation will take part in supporting the Eurocopter accident investigations by coordinating all the relevant parties and by establishing an improved relationship with the partly-owned simulator company, Helisim.

2.7.5 Actions taken by State Supervision of Mines

The State Supervision of Mines did not conduct a separate investigation, but instead took part in the investigation carried out under the control of the NAM. On 20 March 2007, the main conclusions from State Supervision of Mines' point of view were issued in a Health and Safety Information Bulletin.
A summary of these conclusions is presented below:

1) Although the decision to evacuate was taken with the best of intentions for the staff involved and though the decision was also agreed with all line managers, the rescue helicopter should, in hindsight, not have been used for this evacuation. There was no real emergency; the staff involved could have remained on board the mobile drilling installation, albeit improvised and in some discomfort.
2) The two externally mounted life rafts on the rescue helicopter could not be used/ activated. A third (smaller) life raft was deployed at a later stage by the crew, but quickly drifted away from the helicopter, as a result of which the passengers or pilots could not be taken on board.
3) Various opinions exist as to the behaviour of a helicopter after it lands on the sea and its flotation devices are activated. It is also unclear whether passengers and crew should stay on board or whether they should immediately jump into the sea. In this particular case involving the rescue helicopter, it was assumed that the helicopter would capsize, which, in fact, did not occur.
4) Some personal protective equipment did not function optimally or was not used effectively. Some of the survival suits had leaked water, the hoods and gloves were not used by everyone and in certain cases, the lights on the life jackets did not work.

60 A Service Bulletin (commonly abbreviated to SB) is a notification to aircraft owners/operators from the manufacturer of a known safety issue with a particular model of aircraft, engine, avionics or other system.

The Health and Safety Information Bulletin can be found in Appendix N.

2.7.6 Actions taken by the Ministry of Transport, Public Works and Water Management's

North Sea Task Force
A week after the G-JSAR accident, the interdepartmental working group Task Force Noordzee (North Sea Task Force) within the Ministry of Transport, Public Works and Water Management[61] held a special SAR meeting to discuss the operational consequences of the decrease in SAR capacity and performance for the offshore helicopter operations above the North Sea. As a result of this meeting, the NOGEPA and helicopter operators decided to reduce the number of passengers on its transport flights to offshore installations following a similar immediate reaction by NAM (see section 2.8.1). A so- called Flying Staff Instruction for helicopter offshore operators became effective on 9 December 2006. This instruction contains a 'matrix of permitted operation' for commercial air transport on the Dutch Continental Shelf. As soon as the G-JSAR was replaced by another SAR helicopter, these precautions were withdrawn.[62]

ICAO 2008 audit
In April 2008, the Kingdom of the Netherlands was subjected to an ICAO safety oversight audit as part of the ICAO universal safety oversight programme. The audit was carried out with the objective of reviewing the State's compliance with ICAO standards and recommended practices in all safety-
related Annexes and their associated guidance material, as well as with related Procedures for Air Navigation Services.

During the audit, a finding was raised against the Kingdom because no evidence was provided indicating that a mechanism had been established to carry out a safety oversight of the provision of search and rescue services.[63]

The following actions were proposed by the Kingdom of the Netherlands in the corrective action plan:[64]

- The Civil Aviation Authority of the Netherlands will advise on the different possibilities for establishing the safety oversight function of the Netherlands Coastguard.
- The Netherlands Coastguard will select the best way to establish the oversight function and will propose this to the Coastguard Board.
- The Directorate General for Public Works and Water Management North Sea will create the legal basis for the oversight function.

The Ministry of Transport, Public Works and Water Management had indicated that steps have been taken in 2009 to introduce a quality system for the Coastguard and that supervision on the SAR duties of the Coastguard as a part of that quality system is being developed.

2.7.7 Actions taken by the UK Civil Aviation Authority

The UK Civil Aviation Authority stated that it would be inappropriate to take formal action until the outcome of the Safety Board's investigation has been concluded and is awaiting the outcome of the investigation and recommendations. Bristow, in the meantime, at the informal recommendations of the UK CAA, instigated revised crew Emergency and Safety Equipment Training procedures.

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61 The responsibilities of the North Sea Task Force are described in section 4.12.
62 According to the contract between Bristow and the Company Group, Bristow had to ensure that the following information was passed immediately to the Joint Rescue and Coordination Centre in the event of G-JSAR downtime for maintenance or other purposes: estimated duration of downtime, nature of unserviceability, estimated arrival time of backup aircraft (if appropriate) and availability of alternative SAR resources.
63 *Draft final report on the safety oversight audit of the civil aviation system of the Kingdom of the Netherlands*, Appendix 1-7-09, Findings and recommendations related to Air Navigation Services.
64 *Draft final report on the safety oversight audit of the civil aviation system of the Kingdom of the Netherlands*, Appendix 3A-7-9, Corrective action plan proposed by the Netherlands in relation to Air Navigation Services.

3 FRAME OF REFERENCE

3.1 General

This section specifies the criteria that are used as a reference with regard to the investigation of the facts and circumstances leading to, during and after the emergency landing in the North Sea of the G-JSAR on 21 November 2006. The Dutch Safety Board uses this frame of reference in order to test its findings, as established during the course of the investigation, with regard to the analysis of the sequence of events, the determination of the direct cause, including the underlying causes, the extent of the consequences, the determination of the structural safety deficiencies and to formulate its recommendations.

This frame of reference has been divided into three parts. The first part describes the relevant legislation and regulations and has been arranged according to the legal subjects as they are relevant to this investigation. The second part is based upon the international and national guidelines, as well as company agreements and manuals, including the internal safety management systems. Since each stakeholder in this investigation is committed to its own particular guidelines, directives, contracts and company regulations, this part of the frame of reference has been arranged following the (most important) stakeholders in the investigation. Illustration 8 represents a schematic overview of the scope of the applicable regulations, standards, certificates, standards and agreements for this investigation.

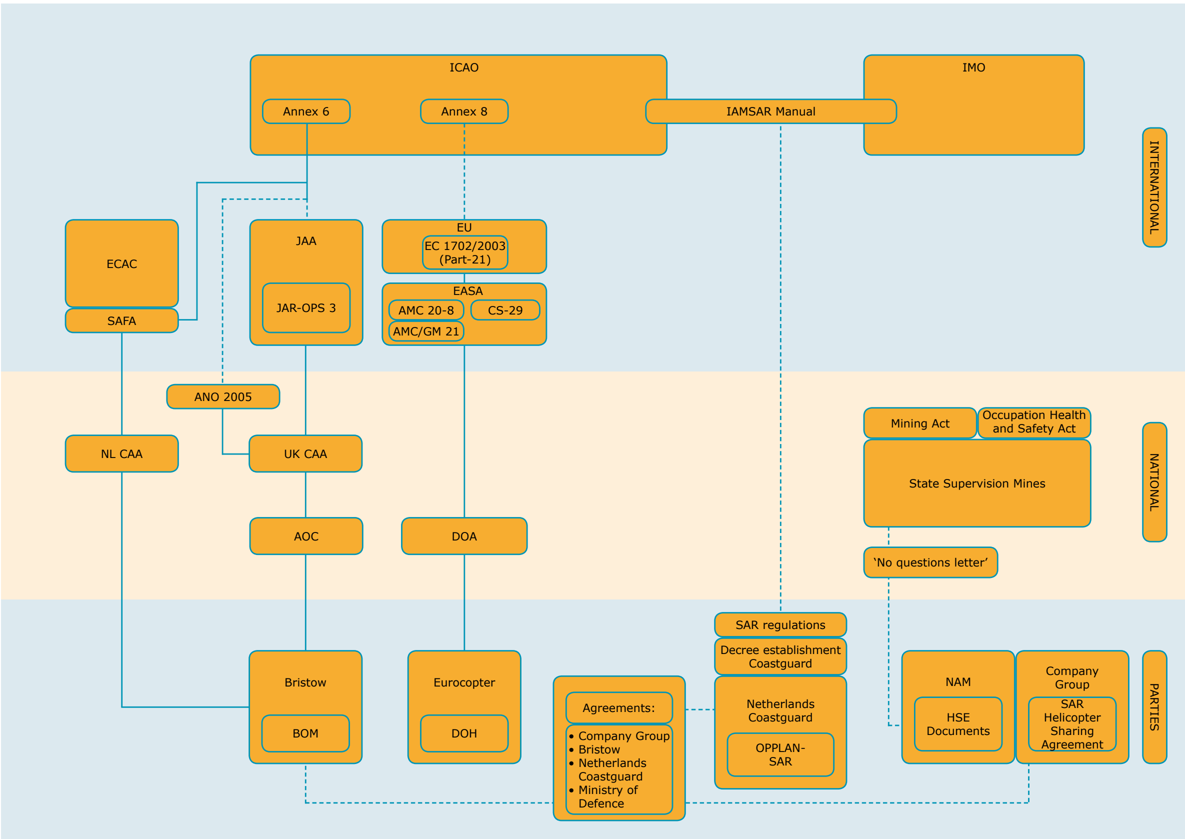


Illustration 8: scope of applicable regulations, standards, certificates, standards and agreements for this investigation.

The third part of the frame of reference describes the standards used by the Safety Board to assess how the parties concerned should carry out their responsibilities and implement their safety management systems. This part of the frame of reference is not specifically based upon the organisation of the parties involved and is of a more general nature. This third part can be used as a guideline for assessing the adequacy of the safety management systems as established by the different parties involved, which are described in the second part of the frame of reference. The Safety Board has formulated five safety priorities that indicate the factors that may be relevant (to a greater or lesser extent).

3.2 Legislation

3.2.1 Mining and Occupational Health and Safety

The relevant legislation and regulations for this part of the investigation are: the Mining Act (2003), Mining Decree (2003), Mining Regulations (2003), Occupational Health and Safety Act (1998) and the Occupational Health and Safety Decree (1997). A short description is given below:

Mining Act (Mijnbouwwet 2003)
The Mining Act lays down the terms and conditions that apply to the process of obtaining, keeping and executing a permit for the exploration and production of minerals. Part 4 of article 33 states that the execution of processes granted in a permit should not adversely affect safety. The State Supervision of Mines is responsible for the supervision and enforcement of the Mining Act. This inspectorate forms part of the Ministry of Economic Affairs.

Mining Decree (Mijnbouwbesluit 2003)
The Mining Decree contains specific rules for implementing the Mining Act. These rules mainly focus upon the process of exploration and production of minerals. Part of the Decree is the rule for an Emergency Response Plan. This plan in the mining decrees focuses upon the environment and the safety of shipping and fishing.

Mining Regulations (Mijnbouwregeling 2003)
The Mining Regulations provide detailed regulations. For instance, chapter 4 deals with the positioning and terms and conditions in relation to helicopter decks, navigation aids and telecommunication equipment on offshore installations. These regulations do not play an important role in this investigation.

Occupational Health and Safety Act (Arbeidsomstandighedenwet 1998)
Rules and regulations on occupational health and safety for mining installations have been changed recently. These used to form part of the old Mining Act and Regulations. Since 2003, the Occupational Health and Safety Act also applies to installations that are subject to the Mining Act. However, State Supervision of Mines still acts as the supervisory inspectorate for occupational health and safety on mining installations. On 1 January 2007, the Occupational Health and Safety Act was amended. Changes include a focus on employers taking responsibility for occupational health and safety, thus supporting a decreasing need for specific and detailed regulations. The following descriptions of articles of the Occupational Health and Safety Act refer to the act that was in force on 21 November 2006. The articles referred to have not substantially changed in the new act.

Article 3 of the Occupational Health and Safety Act compels employers to manage health and safety at work to the best of their abilities. The work has to be organized in such a way (state of the art) that the health and safety of an employee is not adversely affected. Employers will, according to article 5, conduct a hazard identification and analysis (Risico-Inventarisatie en -Evaluatie - RI&E). This analysis incorporates risk mitigation measures to the hazards identified. An action plan mitigating the acknowledged shortcomings forms part of the report. In addition to hazard identification and analysis, employers need to educate their employees to be able to cope with the potential hazards caused by their work and the environment in their place of work. Safety training and the use of Personal Protective Equipment (PPE) forms part of that education (article 8).

Occupational Health and Safety Decree (Arbeidsomstandighedenbesluit 1997)
The Occupational Health and Safety Decree in Chapter 2 Part 6 (articles 2.40 to 2.42i) sets specific demands on mining industries. As part of article 3 of the Decree, a health and safety management system (hereinafter referred to as the safety management system or SMS) should be in place. A health and safety document must be prepared for each mining installation. Safety training and Emergency Response Training form part of the management system. This includes down manning and evacuation. Chapter 3 part 3C of the Occupational Health and Safety Decree (articles 3.37j to 3.37y) sets requirements for the mining installation, including requirements for instructions for a safe means of transportation of people to and from the mining installation and the requirement for an emergency plan, such as in the event of an evacuation.

3.2.2 Civil aviation

This section contains an outline of the relevant international standards, recommended practices, national legislation and rule-making with regard to civil aviation. The regulation of civil aviation has a strong international nature. Consequently, international law and guidelines provide the basis for this part of the framework.

In this section, a distinction is made between binding (inter)national law and legislation on the one hand and international standards and recommended practices which are of a less binding nature on the other. For a large part, the international standards and recommended practices are not binding in so far as an absolute obligation to implement these rules in national legislation does not exist. However, as implementation at a national level is accomplished on practically every occasion within the European countries, these international standards and recommended practices do indeed appear to be binding in nature.

The international rules with regard to aviation safety that are relevant to this investigation (see illustration 8) are:

1. Standards and Recommended Practices in Annexes from the International Civil Aviation Organization (ICAO)
2. Regulations from the European Community
3. Requirements which apply to the operation of helicopters for the purpose of commercial air transportation from the Joint Aviation Authorities (JAA)
4. Requirements which apply to the operation of British registered helicopters for the purpose of commercial air transportation
5. Safety Assessment of Foreign Aircraft (SAFA)

Ad. 1 International Civil Aviation Organization Annexes

Practically every country in the world is a contracting state to the Convention on International Civil Aviation (the Chicago Convention) which, in its original form, was established in 1944 to facilitate international aviation. The convention provides Annexes containing standards and recommended practices relating to numerous issues in relation to a safe and orderly international civil aviation. According to the Convention, the contracting states endeavour to bring their national legislation in line with these standards and recommended practices. If a standard is not adopted, the contracting state must notify ICAO accordingly. All other contracting states will be informed about the filed differences through ICAO. This procedure does not apply to the implementation of recommended practices.

Annexes 6, 8 and 12 are of particular interest to this investigation.

ICAO Annex 6 - Operation of Aircraft - Part III - Helicopters

The purpose of Annex 6 is to contribute to the safety of international air navigation by providing criteria for safe operating practices. Accordingly, a contribution is made to the efficiency and regularity of international air navigation and contracting states are encouraged to accept commercial and general aviation aircraft of another state that are operated in conformity with these criteria to fly into, or across, their territory.

Annex 6, Part III (Helicopters) specifies the requirements for commercial air transport and for general aviation with helicopters. Chapter 2 (Applicability) of Annex 6, Part III stipulates:

“The Standards and Recommended Practices contained in Annex 6, Part III, shall apply to all helicopters engaged in international commercial air transport operations or in international general aviation operations, except that these Standards and Recommended Practices do not apply to helicopters engaged in aerial work.”

According to Annex 6, Part III (Chapter 1, definitions), general aviation is defined as:

“An aircraft operation other than a commercial air transport operation or an aerial work operation.”

And aerial work is defined in Annex 6, Part III (Chapter 1; Definitions) as:

“An aircraft operation in which an aircraft is used for specialized services such as agriculture, construction, photography, surveying, observation and patrol, search and rescue, aerial advertisement, etc.”

As (international) SAR operations are designated as aerial work, this category of operations is not considered to be general aviation or commercial air transport. Consequently, SAR operations are excluded from the applicability of Annex 6, Part III and no standards or recommended practices shall apply.
However, with regard to commercial air transport operation and general aviation operation, Annex 6, Part III provides various safety requirements and procedures that are relevant to the investigation under consideration.

ICAO Annex 8 - Airworthiness of Aircraft - Part IV - Helicopters
Annex 8 provides Standards and Recommended Practices with regard to the airworthiness of aircraft, including the requirements relating to the type certification, design approval, certification of airworthiness and continuing airworthiness (please also refer to ad.2 as indicated below for further information on these items). The initial three chapters of Annex 8 are introductory in nature. These chapters apply to all categories of aircraft. Chapter 4 deals with continuing airworthiness and applies to all aircraft. The following information is relevant to the investigation:

Article 4.2.1.1
"The State of Design of an aircraft shall:

a) Transmit to every Contracting State which has advised the State of Design that it has entered the aircraft on its register in accordance with 4.2.3 a), and to any other Contracting State upon request, any generally applicable information which it has found necessary for the continuing airworthiness of the aircraft, including its engines and propellers when applicable, and for the safe operation of the aircraft, (hereinafter referred to as mandatory continuing airworthiness information) and notification of the suspension or revocation of a Type Certificate;

b) Ensure that, in respect of aeroplanes over 5700 kg and helicopters over 3175 kg, maximum certified takeoff mass, there exists a system for:
    i) Receiving information submitted in accordance with 4.2.3 f)
    ii) Deciding if and when airworthiness action is needed
    iii) Developing the necessary airworthiness actions and
    iv) Promulgating the information on those actions including that required in 4.2.1.1 a);
c) Ensure that, in respect of aeroplanes of over 5700 kg maximum certified take-off mass, a continuous structural integrity programme exists to ensure the airworthiness of the aeroplane. The programme shall include specific information in relation to corrosion prevention and control; and
d) ensure that, where the State of Manufacture of an aircraft differs from the State of Design, an agreement is acceptable to both States to ensure that the manufacturing organisation cooperates with the organisation responsible for the type design in assessing information received on the basis of experience with operating the aircraft."

Article 4.2.3 stipulates

"The State of Registry shall:
(…)
(f) ensure that, in respect of aeroplanes of over 5700 kg and helicopters of over 3175 kg maximum certified take-off mass, a system exists whereby information on faults, malfunctions, defects and other incidents that cause or may cause adverse effects on the continuing airworthiness of the aircraft is transmitted to the organisation responsible for the type design of that aircraft."

Article 4.2.4 stipulates

"All Contracting States
Each Contracting State shall establish, in respect of aeroplanes of over 5700 kg and helicopters of over 3175 kg maximum certified take-off mass, the type of service information that must be reported to its airworthiness authority by operators, organisations responsible for the type design and maintenance organisations. Procedures for reporting this information shall also be established."

ICAO Annex 12 - Search and rescue
Annex 12 to the Convention of Chicago sets forth the provisions for the establishment, maintenance and operation of search and rescue services in the territories of the contracting States. It contains Standards and Recommended practices with regard to the organisation of search and rescue services, cooperation between states, preparatory measures and operating procedures. The definitions as outlined below are of interest in connection with the investigation under consideration:

According to Annex 12 (Chapter 1, definitions) the distress phase is understood to be:

ICAO Annex 12 - Search and Rescue
"A situation in which there is a reasonable certainty that an aircraft and its occupants are threatened by grave and imminent danger and require immediate assistance."

And according to Annex 12 (Chapter 1, definitions) rescue is:

"An operation to retrieve persons in distress, provide for their initial medical or other needs and deliver them to a place of safety."

And, finally, according to Annex 12 (Chapter 1, definitions) search is defined as:

"An operation normally co-ordinated by a rescue coordination centre or rescue sub-centre using available personnel and facilities to locate persons in distress."

Article 2.1 sub 2.1.1 stipulates:
"Contracting States shall, individually or in cooperation with other States, arrange for the establishment and prompt provision of search and rescue services within their territories to ensure that assistance is rendered to persons in distress. Such services shall be provided on a 24-hour basis."

Ad. 2 Regulations of the European Community
Regulations of the European Community apply directly to the Member States and prevail over national legislation. Consequently, these regulations - contrary to the EC directives by which the Member States are required to incorporate the relevant subject matter into their national legislation- are comparable de facto to the legislation at national level.

The European Aviation Safety Agency (EASA)
EASA has been established by Regulation EC 1592/2002 of 15 July 2002 (which has since been replaced by Regulation EC 216/2008 of 20 February 2008). EASA is responsible for the implementation of European Community regulations relating to aviation safety in accordance with Regulation EC 1702/2003 and Regulation EC 2042/2003. Subsequently, EASA provides for the further development of guidelines in relation to compliance with these implementing rules in the Acceptable Means of Compliance (AMC). These AMCs are not strictly binding but indicate how compliance with the implementing rules can be achieved. Within the applicable means available, alternative compliance with the requirements of the implementing rules is permitted. Furthermore, EASA issues guidelines containing further clarification with regard to its requirements, the Guidance Material.

Regulation EC 1702/2003
Regulation EC 1702/2003 of 24 September 2003, as mentioned above, stipulates the requirements and procedures in the field of certification with regard to the (initial) airworthiness and environmental certification of aircraft and related parts, appliances and products and also the certification of design and production organisations. Attached to the regulation is an annex, called Part 21, which contains detailed requirements that must be fulfilled in order to qualify for certification in the fields as mentioned above. Certification as well as supervision is the prerogative of EASA.

Article 21A3 of Part 21 requires that the holder of a type-certificate or another relevant approval issued in pursuance of regulation EC 1702/2003 shall have a system for collecting, investigating and analysing reports of, and information relating to faults, malfunctions, defects or other incidents which cause or may cause adverse affects on the continuing airworthiness of the product, part or appliance covered by the type-certificate. Information about this system shall be made available to all known operators of the product, part or appliance and, upon request, to any person authorised under other associated implementing Regulations. Furthermore, these faults, malfunctions or defects shall be reported to EASA if they have resulted or may have resulted in an unsafe condition. When an incident reported to EASA results from a deficiency in the design, or a manufacturing deficiency, the holder of the type-certificate shall investigate the reason for the deficiency and report the results of its investigation and any action it is taking or proposes to take to correct that deficiency to the Agency.

Article 21A.3B of Part 21 deals with the issuance of the Airworthiness Directives. An Airworthiness Directive is a document issued or adopted by EASA which mandates actions to be performed on aircraft to restore an acceptable level of safety, when evidence shows that the safety level of this aircraft may otherwise be compromised. EASA issues an Airworthiness Directive if:

1. An unsafe condition has been determined by the Agency to exist in an aircraft as a result of a deficiency in the aircraft or an engine, propeller, part or appliance installed in this aircraft and
2. That condition is likely to exist or develop in other aircraft.

With regard to the requirements pursuant to the regulation, a set of so-called Acceptable Means of Compliance and Guidance Material is available. Decision no. 2003/1/RM of 17 October 2003 issued by the Executive Director of the Agency establishing Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Part 21 is of primary importance in this regard.

GM 21A.3(a) elaborates upon the requirements for the "system for collection, investigation and analysis of data" as indicated in article 21A3 of Part 21: the word "collection" means the setting up of systems and procedures which will enable relevant malfunctions, faults and defects to be properly reported when they occur.

AMC 21A3B(b) provides a detailed definition of the concept of "unsafe condition", which, in connection with the investigation under consideration, is a concept of vital importance, as a similar incident must only be reported to EASA and EASA is only able to issue an Airworthiness Directive in unsafe conditions. Added to this AMC is GM 21A3B(b), which provides extensive guidelines, together with a list of examples, in order to determine if a condition is unsafe.

Furthermore and of a rather indirect interest is Decision 2003/12/RM of 5 November 2003, issued by the Executive Director of the Agency that aims to establish generally acceptable means of compliance for the airworthiness of products, parts and appliances. Part AMC 20-8 deals with the subject of "Incident Reporting".

Although in this frame of reference the subject matter of incident reporting is approached further in a much wider context, various provisions are of interest in this specific context:

- In AMC 20-8, paragraph 10 sub c, it is established that if a design organisation receives a report of an incident from its primary source of information, it will normally perform some kind of analysis to determine whether an incident has resulted or may result in an unsafe condition and a report should be made to the authority.
- AMC 20-8, paragraph 10 sub d, stipulates that the primary concern of production organisations is to inform design organisations of deviations. Only in the event that an analysis in conjunction with the designer indicates that the deviation could lead to an unsafe condition should a report be made to the Agency or the National Authority.

Finally, the criteria established by EASA with regard to type certification are laid down in the so-called Certification Specifications (CS). CS 29 provides airworthiness standards for large rotorcraft.

CS 29.1529 stipulates:

"CS 29.1529 Instructions for Continued Airworthiness
Instructions for continued airworthiness in accordance with Appendix A to CS-29 must be prepared."

Appendix A to CS 29 provides instructions in relation to continued airworthiness. Appendix A, article A29.2 stipulates:

"A29.2 Format
(a) The instructions for continued airworthiness must be in the form of a manual or manuals as appropriate for the quantity of data to be provided.
(b) The format of the manual or manuals must provide a practical arrangement."

And article A29.3, in so far as relevant in this context:

"A29.3 Content
(…) The instructions for continued airworthiness must contain the following manuals or sections, as appropriate, and information:
(…)
(2) Trouble-shooting information describing probable malfunctions, how to recognise those malfunctions and the remedial action for those malfunctions.
(…)"

Article 29.1581 of CS 29 is of interest to this investigation, in which the following is stipulated:

"CS 29.1581 General
(a) Furnishing information. A Rotorcraft Flight Manual must be furnished with each rotorcraft, and it must contain the following:
    (1) Information required by CS 29.1583 to 29.1589.
    (2) Other information that is necessary for safe operation due to design, operating or handling characteristics.
    (b) Approved information. Each part of the manual listed in CS 29.1583 to 29.1589 that is appropriate to the rotorcraft must be furnished, verified and approved, and must be segregated, identified and clearly distinguished from each unapproved part of that manual.
(…)"

Regulation EC No. 2042/2003
Regulation EC no. 2042/2003 of 20 November 2003 deals with the continued airworthiness of aircraft and aeronautical products, parts and appliances and the approval of personnel and

organisations involved in the continued airworthiness of aircraft and components, including maintenance. It establishes common technical requirements and administrative procedures for ensuring the continued airworthiness of aircraft, including any component for installation thereto, which are registered in a Member State. Attached are 4 annexes, of which Annex I (Part M) is relevant to this investigation:
Annex I (Part M), establishes the measures to be taken to ensure the continued airworthiness of aircraft and components is maintained, including maintenance. It also specifies the conditions to be met by the persons or organisations involved in such continued airworthiness management.
In this regard, it should be realised that, contrary to the initial airworthiness (Part 21), the national authorities are still responsible for continued airworthiness as far as maintenance is concerned.

Ad. 3 Joint Aviation Regulations
The Joint Aviation Authorities (JAA) is a co-operation between the national civil aviation authorities of various European states. De JAA is an associated body of the European Civil Aviation Conference (ECAC), a European cooperation within ICAO. The objective of JAA is to develop and implement common safety standards and procedures for European civil aviation: in actual fact it concerns the effectuation of ICAO requirements in a European context. To that effect, JAA issues the so-called Joint Aviation Requirements (JARs). Member States agreed to incorporate the JARs into their national legislation. By implementing the JAR in national or European legislation, compliance has become mandatory.

For most JAA Member States, European Community Regulations authorise the EASA to act as the European civil aviation authority in the meantime. The European legislation that forms the basis for EASA's duties and responsibilities originates from the JARs.
The text as laid down in the appendices of Regulation 1702/2003 and 2042/2003 is largely identical to the text of the former JARs that relate to these subjects. The numeration (formerly it concerned JAR 21 and JAR-OPS/M respectively) has also been maintained.

JAR-OPS Part 3 - Commercial Air Transportation (Helicopters)
The JARs are still relevant to the fields that are not yet served by EASA. With regard to the current investigation, JAR-OPS 3 - Commercial Air Transportation (Helicopters) is of further interest.

The section 'Applicability' in JAR-OPS 3 reads, in so far as it is of interest in this context:

"JAR-OPS Part 3 prescribes requirements that apply to the operation of any civil helicopter for the purpose of commercial air transportation by any operator whose principal place of business is in a JAA Member State. JAR-OPS Part 3 does not apply:
(1) To helicopters when used in military, customs, police services or SAR; nor
(…)."

Further information on the exclusion of SAR-flights in JAR-OPS 3 can be found below, under 'Ad. 4 Civil Aviation in the United Kingdom'.

Appendix O contains the requirements of JAR-OPS 3 that are relevant to the investigation currently under consideration.

Finally, the requirement on Synthetic Training Devices (JAR-STD) is also of interest:

JAR-STD 1H - Helicopter Flight Simulators
The regulations contain requirements that apply to those persons or organisations (Synthetic Training Device Operators) seeking qualification of Flight Simulators.

The section 'Applicability' reads that:

"JAR-STD 1H applies to those persons or organisations (STD operators) seeking qualification of Flight Simulators (FS). Flight Simulator Users shall also obtain approval to use the Flight Simulator as part of their approved training programmes despite the fact that the Flight Simulator has previously been qualified. Although this document provides guidance material for Flight Simulator users, precise details of such approvals can be found in JAR-OPS, JAR-FCL and other applicable documents."

According to JAR-STD 1H, the highest level of simulator performance is level D. A full daylight/ dusk/ night visual system is required with a continuous field of view per pilot of not less than 180 degrees horizontally and 60 degrees vertically and there shall be complete fidelity of sounds and motion buffets. Level D requires fulfilment of the requirements of all other levels (A, B and C). Level A requires an enclosed full-scale replica of the helicopter cockpit/flight deck with representative pilot seats, including simulation of all systems, instruments, navigational equipment, communications and caution and warning systems.

Ad. 4 Civil Aviation in the United Kingdom

The Air Navigation Order 2005

In the United Kingdom, the Air Navigation Order of 2005 applies (ANO 2005). The ANO regulates the certification of air operators with regard to public transport. This certification is the responsibility of the UK Civil Aviation Authority (UK CAA).

Article 6 of the ANO 2005 reads as follows:

"(1) (…) (An)aircraft registered in the United Kingdom shall not fly on any flight for the purpose of public transport, other than under and in accordance with the terms of an air operator certificate granted to the operator of the aircraft under paragraph (2), certifying that the holder of the certificate is competent to secure that aircraft operated by him on such flights that are operated safely.

(2) The CAA shall grant an air operator's certificate if it is satisfied that the applicant is competent, paying particular attention to:

(a) His previous conduct and experience; and

(b) His equipment, organisation, staffing, maintenance and other arrangements to secure the safe operation of aircraft of the types specified in the certificate on flights, of the description and for the purposes so specified."

In so far as on interest in this context, Article 157 of the ANO 2005 reads as follows:

"(1) (…)

(3) (…) For the purposes of this Order, (an) aircraft in flight shall be deemed to fly for the purpose of public transport:

(a) (…)

(b) If any passengers or cargo are carried gratuitously in the aircraft on that flight by an air transport undertaking, not being persons in the employment of the undertaking (including, in the case of a body corporate, its directors and, in the case of the CAA, the members of the CAA), persons with the authority of the CAA either making any inspection or witnessing any training, practice or test for the purposes of this Order, or cargo intended to be used by any such passengers as aforementioned, or by the undertaking (…);

(c) (…)"

By reason of the provision as indicated above, the UK CAA in principle applies the rules relating to public transport to civil SAR-flights during which persons actually rescued are transported. These rules are laid down in ANO 2005. If compliance with the requirements of JAR-OPS 3 is established, however, the UK CAA provides an exemption from parts of the ANO regulations in the particular Air Operator's Certificate, under the condition that compliance with JAR-OPS 3 is continued. Furthermore, the UK CAA tends to include various exemptions from the ANO 2005 regulations for public transport and the JAR-OPS 3 requirements in the Air Operator's Certificate, specifically for the purpose of the operation of SAR flights. The ANO 2005 contains no definition of SAR.

Ad. 5 Safety Assessment of Foreign Aircraft (SAFA)

The European Civil Aviation Conference (ECAC), with its associated body, the Joint Aviation Authorities, set up a program called the safety assessment of foreign aircraft to complement ICAO's safety oversight program. Part of this Safety Assessment of Foreign Aircraft (SAFA) programme includes the ramp inspections on foreign aircraft, whether registered in ECAC or non-ECAC Member States, which land in ECAC countries.

The ECAC SAFA programme was active from 1996 to 2006. Since April 2006, the European Community has continued the SAFA programme with coordinating support from EASA. The voluntary SAFA Programme was launched in 1996 on the understanding that maintaining confidence in the safety oversight provided by other States was a prerequisite for the continued development of a well-functioning and reliable air transport system. The Programme took ramp inspections of aircraft landing in ECAC States as its starting point and progressed, when circumstances so required, to the involvement of States of Registry or States of Operator.

3.2.3 Search and rescue in the Netherlands

Regulation regarding the SAR-service 1994[65]

The regulation regarding the SAR-service 1994 is based directly on the Convention of Chicago and the attached Annex 12 as far as aviation accidents are concerned, and is based on the International Convention on Maritime Search and Rescue (SAR Convention 1979) as far as shipping accidents are concerned. Both Conventions require the establishment of a search and rescue service for the category of accidents covered by the respective convention. The regulation regarding the SAR Service 1994 provides for the establishment of a search and rescue Service (SAR service) in the Netherlands. The Netherlands Coastguard is responsible for this service (see below for further information).

The SAR-service is responsible for the search and rescue of crews and passengers on aircraft, ships and mining installations that are in distress within the territory as indicated in the Regulation. The category 'mining installations in distress' has apparently been added to the category 'aircraft in distress' and the category 'ships in distress'. It should be noted that this addition does not result from one of the two conventions as mentioned above. On the grounds of article 5 of the Regulation, the Netherlands Coastguard Centre functions as a combined aeronautical and maritime rescue coordination centre for the SAR-service, under the provisions of the Directorate General for Freight Transport and Civil Aviation. In the explanation of the Regulation, it is stated that this Directorate is accountable for the policy-making of the SAR-service. The Regulation also makes flying SAR-units available from the Minister of Defence following consultation with the Minister of Transport, Public Works and Water Management. On the grounds of article 6 of the Regulation, the Director of the Netherlands Coastguard must establish an operational plan (OPPLAN-SAR), as he/she is responsible for the coordination of search and rescue duties. The explanation of the Regulation also states that the OPPLAN-SAR will be established by the Director of the Netherlands Coastguard in consultation with the Directorate General for Freight Transport and Aviation from the Ministry of Transport, Public Works and Water Management, including the Royal Netherlands Navy and the Royal Netherlands Sea Rescue Institution - KNRM.

Decree re. the establishment of the Coastguard

The Netherlands Coastguard was originally established by agreement of 26 February 1987. A new agreement was produced on 1 June 1995. Parties to these agreements were the Ministers of the Interior and Kingdom Relations, Defence, Finance, Justice, Agriculture, Nature and Food Quality and the Minister of Transport, Public Works and Water Management. The agreement established a co-operation between public services with regard to the operational execution of the Netherlands Coastguard's duties. The Commander of the Royal Netherlands Navy was responsible for the operational management; whereas the Director of the Netherlands Coastguard was responsible for the daily operational management. Departments and civil services maintained their own responsibility for their respective policy and the competent authorities maintained their responsibility for compliance with the legal requirements. Policy measures relating to the Netherlands Coastguard were set out in coordination between the Ministry of Transport, Public Works and Water Management and the Permanent Contact Group for Enforcement in the North Sea (Permanente Kontaktgroep Handhaving Noordzee - PKHN). In order to maintain a proper balance between policy-making and implementation, consultations were arranged periodically between the Netherlands Coastguard, the Ministry of Transport, Public Works and Water Management and the PKHN. At the end of 2006, this coordination arrangement regarding the Netherlands Coastguard was transferred into a Netherlands Coastguard New Style. The legal arrangement was abandoned by agreement. The Netherlands Coastguard New Style was established by Decree by the Minister of Transport, Public Works and Water Management and the Minister of Justice establishing a Coastguard for the Netherlands.[66]

This Decree came into effect on 1 January 2007. The main reason for this transformation was the demand for a clear set of provisions relating to the duties and responsibilities of the Netherlands Coastguard and the assurance of a comprehensive and transparent balancing out of the interests concerned. One of the provisions was the establishment of a so-called Coastguard Board (Raad voor de Kustwacht). The Coastguard Board advises the Minister of Transport, Public Works and Water Management on the policy, enforcement, service, control, information and financial plans with regard to coastguard duties. Representatives of the seven ministries involved are members of the Coastguard Board. The Director-General for Transport, Public Works and Water Management chairs the Board on behalf of the Ministry of Transport, Public Works and Water Management.

65 *"Regeling inzake de SAR-dienst 1994"(Regulation regarding the SAR-Service of 26 August 1994, and subsequently amended by the Regulation of 23 December 2005, State Gazette. 2006/1).*

66 "Besluit instelling Kustwacht", Decree of the Minister of Transport, Public Works and Water Management and the Minister of Defence establishing a Coastguard for the Netherlands, 17 November 2006/ No. SDG 2006/1961 Rijkswaterstaat, State Gazette 2006/229.

Sub-task regulation Command Naval Armed Forces 2005
According to the Sub-task regulation Command Naval Armed Forces 2005 (Subtaakbesluit Commando Zeestrijdkrachten 2005), the Royal Netherlands Navy and its Command Naval Armed Forces is under the command of the Commander of the Royal Netherlands Navy. On the grounds of article 2 sub g of the Regulation, the Netherlands Coastguard Centre forms part of the Command Naval Armed Forces. Article 9 states that the Director of the Netherlands Coastguard is in charge of the Netherlands Coastguard Centre. The Director is responsible for:

a. The operational management of the Netherlands Coastguard, taking into account the instructions and guidelines from the Commander of the Royal Netherlands Navy , the Minister of Transport, Public Works and Water Management, and the Permanent Contact Group for Enforcement in the North Sea;
b. (…);
c. The efficient organisation, management and supervision of the Netherlands Coastguard Centre.

3.3 Relevant manuals, agreements and safety management systems

3.3.1 NAM

Introduction to Safety Management in ONEgas
The identification and analysis of hazards, the mitigation of these hazards and the approach to deal with the resulting risk for NAM ONEgas operations and projects, is covered in safety cases, entitled "VGM-Documenten" (Safety, Health and Environment documents or SHE documents).

The SHE documents and the risk management process in NAM are based upon a systematic process of identifying, analysing and controlling risk, which is called the Hazard and Effect Management Process (HEMP). This is used for both design and development, as well as for production and health and safety aspects of projects. All operational aspects of the health and safety care system are checked at least every three years as part of the audit and review programme.

Four documents are of main interest to this study and form a frame of reference on the basis of the safety case principle. These documents are:

- SHE Document Asset ONEgas (NL) - Generic part. This document describes the basics of safety management in ONEgas
- SHE Document Asset ONEgas - Location K15-FB-1. The document specifically concerns the risk assessment of K15B and its satellite installations
- Concurrent Operations Script (COS) K15-FB-1 and Noble George Sauvageau Well K15-FB-107. The COS describes the risk assessments, agreements and deliverables of the concurrent operations
- SHE Document Transport, NAM. This document describes the risk assessment of transportation, including helicopter flights to and from offshore installations.

Start of operation
State Supervision of Mines checks the SHE Documents. Its 'approval' for a planned activity is documented and confirmed to the operator by a "no questions" letter. For the operator, this means that he can start the operation.

Some relevant information on these documents and the NAM safety system on the K15B is described below.

K15B Safety Systems
In normal operations, two gas generators are responsible for the power supply to the installation. When the gas generators are not available, the diesel generator will supply energy to the systems that are critical to safety, such as the fire and gas detection systems and the firewater pumps. In the systems design, it will take a minute at most for the diesel generator to start once the gas generators have stopped. A 'No-Break' system protects the critical systems against a power dip as a result of the gas generator disengaging and the diesel generator coming into operation. Essential systems such as emergency lighting, navigation lights and the fire and gas detection systems are backed up by batteries, to provide the availability of those systems in the event that the power supply is unavailable. According to NAM, the emergency lighting is designed to last for 90 minutes and the backup batteries for the fire and gas detection systems are designed to last for about three hours. On the basis of this set-up, systems cannot be expected still to be operational after this designed backup period. Firewater pumps do not have a backup facility. If the diesel generator fails during a blackout, no firewater will be available.

If the facility is going to operate outside a set operating envelope, a safety system will activate automatically: safety valves protect the wells and riser isolation valves isolate the risers (incoming and outgoing pipelines) from the installation. Whenever Emergency Shutdown (ESD) takes place, isolation valves shut down, wells are isolated and the valves to the vent stack open. The platform will therefore be closed-in (isolated from wells and pipelines) and depressurized (hydrocarbons emitted through vent stack). Although high-pressure hydrocarbon systems are depressurized, vessels and pipelines still contain hydrocarbons at atmospheric pressure. The diesel generator will also start running to provide power to systems that are critical to safety, such as fire and gas detection systems and firewater pumps.

K15B safety logic on blackout
The logic of cause and effect is meant to make the installation 'fail safe'.[67] Should a system (that is critical to safety) fail, the operations and the installation will go into safe mode. On K15B, failure of the power supply caused an ESD. To restart the installation following an ESD, power from the diesel generator is needed, as the gas supply to the gas generators will have been isolated.

Other failure modes are described in the Matrix of Permitted Operations (MOPO). This manual contains a matrix which translates the outcome of risk analysis and safety studies into normal operations. The matrix shows what activities are permitted whilst certain systems that are critical to safety fail or are taken out for maintenance, and what action should be taken on the unavailability of a system. The following relevant failure-action conditions in the table are stated in the MOPO:

Failure condition	Action required
Emergency diesel generator	Close-in and depressurize the installation and review all activities on the installation
Unavailability of firewater	No operations are permitted, helicopter operations still allowed
Fire and gas detection systems are not available	Stop all operations, including helicopter operations, and assign standby fireman in the accommodation room[68]
Unavailability of evacuation or escape facilities (lifeboat and life rafts)	Down-manning of non-essential staff

Table 4: Relevant failure-action conditions from the Matrix of Permitted Operations.

Concurrent operation K15B and Noble George Sauvageau
Chapter 7 of the Concurrent Operations Script contains a Concurrent Operations Matrix 'Drilling and Production during drilling Well K15B-FB-107'. According to the matrix, the situation "Loss of Primary and Backup Power Supply" of the K15B performing "Normal Drilling Activities in accordance with DDP"[69] falls under the responsibility of the Head of Concurrent Operations.

The Concurrent Operations Script provides a tool in chapter 9 - Management of change, which recognises the need for change to previously developed work task instructions, and which provides a defined process for dealing with the change. A need for change has to be 'flagged up' to identify the seriousness of the situation. There are 5 levels of risk, from "Minor" to "Major", corresponding with the 5 levels of the NAM Risk Matrix (see below and also Appendix P):

Minor (level 1 / NAM Risk Matrix)
- *Changes have not been planned but are well within the scope of normal operations (no unique processes). The work task is well within the capability and competence of people undertaking the activity.*
- *The revised method is fully covered by an existing generic work procedure and generic risk assessment, which must show a low risk factor after controls have been specified (both documents must be available at the work site).*

Significant (level 2 & 3 / NAM Risk Matrix)
- *Changes are not covered by the planned approved procedures and may deviate from normal operations. The key parts of the revised work are not covered by generic procedures or generic risk assessments that are available at the particular barge, ship or work site.*

67 'Fail safe' means that in case of failure, the failure mode is a safe mode.
68 NAM stated that in practice, the standby fireman will also carry out walk-around inspections to ensure that the platform is in a safe condition.
69 Daily Drilling Program.

The assessment of the work task must be within the capability and competence of people undertaking the activity.

Major (level 4 & 5 / NAM Risk Matrix)

- *The changes require further assessment by the onshore project team because the engineering work performed during the onshore engineering phase or the equipment mobilised cannot accommodate the required change. The re-engineering cannot be undertaken and checked by the people at the work site.*

In level 1 "Minor" the Head of Concurrent Operations has to approve the actions to be taken and the Operations Manager has to be informed. According to level 2/3 the approval of the Operations Manager is required.

In chapter 6.1.1 of the Concurrent Operations Script, the Head of Concurrent Operations' responsibilities are partly defined: "The Head of Concurrent Operations shall ensure compliance with the Concurrent Operations script. Non-compliance or exceptions must be discussed with the Operations Manager."

Chapter 10.5 contains, among other things, the "Abandon Platform Procedure", which forms part of the emergency response systems and procedures during concurrent operations. It states that both installations are abandoned through their own means of escape. Both platforms' primary means of escape are the lifeboats, with life rafts as a secondary means of escape. It is also stated in the Concurrent Operations Script that if a helicopter is either on the helideck or in the vicinity, it may be used to assist the evacuation, if safe to do so. As long as the two installations are linked by a bridge, evacuation shall be made in accordance with the installations' normal emergency evacuation procedures. Personnel will follow the procedures of the installation on which they are located during an alarm or emergency. The procedure for the K15B states:

- The platform shall be evacuated in accordance with the Offshore Contingency Plan
- The freefall lifeboat provides the primary means of escape
- The life rafts provide the secondary means of escape
- If a helicopter is either on the helideck or in the vicinity, it may be used to assist the evacuation if safe to do so.

Escape routes lead to the accommodation, which serves as a temporary safety refuge. It has been designed to provide people on board with 30-minute protection to prepare to evacuate the installation. The primary means of evacuation is the freefall lifeboat that has a capacity for 25 persons. The lifeboat is located at the back of the accommodation. The lifeboat entry is shielded from the process area by the accommodation unit. The helideck is based on top of the accommodation. Although evacuation by helicopter is possible in theory, this is not a primary (self-sufficient) means of escape. Secondary means of evacuation are two life rafts that can be thrown overboard and scramble nets[70] that provide access to the water.

Acceptable probability of survival

On the basis of several studies adopted by NAM, if people wearing survival suits could be brought to safety within two hours, this would give them an acceptable probability of survival.[71] NAM and other oil and gas-producing operators adopted the following target: any person having to enter the sea either during an emergency abandonment situation or due to any other reasonably foreseeable event should have a good chance of survival and rescue. This resulted in the following 'SAR performance standard': personnel wearing protected clothing shall be retrieved from the water within 120 minutes and taken to a place of safety within 140 minutes. A more elaborate description of the SHE documents is presented in Appendix P of this report.

Aircraft management guidelines

The International Association of Oil & Gas Producers (OGP) issued Aircraft management guidelines that contain general guidelines and procedures for air operations. This document will be edited from time to time to keep it updated. The February 1998 issue of the guide applied during the accident with the G-JSAR. This document contains the following information with regard to search and rescue:

"Types of Emergency Flight

The following definitions are now accepted throughout the group:

a) Search and Rescue (S.A.R.). An emergency mission to locate and rescue a person who is in

70 Scramble nets are wide rope ladders that can be used by several persons at the same time.

71 Review of probable survival times for immersion in the North Sea, D.H. Robertson and M.E. Simpson, Health and Safety Executive report OTO 95 038, January 1996. Rescue at Sea of People, working in the Mining Industry on the Dutch Continental Shelf, revision 8, NOGEPA.

an abnormal environment and whose life is threatened if not removed from that environment or if not provided with protection or assistance.

b) *Medrescue (Medical Rescue). Indicates a "life or limb" emergency and is a medical mission to rescue a person who is in a hostile environment.*

c) *An evacuation or a Doctor's visit is necessary to prevent death or serious damage to a person's health.*

d) *Medevac (Medical Evacuation). Indicates a non-urgent medical situation requiring a seat in an aircraft at a time to be specified by MEDICAL. This terminology is necessary to alert those concerned to the degree-of-response facilities required,*

e) *This had no priority other than seat allocation; priority shall be advised by the doctor."*

The following information is additionally contained in the document:

"Authority for Despatch
To determine a safe and effective response to genuine S.A.R. situations and medical emergencies, it is vital that a prompt orderly authorisation process is undertaken prior to the launch of rescue helicopters or other aircraft. A decision to launch must always be taken by the Company manager responsible after considering all of the circumstances. This process, if planned and implemented meticulously, will prevent over-reaction to the type of uncomplicated medical situations which have led to exposure to possible hazards and unnecessary risks in the air in the past."

3.3.2 Eurocopter

Design Organisation Handbook
Eurocopter's Design Organisation Handbook contains a summary of the organisational structure and internal procedures of Eurocopter in compliance with the requirements for the approval as a Design Organisation on the basis of Regulation EC 1702/2003 (Part 21). The Design Organisation Approval Certificate issued by the EASA states under the heading scope of approval:

"The Design Organisation Approval Certificate has been granted for:
- *Designing rotorcraft and changes and repairs thereto in accordance with the applicable type certification basis and environmental protection requirements*
- *Showing and verifying compliance with the applicable type certification basis and environmental protection requirements, and*
- *Demonstrating this compliance to the Agency."*

Section 6.3 Continued Airworthiness outlines how to deal with incidents which affect or could affect the production aircraft that have been delivered or are currently being delivered. It is stipulated that possible unsafe conditions will be reported to EASA, by the airworthiness department, within 3 days following their identification. Furthermore, it has been established that the airworthiness incidents will be the subject of discussion during meetings that will be arranged either at the request of Eurocopter or the National Authority (in this case delegated to EASA) and will be chaired by the airworthiness department of Eurocopter (continued airworthiness meetings). The primary objective of these meetings is to ensure proper coordination between EASA and the manufacturer, as such coordination is indispensable before any statutory measures are introduced, in order to maintain the airworthiness (Airworthiness Directives).

Eurocopter Instructions 050-05-007
Eurocopter Instructions 050-05-007, Section 4.2.2, relate to the role of Eurocopter in investigations referred to in ICAO Annex 13 (Aircraft Accident and Incident Investigation). The organisation of investigations within Eurocopter is managed by the Technical Support Directorate Accidents Investigation Group and stipulates that:

> *"During the investigation, the Technical Support Directorate must undertake, if necessary, to initiate any preventative measures required by establishing an In-Service Incident Report in accordance with paragraph 5 - Continued Airworthiness."*

Section 5 Continued Airworthiness states that an In-Service Incident Report must be produced and issued whenever:

> *"- During the investigation, it is found that the manufacturer may be liable for the cause of the accident. Manufacturer's liability refers to any failure in relation to the design or manufacture of the product or failure to give the documentation to the customer.*
> (...)
> *- The final report of an investigation committee contains one (or more) safety recommendations involving Eurocopter"*

If the accident relates to the manufacturer's responsibility for design, production or documentation, a link is made with Eurocopter Procedure EP14-02, analysis of "major incidents".

Eurocopter Procedure EP 14-02
The procedures for collecting information on incidents and for issuing this information within Eurocopter and to the Authority have been described in a so-called Eurocopter Procedure. Document EP 14-02 applies in this regard. EP 14-02 C (application date 16/11/2006) describes a 4-step process for dealing with incidents/discrepancies on Eurocopter Group-certified and/or qualified products:

Step 1: Information gathering and internal distribution.
Step 2: "Incident" analysis.

This step classifies incidents into "minor" and "major" incidents. The category "major" incidents is relevant to this investigation. With regard to "major incidents", the hazard level must be defined for each "major incident" in order to determine its critical level and whether an unsafe condition exists. Circumstances affecting the helicopter, its occupants, other persons (e.g. persons on the ground) as well as systems and equipment intended to minimize the hazardous effects of survivable accidents shall be taken into consideration in this regard. The hazard level is defined by considering how critical it is, as well as the probability of possible consequences.

The concepts of "unsafe condition" and "major incident" are defined further in appendices A and B to document EP 14-02. The definition of "unsafe condition" is in conformity with the European definition as laid down in AMC 21A3B(b), in accordance with Regulation EC 1702/2003, section 3.2.2 ad. 2.

Step 3: Implementation of the protective measures.
Step 4: Implementation of the corrective measures.

The criticality category for the failure conditions are defined further in appendix C to EP 14-02. The applicable category for this investigation has been determined as "hazardous/major severe":

"Failure conditions that would reduce the capability of the aircraft or the ability of the crew to cope with adverse operating conditions to the extent that there would be:
- *(i) A large reduction in safety margins or functional capabilities*
- *(ii) Physical distress or higher workload such that the flight crew could not be relied upon to perform their tasks accurately or in full*
- *(iii) (…)*
- *(iv) Loss of ability to continue safe flight to a suitable landing site."*

AS332L2 Flight Manual
Eurocopter issued the AS332L2 Flight Manual in accordance with article CS 29.1581. The AS332L2 Flight manual contains the description, limitations and operational requirements of the AS332L2, as far as the responsibilities of the manufacturer are concerned.

In the Flight Manual, section 8.3 Check Sheet 2E, it is mentioned that correct engine alignment following engine or module replacement means an 'engine gas turbine rotor RPM difference' (Ng difference) equal to or less than 1%. Section 3.13, paragraph 1.1 indicates that when the Ng difference becomes 7.5% or more, the system generates a red master alarm light on the instrument panel and a red DIFF NG light on the central warning panel. Eurocopter considered that, when dealing with emergency procedures up to a Ng difference equal to 7.5%, the helicopter could be flown without the crew taking any action.

Training helicopter manual
Eurocopter issued an instruction manual for the AS332L2. According to Eurocopter, the purpose of the helicopter instruction manual is to discuss all of the aircraft systems from a functional perspective with a pedagogical approach. Purely technological aspects, self-evident descriptions and secondary features are not discussed in this manual, nor are maintenance or servicing considerations, for which the reader is referred to the maintenance manual. The manual is referred to as a training helicopter manual (THM).

Chapter 14 discusses the engine installations. Subjects such as a general description of the engines, starting controls and displays and fuel flow are discussed. Engine rotation speed monitoring, engine torque monitoring and the power failure indication system are also described. No clear information is provided with regard to crew actions for non-standard operating conditions without a warning.

3.3.3 Bristow

General

In accordance with JAR-OPS 3 (Helicopters), see section 3.2.2 ad. 3, Bristow issued a number of documents that describe the company's policies and procedures. The company's basic organisation, its policies and procedures are summarized in the Operations Manual Part A (JAR-OPS 3.200). This document then refers to more detailed policy material in the "Operations Quality Exposition" and the "Safety Management System Manual". These documents set out management duties and responsibilities.

Bristow established a quality system (JAR-OPS 3.035) and designated a quality manager to monitor compliance with, and the adequacy of, procedures required to ensure safe operational practices and airworthy helicopters. The quality system must include a quality assurance programme that contains procedures designed to verify that all operations are being conducted in accordance with all applicable requirements, standards and procedures.

Bristow established an accident prevention and flight safety programme (JAR-OPS 3.037): the Bristow Flight Safety System is part of the Safety Management System, which is detailed in the Operations Manual Part A and described further in the Operational Organisation & Procedures.

The policies and procedures published in the Bristow Operations Manual (Parts A, B and D), the Quality Exposition and the Safety Management System Manual are approved by the UK CAA as part of the Air Operator's Certificate (AOC) process. In the AOC process, the Bristow management (Accountable Manager, Post-Holders and Quality Manager) was also accepted by the UK CAA.

For this investigation, the relevant issues within the 'Quality Exposition' are:
- Bristow Operations Manual
- Bristow Helicopter Training School - Eurocopter AS332L2 Conversion Study Guide
- Quality Management and Accident Prevention and Flight Safety Programme
- Den Helder Base Instructions
- Den Helder Base Instructions for SAR

Bristow Operations Manual

The Bristow Company Operations Manual is sub-divided into four parts (A, B, C, and D), which may be supplemented by other publications such as the helicopter flight manual or pilot's operating handbook, and commercially-produced route and airway manuals. Parts A, B and D only of the manual are relevant to this investigation:
- Part A of the manual describes the general/basic information, requirements, operating procedures and flying staff instructions. Part A focuses upon the Bristow organisation and related responsibilities, operational supervision and control, crew composition and qualification requirements, crew health precautions and flight time restrictions, operating procedures, transportation of dangerous goods and weapons and to the handling of accidents and incidents. Section 1 of Part A refers to the authority, duties and responsibilities of the captain, co-pilot and winchman. The supplement to Part A, which is referred to as Search and Rescue Operations, details the additional training and qualification requirements that are to be met prior to crew members being permitted to conduct SAR operations. The responsibilities of the captain include a clause entitled "emergencies" that authorises him/her to deviate from company "rules, operational procedures and methods in the interests of safety." Attention is given to SAR response criteria, the authority to request a call-out, the authorization to launch, authorization-nominal lists and specialist equipment. Appendix I contains relevant information about flight crew responsibilities and extracts related to the following flight crew flying duties: division of duties between the pilot flying and the pilot not flying, co-pilot handling of the aircraft, aircraft checks and emergency procedures.
- Part B describes the helicopter-type operating procedures and requirements (referred to as: Helicopter Operating Procedures and Requirements). This Part may refer to, but not necessarily duplicate, information from the helicopter flight manual or pilot's operating handbook. Part B for the AS332L2 is linked to the SAR supplement to Part A. It is stated in the manual, section 3 - Actions following ditching, that when the aircraft is unstable and likely to capsize, all exits must be jettisoned and all occupants evacuated from the aircraft as soon as rotors have stopped. An appendix to Section 3 of Part B for the AS332L2 contains the checklist of emergency procedures (with an explicit reference to the G-JSAR).
- Part D is the Training Manual. Training policies and procedures are divided into generic and type-specific in 2 parts of the manual, Part D and the AS 332L2 Conversion Supplement. Section 8 of the SAR Supplement to Part A of the Operations manual also contains information that is relevant to SAR training.

The applicability of Part D for SAR operations is addressed in Sections 3.5 'Periods of Validity' and 9.7 'Special Competence Checks'. The task of search and rescue is classified as a special skill. Both sections mention that:

"Items which cannot be carried out during a routine Line Check must be completed on a separate non-revenue flight, as close as possible to the date of the Line Check. Tasks included in this definition are Winching, External Load Carrying, Mountain Flying, SAR and Cabin Attendant duties."

Section 5.6 'Flying Training' states that:

"Flying training will be structured and sufficiently comprehensive to familiarise the member of the flight crew with all aspects of restrictions and normal operation of the helicopter in detail, including the use of all cockpit equipment and all emergency procedures, and these must be carried out by a suitably qualified TRI(H)/TRE(H). Additional training will be required for specialised operations such as SAR and Offshore operations."

SAR flight crew appointed to dedicated SAR units is required to perform a line check that differs from a commercial air transport line check and is consequently restricted to SAR operations only. This is addressed in section 9.5 'Line Check':

"Pilots appointed to dedicated SAR units are not required to complete a commercial air transport Line Check while serving on that unit, but will complete a SAR Line Check that will include a night section, a Flight Path Controller Check (FPCC) and a Winch Competence Check. SAR pilots should endeavour to practise night deck landings to a suitable landing site. Pilots at a SAR unit who are required to undertake commercial air transport operations must complete a Line Check as previously specified."

In the event that just a SAR line check suffices, the offshore elements of the commercial air transport line check do not have to be checked.

Bristow Helicopters Training School - Eurocopter AS332L2 Conversion Study Guide
The Study Guide advises the Type Rating Instructor to refer to the following other documents during the conversion: the AS332L2 Flight Manual, the Bristow Operations Manual Part A and the Bristow Operations Manual Part B, including appendix A to Section 3 of Part B (Emergency Operating Procedures) and appendix A to Section 4 of Part B (Normal Operating Procedures). Appendix Q contains relevant extracts that relate to flight crew duties.

Flight Safety System
In accordance with JAR-OPS 3.037, Bristow has established an Accident Prevention and Flight Safety Programme. This programme includes, amongst other things, an incident reporting system which enables the collection and assessment of reports in order to identify adverse trends or to address deficiencies affecting flight safety and to make recommendations for prevention. Bristow's Safety Management System Department is responsible for the Air Safety Report (ASR) processing within the company. ASRs are stored in Sentinel, the company database. Actions resulting from the ASR processing are subsequently reviewed by the monthly Safety Action Review Meeting. According to Bristow, representatives from manufacturers and UK CAA are also invited to these meetings. There are no minutes of these meetings.

Events that are not incidents are filed as Pilot Operations Report, according to the Bristow Den Helder Base Instructions (see explanation in section below). In the Flight Safety section of the Bristow Den Helder Base Instructions SAR, it is stated:

"Air Safety and Pilot Operations Reports are available in Flight Planning, and should be completed in accordance with the Operations Manual. The chief pilot or his deputy must be informed of any accidents, incidents or unusual incidents straight away, which may require a formal report."

For SAR missions, post-flight reporting was developed, with the purpose of debriefing the tasking agency.[72] The procedure requires that after every G-JSAR mission, a SAR report is completed by the crew. SAR reports are treated as information on normal operations and are not stored in the company database, but are assembled in paper form. Bristow distributes the SAR reports informally to all of its SAR base units, including the European Business Unit senior operations management.

72 Post-flight reports, Bristow Operation Manual Part A, SAR supplement, section 4.7.

Den Helder Base Instructions
The Bristow Operation Manuals contain the 'general' procedures that apply to all Bristow's flight operations. For local procedures, such as restrictions to fuel and weather minima, Bristow publishes "relevant local considerations" in its Operation Base Instructions. The Operation Base Instructions Den Helder consists of 2 instruction manuals: Den Helder Base Instructions and Den Helder Base Instructions SAR. The Den Helder Base Instructions SAR are in addition to the Den Helder Base Instructions. On the cover of the Den Helder Base Instructions SAR is stated:

"To be read in conjunction with the current Den Helder Base Instructions."

The Den Helder Base Instructions SAR state under the heading of "SAR Operations Authority to Initiate Callout" that:

"All operational requirements will be co-ordinated by the Kustwacht JRCC".

And, that outside Aerodrome De Kooy opening hours:

"The airfield can be opened for the following:
- Flights requested and planned for in advance
- SAR flights
- MEDEVAC flights"

The base instructions for SAR state that:

"Bristow Helicopters has dispensation to operate outside normal airport hours and that (…) All flights must strictly be SAR/CASEVAC IMMEDIATE only, and only departures are authorised. The airport must be open for arrival and landing (…)."

The possibility of a "Night emergency call-out" and a "Rig evacuation" are described in the Den Helder Base Instructions. These call-outs should be performed with the help of Bristow Norwich Operations.

(…) "In that case, Norwich Operations will contact the duty crew and duty engineer. They will also contact the Den Helder Operations Duty Officer, who will then call SNH [Schreiner Den Helder - which is nowadays known as CHC] to open the airfield, file a flight plan and arrange for a refuelling crew. In the event of a request for a rig evacuation, the Operations Controller will record the fact in the diary and ascertain as much information as possible. He should also note the contact name and telephone number of the person making the request".

The instructions continue with further details about necessary actions in relation to the requested evacuation.

Bristow indicated that Den Helder SAR crews do not need to know what is going on with regard to public transportation regulations and applicable manuals.

The Den Helder Base Instructions SAR state under the heading of "PASSENGER CONTROL", under "Passenger Briefing:"

"It is the commander's responsibility to ensure that passengers are properly briefed prior to the flight. The commander may delegate this task to another crew member. Passengers will normally be briefed verbally".

Air Operator's Certificate
The Bristow Air Operator's Certificate (AOC) and the applicable appended specifications issued by the UK CAA certify the transportation of passengers and cargo with the Eurocopter AS332L2 Super Puma. The AOC itself is granted on the assumption that Bristow complies with all those provisions contained in JAR-OPS 3 as adopted by the JAA on 1 April 1995. The AOC specifications contain special authorisations, approvals and exemptions, which are applicable to the Bristow helicopter offshore operations, SAR operations or SAR training. Exemptions are granted from some of the provisions of JAR-OPS 3 and/or the UK Air Navigation Order 2005. They apply when conducting SAR 'operational flights' and SAR 'training flights' either to Bristow as a company or to the Bristow captain. Some exemptions are supplemented with special conditions. Appendix R contains the AOC Operations Specifications for Bristow. For general information relating to the granting of AOCs and the exemptions relating to the execution of SAR flights that may be included, please refer to section 3.2.2 ad. 4.

Upon request, the UK CAA indicated the following with regard to the application of the exemptions for SAR-flights. SAR-flights are considered to be public flights under the ANO.[73] When operating these public transport flights, the helicopter operator must comply with all the relevant regulations, except when dispatched on an "operational" flight (SAR-flight), when the captain may exercise the various exemptions detailed in the AOC document to achieve the aims of the "search and rescue" operation. Neither the UK ANO 2005 nor the Bristow AOC provide a definition of SAR, but the UK CAA has adopted the ICAO definitions of "Search" and "Rescue" as presented separately in Annex 12. The UK Maritime and Coastguard Agency, through HM Coastguard, is responsible for the initiation and co-ordination of civil maritime SAR. This includes the mobilisation, organisation and tasking of adequate resources to respond to persons either in distress at sea or to persons at risk of injury or death on the cliffs and shoreline of the UK. The demarcation line between SAR "operational" and "training" flights therefore depends upon the tasking agency. The only organisation that can dispatch an "operational" flight in the UK or the Netherlands is the UK Maritime and Coastguard Agency or the Netherlands Coastguard; the helicopter operator can dispatch training flights. The only time that the SAR exemptions (which are contained in the AOC documentation) can be exercised is when the helicopter is dispatched on an "operational" flight by the appropriate tasking agency or during a SAR training flight.

The UK CAA furthermore indicated that they found it difficult to put civil SAR operations under a JAR-OPS AOC, since there is a significant omission of a clear definition of what constitutes a SAR task and what responsibilities the tasking agency has. Any aircraft on an operator's AOC, including any SAR aircraft, may be used for public transport operations, provided it is suitably equipped. The CAA stated that it is awaiting the deliberations of the European Aviation Safety Agency (EASA) as to what they consider the status of SAR should be, i.e. an EASA or a State activity.

3.3.4 General Crew Resource Management standards

Introduction
Crew Resource Management (CRM) encompasses a wide range of knowledge, skills and attitudes including communications, situational awareness, problem-solving, decision-making, teamwork etc., together with all the attendant sub-disciplines which each of these areas entails. The elements which comprise CRM are not new but have been recognised in one form or another since aviation began, usually under more general headings such as 'Airmanship', 'Captaincy', 'Crew Co-operation', etc. In the past, however, these terms have not been defined, structured or articulated in a formal way, and CRM can be seen as an attempt to remedy this deficiency. CRM can therefore be defined as a management system which makes optimal use of all available resources, equipment, procedures and people to promote safety and enhance the efficiency of flight operations.

CRM is more concerned with the cognitive and interpersonal skills needed to manage the flight within an organised aviation system than with the technical knowledge and skills required to fly and operate an aircraft. In this context, cognitive skills are defined as the mental processes used for gaining and maintaining situational awareness, for solving problems and for taking decisions. Interpersonal skills are regarded as communications and a range of behavioural activities associated with teamwork. In aviation, as in other walks of life, these skill areas often overlap with one another, and they also overlap with the required technical skills. Furthermore, they are not confined to multi-crew aircraft, but also relate to single pilot operations, which invariably need to interface with other aircraft and with various ground support agencies in order to complete their missions successfully.

Purpose of Crew Resource Management
Human failure can be accounted for in 70% of all aviation accidents. The purpose of CRM is to improve safety and efficiency onboard an aircraft with a multi-crew cockpit and to prevent human error as the cause of an accident. The aspects of human behaviour are defined in courses. The courses must be adapted to the company culture and the nature of the operation of the airline company. Using theory, examples from actual practice and case studies, persons involved in air transportation are encouraged to implement these topics in everyday practice. It goes without saying that during test and check flights, the actual implementation of CRM is assessed by crews during flight operation.
CRM is not effective if only one crew member is motivated to implement good CRM practice. It must be supported by all crew members during flight operation. Furthermore, it is the company's 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 are primarily involved in flight preparation, execution and administration.

73 See also section 3.2.2 ad 4.

Contents of Crew Resource Management training
Operating aboard an aircraft/helicopter where duties are divided between more then one crew member requires accurate cooperation and harmonization. The major part of a crew member's training focuses on flying skills and knowledge of procedures, both on board the aircraft as well as in the air. However operating on board an aircraft/helicopter does not just involve the management of techniques and procedures, but also, to just as great an extent, 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, the recognition of errors too late and conflicts between colleagues. During Crew Resource Management courses, the factors affecting our daily performance are clarified. By providing theoretical knowledge, discussing previous accidents and sharing experiences, the students learn how they, as crew members, affect the safety on board.

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 that has an interpersonal nature.
A style of work is affected by company culture to a considerable extent. Styles of work and company culture are inextricably interconnected.

CRM reference material
The UK CAA has published a document on practices and training of CRM under the title "CAP 737 Crew Resource Management (CRM) Training". The introduction of this paragraph is taken from this publication. This document is now used by Bristow for CRM training and assessment.

3.3.5 Search and rescue in the Netherlands

International Aeronautical and Maritime Search and Rescue manual
The primary purpose of the 3 volumes of the International Aeronautical and Maritime Search and Rescue Manual (IAMSAR manual) is to assist States in meeting their own search and rescue needs, and the obligations they accepted under the Convention on International Civil Aviation, the International Convention on Maritime Search and Rescue and the International Convention for the Safety of Life at Sea (SOLAS). These volumes provide guidelines for a common aviation and maritime approach to organizing and providing SAR services. States are encouraged to develop and improve their SAR services, co-operate with neighbouring States and to consider their SAR services to be part of a global system.

Each volume of the IAMSAR Manual is written with specific SAR system duties in mind, and can be used as a standalone document, or, in conjunction with the other 2 Manuals, as a means to attain a full view of the SAR system.

- The Organization and Management volume (Volume I) discusses the global SAR system concept, establishment and improvement of national and regional SAR systems and co-operation with neighbouring States to provide effective and economical SAR services
- The Mission Co-ordination volume (Volume II) assists personnel who plan and co-ordinate SAR operations and exercises; and
- The Mobile Facilities volume (Volume III) is intended to be carried aboard rescue units, aircraft and vessels to help with performance of a search, rescue or on-scene co-ordinator function and with aspects of SAR that pertain to their own emergencies.

In Volume I of the manual, the following is stated about the application of risk management:[74]

"Search and rescue (SAR) organizations have a lot to learn from the emergency management community where risk management principles are used so that the uncertainties that exist in potentially hazardous situations can be minimized and public safety maximized (...)."

Operational plan Search-And-Rescue (OPPLAN-SAR), 1 June 2004[75]
The OPPLAN-SAR is an operational plan that contains the description of the SAR service, the intended operational process and the procedures to be followed (see also under 3.2.3). The OPPLAN-SAR is not based on a risk assessment and analysis. The Netherlands Coastguard, especially the Joint Rescue Coordination Centre (JRCC) is responsible, among others, for the alarming of SAR units, the registration, reporting and evaluation of SAR actions, and the coordination of medical evacuations. The OPPLAN-SAR distinguishes different states of emergency levels (see Appendix S)

74 Applying Risk Management, section 6.3.2, IAMSAR manual, Volume I, Organization and Management, Document 9731-AN/958, IMO/ICAO, London/Montréal, 2007, p 6-2.
75 The origin of the OPPLAN-SAR is within article 6 of the Regulation regarding the SAR-service 1994.

on the basis of the SAR Convention 1979 procedures, which describe that the SAR tasking agency evaluates the request for search and/or rescue in order to estimate the degree of emergency and the size of the rescue operation.

The OPPLAN-SAR requires that on the basis of the reporting and alerting of the 'incident', and following verification of the information, the seriousness of the situation will be assessed. The incident will then be categorized in accordance with the three (internationally applicable) different states of emergency phases: uncertainty phase, alert phase and distress phase. The alert phase and distress phase contain an instruction for the JRCC to verify the information and to collect as much information as possible in order to assess the state of emergency effectively.

The OPPLAN-SAR contains all agreements that apply to the Netherlands Coastguard's SAR tasks too. One of the agreements is with the Royal Netherlands Sea Rescue Institution (KNRM). Article 1 of the agreement states that the SAR agency can make use of the KNRM services and of its available equipment. The quality, quantity, location and the operation of the rescue equipment remains the sole task of the KNRM.

The OPPLAN-SAR contains a procedure for JRCC Den Helder to make an "incident-report" in the "Action Data System" database for the registration and support of SAR-incidents. The Action Data System enables the Netherlands Coastguard, amongst others, to generate final incident reports. The OPPLAN-SAR does not contain a definition of 'evacuation'. The Netherlands Coastguard indicated that the word 'evacuation' meant that "a life-threatening situation existed which allowed the dispatch of the civil SAR-helicopter." In addition, the Director of the Netherlands Coastguard stated that the assessment of the actual situation on an offshore mining installation "belongs to the offshore industry (the Offshore Installation Manager in particular), according to the contract with the offshore mining industry." He is of the opinion that such assessment should remain at the offshore industry. He stated that in future similar situations, the Netherlands Coastguard would act in the same way according to the principle "whoever asks for help defines what kind of assistance is required."

Absence of national legislation for aerial work and SAR
SAR operations fall under the definition of aerial work.[76] Helicopter operations in the Netherlands performed by the Royal Netherlands Air Force (RNLAF) and the Dutch Aviation Police are regarded as aerial work. The RNLAF is developing an Operations Manual for its operations, which will be subjected for approval by the so-called Military Aviation Authority (Militaire Luchtvaart Autoriteit) part of the Ministry of Defence, but is not public information. The Dutch Aviation Police has developed its own operations manual, which is not subjected to authority approval. Training requirements for the RNLAF and Dutch Aviation Police helicopter operations are developed within their own organisations.

3.3.6 Agreements between the Company Group, Netherlands Coastguard, Bristow and the Ministry of Defence

This section describes the agreements between the Company Group, Netherlands Coastguard, Bristow and Ministry of Defence with regard to the G-JSAR operation.

The following agreements shall apply:
a. Company Group (the group of operators of which NAM is one operator that are engaged in the exploration and production of hydrocarbons on the Dutch Continental Shelf)[77]
b. Company Group and Bristow[78]
c. Company Group and Netherlands Coastguard[79]
d. Netherlands Coastguard and Bristow[80]
e. Ministry of Defence, Netherlands Coastguard, and Bristow[81]

Company Group
In this agreement, the offshore operators involved agree, in view of safety requirements in support of its operations, to jointly lease, at their cost and expense and in support of current SAR

76 See section 3.2.2 under ad 1.
77 SAR Helicopter Sharing Agreement, NAM contract No. 60017, effective 17 November 2003.
78 Commercial Helicopter SAR services in the Netherlands, NAM contract no. 60004 d.d. 12 November 2003.
79 Coöperation between the Operatorsof the Dutch Oil- and Gas industry and the Coastguard Centre (KWC) concerning the use and deployment of the Offshore SAR Helicopter (J-SAR), NAM contract no. 60017 d.d. 3 December 2003.
80 Standard Operational Procedure J-SAR, version 4, d.d. 4 May 2005.
81 Agreement on the use of the J-SAR helicopter of the Aerodrome De Kooy for Search and Rescue operations, d.d. 29 June 2004.

operations, a SAR helicopter. The agreement states that emergency means a situation in the SAR operations area where:

- "There is danger to life or a MEDEVAC situation related to the offshore industry (including offshore vessels); or
- Life-threatening circumstances not related to the offshore industry under which the dispatch of the SAR helicopter is deemed necessary."

Company Group and Bristow
The contract between the Company Group and Bristow provides for commercial helicopter search and rescue operations in the Netherlands. On one hand, the contract sets out Bristow's obligation to comply with and strictly adhere to instructions and directions from the Company Group. On the other hand, the contract stipulates that the Bristow captain is responsible for the safety of the helicopter operation, the safety of the helicopter itself, its passengers and crew, freight carried and its distribution, and all other related matters, as well as whether or not any flight should be undertaken. The contract contains detailed information with regard to:

- Scope of work and technical specifications
- Training directive for civil SAR crew
- G-JSAR maintenance schedule.

The agreement states that the work to be performed by Bristow:

"(…) shall be to provide an all-weather Search and Rescue (SAR) helicopter cover as directed by the Netherlands Coastguard."[82]

and that Bristow:

"(…) shall respond to tasking in accordance with the Netherlands Coastguard Standard Operating Procedures from the Coastguard's Joint Rescue Coordination Centre (JRCC)."

Company Group and Netherlands Coastguard
The agreement delegates the authority to call out the SAR helicopter and to exercise operational control to the Netherlands Coastguard. The Netherlands Coastguard acts as the national Joint Rescue Co-ordination Centre. The agreement includes the operational supervision on the dispatch of the G-JSAR executed by the Steering Committee. The committee is formed by representatives of the Company Group, the Netherlands Coastguard and Bristow, and is chaired by the representative of the Company Group. According to the agreement, the JRCC-duty officer of the Netherlands Coastguard shall judge whether a request for activation of the G-JSAR (in this case by NAM) forms part of the tasks mentioned in this agreement, being (translated and reported concisely):

- *"SAR actions and MEDEVACs, both related to the Dutch Oil and Gas industry (including all related activities).*
- *Life threatening circumstances not related to the offshore industry under which the dispatch of the SAR helicopter is considered necessary supplementary to the available Lynx SAR capacity, such as for the judgement by the Director of the Netherlands Coastguard. If applicable, priority will be given to the SAR actions mentioned in the first bullet."*

Netherlands Coastguard and Bristow
The agreement is written in a so-called Standard Operational Procedure (SOP). It states that the Netherlands Coastguard has the operational control of the G-JSAR. The meaning of operational control is not explained further. The SOP describes operational matters relevant to the dispatch of the G-JSAR. The SOP describes the following relevant subjects:

- Priority tasking: (offshore-related and non-offshore related).
- Call-out definitions (SAR, immediate/urgent casualty and medical evacuation).
- After each SAR, the G-JSAR captain will send a so-called first impression report (FIR) to the JRCC.
- The Netherlands Coastguard will provide an incident report in which the full incident is described.
- A G-JSAR representative may be consulted for the Periodical Operational SAR Meeting (Periodiek Operationeel SAR Overleg - POSO), which is held twice per year.

The G-JSAR priority tasking according to the SOP is:

- *"Primary tasking: offshore industry-related SAR/offshore industry-related MEDEVAC.*
- *Secondary tasking: life-threatening circumstances other than offshore-related, to be judged by the Director of the Netherlands Coastguard."*

82 Article 1 of section IV of the contract between the Company Group and Bristow.

The SOP gives the following explanation for the primary tasking of the G-JSAR for offshore industry SAR operations in emergency situations, and includes evacuations:

"Offshore SAR operations (e.g. helicopter ditch, fire and/or explosion, well blow-out, ship collision, man overboard, evacuation) immediate dispatch of the G-JSAR."

Appendix T contains detailed information with regard to the above-mentioned subjects in the SOP.

Ministry of Defence, Netherlands Coastguard and Bristow
In the agreement, arrangements are made between the Ministry of Defence, the Netherlands Coastguard and Bristow that the G-JSAR is allowed to take off from the civil part of Aerodrome De Kooy outside of airport opening times and without the airport services on duty during an 'SAR alarm'. The agreement also refers to the other agreements (b, c and d) as described in this section.

The procedure for a 'SAR alarm' is described in the appendix to the agreement and states (translated):

2) *"The JRCC (Duty Officer of the Coastguard Centre) makes the assessment regarding the necessity to dispatch the J-SAR. This concerns offshore-related SAR dispatch (e.g. helicopter ditch, fire or explosion, well blow-out, offshore medical evacuation (MEDEVAC), ship collision, man overboard, evacuation) when loss of lives are likely without immediate dispatch.*

3) *"When the Duty Officer deems dispatch of the J-SAR to be necessary, he will make an SAR alarm, in accordance with the SOP J-SAR under 'Alerting protocol' (…)."*

Appendix U contains detailed information regarding the SAR alarm procedures.

G-JSAR operational flight feedback reporting
The investigation revealed that the procedure was that after every G-JSAR operational flight, a post- flight report or a SAR report[83] was made by one of the crew members, see section 3.3.3. The SAR report has a standardized format including information to debrief the tasking agency.[84] Each SAR report was sent to the Netherlands Coastguard.[85] The SAR reports were also distributed to all Bristow SAR base units, including the Bristow EBU senior operations management. Every 4 weeks, the G-JSAR chief pilot sent G-JSAR operational flight summary reports to the Netherlands Coastguard and to a representative of the Company Group.

The Netherlands Coastguard produced monthly incident reports, which were sent to a representative of the Company Group and Bristow.[86] These incident reports were for the use of the G-JSAR Steering Committee or for further analysis and evaluation of the SAR mission. Post -flight reports such as the SAR report are treated as information on normal operations and are not stored in a database. Bristow explained it encouraged crews to make comments within post-flight reports with the purpose of improving equipment and training.

Illustration 9 visualises the scope of the investigation regarding the G-JSAR dispatch. It presents the parties involved, the interrelations, the flow of information and internal regulation (learning) loops.

In addition to the SAR reports, Bristow indicated that it also established the following feedback opportunities for the EBU SAR Operations Manager and Bristow's SAR Training and Standardisation team:

- Den Helder base visits by the EBU SAR Operations Manager, who also often undertakes SAR flights. This gave an opportunity for informal feedback of Den Helder SAR base-related issues, such as recommendations and views on potential improvements in training and operational procedures. Equally, such visits provided an opportunity for the Operations Manager to monitor SAR operating standards and related procedures at Den Helder and to change them as appropriate.

83 Also called first impression report in the SOP, version 4, d.d. 4 May 2005.
84 Post-flight reports, Bristow Operation Manual Part A, SAR supplement, section 4.7.
85 According to the SOP, the G-JSAR captain will send a first impression report to the JRCC by e-mail. This document should remark the critical success factors required and/or used during the mission. This report will be included in the Netherlands Coastguard's incident file.
86 According to the SOP, the Netherlands Coastguard (…) will provide an incident report in which the full incident is described, including the specific reasons for selecting the G-JSAR, especially in the event that the incident is not related to the oil and gas offshore industry. The incident report will be sent to the Operators and Bristow Den Helder.

- Den Helder base visits paid by Bristow's SAR Training and Standardisation (audit) team. These visits provide opportunities for feedback on training and equipment issues.
- Chief pilot meetings held and attended by key personnel from each of the Bristow SAR bases, including senior rear crew representatives. There were no minutes of these meetings.

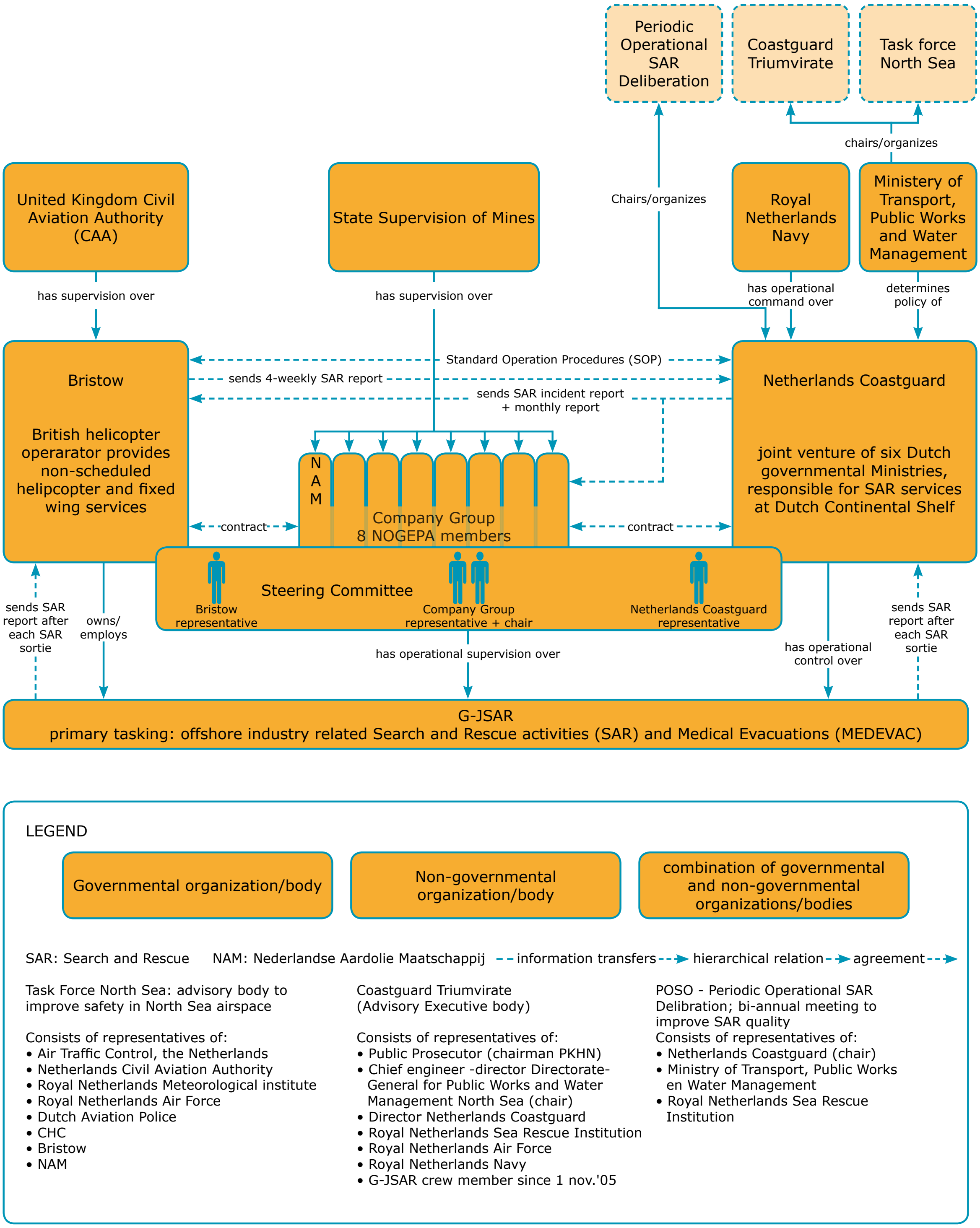


Illustration 9: scope of the investigation regarding the G-JSAR operations, presenting the parties involved, the interrelations, flow of information and internal regulation (learning) loops.

3.4 Frame of reference for safety management

In addition to legislation and regulations and the supplementary sector-related guidelines, agreements and manuals, the Dutch Safety Board employs a third component in its analytical framework. This encompasses the Board's expectations in respect of the way in which the parties involved should fulfil their personal responsibility for safety and safety management.

In principle, numerous avenues of approach can be taken to appraise and assess the way in which an organisation fulfils its individual responsibility for safety. Consequently, there is no single, universal guide that applies to all situations. The Board has therefore selected 5 safety priorities of its own that indicate the factors that (to a greater of lesser extent) may have a role to play.

The Board is of the opinion that this choice is justified in view of the fact these safety priorities have been included in numerous examples of (inter)national legislation and regulations and in a large number of widely-accepted and implemented standards and principles. For example, the Occupational Health and Safety Decree includes fundamental principles, which include the possession of a risk assessment and evaluation. The fundamental principles employed by the Board are an expansion of these in more detail. It has been shown from various accidents in the past that the structure of the safety management system and the way in which this is interpreted by the parties involved play a crucial role in the management, safeguarding and continuous improvement of safety.

Safety management relates to the way in which organisations interpret safety in addition to the available legislation and regulations. It concerns, for example, the way in which the risks are mapped out for the parties involved and managed in a structured manner. Structure is necessary within the organisation in order to execute this entire process and make it transparent, as well as to create opportunities for continuous improvement. That structure is referred to as the safety management system.

1. *Acquiring demonstrable insight into the risks relating to safety as the foundation for the approach to safety*
   The starting point for achieving the required level of safety is:
   - An exploration of the entire system and
   - An inventory of the corresponding risks.

   The dangers that should be managed and the preventative and repressive measures that are necessary in that regard will be established on the basis of this.

2. *A demonstrable and realistic approach to safety*
   A realistic and practical approach to safety (or safety policy) must be established to prevent and manage undesirable events. This approach to safety is based on:
   - Relevant, current legislation and regulations
   - Available standards, directives and best practices from the sector, the organisation's own insights and experiences and the safety objectives specifically compiled for the organisation.

3. *Execution and enforcement of the approach to safety*
   Execution and enforcement of the approach to safety and management of the risks identified is done by means of:
   - A description of the way in which the employed approach to safety will be executed with a focus on the specific objectives and including the preventative and repressive measures arising from it
   - Transparent, unambiguous and universally-accessible division of responsibilities in respect of safety in the workplace as far as the execution and enforcement of safety plans and measures are concerned
   - Clearly establishing the required deployment of personnel and expertise for the various tasks
   - The clear and active centralised coordination of safety activities
   - Realistic drills and testing of the approach to safety.

4. *Fine-tuning the approach to safety*
   The approach to safety should be subject to continuous evaluation and fine-tuning on the basis of:
   - Conducting (risk) analyses on the subjects of safety, observations, inspections and audits (pre-emptive approach) periodically or, at least, in the event of any change to the underlying principles
   - A system of monitoring and investigating near-accidents in the complex and an expert analysis of these (reactive approach). Evaluations will be carried out and points for improvement will be brought to light on the basis of this on which action can be taken.

5. *Management control, involvement and communication*

The management of the parties/organisation involved should:

- Ensure that expectations are clear and realistic internally in respect of safety ambitions, ensure there is a climate of continuous improvement of safety in the workplace
- Communicate clearly externally about general working practices, the way in which they are tested, procedures in the event of anomalies, etc. on the basis of clear and established arrangements with the environment.

4 THE PARTIES INVOLVED AND THEIR RESPONSIBILITIES

This chapter describes the parties that are involved and their responsibilities in relation to the research questions.

4.1. Nederlandse Aardolie Maatschappij and its contractors

The Nederlandse Aardolie Maatschappij B.V. (NAM) is a corporation that is registered in the Dutch Trade Register. NAM therefore has its own legal identity and responsibilities. The organisation of NAM is incorporated in the organisation of Shell Exploration and Production Europe (Shell EPE or EPE for short). The Commercial Director of the Board of Directors of Shell EPE is Statutory Director of the NAM corporation. Shell and Esso (Exxon) each have a 50% share in NAM. Since 2004, NAM operations have been combined with the Shell EPE operations. The Dutch NAM offshore operations were merged with the British Shell offshore operations in ONEgas asset. ONEgas asset is divided into a United Kingdom part (ONEgas UK) and a Dutch part (ONEgas NL). ONEgas NL is one of the parties involved in this investigation. ONEgas NL will be referred to in this report as NAM or ONEgas NL.

NAM has operational responsibility for exploration and production of the K15 field, including well operations and the operations of K15B. The Noble George drilling rig was contracted by NAM to perform drilling operations. At the same time, routine construction and maintenance activities have been carried out by contractors under contractor supervision and NAM safety coordination. However, NAM has final responsibility with regard to the safety process, including the decision to evacuate.

The K15B Offshore Installation Manager (OIM) was in charge of the K15B and had an acting OIM for backup, while the Noble George Rig Manager was in charge of the Noble George. Due to the concurrent operations with the Noble George, the K15B OIM was also Head of Concurrent Operations (HCO). In case of emergency, the HCO and Rig Manager shall inform one another of the incident and a decision will be taken as to the best course of action in accordance with the Offshore Contingency Plan. During emergencies, the HCO has overall responsibility and will co-ordinate the emergency response for both the K15B and the Noble George. Helicopter flights to and from the K15B and the Noble George require the approval of the HCO.

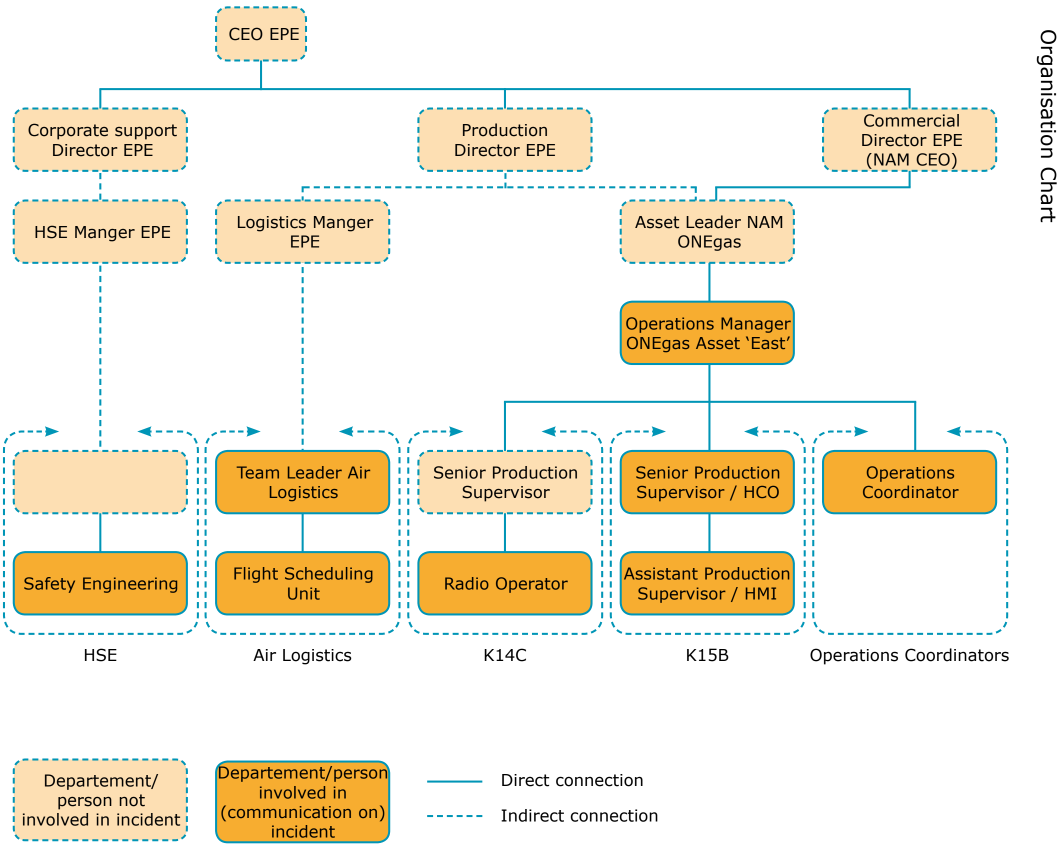


Illustration 10: NAM (ONEgas) and persons involved in the G-JSAR investigation.

Personnel who work at K15B are flown in by helicopter. NAM contracted Bristow Helicopters, which are based at Aerodrome De Kooy, to transport personnel to their offshore installations. NAM sets training and health demands for staff, including contractor staff, to be allowed to fly offshore, according to but not limited to the NOGEPA branch guidelines. This includes the compulsory HUET training for offshore personnel. The 13 transported K15B personnel followed the HUET training and were accustomed with offshore helicopter public transportation and procedures. They were not accustomed with SAR helicopter procedures.

NAM is responsible for the safety of its operations, i.e. identification and analysis of hazards, the mitigation of these hazards and the approach to deal with the resulting risk for NAM ONEgas operations and projects, which is covered in "VGM-Documenten" (Veiligheid, Gezondheid en Milieu documenten - Safety, Health and Environment documents or SHE documents). NAM has shared responsibility as member of the Company Group and the Steering Committee, the latter being responsible for the supervision of the G-JSAR operation.

4.2 Company Group

The Company Group consists of eight offshore oil and gas operators, as well as members of the Netherlands Oil and Gas Exploration and Production Association (NOGEPA). Awaiting the decision of various governmental organisations with regard to future SAR helicopter support and funding on the Dutch Continental Shelf, the Company Group was formed. The Company Group hired the G-JSAR to increase search and rescue potential at some distance away from the Dutch coast. The provision of the G-JSAR also increases survivability of passengers involved in a helicopter ditching. The Company Group signed contracts with Bristow, the operator and owner of the G-JSAR, and the Netherlands Coastguard, which is responsible for activating SAR missions, for the operation of this helicopter.

The operators, joined in the Company Group, including NAM, have shared responsibility for the functioning of the Steering Committee, which is intended to be responsible for the supervision of the G-JSAR operation. The Company Group provides a representative and the Chairman of the Steering Committee. The Company Group received information from Bristow and the Netherlands Coastguard for the supervision of the G-JSAR operation.

4.3 Steering Committee

The Steering Committee is responsible for the operational supervision of the dispatch of the G-JSAR. The Steering Committee consists of representatives of the Company Group, the Netherlands Coastguard and Bristow, and is chaired by a representative of the Company Group. In order to fulfil its duty, the Steering Committee may make use of the reports of all G-JSAR dispatches from Bristow and the Netherlands Coastguard.

The Safety Board requested the minutes of the meetings of the Steering Committee. NAM, which is one of the members of the Company Group, indicated that there were no minutes of meetings as the Steering Committee never functioned during the existence of the G-JSAR operation, although the intention was to convene a meeting about three times per year. According to the Netherlands Coastguard and Bristow Steering Committee, meetings were held during the initial phase of the G-JSAR operation only, at the end of 2003 and in early 2004.

The Netherlands Coastguard and Bristow indicated that they were aware that during the G-JSAR operation, their representatives did not meet in the Steering Committee during the course of 2004 and the following years, however neither organisation, nor their representatives, took action.

4.4 European Aviation Safety Agency

Nowadays, the European Aviation Safety Agency is the certifying authority of helicopters in the same class as the Eurocopter Super Puma helicopter and the Turbomeca Makila 1A2 engines. The Super Puma helicopter and the Turbomeca Makila engines were originally certified by the French Direction Générale de l'Aviation Civile (DGAC). EASA is responsible for the oversight on the Eurocopter Design Organisation and issued the Design Organisation Approval Certificate for Eurocopter. EASA responded to the Safety Board's recommendations in relation to the life raft activation system.

4.5 Eurocopter

The Eurocopter Group (Eurocopter) is the manufacturer of the Super Puma. Eurocopter is a manufacturer which designs, constructs, sells and supports helicopters, components and related systems. The Eurocopter Design Organisation activities covered by the European Aviation Safety Agency approval are design, development and testing, equipment qualification, certification and continued airworthiness of 52 different types of helicopters. The Super Puma involved in this investigation is an AS332L2 (Super Puma MkII) and is equipped with 2 Turbomeca Makila 1A2 gas turbine engines.

The Head of Design Organisation is responsible for all departments of the organisation that are involved in the design of the product. If the design departments are functionally linked, the Head of Design Organisation still bears ultimate responsibility for the organisation's compliance with EASA Part 21 Subpart J. He is ultimately responsible for demonstrating compliance with airworthiness requirements and the timely and complete finishing of the investigation.

The Head of the Airworthiness Department is authorised by the Eurocopter Head of Design Organisation to, amongst others:
- Ensure continued airworthiness of Eurocopter helicopters
- Ensure that in-service incidents are dealt with and that protective or corrective measures are put in place for continued airworthiness.

Eurocopter is a 45% owner of Helisim, a company that uses simulators. Helisim has an AS332L2 simulator.

4.6 Turbomeca

Turbomeca is the manufacturer of the 2 Makila 1A2 gas turbine engines installed in the AS332L2 helicopter. As an engine manufacturer, Turbomeca holds EASA Part 21 approvals for the design and construction of engines.

4.7 Bristow Helicopters Limited

Bristow is the owner and operator of the Super Puma concerned with UK registration G-JSAR. Bristow forms part of the Bristow Group and is based in the United Kingdom, with its headquarters in Aberdeen, Scotland. The company was formed in 1955 and was one of the early suppliers of offshore helicopter services in the United Kingdom. In 1996, an American company, Offshore Logistics, purchased a 49% share in Bristow Helicopters. In 2006, Air Logistics, the helicopter carrier owned by Offshore Logistics, and Bristow Helicopters became part of what is now known as 'The Bristow Group'. The group operates an extensive fleet of helicopters and a number of fixed wing aircraft around the world.

Bristow provides non-scheduled helicopter and fixed wing services, contracting in support of oil exploration and production, geophysical and general survey work. Bristow has been involved in dedicated SAR helicopter operations for over 30 years.

Bristow is responsible for the airworthiness of the G-JSAR. It operates regular offshore flights on behalf of NAM from Aerodrome De Kooy. It is responsible for the safety of its crew and passengers during commercial air transportation in general and for the safe transport of its crew and passengers (survivors) during a search and rescue operation. This responsibility is confirmed by the requirements of the UK Air Navigation Order and JAR-OPS 3 (see Appendix O). JAR-OPS 3 specifically requires Bristow to have nominated an accountable manager acceptable to the UK Civil Aviation Authority who has corporate authority for ensuring that all operations and maintenance activities can be financed and carried out to the standard required by the Authority. Bristow must also have nominated post-holders acceptable to the UK CAA, who are responsible for the management and supervision of flight operations and crew training, etc.

The Den Helder SAR base, together with Bristow's other 4 SAR bases at the time of the accident, falls under the overall responsibility of the Bristow European Business Unit (EBU). The Bristow EBU is based at Aberdeen and is headed by a director reporting to the Board of Bristow Helicopters Limited. The managing/chief pilot is responsible for the safe and efficient conduct of the operation (including SAR) and for meeting the contractual obligations. Decisions on contractual or controversial matters affecting safety, or efficiency that cannot be resolved locally shall invariably be referred to the relevant Head of Flight Operations. The chief pilot of the Bristow Den Helder SAR base is a member of the EBU SAR management team, which is chaired by the EBU SAR Operations Manager. The EBU SAR Operations Manager is in charge of the European Operations. Regular Chief Pilot meetings are held and attended by key persons from each of the SAR units (including senior rear crew representatives).

Within Bristow Helicopters' Eastern Hemisphere operations, the Accountable Manager is the Managing Director. Reporting to him is the Quality & Safety Director, who heads the Quality & Safety department. The Quality & Safety department comprises three disciplines viz. Quality (responsible for Quality, Safety Case administration and engineering approvals), Health & Safety and Flight Safety. Each of these disciplines is led by an appropriate manager supported, in turn, by a number of staff. In the 'Quality' discipline, one of those staff is the Quality Assurance (Operations) officer; a post established to provide the necessary operational expertise. However, that post became vacant in July 2005 and was not filled until May 2007. This post exercises Quality 'oversight' of the Operations Manual, a document which is the responsibility of the Head of Flight Operations.

During the investigation, regular contacts were established with the Bristow Eastern Hemisphere Flight Safety Officer. He indicated that the above-mentioned vacancy was the reason for the inability to give answers to the questions raised by the Dutch Safety Board with regard to the content of the quality management system and for the absence of several Quality Information documents.

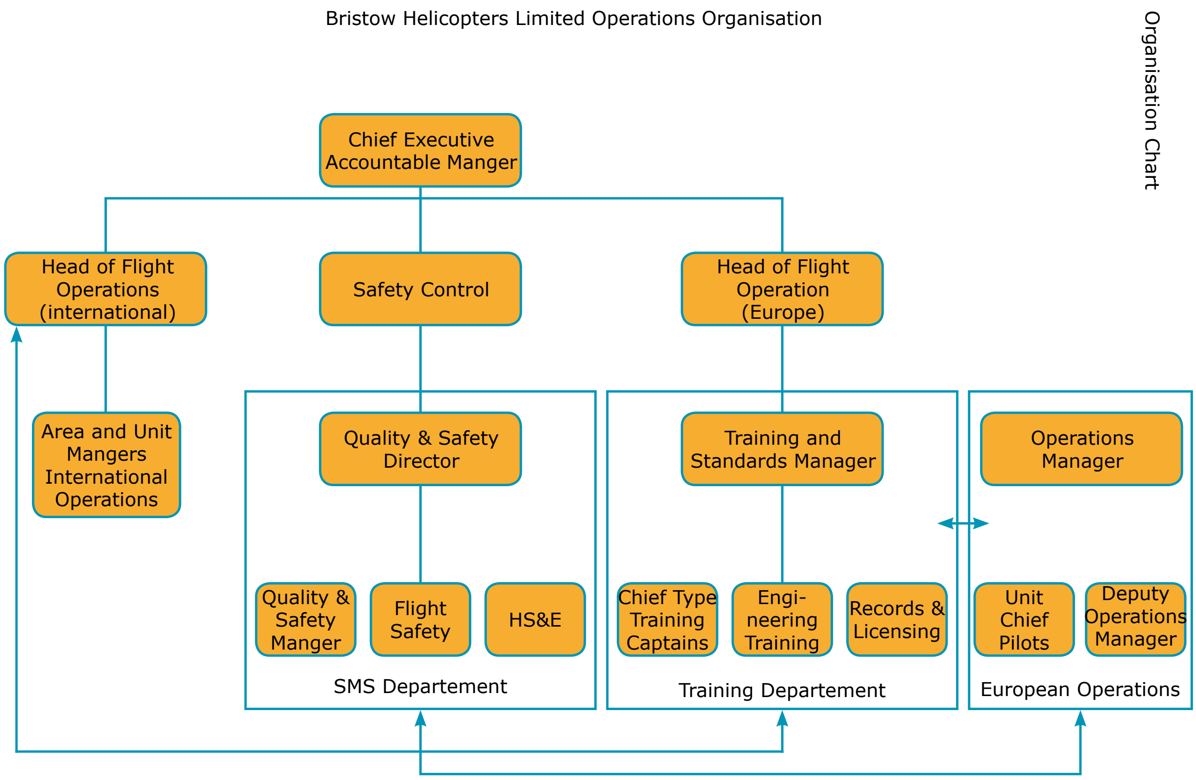


Illustration 11: Bristow organisation

Captain
According to the requirements of JAR-OPS 3, the captain of the helicopter is charged with a personal responsibility for ensuring the conduct of a safe flight. He/she may deviate from company rules, operational procedures and methods in the interest of safety, when rotors are turning.

According to Bristow procedures, all SAR flights must be authorised by a pilot who is conversant with the situation. This pilot can either be a:

- Managing Pilot or Chief Pilot of Unit
- Pilot-in-charge of SAR (PICSAR)
- Training Captain or, in the absence of any of the above,
- The most senior pilot available.

On the evening of the accident, the G-JSAR captain was one of the nominated pilots who was self-authorising.

Rear crew
With regard to the rear crew's (winch operator and winchman) responsibilities, it is standard practice that during a SAR flight, the rear crew are responsible for the safe operation of hoisting the passengers into the helicopter and/or taking care of the passengers in the cabin.

Further details about specific crew responsibilities in the Bristow organisation can be found in Appendix I.

Attendance of Periodical Operational SAR Meetings (POSO)
Since 1 November 2005, a representative of Bristow has attended the Periodical Operational SAR Meetings (POSO), which are held twice per year. See section 4.8, Netherlands Coastguard, for further information about the purpose of these meetings.

4.8 Netherlands Coastguard

The Netherlands Coastguard is responsible for a number of operational and enforcement duties on the North Sea. At the time of the accident, the Netherlands Coastguard was a joint venture consisting of six Dutch Ministries. As of 1 January 2007, it is now a joint venture consisting of seven Dutch governmental Ministries.[87] The operational command of the Netherlands Coastguard has been assigned to the Royal Netherlands Navy Command (see illustration 12).

To carry out its tasks, the participating ministries have placed their nautical and aeronautical assets at the disposal of the Netherlands Coastguard. For SAR, rescue vessels from the Royal Netherlands Sea Rescue Institution (KNRM) are mobilized. The Netherlands Coastguard has an Operational Centre in Den Helder, which is manned 24 hours a day and functions as a central reporting, information and coordination centre and is also the National Maritime and Aeronautical Rescue Centre (JRCC).

The Director of the Netherlands Coastguard is in charge of the Netherlands Coastguard and provides an operational plan (OPPLAN-SAR). He is responsible for the efficient organisation, management and supervision of the Netherlands Coastguard Centre and for the operational management of the Netherlands Coastguard, considering the instructions and the guidelines from the Commander of the Royal Netherlands Navy, the Minister of Transport, Public Works and Water Management, and the Permanent Contact Group for Enforcement in the North Sea (Permanente Kontaktgroep Handhaving Noordzee - PKHN). The Netherlands Coastguard does not have a system in which the quality of the available or hired rescue services are safeguarded and/or these rescue services are supervised, nor does it perform internal audits.

The Netherlands Coastguard is in charge of the operational control of the G-JSAR and is responsible for the dispatch of the G-JSAR in accordance with the Standard Operational Procedure. The Netherlands Coastguard carries shared responsibility as a member of the Steering Committee, and the latter is responsible for the supervision of the G-JSAR operation.

Periodical Operational SAR Deliberation
Twice a year, the Netherlands Coastguard organizes a so-called Periodiek Operationeel SAR Overleg - POSO (Periodical Operational SAR Meeting).[88] The Deputy Director of the Netherlands Coastguard and the Head of KNRM Operations alternately chair the POSO meetings. These meetings are attended by representatives of the Royal Netherlands Navy, the Royal Netherlands Air Force, the Ministry of Transport, Public Works and Water Management (Directorate-General for Public Works and Water Management - North Sea), the Royal Netherlands Sea Rescue Institution (KNRM), and since 1 November 2005, also a representative of Bristow involved in the G-JSAR operation. The objective of the SAR meetings is to enhance co-operation between the SAR units and to share SAR-related experiences.

Coastguard Triumvirate
The Director of the Netherlands Coastguard is one of the three members of the Coastguard Triumvirate (Driehoeksoverleg, later referred to as the Kustwacht-driemanschap in the Netherlands Coastguard New Style). Policy measures in relation to the Netherlands Coastguard were set out in coordination between the Ministry of Transport, Public Works and Water Management and the Permanent Contact Group for Enforcement in the North Sea (PKHN). In order to maintain a proper balance between policy- making and realization, consultations were arranged periodically between

87 Ministry of Transport, Public Works and Water Management, Ministry of Defence, Ministry of Finance, Ministry of Agriculture, Nature and Food Quality, Ministry of the Interior and Kingdom Relations, Ministry of Justice. As of 1 January 2007, also the Ministry of Economic Affairs.
88 Section 5.4 Report, analysis and evaluation, Operational search and rescue plan (OPPLAN-SAR), version 6.

the Director of the Netherlands Coastguard and representatives of the Ministry of Transport, Public Works and Water Management and the PKHN.

Coastguard Board
One of the provisions in the Netherlands Coastguard New Style was the establishment of the Coastguard Board (Raad voor de Kustwacht) on 1 January 2007. The Coastguard Board advises the Minister of Transport, Public Works and Water Management on the policy, enforcement, service, control, information and financial plans with regard to coastguard duties. Representatives of the six ministries involved are members of the Coastguard Board. The Director-General for Public Works and Water Management chairs the Coastguard Board on behalf of the Ministry of Transport, Public Works and Water Management.

4.9 Ministry of Economic Affairs

In its role as legislator, the Dutch Ministry of Economic Affairs is responsible for the Mining Act. Part of the Ministry is an oversight agency on the oil, gas, salt, and marl exploitation, known as the State Supervision of Mines. Due to the specific nature of the production of minerals, the State Supervision of Mines acts as supervisor and enforcer for the Mining Act and the Mining Decree. State Supervision of Mines is also the supervising inspectorate for Occupational Health and Safety on mining operations/mining facilities, both onshore and offshore. Offshore air transportation in general or the G-JSAR helicopter operations in particular are excluded from this supervision.

Health, Safety and Environment documents or 'VGM documents' with regard to mining facilities (such as K15B or the Noble George) are submitted to the State Supervision of Mines. State Supervision of Mines verifies the content of the applicable 'VGM documents' on the basis of selected inspection projects. At the time of the accident, this review process was concluded with a "no questions" letter from the State Supervision of Mines to the operator.

4.10 UK Civil Aviation Authority

The Civil Aviation Authority of the United Kingdom is responsible for the issue of Bristow's Air Operator's Certificate with special authorizations, approvals and exemptions. The issuance of an Air Operator's Certificate (AOC) is evidence of authority approval. Bristow is in possession of an AOC with SAR operations listed as an approved operational activity. The UK CAA is also responsible for issuing the Certificate of Airworthiness of the G-JSAR and its engines and for the supervision of the operation of the G-JSAR. The policies and procedures published in Parts A, B and D of the Bristow Operations Manual are subject to approval by the UK Civil Aviation Authority and Part A identifies managers responsible for the content of the material that is submitted for approval. The UK CAA granted Bristow approval to use the Helisim at Marignac simulator for License Skill Tests (LST).

4.11 Direction Générale de l'Aviation Civile

The French Direction Générale de l'Aviation Civile (DGAC) qualified the AS332L2 simulator at Helisim in Marignac (France) for level D training, which is used for training the Bristow G-JSAR flight crews.

4.12 Ministry of Transport, Public Works and Water Management

Regulatory oversight of air transportation in the Netherlands' flight information region is conducted by the Transport and Water Management Inspectorate, an agency of the Ministry of Transport, Public Works and Water Management. The Transport and Water Management Inspectorate does not supervise foreign aircraft operators or foreign maintenance organisations in the Netherlands. This is the responsibility of the regulator of the State of Registration, unless there is an arrangement with the regulatory inspectorate concerned. Such an agreement does not exist for the Bristow operation in Den Helder. Up to 1 January 2008, the Ministry was co-providing fixed wing flying SAR units for the Netherlands Coastguard.

The Transport and Water Management Inspectorate supervises Dutch registered aircraft and performs SAFA (Safety Assessment Foreign Aircraft) inspections on aircraft with Dutch and foreign registration on airports in the Netherlands. The Transport and Water Management Inspectorate indicated that no SAFA inspections have been carried ut on the G-JSAR since operations began in Den Helder in 2003.

At the time of the accident, the Directorate-General for Freight Transport and Civil Aviation of the Ministry of Transport, Public Works and Water Management was responsible for policy-making in relation to the SAR-service in the Netherlands, i.e. the Netherlands Coastguard.[89] In this respect, the Ministry has shared responsibility with the Commander of the Royal Netherlands Navy with regard to the content of the Netherlands Coastguard's OPPLAN-SAR. Several representatives of departments of the Ministry are involved in search and rescue operations. The representatives take part in the following governmental organisations/bodies:

- North Sea Task Force
- Coastguard Triumvirate
- Periodic Operational SAR Deliberation (POSO).

North Sea Task Force
The North Sea Task Force is an interdepartmental working group within the Ministry of Transport, Public Works and Water Management. The Transport and Water Management Inspectorate is responsible for providing the chairman of the Task Force. The Task Force is responsible for maintaining and, if possible, improving the safety of North Sea airspace and offshore helicopter operations by implementing several pre-established safety recommendations. The Task Force also advises the Ministry with regard to safety-related issues in North Sea airspace and offshore helicopter operations. The Task Force established a SAR Helicopter Policy and Performance Standard and was instrumental in establishing a matrix of permitted operation for offshore commercial air transport helicopter operators on the Dutch Continental Shelf following the G-JSAR accident.
Appendix V gives further background information about the North Sea Task Force and the Coastguard Triumvirate.

4.13 Ministry of Defence

The Netherlands Coastguard Centre forms part of the Royal Netherlands Navy and has been placed under the command of the Commander of the Royal Netherlands Navy. The Ministry of Defence is responsible for the Commander of the Royal Netherlands Navy. Therefore, the Ministry of Defence is responsible for the functioning of the Netherlands Coastguard.

At the time of the accident, the Royal Netherlands Navy was the owner and operator of the SAR Westland Lynx helicopters.[90] Twenty-four hours per day, a minimum of one Lynx SH-14D helicopter with crew was on standby for use and operational within a predetermined amount of time depending on the time of day and the day of the week: 20 minutes during weekdays between 08.00-16.30 hours, 45 minutes on weekdays between 16.30-08.00 hours, 45 minutes on weekends during daylight hours and 60 minutes after dusk.

At the time of the accident, the Royal Netherlands Navy provided air traffic services, i.e. a terminal approach control service and aerodrome control service, and provided fire brigade services at Aerodrome De Kooy.[91]

4.14 Aerodrome De Kooy

Aerodrome De Kooy is a military airport.[92] Part of the airport is used by Den Helder Airport for the purpose of civil aviation. The municipality of Den Helder is the owner of Den Helder Airport. The airport acts as the main gate to offshore operations and it is operated under a permit by the Ministries of Defence and Transport, Public Works and Water Management. At the time of the accident, the Royal Netherlands Navy was responsible for the airport facilities.[93] No airport facilities are available outside of opening hours.

89 In 2008, this task was taken over by the new Directorate-General for Civil Aviation and Maritime Affairs.
90 During the investigation, the command of these helicopters was taken over by the Royal Netherlands Air Force command.
91 During the investigation, the command of these facilities was taken over by the Royal Netherlands Air Force command.
92 During the investigation, the command of the military airport 'Naval Airstation De Kooy' was taken over by the Royal Netherlands Air Force command.
93 During the investigation, the command of these facilities was taken over by the Royal Netherlands Air Force command.

4.15 Royal Netherlands Sea Rescue Institution

The Royal Netherlands Sea Rescue Institution (Koninklijke Nederlandse Redding Maatschappij - KNRM) is a private organisation which rescues persons in distress at sea in the Netherlands. KNRM operates 24 hours a day, all year round. The maximum response time for KNRM is ten minutes and within ten nautical miles from the coast, the first KNRM-vessel has to arrive at the scene of the incident within under an hour.

5 ANALYSIS: THE DOWN-MANNING OF THE PRODUCTION PLATFORM K15B AND THE ACTIVATION OF THE G-JSAR

This section contains the analysis of the down-manning of the production platform K15B and the activation of the G-JSAR. It provides an answer to the first research question: Why was the decision taken to down-man the offshore installation using a search and rescue helicopter? Section 5.1 describes the time frame following the blackout for manning and down-manning by helicopter and the safety condition of an installation during blackout. Section 5.2 contains the analysis with regard to the decision to take non-essential staff to shore. Section 5.3 contains the analysis with regard to the decision to use the G-JSAR for transportation to shore and the role of each party. Section 5.4 provides an answer to the research question of this part of the investigation.

5.1 Moving staff from K15B to Noble George Sauvageau

On Tuesday 21 November 2006, close to 20.00, at the time of the power failure and subsequent emergency shutdown on K15B, all staff were present in the living quarters. At around 21.00, it became evident that power would not be restored that night. The Head of Concurrent Operations then contacted operations staff who were on duty onshore to discuss the alternatives. All staff on K15B moved to the Noble George at around 22.00. 'Essential staff' for start-up took up their quarters on the Noble George and 'non-essential staff' waited with their bags packed for helicopter transportation.

5.1.1 Time frame

From the start of the power failure on K15B, one hour passed before it became evident that the power failure would continue. From then onwards, NAM personnel onshore were contacted and after half an hour, the decision was taken to take 'non-essential staff' off the installation. This was followed by organizing a flight, which also took half an hour. At this moment (two hours after the initial power failure), the Netherlands Coastguard was contacted. All personnel were moved to the bridge connected drilling rig where they stayed inside the living quarters. Three hours after the power failure, the G-JSAR landed on the Noble George helicopter deck and the transportation of non-essential personnel commenced. The Dutch Safety Board compared this actual sequence with the risk assessments and operational safety requirements of NAM.

5.1.2 K15B operation (stand-alone)

The K15B is a fully self-supporting production platform. In the event of power failure on K15B, some safety systems will not function. The most important system out of service is the firewater system, due to the unavailability of the fire pumps, which are required in the event of an ignited gas/fluid release. In the event of power failure, the platform is isolated and blocked-in (all emergency valves are closed), followed by depressurization (all hydrocarbons are vented to atmospheric pressure). This is called a Total Platform Shutdown, as all operations are suspended.

In the Matrix of Permitted Operations (MOPO), the Offshore Installation Manager is aware of how to act in the event of system/component failures. The platform's MOPO applies to the unconnected/stand- alone situation and has been produced to assist and structure the decision-making process if a single part or multiple parts of a system have failed, the measures to be taken and considered, and whether or not an activity on the platform may still be permitted. In the event of a blackout and complete unavailability of multiple safety systems, all operations are instantly suspended and the Offshore Installation Manager must consider the evacuation of non-essential personnel: no operations are permitted. The MOPO also suggests "down-manning of non-essential personnel" in the event of a Total Platform Shutdown after a prolonged period in time. The prolonged time period is judged at the Offshore Installation Manager's discretion.

In such a case, the Offshore Installation Manager will assess the situation and conditions (time of the day/night, environmental conditions, number of personnel present on board, status of the platform etc.) and take additional measures as required. An important aspect of the decision-making process is the status of the platform over time. By design, following a blackout of three hours or more, apart from the unavailability of firewater, no helicopter landing lights will be available, emergency lighting will fade and fire and gas detection will cease to operate (see section 3.3.1 - K15B safety logic on blackout). The blackout situation, or the measures taken on behalf of the MOPO, do not interfere with the means of evacuation provided by the freefall lifeboat or secondary means of escape to sea. In other words, evacuation measures are still available. However, the necessary illumination of escape routes (to the accommodation or to the muster stations) will fade after 90 minutes.

The total loss of power and the ceasing of backup battery facilities cause a worsening of the conditions inside the living quarters, including darkness (although windows are fitted in the cabins), empty batteries after 90 minutes, loss of heating, ventilation, air conditioning systems, loss of catering facilities and sanitary provisions (water). Torches are available and can be used to provide some lighting in the living quarters. In such a situation, the well-being of personnel staying inside the accommodation block may be affected. However, the installation is considered to be in a safe condition, as the platform is isolated, blocked-in and depressurized.

5.1.3 Combined operation K15B - Noble George Sauvageau

In the occasion described in this report, things were different from normal operations because of the concurrent operations of K15B and the adjacent drilling rig. The platform is occasionally attended and connected (by means of a bridge) to a drilling rig for the drilling and/or maintenance of the wells. The connected situation allows personnel to move between the production (K15B) and drilling installation (Noble George). The movement is controlled by strict procedures in order to assure that all personnel present on the installation are accounted for/recorded in the event of an emergency.

For each concurrent operation, a so-called Concurrent Operations Script is prepared describing the management of risk of the combined activity. The Concurrent Operations Script also contains a Concurrent Operations matrix. This matrix describes which activities can be carried out concurrently and which cannot, as well as which activities are subject to the decision of the Head of Concurrent Operations. In the event of a loss of primary and backup power supply on K15B, the Concurrent Operations matrix limits a number of drilling activities on the Noble George. The majority of the activities are controlled by the decision of the Head of Concurrent Operations (see section 3.3.1 - Concurrent operation K15B and Noble George Sauvageau and Appendix P).

The availability of the drilling rig to host personnel plays a role in the decision-making by the Head of Concurrent Operations, i.e. there is always the option to move personnel to the drilling rig for reasons of comfort, where they are safe and sheltered. The Noble George provided illuminated shelter, an operational helideck, and food and hot drinks. However, the Concurrent Operations Script did not address overnight staff accommodation. The Noble George Rig Manager allowed K15B staff to sleep in the recreation room, but could not provide enough beds for all. Hot bedding[94] was also possible, but was considered unacceptable because this had not been practiced for many years. Both options would have created discomfort, but no hazards. Noble George lifeboats offered sufficient evacuation capacity. As the Concurrent Operations Script did not provide information on overnight staff accommodation and because it was not clear how down-manning could be organized during the closing hours of Aerodrome De Kooy, the Head of Concurrent Operations contacted the NAM Operations Coordinator and the Operations Manager (onshore) to discuss the situation in accordance with the responsibilities of the Head of Concurrent Operations, as described in the Concurrent Operations Script.

5.1.4 Understanding of safety condition

While installations are largely dependent on power supply, the loss of main and emergency power does not cause an emergency. Following power failure, K15B was closed-in and depressurized, as this was a safe operational mode. In this mode, vessels and pipes still contain hydrocarbons at atmospheric pressure or just above, but potential for leakage and ignition of hydrocarbons has been minimized and is logic remote according to the system.

The Concurrent Operations Script included a K15B blackout/power loss in combination with Noble George drilling and addressed the constraints on further activities. According to the script, the Head of Concurrent Operations was responsible for making a decision on level 1 /NAM Risk Matrix cases, which was the situation in this case (see section 3.3.1). Only the Operations Manager onshore had to be informed. Up to this point, the permitted operations and procedures had been clear. Both the Head of Concurrent Operations and the (acting) K15B Offshore Installation Manager stated that the K15B installation was safe, but uncomfortable, for personnel to be accommodated. However, the Operations Coordinator onshore who was contacted by the Head of Concurrent Operations believed the situation on the K15B to be unsafe, as fire and gas detection would be lost upon depletion of power from the battery backup and firewater would not be available, while the drilling activities on the Noble George continued. A calamity on the Noble George could have affected the safety of personnel on the K15B. There appeared to be no common understanding of the safety condition of the situation and this therefore became an incentive to evacuate personnel. The Concurrent Operations Script does not expressly address down-manning of (non-essential) personnel as this decision is

94 Procedure in which one bed is used by more persons working in shifts.

left to the Head of Concurrent Operations. Eventually it was decided to evacuate the 'non-essential' staff ashore. The NAM Operations Manager supported this decision (see also section 5.2).

The Safety Board is of the opinion that the Concurrent Operations Script did not include the assessment of hazards in the event of a prolonged blackout on the K15B in combination with ongoing drilling activities on the Noble George. In hindsight, staying on the K15B meant the K15B staff taking unnecessary risks. The fact that the blackout lasted for a prolonged period of time also meant that it was shifting towards level 2/3 of the NAM Risk Matrix, in which approval of the Operation Manager was required. The decision to bring all K15B staff to the Noble George was therefore rational.
K15B staff could have been accommodated on the Noble George, although in that case, the discomfort of not sleeping in beds or practising hot-bedding would have been inevitable. If the power loss had persisted the following day, the staff could still be transported to shore during daylight hours. In that case, the decision to evacuate personnel on the evening of 21 November 2006 would have been avoided.

- *The decision to bring all K15B staff to the Noble George Sauvageau avoided exposure to the unnecessary risks of staying on the K15B.*
- *The hazards of a prolonged black out on the K15B combined with the ongoing drilling activities on the Noble George Sauvageau were not described in the Concurrent Operations Script.*

5.2 Decision to take non-essential K15B-staff to shore

The Offshore Installation Manager is responsible for the crew and the installation of K15B at all times, as is the Rig Manager for the Noble George. For the concurrent operations, the Head of Concurrent Operations has ultimate responsibility with regard to health and safety for both K15B and Noble George staff. Given the situation that the Concurrent Operations Script did not include the assessment of hazards of the situation of a prolonged blackout on the K15B in combination with the ongoing drilling activities on the Noble George, it is understandable that the Head of Concurrent Operations contacted the NAM Operations Coordinator and the Operations Manager to discuss the situation (see section 5.1.3).

The decision to bring staff onshore from the Noble George was taken lightly and made on the basis of comfort considerations only, given the sleeping accommodation on the Noble George for all K15B staff, whilst inadequate knowledge was available regarding the alternatives for down-manning.
The Safety Board found that offshore operations staff had inadequate information at their disposal regarding the conditions and timeframes for the transportation of personnel to and from the installation. Consequently, the NAM staff involved had different views with regard to the availability and use of public transport and SAR helicopters. They had no knowledge of the availability of public transport helicopters from Norwich either.

Onshore staff made the evacuation request known to the K14C radio operator. The radio operator in turn contacted the Flight Scheduling Unit representative in Den Helder with a request for the evacuation. The NAM Flight Scheduling Unit representative was also not aware of the standby arrangement of a Bristow public transport helicopter at Norwich, which had been agreed upon since the Shell UK and Dutch NAM operations on the southern part of the Continental Shelf were combined in the EPE organisation. NAM is able to activate a Bristow helicopter for public transport that is on standby and normally operates on the UK Continental Shelf. This helicopter operates from Norwich airport in the UK (see section 3.3.3 Bristow - Den Helder Base Instructions). During the night of the incident, use of this helicopter for the down-manning of K15B, situated on the Dutch Continental Shelf, was not taken into consideration. This alternative could have been an option assuming that the offshore staff would have been familiar with the availability of the Norwich-based helicopter and the Flight Scheduling Unit representative would have understood the nature of the problem and the subsequent request of K15B that night. On this occasion, however, the K14C radio operator was advised by the FSU representative to contact the Netherlands Coastguard, as the impression had been given that the platform needed to be evacuated. The FSU representative believed an evacuation to be an emergency and did not challenge that information. The significance of the definition "emergency" in relation to the roles of the various parties involved will be explained in section 5.3.2.

The sequence of events between the involved NAM offshore and onshore staff during the decision- making process with regard to the assessment of the safety condition of the installation and the necessity for evacuation indicated that opinions and responsibilities were influenced by onshore staff.

The investigation revealed that the NAM staff involved in the decision-making process were not properly informed about the availability and the use of public transport helicopters during the night and the G-JSAR helicopter in particular. The Safety Board believes that such information was necessary for an appropriate risk assessment, duly balancing the risk of helicopter flying with the G-JSAR against the risk of staff staying offshore, which could have led to a decision not to evacuate staff from the Noble George.

- *The decision to take the non-essential K15B staff onshore was taken on the basis of a perceived loss of comfort caused by the blackout, on an unclear basis and with the wrong classification of urgency.*
- *The applicable NAM documentation did not contain procedures regarding the availability and the conditions for using public transport helicopters or the G-JSAR helicopter, nor for alternative helicopter public transport during night-time hours. NAM staff involved had different views with regard to the availability and use of public transport helicopters in general and the G-JSAR helicopter when used for public transport in particular.*

5.3 Decision to dispatch G-JSAR for transportation to shore

5.3.1 Air Operator's Certificate exemptions for SAR

The purpose of the international legislation in the field of search and rescue (see section 3.2.3) is to assure the establishment of a search and rescue service within each contracting state. The result of this condition is that the individual states are currently responsible for assuring the safety of SAR operations. The G-JSAR which that registered in the UK was subject to UK regulations and supervision. As the regulation of SAR operations is not yet well developed at international level (see section 8.3.1), the UK opted for the following solution. With regard to the issuance of Air Operator's Certificates (AOC), the Air Navigation Order 2005 (ANO 2005) in particular shall apply (see section 3.2.2, ad 4). If compliance with the JAR-OPS 3 requirements is established, exemption from part of the ANO 2005 requirements with regard to the issuance of an AOC may be allowed. SAR operations transporting passengers and/or baggage are, according to the ANO 2005, considered to be within the scope of its application. However, specific exemptions regarding the ANO 2005 as well as the JAR-OPS 3 requirements may be included in an individual AOC for the execution of SAR operations. This technique allows for the combination of executing SAR operations as well as public transport operations within the framework of one individual AOC.

Bristow provides regular public transport operations as well as SAR operations. The AOC issued to Bristow included certain exemptions from the legal requirements with regard to the execution of SAR operations with the G-JSAR, as explained above (see also section 3.3.3 and Appendix R). Therefore, it is only allowed to transport more passengers than the number of available passenger seats on SAR flights. An exemption was provided for the captain as he/she is responsible for ensuring that the passengers are properly secured in their seats - on the condition that the helicopter would be equipped with a handhold for use by any passenger. Under certain operating conditions, not being strapped into an (airworthy) seat may result in an increase in the risk to the passengers' safety. However, the UK CAA accepts that life-threatening conditions such as those that necessitate SAR operations justify this increased risk. The Safety Board agrees with this principle.

The G-JSAR was specifically equipped for the provision of search and rescue services in emergency situations. As cabin space was reserved for the transportation of stretchers, the G-JSAR was only equipped with four passenger seats in the cabin. This limited seating availability alone made the operation of the G-JSAR on 21 November 2006, with 4 crew and 13 passengers on board, impermissible if the flight could not be regarded as a SAR operation within the framework of the AOC. Under the conditions described in sections 5.1 and 5.2, the transportation of people to shore can be appreciated, but these conditions do not result in an emergency situation that justifies a search and rescue operation with increased safety risks.

The latter conclusion corresponds with the basic assumptions as laid down in the AOC. With regard to defining the SAR concept as laid down in the AOC, the UK CAA, on being asked, referred to the definitions of the concepts of "search" and "rescue" as laid down in Annex 12 to the Convention of

Chicago. Though these definitions are conceived for civil aviation operations and not for the offshore industry, the answer to the question as to whether an emergency situation is serious enough to justify a search and rescue operation with the corresponding safety risks included, will basically be of a similar nature within each sector of operation. According to the definitions as laid down in Annex 12 with regard to "distress" or "rescue", a SAR action is involved in the event of a "threatening by grave and immediate danger" (see section 3.2.3). Consequently, they concern actual and acute emergency situations, but this was not the case. The different phases of emergency situations as defined in the OPPLAN-SAR by the Netherlands Coastguard that are based on the International Convention on Maritime Search and Rescue from 1979 (see sections 3.2.3, 3.3.5, and Appendix S), do indeed allow for a more extended scope of interpretation, but these specifications, which incidentally also include "search" situations, did not apply either.

Judging by the information provided by the competent authorities, the flight that was operated with the G-JSAR on 21 November 2006 could not be deemed to be a SAR operation according to the AOC requirements. Consequently, AOC-exemptions, such as the possibility of transporting passengers without the availability of proper passenger seats or life jackets, were not applicable. Therefore, the operation should not have been executed, as the transportation of passengers using the G-JSAR meant taking an unnecessary risk.

On the basis of the requirements as laid down in the Air Operator's Certificate of Bristow, the operation with the G-JSAR on 21 November 2006 should not have been executed.

5.3.2 The role of the various parties involved

In the decision-making process with regard to the dispatch of the G-JSAR, various parties were involved, which were the NAM, the Netherlands Coastguard and Bristow. The role of each stakeholder, and its part in the decision-making process, will be explained below.

The role of NAM
The investigation has revealed so far that NAM staff did not realize that the conditions for SAR flights differ from those for public transport flights. For example, it was assumed that luggage could be transported back to Den Helder, which is not allowed during a SAR flight. Another example is that some of the NAM staff involved in the decision-making process appeared to be unaware of the fact that the G-JSAR was not equipped with a sufficient number of seats.

Even though the NAM specifically requested the G-JSAR, the formal role of the NAM in this process was to ask the Netherlands Coastguard for assistance, and not to make a final decision with regard to the dispatch of the G-JSAR. According to the agreements made between the offshore operators (SAR Helicopter Sharing Agreement), G-JSAR only would be used for purposes "in connection with an emergency in the SAR Operation Area and in accordance with the agreement". Consequently, the definition "emergency" is of primary importance. On the one hand, according to the agreement it is to be understood as a situation in which "danger of life or a Medevac situation related to the offshore industry" is involved, and on the other hand, a situation of "life-threatening circumstances not related to the offshore industry under which the dispatch of the SAR Helicopter is deemed to be necessary" (see section 3.3.6). A similar delineation with regard to the dispatch of the G-JSAR has been laid down in cooperation agreements between the operators and the Netherlands Coastguard (see section 3.3.6) in the Standard Operational Procedure, as agreed between Bristow and the Netherlands Coastguard (see section 3.3.6 and Appendix T), and the SAR alarm procedure as agreed between the Ministry of Defence, the Netherlands Coastguard and Bristow (see section 3.3.6 and Appendix U). With regard to the offshore industry, the relevant sector in this connection, this delineation is in accordance with the Aircraft management guidelines of the International Association of Oil & Gas Producers, in which the significance of omitting an unnecessary dispatch is emphasized (see section 3.3.1).

In the first instance, the definition "emergency" includes life-threatening situations and the emergency conditions that justify search and rescue action as mentioned before. The definition also includes the so-called Medevac-situations, i.e. situations in which transport is necessary for medical reasons. The term Medevac has been explained in further detail in the Standard Operational Procedure for the G-JSAR: in the event that no doctor is required during the flight, the G-JSAR may be used for evacuations for medical reasons. As explained before, the necessity of a search and rescue operation did not occur on this occasion, and neither did a medical reason for the evacuation of one or more persons. Therefore the evacuation under consideration has not actually been considered a Medevac. Consequently, the NAM's request for the dispatch of the G-JSAR was unjustified and by doing so, it exposed its personnel to unnecessary safety risks. Though the NAM indeed has no responsibility for Bristow's compliance with the rules, it should have been responsible, as it was directly involved in the dispatch of the G-JSAR and knew of the layout of the helicopter's cabin. NAM staff involved should have realised that the carriage of thirteen passengers in the G-JSAR could not be accomplished following the normal procedures, requiring a seat for each passenger, and that this caused an increase in safety risk. The term "evacuation" that was used by the NAM staff involved in their request for assistance may have aggravated the confusion regarding the dispatch of the G-JSAR during the continuation of the procedure. In the Standard Operational Procedure that has been agreed between Bristow and the Netherlands Coastguard, the term evacuation plays a role within the definitions of Medevac and Casevac[95] in connection with the decision-making process with regard to the dispatch of G-JSAR, as well as with regard to the classification of the operation. Consequently, this term could have caused the wrong impression with regard to the necessity of dispatching the G-JSAR.

The explanation above is all the more convincing, as alternatives to the dispatch of the G-JSAR were available. One of the alternatives could have been to use the 'night standby' Bristow helicopter for public transport outside of office hours as referred to in section 5.2.

Although the decision on the safety status of an installation should not be challenged by others, the Safety Board concludes that during or after the request to the Netherlands Coastguard, the Flight Scheduling Unit representative could have asked the K14C radio operator, the Head of Concurrent Operations, the Operations Coordinator or the Operations Manager to provide an indication of the nature and necessity of the assistance required. Information that would clarify whether an evacuation was required as a result of a fire or an explosion, whether evacuees were injured or if personnel on board were preparing to deploy the lifeboats would give rescue services an idea of the nature of the assistance required and whether the support requested would be adequate. In this particular case, the Flight Scheduling Unit representative could have brought the evacuation request up for discussion, because the Head of Concurrent Operations had indicated to the K14C radio operator that there was no life-threatening situation.

The case under consideration did not warrant the transportation of persons using a SAR helicopter without sufficient seats. No adequate risk assessment was provided by NAM. As a result, NAM Operations staff involved were not familiar with the consequences of the G-JSAR dispatch and were not adequately prepared to take decisions in this respect.

- *NAM's decision to use the G-JSAR for a non-emergency flight was not in accordance with the agreements and procedures as established between the Company Group, the Ministry of Defence, the Netherlands Coastguard and Bristow, nor with the international guidelines of the International Association of Oil & Gas Producers.*
- *NAM's offshore risk analyses did not take into account all the hazards involved in SAR helicopter flights in general, and with the G-JSAR in particular. Consequently, NAM was not adequately prepared for down-manning offshore installations during the closing hours of Aerodrome De Kooy.*

The role of the Netherlands Coastguard
During the dispatch of the G-JSAR, the Netherlands Coastguard played a decisive role: it is the Netherlands Coastguard that dispatched the G-JSAR for Search and Rescue. The Netherlands Coastguard's actions must be in accordance with the Netherlands Coastguard's OPPLAN-SAR (Appendix S), the Standard Operational Procedure (SOP) as agreed between the Netherlands Coastguard and Bristow (Appendix T) and the SAR alarm procedure as agreed between the Ministry of Defence, the Netherlands Coastguard and Bristow (Appendix U). It is even more important in this respect that the actions are in accordance with the requirements of the Air Operator's Certificate (AOC) exemptions for SAR operations (Appendix R). The role of the Netherlands Coastguard is emphasized in the cooperation agreement made by the offshore operators and the Netherlands Coastguard Centre and is also mentioned in the agreement made by the offshore operators and Bristow. The Netherlands Coastguard used the Standard Operational Procedure for the dispatch of the G-JSAR.

Following the request by NAM, which was logged in the files of the Netherlands Coastguard as to "evacuate the K15B", the Duty Officer of the Joint Rescue and Coordination Centre (JRCC) called the Duty-Captain of the G-JSAR at the Bristow Den Helder unit. The SOP provides examples of emergency situations such as "helicopter ditch, fire and/or explosion, well blow-out, ship collision, man overboard, evacuation" that require immediate G-JSAR dispatch. The word "evacuation" is not explained in any further detail, but in any case it means that there is a life-threatening situation

95 Casualty evacuation, see Appendix R.

for the people involved. The JRCC Duty Officer classified the request for evacuation as an "offshore SAR operation" (SAR-incident), because, according to the SOP, evacuation "required immediate G-JSAR employment" (see section 3.3.6, Appendix T and Appendix U). As explained before, the request for evacuation was not based on an emergency situation.

The Netherlands Coastguard - JRCC's standing practice to dispatch the G-JSAR illustrated to the Safety Board that the JRCC did not realise that its decisions concerning the dispatch had direct consequences for the applicability of the Air Operator's Certificate exemptions for SAR operations as laid down in the AOC (see section 3.3.3 and Appendix R). As explained by the UK CAA, an operation such as a SAR mission must be authorised by the UK Maritime and Coastguard Agency or the Netherlands Coastguard (see section 3.3.3 - Air Operator's Certificate). Consequently, the decision of the Netherlands Coastguard with regard to the dispatch of the G-JSAR was a deciding factor in determining the applicable exemptions as laid down in the AOC. As mentioned before, these exemptions may result in an increase in safety risks, which is justified in emergency situations only. Though the Netherlands Coastguard is not subject to the English legal system, it is nevertheless essential that it is aware of this role should the occasion arise, especially since the Bristow SAR crew members who also operate on the G-JSAR have experience in working with the UK Maritime and Coastguard Agency. The UK Maritime and Coastguard Agency consults with the company or person requiring assistance before deciding if it is appropriate to deploy its SAR equipment. The Periodic Operational SAR Meetings (POSO) meetings could have been used to share this information.

As concluded above on the basis of the requirements as laid down in the AOC, the flight should not have been operated in this way. Although the Netherlands Coastguard is not legally committed to apply the AOC requirements (which are addressed to the operator - Bristow), it is obliged to apply any consequences they may have as laid down in the SOP. It is obvious that in the event of a (possible) emergency call there will be hardly any time for an extensive assessment regarding the nature of the request. Nevertheless, on the basis of the instructions following the categorization as laid down in the OPPLAN-SAR, and in addition to the Standard Operational Procedures, a concise assessment of the request for assistance may have resulted in the conclusion that the situation did not justify a search and rescue operation. The OPPLAN-SAR contains an instruction for the JRCC to verify the information and to collect as much information as possible in order to assess the emergency level properly (see section 3.3.5 and Appendix S). The Netherlands Coastguard stated that they follow their Operational plan Search-and-Rescue (OPPLAN-SAR) procedures with the different phases of emergencies, but they could not demonstrate the categorization of the state of emergency phase of SAR-incidents, because it is not recorded in the incident files. Even during the flight to the Noble George, the G-JSAR could have been called back if it had been concluded that this did not concern an emergency situation.

- *The Netherlands Coastguard acted as a communication channel between NAM and Bristow only during the decision to dispatch the G-JSAR on 21 November 2006.*
- *The G-JSAR dispatch on 21 November 2006 was not in accordance with the Standard Operating Procedure or with the SAR alarm procedure.*
- *The Netherlands Coastguard did not follow the instructions for adequately assessing the emergency level in accordance with the OPPLAN-SAR.*

The role of Bristow

On the evening of 21 November 2006, the Netherlands Coastguard dispatched the G-JSAR from its base at Aerodrome De Kooy. It is assumed that Bristow, being the operator and subject to the AOC, was formally responsible for operating the flight with the G-JSAR according to the AOC requirements. This formal responsibility must be regarded as being separate from the issue concerning the question as to whether the captain of the G-JSAR, confronted with the decision of the Netherlands Coastguard, should have refused to operate the flight. In the initial call by the Joint Rescue Coordination Centre Duty Officer with the G-JSAR captain, there was no mention of any categorization of the flight in the order of SAR, Casevac or Medevac, in accordance with the SOP. The term "evacuation" sufficed. Thereafter, the captain of the G-JSAR made a confirming phone call with the K14C radio operator. Her telephone call with the K14C radio operator confirmed that there were thirteen persons to be 'evacuated', that there was no life-threatening situation for the thirteen persons and that the request for 'evacuation' was backed-up by the NAM Operations Manager.

The captain accepted the evacuation task as such. However, it became apparent that there were some doubts about the request in the minds of the flight crew. This can be concluded from the discussions between the crew members when they were en route to the drilling rig. They discussed the total number of life jackets on board. When they initially concluded that they were short of one life jacket, the discussion progressed in the direction of the validity of the rescue argument, because that would be an argument for an exemption to the regulations about wearing life jackets during public transportation flights. After finding enough life jackets, a clear and distinct conclusion about the rescue argument and the applicability of the exemptions of the regulations for a SAR-mission was not reached. During the flight to the Noble George, the captain verified the need to evacuate thirteen persons using the K14C radio operator.

It must be assumed that the Netherlands Coastguard is responsible for taking the decision to dispatch a SAR flight, as mentioned earlier. It is therefore the Netherlands Coastguard's duty to decide whether the situation justifies a search and rescue operation and if the risks in connection with that operation are acceptable considering the particular emergency situation. The agreement between the offshore operators and Bristow therefore states that the final decision as to whether the aircraft can attempt a given task lies with the aircraft captain following consultation with JRCC. This responsibility must not however be considered as providing an option to overrule the decision of the Netherlands Coastguard concerning the dispatch for search and rescue. The existence of a similar overruling authority of the captain would result in unworkable relations in emergency situations that are connected with search and rescue duties. The final decision of the captain, who has ultimate responsibility for the flight, firstly and in particular concerns the safety of the flight. This responsibility must be distinguished from the responsibility to dispatch the mission as mentioned before, which should be based upon a more extensive assessment that also takes the situation and safety risks at the location of the emergency into consideration. Therefore, apart from the situation, which incidentally must be regarded as absolutely theoretical, in which a request for assistance would obviously be absurd and it would have been authorized by the Netherlands Coastguard, it cannot be alleged that the captain should refuse a SAR flight in cases that allow for doubt concerning the necessity for search and rescue as determined by the Netherlands Coastguard.

As the decision to dispatch a SAR flight lies with the Netherlands Coastguard, the G-JSAR captain could not be expected to refuse the flight.

5.4 Answer to research question and main conclusions

This section gives an answer to the first research question: Why was a decision taken to down-man the offshore installation by means of a search and rescue helicopter?

The decision to use the G-JSAR for down-manning of the installation was taken unfounded and based on an inadequate assessment of the risks involved. A search and rescue helicopter with a limited number of passenger seats is unsuitable for non-emergency transportation if the number of passengers exceeds the number of seats and/or safety belts. In that case, the risks involved for the passengers during a helicopter in-flight emergency, such as ditching, clearly outweigh the benefits of the transportation with a SAR helicopter compared with a public transport helicopter. The discharge of the respective responsibilities of the parties involved, be it the NAM, the Netherlands Coastguard or Bristow, as laid down in the respective agreements, was ineffective and inadequate. The experiences gained in the preceding years were not used to evaluate the respective agreements.

6 ANALYSIS: THE G-JSAR FLIGHT AND THE EMERGENCY LANDING

This section contains the analysis of the technical investigation and the events during the return flight from the Noble George. The research question for this part of the investigation is: What are the events and conditions that resulted in the decision to make an emergency landing? This question cannot be answered without a careful analysis of the human factor. The analysis of the flight crew actions is based upon information from the cockpit voice recorder and the flight data recorder data and on crew interviews. More detailed information can be found in Appendix C.

Section 6.1 contains the analysis of the engine control. Section 6.2 contains the analysis of the flight crew actions related to the engine anomalies. Sections 6.3 and 6.4 contain the analysis of the automatic flight and flight control system respectively. Section 6.5 provides the analysis regarding the flight crew actions that relate to the control problem. Section 6.6 contains the analysis regarding the Crew Resource Management. Section 6.7 contains the analysis regarding training and checking. In section 6.8, the Dutch Safety Board will provide an answer to the research question.

6.1 Engine control

In this analysis, the Safety Board considers a difference in engine gas turbine rotor RPM (gas turbine rotor speed - Ng) indications between both engines of more than 1% to be an anomaly. This criterion is based upon the requirement mentioned in the maintenance documentation from Eurocopter that differences of more than 1% should be reported. During the flight from Aerodrome De Kooy to the Noble George, neither engine anomalies were reported by the flight crew on the cockpit voice recorder, and neither were they recorded on the flight data recorder. During the stop at the Noble George, the flight data recorder recorded a difference in gas turbine rotor speed of approximately 3% with an intermittent nature. This was not observed by the crew, as the duration was short and there was no need to closely monitor the engine instruments whilst standing on the platform. Before the return flight to De Kooy was initiated, the difference returned to less than 1% Ng.

When flying at 3000 feet, the crew observed a difference in gas turbine rotor speed between the two engines. FDR data confirmed that this was about 5% Ng. A descent was initiated. Within the next 2 minutes, the difference between the two engines increased to 7% Ng, together with other fluctuating engine parameters. The fluctuations of engine parameters, including the gas turbine rotor speed of both engines, occurred under both constant and varying collective pitch.

When the difference in Ng exceeded 7.5%, the DIFF NG warning was activated. Subsequently, the Master Warning was triggered. From this moment on, various DIFF NG warnings reoccurred because the difference between both gas turbine rotor speeds varied around 7.5%.

During descent, engine number 2 tended to stabilize at a power setting of approximately 85%. This power setting level is the same as the governing failure safe preset cruise power setting, when the digital engine control unit (DECU) signal to the fuel control unit or position transducer signal is lost. This normally results in a governor warning light. However, the flight crew did not observe a GOV warning light during the event flight. Activation of a GOV warning light is not recorded on the FDR but is recorded on the DECU. The governor warning that was recorded on the DECU of engine number 2 turned out to be the result of an engine shutdown for training during a previous flight on the day of the incident. Therefore, it could be concluded that the GOV warning was not activated during the incident flight.

Although requested by the Safety Board during the investigation, neither Eurocopter nor Turbomeca could give a technical explanation for the differences in gas turbine rotor speed. Following the statement by Eurocopter that gas turbine rotor speed differences of less than 7.5% should be regarded as 'normal', the Safety Board was unable to find a confirmation of this Eurocopter position in the AS332L2 Flight Manual or the Eurocopter Training Manual (see section 3.3.2).

Using data analysis, the Safety Board concludes that the gas turbine rotor speed difference between both engines developed progressively over time due to an unexplained malfunctioning of the engine control systems, which ultimately resulted in successive DIFF NG warnings. However, both engines together still delivered sufficient power for continuation of the flight.

6.2 Flight crew actions related to the engine anomalies

During cruise flight at 3000 feet, the first indication of an abnormal engine indication was noticed by the captain who alerted the co-pilot to the "huge" difference between the two engine gas turbine rotor speed readings. This was confirmed by the co-pilot with the remark that engine 1 had a fluctuating Ng. For a short time, the crew observed and discussed the engine readings. The co-pilot then announced "I am going to slow down because we got a fluctuating…" and before he finished his message, the captain broadcasted a "Pan call" to ATC accompanied by a request for a slow descent to 1000 feet because of fluctuations on engine number 1.

There is no procedure for the observed abnormal engine indication. However, in the opinion of the crew, the extent of the engine deviation called for immediate action. This can be derived from the co-pilot's intention to slow down, the captain's "Pan call" and the request for a descent to 1000 feet. The sense that something had to be done directed the crew to the objective to fly "lower and slower", which is not unusual when a helicopter encounters an abnormal situation. Shortly before descent, the co-pilot disconnected the autopilot upper modes, which enabled him to fly manually. He then asked the captain to bring out the emergency operating procedures (EOPs). As the EOPs did not contain an applicable procedure, the captain's reaction that she had "no idea where to look" makes sense. During descent, on request of the captain without reference to a checklist, the co-pilot moved the collective. The captain observed both engines responding without the appearance of a GOV light. FDR data confirm that the engines responded correctly on varying collective inputs and that the difference in gas turbine rotor speed reading remained present.

The captain concluded that her observation could indicate a minor or a major governor failure. In fact, the action of the flight crew was in line with the procedure called 'ENGINE MAJOR GOVERNOR FAILURE'. Moving the collective is a subsequent step in the procedure.

When, during cruise flight, the abnormal engine reading was observed by the crew, the engines were supplying sufficient power to maintain altitude. Although the difference in gas turbine rotor speed was more than observed on other occasions, it was still within operating limits and no immediate action was required. Under these circumstances it is preferred to maintain steady flight conditions until fault analysis is completed and a plan has been drawn up. By initiating the descent, the crew changed the steady flight condition and made it more complicated to analyse the condition of both engines.

Both Eurocopter and Bristow confirmed that given the initially observed engine readings, the flight crew could have abandoned troubleshooting and continue the flight normally. However, neither Eurocopter in its AS332L2 Flight Manual nor Bristow in its Operating Manual provide clear and unambiguous information on what is expected from flight crews when non-standard operating conditions emerge. The Safety Board emphasises the need to provide flight crews with clear information and handling instructions if system behaviour noticeably differs from the standard. In the investigation of a serious incident with a Super Puma in the North Sea in 1998, it was already concluded that there is a need for flight crews to improve theoretical understanding of the engine control system (Appendix C, section 1.18.4).

When descending through 1600 feet, several DIFF NG warnings went on and off and the captain called for a straight track to De Kooy Aerodrome. Some anxiety can be noticed in the communication from the captain as she said: "There is a DIFF NG but I like to keep both engines running as long as possible". Until that moment, no explicit conclusion could be made with regard to the engine problem and the crew was still unsure as to which engine was at fault. The - as it appeared - erratic indications resulted in uncertainty with regard to the condition of the engines and an increased urgency for the crew to arrive at the destination as soon as possible.

No action was taken to look again in the EOPs for an emergency procedure concerning the DIFF NG warning. A DIFF NG warning without an accompanying oil pressure warning would have directed the flight crew to either an ENGINE MAJOR GOVERNOR FAILURE or an ENGINE MINOR GOVERNOR FAILURE. In the opinion of the Safety Board, these procedures are rather complicated because one has to choose from different options which are not easily distinguished and none of these are based on a sole DIFF NG warning. When looking at the published EOPs for governor failures, the Safety Board noticed that it is difficult to understand the meaning of the listed indications. Many different combinations of indications can lead to a procedure, but it is difficult to determine which procedure is applicable. The Safety Board concludes that these procedures are useful when ample time is available. If you put this in the context of the already existing workload and the incomplete mental model of the situation, one can understand why the EOPs were not consulted further. This was particularly true when the crew was confronted with the control problem shortly afterwards.

- *When confronted with engine behaviour that differed from the crew's experience, the flight crew tried to find out which engine caused the problem.*
- *Neither Eurocopter in its Flight Manual nor Bristow in its Operating Manual provide flight crews with clear and unambiguous information about what they can expect from the coo-peration of both engine governor systems under normal and non-normal operating condi-tions.*
- *The AS332L2 Emergency Operating Procedures for DIFF NG warnings are complicated.*
- *Both engines were running and sufficient engine power was available to continue the flight.*
- *The investigation did not reveal a technical cause for the engine anomaly.*

6.3 Automatic flight

Shortly before descent, the co-pilot disconnected the Automatic Flight Control System (autopilot) upper modes, which required him to manually control the intended flight path.

Optimal use of the autopilot effectively supports the pilots in their primary task of controlling the aircraft's flight path. During abnormal situations in particular, full use of the autopilot's potential creates more room for other tasks. By disconnecting the autopilot upper modes, the crew intensi-fied their task and consequently were able to pay less attention to information analysis and deci-sion- making. During descent, both pilots paid attention to trouble-shooting and this hindered their primary task of controlling the flight path. This can be observed by considering the speed during descent, whereby the intention to slow down was not achieved until shortly before ditching.

No procedures or policy for optimal use of the autopilot upper modes other than during hoist opera-tions was found in the Bristow Operations Manual. Discussions with the flight crew and the Bristow management after the accident revealed that opinions within the company about the optimal use of the AS332L2 autopilot functions differ. According to the crew, it is common practice within the Bristow SAR operation to switch off the autopilot upper modes during non-standard situations. Ac-cording to Bristow management, this is counter-productive and information on how and when auto-mation must be used forms part of the training. Neither statement is laid down in a procedure or a training note.

The Safety Board is of the opinion that optimal use of automation reduces the crew's workload during the flight. In complex situations, this reduction in workload is significant. The Safety Board therefore recommends that manual flight must be discouraged during abnormal situations and em-phasizes that optimal use of automation must be incorporated in flight procedures and in the Train-ing Manual.

- *Decoupling the upper modes of the Automatic Flight Control System affected the flight crew's ability to effectively control the flight path and implement failure management.*
- *The Bristow Operation Manuals do not contain a policy or procedures for optimal use of the autopilot upper modes during operations other than hoist operations.*
- *Within Bristow there are different opinions about the optimal use of the AS332L2 autopilot functions.*

6.4 Flight control system

When descending through 1300 feet and at approximately one minute after the first DIFF NG warn-ing, the PF mentioned a cyclical control restriction. This problem aggravated and ultimately an emergency landing was made.

The investigation team put great effort into finding a technical cause for the control problem. After the accident, the aircraft was visually inspected for possible control system anomalies, fluid lev-els and possible leaks. No anomalies were observed, fluids levels were found to be normal and no leakage was identified.

During a detailed inspection of the control system, a navigation map, the remains of a notebook and a cassette box were found in the hydraulic cabinet near to the controls. A possible restriction of the controls by these objects was investigated, but it was concluded that this did not occur.

As one life jacket was missing, it was tested whether there was any evidence of a life jacket blocking any of the controls, which there was not.

Aircraft systems related to the control of the aircraft were tested on the aircraft in the Eurocopter facilities. The relevant components were removed from the aircraft in order to perform a detailed component check. During the system checks, representatives of the French BEA and/or the Dutch Safety Board were present. Components were tested at different vendors, supervised by Eurocopter, BEA and/or the Dutch Safety Board representatives. Additional tests were performed on the basis of the test results.

Particular attention was paid to the possibility of an autopilot hydraulic failure. On the basis of the autopilot hydraulic warning system, it is concluded that steady autopilot hydraulics off situation did not occur, as no warning was recorded on the FDR and the warning system showed no anomalies. However, an intermittent autopilot hydraulic failure could not be excluded because no warning is generated when the system is inoperative for less than 0.8 seconds.

Various (test) flights showed that an intermittent autopilot hydraulic failure can result in cyclic force variations without presenting an autopilot hydraulics warning to the crew. The aircraft was still controllable in all situations, but the effort required to perform a stable flight increased significantly. This is due to increased control forces and the absence of autopilot stabilisation. The effect is known to be more significant at a speed of 150 knots due to the reduced stability of the aircraft, even though control input forces are no greater than at low speeds.

The sound of a cycling autopilot hydraulic electro valve is recorded on cockpit voice recorder recordings of the test flights. If, during the final phase of the accident flight, the autopilot hydraulic system inadvertently cycled within 0.8 seconds numerous times, it should have produced the same cycling sound, but a similar sound could not be identified on the accident cockpit voice recorder. It was also investigated whether pre-existing failures were present in the autopilot hydraulic switching system, but no proof of that could be found.

In the opinion of Eurocopter, one of the G-JSAR autopilot hydraulic switches on the collective pitch lever could have caused an inadvertent cycling of the autopilot hydraulic system because the salt water that was found in the switch after the accident may have been present before the accident. However, the laboratory that investigated the switches concluded that there was no evidence that sea water was present in the switch before the accident because there was no sign of corrosion inside the switch.
Although it is possible that autopilot hydraulic switching occurred, this theory could not be confirmed. In addition, this the crew stated that the feeling of control they experienced did not correspond with the feeling of flying with the autopilot hydraulics off.

Investigation of the relevant flight data did not identify a restriction in cyclic control movement, either in the longitudinal or in the lateral plane. When comparing the cyclic position data, however, a difference is observed between the data before and immediately after the co-pilot announced that he felt some restriction. The difference cannot be explained but it is logical to assume that there is a relation between the feeling of control experienced and the way in which the cyclic positions change. Shortly before ditching, the cyclic positions change in magnitude but this is in line with reference data taken from other approaches and landings and could not be associated with a control restriction. No quantification of forces applied by the flight crew on the controls can be given because these forces are not recorded on the flight data recorder.

It must be noted that the sampling rate of the cyclic position recording is twice per second. This means that no information can be derived from the recorded data for a duration shorter than half a second. It can be derived from the FDR data that the relationship between cyclic position and aircraft attitude is normal throughout the flight, including the period of reported flight control problems.

The Safety Board concludes that, in spite of the extensive investigation, a technical cause could not be identified for the control problem experienced.

- *Flight recorder data do not show cyclic control deflection restrictions during the accident flight.*
- *Cyclic and collective control forces are not recorded.*
- *Insufficient verification is available to conclude that autopilot hydraulic switching took place in the minutes before the ditch.*
- *It is considered unlikely that an intermitted switching of the autopilot hydraulic system could result in the control restriction as experienced by the crew.*
- *A technical cause has not been found nor could it be excluded for the reported control problem.*

6.5 Flight crew actions related to the control problem

Descending through 1300 feet with a speed of 150 knots, the co-pilot turned towards the field and indicated that he felt "some restrictions on the controls". The winch operator spontaneously advised "nearest part of land Texel". The captain adopted this implicit advice and ordered the co-pilot to fly to the nearest part of land. The co-pilot then indicated that his control problem was serious and the captain replied with a mayday call. Shortly afterwards, the co-pilot announced that he was losing control and had to ditch. It took 38 seconds from the first concern about the restriction on the controls until the call that ditching was inevitable. The crew confirmed during interviews that during that stage, the captain took the cyclic control and felt that it was "deadlocked" in all directions.

The crew was confronted with an additional problem that required priority. It is common sense that their attention focused immediately on the control restriction because of its serious implication. No immediate actions are prescribed, as this reduced control capability is not anticipated during certification and consequently no training was received on this matter. During the investigation, it turned out to be impossible to reproduce a feeling similar to what the crew encountered during the flight. No solid explanation for the problem could be found except for the theory that it was caused by intermittent hydraulic switching.

The crew had to deal with a complex situation in a hostile environment, as they were flying at night over a cold sea in strong winds. The unsettled engine malfunction and the thought that there was some kind of relationship between the engine and the control problem may have initiated the mindset that things were getting beyond control. In the opinion of the Safety Board, there was an opportunity to evaluate the capacity of the control system before ditching was deemed inevitable. An attempt to reselect the autopilot upper modes may have restored automatic control. A co-ordinated change of controls may also have been a valuable tool in assessing the significance of the problem. When the control feeling experienced remained, the co-pilot really got the feeling that he was losing control and that ditching was inevitable. This was supported by the captain on basis of the same perception. The decision to ditch was made almost immediately and, in hindsight, hindered the possibility of assessing the situation. From a time perspective, it took one minute and forty-six seconds between the first indications of a control problem until the landing on water.

The winch operator became aware of the intended landing on water by the call from the captain to ATC and advised the aircraft to slow down before ditching. The co-pilot was able to maintain control over the helicopter and reduced speed at very low height over the sea just before touchdown. The captain inflated the floatation devices before landing.

In the opinion of the Safety Board, the call from the rear crew member to slow down was an important alert. The speed was higher than intended during the entire descent and no co-ordinated action was carried out to reduce the speed until after that call. Both flight crew members stated that although high forces were used to pull the cyclic backwards in order to reduce speed, the cyclic hardly moved. However, the co-pilot was able to maintain sufficient control for a successful emergency landing.

The recorders do not record control forces, so no data are available to measure what was experienced by the flight crew. A clear view of the control problems experienced by the flight crew could not be established. A technical cause could neither be found nor excluded. A restriction on the flight controls is not confirmed by analysis of the flight data. On the basis of the recorded control positions and the successful emergency landing, the Safety Board concludes that the helicopter remained controllable, although with great effort.

- *The flight crew got the feeling that they were losing control and that ditching was inevitable.*
- *The decision to ditch was made without a proper assessment of the control problem.*
- *The helicopter remained controllable, although with great effort.*

6.6 Training and checking

The Bristow training department provided the Safety Board with copies of all available records of training, checking and qualification prescribed in JAR-OPS 3 undertaken by the G-JSAR crew members. This information showed that the captain passed her first license skill test (LST) for the AS332L2 on 17 November 2003.
The information is unclear about the amount of simulator training received by the captain since her LST. The captain provided the Safety Board with a copy of relevant entries in her personal logbook. These entries showed that she spent an initial session of 6 hours in a simulator on 29-30 December 2003, where half of the time was used for IFR training and the other half for VFR training. A second session of 6 hours was held on 13-14 November 2006 and this time only IFR training was logged. In the training records at Helisim in Marseille, this last 6-hour simulator session by a Bristow crew of two pilots (including the captain) and an instructor was logged. On a Bristow training sheet, some training information - dated 17 November 2006 - may possibly be related to this same simulator session a few days before the accident. This information specified that attention was given to flight procedures using the cockpit instruments and visual cues from outside generated by a visual system and some selected emergency procedures.

The remainder of the captain's training and checking since November 2003 was recorded by Bristow to have taken place in the aircraft or in a classroom. The records of the half-yearly proficiency checks - six in total - state that she completed a satisfactory check on the aircraft and that an 'autopilot hydraulic failure in the coupled hover and single engine fly-away' was executed.

From the information provided by Bristow, it is concluded that the co-pilot received one session of simulator training since his type qualification training was completed one year before the accident. Helisim information reported that this six-hour session took place on 5-6 June 2006. The session was used for training in flight procedures using the cockpit instruments and visual cues from outside generated by a visual system, for training in some selected emergency procedures and for proficiency checking.

The Safety Board concludes that the Bristow training records available at the time of the accident were incomplete and did not serve the purpose of assuring that crew members receive training and checking as intended by Bristow and the regulator. The training records also disclosed that the captain did not receive any simulator training during a period of almost three years.

The investigation revealed that a training programme that assured a balanced programme of aircraft and simulator training did not exist. It is left up to the individual Bristow instructors to compose their programmes and no record has been made of the way in which they were completed. The Board is of the opinion that neither the training programme, nor the training records offer an indication of the quality of the trained procedures. The records show a list of items, which have to be dealt with during training, but neither the list nor the programme approved by the UK CAA gives an indication of the quality of the training. The Board concludes that the records formally confirm that training was received in accordance with the training programme. However, the content of the training program was neither recorded nor described.

Section 2.6.3 mentions that managing pilots of Bristow and the RNLAF acknowledge the differences between the AS332L2 simulator at Helisim and the AS332L2 aircraft itself. The simulator has a cockpit layout similar to the Royal Netherlands Air Force Cougar. As a consequence, the layout of the centre console is significantly different for the G-JSAR flight crew. Moreover, the visual cues near the ground are poor and some of the emergency procedures for this simulator do not correspond with those in use for the G-JSAR. The Joint Aviation Requirements for synthetic helicopter training devices (JAR-STD 1H) do not allow for these differences between the simulator and the aircraft in use. Bristow stated that although this simulator has some shortcomings, it is still a valuable training aid. Despite these shortcomings, the French DGAC approved this simulator for level D training (see section 2.7.3), which is the highest level possible, and the UK CAA granted Bristow approval to use the simulator for Licence Skill Tests. Taking into account these requirements and the above-mentioned differences with the G-JSAR aircraft cockpit configuration, the Safety Board wonders if these approvals were justified.

The Dutch Safety Board and its predecessor, the Dutch Transport Safety Board, investigated two helicopter accidents, in 1997 and in 2004, in which (a lack of) CRM training was a contributing factor (see Appendix C, sections 1.18.1 and 1.18.5). Whereas CRM training was not legally required in 1997, it was mandatory on the date of the accident under investigation and provided by the company.

However, the investigation revealed that the significance of CRM training was not recognised by all stakeholders within Bristow. With regard to training of non-technical skills, a clear outline of the intended result was not established.

The training files of the flight crew showed that both the captain and the co-pilot attended (recurrent) CRM training in a classroom. Because there were no records of the contents of the CRM training courses, the Safety Board is not in a position to analyse the effectiveness of the Bristow CRM training or to assess the effect of this training on the actual performance of the G-JSAR flight crew. It is the Safety Board's opinion that, to practise effective management, CRM training should be performed in simulators. Training of CRM skills in a classroom only is considered inadequate.

- *Recurrent training of abnormal and emergency procedures related to system failures in a realistic simulated environment was very limited.*
- *The operational training of Crew Resource Management had only been conducted in classrooms. This is considered inadequate.*
- *The recurrent training programme for abnormal and emergency procedures consisted of a list of items to be completed during a three-year period. Training methods were not defined, and neither was the amount of time to be spent on individual items.*
- *The granting of the level D approval by the French DGAC of the AS332L2 simulator at Helisim is questionable.*

6.7 Crew Resource Management

Initially, the communication between the captain, co-pilot and winch operator indicated a relaxed but professional atmosphere in the cockpit. When departing from the Noble George, the co-pilot did the crew briefing. He was not familiar with the standard offshore take-off briefing and informed the captain accordingly. The briefing was completed with the captain's assistance. During take-off from the Noble George, the captain was supportive to the co-pilot and clearly in command.

Things changed when the crew experienced a non-normal engine indication. The crew had to deal with a situation for which their directives did not provide an answer. By leaving cruise altitude and flying manually and relatively fast, the crew deprived themselves of the opportunity to collect, analyse and structure information. As a consequence, the crew had to manage the situation on the basis of an incomplete mental picture. Circumstances were seriously aggravated when the co-pilot encountered a control problem. In order to evaluate the situation, the perceptive process depends not only on current information but also relies on experience (training) and is affected by senses.

In the opinion of the Safety Board, a situation developed in which the crew became convinced that the situation was getting beyond control and, on the basis of their observations, concluded that a landing on water was the only option remaining.
The crew operated in a stressful, difficult, night-time, over-water situation. No realistic (simulator) training had been provided to gain experience in handling such a situation. The crew eventually managed to make a successful ditching, which resulted in the survival of all passengers and crew members.

- *The flight crew had an incomplete mental picture of the actual situation.*
- *The flight crew became convinced, on the basis of their observations, that a landing on water was the only option remaining.*

6.8 Answer to research question and main conclusions

This section provides an answer to the second research question: what were the circumstances that resulted in the decision to make an emergency landing?

The investigation did not find a technical explanation to the engine anomalies, but by means of data analysis, the Safety Board concludes that the gas turbine rotor speed difference between both engines developed progressively over time due to an unexplained malfunctioning of the engine control systems, which ultimately resulted in successive DIFF NG warnings. However, both engines together still delivered sufficient power for the flight to continue.

A technical cause for the control problem was neither identified nor excluded. As the recorders do not record control forces, there are no data available to measure what was experienced by the crew. The restriction on the flight controls could not be confirmed by analysing the flight data. Flight data did however reveal a change in cyclic control deflections after the co-pilot indicated a control problem. Based on the recorded control positions and the successful emergency landing, the Safety Board concludes that the helicopter remained controllable. In the opinion of the Safety Board, the crew had an opportunity to evaluate the capacity of the control system before deciding that ditching was unavoidable.

Based on the strong feeling that a landing was the most suitable option under the existing circumstances, the flight crew decided to land on the sea. This was conducted successfully with the survival of all passengers and crew.

7 ANALYSIS: THE EVACUATION OF THE G-JSAR AND THE RESCUE OPERATION FOLLOWING THE EMERGENCY LANDING

This chapter contains the analysis of the evacuation of the G-JSAR and the rescue operation following the emergency landing and provides an answer to the following research question: Did all the life-saving appliances and procedures function as planned? If not, why did they not function properly? Section 7.1 contains the analysis of the G-JSAR evacuation. Sections 7.2, 7.3, 7.4 and 7.5 contain the analysis of the use of the life-saving equipment: i.e. the life rafts, survival suits, gloves and hoods, and life jackets respectively. Section 7.6 gives a short evaluation of the circumstances that contributed to the rescue of the 17 occupants. The research question will be answered in section 7.7. The Tripod analysis was used for this part of the investigation, with the top event being the "potential death of hypothermia". See also the Tripod analysis in Appendix W.

7.1 Evacuation

Operational procedures require a pre-flight briefing of the passengers to be held prior to departure and an emergency briefing informing the passengers during emergencies (see section 3.3.3 - Den Helder Base Instructions). The briefing in the Noble George radio room was given by the winch operator. According to the winch operator, the passengers were asked if they understood the briefing and no questions were asked either about the briefing or the operation of the life jackets used. He was under the impression that the passengers were not listening very attentively. However, the winch operator was not used to giving such briefings. Three different types of life jackets were used that contained a different design of survival aids. He was probably unaware that one passenger had difficulties understanding the English language (see section 2.2.3).
Although the captain instructed the passengers in her pre-flight briefing to follow the crew's instructions during emergencies, several passengers did not receive this message, probably because the message was disrupted by the engine noise and due to unfamiliarity with such briefings. The briefing was not as detailed as that which is usually presented to passengers by video during a public transport flight. Prior to the ditching, no warnings were provided by the captain or the rear crew for the impending ditching, nor did the passengers receive the command to 'brace for impact'. The only means of communication with the passengers in the direct vicinity of the rear crew was given verbally or by hand signals, but these were not understood by everyone (see section 2.2.5).

This lack of communication options resulted in several implications. The passengers were not instructed to don their private survival equipment (hoods and gloves), nor to mentally rehearse their means of exiting the aircraft and the actions to be completed thereafter. This subsequently resulted in problems with donning gloves in the darkness and in the water. Many of the passengers, however, believed they had made a normal landing and there were few signs of panic during the evacuation. However, if the aircraft were to have capsized, the serious consequences of the absence of proper passenger preparation would have increased considerably.

During the time between the decision to ditch and the ditching itself, the flight crew was concentrating on maintaining control of the aircraft. The public address system was not used to announce that the aircraft was going to ditch. Passenger warning forms part of the immediate actions before ditching and even an effective warning in its most abbreviated form would have given the passengers a chance to prepare themselves. The passengers may have had difficulty hearing everything in a pre-flight briefing by a crew unaccustomed to using it. If the public address system had been used correctly with clear speech immediately prior to ditching, it should have been heard in the cabin, especially for short statements such as "Prepare for ditching" and "Brace Brace Brace" spoken prior to touchdown.

Following the successful ditching of the helicopter, the operating crew's primary aim was to evacuate the passengers and themselves as quickly as possible. The cabin evacuation began before the main rotors were stopped completely and without the authority of the captain.
The floatation equipment kept the helicopter upright and level with the normal exits above the water level. This 'dry floor concept' is intended to allow occupants to leave the aircraft and board the life rafts without immersion in water, thereby improving their resistance to coldness whilst awaiting rescue. However, the crew believed the helicopter was in imminent danger of capsizing in the present sea conditions (5-6 Beaufort[96] wind and 2 - 2.5 meters average wave height reported by the Netherlands Coastguard vessel Arca on scene, see Appendix C, section 1.7), and consequently evacuated the passengers and themselves directly into the water. This 'capsizing' mindset was also demonstrated by the concern of the rear crewman who re-entered the helicopter to retrieve the life

96 5-6 Beaufort is approximately 8-14 knots.

raft and the advice given to the passenger who wished to re-enter the cockpit. The passenger believed he was starting to suffer from hypothermia and in hindsight would have improved his survivability time considerably by removing himself from the water.[97]

It must be noted that the helicopter remained afloat for a further eight hours in a 8-14 knots wind and an average wave height of between 2 and 2.5 meters (6.5 - 8 feet). This confirms the statement in Bristow's Operations Manual that:

"(…) successful ditching without capsizing should be possible in sea conditions up to and including sea state 4 (wave height of 6.5 feet-wave height to length ratio 1 to 10) depending on wind conditions".

Given the prevailing weather conditions, the Safety Board is of the opinion that the aircraft was, in reality, touching the maximum demonstrated sea condition for remaining upright. Previous incidents of helicopter ditching suggest that when the aircraft does not roll over immediately, it is likely that occupants will have time to evacuate the aircraft in the intended manner directly into the life rafts. However, given the prevailing weather conditions (it was dark with no moon and gusting winds), the judgement that under the circumstances the G-JSAR definitely would not capsize is not made easily. In the past, there have been many offshore accidents with fatalities as a result of occupants having little or no time to evacuate from an inverted helicopter. In many of the investigation reports regarding these accidents, recommendations are laid down addressing the need for improvement of survivability in helicopter accidents or for more research and development with regard to this issue. The Board is of the opinion that adequate training and education is required to learn to assess the life-threatening nature of a situation and whether a higher risk of capsizing requires an immediate evacuation without using the life rafts. In this respect, Bristow could have used the experiences from the Bristow Super Puma accident in 1995 in its training (see Appendix C, section 1.18.2), in which the helicopter's buoyancy system operated effectively to maintain the helicopter in a stable position, despite the prevailing high sea conditions. To this end, further attention should be paid to education and training, including the latest developments and experiences derived from investigation reports. In this respect, the UK CAA published Civil Aviation Publication 641 (CAP 641) Review of Helicopter Offshore Safety and Survival, and seventeen recommendations were made as a result of the review. The review followed a recommendation made by the UK AAIB following an accident with a Super Puma in the North Sea in 1992 (see Appendix C, section 1.18.1):

"The CAA, in consultation with the offshore oil industry and other appropriate bodies such as the HSE [Health and Safety Executive], should re-assess offshore helicopter passenger safety and survivability in normal operating conditions using the concept of an integrated escape and survival system in order to promulgate such regulations as necessary in order to achieve it: such an assessment should be made against both a controlled ditching and an uncontrolled crash into the sea where the helicopter inverts and sinks almost immediately."

Apparently, the lessons that could be learned within the helicopter offshore community as a result of accidents that happened in spite of the ongoing research of improving helicopter safety and survivability in the water (see Appendix C, section 1.18) were not communicated sufficiently. The Dutch Safety Board and the UK Air Accident Investigation Branch believe there is an opportunity to update Civil Aviation Publication 641 with the information and lessons learned from the accident to the G-JSAR. This could help to take away the mixed opinions as to whether a helicopter, landing with floats deployed, will capsize immediately after landing and the lack of clarity as to whether passengers/crew should remain on board until the life rafts are deployed, or evacuate immediately into the water. The experience of the ships' rescue crews that the passengers' survival suits were slippery and the inflated life jacket made man-handling difficult during the rescue operation could also be taken into consideration.

The flight and rear crew had never been trained in the life raft launching procedure by pulling one of the launching handles. The rear crew members were not trained to play the role of cabin attendant in the event of a ditching with passengers. However, all crew members received training in accordance with the Helicopter Underwater Escape Training (HUET) programme. This programme provides training in escaping from a mock-up of a cabin equipped with passenger seats, turned upside down in an inverted position in the water of a swimming pool. The rear crew was unfamiliar with the situation following the ditching. This may therefore have encouraged the rear crew to evacuate the G-JSAR immediately.

97 "Essentials of Sea Survival", Frank Golden and Mike Tipton, 2002, "(…) although being out of the water may feel colder than being in it, the rate of heat extraction from the body while immersed will far exceed that in air. Better still, a person should board a life raft or other suitable craft where some shelter from ambient conditions can be found and efforts made to control the surrounding environment."

After the accident, Bristow changed its Aircraft Evacuation Drill and the initial and recurrent Emergency and Safety Equipment training, because the rear crew Emergency and Safety Equipment training did not include cabin evacuation with passengers (see Appendix H).

- *Both the flight and the rear crew were insufficiently trained for a ditching with passengers.*
- *The crew did not brief the passengers properly before departure from the Noble George Sauvageau drilling rig.*
- *The passengers were not given a proper warning prior to ditching.*
- *The crew did not follow the evacuation procedure as described in the Super Puma (AS332L2) Operations Manual, Part B, specifically:*
    - *The cabin evacuation was started before the rotors were stopped completely and without the authority of the captain*
    - *The cockpit life raft deployment handles were not used*
    - *The rear crew did not consider deploying the life rafts before evacuating the aircraft*
    - *The external cabin life raft deployment handles were not used.*
- *The crew was not sufficiently familiar with the floating capabilities of the helicopter concerned.*
- *Under the prevailing weather conditions (2-2.5 metres' average wave height and 8-14 knots of wind) the aircraft was, in reality, touching the maximum demonstrated sea condition for remaining upright.*
- *Previous occurrences of helicopter ditching suggest that if the aircraft does not roll over immediately, it is likely that occupants will have time to evacuate the aircraft in the intended manner directly into the life rafts.*
- *The lessons that could be learned within the helicopter offshore community as a result of accidents that happened during the ongoing research of improving helicopter safety and survivability in the water were not communicated sufficiently. The UK CAA published Civil Aviation Publication 641 (CAP 641) 'Review of Helicopter Offshore Safety and Survival' in 1995, which has not been updated since.*

7.2 Life rafts

One of the most important factors for improving survivability and reducing susceptibility to hypothermia and drowning is to have the crew and passengers board a life raft. After the helicopter had made a successful ditching, the opportunity for the sponson-mounted life rafts to be inflated and occupants to board them without entering the water was available. Bristow's Operations Manual and company training emphasise the need to launch and inflate both life rafts as soon as the windows and doors have been jettisoned. The fact that life raft deployment did not occur is a source of concern and could have resulted in serious consequences in the event that the search and rescue operation were to have taken more time.

The Safety Board finds it remarkable that none of the four crew members succeeded in deploying at least one life raft, which could have accommodated all seventeen occupants. Each life raft can be deployed using either a handle in the cockpit or another one mounted externally on the fuselage wall. The Operations Manual does not identify a primary method of deployment, probably because this may be deemed too detailed a prescription vis-à-vis the varying evacuation scenarios. In this accident, the cockpit deployment handles remained unused. Even by the time the rotors stopped rotating and the passengers were in the water, the flight crew did not think of deploying the life rafts. The rear crew did not consider deploying the life rafts either before evacuating the aircraft. The winch operator stated that he ordered the evacuation because he was sure the aircraft would capsize immediately, and secondly, because nine unstrapped/unsecured passengers were in the back of the aircraft who would stand little chance of escaping if the aircraft capsized as they were not trained for this situation (the HUET procedure is trained with passengers strapped in with belts on passenger seats). The winchman, who attempted to manually deploy the life raft directly from the sponson at a later stage, could not explain why he did not use the externally mounted handle on the fuselage prior to the evacuation. He did not manage to use the release handle in the sponson properly either. Emergency and Safety Equipment training conducted annually covers instruction on the location of this handle but does not include actually pulling the handle.

Furthermore, it is obvious that training cannot simulate the stress of a real ditching. These factors may explain why the winch operator pulled the right-hand side main door jettison handle, while this door was already opened, possibly in an attempt to deploy the right-hand sponson life raft. The Safety Board did not investigate further the reason why the four crew members did not deploy the life raft. Bristow's post-traumatic stress programme for the crew following the incident was not investigated either.

Bristow has reviewed its Emergency and Safety Equipment training since this accident and has amended various sections of its Training Manual (see Appendix H). It must also be noted that the external handle is painted in a contrasting colour to the surrounding fuselage. However, it was dark when the accident occurred and the handle is unlit.

The investigation of the Safety Board showed that even if the crew should have activated the cockpit or cabin deployment handles, the life rafts would probably not have been deployed, because the mechanism involved did not function properly (see section 2.3.3 and Appendix C, section 1.16.6).

- *The flight crew did not pull the life raft activating handles. The rear crew did not consider deploying the sponson life rafts before evacuating the aircraft because they were sure that the aircraft would capsize immediately and that the nine unsecured and for this situation untrained passengers would have little chance to escape if the aircraft capsized.*
- *The AS332L2 mechanism to activate the sponson life rafts showed serious deficiencies.*

7.3 Survival suits

There are many factors that affect survivability when immersed in the sea having escaped from the helicopter. These include sea conditions, water temperature, buoyancy, insulation from undergarments and immersion suit leakage. Most of the immersion suits were reported as having some moisture or water inside and the most likely source of water ingress was through the neck and wrist seals. In general, the use of the suits proved to be effective, however tailoring of the neck and wrist seals is critical to their effectiveness (see Appendix C, section 1.16.6.2).

- *The use of immersion suits was effective.*
- *Close attention to having good neck and wrist seals can improve survival time.*

7.4 Gloves and hoods

The glove performance appears to have been satisfactory but there were some difficulties in donning them in the water and in darkness. The manufacturer and the operator responsible for the passengers' immersion suits are reviewing possible improvements to the glove, i.e. by improving the distinguishing features of the backs of the gloves to aid donning.

It is a source of concern that most of the crew were not wearing gloves or carrying gloves with them. Having cold hands was the reason that the co-pilot was unable to fire his emergency flares. This could have resulted in much more serious consequences had he been separated from his group.

Only one hood was donned, which is to be attributed to the absence of a warning that ditching was imminent and the difficulty in subsequently donning them whilst being in the water. Donning a hood will significantly reduce heat loss and can improve the performance of the immersion suit neck seal. A contributing factor may also have been that in this case, the Bristow pre-flight safety video for public transport flights (showing the donning of hood and gloves) had not been shown to the passengers. During the HUET simulator programme, no training was provided in donning the hood, due to the requirement to wear protective head gear in the HUET simulator from the beginning of the training session. No training was provided in donning the gloves, either. To emphasise the importance of locating and subsequently donning gloves and hoods, these items should actually be practised and incorporated into routine emergency training.

Before the accident, the G-JSAR rear crew received ground instruction in accordance with a list of items under the heading "Safety Equipment and Drills". The items had to be completed prior to the 20 training sorties which were planned for ab initio training of rear crew members. However, recurrent training was not planned. The Safety Board observes that after the accident, Bristow changed the requirements for the training of rear crew members (defined as crew members other than flight crew). Recurrent training will be given in this new training programme, which may be combined with recurrent checking (see Appendix H). Recurrent training will now cover the actions assigned to each crew member in normal and emergency procedures and drills relevant to the type(s) and/or variant(s) of helicopter on which they operate. This training will now be conducted in the helicopter or in a suitable alternative training device and will include both theoretical and practical elements, together with individual practice using touch drills. A comprehensive Wet Dinghy Drill to cover all ditching procedures will now also be practised and this practice will be conducted using the equipment while in the water. After the accident, Bristow rewrote its Training Manual, including the normal and emergency procedures to be trained. This training will also be conducted in a more realistic environment. However, the Board is concerned about the fact that training to don the hoods and gloves is not mentioned in the new Training Manual (see section 3.3.3 and Appendix H).

- *Because neither the flight crew nor the rear crew gave a proper warning prior to the ditching, most occupants did not have a chance to prepare themselves properly for the evacuation.*
- *Donning gloves and hoods in the water proved to be difficult, partly due to the fact that these actions do not form part of the Bristow training syllabus.*

7.5 Life jackets

The passengers were familiar with the NAM standard life jacket, which is the LAPP jacket. The standard number of life jackets for the passengers on board the G-JSAR was thirteen in total and the life jackets came in three different types. As the passengers were all hired by NAM, they were unfamiliar with the other two non-NAM-standard life jackets. Some of the accessories in the life jackets (flares) were not used. On the other hand, all the life jackets that were donned were successfully inflated, albeit with some initial problems.

Another matter of concern is that the captain did not have a life jacket when she was in the water. The scenario in which the life jacket could have been unsecured whilst releasing the safety belt after ditching and subsequently lost during the captain's exit through the cockpit door was deemed most probable. The implications of not wearing a life jacket are obvious, particularly if the captain had been separated from other survivors.

- *Because three different types of life jackets were used, some of the passengers were unfamiliar with the non-standard life jacket, which caused initial confusion and difficulties in using its available safety equipment.*
- *The scenario in which the life jacket was unsecured whilst releasing the safety belt after ditching and subsequently lost when the captain left through the cockpit door was deemed most probable.*

7.6 Timely rescue and other survivability factors

There were three favourable circumstances that contributed to the rescue of the seventeen occupants of the G-JSAR:
- The scene of the accident was relatively close to Aerodrome De Kooy (approximately ten nautical miles).
- The vessel "Arca" was in the vicinity (three to four nautical miles from the scene of the accident) and arrived about half an hour after the ditching.
- The 'responder radar' element of the ADELT beacon on the G-JSAR assisted the rescue ship(s) in locating the area of the ditched aircraft due to returns from this transponder on their radar screens.

With regard to the rescue operation following the G-JSAR emergency landing, several survivability factors that worked as intended are worth mentioning in the following sections.

7.6.1 Response time of the Royal Netherlands Navy Lynx SAR helicopters

Outside of working hours during the night, the maximum response time of the Navy Lynx helicopter is one hour (see section 4.13). The first Lynx was airborne thirty-two minutes after the MAYDAY message and arrived at the scene of the accident approximately seven minutes afterwards.
The second Lynx helicopter (its availability is not mandatory, but was available quickly due to adequate anticipation of ATC De Kooy) was airborne after fifty minutes and arrived at the scene of the accident approximately six minutes afterwards.

7.6.2 Response time of the Royal Netherlands Sea Rescue Institution

The maximum response time of the Royal Netherlands Sea Rescue Institution (KNRM) is ten minutes and when the scene of the incident is within ten nautical miles from the coast, the first KNRM-vessel must be at the scene within a maximum of one hour after dispatch (see section 4.15). "Dorus Rijkers" was on its way ten minutes after the MAYDAY message and arrived at the scene of the accident sixty-five minutes after the MAYDAY message, five minutes later than the objective of one hour. The probable reason for this was that both the "Dorus Rijkers" and the "Arca" had to proceed towards the floating G-JSAR at a low speed as a precaution, so as not to sail across the survivors who may have been floating in the vicinity.

7.6.3 Maximum time in water

The requirements of the Netherlands Oil and Gas Exploration and Production Association (NOGEPA), accepted by the State Supervision of Mines, state that the maximum acceptable time for persons wearing proper survival suits to be in the water is two hours (see section 3.3.1 - Acceptable probability of survival). All persons involved must have been brought to safety within a maximum of two hours and twenty minutes. All seventeen occupants of the G-JSAR were brought to safety within one hour and fifteen minutes.

7.6.4 Behaviour in the water

Once in the water, the pilots and the passengers formed, coincidentally, two distinct groups: one of five and one of ten people (including the pilots). The two rear crew members had positioned themselves in an air-deployable life raft, which was retrieved after the ditching. Several passengers and crew commented that remaining together as a group significantly improved their mental state. They felt that this aspect of their survival training was particularly useful.

7.7 Answer to research question and main conclusions

This section provides an answer to the second research question: Did all the life-saving appliances and procedures function as planned? If not, why did they not function properly?

Several available life-saving appliances did not work as intended and/or were not used properly. A number of procedures involved were not adequate and/or were not followed appropriately. The crew were insufficiently trained for a ditching with passengers. Nevertheless, all persons involved were saved, thanks to some favourable conditions and adequate search and rescue operations by the Netherlands Coastguard, the Royal Netherlands Navy and KNRM.

8 ANALYSIS: SAFETY AND QUALITY MANAGEMENT AND SUPERVISION

This chapter contains the Dutch Safety Board's assessment of the safety management performed by the parties involved. Section 8.1 contains the analysis regarding the Steering Committee, a joint safety management instrument established by the Company Group, the Netherlands Coastguard and Bristow. Sections 8.2, 8.3, 8.4, and 8.5 contain the Board's appreciation of the NAM, the Netherlands Coastguard, Bristow and Eurocopter safety management respectively. Section 8.6 contains the analysis with regard to the regulation and supervision of search and rescue operations in the Netherlands.

8.1 Steering Committee

The Standard Operational Procedure (the agreement between the Netherlands Coastguard and Bristow) contain procedures for the evaluation of SAR dispatches and missions with the G-JSAR (see section 3.3.6 and Appendix T). The procedures refer to the submission of SAR reports (first impression reports) by the captain, monthly incident reports by the Netherlands Coastguard and summary reports from Bristow. The Company Group, the Netherlands Coastguard and Bristow also established a Steering Committee in order to supervise the G-JSAR missions (see section 3.3.6). A potential management instrument for the G-JSAR missions was established with the Steering Committee. However, the Steering Committee never functioned properly during the period that the G-JSAR was in operation. Though the Steering Committee convened during the initial phase of the G-JSAR operation, from mid-2004 onwards the Steering Committee never convened a meeting again. As such, the available feedback reports of the G-JSAR dispatches and missions were never reviewed in the Steering Committee. This explains why this management instrument did not result in any action or amendments with regard to existing procedures.

Although the Steering Committee was established for this purpose, the NAM's analysis of the investigation in its report is the first in-depth analysis of the G-JSAR operation, though the Steering Committee was actually established for this purpose. In its report, the NAM concluded that there was no real emergency that warranted the evacuation of personnel after 21.00 using the G-JSAR helicopter. The NAM's conclusion is supported by the following findings:

- *"(…) well-being of staff was the main driver for transporting them to shore*
- *The risk of helicopter flying was not taken into account sufficiently in the decision-making process; and*
- *The specific risk of using G-JSAR for transportation was not understood."*

In addition to the conclusions of NAM, the analysis of the Safety Board brought up several subjects that should have been considered by the Steering Committee as well:

- Investigation of evacuation flights in the past (see section 2.4.2) that were comparable to the accident flight revealed that there had been several other occasions to be considered for further analysis during the existence of the G-JSAR operation.
- The interpretation of the Standard Operational Procedures by the Netherlands Coastguard changed over the course of time. Fully in line with the Standard Operational Procedures, on the first evacuation mission on 15 December 2003, the G-JSAR was dispatched to evacuate personnel from an offshore installation during an emergency situation, but was not used for (public) transport of the personnel back to the installation once the risk had subsided. In later evacuation missions, the interpretation of the Standard Operational Procedures regarding the difference between the dispatch of the G-JSAR during emergency situations and public transport missions was not followed properly.

The Safety Board is of the opinion that the main drivers for the functioning of the Steering Committee were the operators that were joined in the Company Group, because a Company Group's representative chaired the Committee. Although availability figures were made available to a representative of the Company Group members, neither the Steering Committee nor the Company Group evaluated or audited the G-JSAR operation. It is the Safety Board's opinion that Bristow could also have informed the Steering Committee that the procedures for the Den Helder SAR unit differed from the agreements between the parties involved and from those in the UK and that they had been changed over the course of time.

The Netherlands Coastguard, as well as Bristow, indicated that they were aware of the fact that during the course of 2004, their representatives did not convene in meetings of the Steering Committee following the meetings that took place in the initial phase of the G-JSAR operation, however neither the organisations nor their representatives took any action. According to the Netherlands Coastguard, there was no lack of reason to take action, because they did not experience difficulties with the G-JSAR operation that would warrant such action. As long as the operations seemed normal, there was no reason for a review. This situation was not challenged by the Company Group, NAM (see also section 8.2) or Bristow, because they more or less acted according to the same principle. The Dutch Safety Board concludes that this attitude of the parties involved is linked to the wrong decisions and actions taken by each of the individuals and parties involved.

- *The Steering Committee did not play its intended role in evaluating the G-JSAR missions.*
- *The Company Group, the Netherlands Coastguard and Bristow each had opportunities to evaluate similar G-JSAR evacuation dispatches and missions prior to the accident flight that justified the need for evaluation, but none of the parties involved did so.*

8.2 NAM

For the combined operation of the installations, K15B and Noble George NAM had a safety management system in which it had identified and analyzed hazards, the mitigation of these hazards and the approach to deal with the resulting risk in the applicable Safety, Health and Environment documents. The Concurrent Operations Script considered the scenario in which K15B experienced a loss of power during drilling operations on the Noble George. Eventually, the decision was made to bring all K15B staff to the Noble George and avoided exposure to unnecessary risks when staying on the K15B. The Safety Board's investigation revealed a number of deficiencies and inconsistencies in NAM's management of safety:

1. It was not clear to the onshore and offshore NAM staff involved whether the K15B was a safe place to stay overnight for K15B personnel during a prolonged blackout in combination with drilling activities on the nearby Noble George. In this respect, the Concurrent Operations Script was insufficient.
2. The applicable NAM Safety, Health and Environment documents neither contained procedures regarding availability and conditions for the use of public transport helicopters, nor for alternative helicopter public transport during the night. NAM's offshore risk analyses did not take into account all the hazards involved with SAR helicopter flights in general, or with the G-JSAR when used for public transport in particular. Consequently, NAM staff involved had different views regarding the availability and the use of public transport helicopters in general and the G-JSAR helicopter in particular. NAM staff were not adequately prepared for down-manning offshore installations during closing hours of Aerodrome De Kooy.
3. The combination of (1) and (2) resulted in the situation in which it was not clear who should make the decisions and eventually a request to the Netherlands Coastguard for evacuation of offshore personnel with the G-JSAR was made on the basis of wrong assumptions.

The Safety Board's investigation also revealed that NAM missed a number of opportunities associated with offshore installation blackouts and incidents to improve the safety of the G-JSAR operation:

- NAM did not actively review the possible long-term consequences of previous blackouts of installations and an earlier blackout on the K15B. These incidents which were reviewed were shorter in duration and were treated differently due to different circumstances and were logged as operational downtime (see section 2.4.1). The Board is of the opinion that these incidents -albeit different in size and seriousness - once properly analyzed, could have given an incentive to improve existing opinions and procedures.
- Investigations of the G-JSAR evacuation missions in the past (see section 2.4.2 and Appendix E) that were comparable to the accident flight revealed that NAM was involved in two of these missions. Apart from what has been said about the responsibility of each of the members of the Steering Committee in section 8.1, a thorough evaluation of these missions could have produced more insights into the limitations of public helicopter transportation during the closing hours of Aerodrome De Kooy, including the availability and capacity of the G-JSAR. The scope of NAM's safety management appeared to be limited to its own offshore operations and did not include experiences of the other partners in the combined SAR operation.
- None of the members of the Company Group performed an audit, reviewed an internal Bristow audit or reviewed a UK CAA audit of the Bristow Den Helder SAR unit.
- The NAM (or Company Group) representative in the Steering Committee did not actively initiate new meetings of the Committee after the initial meeting(s).

The Safety Board concludes that NAM's safety management had a number of shortfalls.
The Board noted that NAM did not address the non-functioning of the Steering Committee in its internal report, while this Committee was an important management instrument for managing the safety of the G-JSAR operation. In the investigation performed by NAM after the accident with the G-JSAR, NAM recognized the additional risks of the G-JSAR helicopter dispatch and has taken precautionary measures (see Appendix J).

NAM's safety management regarding the development of the Concurrent Operations Script and the monitoring of offshore operations revealed a number of deficiencies associated with actively reviewing possible consequences of prolonged offshore installation black outs and incidents regarding the limitations of (public and SAR) helicopter transportation. Opportunities were missed to identify risks and address these, in order to improve the safety of the G-JSAR operation.

8.3 Netherlands Coastguard

On the grounds of the Regulation regarding the SAR-service 1994, the Director of the Netherlands Coastguard established an operational plan (OPPLAN-SAR) in relation to this responsibility for the coordination of search and rescue duties, which contained the intended operation process and the procedures to be followed in consultation with the Directorate-General for Freight Transport and Civil Aviation,[98] including the Royal Netherlands Navy and the Royal Netherlands Sea Rescue Institution - KNRM (see sections 3.2.3 and 3.3.5).

With regard to the NAM's request to the Netherlands Coastguard for an evacuation of offshore personnel using the G-JSAR whilst there was no emergency situation, the Board concluded in section 5.3.2 that the Netherlands Coastguard:

- Only acted as a communication channel between the NAM and Bristow during the decision to dispatch the G-JSAR on 21 November 2006
- Did not dispatch the G-JSAR in accordance with the Standard Operating Procedure or with the SAR alarm procedure
- Did not follow the instructions to assess the state of emergency adequately in accordance with the OPPLAN-SAR (see section 3.3.5 - Search and rescue in the Netherlands).

Furthermore, the investigation revealed that the Netherlands Coastguard did not and does not have a structure in which the principles of safety management for search and rescue operations are applied. The purpose of the "Action Data System" database was to register and support SAR-incidents. Information such as the categorization of the emergency level and subsequent actions were not logged in the database, which makes it less useful for monitoring and analysis.
The Periodical Operational SAR Meetings (POSO), which were organized twice a year, could have provided a useful platform for feedback with the rescue parties involved. However, the available information was not used for this purpose. For a systematic review of the rescue operations, it is necessary that responsible staff have access to all relevant information. In addition, the Netherlands Coastguard does not have a system in which the quality of the available rescue services is safeguarded. The Netherlands Coastguard does not supervise the rescue services, nor does it perform audits.

The Netherlands Coastguard's applied principle: "whoever requires assistance defines what kind of assistance is required" is in conflict with the procedures contained in its OPPLAN-SAR and to a certain extent, also with the Standard Operational Procedure and the SAR alarm procedure. The Safety Board is concerned that in a similar situation, the Netherlands Coastguard would again accept requests without subsequent assessment. In this respect, the Netherlands Coastguard should also take notice of the recent developments to include risk management principles for assessing SAR response and SAR system performance, as referred to in the International Aeronautical and Maritime Search and Rescue (IAMSAR) manual. With regard to the application of risk management, the following is stated in Volume I, Organization and Management:[99]

"Search and rescue (SAR) organizations have a lot to learn from the emergency management community, where risk management principles are used so that the uncertainties that exist in potentially hazardous situations can be minimized and public safety maximized (...)."

98 The Directorate-General for Freight Transport and Civil Aviation was involved at the time of the accident. In 2008, a new Directorate-General was established for Civil Aviation and Maritime Affairs.
99 Applying Risk Management, section 6.3.2, IAMSAR manual, Volume I, Organization and Management, Document 9731-AN/958, IMO/ICAO, London/Montréal, 2007, p 6-2.

The Safety Board did not find procedures or results regarding structural oversight of the Netherlands Coastguard from the responsible Directorate-General for Freight Transport and Civil Aviation of the Ministry of Transport, Public Works and Water Management with regard to policy-making. The Royal Netherlands Navy is responsible for the functioning of the Netherlands Coastguard, because the Netherlands Coastguard is placed under the command of the Commander of the Royal Netherlands Navy (see section 4.13). The Safety Board did not find any procedures or results with regard to supervision from the Royal Netherlands Navy or from the Ministry of Defence in relation to the Netherlands Coastguard's functioning either. The Board noted that on 1 January 2007, a new Institution Coastguard Decree came into effect with a complex set of government oversight parties. One of the provisions was the establishment of a Coastguard Board (see section 8.6.3 - Oversight of commercial SAR activities in the Netherlands). The possible effect of this new Decree on the future SAR operation was not investigated by the Safety Board because it was outside the scope of investigation. However, the fact that a finding against the Kingdom of the Netherlands was raised during ICAO's universal safety oversight programme (audit) because no evidence was provided indicating that a mechanism had been established to carry out a safety oversight of the provision of search and rescue services (see section 2.7.6), indicated that the New Decree did not provide for supervision of the search and rescue services either. The Ministry of Transport, Public Works and Water Management has indicated that steps have been taken in 2009 to introduce a quality system for the Coastguard and the supervision of SAR duties of the Coastguard as a part of this quality system are being developed.

- *The Netherlands Coastguard's standing practice for dispatch of civil Search and Rescue (air) assets was inadequate and not in accordance with the International Aeronautical and Maritime Search and Rescue safety management principles.*
- *At the time of the accident, supervision of the Netherlands Coastguard by the Directorate-General for Freight Transport and Civil Aviation with regard to policy-making and by the Royal Netherlands Navy with regard to management and operation did not exist.*
- *On behalf of the Ministry of Defence, the Royal Netherlands Navy had operational command over the Netherlands Coastguard, but did not supervise the functioning of the Netherlands Coastguard.*

8.4 Bristow

Bristow is permitted to conduct public transport and SAR helicopter flights under the specifications of its Air Operator's Certificate issued by the UK Civil Aviation Authority. For this purpose, Bristow had to comply with the provisions contained in the UK Air Navigation Order 2005 and JAR-OPS 3 (see section sections 3.2.2 ad 3 and 4, and 5.3.2). Compliance with JAR-OPS 3 provisions is a prerequisite for commercial air transport operators and provides the basis for safe flight operation, i.e. analyzing hazards, the mitigation of these hazards and the approach for dealing with the resulting risk.

8.4.1 Operational feedback system

One of the JAR-OPS 3 provisions is the establishment of an Accident Prevention and Flight Safety Programme, which may be integrated with the Quality system. The effectiveness of changes resulting from proposals for corrective action identified by the Accident Prevention and Flight Safety Programme shall be monitored by the Quality & Safety Manager.

The Safety Board's investigation revealed the following shortfalls regarding the implementation of Bristow's Accident Prevention and Flight Safety Programme:
- The G-JSAR was not equipped with any handholds for passengers outnumbering the number of seats in accordance with the Air Operator's Certificate. This remained unreported during all 140 SAR-missions, and was not reported during Bristow's internal inspections or audits.

Examination of all SAR-mission reports revealed that in 2005 and 2006, a total of five evacuation flights were performed. Three flights had an unclear status and two missions -including the accident flight - were non-emergency flights that used the G-JSAR for public transport (see section 2.4.2). In all five of these missions, the number of occupants outnumbered the number of available seats. Three of these evacuation missions were executed by (SAR) line managers as flight crew (Line Check Pilot, Deputy Chief Pilot of the Den Helder SAR base and Chief Pilot of the SAR operations). These line managers were competent to take the initiative to report about the unclear status of these 'evacuation' flights.

- Bristow stated that it encouraged crews to make comments in SAR-reports to improve equipment and training (section 3.3.6 - G-JSAR operational flight feedback reporting). However, there is no mention of such encouragement in the applicable SAR supplement of the Operations Manual.

The Safety Board concludes that possible shortfalls in procedures, equipment or training of the G-JSAR flights in general or similar G-JSAR evacuation missions in the past, comparable to the accident flight in particular, were not reported. These shortfalls remained unnoticed during Chief Pilot meetings, inspections and audits, although the SAR-reports were distributed to all SAR base units. However, in three of the five G-JSAR evacuation missions in the past, the Board could not determine whether these missions could be categorized as an emergency on the basis of the available information. The same questions which the Board has regarding these evacuation missions could have been raised within Bristow's organisation. The fact that possible comments regarding shortfalls in procedures, equipment or training were not found in Air Safety Reports, Pilot Operations Reports or SAR reports (see sections 2.4.2 and 2.4.3) could also mean that such shortfalls were present and considered a problem. However, if reports do not contain any observations, the Safety Board wonders whether the feedback system actually works. The Board concludes that Bristow's Accident Prevention and Flight Safety Programme did not receive adequate feedback from the safety-related information available from the G-JSAR operations. Additionally, Bristow's management did not ask any questions regarding the absence of these observations.

8.4.2 Documentation review

Another JAR-OPS 3 provision is that the company's policies and procedures are described in the Operations Manuals. Part A (General) and its Supplement (Search and Rescue Operations), Part B (Helicopter Operating Procedures and Requirements) and Part D (Training Manual) are relevant to this investigation. For local procedures of the Den Helder Base units for public transport and SAR operations, Bristow also issued Base Instructions and SAR Base Instructions. Bristow has chosen to combine public transport and SAR requirements and procedures in its Operations Manuals. The Safety Board's investigation of the procedures in the manuals and local instructions revealed the following:

Bristow Operations Manual Part A and Supplement
Part A states that for all Bristow flights, the captain shall ensure that all passengers are briefed on the use of the seatbelts and that they are properly secured in their seats, in accordance with the Air Operator's Certificate. The SAR supplement to Part A does not overrule this instruction for the passengers' safety during SAR flights. For a proper understanding of the captain's responsibilities in this respect, the 'Operations Specifications' in the Air Operator's Certificate have to be read. These specifications state, among others, that for SAR flights, the captain is exempt from ensuring that all passengers are properly secured in their seats, provided that the helicopter is equipped with a handhold to be used by passengers. The Safety Board is of the opinion that the Bristow Operations Manual must be adapted to the Bristow Operations Specifications and must be clear in indicating which procedures apply to public transport operations, to SAR, or to both. Staff do not always have, read or know the details of the Air Operator's Certificate: they work with the company manuals.

Bristow Operations Manual Part D
In Part D, most sections deal with training information for public transport in general. Some sections also deal with elements that refer to SAR operations. The structure of the Training Manual and also of the relevant texts in the sections does not always clearly differentiate which requirements are valid for public transport and which are valid for SAR operations only. This was already concluded in section 6.7 - Training and checking.

An example of ambiguity in the Training Manual is the way in which Bristow organized line checking. The line check to confirm the crew member's competence during commercial air transport operations is a JAR-OPS 3 requirement. Bristow made a distinction between a line check for public transport and a line check for SAR. However, the Training Manual gives the impression that SAR crews are given the complete training required to perform duties during public transport flights and also additional training for SAR duties. It therefore remains unclear whether SAR flight crew members are restricted to SAR operations only or not. In section 2.7.6, it has already been addressed that the G-JSAR flight crew received a SAR line check only and that they were not qualified for public transport operations.

Den Helder Base Instructions
The Den Helder SAR Base Instructions (see section 3.3.3 - Den Helder Base Instructions), which deal with the Aerodrome De Kooy opening hours, state that outside the normal airport opening

hours, Bristow has dispensation to operate “strictly SAR/CASEVAC IMMEDIATE” flights only. However, in the Den Helder Base Instructions (i.e. the general part for public transport operations) the possibility of a “Night emergency call-out” is described, also in the event of a request for a rig evacuation. This ‘call- out’ should be performed with the assistance of Bristow Norwich Operations. This information was not included in the Den Helder SAR Base Instructions. Bristow indicated that Den Helder SAR-based crews do not need to know about Bristow’s public transport procedures. The Board does not agree with this position. When an urgent need exists for passenger transportation during the airport closing hours,, SAR crews must know that they are not the only ones who can transport people during these hours.
Below are the Safety Board’s findings of the investigation into the above-mentioned Bristow manuals and local instructions are summarized:

- The Bristow Operations Manuals, including the supplements, contain contradictions and sometimes it was unclear whether a procedure in the supplement is additional to, or in replacement of the procedure in the applicable general part of the manual.
- The training programme for public transport was not clearly differentiated from the SAR training programme, but the flight crew line checks for public transport and SAR are different.
- The G-JSAR flight crew was qualified to perform SAR flights and was not qualified to perform public transport flights.
- Because Bristow Den Helder-based SAR crews did not need to know about Bristow’s public transport procedures, the G-JSAR captain was unaware of the Norwich-based helicopter, which was available for public transport during the night.

The Safety Board’s findings with regard to Bristow’s manuals and instructions show that the combination of both public transport and SAR operations under one Air Operator’s Certificate could form a source of confusion if the operator does not clearly differentiate both types of operation in its manuals and procedures. The above-mentioned shortfalls in Bristow’s Operating Manuals form a basis for ambiguities and could therefore generate additional risks in the operation. The crew’s discussion on the G-JSAR outbound flight is indicative of the status of the mission in relation to the number of life jackets for the passengers, though passengers are exempt from wearing life jackets during a SAR flight. This discussion was ended without a conclusion when it became clear that enough life jackets were available, without realizing that other risks were also involved in the operation. The Board concludes that Bristow’s documentation demonstrated several shortfalls, which is not in line with the applicable JAR-OPS 3 provision in which an operator shall ensure that the Operations Manual contains all instructions and information necessary for operations personnel to perform their duties and that the contents shall not contravene the conditions contained in the Air Operator’s Certificate or any applicable regulation (see Appendix O - JAR-OPS 3.1040).

8.4.3 Verification of Procedures

After the G-JSAR accident, Bristow recognized the safety shortfalls in its training programme and reviewed/amended the entire Training Manual (Part D), including the Crew Resource Management training and the Emergency and Safety Equipment training. These shortfalls should, however, have been noticed and/or reported earlier as a result of audits, observations and inspections. The non-functioning of the Steering Committee should also have been noticed and addressed.

JAR-OPS 3 requires Bristow’s Quality System to include a Quality Assurance Programme.

The Safety Board’s observation with regard to flight crew training was indicative of the shortfalls of Bristow’s Quality Assurance Programme. Bristow uses forms that need to be filled in after flight crew members have received training or completed a check. A number of these forms, which relate to the flight crew involved in the accident, were presented to the Safety Board. The investigation revealed that these forms were not filled in completely and therefore their intended purpose was lost to a significant degree.

Another observation of Bristow’s flight crew training originates from Bristow’s internal audit report (Den Helder SAR unit, October 2006). The audit concluded that “all observed flying was of a high standard; adherence to SOPs was above-average and the standard of CRM exhibited by all was generally good.” The report was based on the observation of about six hours of SAR flight training with the G-JSAR. The report confirms the observations of the Safety Board that Bristow focused on the quality of the execution of specific SAR tasks and not on the tasks related to the handling of aircraft emergencies or the general safety of passengers in the event of passenger transportation.

8.4.4 Management involvement and review

The Board's investigation revealed the following findings with regard to the implementation of Bristow's safety management:

- During the investigation in 2007, it appeared that several Quality Information documents were not in place.
- Chief Pilot meetings were held and attended by key personnel from each of the Bristow SAR bases, including senior rear crew representatives. These meetings may have provided a platform for discussions about the SAR status of evacuation missions. However, there are no minutes of these meetings.
- The Bristow representative in the Steering Committee did not initiate new meetings of the committee after the initial meetings during the initial phase of the G-JSAR operation.
- Bristow's attendance at the Netherlands Coastguard's 'POSO' meetings (another platform to receive and evaluate information on the SAR-missions, which were held twice a year) did not commence until 1 November 2005, almost two years after the start of the G-JSAR operation.
- The finding of the audit conducted on 9-10 March 2004, stating: "The G-JSAR Steering Committee meets as required (attended by NOGEPA, the Netherlands Coastguard and Bristow)", was never checked again in one of the next three audits (see section 2.5.2 and Appendix F).
- Bristow's internal audit reports and the UK CAA audit reports of Bristow differed significantly. The UK CAA's appraisal of Bristow's Quality and Safety System indicated shortfalls that remained unnoticed during the Bristow internal audits (see sections 2.5.2 and 2.5.3, including Appendix F and G respectively).

The fact that Bristow's internal audit reports differed significantly from the UK CAA audit report findings should have raised questions at Bristow's management regarding the quality of Bristow's internal audit system. During the investigation, Bristow indicated that a reason for this could be the long-standing vacancy of relevant positions in Bristow's Safety Management Systems Department and the insufficient level of proficiency of Bristow's own auditors. In its response to the UK CAA audit in 2006, Bristow indicated that it provides audit training for its auditors. This should also have been the incentive to evaluate Bristow's management of safety and to commence improvement actions. The Safety Board concludes that Bristow's safety management with regard to monitoring, inspection, auditing and management review of the Den Helder SAR base unit operations had several shortfalls.

Bristow's supervision and management review of the Den Helder SAR base unit operations had shortfalls associated with documentation, procedures, training, feedback and analysis. The absence of handholds in the G-JSAR did not go unnoticed either. Opportunities to identify risks and address these were missed to improve the safety of the G-JSAR operation.

8.5 Eurocopter

8.5.1 Investigation of previous incidents

In accordance with European regulation (see section 3.2.2 ad 2) Eurocopter as type certificate holder of the AS332L2 is required to have a system for collecting, investigating, and analysing reports of, and information related to failures, malfunctions, defects or other incidents which cause or might cause adverse affects on the continuing airworthiness of its products. The actions for collecting information regarding incidents and for issuing this information within Eurocopter and to EASA have been described in a Eurocopter Procedure. It is stipulated that the hazard level needs to be defined for each "major incident" in order to determine its critical level and whether an unsafe condition exists. According to the Eurocopter procedures, the discovered failure of the life raft mechanisms (see section 2.3.3) were considered a "major incident". In response to the publication of the intermediate report of the Dutch Safety Board on 29 March 2007 with regard to the life raft mechanism (see section 2.8.3), Eurocopter informed EASA and issued 2 Service Bulletins applicable to AS332L2 helicopters.

A controllability problem as reported in the G-JSAR accident is also considered a major incident. The hazard level is defined as "hazardous/severe major" (see Eurocopter Procedures "EP14-02 C" in section 3.3.2). In that case, Eurocopter is obliged to inform EASA. Based on the Eurocopter design operation handbook procedures, an investigation should be performed. The G-JSAR event was treated as an unsafe condition.

Eurocopter informed the Safety Board that during a test flight in 1995, a mechanical control restriction had occurred. This problem was corrected by a modification in the production process (see Appendix C, section 1.17.3). Eurocopter informed the Safety Board that it is not aware of other AS332L2 incidents with control problems. However, information provided by the Royal Netherlands Air Force (RNLAF) revealed that such incidents occurred in 1996. Even after the Safety Board had informed Eurocopter about the RNLAF events, Eurocopter explained incorrectly that these problems were solved by the mechanical modification mentioned above. Later, Eurocopter stated a mistake was made as a result of incorrect administration. The investigation into the cause of two events in 1996 with a Eurocopter test pilot onboard a RNLAF aircraft was not completed (Appendix C, section 1.17.3). The Eurocopter report concluded:

"Only the trim presented, at this stage of the investigation, a fault that may have a connection with the problem encountered; however, the investigation must be continued before conclusions are drawn. As the investigation is being continued, a test set is being defined for installation in the helicopter and for identification of the fault if it occurs again during the following flights."

Eurocopter was unable to retrieve the relevant documentation, not even after the Safety Board provided Eurocopter with its own reference to the investigation report. Eurocopter, however, indicated that the Super Puma fleet logged more than 3.5 million flight hours without flight control related incidents. The Dutch Safety Board finds it disappointing that Eurocopter could not provide the Board with information regarding historical incidents, not even regarding events that had occurred with Eurocopter test pilots on board the AS332L2 helicopters. The Safety Board doubts whether the information regarding all related AS332L2 incidents have been registered and investigated by Eurocopter. The Safety Board regards the 1996 incidents in Eurocopter's report as an unsafe condition. Although the incidents of controllability problems in the past occurred during a different legal regime -JAR 21 instead of EASA Part 21- it does not discharge Eurocopter from its responsibility to determine if an unsafe condition exists.

The Safety Board is of the opinion that the reported aircraft controllability problems in the past should have been treated as unsafe conditions in accordance with the EASA regulation and ongoing Eurocopter airworthiness procedures (see sections 3.2.2, ad 2 and 3.3.2). The information emanating from the required analysis of the unsafe conditions in the past, might have helped the G-JSAR investigation.

8.5.2 Conduct of technical investigation

Eurocopter participated in the G-JSAR investigation from the beginning. Eurocopter proposed a comprehensive plan to check all systems that were related to the control of the helicopter (see Appendix C, section 1.16). A great deal of effort put in by Eurocopter staff to propose a technical investigation plan and perform tests on the aircraft and its components. During the execution of the test plan, a theory was developed that the discrepancy, which had been detected on the pilot hydraulic cut-off switch, had caused a variation in hydraulic pressure in the control system. This pressure variation could have acted directly on the cyclic controls and had not triggered any alarm on the cockpit warning panel. The Safety Board supported this theory as a possible cause of the control problems experienced by the crew, provided that additional evidence was produced to support this theory. Therefore, the Safety Board posed questions to Eurocopter for the follow-up investigation. A written analysis of the flight test department was requested regarding the validity of this theory but, despite the efforts of the Eurocopter investigation team, it was not provided. Furthermore a theoretical study of fluid dynamics in the autopilot hydraulic system was requested but was not performed by Eurocopter.[100] It also proved to be difficult for the Eurocopter accident investigation staff to organise a simulator test and a test flight. To keep the investigation going, the Safety Board organised a simulator test and later a test flight himself.

Later on, Eurocopter also performed a test flight. The results that were provided to the investigation team consisted of a graphical presentation of the cyclic control deflections that was visually similar to the cyclic deflection pattern of the accident flight. This graph was presented as supporting evidence for the theory that the cause of the accident was an intermittent failure of the autopilot hydraulic switching (see Appendix C, section 1.16.5.4). The Eurocopter flight test flight data recorder data was in first instance not made available to the investigation team.[101] The control forces were not recorded. The produced visual evidence to demonstrate the resemblance of the Eurocopter test data with the recorded data of the G-JSAR were not convincing enough to the Board to alleviate doubts about the autopilot hydraulic failure theory. Therefore the Board organised additional tests, including a test flight in the UK.

100 During the review of the draft final report, Eurocopter stated that such a study is not useful.
101 During the review of the draft final report, the data became available to the Dutch Safety Board.

On 15 October 2007, another incident with the Bristow AS332L G-BWWI occurred in the UK (see section 2.3 and Appendix C, section 1.17.1). According to Eurocopter, the G-JSAR accident was identical to the G-BWWI incident, in terms of introducing inadvertent switching of the autopilot hydraulic system, which was caused by a problem in one of the autopilot hydraulic cut-off switches. Eurocopter and the Safety Board share the opinion that, in the case of the G-BWWI, the cause was a mechanical problem in one of the switches.

In the opinion of Eurocopter one of the G-JSAR autopilot hydraulic switches on the collective pitch lever could have caused an inadvertent cycling of the autopilot hydraulic system because the seawater that was found in the switch during investigation may have been present before the accident (see section 2.3.1 and Appendix C, section 1.16.5.3). However, the laboratory that investigated the switches concluded that there was no evidence that seawater was present in the switch before the accident, because there was no sign of corrosion inside the switch (see section 6.4). Although considered a possible theory there is insufficient evidence to confirm and conclude that autopilot hydraulic switching occurred.

In conclusion, the Safety Board does not share the Eurocopter opinion that in the G-JSAR investigation an autopilot hydraulic cut-off switch caused inadvertent switching of the autopilot hydraulic system. Besides this, there is insufficient evidence that intermittent cycling of the autopilot would have resulted in a control restriction as experienced by the flight crew.

In June 2008, Eurocopter issued an operator's message with information to warn flight crews about the (remote) possibility of controllability problems during flight as a result of failure of one of the autopilot hydraulic switches.

8.5.3 Investigation capacity

In the course of the investigation, the Safety Board proposed to obtain a first indication of the possible effects of an intermitted autopilot hydraulics failure on the handling characteristics of the aircraft during a simulator test. Despite the efforts of the Eurocopter investigation team, organizing this test appeared to be difficult for Eurocopter, although Eurocopter is co-owner of the Helisim training facility which is located next to the Eurocopter facilities. Furthermore, the Eurocopter accident investigation staff showed limited possibilities to organize support from the flight test department. The Safety Board is of the opinion that the number of accident investigation staff is too limited in relation to the number of Eurocopter aircraft operating worldwide. The accident investigation staff are part of the Technical Support Department, which is located in the Support and Services Department. The accident investigation task is the responsibility of the Research and Development Department, which is headed
by the Head of Design Organisation. What is more, there is no direct relation with the Quality Assurance Department, which is positioned 'close to the CEO'. Based on the 1996 RNLAF incidents, the Safety Board is concerned about the efforts Eurocopter puts into the follow-up of incidents with unsafe conditions regarding controllability problems with AS332L2 helicopters. The Safety Board concludes that the Eurocopter accident investigation team put much effort into the investigation but appeared to have insufficient authority to organize the necessary support from other Eurocopter departments, which was necessary in the G-JSAR investigation. This was a contributing factor to the fact that insufficient steps were taken to validate the Eurocopter theory about the cause of the accident.

At the end of 2008, Eurocopter announced it had taken into account the observations made by the Safety Board from the G-JSAR investigation. The newly set up Fleet Safety organisation will participate to support the Eurocopter accident investigations by coordinating all the relevant parties and by establishing an improved relationship with Helisim.

- *Eurocopter could not retrieve relevant historical data, including an internal report regarding a significant controllability problem with an AS332L2 helicopter in 1996. The internal report revealed that this investigation was not completed.*
- *Eurocopter did not apply fully to the EASA regulation and Eurocopter procedures regarding the controllability problems regarding the 1996 occurrences.*
- *The Safety Board doubts whether all related AS332L2 occurrences were registered and investigated by Eurocopter.*
- *Eurocopter finished its investigation on the cause of the controllability problems of the G-JSAR with the conclusion that inadvertent autopilot hydraulic switching had resulted in the perceived high cyclic stick forces. The Safety Board does not support the Eurocopter conclusion because insufficient evidence is available.*
- *Eurocopter investigators appeared to have difficulties in organising the necessary support from other Eurocopter departments during the G-JSAR investigation. The relatively limited number of staff and the position of the Eurocopter accident investigators in the organisation resulted in limited authority to organise support within the Eurocopter organisation.*

8.6 Regulation and supervision of SAR operations

This section focuses on the regulation and inspection by the authorities of SAR operations and offshore activities. It addresses the absence of international requirements for SAR operations and the role of the English and the Dutch authorities in this respect.

8.6.1. Search and rescue

The purpose of the international legislation in the field of search and rescue (see section 3.2.3) is to assure the establishment of a search and rescue service within each contracting state. Of course the requirements aimed at this assurance remain within the framework of the relevant regulations in this connection. This means that the establishment of a search and rescue service is required regarding aviation and shipping respectively. In terms of Dutch legislation, this requirement is extended to the category of mining, which includes the offshore industry.

Thus the requirements as indicated provide for the safety of persons requiring assistance by search and rescue. Executing SAR activities at sea or in the air does entail possible safety risks and hazards by nature of the job. The requirements stated do not address the risk control regarding these hazards. Furthermore, Annex 6 to the Convention of Chicago (see section 3.2.2, ad 1) and JAR-OPS 3 (see section 3.2.2, ad 3), the two regulations that are of primary importance in this connection, exclude SAR operations. As a consequence, the safety of international commercial SAR operations has not been regulated.

With a view to the premise that SAR missions are inherently operated under extraordinary circumstances, their exclusion from the regular requirements can be understood. This premise as mentioned however, does not exclude the existing possible hazards; on the contrary, since SAR operations are executed under special and importunate circumstances it must be understood that they are of a risk increasing nature. Originally, search and rescue was primarily a subject of mainly national interest, which may explain the absence of international safety legislation in this field. Since relations in this field are increasingly international - as is indicated by the incident under consideration - it seems that the moment has come to regulate this subject matter on international level. It is therefore in this context that the UK Civil Aviation Authority made the observation that further considerations by the European Aviation Safety Agency are awaited (see section 3.3.3 - Air Operator's Certificate). However, EASA is not yet authorised in the field of public helicopter operations and therefore it cannot be expected that EASE will come up with a solution in the near future. In the meantime the UK CAA accepted its responsibility for the regulation and supervision of Bristow's international commercial SAR operation. However, the UK CAA did not develop or substantiate SAR requirements in addition to the existing public transport requirements. When needed for SAR operations, various exemptions from the regulations for public transport are laid down in the Air Operator's Certificate of a helicopter company which executes SAR missions like Bristow. What is more, UK CAA did not define the responsibilities of the tasking agency in relation with the operator, who is, in this case, the Netherlands Coastguard (see section 3.3.3 - Air Operator's Certificate). UK CAA indicated that they found it difficult to put civil SAR operations under a JAR-OPS Air Operator's Certificate, since there is no clear definition of what constitutes a SAR task and what constitute the responsibilities of the tasking agency.

- *The UK Civil Aviation Authority accepted its responsibility for the regulation and supervision of Bristow's international commercial SAR operation.*
- *The UK Civil Aviation Authority regulation for search and rescue did not provide clarity on the definitions of an SAR or operational flight, nor on the responsibilities of the tasking agency because of the difficulty to put commercial SAR operations under a JAR-OPS Air Operator's Certificate, since there no clear definition of what constitutes a SAR task and what constitute the responsibilities of the tasking agency.*
- *Search and rescue is not exclusively a national affair. International regulation in this field must be seriously considered.*

8.6.2 Oversight of Bristow operations by UK Civil Aviation Authority

The UK CAA approved Bristow's commercial SAR operations and related policies and procedures in the Bristow Operation Manual provided, which Bristow compiled with the provisions contained in the Air Navigation Order 2005 and JAR-OPS 3 (see sections 3.2.2 ad 3 and 4, and 5.3.2). Bristow has been involved in public helicopter transportation and SAR operations for many years now and its policy and procedures in the manuals have been subjected to approval by the authorities since the establishment of JAR-OPS 3 requirements. However, there are no definitions of SAR in the applicable Air Navigation Order 2005 or JAR-OPS 3.

The UK CAA performed audits and inspection flights of the Bristow SAR operations in the UK and the Netherlands annually. The audit results from 2005 and later, including an audit in 2007 after the accident flight, contained repeated findings regarding shortfalls in Bristow's Quality and Safety System. Each audit result was followed by a response from Bristow, based on which the UK CAA concluded its finding(s). The Safety Board noted that these findings were concluded repeatedly while at the same time UK CAA planned to pay extra attention to the Quality and Safety System in the next (annual) audit. The Board is of the opinion that, by doing so without active monitoring, the opportunity to address the fact that Bristow's Quality and Safety system had several structural deficiencies was missed.

Of note in this respect is the UK CAA's follow-up of a recommendation made by the UK AAIB after the accident with a Bristow Super Puma helicopter in the North Sea in the UK in 1995 (see Appendix C, section 1.18.2):

"The CAA should ensure that the North Sea helicopter operating companies include in their very effective recurrent training for crews, a discussion and, where possible, 'hands on' practice of the procedures necessary to accomplish a successful evacuation from a floating helicopter following a ditching or alighting on the sea."

In 1997, the UK CAA completed a review of the Operations Manuals of all (British) North Sea helicopter operators to ensure that they contain the necessary procedures to accomplish a successful evacuation from a floating helicopter following a ditching or alighting on the sea. In this respect, the Safety Board findings of the G-JSAR investigation showed that the recurrent training including 'hands on' practice of the procedures in Bristow's Training Manual necessary to accomplish a successful evacuation should be updated. After the accident, Bristow rewrote its Training Manual, including an amendment and expansion of the Emergency and Safety Equipment training. A new Aircraft Evacuation drill became effective. Initially, recurrent Emergency and Safety Equipment training and checking requirements for crew other than the flight crew were announced and amended. Instructions were made more robust, including 'hands on' training with both the front and rear crew (see section 2.8.2 and Appendix H).

The Safety Board concludes that the system of audits and inspections of the CAA UK uncovered shortfalls in Bristow's Quality System and Quality Assurance Programme, but did not uncover the specific risks involved regarding Bristow's management of safety within the Den Helder SAR operation. The Safety Board concludes that the UK CAA's supervision was accomplished according to existing requirements but nevertheless, without short term active monitoring, failed to address several structural deficiencies of Bristow's Quality and Safety System regarding operational feedback, documentation review, verification of procedures, and management involvement and review which were therefore not resolved (see section 8.4).

- *UK Civil Aviation Authority supervision was accomplished according to existing requirements but, without active short term monitoring, failed to address structural deficiencies of Bristow's Quality and Safety Syste which were therefore not resolved.*
- *The result of UK Civil Aviation Authority's review of (British) North Sea helicopter operator's Operations Manuals to ensure that these manuals contain the necessary Emergency and Survival training methods and procedures to accomplish a successful evacuation from a floating helicopter following a ditching or alighting on the sea, was not demonstrated with the G-JSAR evacuation. After the G-JSAR accident, Bristow rewrote its Training Manual. A new Aircraft Evacuation drill became effective. Initial, recurrent Emergency and Safety Equipment training and checking requirements for crew other than flight crew were announced and amended. Instructions have been made more robust, including 'hands on' training with both the front and rear crew.*

8.6.3 Oversight of commercial SAR activities in the Netherlands

Civil operators that are contracted to carry out SAR duties are not uncommon in the aviation sector and this is in the development process. It is not the responsibility of the State Supervision of Mines to conduct an oversight on offshore (commercial) air transportation in general or on commercial SAR helicopter operations in particular. The Transport and Water Management Inspectorate does not conduct oversight on foreign registered aircraft, except for SAFA inspections on airports (see section 3.2.2, ad 5). The basic principle of international aviation regulations is that every state is sovereign and therefore is responsible for its own aviation rulemaking and safety oversight. With regard to the British registered G-JSAR, the United Kingdom is the state of registration and the UK CAA is responsible for the oversight. The only exception to this are the SAFA inspections. However, the Transport and Water Management Inspectorate indicated that no SAFA inspections were carried out on the G-JSAR from the beginning of its operation in Den Helder in 2003. The Board is of the opinion that if the G-JSAR had been inspected by the SAFA team, it would probably not have affected the operation, because of SAFA's limited scope.
The Safety Board is of the opinion that when a state accepts that SAR duties are carried out under the rules of another state, these rules should have been evaluated and accepted or additional requirements set. In particular, prior to the G-JSAR operation, the UK CAA derogations from JAR-OPS 3 in the Air Operator's Certificate should have been evaluated by the involved state authorities from the Ministry of Defence and the Ministry of Transport, Public Works and Water Management.

In section 8.3 the conclusion is reached that the Royal Netherlands Navy, responsible for the management and operation of the Netherlands Coastguard on behalf of the Ministry of Defence, did not fulfil its supervision responsibilities. In addition to the Safety Board's conclusions regarding the supervision of the Netherlands Coastguard, the Board noted that at the time of the accident there were six Ministries involved with the Netherlands Coastguard tasks (see section 4.8), in particular the Ministry of Defence and the Ministry of Transport, Public Works and Water Management. The investigation revealed signs of compartmentalisation within the Ministry of Transport, Public Works and Water Management, between representatives from different directories that take part in different policy, advisory or executive bodies with regard to the search and rescue and Netherlands Coastguard duties. These representatives take part in the North Sea Task Force, the Periodic Operational SAR Deliberation meetings, and its executive body Coastguard Triumvirate and the Coastguard Board (see section 4.12) which was formed later. In order to carry out the many tasks of the Netherlands Coastguard for a total of six ministries, interdepartmental and departmental communication and co-ordination is essential. The fact that there is no jurisdiction of Dutch authorities on the G-JSAR, except for the Netherlands Coastguard's decision to dispatch, should have been taken into account in a risk assessment. Also, none of the representatives were aware of the fact that the Steering Committee did not function during the G-JSAR operation.

The Safety Board is of the opinion that the compartmentalisation between and within the ministries involved in SAR operations in the Netherlands, and in particular within the Ministry of Transport, Public Works and Water Management contributed to the fact that the G-JSAR Steering Committee's lack of function remained unnoticed within the ministries involved.

In 2006, the Dutch government already reached the decision that the Netherlands Coastguard had to be transferred into a Netherlands Coastguard New Style (see section 3.2.3). The most important reason for this transformation was the demand for a clear set of provisions regarding the duties and responsibilities of the Netherlands Coastguard and the assurance of a comprehensive and transparent balancing out of the interests concerned. For this purpose, a new Decree Institution Coastguard, dated 17 November 2006, came into effect on 1 January 2007 with a complex set of government oversight parties. One of the provisions was the establishment of a Coastguard Board.

The Coastguard Board advises the Minister of Transport, Public Works and Water Management on the policy, enforcement, service, control, information, and financial plans with regard to coastguard duties. The possible effect of this new Decree on the G-JSAR accident was not investigated by the Safety Board, because it was considered outside the scope of the investigation. The Ministry of Transport, Public Works and Water Management has indicated that steps have been taken in 2009 to introduce a quality system for the Coastguard and the supervision of SAR duties of the Coastguard as a part of this quality system are being developed.

- *There are no Dutch requirements for civil SAR helicopter operations.*
- *There is no central or co-ordinated supervision on (parts of) the SAR operations in the Netherlands.*
- *There is no jurisdiction of Dutch authorities on the G-JSAR operation. The only oversight opportunity for the Dutch authorities on the G-JSAR operation is the performance of SAFA inspections, but these have not been executed.*
- *The Royal Netherlands Navy did not fulfil its management and operational responsibilities regarding the Netherlands Coastguard.*
- *With regard to Bristow SAR operations in the Netherlands, there is insufficient interdepartmental communication and co-ordination between the representatives of the involved Ministries, in particular within the Ministry of Transport, Public Works and Water Management.*

8.6.4 Regulation and supervision of offshore operations

State Supervision of Mines took part in the investigation carried out by NAM. In this investigation, State Supervision of Mines did not observe that NAM's safety management regarding the monitoring of offshore operations, in particular of prolonged offshore black outs and incidents regarding the limitations of (public and SAR) helicopter transportation, had a number of shortfalls.

State Supervision of Mines did not observe that the investigation of NAM's safety management regarding the monitoring of offshore operations, did not include prolonged offshore black outs.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

This section contains the summary of conclusions and supporting findings of the investigation.

Conclusion 1
The Company Group Operators, Netherlands Coastguard, and Bristow did not supervise the G-JSAR operation. The result was that the misuse of SAR flights for passenger transport was not detected.

Supporting findings:
- The Company Group, Netherlands Coastguard, and Bristow representatives convened in the Steering Committee during the initial phase of the G-JSAR operation; the Steering Committee did not meet again from mid 2004 onwards. Therefore the Steering Committee did not adhere to the agreed procedures and thus did not play its intended role in evaluating the G-JSAR dispatches.
- The Company Group, Netherlands Coastguard, and Bristow each had opportunities to evaluate similar G-JSAR evacuation dispatches and missions prior to the accident flight that justified the need for evaluation, but none of the parties involved did so.

Conclusion 2
NAM's safety management regarding monitoring offshore operations had a number of shortfalls associated with reviewing possible active consequences of offshore installation black outs and incidents regarding the limitations of (passenger and SAR) helicopter transportation. Opportunities were missed to identify and address risks.

Explanation:
NAM did not actively review the safety consequences of previous black outs of installations and an earlier black out on the K15B. NAM did not review preceding evacuation missions in which the G-JSAR was involved. Neither were audits of the Bristow Den Helder SAR unit performed, nor were internal Bristow audits or UK CAA audits of Bristow reviewed. The fact that the Steering Committee was not functioning was not addressed. The result was that:

1. There was a lack of clarity among the staff involved in the decision-making process regarding the level of safety of the K15B and the Noble George Sauvageau.
   Supporting findings:
   - The Concurrent Operations Script did not cover the scenario of a prolonged black out on the K15B in combination with ongoing drilling activities on the Noble George Sauvageau.
   - The decision to transport the non essential K15B staff onshore was taken on the basis of comfort, on an unclear foundation, and with the wrong classification of urgency.

2. An assessment of the extra risks of the dispatch of the G-JSAR for transportation of passengers was not carried out. NAM staff involved in the decision making process did not appreciate these extra risks and did not consider the alternative for the use of the G-JSAR for down-manning of the K15B.
   Supporting findings:
   - NAM's offshore risk analyses did not take into account all the hazards involved with SAR helicopter flights in general, and with the G-JSAR in particular. Consequently, the NAM staff involved were not adequately prepared for down-manning offshore installations during the closing hours of Aerodrome De Kooy.
   - The applicable NAM documentation did not contain procedures regarding the availability and the conditions to use passenger transport helicopters or the G-JSAR helicopter, nor for alternative helicopter passenger transport at night time. Consequently, the NAM staff involved had different views regarding the availability and the use of passenger transport helicopters in general and the G-JSAR helicopter when used for passenger transport in particular.

3. NAM staff did not follow its own guidelines and agreements.
   Supporting finding:
   - The decision to use the G-JSAR was not made in accordance with the agreements and procedures between the involved parties (Company Group, Netherland Coastguard and Bristow), nor with the international guidelines of the International Association of Oil & Gas Producers.

Conclusion 3
The Netherlands Coastguard did not follow its own instructions or international standards and principles sufficiently, nor did it act in accordance with the agreements reached between the parties involved in the G-JSAR operation. The result was that the Netherlands Coastguard acted as a communication channel only between NAM and Bristow instead of a tasking agency when on 21 November 2006 the G-JSAR was dispatched.

Supporting findings:
- The Netherlands Coastguard did not follow the instructions given to assess the emergency level in accordance with its OPPLAN-SAR adequately.
- The G-JSAR dispatch on 21 November 2006 was not carried out in accordance with the Standard Operating Procedure as agreed between the Netherlands Coastguard and Bristow, or with the SAR alarm procedures as agreed between the Netherlands Coastguard, Ministry of Defence, and Bristow.
- The Netherlands Coastguard's standing practice for the dispatch of civil search and rescue (air) assets was inadequate and not in accordance with the International Aeronautical and Maritime Search and Rescue safety management principles.

Conclusion 4
Transportation of the passengers in the G-JSAR helicopter created additional risks compared to transportation in a passenger transport helicopter.

Supporting findings:
- The acting G-JSAR flight and rear crew were specifically trained and prepared for the execution of SAR missions, but not for passenger transport.
- The G-JSAR had only four airworthy passenger seats for two rear crew and thirteen passengers.
- The handholds required to partially compensate for the lack of adequate seats during SAR operations were absent.

Conclusion 5
The flight crew experienced gas turbine rotor speed differences between the two engines, and flight control problems during the following descent after switching off the autopilot upper modes. The investigation did not find a conclusive explanation for the differing engine rotor speeds and the flight control problem experienced by the flight crew.
Explanation:
A malfunction of the engine control systems is regarded as being the source of the differing engine rotor speeds. A technical explanation for this malfunction could not be found. The investigation did not reveal the cause for the reported flight control problem.
Supporting findings:
- Both engines were running and sufficient engine power was available to continue the flight.
- The helicopter remained controllable, although this took a great deal of effort.
- The steering force that was used to control the helicopter is not a recorded parameter and could not be determined.
- Eurocopter finished its investigation on the flight control problem with the conclusion that inadvertent autopilot hydraulic switching had resulted in the perceived high cyclic stick forces. The Safety Board does not support the Eurocopter conclusion, because there is insufficient evidence to back-up this theory.

Conclusion 6
The flight crew became convinced that an emergency landing was inevitable after they experienced a flight control problem that intensified. The investigation could neither confirm nor deny the inevitability of an emergency landing.

Explanation:
The flight crew suspected a relation between the engine behaviour and the helicopter flight control problem. They assumed that the aircraft had become uncontrollable and that a landing was the only remaining option. In the opinion of the Dutch Safety Board, this decision was taken with an incomplete mental picture of the actual situation.
Supporting findings:
- The helicopter remained controllable, although with a great deal of effort.
- The decision to ditch was made without a proper assessment of the flight control problem.

Conclusion 7
The flight crew was not sufficiently prepared to handle the engine rotor speed differences, the flight control problem, and the autopilot. This resulted in sub-optimal decisions from the moment that the two engine rotor speeds differed during the return flight.

Explanation:
The crew could not manage the situation with firm knowledge and adequate actions. Inadequate training and directives are identified as causal factors.
Supporting findings:
- Bristow AS332L2 flight crews are not provided with clear information about what they can expect from the cooperation of engine control systems and consequently the flight crew did not know how to deal with the engine behaviour.
- The Bristow Operation Manuals do not contain a policy or procedures for optimum use of the autopilot upper modes during other hoist operations.
- Recurrent training of abnormal and emergency procedures related to system failures in a realistically simulated environment was very limited: training methods were not defined, nor was the amount of time to be spent on individual items.
- The operational training of Crew Resource Management had only been conducted in classrooms. This is considered to be inadequate.

Conclusion 8
The crew did not provide the passengers with proper briefings. The result was that the passengers were not sufficiently prepared for the emergency landing.

Supporting findings:
- As three different types of life jackets were to be used, this briefing included an explanation of how to inflate each type. It did not include briefing on the additional aids contained in one type of jacket. One passenger did not remember the content of the briefing and needed the help of a colleague to inflate his life jacket.
- Several passengers were unable to hear the announcements made by the captain over the aircraft's public address system, because of the engine noise and probably because of unfamiliarity with such a briefing.
- The passengers were not given a proper warning prior to ditching: they were not given instructions to don their hoods and gloves, nor to mentally rehearse their means of exiting the aircraft and the actions to be completed thereafter.

Conclusion 9
The crew did not follow the evacuation procedure as described in the AS332L2 Operations Manual. The result was that the passengers were exposed to additional risks.

Supporting findings:
- The cabin evacuation was started before the main rotors were stopped completely and without authority having been given by the captain.
- The cockpit life raft deployment handles were not used.
- The rear crew did not consider deploying the life rafts before evacuating the aircraft.
- The external cabin life raft deployment handles were not used.

Conclusion 10
Previous incidents of helicopter ditching suggest that when the aircraft does not roll over immediately, it is probable that occupants will have time to evacuate the aircraft in the intended manner directly into the life rafts.

Supporting finding:
- The lessons that could be learned within the helicopter offshore community as a result of accidents that happened during the ongoing research of improving helicopter safety and survivability in the water were not communicated sufficiently. In 1995, the UK CAA published the Civil Aviation Publication 641 (CAP 641) entitled 'Review of Helicopter Offshore Safety and Survival', which has not been updated since for the latest insights.

Conclusion 11
Bristow's supervision and management review of the Den Helder SAR base unit operations had shortfalls associated with documentation, procedures, training, feedback and analysis. Opportunities to identify and address risks which could have improved the safety of the G-JSAR operation were missed.

Supporting findings:
- On the basis of the requirements as laid down in the Air Operator's Certificate of Bristow, the operation with the G-JSAR on 21 November 2006 should not have been executed.
- Bristow's Operations Manuals do not sufficiently differentiate between passenger transport and SAR operations and procedures. This is a basis for ambiguities and could generate additional risks in the operation.
- The Bristow internal auditing system did not pay sufficient attention to the system's possibilities to provide feedback and also did not cover the quality of simulator and emergency equipment training.
- Safety information regarding the G-JSAR non-emergency evacuation flights in the past was not reported through the formal flight safety system by crew members (some of them also being line managers), nor in meetings held by line managers.
- Bristow post flight reports of G-JSAR missions in general do not contain the information needed in order to carry out a proper evaluation.
- Bristow internal audit reports were more positive than the UK Civil Aviation Authority audit reports of Bristow. This did not result in an evaluation of Bristow's audit system.

Conclusion 12
Eurocopter did not sufficiently comply with the obligation to investigate and register incidents. The result was that opportunities were missed to identify and address risks regarding flight control problems with the AS332L2.

Supporting findings:
- Eurocopter could not retrieve relevant historical data, including an internal report regarding a significant controllability problem with an AS332L2 helicopter in 1996. The internal report revealed that this investigation was not concluded. This was not in line with Eurocopter procedures and continuing airworthiness procedures.
- Eurocopter did not apply the Eurocopter investigation procedures sufficiently regarding the controllability problems of the 1996 incidents.
- The Safety Board doubts whether all related AS332L2 incidents are reported to and registered and investigated by Eurocopter.
- Eurocopter investigators repeatedly appeared to experience difficulties in organising the necessary support from other Eurocopter departments during the investigation. The relatively limited number of staff and the position of the Eurocopter accident investigators within the organisation resulted in a limited authority to organise support within the Eurocopter organisation.
- The opinion of the Eurocopter flight test department on the possible autopilot hydraulic system problem proved difficult to provide. The Safety Board organised a simulator and flight test.

Conclusion 13
The left-hand G-JSAR sponson life raft was not ready to be used.

Supporting finding:
- The left-hand G-JSAR life raft could not be released using the exterior nor the interior release handles. A detailed investigation of the cable grip and the release control cable proved that it had not slipped, but that the control lever angle was too large in relation to its horizontal axis and prevented the control lever from functioning in its normal operating range.

Conclusion 14
International and Dutch regulations for commercial search and rescue operations do not exist. The UK regulation remains unclear in defining commercial search and rescue operations.

Supporting findings:
- The jurisdiction of Dutch authorities on the G-JSAR operation was limited to the execution of SAFA inspections, but these had not taken place. If SAFA inspections had taken place, it would probably not have affected the operation, because of SAFA's limited scope.
- UK Civil Aviation Authority took responsibility for the regulation and oversight of Bristow's commercial search and rescue operations.
- UK Civil Aviation Authority regulation for search and rescue was not clear regarding the definitions of an SAR or operational flight, or regarding the responsibilities of the tasking agency (i.e. Coastguard), because of the difficulty to put commercial SAR operations under a JAR-OPS Air Operator's Certificate.

Conclusion 15
UK Civil Aviation Authority oversight repeatedly reported shortfalls regarding Bristow's Quality and Safety system in 2006-2007, but did not achieve the necessary structural improvements.

Supporting findings:
- UK Civil Aviation Authority repeatedly concluded its finding(s) regarding structural deficiencies in Bristow's Quality and Safety system, while at the same time planning to pay extra attention to the system in the next annual audit.
- The review of Emergency and Survival training methods and procedures of North Sea helicopter operator's Operation Manuals did not achieve its intended result to ensure that these manuals of Bristowcontain the necessary Emergency and Survival training methods and procedures to accomplish a successful evacuation from a floating helicopter following a ditching on the sea.

Conclusion 16
Dutch supervision of search and rescue operations in the Netherlands was non-existent at the time of the G-JSAR operation.

Explanation:
The G-JSAR operations fall under the jurisdiction of the United Kingdom, as a result of the British registration of the helicopter and the British Air Operator's Certificate of Bristow. However, the organisation of search and rescue operations in the Netherlands is the responsibility of the Dutch government. The operational command of the Netherlands Coastguard falls under the Command Royal Netherlands Navy, which in turn is placed under the Ministry of Defence. The fact that the G-JSAR Steering Committee were not functioning remained unknown by the Dutch authorities.

Supporting findings:
- The Royal Netherlands Navy did not supervise the Netherlands Coastguard and the Ministry of Defence did not supervise the Royal Netherlands Navy regarding the operational command of the Netherlands Coastguard either.
- The policy of the Ministry of Transport, Public Works and Water Management, by means of the Directorate General for Freight Transport and Civil Aviation was insufficiently aimed at the use of foreign SAR operators in the State's search and rescue service.
- Regarding the G-JSAR operations in the Netherlands there was insufficient (inter)departmental communication and co-ordination between the representatives of the ministries involved with the joint venture of the Netherlands Coastguard, in particular within the Ministry of Transport, Public Works and Water Management.

Conclusion 17
State Supervision of Mines participated in NAM's internal investigation. In this investigation the absence of the risk of the prolonged black out was not noticed.

9.2 Recommendations

This section contains the recommendations that follow from the investigation.

The Minister of Defence
The Board recommends that the Minister of Defence:
3. ensure that the Coast Guard Centre complies with the evaluation procedures for the use of Search and Rescue;
4. ensure that the Director of the Coast Guard accepts responsibility for the realisation tasks of the Coast Guard by providing a system for the evaluation of the quality thereof.

The Minister of Defence and the Minister of Transport, Public Works and Water Management
The Board recommends that, in line with the relevant finding from the audit conducted by the International Civil Aviation Organisation, the Minister of Defence and the Minister of Transport, Public Works and Water Management give shape to the supervision of the Dutch Search and Rescue activities and the realisation of these activities by the Coast Guard Centre.

Nederlandse Aardolie Maatschappij (NAM)
In addition to the evaluation of the risks of short-term power outages on offshore installations the Board recommends that the NAM map out and manage the risks of long-term power outages.

Bristow Helicopters Limited (Bristow)
The Board recommends that Bristow:

4. expand and optimise the training programme of (Search and Rescue) pilots with regard to the simulator training, the use of the "autoflight" system, evacuation and the use of rescue equipment;
5. describe in the Operations Manual how the cockpit crew should handle discrepancies of the engine revolution counts that do not result in a warning signal, as well as include a procedure for the use of the automatic pilot in non-standard situation;
6. adapt its safety management system in view of the shortcomings described in this report.

UK Civil Aviation Authority (UK CAA)
The Board recommends that the UK CAA consider including information regarding the application of the aforementioned operational parameters in its guideline "Review of Helicopter Offshore Safety and Survival", so that crews are better able to evaluate the chances of capsizing after a successful emergency landing. In addition it is advisable that this guideline provides solutions with regard to the smoothness of survival suits in combination with inflated lifejackets, so that survivors can be retrieved from the water more quickly.

Eurocopter
The Board recommends that Eurocopter ensure that all incidents involving its own products are reported to Eurocopter, that these reports are documented in a structural manner and analysed for the purpose of continued airworthiness, and that the company's own investigation capacity is focused on these tasks.

European Aviation Safety Agency (EASA)
The Board recommends that EASA consider expanding the parameters for the flight data recorders of helicopters to include the forces of the steering ("control forces"), as is the case in some categories of fixed wing aircrafts.

Direction Générale de l'Aviation Civile (DGAC)
The Board recommends that the French DGAC reconsider its approval for the use of the Helisim AS332L2 simulator for training helicopter crews to the highest level, 'level D', as the simulator differs from the type AS332L2 helicopter, which means it does not comply with the European requirements on this point.

The governmental bodies towards which a recommendation has been issued must take a stance regarding the follow-up of this recommendation within six months of publication of this report to the minister concerned. Non-governmental bodies or individuals to whom 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 INVESTIGATION

1. Preliminary investigation
   The incident was reported on 21 November 2006 to the Dutch Safety Board shortly before midnight. The primary activities of the Safety Board's investigators included establishing contact with the local authorities in order to salvage the helicopter and the recording of vital information, i.e. taking photographs, holding brief interviews with crew and passengers, the securing and transportation of flight recorders. Later on, the investigation team was reinforced on location by the accredited representatives and their advisors and experts from the United Kingdom and France, representing the State of the Operator and the State of the Design/Manufacturer respectively.

2. Scope of investigation
   The investigation was conducted according to the Kingdom Act concerning Safety Investigation Board and following European and ICAO directives that apply to the investigation of civil aviation accidents.[102] On the basis of the preliminary findings, a Preliminary Report[103] was presented to the Board in its meeting of 5 December 2006 and a plan of action was proposed to and approved by the Board in its meeting of 12 December 2006. The Preliminary Report was distributed to the parties involved, including ICAO, and was published on the Dutch Safety Board's website on 21 December 2006.

From the beginning of the investigation, the Dutch Safety Board was aware that the incident was potentially a serious accident that had a fortunate outcome. The investigation was divided into three different parts, each demanding a different approach. These three investigation parts include:

Part 1: the down-manning of the production platform K15B and the activation of the G-JSAR.
Part 2: the G-JSAR flight and the emergency landing.
Part 3: the evacuation of the G-JSAR and the rescue operation after the emergency landing of the G-JSAR.

The main question for each part is respectively:
- Why was to the decision taken to down-man the offshore installation by means of a search and rescue helicopter?
- What were the events and conditions that resulted in the decision being taken to make an emergency landing?
- Did all the life saving appliances and procedures function as planned? If not, why did they not function properly?

This project will not examine the underlying factors that resulted in the black out of the K15B, nor the choices that were made to assemble the NAM staff onshore or the aftercare. In a later stage of the investigation, the scope was also limited to the audits of the Oil & Gas Industry related to the civil SAR helicopter.

3. Project organisation

3.1 Project team

The investigation was performed in project teams. The investigation was performed by a core team of investigators supplemented by expert-investigators from the Dutch Safety Board for each part of the investigation or for specific information. Where necessary, external experts were added to the investigation teams.

102 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).

103 In accordance with the Kingdom Act and the ICAO standards, the Safety Board issued a Preliminary Report. *When the aircraft involved in an accident is of a maximum mass of over 2, 250 kg, the State conducting the investigation shall produce and send the Preliminary Report within 30 days to the ICAO and the involved member States.*

Name	Function
Internal:	
K.E. Beumkes	project manager
Part 1	
M. Jager	project manager part 1 (until July 2008)
Part 2	
G.J. Vogelaar	project manager part 2/ acting project manager
W.F. Furster	investigator - flight recorder specialist
A. Samplonius	investigator - engine specialist
M. Schuurman	investigator - flight recorder specialist
A.J. van Utrecht	investigator
Part 3	
T.D. van Hoorn MSHE	project manager part 3 (until May 2007)
P. Verheijen	investigator (until January 2007)
General	
E.M de Croon	analyst
B.J. van de Griend	secretary - legal advisor
S. Groenendal	communication advisor
J.K. Hinsbeeck	research assistant
G.J.M. Oomen	investigator (interviews passengers)
M.L.M.M. Peters MSHE	investigator (interviews passengers)
H. van Ruler	investigator (initial investigation)
L.J. Wagtendonk-Vink	investigator (until December 2007)
External:	
H.G. Paar	External expert
L.H.A. Scholte	External expert
R. Vossen	External expert DALPA/AIG
A. Young	External expert (until January 2007)

3.2 Advisory Committee

The investigation of the Safety Board was supported by an Advisory Committee. The Advisory Committee provides advice on the draft report produced by the project team during the investigation. With the selection of the Advisory Committee members, care was taken with their expertise regarding this investigation.

Name	Function
J.P. Visser	Chairman; board member and chairman of the Aviation and Industry Committee during the investigation
J.T. Bakker	Expert committee for Aviation
J. Marijnen	Expert committee for Aviation
J.A. Mulder	Expert committee for Aviation
H. Munniks de Jongh Luchsinger	Expert committee for Aviation
W.B. Patberg	Expert committee for Industry
W.A. Wagenaar	Expert committee for Industry

The Advisory Committee held eight meetings during the investigation. During these meetings, the various stages of the draft report were discussed.

3.3 The investigation

3.3.1 Part 1: the down-manning of the production platform K15B and the activation of the G-JSAR
NAM performed its own investigation of the incident. The scope of the NAM investigation included the decision to evacuate, the performance of safety equipment and emergency procedures, rescue, recovery and emergency response processes. The scope excluded the power failure on the

K15-FB-1 platform and the technical failure of the helicopter. A representative of the State Supervision of Mines joined the NAM investigation team.
Within the context of the investigation, interviews were carried out with passengers from December 2006 - January 2007 and other parties involved, logbooks and documentation were examined and the safety equipment inspected. The NAM report was published on 9 February 2007. The Dutch Safety Board performed a verification of the facts mentioned in the NAM report and held several interviews with involved NAM and Netherlands Coastguard staff. The following information was gathered/provided:

- NAM's safety case documents (HSE documents) regarding the K15B and Noble George Sauvageau concurrent operation
- History of NAM platform black out incidents
- NAM, NOGEPA, and OGP standards regarding SAR helicopter operations
- Applicable agreements between the Company Group, the Netherlands Coastguard, Bristow and Ministry of Defence
- Records of all G-JSAR post flight SAR reports from Bristow
- Audits of the G-JSAR operation performed by the Company Group members
- Radio communication transcripts, tower logs, and radar data from the Royal Netherlands Navy Air Traffic Control of Aerodrome De Kooy
- Radio communication tapes, logs, POSO meeting minutes, annual reports, and first impression reports from the Netherlands Coastguard
- Meteorological conditions from the Royal Netherlands Meteorological Institute
- SAFA information, relevant documents and minutes of meetings of the North Sea Task Force from the Transport and Water Management Inspectorate
- Safety oversight on SAR in general and the G-JSAR operation in particular
- Bristow internal audit information
- UK CAA audit information of Bristow
- Legislation, manuals and documents regarding the SAR operation

The UK CAA refused to disclose its audit reports from Bristow on the basis of the protection of the UK Freedom of Information Act (FOI2000) using exemption provided under Section 31. The UK CAA takes the view that the public interest is best served by ensuring the free exchange of information between the industry and itself and that this would be jeopardised if confidentiality was compromised by giving copies of the UK CAA audit reports from Bristow to the Dutch Safety Board. The UK CAA is of the opinion that it would effectively be placing information on the public domain if it deemed the public interest was best served by disclosure. However, UK CAA was willing to divulge pertinent information outside of the FOI. For this reason, the Dutch Safety Board visited the UK CAA on 19 February 2008. UK CAA provided access to the UK CAA audit reports from Bristow, but did not allow copies to be made of its audit reports.

3.3.2 Part 2: the G-JSAR flight and the emergency landing
In cooperation with representatives and experts of the involved parties, the British Air Accident Investigation Branch (AAIB), the French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA), Bristow, Eurocopter (helicopter manufacturer), Turbomeca (engine manufacturer), and the Royal Netherlands Air Force (RNLAF), the Dutch Safety Board investigated all possible mechanical, electrical or hydraulic causal failures regarding the reported engine behaviour and controllability problems in accordance with the party system principle after the salvage of the helicopter. Assistance from a RNLAF Cougar test pilot and technicians was received during the investigation. Many tests have been carried out on relevant helicopter components and systems. The table below shows a summary of the actions taken over time.

Date	Event
November 2006 - April 2007	Interviews of the flight crew
December 2006 - February 2007	Interviews of the rear crew
December 2006 - January 2007	Interviews of the passengers
March - April 2007	Passenger questionnaire
29 November 2006	G-JSAR control system test in Den Helder
7 December 2006	Cassette box interference test in Marignane
20 December 2006	Test of the survival suits by the Shark Group - North Broomhill-Morpeth UK
December 2006 - March 2007	Visits Bristow - Den Helder Base Unit for SAR
11-12 January 2007	Visit Bristow - Aberdeen - operation manuals
December 2006 - July 2007	Visits Eurocopter, Marignane - testing
December 2006 - July 2008	Visits BEA - Paris - FDR/CVR read out analysis
June 2007 - February 2008	Visits RNLAF/test flights Cougar
26-26 November 2007	Expert meeting at the Dutch Safety Board
15 February 2008	Visits Bristow - Aberdeen - safety management
16-18 February 2008	Test flights Bond Offshore AS332L2 helicopter - Shetland Islands
19 February 2008	Visit UK Civil Aviation Authority - Gatwick - CAA audits
19 February 2008	Visit AAIB UK - validation test flight results
9 April 2008	Expert meeting at the Dutch Safety Board

The following information was gathered/provided:

- Bristow Operation Manuals
- Bristow Helicopters Training School - Eurocopter AS332L2 Conversion Study Guide
- AS332L2 Flight Manual
- Training helicopter manual
- Bristow flight crew and rear crew training records
- Eurocopter Design Organisation Handbook
- Eurocopter Instructions and Procedures
- History of AS332L2 controllability problems
- Relevant international legislation

During the investigation, expert information regarding helicopter operation, training and crew resource management was provided by an investigator of the Accident Investigations Group of the Dutch Airline Pilots Association.

3.3.3 Part 3: the evacuation of the G-JSAR and the rescue operation after the emergency landing of the G-JSAR

The following investigations were performed:
- Investigation of the personal protection of the crew and passengers performed by the UK AAIB
- Investigation of the deployment mechanisms of the G-JSAR by the Dutch Safety Board
- Investigation of crew training
- History of other related incidents
- Compliance with rescue response times

This investigation of the accident presented an opportunity to assess the performance of the survival equipment. To examine proper operation of the survival suits, three parallel activities were undertaken:
- A questionnaire was sent to the 13 passengers and the four crew members requesting information regarding the performance of their immersion suits, life jacket and accessories, as well as about their physical state.

- The passenger suits were taken to the manufacturer, visually inspected and tested for leaks.
- The crew suits (different manufacturer to the passenger suits) were also taken to the manufacturer, visually inspected and tested for leaks.

The UK AAIB provided information for the report regarding the personal survival equipment of the crew and passengers.

The Safety Board's investigation of the deployment mechanisms was followed by an intermediate report with recommendations to improve the activating mechanism.

For this part of the investigation, the Tripod analysis proved to be of assistance. The top event is "potential death as a result of hypothermia".

3.4 Perusal

In accordance with the legal requirements, the draft final report, excluding the consideration and recommendations, was subsequently sent on 7 October 2008 to the following parties or persons involved for perusal.

Bureau d'Enquêtes et d'Analyses de l'Aviation Civile (BEA)
Bristow Helicopters Limited (BHL)
Coastguard Board
Coastguard Triumvirate
Eurocopter
European Aviation Safety Agency (EASA)
G-JSAR crew accident flight
Ministry of Defence
Ministry of Economic Affairs
Ministry of Transport, Public Works and Water Management
Nederlandse Aardolie Maatschappij (NAM)
Netherlands Coastguard
Netherlands Oil and Gas Exploration and Production Association (NOGEPA)
Royal Netherlands Navy
Turbomeca
UK Air Accident Investigation Branch (UK AAIB)
UK Civil Aviation Authority (UK CAA)

Comment on the draft report
The Safety Board received reactions from all parties. The reactions from the Coastguard Board, EASA, NOGEPA, and Turbomeca did not contain comments. EASA indicated not to respond to draft final reports principally and that they will take note of the report and take action when EASA regard this necessary. The Safety Board did incorporate the comment of the parties or persons involved in the final report where appropriate. Substantial comments received from the Ministry of Economic Affairs - State Supervision of Mines and the G-JSAR flight crew were reason for the Safety Board to hold several additional interviews and to perform several additional investigations. With regard to the comment that was not adopted by the Safety Board, the parties involved receive a motivation in writing. The actual comment that has not been incorporated, addresses the issues as outlined below and is presented per party or person involved:

Bureau d'Enquêtes et d'Analyses de l'aviation civile (BEA)

- Cockpit voice recording - autopilot hydraulic switching sound

  The BEA does not support the Safety Board's argumentation that no autopilot hydraulic switching noise was identified on the cockpit voice recorder, which indicated that an autopilot hydraulic system failure was unlikely, because:
  - a switching noise was recorded during some tests but its acoustic signature was not specific enough to be identified, noticeably in the G-JSAR noise environment;
  - the absence of autopilot hydraulic switching clues on the cockpit voice recorder is not convincing since the phenomenon may have actually occurred despite the noise not being identified ("no noise does not mean no phenomenon").

Reaction of the Dutch Safety Board
The ability to detect autopilot hydraulic switching on the cockpit voice recorder is difficult. However, the frequency of switching as argued by Eurocopter to achieve controllability problems -as experienced by the G-JSAR flight crew, suggest that the switching sound is detectable. The Safety Board is therefore of the opinion that an intermittent switching of the hydraulic system is unlikely and not unambiguously supported by the data and evidence available.

- AS332L2 Training Helicopter Manual - engine operating system information

The BEA stated that the AS332L2 Training Helicopter Manual (THM) chapter 14 provides crew with clear information about what they can expect from the engine operating system.

Reaction of the Dutch Safety Board
The Safety Board does not share the opinion of the BEA. Chapter 14 of the THM does not provide clear information regarding engine behaviour which is any different compared to what is usually experienced by the crew, which does not result in a DIFFNG warning.

Bristow Helicopters Limited (BHL)

- Format of the report and the absence of safety recommendations for comments:
  "(…) We are disappointed that in writing the report, the Dutch Safety Board has elected to depart from the disciplines of ICAO's 'Annex 13'. The result, in our view, is a disjointed document where the logic behind the conclusions is unclear.

  The aim of a good air accident investigation is to provide a report with a clear, unambiguous, logical path to safety recommendations which are aimed at the reduction of the probability of a recurrence. It is in support of that aim that all reputable air carriers are willing to do everything in their power to assist the air accident investigator. It is the view of Bristow Helicopters that this report, in trying to be an amalgam of two (or possibly three), reports, has not met that primary aim.

  From an aeronautical standpoint, the 'Annex 13' investigation, albeit restricted to factual information and relegated to an appendix, does represent the required clarity; unfortunately the analysis and conclusions are subsumed into the main report.
  The draft report offers no safety recommendations for comment (…)."

Reaction of the Dutch Safety Board
The International Civil Aviation Organization has issued standards and recommended practices for the investigation of civil aviation accidents and serious incidents. These are contained in Annex 13 "Aircraft Accident and Incident Investigation". The final report of the Dutch Safety Board has the same structure as the Annex 13 report: factual information, analyses, conclusions, and recommendations. The Annex 13 report defines the factual report in a specific template only. The Safety Board's report also contains:
- A section entitled 'Frame of Reference' (section 3) in order to test the findings, analyses, and conclusions.
- A section with the involved parties and their responsibilities (section 4).
- A section entitled 'Safety and Quality Management' (section 8) in the analyses.

The scope of this investigation is not limited to (civil) aviation safety, but also includes safety in the oil and gas industry and the safety of rescue operations involving passengers.

The Dutch Safety Board did not separate the Annex 13 investigation from the other investigations in this incident by publishing a stand-alone 'Annex 13 report', because the Board is of the opinion that with two different reports, the lessons drawn from the many interface problems between the involved aviation and non-aviation parties in this incident would be less clear, if not, lost entirely. This is especially the case with helicopter offshore operations such as the commercial search and rescue operation investigated.

Therefore, for the aviation community, which is accustomed to the Annex 13 format, the Safety Board has included the Annex 13 format report - factual information in Appendix C of this report and included in the bookmarker, in section 1.5.1 a specific 'ICAO Annex 13' section for guidance.

It is the Safety Board's policy not to include draft recommendations in its draft final report which is sent to involved parties and persons for their comments. Formulating the recommendations is a specific task for the Board. Recommendations are made after the comments on the draft final report (excluding recommendations) have been received and incorporated in the final report.

- Discussion with Quality System personnel
  Bristow indicated that the Safety Board did not attempt to discuss the oversight of the Den Helder operation performed by the Aberdeen based Quality team, neither with the Quality System Manager at that time or any of the auditors involved in performing this oversight.

Reaction Dutch Safety Board
During the investigation, regular contacts were established with the Bristow Eastern Hemisphere Flight Safety Officer. The Flight Safety Officer was Bristow's contact for questions related to the Safety Board's investigation. The Flight Safety Officer indicated that the absence of the Quality Assurance (Operations) Officer, a post established to exercise a Quality 'oversight' of the Operations Manual, was the reason for the inability to give specific answers to the questions raised by the Dutch Safety Board investigators with regard to the content of Bristow's quality management system and for the absence of several Quality Information documents in 2007.

Eurocopter

- AS332L2 Training Helicopter Manual - engine operating system information
  Eurocopter stated that chapter 14 of the AS332L2 Training Helicopter Manual (THM) provides crew with clear information about what they can expect from the engine operating system.

Reaction of the Dutch Safety Board
The Safety Board does not share the opinion of Eurocopter for the same reason as indicated in the response to the BEA above. Chapter 14 of the THM does not provide clear information regarding engine behaviour which is any different compared to what is usually experienced by the crew, which does not result in a DIFF NG warning.

- Section 8.5 - Eurocopter
  Eurocopter indicated that the G-JSAR investigation took place on the basis of a comprehensive program starting from a "blank sheet". No influences have been taken into account from the past and no information from the past was necessary to undertake such a program.

Reaction of the Dutch Safety Board
In the opinion of the Safety Board, it is important to use information from previous similar incidents and investigations within the scope of accident investigations.

- Fluid dynamic study in the autopilot
  Eurocopter indicated that a study of fluid dynamic in the autopilot was not performed. The AS332 AP hydraulic unit was designed at the beginning of the 1950's by Sikorsky, manufactured under licence by Sud Aviation (ex Eurocopter) towards the end of the 1950's and mounted on the first heavy transport helicopter designed partially by Sud Aviation (SA321 Super Frelon) in 1962. At that time no specific study of dynamic flow had been carried out with results of qualification tests being preferred to imprecise theoretical modelling (modelling at that time was very limited due to a lack of tools). The design of the AS332 Mk2 autopilot hydraulic unit has been considerably simplified compared to the Super Frelon, Puma and Super Puma Mk1 design, meaning that the hydraulic trims actuators and the yaw damper and associated opened loop actuation has been stopped on the AS332 Mk1 design. Several qualification tests have been performed on this old design through particular measurements of performances at extreme temperatures.
  In the case of AS332 Mk2 G-JSAR, the Eurocopter Design Office believes that theoretical modelling was not the best solution (was not necessary), meaning we had the opportunity to have the hydraulic unit which was present on the helicopter during the incident. It is preferable to obtain results of tests performed on this unit directly instead of trying to make the most of theoretical modelling, which needs to be defined with (several) input parameters if we want to perform a good influence analysis.

Reaction of the Dutch Safety Board
The Eurocopter explanation for not performing a theoretical study was provided after the draft final report was sent to Eurocopter. In the opinion of the Safety Board, it does not explain that a theoretical model would not be useful in the investigation.

G-JSAR crew accident flight

- Section 2.4.2 G-JSAR 'evacuation' flights
  According to the flight crew, the Royal Netherlands Navy performed several 'evacuation

flights' under the same circumstances as the G-JSAR did and asked why these flights were not also investigated by the Dutch Safety Board?

Reaction of the Dutch Safety Board
The scope of the Safety Board's investigation was limited to the G-JSAR operation and did not include the Royal Netherlands Navy SAR Lynx operation. The merits of such expansion of the investigation were considered to be limited for the investigation in relation to the efforts.

- Section 6 ANALYSIS: The G-JSAR flight and the emergency landing
  The flight crew asked why the Dutch Safety Board refused to include the cockpit voice transcript in the report?

Reaction of the Dutch Safety Board
The Dutch Safety Board is very prudent with the use of (parts of) transcripts of cockpit voice recordings in its reports. Although the Dutch Safety Board Kingdom Act protects against the use of the transcript of the cockpit voice recorder in any Dutch court of law, (parts of) transcripts of the cockpit voice recorder shall be included in the final report only if these are deemed pertinent to the analysis of the accident. Parts of the records not relevant to the analysis shall not be disclosed. The Safety Board follows the applicable international standards (Annex 13, par. 5.12 and 5.12.1).

Nederlandse Aardolie Maatschappij (NAM) [Netherlands Natural Gas Company]

- General:

  "(…) The key question regarding the status of private SAR provisions, or SAR provisions provided by civil industry warrants context and a bit more explanation. We would be very interested to learn - as a fundamental basis for this SAR configuration - the Board's views on private SAR operations versus member state driven operations. The industry has taken the necessary action to arrange for the required rescue means but the incident and your investigation raise the important question regarding accountability for SAR availability, deployment and management overview.

Reaction of the Dutch Safety Board

At an international level it has been stated that search and rescue is the responsibility of the individual states. The applicable regulations do not suggest that SAR services should be operated by the government. Apart from the operation with the G-JSAR as well as with its successor, the KNRM is also, for instance, a private organisation that plays an important role with regard to search and rescue at sea. Furthermore, if compared to ambulance services, no unambiguous indications are provided, either because the non-exclusive operation of similar services is in the domain of the government, but often contracted out to civil or even commercial providers. The purpose of the G-JSAR operation is twofold. On the one hand it provides a search and rescue service and on the other hand the helicopter is needed to efficiently and effectively assure the safety of offshore personnel within a radius of 500 meters from the offshore installation. The helicopter is also needed to bring the safety of passengers using public transport helicopters for transportation between the platforms, to an acceptable level, for instance in case a calamity such as a ditching occurs. The latter, being the responsibility of the oil and gas operators in the offshore industry, was originally the reason the G-JSAR operation was brought into existence. At the start of the 21st century, it appeared that the SAR capability at the Dutch Continental Shelf in general, with a view to the expanding offshore industry and the very busy shipping traffic, was short. Furthermore, utilizing a large helicopter appeared to be the most effective way of economically assuring the safety of platform personnel of all installations. The oil and gas operators, united in the Company Group, assumed their responsibility with regard to this issue. The available Westland Lynx helicopters are, for the provision of some services, too small and have also become outdated in the meantime. As a replacement for the Lynx helicopters, the NH-90 helicopter, having a larger capacity and range, has been ordered. However delivery has been postponed several times and it is expected that the SAR NH-90 will not be operational before 2013. With the dispatch of the NH-90 in the future, the requirements for SAR capability at the Dutch Continental Shelf will be complied with. Before the introduction of the G-JSAR operation, discussions were held between the government and the Company Group with regard to the operational expenses of the G-JSAR. Due to reasons of economic advantages, the Company Group assumed total financial responsibility. This issue in particular, which was already known shortly after the accident with the G-JSAR, caused the Safety Board to decide not to place the comparison of the differences between civil and government operated SAR services on its investigation agenda. When in the course of the investigation, several other aspects with regard to this issue were revealed, the Safety Board did not change its decision in this regard. The comments of NAM, NOGEPA and State Supervision of Mines did not change the Boards opinion either, in particular since a comparison between the fire brigade and ambulance services also does not lead to unambiguous argumentation.

- Section 4.1 NAM
  NAM stated that contractors offshore are not subjected to NAM management decisions as such, but that they have their own responsibility, like the employer's individual care towards his employees (i.e. Helicopter Underwater Escape Training).

Reaction of the Dutch Safety Board:
The Safety Board does not agree with NAM's position in this respect, because NAM has the final responsibility with respect to the safety of the process and that includes the decision to evacuate.

- Section 8.2 NAM
  NAM stated that there were no common denominators in the previous black outs, therefore a safety analysis was not possible.

Reaction of the Dutch Safety Board:
NAM did not actively review the possible long term consequences of previous black outs of installations and an earlier black out on the K15B. The incidents which were reviewed lasted for a shorter period of time and were treated differently because of different circumstances. The Board is of the opinion that for a thorough risk assessment, these incidents -albeit different in size and gravity- once properly analyzed, could have been the incentive to improve existing opinions with NAM staff and procedures in the Concurrent Operations Script. Following that line, the issues regarding availability and conditions to use public transport helicopters for down-manning or evacuation of offshore installations during closing hours of De Kooy Aerodrome would have been raised and used to improve existing procedures.

Netherlands Coastguard

- Conclusion 2, sub 4
  The Director of the Netherlands Coastguard is of the opinion that the Steering Committee has functioned, but did not find it necessary to convene a meeting. The contact between Bristow SAR unit and the Netherlands Coastguard is excellent on a 'day-to-day business'.

Reaction of the Dutch Safety Board:
The Steering Committee was responsible for the operational supervision of the G-JSAR dispatch. The investigation revealed that the intention was to convene Steering Committee meetings approximately three times per year, but that the Steering Committee convened during the initial phase of the G-JSAR operation, at the end of 2003 and in early 2004. What is more, the investigation revealed that there were several opportunities for the Steering Committee members (representatives from the Company Group, Netherlands Coastguard, and Bristow) to evaluate similar G-JSAR 'evacuation' dispatches and missions prior to the accident flight, which justified the need for evaluation, but none of these parties involved did so. The absence of such evaluations support the fact that this part of (reactive) safety management was not properly functioning with the parties involved, and in the case of the Netherlands Coastguard, safety management was more or less absent. Within the context that the Netherlands Coastguard does not follow safety management principles, the Safety Board can understand the reaction of the Director of the Netherlands Coastguard, but at the same time the Safety Board is concerned and addresses the need to implement safety management principles within the Netherlands Coastguard organisation.

Royal Netherlands Navy

- Section 8.3 Netherlands Coastguard
  The Deputy Commander of the Royal Netherlands Navy stated that it is not clear to him in what aspect the Royal Netherlands Navy, being part of the Ministry of Defence, did not fulfil its role regarding the supervision of the Netherlands Coastguard, because the Ministry of Transport, Public Works and Water Management is responsible for policy-making regarding SAR services in the Netherlands.

Reaction of the Dutch Safety Board:
The Netherlands Coastguard (Centre) is part of the Royal Netherlands Navy and placed under the command of the Commander of the Royal Netherlands Navy. The command of the Royal Netherlands Navy is placed under the Ministry of Defence. Therefore, the Ministry of Defence is responsible for the functioning of the Netherlands Coastguard. This has been added in section 4.13. Because the Netherlands Coastguard is part of the Royal Netherlands Navy and placed under the

command of the Commander of the Royal Netherlands Navy, the Commander of the Royal Netherlands Navy is responsible for the supervision of the Netherlands Coastguard. This supervision is related to the functioning of the Netherlands Coastguard, i.e. operations and management, since the Ministry of Transport, Public Works and Water Management is responsible for policy-making at SAR services.

UK Air Accident Investigation Branch (UK AAIB)

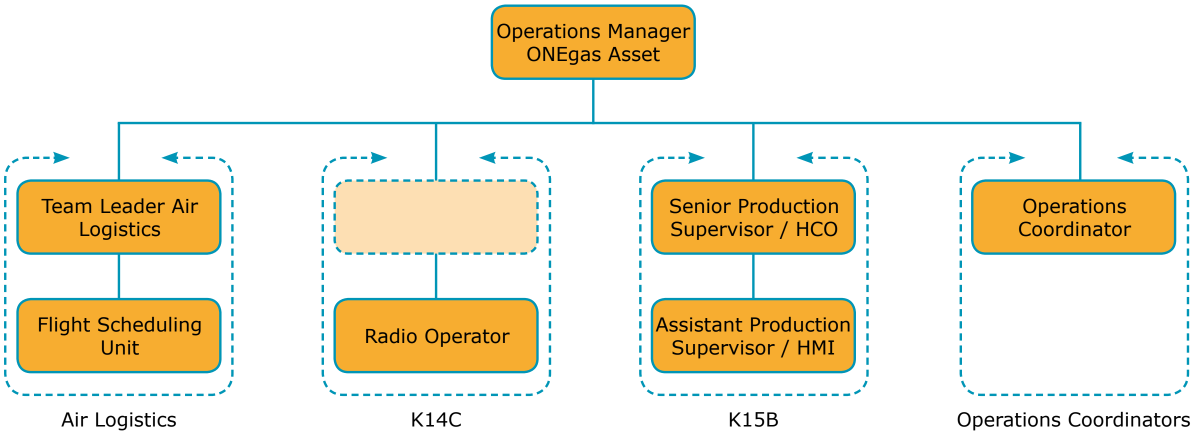
- Format of the report and the absence of safety recommendations for comments
  The UK Air Accident Investigation Branch accredited representative response: "The format of the report does not follow the recommended ICAO Annex 13 template for a final report. We appreciate that the Annex 13 investigation is only part of a much wider investigation, but international expectation is of a report that conforms more closely with the ICAO final report format. This format has developed over many years and is widely accepted as best practise in delivering a civil aviation safety report. We suggest a separate ICAO Annex 13 style report to complement the wider Dutch Safety Board report."

  "(…) There are no draft recommendations. The style of the report appears to be leading towards recommendations but stops short of presenting them for comment. We feel that this is a missed opportunity for both the recipient of the recommendation and the Dutch Safety Board to produce a mature recommendation that best reflects the identified deficiency."

Reaction of the Dutch Safety Board:
For the answer to this comment, see the answer given to Bristow above.

APPENDIX B: ORGANISATION CHART FOR NAM ONEGAS ASSET

This chart shows persons involved in the decision making process for evacuation of non-essential staff from the K15B platform on 21 November 2006.



- Operations Manager of ONEgas Asset: responsible for safety and production of ONEgas Asset, the offshore oil- and gas production on the Dutch Continental Shelf.
  - The Operations Manager communicated with the Head of Concurrent Operations (HCO), the Operations Coordinator and the K14C radio operator.
- Team Leader of Air Logistics: responsible for ONEgas air logistics operations for the Southern North Sea, from Den Helder in the Netherlands and Norwich in the United Kingdom.
  - The Team Leader of Air Logistics was contacted by the K14C radio operator for evacuation of K15B. He advised him to contact the Netherlands Coastguard for the use of the SAR-helicopter.
- Flight Scheduling Unit: Day to day planning of helicopter transit flights.
- Radio Operator K14C: 24 hour watch for radio communication, organizes flights outside office hours.
  - The radio operator was asked to contact the Netherlands Coastguard for evacuation of personnel from K15B. After the MAYDAY call from the G-JSAR, he informed the K14C Offshore Installation Manager, who in turn informed the Operations Manager.
- Senior Production Supervisor: responsible for K15B operations. On a day to day basis, on his shifts offshore, the Senior Production Supervisor is the K15B Offshore Installation Manager (OIM).
  - The Senior Production Supervisor was Head of Concurrent Operations, holding single responsibility for safety for the concurrent operations on both the K15B and the Noble George Sauvageau.
- Assistant Production Supervisor: on a day to day basis, the Assistant Production Supervisor acts as backup for the Senior Production Supervisor.
  - The Assistant Production Supervisor was the acting K15B Offshore Installation Manager (OIM) under the supervision of the Head of Concurrent Operations.
- Operations Coordinator: responsible for onshore planning and control of all wellhead activities. Also one in four weeks on call for the Emergency Coordination Team (ECT) in Assen, the Netherlands.
  - The operations coordinator happened to know everything about the concurrent operations on K15B and Noble George Sauvageau, and was also on call in the ECT. He was contacted by the Head of Concurrent Operations and the Operations Manager and advised to bring non-essential staff to shore for safety reasons.

APPENDIX C: ICAO ANNEX 13 INVESTIGATION

This appendix contains the 'Annex 13' investigation subjects.

Contents:

1.1 History of flight

1.1.1 The outbound flight

The captain -on duty- of the Bristow Super Puma search and rescue helicopter accepted the request from the Netherlands Coastguard duty officer. Because the G-JSAR was equipped with only four cabin seats, the captain verified the need to 'evacuate' 13 persons with the K14C radio operator. The radio operator replied that the evacuation was requested by the K15B Offshore Installation Manager, which was backed up by the NAM Operations Manager and added that there was no need to take a medic on board since there was no life threatening situation. Because of the absence of a life threatening situation, the captain initially questioned the validity of the SAR-mission with the G-JSAR, but eventually accepted the mission. The captain subsequently briefed the co-pilot and the rear crew, consisting of the winch operator and the winchman, about the mission. The captain and the co-pilot verified the weather conditions for the flight. The terminal aerodrome forecast indicated thunderstorms and rain showers but weather radar pictures indicated that these had already passed. The G-JSAR had about 2900 pounds of fuel on board at take-off, which was sufficient for the outbound flight and the return flight.

At 22:35, the G-JSAR departed Aerodrome De Kooy. During radio communications, the flight was called "Coast Guard Rescue Alpha Romeo", the call sign to be used for SAR missions. The flight was conducted under instrument flight rules. The captain was the pilot flying and in the right-hand seat. The co-pilot was in the left-hand seat. The flight was conducted at 2000 feet on a direct track to the Noble George Sauvageau.

During the flight, the cockpit voice recorder (CVR) recorded the flight crew informing the Noble George radio operator that the passengers could not take luggage with them because the G-JSAR was not equipped for stowing luggage for so many passengers and because it was an evacuation. The Noble George radio operator confirmed this message. Later on the flight deck the flight crew briefly discussed the validity of the SAR call out. The captain concluded that the only reason for using the G-JSAR for the call out was the closure of Aerodrome De Kooy for regular transport operations. Although the G-JSAR has an exemption for its passengers to carry life jackets during SAR missions, a discussion between the crew about the number of passenger life jackets on board during the flight initially ended in an open-ended manner. The rear crew counted twelve extra life jackets for thirteen passengers. The remainder of the flight to the Noble George was uneventful.

At 23.00, the G-JSAR landed on the helideck. The captain and co-pilot remained on board the G-JSAR while the engines and the rotors were kept running. FDR recording reveals an intermittent engine parameters split condition of approximately 3% difference Ng with a duration of 10-25 seconds for a period of 8 minutes. One of the rear crewmembers informed the flight crew that thirteen life jackets were found. The rear crewmembers left the helicopter and met the passengers who were waiting beside the helipad with their bags. The winch operator took them to the radio room to brief them and told them that bags would not be allowed. The passengers were all wearing their survival suits, earplugs were also available. Thirteen life jackets of three different types (Beaufort Mk 15, Beaufort Mk28, and Shark LAPP) were distributed among the passengers. According to the winch operator, the passengers were asked if they understood the briefing and no questions were asked either about the briefing or the operation of the life jackets used. He was of the impression that the passengers were not listening very attentively. The crew members accompanied the passengers back to the G-JSAR. During interviews carried out after the accident, the rear crewmembers stated that they had briefed the passengers on the use of the different types of life jackets. However, several passengers indicated that there was some confusion about the life jackets, because of the mix of the three different types and that they did not fully comprehend what survival aids the individual jackets contained. One passenger indicated that he did not understand most of the briefing, because he did not understand the English language very well.

The passengers boarded the G-JSAR on the right-hand side. Four passengers took the only available passenger seats and nine of them sat on the floor. The two rear crewmembers knelt on the floor in the middle of the cabin, were wearing headsets and able to communicate with the pilots.

During the preparation of the return flight, the co-pilot expressed his unfamiliarity with the contents of a commercial air transport offshore take-off crew briefing. The captain allowed him to give this briefing and confirmed its adequacy. The captain also confirmed the need for more training in offshore operations. The crew noted a fuel state of 2470 pounds and estimated the take-off weight to be 20,000 pounds.

1.1.2 The return flight

The captain's message on the public address system to the passengers was recorded on the CVR. The captain informed the passengers that the flight time to De Kooy was about 25 minutes and instructed them to remain seated during the entire flight and to follow the instructions of the crew during an emergency. During interviews, several passengers indicated that they did not receive an emergency or evacuation instruction in the helicopter, but none of the passengers had made a remark about this to the crew.

The G-JSAR departed the Noble George helicopter deck at 23:13 with the co-pilot as pilot flying. According to FDR data at that moment, no split engine parameters existed. The aircraft climbed to 3000 feet and followed a direct track to the "HDR" VOR (navigation radio beacon). During the climb, the crew checked the flight conditions for possible icing. No signs of ice were detected. When levelling off at 3000 feet the captain noticed an outside air temperature of 4 degrees Celsius and the CVR recording shows that anti-icing was switched on. The indicated airspeed, recorded on the FDR during the cruise flight, was approximately 140 knots.

At 23;20:39 the CVR recorded the captain's first remark of a "huge" difference between the two engines. According to FDR data, this difference for the Ng parameters was approximately 5%. The crew noticed that number one engine gas turbine rotor RPM (NG1) was unstable. Approximately twenty seconds later they noticed a difference in the exhaust gas temperature (EGT) indicated as T4 on this type of aircraft. Both pilots concurred that engine number 1 indications showed fluctuations. They discussed the variations of some other parameters. At 23:21:08 the captain made contact with air traffic control 'De Kooy Approach' (ATC) and reported "inbound to the field, 25 miles to run, 17 persons on board, at 3000 feet" (For more extensive information from the CVR, see section 1.11.2).

Half a minute later the co-pilot announced his intention to "slow down because we have an engine fluctuating". At this moment there were no warnings. The captain then directly responded with a PAN PAN message on the radio due to fluctuations on engine number one and a request to ATC for "a slow descent down to 1000 feet". ATC granted the descent. At 23:21:58 the co-pilot reported disconnecting the autopilot (AP) upper modes and subsequently asked the captain to get out the Emergency Operating Procedures (EOPs). As the co-pilot initiated the descent, the captain stated that she did not know where to look for an applicable EOP and the co-pilot expressed he did not either; no applicable EOP procedure exists for this situation. The captain noticed torque fluctuations and ordered the co-pilot to maintain a slow descent while mentioning the present rate of descent of 900 feet/minute. The captain confirmed that both fuel flow control levers were "in the gate". She asked the co-pilot to move the collective slowly.

As the co-pilot continued his descent he moved the collective and the indicated airspeed was approximately 140 knots. As the captain concluded at 23:23:06 that both engines had responded, the rear crew informed the cockpit about the bearing and distance to Texel in the meantime. With the absence of a governor (GOV) light the captain announced that her first reaction would be that this could be a minor or major governor failure. At 23:23:51, the captain reported to her crew that they had 20 nautical miles to run to the field and she ordered the co-pilot to descend to 1000 feet. She twice asked the co-pilot if he was still happy to remain flying. The co-pilot confirmed this after the second request. The captain then observed that both engines were looking normal; there were no indications on the central warning panel. At 23:24:09 she informed the co-pilot there was no DIFF NG (RPM difference between the two engines) warning light and that the main rotor RPM was normal.

According to the FDR at 23:24:44, the difference in Ng between both engines exceeded 7.5% resulting in a first DIFF NG warning which was acknowledged by the captain. She instructed the co-pilot to get as close to Aerodrome De Kooy as possible, "to keep the diamond on" and to continue with the slow descent. When the first officer manipulated the collective at 23.25.06 to identify the faulty engine, the crew observed that both engines responded. FDR data confirm the engines reacted properly on changing collective and also show that the engine split condition remained.

Based (purely) on CVR recordings it appeared, as though the captain anticipated OEI warnings from 23:25:10. She observed the OEI HIGH (one engine inoperative high) armed light turning on and off. When the DIFF NG warning reappeared for the second time, the OEI HIGH light also came on again as DIFF NG warning arms OEI stops. According to CVR, the last OEI action that was discussed by the crew was at 23:25:20. The captain mentioned that she deselected the OEI HIGH and confirmed that OEI LOW (one engine inoperative low) was on. When the co-pilot mentioned an increasing exhaust gas temperature of engine one, the captain instructed him to keep going to the field and to correct the heading 10 degrees.

At 23:25:49 the co-pilot stated that he had some restrictions on the controls and that he had some problems with steering. According to his observations, the control problems seemed to increase over time. During his observations the rear crew called that the island Texel was the nearest part of land.

At 23:26:19 the captain transmitted a MAYDAY message to ATC and indicated that they were experiencing steering and engine problems and that they were diverting to Texel, the nearest part of land. Shortly after the distress message, the co-pilot announced he was going to ditch the aircraft because he was losing control. The captain immediately reacted with a radio transmission in which she stated that the G-JSAR was going to ditch. The co-pilot announced twice that he could not "fight the controls anymore". Aware of the predicament, the winch operator asked the cockpit crew members to slow down. At this time, the FDR recorded a groundspeed of 150 knots and a radio altitude of 500 feet. At 23:27 the rear crew transmitted a MAYDAY message with its own radio on the frequency of the Netherlands Coastguard. The distress message did not include the position of the G-JSAR.

At 23:27:03, the CVR recorded the altitude voice alert ONE HUNDRED FEET and FDR data indicated a groundspeed of approximately 110 knots and the co-pilot announcing to flare the aircraft. The CVR also recorded the ROTOR HI voice alert caused by the high nose attitude whilst slowing down. The captain commanded the co-pilot to keep the aircraft in the air. During a period of 16 seconds the UNDERCARRIAGE voice alert sounded three times (note: emergency procedures allow for ditching with the undercarriage down or up). Eventually G-JSAR slowed down with a radio altitude close to zero from 100 knots to a ditching speed close to zero knots. The captain inflated the floatation gear, which she had previously armed.

The recorded elapsed time between the ONE HUNDRED FEET and the ROTOR LO voice alerts after engines were shutdown was about half a minute. During the last two minutes of the flight, once the control problems had started, there was no further discussion about the engine problems.

From the FDR, it is derived that until 23:27:35, a total of 11 DIFF NG warnings (re)occurred when the difference between both NG's exceeded 7.5 % .

The estimated ditching time of the G-JSAR was 23.28. This was also the time that both the CVR and the FDR recordings stopped. During the final two minutes of the flight, once the control problems had started, there was no further discussion about the engine problems.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others	Total
Fatal	-	-	-	0
Serious	-	-	-	0
Minor/None	4	13*)	-	17

*) One passenger suffered from mild hypothermia.

1.3 Damage to aircraft

The helicopter sustained substantial damage.

1.4 Other damage

During the rescue operation of the G-JSAR occupants, a rigid inflatable boat from the Coastguard vessel Arca was damaged beyond repair.

1.5 Personnel information

1.5.1 Captain

Captain	**Female, aged 33 years**	
Aircraft ratings	Airline Transport Pilot's Licence (Helicopters) Commercial Pilot's Licence (Aeroplanes)	
Last License Proficiency Check	17 November 2006	
Last Instrument Rating Renewal	13 November 2006	
Last SAR line Check	17 January 2006	
Last night time flight	5 November 2006	
Last medical	8 November 2006	
Flying experience (night) in hours	Total all types	3700 (328)
	Total aeroplanes	450
	Total helicopters	3250 (37)
	Total SAR-command	165
	On type	585
	On type SAR-command	165
	Last 90 days	47.20 (2.40)
	Last 28 days	28.25 (1.50)
	Last 24 hours	0 (0)
Previous rest period	24 hours	
Crew Resource Management Training	12-13 September 2006	
Emergency and Safety Equipment	17 November 2006	
Emergency Exit Jettison	17 November 2006	
Helicopter Underwater Escape Training	8 January 2004	
Wet Dinghy Drill	8 January 2004	

1.5.1.1 Operational experience

After civilian helicopter training, the captain joined an offshore helicopter operator in July 1997 as a co-pilot. She flew the Dauphin N and the Dauphin C2 during pilot winching missions in the Rotterdam harbour area and during offshore transport flights from Aerodrome De Kooy. She joined BHL in November 1998 as a co-pilot on S76 during Oil & Gas support operations. She gained her first captaincy on S76 in January 2002. She joined the BHL SAR operation in October 2003 and attained a SAR command position in January 2006.

1.5.2 Co-pilot

Co-pilot	**Male, aged 39 years**	
Aircraft ratings	Commercial Pilot’s Licence (Helicopters)	
Last License Proficiency Check	3 October 2006	
Last Instrument Rating Renewal	3 October 2006	
Last SAR line Check	17 January 2006	
Last night time flight	19 November 2006	
Last medical	12 July 2006	
Flying experience (night) in hours	Total all types	1200 (26.15)
	Total aeroplanes	0
	Total helicopters	1200 (26.15)
	Total SAR-command	0
	On type	200
	On type SAR-command	0
	Last 90 days	46.15 (10.00)
	Last 28 days	22.20 (10.00)
	Last 24 hours	00.25 (0)
Previous rest period	24 hours	
Crew Resource Management Training	12-13 September 2006	
Emergency and safety equipment	25 October 2006	
Emergency exit jettison	25 October 2006	
Helicopter Underwater Escape Training	17 October 2005	
Wet Dinghy Drill	17 October 2005	

1.5.2.1 Operational experience
The co-pilot joined an offshore helicopter operator as a winch operator on pilot winching operations in the Rotterdam harbour area in 1997. After civilian training for a helicopter CPL, he was employed as S76 co-pilot during Oil & Gas support operations in 2003. He then joined Bristow SAR operation and was moved to the AS332L2 in November 2005.

1.5.3 Winch Operator

Winch operator	**Male, aged 49 years**
Emergency and Safety Equipment	14 March 2006
Emergency Exit Jettison	4 March 2004
Helicopter Underwater Escape Training	13 July 2006
Wet Dinghy Drill	13 July 2006

1.5.4 Winch man

Winch man	**Male, aged 31 years**
Emergency and Safety Equipment	14 February 2006
Emergency Exit Jettison	14 February 2006
Helicopter Underwater Escape Training	21 February 2006
Wet Dinghy Drill	21 February 2006

A comprehensive list of type of (search and rescue) training and training dates is presented in Attachment 1.

1.6 Aircraft information

1.6.1 General

The Eurocopter AS332L2 "Super Puma" is a twin engine helicopter designed for passenger transport. The military version of the super Puma L2 is named Cougar. The Super Puma has a conventional semi-monocoque fuselage and tail pylon and a retractable tricycle landing gear. There is a four-bladed main rotor and a four-bladed tail rotor. In the Bristow SAR configuration, the aircraft cabin contains only four standard passenger seats. As a SAR helicopter within the Bristow operation, the aircraft has a crew of four; two pilots and two rear crew. The rear crew consists of a winch operator and a winch man.

Aircraft type		Eurocopter AS332-L2 "Super Puma"
Year of construction		2002
Registration		G-JSAR
Serial number		2576
Certificate of airworthiness		Valid until 18 December 2007
Total flying hours		2352.23
Certified maximum take off weight		9,300 kg (20,502 pounds)

Engines		Turbomeca Makila 1A2
Engine #1		
Serial number		3139
Total hours		2406
Hours since overhaul		Not applicable
Date of installation in G-JSAR		28 May 2005
Hours since installation		916
Engine #2		
Serial number		3170
Total hours		1712
Hours since overhaul		Not applicable
Date of installation in G-JSAR		28 august 2005
Hours since installation		749

1.6.2 Weight and balance

The dry operating mass of the G-JSAR is 14,999 pounds. The load sheet was not recovered after the accident. During the investigation, a load sheet was prepared by the captain, based on the information that was available before the accident flight. With 2900 pounds of fuel in the fuel tanks, the take-off mass at departure from Aerodrome De Kooy was 17,899 pounds. Based on CVR information, the fuel state at the Noble George was 2470 pounds. Based on this information and the standard approved weight of passengers loaded (2808 pounds), the take-off mass from the Noble George was estimated as being 20,277 pounds.

The maximum take-off mass allowed is 20,502 pounds. After the accident, the amount of fuel in the tanks was measured. The tanks contained a total of approximately 2150 pounds (circa 1200 litres) of fuel. The total mass at the time of the ditching is estimated as being 19,957 pounds.

Based on interviews of crew and passengers, a reconstruction was carried out of the passenger distribution in the cabin. The rear crew and passengers were equally spread on the four cabin seats and the cabin floor; please also refer to illustration 4 in section 2.2.3 of the report. Weight and balance calculations based on this reconstruction result in an estimated centre of gravity index of approximately 37.5, which is well within limits.

1.6.3 Maintenance records

The helicopter had a certificate of airworthiness that was valid until 18 December 2007. The latest inspection ("50 and 25 hours") was performed on 20 November 2006 at 23:50:14 aircraft hours. The daily inspection was carried out on 21 November 2006 prior to the first flight of the day. There were two deferred items. One regarding the high frequency radio and one regarding the search light (night scanner).

1.6.4 Survival equipment

The G-JSAR has a detailed equipment list of rescue-, medical- and emergency equipment to be carried specific to its search and rescue role. Significant to this report is the survival equipment below:

- Two 18-person life rafts with an overload capacity of 27 persons are mounted in the sponsons outside of the cabin.
- An additional deployable life raft (air-droppable) with a maximum capacity of ten persons is carried inside the cabin for potential emergency use during hoisting activities.
- Ten Beaufort Mk28 (passengers) jackets; two Beaufort Mk15 (rear crew) jackets and one additional Beaufort Mk15 crew jacket: large size; two Beaufort Mk44 (flight crew) jackets; two Shark LAPP jackets.
- The G-JSAR was approved to operate in (limited) icing conditions;
- The G-JSAR was equipped with four seats in the cabin;
- The G-JSAR was not equipped with one or more handholds for use by passengers outnumbering the number of seats.

1.6.5 Aircraft systems

1.6.5.1 Gas turbine engine
In gas turbine engines as installed on most of the commercial airline jets, the low pressure turbine is connected to the low pressure compressor and fan rotor by a shaft. This shaft runs through the shaft that connects the high pressure compressor and high pressure turbine. This design is meant for the principle of jet propulsion.

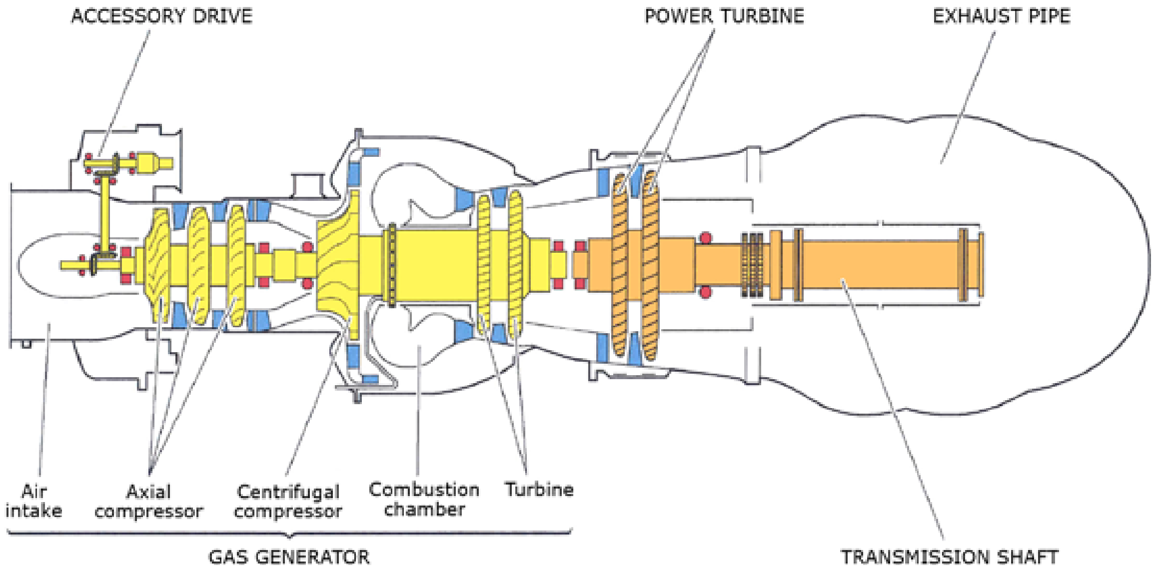


Illustration 1: Makila 1A2 gas turbine engine.

This common application of gas turbine engines, however, is different for gas turbine engines installed in helicopters. The used application of gas turbine is now to drive a main rotor instead of jet propulsion. In contradiction to the jet engine, the low pressure turbine is not connected to the compressor, but mechanically free, see illustration 1. In this design, the low pressure turbine is usually called a free power turbine which drives the rotor blades via the transmission shaft and a gearbox (see illustration 2) and is only aerodynamically coupled to the gas generator.

The type of engine installed on G-JSAR, the Makila 1A2, is a gas turbine engine with a free power turbine. Air is sucked in via the engine air inlet, compressed and mixed with fuel in the combustion chamber where it is ignited. The hot energy gas flows through the turbine and drives the compressor and engine accessories such as oil pumps. This part of the engine is called the gas generator. Downstream, the surplus of energy in the hot gas is further extracted in the free turbine to mainly drive the rotors of the helicopter.

1.6.5.2 Engine configuration

The G-JSAR has been configured for a dual engine operation. Both engines have been installed at the top of the helicopter in front of the main gearbox. Each engine is mechanically connected to the MGB through its transmission shaft from the free turbine. Power is supplied to the main rotor and the tail rotor via the MGB. Normally, both engines drive the main gearbox simultaneously.

In the event of engine failure, the remaining engine is capable of driving the main gearbox alone. However, in this condition the amount of power delivered by one engine is more than the power generated by each engine separately during dual engine operation. Therefore, the time to operate is limited for engine protection (safety) for two engine power ratings, being OEI LO and OEI HI, see below.

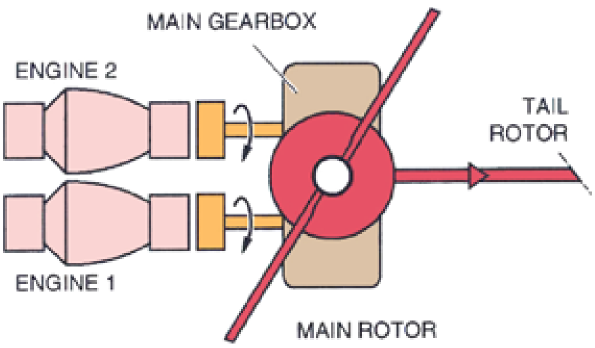


Illustration 2: schematic view of power transmission.

OEI LO
In case of an engine failure mid-flight, the contingency power rating is used and should be limited to 2 minutes. A One Engine Inoperative low (OEI LO) warning light (caption) will be given.

OEI HI
In case of an engine failure during a high power demand situation, a super contingency rating is available. This power rating is limited to 30 seconds. It is accompanied by One Engine Inoperative High (OEI HI) warning light (caption).

OEI HI and its armed light is automatically activated when DIFF NG illuminates, either as a result of engine failure or with governing failures resulting in loss of normal governing control or loss of maximum power. When minor governing failures occur, the maximum engine power remains available but the governing system is impaired. An engine speed mismatch resulting from a minor governing system failure (indicated by GOV light and DIFF NG light), however, also enables an OEI HI rating. When this engine power rating is not needed at that moment, the procedure requires the pilot to disable it by selecting OEI LO.

1.6.5.3 Engine control system
The principle of governing the engine is the closed control loop as demonstrated in illustration 3.

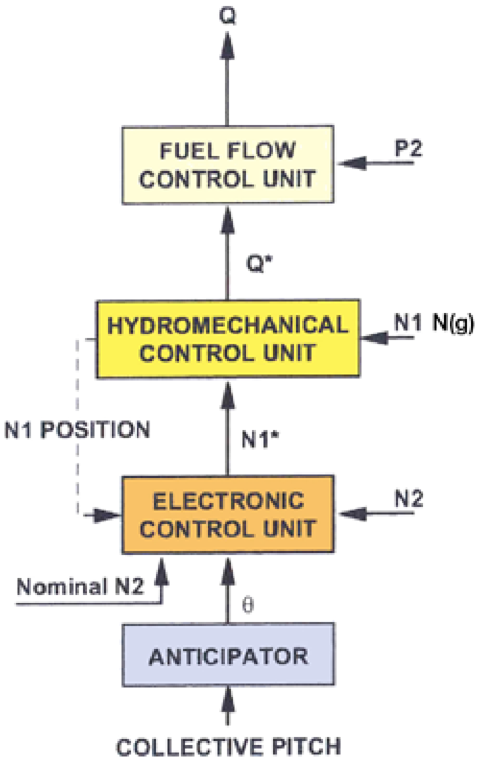


Illustration 3: the engine control system in schematic reflection.

The engine control system is designed to adapt the engine to the power requirements necessary to conduct the flight. At the same time, the control system ensures that the engine operates within defined limits. Each engine is controlled within a separate (individual) control loop.

The following main engine control components are described below:
- Digital engine control unit
- Fuel control unit
- Anticipator

Digital Engine Control Unit (DECU)
The DECU (one per engine) controls and monitors its engine. Considering the situation wherein the required engine power remains on a constant level, the rotor speed nevertheless tends to vary slightly due to (usually) relatively small disturbances (caused by aircraft manoeuvring, turbulence, slight variations in rotor blade pitch, etcetera). Each DECU measures whether the rotor speed matches the required (programmed) rotor speed. If it does not match, it sends a signal to adjust the rotor speed.

Fuel Control Unit (FCU)
In Illustration 3, N1 means Ng and N2 means rotor speed (rotor RPM). To simplify the process, the Ng signal is the main engine control parameter and forms an inner closed loop via the DECU and FCU (one per engine). This signal from the DECU is first sent to the FCU. The FCU measures whether the gas generator RPM (Ng) matches the required Ng associated with the signal from the DECU. When a difference between required and measured Ng exists, the FCU will adapt the fuel flow to re-establish the required speed of the gas generator.

The outer control loop is the rotor RPM loop - the actual rotor RPM is compared to the desired datum rotor RPM derived from the Nominal rotor RPM and the anticipator, and any differences result in a change to the required Ng in the process above.

Summarising the technical realisation, the aforementioned principle of engine governing has been realised in the next configuration: the Ng control signal starts as an electrical signal (electrical current) from the DECU and is transferred into a hydro-mechanical pressure signal in the FCU.[104] This pressure signal is eventually used for metering the fuel flow, and at the same time, varying the power to the engine. When there is no signal (meaning no current), the fuel flow will be the equivalent of (low) cruise power (approximately 85% Ng). By varying the DC control current in intensity and in direction, the fuel valve will open for higher power or close for lower power.

To close the inner loop it is necessary that the Ng is fed back to the DECU. The Ng rotation speed is measured and transformed into a mechanical movement of a core[105] in a position transmitter. The movement is transformed into an electrical signal going back to the DECU where the measured Ng signal can be compared with the commanded Ng signal. Also here, when the core is in the neutral position, the power will be the equivalent of 85% Ng. In the failure mode, the core goes to the neutral position as well.

According to the experience of the operator, the coils residing in the FCU are exposed to heat and vibration and have a history of failure. Recent changes in design seem to have improved this part of the FCU.

Anticipator
The pilot does not directly control the engine power as it is fully controlled and adapted by the engine governing system by maintaining a constant main rotor speed. The pilot, however, does control the angle of the rotor blades by moving the collective stick.[106] A change in drag from moving the collective results in changing rotor RPM, and this is sensed by the DECU and will be transferred into a changed signal to the FCU, which will eventually convert it into a fuel flow command for the new power setting. When the pilot increases the angle of the rotor blades, for instance when he/she wants to climb, this action requires more engine power. The rotor speed will initially drop and, with some delay, partially returns when the engines have increased their power. For lower power demands it shows a reversed response. However, the rotor speed before the power change cannot be exactly re-established. This effect is called 'static droop', and is a normal control system feature.

Static droop is counteracted by the 'anticipator' which is directly linked to the collective (stick). When the collective is moved, the anticipator immediately generates a new rotor RPM datum signal to the DECU anticipating the new power level, either higher or lower. By directly influencing the fuel flow, one effect is that the stabilised rotor speed slightly increases instead of drooping when more power is applied. The rotor speed slightly decreases when less power is applied. The anticipator also promotes that the response time to power changes is reduced. If a fault condition occurs, this will result in a mismatch between the Ng's of the engines. No links exist between the anticipator and the cyclic control although they are in close physical proximity.

1.6.5.4 Governor warnings
In the training manual of the engine manufacturer, a GOV light is considered as an 'abnormal indication' meaning a defect in the electronic control system.

104 This process takes place in the servo valve. A detailed description of how the servo valve operates is deliberately omitted, because it does not support the analysis of the engine behaviour.

105 The core is a magnetic metal in the position transmitter that moves between coils. Its direction indicates whether the measured Ng is less than 85% Ng (neutral position of the core) or more. The voltages induced in the coils are linear with the measured Ng. A detailed description of how the position transmitter operates is deliberately omitted, because it does not support the analysis of the engine behaviour.

106 If the collective is moved upwards, the angle of the rotor blades, referring to their plane of rotation, will increase resulting in more drag. This increase in drag tends to slow down the rotor speed which is sensed by the governing system. The system reacts by injecting more fuel into the engine to correct the drooping in rotor speed, and hence producing more power. When the collective is moved downwards the system will react reversely.

GOV indicator light
According to the Flight Manual, a GOV light on the central warning panel indicates a minor fault condition affecting the respective engine computer or loss of governing redundancy. For each engine a GOV indicator light informs the pilot that the regulation system has a defect.

Some failures may affect the redundancy (backup systems may be impaired) of the control loop system, yet the system still functions in the same way prior to the loss of redundancy. The loss of redundancy is shown during engine start up or after shutting down the engine by a flashing GOV light. In the event that some data for governing the engine is lost, the GOV light illuminates steadily. The engine governing still operates, but its effectiveness is impaired.

Common defects related to flashing GOV warnings are usually minor failures and do not immediately require maintenance or pilot action. Consequently, they are often carried for a while before correction is accomplished. In some cases, for instance when static droop is suspected, special tools are required to correct the complaint. Operators usually do not have such specific tools. Depending on operator procedure a readjustment of the static droop is carried out within a maximum number of next flights or flight hours.
Flashing GOV warnings may be caused by a deviation of the static droop of the FCU and result in a hydro-mechanical failure report in the DECU (MAINT 1-code 0002). By adjusting the static droop the engine response to power changes is normally restored. However, within certain limits, maladjustments of this parameter have no immediate noticeable effect on normal governing.

The design of the system assures that in the case of a major failure in the governing loop, either resulting from a failed component or an electric power supply failure, the engine produces 85% Ng cruising power. Following such a failure, if static droop is incorrectly calibrated, the Ng might be slightly more or less than 85% but this is unlikely to be significant.

Ng differences and DIFF NG warning light
Based on aircraft documentation,[107] during dual engine operation, the difference of Ng will typically remain within 1% throughout the flight. The Turbomeca Training Manual for the Makila 1A2 engine states that, if during a flight the Ng difference between the two engines exceeds 1%, an operational check of the static droop is required. The pilot can read both Ng's from digital displays. There are also delta Ng gauges showing the margin between current Ng and the maximum continuous and takeoff rating Ng's for the current ambient conditions. When the difference in Ng's becomes 7.5% or more the system generates a red master alarm light on the instrument panel and a red DIFF NG light on the central warning panel.

1.6.6 Initial engine inspection
The gas generators and free turbines of both engines were free to rotate by hand, though at first it produced some unusual noise which disappeared after some rotations. The possibility of salt and sand ingestions was considered by the investigation team. The air inlets (first stage axial compressor) and exhaust pipes (second stage free turbine) were visually inspected. Apart from salt traces, the blades and casings were in a clean condition. Fuel filters and oil filter clogging indicators were found to be in a normal position for both engines. Magnetic plugs and electrical chip detectors were pulled on both engines and visually checked. All were found to be free of particles. The fuel tanks were emptied. The remaining fuel was estimated as being 1200 litres.

1.6.7 Engine history on G-JSAR
Various maintenance documents revealed an indication of hours of the main components' until the event flight as presented in table 1.

Aircraft	DECU	Engine	FCU	Anticipator
Engine #1	2352	2405	2362	unknown
Engine #2	2352	1711	1711	unknown

Table 1: indication of main components' hours until the event flight.

The following table demonstrates a list of complaints or events as found in the available maintenance documentation. The list is limited to engines information only for the approximate preceding six months in 2006. The description of the complaints/events and remarks has been listed 'as written down' in the concerning documents and may not be complete enough for every reader to fully understand its meaning. However, it provides an impression of the history of anomalies of both engines.

107 Aircraft complementary flight manual.

2007 Date	Time a/c hours	Complaint/event Components/description	Action and/or additional information Remarks
Nov 21	2352	GOV warning[108]	Training flight.
Nov 20	2350	Governor flashing	HUMS dn load fail, stat drp comp Turbom
Nov 19	2347	Engine # 1 leak check	No governor warning
Nov 17	2343	Governor eng #1	Start up/shut down
Nov 13	2335	Governor eng #1	(no explanation)
Nov 10	2328	Governor eng #1	Shut down/Symtam
Nov 06	2324	Governor eng #1	Engine #1 T4 margin low, bld/p2 gask ok
Nov 03	2315	Governor eng #1	Start up/shut down, maint hmu fail,plt training ?
Oct 25	2302	Engine#1, Engine#2	Run downs
	2247	P2 valve replaced	
Sep 24	2239	Euroarms Health incid.	Both engines check vibration accell Ng, Nf, phonic wheels, probes and wiring
	2239	Nf Ng both engines	Probs/wiring check
Sep 07	2218	Engine #2 chip warning	Metal, mags ok
Jul 15	2137	FCU #2 replaced	Check static droop
Jun 04	2072	Governor eng #2	DECU interchanged, stat droop, acceleration curve, bleed both engines monitor

Table 2: history overview of engine anomalies.

The list suggests that engine #1 had suffered anomalies (minor failures) for some time prior to the event flight, which were probably difficult to identify during maintenance.

1.6.8 Flight controls

1.6.8.1 Helicopter control levers

A helicopter is equipped with two control levers, a cyclic- and a collective control lever. The cyclic lever is the lever used to control the helicopter in forward- aft- and sideways directions. If the cyclic lever is moved forward, the nose of the helicopter will move downwards and its speed will increase. Moreover helicopters will descend if no extra power is selected. If the cyclic lever is moved backwards these movements will be in a reverse direction.

The cyclic trim system enables the helicopter to be trimmed, enabling the altitude of the helicopter to remain constant, without having to manipulate the cyclic lever 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 and the trim release are situated on the cyclic grip and can be manipulated with the thumb.

The collective is the control lever enabling the manipulation of the attitude of the rotor blades simultaneously. By design, the rotor RPM remains constant due to the automatic application of the necessary engine power. 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 in lift. If the collective is moved downwards, these movements will be in reverse; the rotor blade angle decreases and as a result the engine power output decreases.

108 According to Tech Logs, this warning occurred during the second flight of the day on the day of the event flight (the first and second flights were training flights). The third flight was carried out in order to check the hoist operation and the fourth flight was the event flight. The third and fourth flights are not included in the aircraft hours.

1.6.8.2 Hydraulic systems and main servo controls
The aircraft is equipped with two hydraulic systems. Each hydraulic system is pressurized by a main pump driven by a gear box. The left-hand system also has an auxiliary electric driven pump. The main control servos are powered by both the left-hand and the right-hand systems. If one hydraulic system fails, the aircraft remains controllable.

Main servo controls
The main servos are designed to move the main- and tail rotor blades, as commanded by the control inputs. The servo controls have tandem cylinders: one cylinder is supplied by the right-hand system, the other by the left-hand system. The system design allows it to operate on one hydraulic system and on one servo control cylinder in case the other cylinder's servo control distribution valve has failed or seized (illustration 4).

Automatic flight control system AFCS
The AFCS is a control 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 basic mode provides control stabilisation, even during manual flight. The upper modes provide speed, altitude and navigation modes.

Autopilot hydraulic system
The autopilot (AP) hydraulic unit is the power control of the AFCS. The AP hydraulic system is powered by the left hydraulic system with 103 Bar. If the pressure is below 70 Bar for more than 0.8 seconds, a warning is presented to the crew. This warning is also recorded on the FDR. The system transmits and amplifies the orders elaborated by the AFCS to the flight controls. It allows manual piloting in the case of malfunctioning of the AFCS. During manual flight, the AP hydraulic system reduces the control forces and offers stabilisation. When the autopilot hydraulic system is off, the control forces increase and the stability decreases but the aircraft is still controllable.

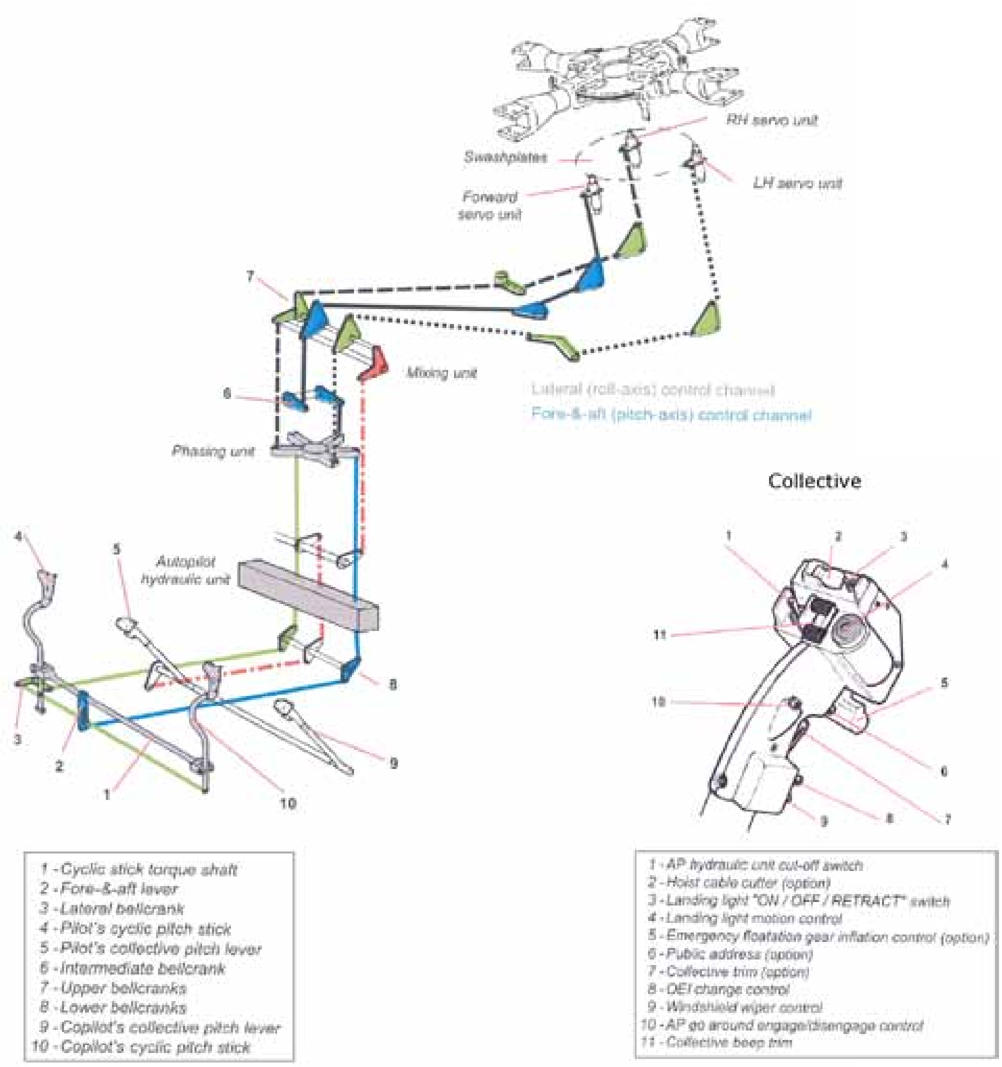


Illustration 4: main rotor control system.

Without a working AP hydraulic system, both upper- and basic AFCS modes are inoperative. On the AFCS control panel no warning is presented when the AP hydraulic system is inoperative.
The AP hydraulic system is switched on and off by the AP hydraulic switches on both collectives. When one of these switches is in the OFF position, the system is off.

Autopilot hydraulic electro valve
The autopilot hydraulic electro valve is the on/off valve of the AP hydraulic system. In the AP hydraulics ON situation there is no power on the AP hydraulic electro valve. The AP hydraulic system is switched off by closing the electrical circuit (fail safe system). A failed switch cannot switch off the system, except when an inadvertent electrical connection is made in the switch. The other possibility to switch off the system comes in the form of an electrical power input somewhere in the wiring harness.

The flight crew stated both autopilot hydraulic switches were in the ON position during the entire flight.

1.7 Meteorological information

The official aviation weather report showed the following forecast:

Synopsis:	South-westerly flow of polar air; north-south oriented trough moving in an easterly direction, expected to reach Dutch west coast during midnight; behind trough westerly flow
Ambient temperature:	Approximately 9 degrees Celsius (average temperature offshore in the afternoon of the 21 November and the morning of 22 November)
Freezing level:	3000-4000 feet
Seawater temperature:	11 to 13 degrees Celsius
Barometric pressure (QNH):	990-995 hectopascal
Weather:	showery rain with a chance of thunderstorms
Winds:	230°-280°/15-25 knots, gusts up to 30 knots during thunderstorms
Clouds:	broken cumulus with base around 2,500 feet, during thunderstorms scattered clouds at 1000 feet and base at 1500 feet
Visibility:	more than 10 km, 5 km during showery rain and reduced to 3.5 km during thunderstorms
Wave heights:	2 to 3 meters

The Arca (rescue vessel on scene) weather report stated:

Winds:	WSW 5-6 Beaufort
Weather:	Showers
Sea:	wave heights 2.0 to 2.5 metres
Swell:	westerly, low
Barometric pressure:	995 hectopascal

Following the ditch and during the rescue there were reports of deteriorating weather conditions.

1.8 Aids to navigation

Not applicable.

1.9 Communications

The helicopter, call sign Coast Guard Rescue Alpha Romeo, used the normal ATC communication channels during the operation. During both distress messages, the G-JSAR flight crew maintained radio contact with De Kooy Approach. These communications were recorded automatically. At the moment of the ditch the winch operator transmitted a distress message with his own radio on the UHF channel of the Netherlands Coastguard.

Communications with the Netherlands Coastguard during the rescue operation of the occupants after the emergency landing were also recorded automatically.

1.10 Aerodrome information

Aerodrome De Kooy/Naval Air station De Kooy is a combined civil-military airport. The airport has two platforms with taxiways to runway 04/22. Air traffic services are provided by the Royal Netherlands Navy.

Aerodrome services and air traffic services are provided during the operating hours as published in The Netherlands' Aeronautical Information Publication. The aerodrome operating hours at the time of the accident were weekdays through from 07:00-22:00 and during weekends and holidays from 07:00-11:00 and 15:00-20:00. Air traffic services are provided during weekdays on Monday-Thursday 07:00-24:00, Friday 07:00-21:00 and during the weekends and holidays from 07:00-10:00 and 15:00-20:00.

1.11 Flight recorders

1.11.1 Flight data recorder

The G-JSAR was equipped with a Honeywell solid state combined Cockpit Voice Flight Data Recorder, model 980-6021-032, serial number 0274. The data on the recorder proved to be useful for the investigation. A transcript was made from the conversations and audio signals in the cockpit and plots were generated from several recorded flight data parameters. The plots are shown in Attachment 2. The relevant flight data is summarised below.

The G-JSAR took off from the drilling rig Noble George Sauvageau at 23:13:00 with a magnetic heading of 239 degrees. A climbing left turn was made with increasing airspeed and decreasing heading. At 23:18:00 the helicopter was flying with a groundspeed of approximately 143 knots and a heading of 135 degrees magnetic at approximately 3000 feet. The recorded outside air temperature was 0 degrees Celsius.

During normal cruise and prior to the fluctuations, later noted by the crew, the recorded engine gas rotor RPM (NG) was 91%, the exhaust gas temperature (T4) was 643/626 degrees Celsius, and the torque was 35% per engine. At 23:20:14 approximately seven minutes into cruise flight, the engine parameters (NG, T4 and torque) of engine #1 and engine #2 split. The parameters of engine #1 increased and the parameters of engine #2 decreased. The flight data recorder shows engine #1 fluctuations of 89-94% on Ng, of 615-684 degrees Celsius on T4, and of 30-43% on torque. The engine parameters of engine #2 were recorded as fluctuations between 83-89% on Ng, 510-654 degrees Celsius on T4, and 18-29% on torque.

At 23:22:06 a descent was commenced and the groundspeed decreased to approximately 130 knots. From 23:22:55 the groundspeed increased again until it reached a maximum of approximately 155 knots at 800 feet radio altitude at about 23.26:35. Descending from 600 feet height till the "ONE HUNDRED FEET" warning, the (computed) vertical speed averaged 1600 feet/minute.

At 23:24:43 the DIFF NG and Master Warning were illuminated for one second. This was the first recorded DIFF NG warning; the DIFF NG warning would be activated ten more times till the end of the flight.

At 23:25:00 the outside air temperature was 5 degrees Celsius.

At 23:26:37 an amber message for collective mode, yaw/roll mode, and pitch mode status[109] were

109 The lettering *C YR P* (collective, yaw/roll, pitch) on the top part of the smart multimode displays (SMD) will turn amber, informing the crew of degraded autopilot performance.

recorded on the flight data recorder for one second. Five seconds later the Manual Control Warning[110] was recorded on the flight data recorder. This parameter was triggered for several seconds before the end of the flight.

At 23:27:10 a zero feet radio altitude was recorded with a groundspeed of approximately 98 knots and 15 degrees nose up attitude. Hereafter the recorded radio altitude increased to a maximum of 40 feet with the groundspeed decreasing to approximately 58 knots and 20 degrees nose up attitude. At 23:27:29, a zero feet radio altitude was recorded again with 19 knots groundspeed and 6 degrees nose up attitude.

The FDR recorded the last complete set of data at 23:27:38.

1.11.2 Cockpit voice recorder

During the outbound flight to the Noble George Sauvageau, the cockpit voice recorder (CVR) recorded the crew briefly discussing the validity of the SAR call out. The captain concluded that the only reason for the call out was the closure of Aerodrome De Kooy for regular transport operations. After a discussion between the crew about the number of passenger life jackets on board, the rear crew counted twelve extra life jackets for thirteen passengers. Once parked at the Noble George, one of the rear crewmembers informed the flight crew that thirteen life jackets had been found.

The captain's message on the public address system to the passengers was recorded on the CVR. She informed the passengers that the flying time to De Kooy was about 25 minutes and instructed them to remain seated during the entire flight and to follow the instructions of the crew during an emergency.

After take-off, when levelling off at 3000 feet, the captain observed an outside air temperature of 4 degrees Celsius and the anti-icing was switched on.

At 23:20:39 the CVR recorded the captain's first remark of a 'huge difference between the two engines".[111] Twenty seconds later, the flight crew observed a difference in the exhaust gas temperatures. Both pilots agreed that the engine number 1 indications showed fluctuations. They discussed the variations of some other parameters. At 23:21:09 the captain made contact with air traffic control 'De Kooy Approach' (ATC) and reported the return of the helicopter with 17 persons on board at 3000 feet.

One minute after the first remark about the difference between the engines, the co-pilot announced his intention to slow down. The captain then directly responded with a PAN-PAN-call on the radio and requested ATC for permission to descent to 1000 feet. ATC provided this clearance. The co-pilot announced he had 'disconnected and (was) going manual'[112] and asked the captain to get out the Emergency Operating Procedures. He stated 'slowly going to descent'.

At 23:22:07, the captain announced that she had no idea where to look in the Emergency Operating Procedures. She instructed the co-pilot to maintain a slow descent while stating the present rate of descent of 900 feet/minute. The captain confirmed that both fuel flow control levers were 'in the gate'. She asked the co-pilot to move the collective slowly. After a brief ATC communication, the captain confirmed that both engines were responding to the changes in power demanded.

At 23:23:17, the rear crew informed the cockpit about the bearing and distance to Texel. The captain remarked that her first reaction would be it was a minor , not a major governor failure, because of the absence of a governor light. Shortly thereafter she concluded it was not.

At 23:23:51, the captain reported to her crew that they had 20 nautical miles to run to the field and she instructed the co-pilot to descend to 1000 feet. She twice asked the co-pilot if he was still happy to remain at the controls. The co-pilot confirmed this after the second request. The captain then observed that both engines were looking normal, there were no indications on the central

110 Warning triggered by aircraft systems recorded on the FDR that the autopilot performance has been degraded.

111 The difference is too low to trigger the 'DIFF NG' warning. The first cockpit indications for a major governor failure as mentioned in the EOPs should be an 'ALARM' and a 'DIFF NG' warning light. The first cockpit indications for a minor governor failure as mentioned in the EOPs should be a 'WARN' + an 'ENG' + a 'GOV' warning light. All four engine failure procedures as mentioned in the EOPs also start with the combination of an 'ALARM' and a 'DIFF NG' warning light.

112 By going manual the autopilot hydraulics remain engaged normally. The pilot controls heading and vertical speed. The attitude of the aircraft (pitch and bank angle and some turn coordination), is maintained by the AP system.

warning panel, there was no DIFF NG warning and Nr was normal. She stated that she had a 'good visual to the field' and that there was no indication that 'one engine is not working as hard as the other engine'.

At 23:24:43, the captain reported that the DIFF NG warning had come on and instructed the co-pilot to get as close to De Kooy as possible, to keep the diamond on and to continue with the slow descent. The captain again confirmed that both engines were responding to the collective. At the same time she observed the 'one engine inoperative high' armed light turning on and off again. The captain disarmed the one engine inoperative high and confirmed that the light for one engine inoperative low was on. When the co-pilot mentioned an increasing exhaust temperature of engine number 1, the captain instructed him to continue to proceed to the field and to correct the heading by 10 degrees.

At 23:25:49, the co-pilot announced that he was experiencing some restrictions on the controls and that he had some problems with steering. According to his observations, the control problems seemed to increase. During his observations the rear crew reported that the island Texel was the nearest part of land. At 23:26:19, the captain transmitted a MAYDAY-call on the radio indicating that they were having steering and engine problems and that they were diverting to Texel.

At 23:26:31, the co-pilot announced that they had to ditch because he was losing control. The captain immediately reacted with a radio transmission in which she stated that the G-JSAR was ditching. The co-pilot announced twice that he could not 'fight the controls anymore'. The winch operator requested that the cockpit crew members slowed down.

At 23:26:56, the CVR recorded a 'bleep-bleep-bleep-CHECK-HEIGHT' warning, which 5 seconds later was followed by a 'ONE-HUNDRED-FEET-bleep-bleep-bleep' warning. The co-pilot announced that he flared the helicopter. At 23:27:07 the first of two consecutive 'ROTOR-HIGH' warnings was recorded. The captain commanded the co-pilot to keep the aircraft in the air. At 23:27:17, the first of three consecutive 'clang-clang-clang-clang-clang-clang-UNDERCARRIAGE' warnings[113] was recorded.

At 23:27:35, the winch operator called to jettison the door and one second later the co-pilot announced to be ditching. The 'ROTOR-LOW' warning sounds at 23:27:37 and the last recording on the CVR is the co-pilots 'OK' at 23:27:39.

1.12 Wreckage and impact information

About eight hours after the ditching, the helicopter was found on the beach at the North-west side of the island Texel. The main floats and the left-hand front float were inflated, the right-hand front float was empty. Both cabin sliding doors were open. The jettison mechanism was not used. The left-hand cockpit door was open, the right-hand cockpit door was not found. Two windows were broken on both the left and right side of the cockpit. On the right-hand side, a cockpit window post was bent. Both autopilot hydraulic switches were in the ON position. The cockpit and cabin floor were wet. Sand was on the floor. The right-hand sponson life raft compartment cover and the life raft itself were not in place. The left-hand sponson life raft compartment cover was in place. The tail boom was wrinkled at the lower side, close to the connection with the main fuselage. The main rotor and tail rotor did not show visible damage. There were no signs of damage or excessive oil leaks on the engine and main gear box. The air inlets were open and undamaged. The engine covers showed no damage.

1.13 Medical and pathological information

Both pilots held valid medical certificates. The captain used an approved anti-allergic medicine that can cause some fatigue. The Aero Medical Section of the CAA Netherlands was informed about the medicine the captain was taking and had no objections to this. The investigation did not reveal indications of fatigue. There are no indications of a medical contribution to the causes of the emergency landing.

After the landing at the airport, the survivor suffering from mild hypothermia was moved by ambulance to the hospital in Alkmaar. In the early morning upon his recovery he was discharged from the hospital.

113 The voice alert UNDERCARRIAGE is actuated if the landing gear is not extended when the airspeed is 60 knots or less and the aircraft height is 300 feet or lower.

1.14 Fire

No fire occurred.

1.15 Survival aspects

The flight crew did not use the public address system to announce that the aircraft was ditching. Because all four crew members were connected with the intercom system, the rear crew was aware of what was happening. The rear crew were able to inform some of the passengers in their direct vicinity verbally or by hand signals, because of the engine noise. During post-accident interviews all the passengers reported experiencing unusually severe turbulence prior to the ditching. This caused some of them to suspect that the aircraft was experiencing a problem. The winchman used hand signals in an attempt to explain that the aircraft was about to ditch but this was not correctly interpreted by the passengers. Several passengers were able to see water outside the window but many believed it was a normal landing until the sliding door was opened and water entered the aircraft. Once in the water, the helicopter emergency exit lights automatically activated. The flood lights, strobe lights, and navigation lights were illuminated before the ditching. The landing lights were not used. The cabin lights, which had been on throughout the flight remained on. The G-JSAR is equipped with an Automatically Deployable Emergency Locator Transmitter (ADELT). After the helicopter ditched, the ADELT deployed automatically and started transmitting.

Once floating in the water, the winchman opened the right-hand sliding cabin door using the normal opening method. The door jettison system was not used. Both rear crewmembers shouted to the passengers to jump into the water, which they did. The captain heard the evacuation initiated by the rear crew and ordered them to wait because the rotor blades were still turning. She subsequently switched off the engines and used the rotor brake to bring the rotor blades to a halt. The winch operator stated that he ordered the evacuation, because firstly he was sure at that time that the aircraft would capsize immediately and secondly, because nine unstrapped/unsecured passengers were in the back of the aircraft who would stand little chance of escaping if the aircraft capsized as they were not trained for this situation The flight crew did not use the life raft deployment handles in the cockpit (see illustration 5). When the captain called "everybody out" she looked behind into the cabin and noticed that most passengers had already left the cabin. Both pilots exited the aircraft through their respective doors and jumped over the floatation bags into the sea. The captain was wearing her gloves during the whole flight, but did not don her hood. The co-pilot did not don his hood and gloves prior to leaving the
G-JSAR. One passenger stated that the main rotor blades completed a final turn before coming to a standstill during his evacuation. A few passengers stated the main rotor blades did not turn during their evacuation, one passenger stated that the rotor blades completed a final turn before coming to a standstill during his evacuation.

The G-JSAR is equipped with life raft deployment handles, located externally on the fuselage within reach at both sides of the doors. The rear crew did not use these after opening both cabin doors. The winch operator stated that he entered the water after evacuating the last passenger from the cabin and found the winchman working on the right-hand sponson life raft. The winch operator assumed that the other jettison handle had not worked and the winchman was attempting to release the life raft manually.

The passengers attempted to inflate their life jackets as they entered the water but several experienced difficulty in doing so because they were wearing a jacket with an unfamiliar design. None of the passengers had time to don gloves or hoods prior to the evacuation. Once the passengers were evacuated, both rear crew also entered the water and the winchman attempted to manually deploy the right-hand sponson life raft. He spent several minutes unsuccessfully trying to locate the deployment cable/handle within the sponson housing and eventually gave up. The winch operator, noting the winch man's predicament and assuming that he had already attempted to use the right-hand external life raft deployment handle, decided to swim around the helicopter externally to inflate the left sponson life raft. This proved to be problematic due to the high sea state and he returned to the right-hand cabin door area.

The co-pilot, who was the only person to evacuate on the left-hand side of the aircraft, moved rearwards to the left-hand cabin door and entered the cabin to check that all the occupants had evacuated. Whilst he was in the cabin, the winch operator shouted to him to evacuate due to concerns about the aircraft capsizing and he consequently joined the others in the sea holding onto the right-hand side of the aircraft. He managed to find the captain in the water. The captain was not wearing a life jacket. Afterwards, the captain stated that in the course of her evacuation she had become detached from her life jacket. However, she had no recollection of how or why. The co-pilot stayed with the captain and assisted her in remaining afloat.

The winch operator then climbed back into the cabin and pulled the right-hand door emergency jettison handle, which was operated by the winchman a moment earlier. This action had no effect because the right-hand door was already open. He then retrieved the air deployable life raft 'air droppable' bag (maximum capacity about 10 persons) and went back into the sea with it. While the winchman held onto the bag, the winch operator pulled out the deployment painter (retrieval or mooring line). The painter was 150 feet long (designed to be dropped from the air) and before this was all pulled out, the winch operator began to tire and became tangled in it. He decided to cut the bag's lace housing with his knife and pulled directly on the inflation bottle which inflated the life raft. During this operation, the rear crew had released their grip on the helicopter side and by the time they climbed aboard the dinghy, they had lost sight of the G-JSAR, because the aircraft had drifted away. The winchman attempted to swim back to the helicopter tied to the life raft's rope but made little headway due to the heavy wind and returned to the dinghy.

In the meantime, in addition to the two crew members in the dinghy, the pilots and the passengers had formed several small groups, out of which two distinct groups were eventually formed.

A group of four passengers initially attempted to swim back to the G-JSAR which had drifted away. However, they decided it was better to save their energy. One passenger within this group, was unable to recall the life jacket briefing and required the assistance of a colleague in order to inflate his life jacket. A second group of four passengers joined up with the first four, to form a group of eight and they formed a circle. This group was later joined by the captain and the co-pilot, who eventually formed the group of ten. Rather than risk losing contact with the group, some passengers chose not to attempt to put on their gloves and hood when they were in the water. Several passengers stated that the lights on their life jackets did not function. None of the life jacket buddy lines were deployed in this group.

Five of the passengers were hanging onto the grab rope fitted to the right-hand side nose float of the G-JSAR and formed the group of five. The opinions about the potential for the floating helicopter to capsize were different among this group. The group decided to hang onto the helicopter for as long as possible. However, one of the passengers in this group who wanted to sit back inside the helicopter's cockpit in order to reduce heat loss was advised against this by the rest of the group. The group decided to hang onto the helicopter for as long as possible.

The group of ten became detached from the helicopter, which in the strong wind, drifted away rapidly. The co-pilot, who was a member of this group, and two other members of the group had mini-flares in their life jackets. The co-pilot's hands were too cold to manipulate the flares, because he was not wearing gloves. However, when a ship proceeding in their direction was sighted, the captain, who had no life jacket but was holding onto the co-pilot, was able to get the flares, whereafter several flares were fired by the co-pilot.

The passengers reported difficulties in donning their gloves whilst in the water with little illumination. They also found donning the hood difficult with waves breaking over them, although some managed to do so by getting assistance from others in the group. Post-accident interviews revealed that many passengers reported that survival suits leaked to a limited extent which had an adverse effect on their mental state. Several passengers and crew commented that remaining together as a group significantly improved their mental state. Several of the passengers were seasick whilst awaiting rescue.

1.16 Tests and research

This section describes the results of the tests that were performed on the aircraft as part of the investigation of the engine issues, control problems and the aircraft survival equipment. Basic investigations were performed at the Bristow facilities in Den Helder, where the aircraft was subsequently transported to the Eurocopter facilities in Marignane (France) for more detailed investigations.

1.16.1 Health Usage Monitoring System

The Health Usage Monitoring System (HUMS) comprises health monitoring for the early detection of defective components, usage monitoring to enhance knowledge of actual component life and status monitoring to be kept informed of helicopter system status. After completing operations with the engines shut down, all data is normally stored in the HUMS on a data card in the helicopter. For further analysis the card has to be downloaded in the office ground station system.
It appeared that the data from the event flight had not been stored because it needs to meet the aircraft on ground conditions. Data from previous flights was available on the ground station of the operator. An initial review of the data showed that no health thresholds were exceeded.

1.16.2 Smart Multi Mode Display

The helicopter is equipped with four Smart Multimode Displays (SMD). Two displays are fitted at each pilot's position. Normally, one has the function of Primary Flight Display (PFD) and the other the function of Navigation and Mission Display (NMD). The PFD shows information for short-term piloting to the crew plus complementary information such as automatic pilot status and Instrument Landing System deviation. The NMD displays the different navigation modes and some other information. Two SMDs are connected to backup battery power and also collect data when only battery power is available. The SMDs are connected to a wide variety of (sub)systems of the helicopter and may contain status information regarding these systems.

At the BEA, the recorded data of two SMDs (S/N 252 and 534) was extracted and analyzed with the cooperation of representatives of the manufacturer. The SMDs contained data, which was extracted. The recorded data was not related to the flight phase in which the engine- and control issues manifested.

1.16.3 Digital Engine Control Unit

The DECU with serial number 0145EC (controlling engine#2) showed a maintenance failure coded as "MAINT1-MEM Panne regul hydro" or hydro-mechanical control failure. The warning refers to static droop values stored in the DECU it derives from. This type of failure is usually accompanied by a flashing GOV light warning generated by the DECU. The usual appropriate maintenance action for this kind of incident is to adjust the static droop line of the concerned Fuel Control Unit (FCU), as the static droop determines how the FCU responds to engine power change. In graphical terms, re-adjusting either the slope and/or the zero value of the droop line by turning two adjustment screws on the FCU may clear the warning.

Flashing GOV warnings sometimes occur when an aircraft is started up for operation. By applying a little more power the warning usually disappears but will return after the engine is shut down. The last recorded and stored GOV warning in the HUMS was at the end of a 14 minute 50 second flight.

The failures registered by the DECU are event recorded, meaning that it is recorded that a failure happened but it cannot be determined at what time (and consequently during which flight) this occurred.

1.16.4 Technical inspections and tests

1.16.4.1 General inspection in Den Helder
The gas generators and free turbines of both engines were free to rotate by hand, though at first it produced some unusual noise, which disappeared after some rotations. The possibility of salt and sand ingestion was considered by the team. The air inlets (first stage axial compressor) and exhaust pipes (second stage free turbine) were visually inspected. Apart from salt traces, the blades and casings were in a clean condition.

Fuel filters and oil filter clogging indicators were found in a normal position for both engines. Magnetic plugs and electrical chip detectors were pulled on both engines and visually checked. All were found to be free of particles. Oil samples were taken from both hydraulic systems. The fuel tanks were emptied. The remaining fuel was estimated as being 1,200 litres.

1.16.4.2 Control system test in Den Helder
On 29 November 2006, a team of Eurocopter, Bristow and Dutch Safety Board personnel performed a control test on the main- and tail rotor system.
During this test, a plastic videocassette box (containing a cassette), a map and the remains of a paper notebook were found on the bottom of the aircraft, between the trim motors. It was concluded that the remains of the notebook and the map could not interfere with the controls. It could not be excluded that the cassette box had caused the reported cyclic control restrictions. Therefore it was decided that a check of the possible interference with the controls should be performed later.

1.16.4.3 Test regarding possible mechanical interference
On 7 December 2006, a team of Eurocopter, BEA, AAIB and the Dutch Safety Board performed a test on the Super Puma MK2 training aircraft in the Eurocopter training centre in Marignane. The training aircraft was powered with electrical and hydraulic power. A cassette box similar to the box that was found was placed in different positions between the control cabinet in an attempt to block the controls. In all situations, the box was crushed by exercising light pressure on the controls at the co-pilot side. It was concluded that the cassette box could not have caused the reported cyclic control restrictions.

The life jacket lost by the captain during the event flight was never found. The RNLAF performed a test on a Cougar helicopter with a similar life jacket as the captain was wearing. Attempts were made to interfere with the cyclic controls in such a way that the cyclic lever felt blocked. The tests did not reveal a possibility of preventing the cyclic lever from moving by the parts of the life jacket.

1.16.4.4 Engines

Investigation of the engine control components

It is stated that the engines were not tested, because the engine control signal processing by the DECU, FCU or anticipator were suspected to explain the engine behaviour during the event flight. The FCU and the anticipator were tested by Turbomeca and Eurocopter.

Downloading the DECUs

The non-volatile memories of both DECUs were downloaded. Because the DECUs had been immersed in water, they had to be disassembled and treated before data could be retrieved. Consequently, a functional check of both DECUs in their original condition could not be reproduced.

The system only records events without time frame or registration of flight. Engine #2 DECU showed a maintenance failure coded as "MAINT1-MEM Panne regul hydro" or hydro-mechanical control failure. The warning refers to a deviation of the static droop of the FCU. DECU also stores electrical malfunction codes if present between DECU and the anticipator. No such failure codes, or any other failures, were stored in the DECU memories.

Testing the Fuel Control Units

The test comprised a visual inspection of the FCU and an electrical test concerning the FCU position transducer and the Ng indicating servo valve. The main part of the testing consisted of functional hydraulic checks of the FCU output on a test bench.

Engine #1 FCU 617M

FCU with serial number 617M had been installed on the left engine (engine #1 with serial number 3139). All warranty seals were present. The visual inspection of the FCU revealed oxidation pits on the thermal compensator box, the position transducer sensor box and mounting screws. The visual clogging indicator on the fuel filter was in the 'not popped' position and no contamination was observed on the fuel filter or its housing. The complaints or events related to the governor of engine #1 however, cannot be related to static droop as testing revealed the static droop of the FCU of engine #1 was satisfactory.

One item of the FCU test included the acceleration curve. A proper curve assures the engine will smoothly accelerate to a higher Ng (higher power) within specified limits usually commanded by the pilot. When exceeding these limits, reliable engine operation may be impaired. For the acceleration curve of 70% Ng and more the measurements (except one) were approximately 1 to 5% below the minimum specified values. However, the split engine behaviour was not introduced after a commanded acceleration response as cruise power had to be maintained. The effect of not being within acceleration limits is considered to be insignificant for the engine split. Other hydraulic checks were within or slightly beyond limits and these cannot explain the engine split.

The measured insulation resistance of the position transducer was between 30kΩ and 170kΩ. The minimum required value is 5MΩ. The cause of this deviation was not investigated. The engine manufacturer assumes it was caused by the influence of salt water after ditching. The engine manufacturer had reportedly seen more cases in which isolation problems occurred due to corrosion.
The operator's experience indicates that the position transducer has a history of failure due to the harsh conditions it is exposed to, such as heat and vibration. It seems the new generation position transducers have been improved.

Engine #2 FCU 496M

FCU with serial number 496M had been installed on the right engine (engine #2 with serial number 3170). Most warranty seals were present forepart from the zero adjustment and slope adjustment of the static droop. It is standard procedure that these are adjusted by the operator when the engine is installed. The visual inspection of the FCU revealed oxidation pits on the thermal compensator box and on the main control and the fuel inlet flange. The visual clogging indicator of the fuel filter was in the 'not popped' position and no contamination was observed on the fuel filter or its housing.

For some hydraulic checks, the FCU outputs were not significantly out of tolerance. Ng speed results of the static droop curve were 0.5 to 0.75% higher than the maximum specified. However, it indicates how the engine reacted to a power change but it did not affect the engine power. As there is no direct link with the power itself it appeared to be irrelevant in explaining the engine split

behaviour. The "hydro-mechanical failure report " recording in DECU #2 is the likely consequence of a slight deviation of the static droop of FCU of engine #2. The electrical test was within tolerance.
In summary it is concluded that the static droop of either engine cannot explain the behaviour of the engines. The acceleration curve, though not meeting the requirements, did not play a role in causing the engine split. The cause of the degraded resistance of the insulation of the coil and the effect upon the control loop signal are unknown.

Testing of the anticipator
A visual inspection of the anticipator indicated evidence of corrosion. The corrosion had developed since the ditch into salt water during the event flight and without subsequent protective treatment. It was expected that this would have a negative effect on the outcome of the test.

Similar to when the anticipator is installed in the aircraft, each channel of the anticipator was powered with 10 Volt input for the test, in order to measure the output signal of the channel. During operation of the aircraft, this signal is normally sent to the DECU to control the engine.
The output of an anticipator channel concerning the DECU normally varies from 0 Volt for low power up to 10 Volt high power (theoretical values), depending on collective pitch position input (normally) or simulated input (test). Via a mechanical link, the output signal is linear with the collective position.

Four measurements were carried out for each channel, representing four distinctive positions of the collective pitch over its operating range. One position, the so called pinned position, is used for rigging the channel output (and thus a certain power level) in accordance with a prefixed position of the collective.

For channel #1 the anticipator input was varied. The channel #1 output values were reported to be "not normal" in the test report produced by the manufacturer. Considering all the signs of corrosion, the test results are not considered to be of use to the investigation.
For channel #2, the anticipator input was varied which should have resulted in higher voltage output and hence more engine power. However, the channel #2 output remained constant at 2.1 Volt. FDR data demonstrates that both prior to and during the split engine condition intervals, engine #2 was not at low power. It is concluded that the channel #2 potentiometer did not work during the test as it is likely to have been affected by the corroded condition of the anticipator.

In a later stage of the investigation, another suggestion made by the operator was that an anomaly in the power supply to either of the potentiometer channels of the anticipator may have occurred, either originating from a poor electrical connection or an incorrect voltage supply from one of the DECU's. However, this possibility was not investigated as an electrical irregularity was not confirmed by any DECU failure report and electrical discontinuities in the anticipator components were not found in the anticipator test. It seems there is no firm evidence to support the theory of bad electrical connections or improper voltage levels supplied to the anticipator.

In summary, no conclusions can be reached regarding the functioning of the anticipator prior to the event and the subsequent behaviour of the engines.

Determination of the failed governing system or engine
Under dual engine operation, a failure in one engine or its control system may result in a decrease or an increase in power (in Ng). The power variation is compensated by the good engine showing an opposite response (in Ng). When engines are mismatched, the rotor speed will become slightly higher or lower than normal. If the Ng of one of the engines increases or decreases similarly with the rotor RPM, this engine can be identified as the engine that is not performing properly. FDR data shows that at the moments of engine split, the changes in rotor RPM are in the same directions as Ng #1. This implies engine #1 is the defective engine and engine #2 the compensating engine.

1.16.5 Flight control systems

1.16.5.1 Introduction
Aircraft systems related to the control of the aircraft were tested on the aircraft in the Eurocopter facilities. Relevant components were removed from the aircraft, in order to perform a detailed component check. During the system checks, representatives of the BEA and/or the Dutch Safety Board were present. Components were tested at different vendors, supervised by Eurocopter, BEA and/or the Dutch Safety Board representatives. Additional tests were performed based on the findings during the tests.

1.16.5.2 Eurocopter tests
Before the main rotor was removed from the aircraft for transportation, a Eurocopter team, assisted by Bristow engineers, performed a main rotor head swash plate check. The test revealed a minor deficiency of the swash plate adjustment. The parts that were removed for transportation were installed again before testing started.

On the following systems related to the control system, checks were performed on the aircraft:
- Control system: movement and control forces of the roll, pitch, collective and yaw control channels.
- Measurement of cyclic and collective control forces at rated pressure.
- Main hydraulic systems.
- Adjustment of swash plate and indices.
- Autopilot (AP) hydraulic components.

In the cyclic pitch control, a minor hard point was found. The cause was a hard point in a bearing which generated some additional control forces. Minor discrepancies were found in the swash plate adjustment. During the investigation of the AP hydraulic system, a sound was heard. The sound came from the AP hydraulic electro valve.

The following components were removed from the aircraft for a detailed inspection and/or functional check:
- Dampers
- Trim motors
- Hydraulic fluid
- Oil filters

During the tests, minor anomalies were found. No anomalies were found that could explain the reported control problems.

The possible failure modes of the AP hydraulic system and the possible influence on the controllability of the helicopter were investigated in detail.

1.16.5.3 Autopilot hydraulic system

Autopilot hydraulic system test
For the test of the AP hydraulic system, the aircraft was powered with external hydraulics and electrical power. The electric power was on the AP hydraulic system only. It was the first time since the accident flight that a part of the electric system was energized. During the investigation, a sound was heard. The sound came from the AP hydraulic electro valve. This valve is the on/off switch of the AP hydraulic system. The test was interrupted and the valve was removed for investigation. A new valve was installed to make further testing of the AP hydraulic system possible. After the new valve was installed, the pilot side autopilot switch showed unreliable behaviour. The system showed no further anomalies. The AP hydraulic bloc was tested on a bench and showed no anomalies.

Autopilot (AP) hydraulic electro valve
The AP hydraulic electro valve was investigated at the manufacturer's facility, in the presence of a BEA technical investigator. It was concluded that the valve itself had failed during the test and was working normally during the accident flight. The investigation concentrated on the control system of the valve.

Electrical circuit AP hydraulic system
In the AP hydraulics concerned, there is no power on the AP hydraulic electro valve. The AP hydraulic system is switched off by closing the electrical circuit (fail safe system). A failed switch cannot switch off the system, except when an inadvertent electrical connection is made in the switch. The other possibility to switch off the system is an electrical power input somewhere in the wiring harness.

AP hydraulic switches

G-JSAR switches
The pilot switch showed unreliable behaviour during the tests carried out in the hangar. The switch was damaged during removal. The co-pilot switch worked normally. Both AP hydraulic switches were investigated. No mechanical defects were found. The investigation revealed that in both switches corrosion products and other non conductive material (grains of sand, aluminium oxides, salt from seawater) was present, which had entered through a small hole in the switch. The inside surfaces of the switch were not corroded. The aluminium oxides in the switches originate from the

thread at the outer surface and fell down through the hole in the housing. The sand and salt came into the switches via the hole, after the accident. There is no evidence that seawater was present in the switches before the accident. When seawater enters the switches during normal operation, corrosion of the inside and short circuits is to be expected.

On the contact surfaces of the pilot switch, non-conductive material was found, which caused an electric non-conductive barrier. After partially removing this material and rebuilding this, the switch functioned normally.

G-BWWI switch
In addition to the switches of the G-JSAR, a switch of an AS332L, registration G-BWWI was investigated. The sequence of events of this incident is described in 1.17.1. Investigations revealed that a failed switch had caused uncontrolled switching of the autopilot hydraulic system. Investigation of the switch revealed that a broken part in the switch had blocked the lever. Due to the blockage, the lever had bent, resulting in unreliable behaviour of the switch.

1.16.5.4 Simulation and flight tests

Test on G-JSAR
Following the inadvertent switching of the autopilot hydraulic (AP) electro valve, a static simulation of an intermittent AP failure was performed on the G-JSAR. In a constant AP hydraulics off situation, control forces are higher than during normal flight. This test indicated that an unexpected switching off and on of the AP hydraulic system can cause an increase in cyclic control forces, without generating an AP hydraulics warning.

An AP hydraulic failure situation can exist for 0.8 second without generating an AP hydraulic warning light. A test was developed to assess the possible influence of an intermittent AP hydraulics failure on the crew performance. This test indicated that an off and on switching of the AP hydraulic system can cause an increase in cyclic control forces, without generating an AP hydraulics warning. Situations that generate and do not generate an AP hydraulics warning were simulated. The French accredited representative (who is a qualified Super Puma pilot) participated in a test that was set up in Marignane on G-JSAR. The aircraft was powered with hydraulics and the AP hydraulics were controlled by a test system, designed by Eurocopter. This system enabled the investigators to switch the AP hydraulics on and off at different frequencies and during periods of varying length. The pilot was asked to assess the difficulty of the cyclic control forces generated by the intermittent operation of the electro valve on a scale of 1 to 10, where a rating of 10 would mean the cyclic felt stuck. The highest rate of difficulty with AP warning light on was rated as 7. Without AP warning, the difficulty was rated as 6.

The G-JSAR accident crew participated in a similar test. The crew was asked to rate the similarity of the cyclic control forces during different circumstances on a scale of 1 to 10, compared to the accident flight. A rating of 10 resembled the same situation as during the accident flight. The highest resemblance rated by the captain (PNF) was 5. The highest rate of resemblance mentioned by the co-pilot (PF) was 6 for a situation in which the AP warning light was on.

To obtain an initial indication of the possible effects of an intermittent AP hydraulics failure on the handling of the aircraft, a simulator test was proposed. This appeared to be difficult to organize for Eurocopter. Eurocopter is co-owner of the Helisim training facility which is located next to the Eurocopter facilities.

Simulator test at Helisim
The Dutch Safety Board requested the assistance of the RNLAF. A simulator session was arranged by the RNLAF at the Helisim training facility. The two purposes of the test were to fly the pattern of the last part of the accident flight and to give the Safety Board investigator (and helicopter pilot) a better understanding of the Super Puma/Cougar helicopter control system and flight technique. During the test it became doubtful as to whether the simulator was accurate enough to test an AP hydraulics off situation at speeds of around 150 Knots. Furthermore, it became clear that the simulator was incorrect for the situation with AP hydraulics switched off. In that situation, the basic modes of the AFCS were still available. This is impossible in the aircraft itself. It was concluded that a test flight was needed in order to investigate the behaviour of the aircraft with AP hydraulics switched on and off erratically during high speeds. The results of the simulator test were discussed with Eurocopter. It was decided that flight tests were necessary. Eurocopter offered to perform a flight test as soon as a Super Puma L2 was available.

Eurocopter Super Puma L2 flight test on 4 October 2007
The purpose of the flight was to evaluate the control input workload at speeds comparable to the final part of the accident flight (the period of the reported control restrictions) and the workload in an AP hydraulic OFF situation at high speeds. The tests were performed by a test pilot and a less experienced crew member, who was not Super Puma rated. The FDR data was downloaded, the CVR data was not.

The test pilot concluded that the aircraft could still be flown at speeds of around 150 knots in an AP hydraulic off situation. For the less experienced crew member, assistance was necessary to control the aircraft around these speeds. At speeds below 140 knots, the crew member was able to keep the aircraft under control. Based on the plotted FDR data of the cyclic position, Eurocopter did a visual analysis and concluded that the control input of the test flight with AP hydraulics off was similar to the accident flight. Since the plots were not to scale and the flight data was not available to the investigation team, it was not possible to validate the Eurocopter analysis. According to the Dutch Safety Board, no conclusions can be drawn from a visual analysis of an FDR plot which is not to scale.

RNLAF flight test
The RNLAF organized a flight test with the Cougar helicopter S433. The purposes of the flight were:
- To investigate the behaviour of the helicopter, the control inputs and forces required for flight with AP Hydraulic OFF at speeds of up to 160 knots.
- To provide CVR/FDR data to compare control inputs with the data from the G-JSAR incident.
- To investigate the indications of switching AP Hydraulic OFF and ON during cruise flight, including whether the switching sound was audible on the CVR.

The helicopter was flown with AP Hydraulic OFF with indicated airspeeds ranging from 70 up to 160 knots. The behaviour of the helicopter was investigated together with control inputs and forces required for straight and level flight, in turns and the approach phase. The AP Hydraulic off flight was started at 100 knots; gradually the airspeed was increased to 160 knots; the manoeuvre was finished by a gradual decrease of up to 70 knots. Both pilots made their own assessment. Throughout the AP Hydraulic Off flight, collective and yaw pedals could be set and frozen; they did not have a negative effect on the control of the helicopter.

Further remarks concerning control inputs and forces are related to the cyclic lever only. In the range from 70 to 80 knots, the helicopter was unstable but relatively easy to fly. Pilot action was required for straight and level flight; the required control inputs were small; the frequency of inputs was low. The inputs were longitudinal and lateral. With increasing airspeed, the frequency of the required control inputs increased. From 100 knots and up, the inputs were more lateral than longitudinal. At speeds above 130 knots, aggressive control of the cyclic lever was required. Prolonged flying in these conditions was possible but tiring. During the entire flight, there was no moment in which the cyclic lever could not be moved.

RNLAF ground test
A ground test was performed to collect data to build a "sounds library" of the Super Puma/Cougar sounds. In addition to the sound of AP switching, various sounds of other systems were recorded on a portable computer. The aircraft used was an RNLAF Cougar. The microphones from the headset that was used by the captain during the accident flight and a similar headset to that worn by the co-pilot were used as input. The library was used to compare this with CVR recording of the accident flight and the test flight.

Super Puma L2 flight test
A flight test was performed with a Super Puma in SAR configuration. The purposes of the flight were:
- To update the sound library with sounds from a super Puma in SAR configuration
- To investigate the behaviour of the helicopter, the control inputs and forces required for flight with AP Hydraulic Off at speeds of up to 160 knots.
- To provide CVR/FDR data to compare control inputs with the data from the G-JSAR incident.
- To investigate the indications of switching AP Hydraulic off and on during cruise flight, including whether the switching sound was audible on the CVR.

In order to update the sound library, the crew executed a checklist run through, which was recorded on the three CVR channels and a computer. The helmet with headset from the G-JSAR accident flight and a similar headset as worn in the accident flight were used. The CVR used was similar to the G-JSAR CVR.

In addition to the AP hydraulic switching, other inputs were made during the flight for CVR data collection purposes. For example, trim and trim release switches were used. All in flight sounds were recorded on the CVR and the computer. A descent profile comparable to the accident flight was flown several times, starting at speeds up to 160 knots in AP ON and AP OFF situations. During the entire flight, there was no point at which the cyclic lever could not be moved.

Analyses of CVR recordings

The CVR recordings of the following flights were investigated for mechanical sounds:

- Flight test RNLAF Cougar
- G-BWWI event, 15 October 2007
- Flight test UK Super Puma L2

Reference sounds were recorded on the CVR and on other recording devices during the RNLAF and UK flight tests, both on the ground and in flight. Furthermore, reference sounds were collected during another ground test at the RNLAF. The collected data was used to build a "sounds library" of the Super Puma Mk2/Cougar sounds.

This library was subsequently used to find similar sounds on the accident flight CVR. The main conclusions of the study are:

- A flight crew is normally able to hear intermittent AP Hydraulic switching.
- AP Hydraulic switching would be detectable on the pilot and co-pilot microphone tracks.
- Spectral and audio analyses of the CVR of the G-JSAR did not reveal any sounds similar to that of AP Hydraulic switching.
- Based on CVR information, it is unlikely that an intermittent AP Hydraulic failure occurred during the accident flight.

1.16.6 Survival equipment

1.16.6.1 Questionnaire

In the UK, several accidents involving helicopter offshore operations have occurred in the past. These were investigated by the UK Air Accident Investigation Branch (AAIB). The UK AAIB participated in this G-JSAR investigation, because Bristow is a British operator and the SAR helicopter had a British registration. The AAIB contributed to the investigation of the survivability aspects of the accident with the G-JSAR, because of their experience, in particular with survivability issues.

The four crew and thirteen passengers were all wearing immersion suits and, with the exception of the two rear crewmembers who used a lift raft, all were immersed in the sea for between 45 and 75 minutes. The sea temperature was estimated to be 11-13 degrees Celsius, the wave height 2-3 meters and the air temperature 9 degrees Celsius. Only one passenger required medical treatment; this was for mild hypothermia.

This accident therefore presented an opportunity to assess the performance of the survival equipment. Three parallel activities were undertaken to investigate the survival suits:

- A questionnaire (see Attachment 3) was sent to the thirteen passengers and the four crew members. This requested information about the performance of their immersion suits, life jacket and accessories, as well as their physical state.
- The passenger suits were taken to the manufacturer, visually inspected and tested for leaks.
- The crew suits (different manufacturer to the passenger suits) were also taken to the manufacturer, visually inspected and tested for leaks.

A summary of the results from the questionnaires and the tests is contained in table 3.

	Crew	Passengers
Total on board	4	13
Required medical attention for mild hypothermia	0	1
Required other medical attention	0	0
Responses received to questionnaire	4	12
Reported wearing a minimum of three layers of clothes	4	12
Reported having felt some dampness or wet inside the suit	3	11
Reported leakage from seals	0	6
Reported leakage from zip	1	1
Reported using gloves	0	10
Reported using hood	0	1
Reported wearing a life jacket in the water	3	13
Suits recovered	3	13
Pairs of gloves available for use	1	13
Hoods available for use	0	12 or 13
Suits inspected and tested OK	1	5
Suits inspected and tested with minor repairs required	2	8

Table 3: Results from questionnaires and tests.

1.16.6.2 Immersion suits
Fourteen of the 16 who responded to the questionnaire reported feeling wet or damp inside their suits, with many reporting leaks from the wrist and neck seals. With the exception of one passenger who only wore two layers under his immersion suit, all the passengers and all the crew appear to have been wearing appropriate clothing under their suits. There is evidence (Tipton)[114] that:

"(...) a 500 ml leak over the limbs has no impact on the rate of fall of deep body temperature, whereas a corresponding leak over the torso significantly increases the rate of fall of body temperature."

The crew and passengers worked for different organisations and each had slightly different processes for issuing and maintaining the immersion suits. The crew were issued with a suit delivered in a sealed bag. With the seal unbroken, the suit would be returned after two years. Within three months after the date the seal was broken it was returned for maintenance, or earlier if it was unserviceable. The passengers were issued a suit, and after six return trips the suits were serviced.

The suits are supplied with neck and wrist seals in a range of sizes. Further tailoring of the seals is routinely carried out by cutting the seals back using a series of small annular rings integral to the seal as a guide for trimming. The inspection of the suits revealed that most of the neck seals had been trimmed, and many of these had been trimmed more than the manufacturer's recommended values for the neck sizes of the individual suit wearers.

1.16.6.3 Gloves and hoods
The lack of warning of the ditching gave the passengers little opportunity to don hoods and gloves prior to their evacuation. Once in the water, many passengers helped each other to put gloves on. Several commented that this was difficult without illumination. Ten passengers reporting using gloves and these worked effectively. Only one passenger reported using a hood and this was only fitted with the assistance of other passengers. Other passengers reported that they were too afraid of letting go of either the helicopter or others to attempt to don their hood. One passenger commented that his survival training did not include donning his hood; a possible reason for this is that protective headgear is sometimes worn during training exercises.

114 *"Cold Water Survival (The Cruel (C)",* Mike Tipton, University of Portsmouth.

None of the crew had hoods available in the dedicated pockets of their suits, and only one had gloves available. Although these are fitted to the suits, there is anecdotal evidence that crew frequently remove them to allow greater comfort and freedom of movement to perform their crew tasks. Robertson and Simpson[115] note that heat loss through the head and neck region can be considerable. The benefits of gloves in maintaining core temperature is less clear, although their use has a considerable impact on comfort, mental state and manual dexterity. It was also noted by one of the suit manufacturers that the use of a hood can significantly improve the performance of the neck seal on the immersion suit.

1.16.6.4 Life jackets

The G-JSAR carried ten passenger life jackets. It was necessary to supplement these with two spare aircrew life jackets and one stretcher life jacket to equip each of the 13 passengers. These life jackets were of three different types and some passengers reported that they were not confident in using an unfamiliar life jacket. The emergency equipment contained within the jackets varied with the different types. Two passengers reported difficulty in inflating their jackets during the subsequent evacuation. Apart from the captain, who lost her jacket during the evacuation, the life jackets for the remaining 16 occupants were all successfully inflated. None of the occupants used the available buddy lines.

1.16.6.5 Life raft release mechanisms

During the investigation, the G-JSAR life raft release mechanisms of the life raft stowed in the left-hand sponson were tested. The release mechanism system is designed by Bristow and constructed by Eurocopter. There are three basic ways to release the sponson mounted life rafts. The life raft can be released using the interior release handles in the cockpit, mounted on the bulkhead high behind both pilot seats (1), or released using the exterior (2) handles on both sides of the fuselage beside the cabin sliding doors. The life raft can also be released using a third handle (3) located in each sponson, which actuates the inflation cylinder inflation control directly.

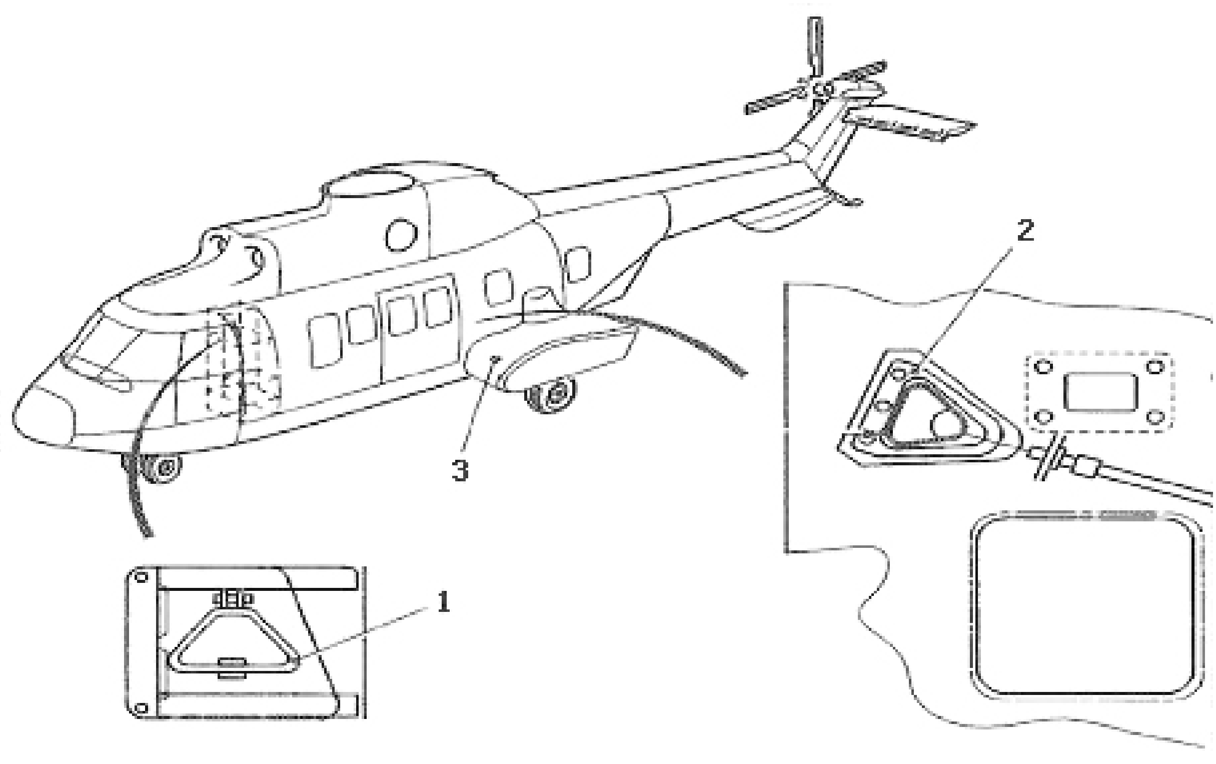


Illustration 5: for each life raft there are three inflation system operating/release handles. One is installed in the cockpit (1), one is installed externally on the fuselage aft of the main door (2), the third handle is installed in the sponson stowage (3).

When carrying out the life raft release test on the left-hand side, it was found that the life raft could not be released using the exterior (2) and interior (1) release handles. The third possibility, release after removing the cover of the sponson, was abandoned. The possibility existed that the previous

115 *Review of probable survival times for immersion in the North Sea*, D.H. Robertson and M.E. Simpson, Health and safety Executive report OTO 95 038, January 1996.

release attempts had armed the release mechanism and this would endanger the person removing the cover of the sponson. Eventually the life raft was released by turning the control lever inside the cabin beyond its normal operating range. After the release it was established that the activating mechanism inside the left-hand sponson (the third release possibility) functioned normally.

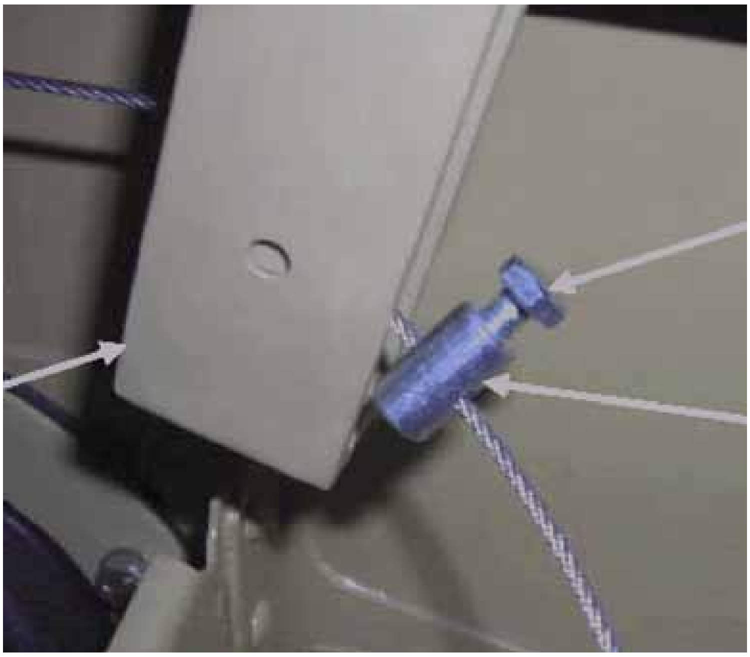


Illustration 6: lower side of the control lever [source Eurocopter].

Maintenance logbook entries indicated that life raft due bay (sponson) services were carried out in accordance with maintenance procedures. Initially, the cable grip of the release control cable (illustration 6) was suspected to have slipped, but a detailed investigation of the cable proved that this was not the case. It turned out that the control lever angle was too large in relation to its horizontal axis and prevented the control lever from functioning within its normal operating range.

The Safety Board did not extend its investigation to other types of helicopter. Eurocopter stated that the AS 332L2 is the only type that is equipped with this life raft activating mechanism. Based on these findings the Dutch Safety Board issued three recommendations on 29 March 2007, addressed to the certifying authority for the Eurocopter products, the European Aviation Safety Agency (EASA), to take necessary actions. EASA responded on the three recommendations on 29 May 2008. The recommendations and responses are given below:

Recommendation 1
Operators check the proper functioning of the life raft activating mechanism on the AS 332L2 Eurocopter helicopters equipped with sponson mounted life rafts within two months after publication of this message.

Response EASA
This recommendation is partially accepted by EASA. Eurocopter Service Bulletin 25.01.93 was therefore published on 25 July 2007 to recommend operators to check the proper functioning of the life raft activation system.

Considering 1) that the yearly check of the release system never revealed the cable slide phenomenon on aircraft in service, and 2) that the time interval between Dutch Safety Board investigations for checking proper life raft deployment and the actual helicopter ditching was two months, EASA considered that issuance of an Airworthiness Directive to mandate this one-time check was not warranted.

Indeed, at the time of the test, the control mechanism cables showed significant signs of corrosion that are deemed to be the cause of the system non-activation when the test itself was performed. It is unlikely that an aircraft correctly maintained would be subject to similar corrosion development. Furthermore, it is EASA’s understanding that the crew did not attempt deployment of such a life raft at the time of the event, i.e. its condition at that time could not be determined to be faulty.

Status - Partial agreement - Concluded

Recommendation 2
Eurocopter improves the design of the sponson mounted life raft activating systems to assure proper release.

Response EASA
This recommendation is accepted by EASA. Eurocopter were asked to launch a design change for improvement of the life raft activation system, so that even in the case of (unlikely) important corrosion, deployment is ensured. EASA reviewed and agreed principles of this change, which consists of:

- replacement of the cable clamp at the end of the control mechanism channel with an improved clamp featuring double tightening devices;
- specifying an improved value of tightening torque to apply to the new cable clamp.

Eurocopter Service Bulletin AS332 25.01.98 was published on 16 April 2008 and recommends the incorporation of this design improvement.

Status - Agreement - Concluded

Recommendation 3
Eurocopter improves the maintenance procedures of the sponson mounted life raft activating systems as needed.

Response of EASA
This recommendation is not accepted by EASA. Work cards already exist, requesting to check and test the life raft activation system every year. Given that an external source of corrosion may only be a salt-air environment as opposed to contact with salt-water from the sea, those maintenance inspections are deemed to be appropriate.

Status - Disagreement - Concluded

1.17 Organizational and management information

Section 1.17 contains the results of the compilation, investigation and analysis of similar engine and/or controllability incidents. Bristow and Eurocopter were asked to check their databases for engine and/or controllability related incidents like the incident on the G-JSAR. The G-JSAR crew informed the Dutch Safety Board of a possible similar incident during a training flight at the Eurocopter facility with a Cougar, the military version of the Super Puma, of the Royal Netherlands Air Force (RNLAF) in the mid nineties. Therefore the RNLAF was also asked to check for similar engine and/or controllability incidents with the Cougar. In addition, the RNLAF asked foreign Cougar operators to provide information of controllability related incidents with Cougar helicopters.

1.17.1 Bristow
Bristow was asked to search in their database for engine and/or controllability related incidents. Bristow's Safety Manager reported that there were no records of similar cases. However, during the investigation on 15 October 2007, a similar event with a Bristow Super Puma Eurocopter (AS332L), registration G-BWWI occurred.

G-BWWI event, 15 October 2007
After a brief air-test, the aircraft returned to the company ramp to collect the passengers for its scheduled flight to the semi-submersible drilling Sedco 712. Taxi out and departure were uneventful. Shortly before levelling at the initial cruise altitude, controls became 'stiff', the 'WARN' and 'HYD' captions illuminated. There was a 'clunking' noise from the hydraulic cabinet, followed a few seconds later by the illumination of the 'APHP' caption. Both crew members found the (cyclic) controls more difficult to handle and a decision was made to return to Aberdeen. After landing, the helicopter taxied back to the Company ramp. Passengers were disembarked and engines were shutdown. There were no injuries.

The engineering investigation discovered two faults. A continually forward motoring of the cyclic stick was confirmed and traced to a defective pitch beeper valve assembly: one of the solenoid valves was stuck open and therefore caused a constant forward beep demand. The pitch beeper valve was replaced.

The second problem, that of a rapidly 'on and off' switching of the autopilot hydraulic system, was found to be caused by an internal defect in the Autopilot Hydraulic ON/OFF switch located on the first officer's collective lever. Similar switches are located on each collective. When subjected to vibration, the failure mode caused the switch contacts to make and break at random. This rapid switching of the autopilot hydraulics was the cause of the noise heard by the crew and may have been a significant causal factor in the failure of the pitch beeper valve too. The autopilot hydraulic ON/OFF switch, located on the co-pilot's collective lever was replaced.

1.17.2 Eurocopter
Eurocopter was asked to search its database for related incidents. It was reported that Eurocopter had no record of incidents of similar cases. The G-JSAR crew informed the Dutch Safety Board about an event during a training flight at the Eurocopter facility with a Cougar of the RNLAF in the mid nineties. When Eurocopter were asked, it was reported that the event happened in 1995. However, information from the RNLAF revealed that the first RNLAF-crews arrived in Marignane in 1996. Eurocopter had no information about events during RNLAF training flights in Marignane in that year.

The technical department of the RNLAF provided the Safety Board with a copy of a Eurocopter report regarding the S400 (serial number 2400) control problems, dated 19 April 1996, Eurocopter reference F/CQ.PSP NO5812/96. The number was provided to Eurocopter to enable them to find the report in their database. The Eurocopter investigator informed the Safety Board that the report could not be found. The RNLAF report was subsequently sent to Eurocopter. See Attachment 4.

1.17.3 Royal Netherlands Air Force

RNLAF Cougar event in Marignane 1995
During a test flight of the first Cougar helicopter built for the RNLAF in 1995, registered as S400, a cyclic control restriction occurred. Investigation provided by Eurocopter revealed the restriction was caused by a mechanical interference of the left cyclic lever by an electrical lead. A modification was initialised for all Super Puma/Cougar helicopters. The corrective measures were modification n° 25 606 which modify the routing of the harness. According to Eurocopter, this modification was incorporated during the production of G-JSAR.

RNLAF Cougar events in France 1996
During two training flights on the RNLAF Cougar S400 in April 1996, cyclic control restrictions were reported. Both flights were training flights for RNLAF pilots. The captains were Eurocopter test pilots, but were classified as pilot not flying (PNF). The pilot flying (PF) during the first event on 4 April was on the observer seat during the second event on 9 April. Several requests to Eurocopter resulted in information being provided on the September 1995 event. No information was provided by Eurocopter regarding the 1996 events.

The RNLAF pilot of the second event could not be interviewed. The pilot, who was pilot flying in the first event and on the observer seat during the second event, was interviewed in September 2007. The total flying experience in helicopters for the pilot flying on the day of the incident was approximately 3,400 hours, of which approximately 155 hours took place in a Cougar. He stated that the event occurred during an instruction flight with a Eurocopter test pilot on the right seat, shortly after take-off from La Fare Les Oliviers aerodrome (North of Marignane). During a climbing, slow right turn, for a period of 15 to 20 seconds the cyclic lever was blocked completely and could not be moved with the force of two hands. His first impression was that the captain had shut down the hydraulic system for training purposes. The pilot reacted by lowering the collective, whereupon the captain asked what he was doing. The pilot stated that he was checking what was wrong and informed the captain he could not move the cyclic lever at all. Suddenly the cyclic lever was released again. The captain asked why he was not informed about the problem immediately. The pilot explained he thought it was part of the training. After the incident the captain flew the aircraft back to Marignane in a straight line. He stated the event looked like an event that had happened before and announced a technical check.

Five days later, the same pilot was on the observer seat during a training flight with another test pilot. During an approach in a southerly direction on to Salons de Provence Airbase, the pilot flying turned around and said in Dutch "nu heb ik het ook" ("now I have the same"). The captain asked what was wrong and while explaining the problem, the cyclic controls became normal again. The captain decided not to land and flew in a straight line back to Marignane. The aircraft was hangared for a number of days.

Because the cyclic lever was blocked for a short time on both flights and this complaint could not be reproduced on the ground, Eurocopter investigated the following flight control system components and/or performed the following tests on the RNLAF Cougar S400:

- linkage between sticks and servo-controls;
- beep trim and beep release electrical circuit;
- maintenance test for AFCS computers;
- AFCS hydraulic unit;
- roll trim, and roll damper.

The results of the investigation were documented in report F/CQ.PSP NO5812/96 "Results of roll channel equipment investigation of a Super Puma TOU 001" by the Eurocopter Quality Directorate on 19 April 1996. The technical department of the RNLAF provided a copy of the Eurocopter report. The conclusions of the report are:

"At this stage of the investigation, only the trim presented a fault that may have a connection with the problem encountered; however, the investigation must be continued before conclusions are drawn.
As the investigation is being continued, a test set is being defined for installation in the helicopter and identification of the fault if it occurs again during the next flights."

Information provided by the RNLAF revealed that, in order to limit the negative effect of the cyclic blockage on the RNLAF flight training program, Eurocopter replaced the roll damper, trim actuator, and the hydraulic unit. The test flight performed on 12 April 1996 was uneventful.
Eurocopter installed a logging system in the aircraft. According to verbal information provided by the RNLAF, the problems did not reoccur during the period that this device was in the aircraft.

RNLAF Cougar control problem events in the Netherlands
An investigation carried out by the RNLAF bureau for technical support (BTO) revealed five technical reports relating to problems with control systems in Cougar helicopters in the period between 1996 and 2005. A technical report, dated 04-11-1998, mentions the crew stated "the cyclic "blocks" while releasing the trim release button on the RH and LH cyclic''. The RNLAF could not relate the technical handling of the events to the pilots that had experienced them. Therefore the pilots who experienced the problems could not be interviewed. Four events were related to AFCS computers and trim actuators. In two of these cases there were sounds coming from the hydraulic cabinet. Information provided by the RNLAF revealed that AFCS computers and trim actuators were modified.

1.18 Additional information

Several databases were checked for similar incidents in the past, among others the database from the Dutch Safety Board's predecessor(s), the ICAO and Oil and Gas Producers (OGP) databases, and other databases from aircraft accident investigation authorities abroad with offshore operations. Relevant information regarding the incidents and actions are summarized below.

1.18.1 Report on the Super Puma G-TIGH accident in the East Shetland Basin in 1992

The accident occurred at night whilst transporting personnel from an oil production platform to nearby accommodation 'Flotel'. The crew had been similarly engaged with other transport tasks since leaving Sumburgh nearly four hours earlier. Weather conditions were severe with winds gusting up to 55 knots, snow showers and very rough seas. However, the helicopter was being operated within its specified wind limits. Having embarked 15 passengers, the helicopter lifted from the platform helideck, transitioned forwards and almost immediately began a right turn towards the Flotel. Climbing to a height of 250 feet and whilst turning downwind, the handling pilot, who was also the captain, reduced power and raised the nose of the helicopter such that the airspeed reduced to zero and a rate of descent built up. Once he was aware of the descent, which was also advised by his co-pilot and the Automatic Voice Alerting Device, he applied full power but the descent could not be arrested before the helicopter struck the sea. Down draughts and incipient vortex ring state may have exacerbated the situation.
The helicopter rolled onto its right side before inverting and sinking within a minute or two. All but five of the occupants managed to escape from the helicopter before it sank. Of the 12 survivors in the sea, only six were recovered alive; the others perished in the hostile sea environment, some of them having survived for a considerable amount of time.

The report was issued by the UK AAIB in April 1993. The following (relevant for the G-JSAR investigation) recommendations were made:

93-26 The Civil Aviation Authority (CAA) should consider amending certification requirements for public transport helicopters operating over the sea to include a suitable system for manual and automatic inflation of emergency hull flotation equipment and this requirement should also apply to helicopter types currently in service.

Status - Fully Accepted - Concluded

UK CAA Response
The CAA accepts this Recommendation. A comparison will be made of the safety benefits and disadvantages which are likely to arise if automatically inflatable flotation equipment was to be installed on a helicopter. If a nett safety benefit is established then changes to the relevant airworthiness requirements will be proposed.

UK CAA Action
The JAA/FAA/Industry Joint Harmonisation Working Group have accepted the recommendation that airworthiness requirements be amended to include, as a minimum, the provision for automatic deployment of flotation systems upon water entry. The subsequent proposal to develop an appropriate JAR/FAR 27 and 29 rule change will be
processed in accordance with agreed JAA and FAA procedures. The justification for retrospective applicability will be considered when this work has been completed.

93-30 The CAA, in consultation with the offshore oil industry and other appropriate bodies such as the HSE [Health and Safety Executive], should re-assess offshore helicopter passenger safety and survivability in normal operating conditions, using the concept of an integrated escape and survival system in order to promulgate such regulations as necessary to achieve it: such an assessment should be carried out against both a controlled ditching and an uncontrolled crash into the sea where the helicopter inverts and sinks almost immediately.

Status - Accepted - Concluded

UK CAA ActionThe Review of Helicopter Offshore Safety and Survival (RHOSS) has been concluded and the report was published (CAP 641)[116] on the 1st March 1995. The review made 17 recommendations and for those aimed at the CAA, follow-up activity has been initiated.

1.18.2 Report on the Super Puma G-TIGK accident in the North Sea in 1995

The Bristow helicopter was conducting a charter flight with two pilots, ferrying 16 maintenance engineers from Aberdeen to the Brae oilfield on 19 January 1995 during daylight in adverse weather conditions. Having just passed a position 120 nautical miles on the 062° radial from the Aberdeen VHF omnirange (VOR) radio beacon, and whilst beginning its descent from 3000 feet above mean sea level, the helicopter was struck by lightning. This resulted in severe vibration, which, a few minutes later, developed into a loss of tail rotor control, necessitating an immediate ditching in

116 This Review was commissioned by the Civil Aviation Authority following recommendations made after the helicopter crash at the Cormorant Alpha platform in 1992. It addresses all aspects of offshore helicopter safety and survival in the context of an integrated system, with the intention of maximising the prospects of occupants surviving a helicopter accident at sea. It does not address the causes or prevention of helicopter accidents. The Review is based upon an Event Tree, which is a diagrammatic representation of an offshore helicopter flight, depicting a number of significant points (or 'nodes') where something might go wrong. The Event Tree thus illustrates all the major possibilities including a safe flight, a ditching, a crash (with or without warning), the subsequent flotation or sinking of the aircraft, the availability or otherwise of life rafts, the functioning of personal safety equipment and the rescue process. The Event Tree is then developed into a System Table, which is a tabular listing of all the significant events in the history of a helicopter accident, grouped into seven phases, commencing with departure from the base and ending with rescue from the sea. A number of elements are identified within each event, and each is analysed in turn in the report, where specific deficiencies and possible remedies are discussed. The penultimate section of the report contains an overall assessment of the present safety and survival system. It points to the 100% success record of survival after ditchings and the inevitably less favourable record of crash survival; it suggests the need for greater emphasis on safety measures related to heavy impacts as opposed to ditchings, but cautions against prejudicing ditching survival in an unrealistic attempt to help the victims of non-survivable crashes.
The report concludes with 17 recommendations. There are few, if any, radical proposals. For the most part, the report endorses work which is already in hand or nearing completion; however, it identifies a number of areas where further studies need to be initiated or where existing work needs to be coordinated or given more urgency. Conversely, it considers and dismisses as impracticable two proposals which have gained currency - the provision of underwater breathing apparatus and the prohibition of offshore flights in weather unsuitable for ditching. The report does, however, make a positive proposal for a more methodical way of ensuring that offshore managers appreciate the relationship between the time it would take to rescue survivors of a crash and the time they could be expected to survive in the water in the prevailing conditions.

heavy seas. The ditching was executed successfully and the helicopter remained upright enabling the passengers and crew to board a heliraft, from which they were subsequently rescued. There were no injuries sustained and the passengers and crew were later returned to Aberdeen by helicopter and ship.

Extract from the conclusions:
- the crew exhibited a high degree of skill in carrying out a successful ditching into the rough sea conditions;
- there were minor errors of procedure made by the crew during the evacuation into the heliraft and within the heliraft, but none of these errors affected the safety or rescue of personnel in this accident;
- the survival of all the passengers reflected well on all the individuals, and on their training and pre-flight briefing;
- there were some minor deficiencies and failures associated with the passengers' safety equipment, however none of these problems affected the safety or rescue of the individuals in this accident;
- the helicopter buoyancy system operated effectively to maintain the aircraft in a stable condition, despite the prevailing high sea state.

The report was issued by the UK AAIB in July 1997. The following (relevant for the G-JSAR investigation) recommendation was made:

97-29 The CAA should ensure that the North Sea helicopter operating companies include in their very effective recurrent training for crews a discussion and, where possible, 'hands on' practice of the procedures necessary to accomplish a successful evacuation from a floating helicopter following a ditching or alighting on the sea.

Status - Fully Accepted - Concluded

UK CAA Response
The Authority accepts this Recommendation. The Authority will require operators to review their Emergency and Survival training methods to ensure that they include a discussion and, where possible, 'hands on' practice of the procedures necessary to accomplish a successful evacuation from a floating helicopter following a ditching or alighting on the sea. Target date: 30 November 1997.

UK CAA Action
The Authority has completed a review of the operations manuals of North Sea helicopter operators to ensure that they contain the necessary procedures to accomplish a successful evacuation from a floating helicopter following a ditching or alighting on the sea.

1.18.3 Report on the Sikorsky S-76B PH-KHB accident in the North Sea in 1997

On 20 December 1997, a KLM ERA Sikorsky S-76B helicopter PH-KHB was conducting a series of transport flight sorties between rigs and platforms over the North Sea in the K5 and Pentacon field area. During the fifth sortie, after sunset and in dark night time conditions, the final approach to production platform L7-A resulted in a go-around. After a left turn, a second approach was initiated. After a reduction in power in order to lose height and speed in a relatively short time, the helicopter lost almost all forward speed and entered a steep descent towards the sea. Realization of this situation was too late and the application of collective power could not prevent the helicopter entering the water. Crew and passengers were able to evacuate the helicopter. After approximately one hour in the water, they were picked up by a supply vessel. During this period one passenger died.

The final report was published by the Dutch Transport Safety Board in January 2000.

Extracts from the conclusions:
- The lack of flight data recorder information hampered the capacity of the investigation to define either the sequence of events, or possible failures. Had the accident been fatal for the flight crew this lack of FDR data would have made the determination of the cause unlikely.
- The captain showed that he was insufficiently aware of the fact that the co-pilot felt uncomfortable during the execution of night approaches. The co-pilot failed to inform the captain in a positive way about this fact. It is likely that the lack of formal CRM training by the crew contributed to this aspect.
- The helicopter hit the water unexpectedly, rolled over right to an inverted position and rapidly filled with seawater. Crew and passengers nevertheless were able to evacuate the helicopter uninjured and up to this point the accident was survivable.

- Because of the unexpectedness of the crash and the inverted position of the helicopter shortly thereafter it was no longer possible to use the helicopter floats and very difficult if not impossible to free the life rafts. As a result, the survivors had to stay immersed in sea-water until they were picked-up by rescue units, which took approximately one hour.
- The deceased passenger died from hypothermia and drowning.
- It is likely that a more efficient use of the available rescue assets could have shortened the time of immersion in the seawater.
- Proper use of all personal survival equipment i.e. hoods and gloves could have decreased the degree of body cooling.

The following (relevant) recommendations were made:

6.1 The Netherlands' CAA should require that helicopters operated in the Public Transport category
(passenger) are equipped with flight data recorders;

Netherlands' CAA response [concisely]:
After 1 April 2000, helicopters used for commercial air transport are, according to JAR OPS 3, to be equipped with a flight data recorder.

5.4 The Netherlands CAA should require that helicopter operating companies introduce crew resource management training to form an integral part of crew training. This is especially important when within the pilot community there is a great difference between background and experience between individual pilots.

Netherlands' CAA response:
CRM training and annual recurrent CRM training is now a requirement of JAR OPS 3 and was in place within the operator prior to the introduction of JAR OPS 3.

5.7 Offshore mining companies should require that all passengers regularly being heli-transported offshore should follow the Helicopter Underwater Escape Training (HUET). In addition, special briefings should stress the dangers of hypothermia and the necessity for correct and full use of personal survival equipment.

Netherlands' State Supervision of Mines response [translated]:

Offshore mining companies have taken several additional measures on their own initiative:
- The types of survival suits have been evaluated critically and new survival suits with neck-seals are in use.
- The HUET training has been made mandatory by the offshore companies for its staff.
- During wintertime, some offshore mining companies added a thermal liner to the survival suit. One offshore mining company has the policy of wearing three layers of clothing under the survival suit and all passengers are equipped with a 'breathing set' of limited use. Within NOGEPA a universal policy is formulated.

NOGEPA's response [translated]:

A 'Helicopter Contact Group' was established in mid 2000. Representatives of the offshore Oil and Gas Producing companies, offshore drilling companies, and offshore helicopter operators form part of this group. The following subjects were investigated:
- Composition of accessible uniform helideck procedures for all offshore companies.
- Confirmation of the new European JAR OPS 3 regulation.
- Development of uniform accepted helicopter improvements, such as: floatation equipment, escape windows, better seat belts and chairs, etc.
- Development of industrial standards for personal equipment for helicopter passengers, such as life jacket, life jacket with or without integrated airpocket, etc.

After the 1997 accident, the Oil and Gas Producing companies performed audits to identify technical and operational weak spots. Consequently,the following improvements were realised, amongst others:
- the helicopters' technical equipment and instrumentation
- emergency lighting and evacuation systems
- the location of deployable life rafts.

An improvement has been made to (helicopter transport) survival suits with the introduction of improved sealing (neckseal). The subject 'hypothermia' has been paid attention to in flyers, training, instruction videos, and additional thermal clothing against cooling down during the winter months has been introduced.

Furthermore, the following subjects have been accentuated or changed during briefings, as well as during the pre-flight safety briefing on the heliport as during the safety briefings on offshore mining installations:

- hypothermia
- new survival suits
- wearing of several layers of clothing under the survival suit.

Hypothermia is an important issue in the NOGEPA mandatory training survival at sea for every offshore employee. The NOGEPA has made the HUET training for its employees mandatory before they are allowed to go offshore.

1.18.4 Report on the Super Puma serious incident in the North Sea in 1998

The helicopter was on a transport flight with two pilots, ferrying 16 passengers to the 'Tor' oil rig in the North Sea on 20 October 1998 in daylight conditions. The flight proceeded normally at an altitude of 2000 feet until the torque on the right engine rose and became unstable. The Ngs of both gas turbines increased. No other indications were observed at that time. The crew then noticed an unusual engine noise. The torque indicator was set to indicate separate torque readings (cross-hatched position). This showed that the torque value on the left engine was correspondingly low. The crew analysed the situation and were under the impression that the problem was related to the right engine. After that, an unusual sound and increasing RPM was heard, the crew reduced the power on the right engine in response to the observations they had made. As a result, the helicopter was almost without engine power and entered an autorotation. During the descent, a MAYDAY call was made and the passengers were informed to assume the 'brace position' and to prepare for an emergency landing at sea. The crew observed that the Ng of the left engine had dropped below 20%, but an attempt to start this engine only resulted in excessive turbine temperature. At the time, the crew ascertained that they had reduced power on the wrong engine, restored power on it and halted the descent, the helicopter was at an altitude of 500 feet.

This incident highlighted a problem that is commonly present when two engines are connected to a common gearbox. The challenge lies in ascertaining whether the one engine is failing in such a way as to place a greater load on the other engine, or whether one engine is taking on too great a load because a fault in that engine makes the other engine 'redundant'.

The most relevant checklist for this situation, 'Engine Governor Malfunction', assumes that the warning light 'DIFF NG' comes on and that the gas turbine rotor RPM is varying. During this flight, it was discovered that something was wrong without this light coming on, and the aforementioned checklist is based on a situation where the problem is associated with the engine governor. The failure that caused this incident was associated with the engine and not with the engine governor, meaning the checklist only partially covered this eventually. The Norwegian AAIB believes that such situations can best be handled by crews with theoretical understanding combined with practical experience acquired with the help of a simulator.

The report was issued by the Norwegian AAIB in June 2000.

1.18.5 Report on the Sikorsky S-61 serious incident PH-NZG in the Waddenzee in 2004

On 30 November 2004, a Sikorsky S-61N of Schreiner North Sea Helicopters (SNH) conducted a return flight from platform L10A in the North Sea to Aerodrome De Kooy. It had three crew members and 12 passengers on board. During the approach in which the helicopter flew in the clouds, the speed of the helicopter dropped back slowly. This was not noticed by the crew. Since the decreasing speed was not compensated for by adding power, the helicopter lost altitude as well. The captain, being the pilot non flying (PNF), tried to stop its high rate of descent. Though the rate of descent reduced, the helicopter still touched the water of the Waddenzee. The contact with the water did not result in injuries or substantial damage.

Section 3.5.2 Safety management of the final report states the following regarding CRM:

"(…) The accident in 1997 did, indeed, involve a KLM ERA helicopter, however because this company was merged into SNH shortly afterwards and all personnel and the helicopters were transferred at that point, 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 adequate CRM training, emerged. CRM training is now legally required and also conducted, but the investigation nevertheless shows that the significance of this training is not recognised by all stakeholders. (…)”

The report was issued by the Dutch Safety Board on 30 August 2007.

1.19 Useful or effective investigation techniques

Not applicable.

ATTACHMENT 1: LIST OF TRAINING CARRIED OUT BY THE G-JSAR CREW MEMBERS

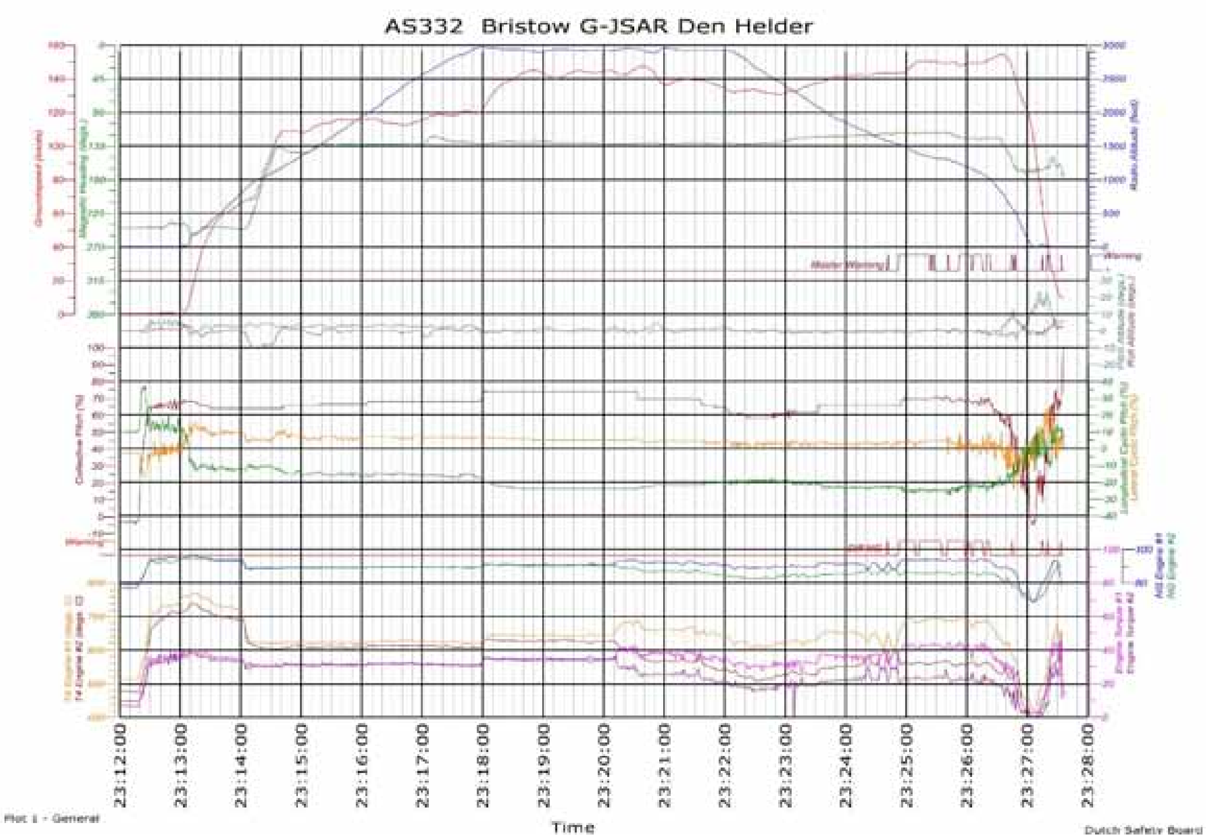
captain (CA), co-pilot (CO), winch operator (WO) and winch man (WM)

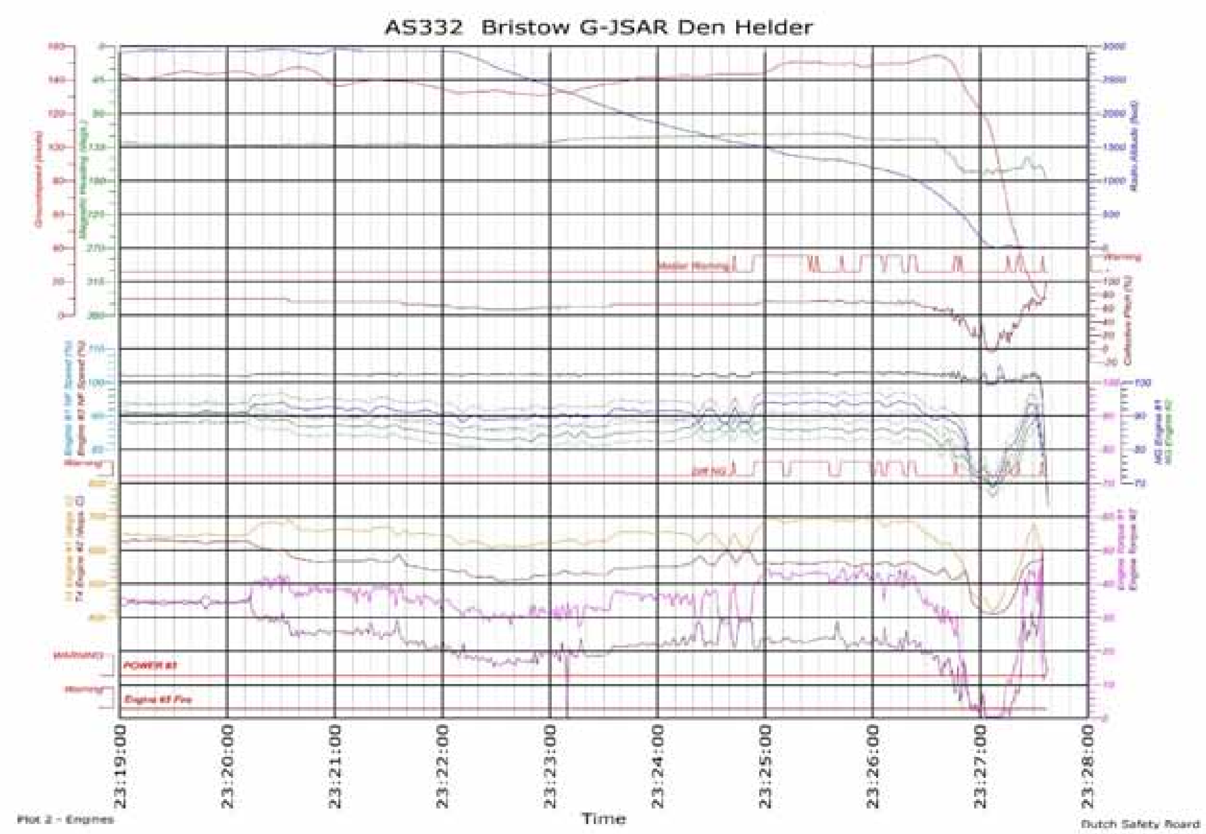
Item		Required by	Validity		Date
Operator Proficiency Check	OPC	All pilots	6 months + remainder of the month of issue. If issued within the final three months of validity of the previous OPC, valid for six months from the expiry date of the previous OPC.	CA CO	17-11-2006 3-10-2006
License Proficiency Check	LPC[117]	All pilots	12 months + remainder of the month of issue. If reissued within the approved validity period of the final three calendar months, valid for 12 months from the expiry date of the previous LPC.	CA CO	17-11-2006 3-10-2006
Line Check Area check Night Deck Recency		All pilots All pilots All Pilots operating offshore (CAT)	12 months + remainder of the month of issue. If issued within the final three months of validity of the previous Line Check, valid for 12 months from the expiry date of the previous Line Check. As above As above; If lapsed, the pilot may operate as part of the night crew (CAT), as the PNF for offshore element, or the PF with a Training Captain if holding the current day Line Check.	CA CO CA CO CA CO	17-1-2006 26-2-2006 17-1-2006 26-2-2006 17-1-2006 26-2-2006
Instrument Recency		All pilots (rated)	Extension to 120 days under the supervision of the Line Training Check/CP	CA CO	
Recent Experience		All pilots	Extension to 120 days under the supervision of the Line Training Check/CP	CA CO	
Emergency and Safety Equipment	EMS	All aircrew	12 months + remainder of the month of issue. If issued within the final three months of validity of the previous EMS Check, valid for 12 months from the expiry date of the previous EMS Check.	CA CO WO WM	17-11-2006 25-10-2006 14-3-2006 14-2-2006

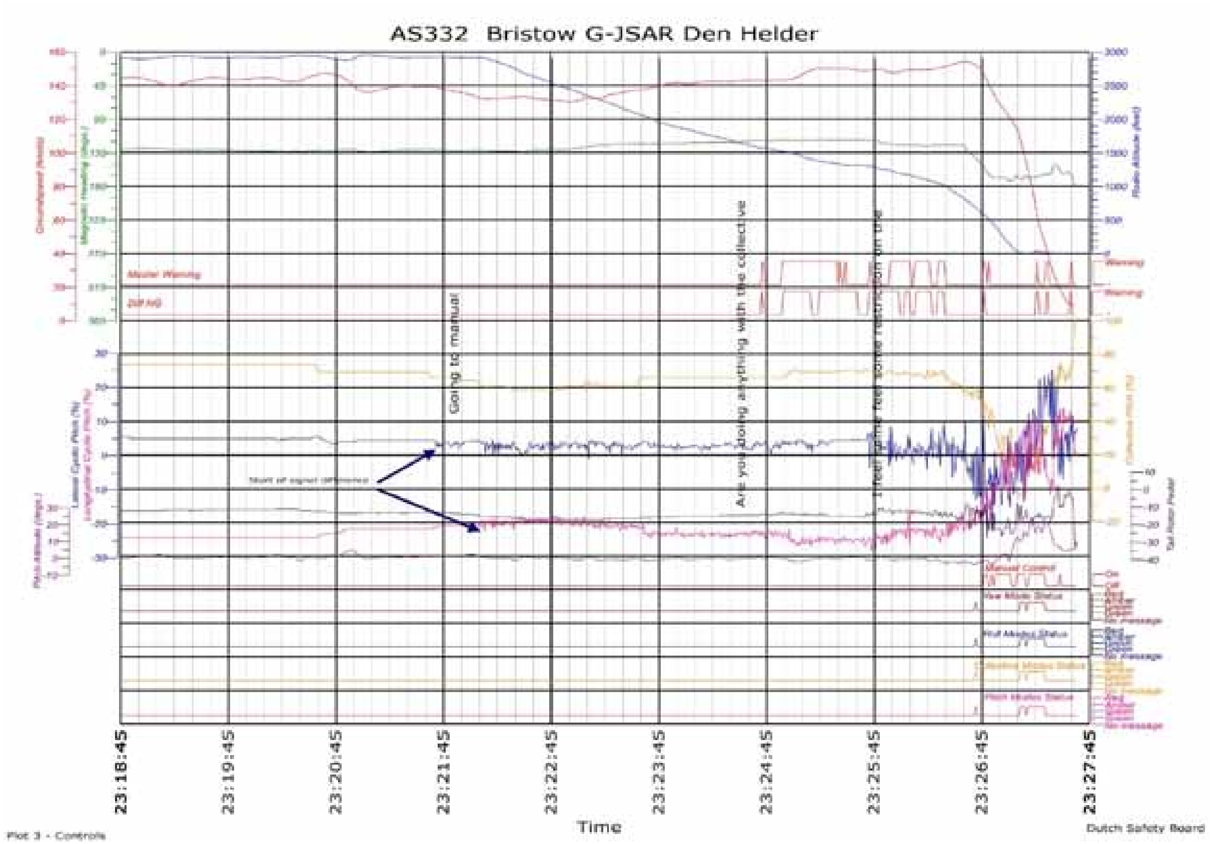
117 The requirements of JAR FCL must be completed every 12 months (LPC) and may be combined with the OPC.

Item		Required by	Validity		Date
Life raft	WDD	All aircrew	36 months + remainder of the month of issue. If issued in the final three months of the validity of previous WDD, HUET, FED, SDC or EEJ then valid for 36 months from the date of the previous WDD, HUET, FED, SDC or EEJ.	CA CO WO WM	8-1-2004 17-10-2005 13-7-2006 21-2-2006
Helicopter Underwater Escape Training	HUET			CA CO WO WM	8-1-2004 17-10-2005 13-7-2006 21-2-2006
Smoke Drill Check (includes Fire Extinguisher Drill - FED)	SDC			CA CO WO WM	16-3-2004 17-10-2005 24-2-2004 22-5-2006
Emergency Exit Jettison	EEJ			CA CO WO WM	17-11-2006 24-10-2005 4-3-2004 14-2-2006
Winch Check		All flight crew if qualified	12 months + remainder of the month of issue. If issued within the final three months of validity of the previous check, valid for 12 months from the expiry date of the previous check.	CA CO WO WM	17-1-2006 21-2-2006 26-2-2006 28-6-2006
Cabin Attendant Check	CAC	All non SAR rear crew	12 months + remainder of the month of issue. If issued within the final three months of validity of the previous check, valid for 12 months from the expiry date of the previous check.	WO WM	n/a for SAR n/a for SAR
Certificate of Release to Service	CRS	All pilots	24 month + remainder of the month of issue. If issued in the final three months of validity then valid for 24 months from the date of the previous CRS.	CA CO	6-9-2006 24-10-2006
Dangerous Goods Awareness	DGA	All pilots and crew members other than flight crew.	24 months from the date of completion of initial or recurrent training. Recurrent training must take place within 24 months of the date on which previous training took place.	CA CO WO WM	19-4-2005 18-10-2005 23-8-2006 19-10-2006

ATTACHMENT 2: FLIGHT DATA RECORDER PLOTS



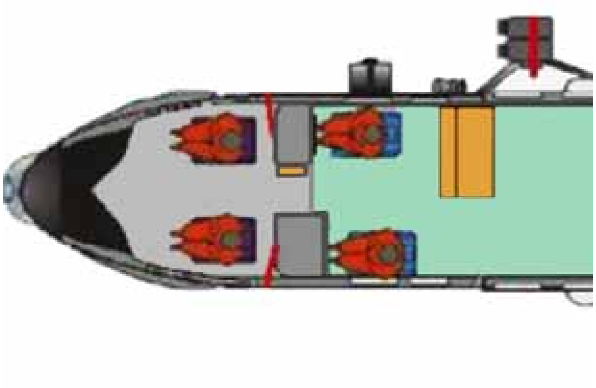



AS332 Bristow G-JSAR Den Helder
Going to manual
Are you doing anything with the collective
Start of signal difference
23:18:45
23:19:45
23:20:45
23:21:45
23:22:45
23:23:45
23:24:45
23:25:45
23:26:45
23:27:45
Time
Plot 3 - Controls
Dutch Safety Board

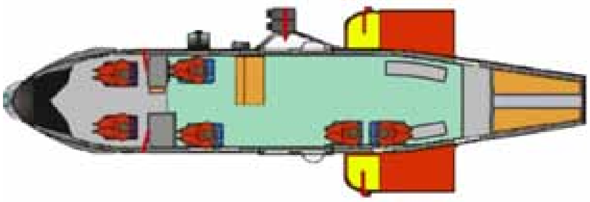
ATTACHMENT 3: QUESTIONNAIRE FOR SURVIVORS

1. Name: ……………………………………………………………

2. Please mark your location in the helicopter cabin during the flight with an "X".



3. Please mark your location in the water after the evacuation with an "X".



4. Personal details

Height: …………………..cm

Weight: ………………….. kg

Wrist measurement: …………………….. cm

Neck measurement: ………………………cm

5. Life Jackets

What type of life jacket were you wearing?

……………………………………………………………………………

……………………………………………………………………………

Did you know how to use the life jacket?

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

What instructions were you given about the use of the life jacket?

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

Did you have any trouble opening/inflating the life jacket?

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

What accessories were there on your life jacket? (spray hood, whistle, light, flare, etc.)

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

What accessories did you use? Why did you use these/why did you not use these?

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

Did the accessories work?

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

6. Survival suit

What type of survival suit were you wearing?

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

Did you wear your own suit?

……………………………………………………………………………

How did you find the suit? E.g. did you find the suit comfortable, hot, cold?

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

What clothes were you wearing underneath (number of layers)?

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

Did you get wet or damp in the survival suit?

……………………………………………………………………………

If so: Why did you get wet?

Did you perspire (sweat) in your suit at any stage?

……………………………………………………………………………

Did it leak in the water? If so, where did it leak?

……………………………………………………………………………

During these circumstances, urinating in your suit can be a normal physical reaction. Did this occur to you?

……………………………………………………………………………

What accessories were there on your survival suit? (gloves, hood, etc.)

……………………………………………………………………………

What accessories did you use? Why did you use these/why did you not use these?

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

Did the accessories work?

……………………………………………………………………………

……………………………………………………………………………

7. In the water

Do you know how long you were in the water for?

……………………………………………………………………………

……………………………………………………………………………

Can you describe your feelings whilst you were in the water? (scared, angry, etc.)

……………………………………………………………………………

……………………………………………………………………………

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ATTACHMENT 4: EUROCOPTER REPORT F/CQ PSP NO 5812/96

Eurocopter France

QUALITY DIRECTORATE
F/CQ.PSP

Marignane, April 19, 96
F/CQ.PSP NO 5812/96

RESULTS OF ROLL CHANNEL EQUIPMENT INVESTIGATION
SUPER PUMA TOU 001

BACKGROUND:

The investigation described in this document was initiated as the pilots felt a hard point on the roll channel on two occasions during training.

The first problem was encountered on April 4, 96 at 90 hrs 25 mn flying time
The second problem was encountered on April 9, 96 at 100 hrs and 30 mn flying time

EQUIPMENT INVESTIGATED:

- Linkage between sticks and servo-controls
- Beep Trim and Beep Release electrical circuit
- Maintenance test for AFCS computers P/N PAN 165100-00, S/N 145 and 119
- AFCS hydraulic unit S/N 1016
- Roll Trim P/N VCC165-03-01, S/N 105
- Roll damper P/N 324700, S/N 003

CONCLUSIONS:

Only the Trim presented, at this stage of the investigation, a fault that may have a connection with the problem encountered; however, the investigation must be continued before conclusions are drawn.

As the investigation is being continued, a test set is being defined for installation in the helicopter and identification of the fault if it occurs again during the next flights.

R. BONNEFOUS, F/CQ.PSP

SUMMARY OF RESULTS

1. LINKAGE CHECK

Documents used:

Technical note 332A042 108 (PV 60V)

Participants:

- Mr CHAZALMARTIN — SUPER PUMA Quality
- Mr CHAUVET — Prototype quality

Actions and results:

1. Hydraulic AFCS, roll channel Trim and damper removed (checked on April 11, 96)

   - Linkage, plays and rod ball joints checked under pilot and copilot floor
   - Linkage, plays and environment of AFCS cabinet checked
   - Linkage and bellcranks between AFCS and rotor hub checked

   No fault detected

2. New AFCS, Trim and damper installed and adjusted (checked on April 12, 96)

   - Clearance of trim rod ball joint checked
   - Interferences and seizing checked at cyclic stick cups and harnesses
   - Rod ball joints and plays checked under pilot and copilot floor

   No fault detected

2. ELECTRICAL CIRCUIT CHECK

Documents used:

Drawing No CAE 223A160 3005

Participants:

Mr MURA — Customer Support

Actions and results (Tests performed on May 12, 96)

Manual measurement of continuities

No fault detected

3. *MAINTENANCE TEST FOR AFCS COMPUTERS*

Documents used:

Software No L5BZPZ2ZATS0E00

Participants:

Mr BURONFOSSE — Equipment quality laboratory

Actions and results:

AFCS computers P/N PAN 16510-00, S/N 119 and 145 (Tests performed on April 12, 96)

Maintenance software run on ATEC 5000

- Energization at ambient temperature (24°C approx.)

No fault detected

4. AFCS HYDRAULIC UNIT

Documents used:

MRV CT 22.3010.850
Technical note 702A040 006

Participants:

Mr TORREGROSA	Mechanical Centre of Competence
Mr BONILLA	Mechanical Quality Dept.
Mr GIARDI	Equipment Quality Lab.

Actions and results:

AFCS hydraulic unit P/N 332A100 092 00, S/N 1016 (Tests performed on April 12 - 19, 96)

1. Functional check in accordance with MRV

- Piston travel
- Electromagnetic gain
- Displacement and deviation speed
- *Input loads*

No fault detected

2. Dynamic response in accordance with Technical note (Tests performed from 1 to 10 Hz)

- Test with piston centred
- Test with piston offset by 15%, output direction
- Test with piston offset by 5%, input direction
- Manual search for hard points around those 3 positions

No fault detected

3. Roll channel removal

- Dimensional check of the parts

No fault detected

5. SFIM-AVIAC ROLL TRIM

Documents used:

ECF document: Appendix to STE 704A47132050
AVIAC document: Acceptance conditions 7-6171-2, Issue 2

Participants:

ECF	Mr FRIOL	Quality Laboratory
DQA	Mr LOPEZ	
SFIM	Mr FAIVRE	Product Support Dept.
	Mr. PINSARD	Quality Dept.
AVIAC	Mr DEFOSSE	
	Mr ASSOGNA	
	Mr VIAL	

Actions and results:

Roll trim P/N VCC165-03-01, S/N 105 (Tests Performed on April 12, 96 at AVIAC)

1. Equipment test in accordance with acceptance conditions, TRIM in horizontal position

No fault detected

2. Check in a position similar to that in the helicopter

- Operation
- Displacement around the point at which the fault occurred (44.6 ± 15%)
- Search for Trim hard points without load and disengaged
- Search for Trim hard points with load and engaged

No fault detected

3. Vibrations and checks described in 2 above repeated

No fault detected

4. Tests after temperature rise to 70°C

No fault detected

5. Equipment opened

- Fine score detected in bottom of trim casing caused by interference with an intenal safetying system bolt

- This interference is in the area where the hard point was felt in flight.

- This interference alone does not explain a stick backload as that felt

- The investigation is being continued to find out whether this interference is made worse in some configurations

The investigation is being continued before conclusions are drawn

6. ***ROLL DAMPER (MANUFACTURED BY SARMA)***

Documents used:

SARMA damper acceptance conditions ATP324 700, Issue A, Edition 1

Participants:

BCF	Mr GEMMATTI	Engineering Dept
SARMA	*Mr GRIMALDI* Mr MORIN MR LIEBERT	

Actions and Results:

Roll damper P/N 324 700 M00, S/N 003 (Tests performed on April 12, 1996 at SARMA and continued until April 22 with Mr CARIOU, F/S)

1. Equipment test in accordance with acceptance conditions:

    No fault detected

2. Measurement of anchoring threshold torque after loading in oven at 80°C

    - Value read is 0.32 Nm against 0.3 Nm max and 0.266 Nm at ambient temperature

    - Second loading in oven with test bench base at 50°C: Value read is 0.32 Nm clockwise and 0.29 Nm counterclockwise

    This slight hardening does not explain the fault that occurred in flight

3. Insulation measured in flight at 1000 Vdc with cover removed

    Resistance is infinite

4. Removal and visual examination

    No fault detected

APPENDIX D: BRISTOW G-JSAR SAR REPORTS WITH EVACUATION MISSIONS

This appendix contains five Bristow SAR reports with reported evacuation missions during the G-JSAR operation between 2003 - 2006.

Legenda SAR report

SAR Report: (Mission Code, Mission Number, Date)
1. Aircraft, Type, Unit, Callsign(s) used
2. Subject of Mission
3. a. Time Alerted, Alerting Agency
   b. Departure Time
   c. On Task Time
   d. Off Task Time
   e. Arrival Time at Base
   f. Total Flying Time
4. Type of Search
5. a. Percentage of Area Searched
   b. Co-ordinates of Area Searched
   c. Position of Incident
6. How Subject Located - Time
7. How Mission effected - Time
8. Particulars of Survivors/Casualties
9. Summary of Equipment Expended
10. Radio/Visual Distress Signals Received/Observed
11. Range of First Contact and Altitude
12. On Scene Commander
13. Other Co-operating Agencies
14. Crew List, Narrative + Weather, Seastate at Scene
(Originating Unit)
(Originator's Name)

SAR REPORT

From: DEN HELDER SEARCH AND RESCUE e-mail: [redacted]@bristow.co.uk
To: NETHERLANDS COASTGUARD
All BHL SAR Units, BHL Aberdeen

BHL SAR REPORT No: 2 03 (2) **DATE:** 15/12/2003

1) COASTGUARD RESCUE HELICOPTER AR
2) a. L9FF1 Platform
   b. MARITIME
   c. NIGHT
3) a. 1755 NETHERLANDS COASTGUARD
   b. 1820
   c. 1850
   d. 2036
   e. 2100
   f. 2.40
4) N/A
5) a. N/A
   b. N/A
   c. N5036.9 E00457.2
6) N/A
7) N/A
8) N/A N/A N/A
9) NIL
10) N/A
11) 12nm @ 1000ft
12) l9ff1
13) NETHERLANDS COASTGUARD
14) [redacted]

Tasked by Netherlands Coastguard to go to Platform L9FF1 and stand by to down man the platform as a vessel in close proximity was drifting towards it. On arrival tasked by OIM to take 7 crewmembers to platformL5A1. On arrival at L5A1 told to stand by and await further instructions. At 1935 told to depart L5A1 and head to and remain rotors running on L9FF1 until vessel was clear. Departed L9FF1 at 2040 to return to Den Helder. Due to unavailability of suitable Public transport seating the crewmembers were not returned to L9FF1.

W/V 330/35 Vis 10k+ Wx Showers reducing vis to 5000m

Job Codes: N MAR M P/A 7 P/R

REGARDS: [redacted]

BRISTOW HELICOPTERS B.V, LUCHTHAVENWEG20, 1786PP, DEN HELDER

SAR REPORT

From: DEN HELDER SEARCH AND RESCUE e-mail: [redacted]@bristow.co.uk
To: NETHERLANDS COASTGUARD
All BHL SAR Units, BHL Aberdeen

BHL SAR REPORT No: 4 05 (31) **DATE:** 28/01/2005

1)		COASTGUARD RESCUE HELICOPTER AR	
2)	a.	power failure K71	
	b.	MARITIME	
	c.	100% NIGHT	
3)	a.	17:25	NETHERLANDS COASTGUARD
	b.	17:45	REFUEL AT THE KOOY DUE TO POOR WEATHER
	c.	18:15	
	d.	19:20	
	e.	19:20	
	f.	1.35	
4)		N/A	
5)	a.	N/A	
	b.	N/A	
	c.	53 34,22N 003 18,18E	
6)		N/A	
7)		N/A	
8)		N/K	
9)		NIL	
10)		N/A	
11)		N/A	
12)		**COASTGUARD RESCUE G-JSAR**	
13)		N/A	
14)		[redacted]	

tasked to transfer 8 pob from the K71 platform to a place of safety due to complete power failure.4 pob to K14 A and 4 pob to the Kooy.
020/10 Br 2000 10K
JOB CODES: N MAR P/A 8 P/R

REGARDS: [redacted]
BRISTOW HELICOPTERS B.V, LUCHTHAVENWEG20, 1786PP, DEN HELDER

SAR REPORT

From: DEN HELDER SEARCH AND RESCUE e-mail: [redacted]@bristow.co.uk
To: NETHERLANDS COASTGUARD
All BHL SAR Units, BHL Aberdeen

BHL SAR REPORT No: 2 06 (93) **DATE:** 06/01/2006

1)		COASTGUARD RESCUE HELICOPTER AR	
2)	a.	Rig evacuation	
	b.	MARITIME	
	c.	DAY	
3)	a.	12.47	NETHERLANDS COASTGUARD
	b.	13.02	
	c.	13.33	
	d.	15.36	
	e.	16.00	
	f.	2.58	
4)		N/A	
5)	a.	N/A	
	b.	N/A	
	c.	K6D N5340.5 E00349.7 / L4PN N5349.5 E0040350 K5EN N5342.41 E00330.45	
6)		N/A	
7)		N/A	
8)		N/K	
9)		NIL	
10)		N/A	
11)		N/A	
12)		**COASTGUARD RESCUE G-JSAR**	
13)		N/A	
14)		[redacted]	

JSAR tasked to evacuate offshore installations K6D, L4PN, K5EN and transport the personel to L7Q.
W/V 100 10-15 BKN 800 VIS 4-5NM
Job Codes: MAR P/A 19 P/R

REGARDS: [redacted]
BRISTOW HELICOPTERS B.V, LUCHTHAVENWEG20, 1786PP, DEN HELDER

SAR REPORT

From: DEN HELDER SEARCH AND RESCUE e-mail: [redacted]@bristow.co.uk
To: NETHERLANDS COASTGUARD
All BHL SAR Units, BHL Aberdeen

BHL SAR REPORT No: 4 06 (95) **DATE:** 08/01/2006

1) COASTGUARD RESCUE HELICOPTER AR
2) a. N/A
b. N/A
c. 80%DAY 20%NIGHT
3) a. 14:55 NETHERLANDS COASTGUARD
b. 15:10
c. 15:25
d. 15:35
e. 15:50
f. 0.40
4) N/A
5) a. N/A
b. N/A
c. N 52 35,7 E 004 31,8
6) N/A
7) N/A
8) N/K
9) NIL
10) N/A
11) N/A
12) **COASTGUARD RESCUE G-JSAR**
13) N/A
14) [redacted]

Jsar tasked to rig Q8 A to evacuate 4 personnel who had been stranded on rig for 3 days with no food
vis 3500 BR few 700 wind 110/10
JOB CODES: MAR P/A 4 P/R

REGARDS: [redacted]
BRISTOW HELICOPTERS B.V, LUCHTHAVENWEG20, 1786PP, DEN HELDER

SAR REPORT

From: DEN HELDER SEARCH AND RESCUE e-mail: [redacted]@bristowgroup.co
To: NETHERLANDS COASTGUARD
All BHL SAR Units, BHL Aberdeen

BHL SAR REPORT No: 47 06 (138) **DATE:** 16/11/2006

1) COASTGUARD RESCUE HELICOPTER AR
2) a. evacuation Q8B
b. MARITIME
c. 100% NIGHT
3) a. 2030 NETHERLANDS COASTGUARD
b. 2050
c. 2105
d. 2130
e. 2130
f. 0.40
4) N/A
5) a. N/A
b. N/A
c. 52 38 23N 004 25 22E
6) N/A
7) N/A
8) N/K
9) NIL
10) N/A
11) N/A
12) **COASTGUARD RESCUE G-JSAR**
13) N/A
14) [redacted]

JSAR was allerted by the coastguard at time 2030 hrs, to evacuate 5 persons stranded on the Q8B platform. Arrived at Q8B boarded all the persons including cargo. Then RTB
JOB CODES: MAR P/A 5 P/R

REGARDS: [redacted]
BRISTOW HELICOPTERS B.V, LUCHTHAVENWEG20, 1786PP, DEN HELDER

APPENDIX E: NETHERLANDS COASTGUARD INFORMATION REGARDING G-JSAR EVACUATION MISSIONS

This appendix contains detailed information regarding five other G-JSAR evacuation flights. Source: data from Netherlands Coastguard incident reports.

G-JSAR mission no. 2 on 15 December 2003 (Monday)
- A bulk carrier reports to be drifting in a Southerly direction at four knots because of engine problems. Its position is four nautical miles North of L9-FF platform and there is a storm forecasted NW with eight Beaufort.
- Netherlands Coastguard vessel Waker is sailing out.
- OIM LF9-FF is informed of the situation.
- In consultation with NAM emergency response coordinator the decision is made to evacuate half of the personnel from L9-FF with G-JSAR. The other half of the personnel will shutdown the platform and can be evacuated with a second G-JSAR flight.
- Seven persons are transported from L9FF to the L5-FA1 platform.
- On arrival of the G-JSAR at L5-FA1, G-JSAR on standby for further instructions.
- L9-FF goes down and pipes vented. G-JSAR cannot return to L9-FF.
- When the engine of the vessel is running again and the risk of collision has passed, G-JSAR returns to Den Helder without passengers after consultation with NAM.
- The seven persons remained at the L5-FA1 due to the unavailability of a suitable public transport helicopter for their return flight.[118]

G-JSAR mission no. 31 on 28 January 2005 (Friday)
- Eight persons on platform K7-FA1 with no accommodation; request from NAM to Netherlands Coastguard to transport four persons to K-14C and four persons to Aerodrome De Kooy;
- Lighting of helideck is unserviceable (complete power failure);
- Weather conditions too poor for landing by public transport helicopter (visibility less than one km);
- Netherlands Coastguard is informed about direct contact between NAM and Bristow and awaits the outcome of this;
- NAM informs the Netherlands Coastguard that G-JSAR is able to land without lighting; G-JSAR hoist is unserviceable;
- Netherlands Coastguard then makes an SAR alarm for the G-JSAR;
- When airborne and on the way to the K7-FA1, the G-JSAR reports that only four seats are available for the transport of passengers and only four passengers can be transported at one go;
- 45 minutes later the G-JSAR reports that it is airborne and on the way to K14A with 12 persons (including the crew) on board;
- 18 Minutes later the G-JSAR reports that it is airborne and on the way to Aerodrome De Kooy with eight persons (including the crew) on board.

G-JSAR mission no. 93 on 6 January 2006 (Friday)
- Nineteen persons on three different platforms (seven on K5EN, eight on K6D, four on L4PN); some of them without water and heating since Thursday; request from offshore oil and gas operator to transport them to L7Q by G-JSAR;
- Public transport helicopters cannot fly due to icy conditions, amongst other issues;
- G-JSAR requests a response from the Netherlands Coastguard and offshore oil and gas operator regarding whether this operation can be called an emergency operation; if "yes", all persons can be transported in one go, if "no" only two persons can be transported in one go, because of the number of available seats;
- The Netherlands Coastguard contacts the offshore oil and gas operator, who indicates that operation under SAR is allowed;
- G-JSAR operations normal at K5EN;
- G-JSAR airborne and on the way to the L7Q with 11 persons (including the crew) on board;
- G-JSAR airborne from L7Q and on the way to the K6D with four persons (the crew) on board to pick up eight persons at the K6D;
- G-JSAR airborne from K6D and on the way to the L7Q with 12 persons (including the crew) on board;
- G-JSAR airborne from L4PN and on the way to the L7Q with eight persons (including the crew) on board;

118 In the incident report, it is mistakenly reported that the G-JSAR transported the seven personnel to their destination platform L9-FF.

- G-JSAR airborne from L7Q and on the way back to Den Helder Airport with four persons (the crew) on board.

(Data from the Netherlands Coastguard message to the State Supervision of Mines)
- Offshore oil and gas operator requests 19 persons on board different platforms be transported to the L7Q;
- Some persons have been without water and heating since Thursday;
- These persons have been transported to the L7Q by G-JSAR.

G-JSAR mission no. 95 on 8 January 2006 (Sunday)
- Rig incident at Q8A; four persons to be evacuated;
- Icy conditions and persons present since Thursday;
- Conversation mentions an incident where people were too close to each other for too long a period of time;
- G-JSAR on its way to Q8A with four persons (the crew) on board;
- G-JSAR on its way to Aerodrome De Kooy with eight persons (including the crew) on board;

G-JSAR mission no. 138 on 16 November 2006 (Thursday)
- Request from offshore oil and gas operator to evacuate five persons from the Q8-B with the G-JSAR, because the contracted air transport helicopter company helicopter is not available.
- Other helicopter company helicopters will probably not be available either.
- Duty captain G-JSAR contacts with the offshore oil and gas operator representative.

APPENDIX F: BRISTOW INTERNAL AUDITS

This appendix presents a summary of relevant findings from the Bristow (internal) Den Helder SAR base audits in 2004-2006.

Auditor	Date	Findings
Bristow SAR	9-10 March 2004	• The JSAR steering committee meets as required (attended by NOGEPA, Netherlands Coastguard and Bristow). • The SAR life jackets are maintained on site. • Training records and alerting system take the form of a locally produced spreadsheet. • Figures recording and collating operational statistics are sent to NOGEPA every three weeks. • Advisory requirements for Wet Dinghy and Fire drills are given by the Senior Line Training Captain. • The Base Instructions for SAR are being rewritten to pose as an appendix to the Den Helder Base Instructions.
Bristow SAR Flight Standards	6-9 June 2005	• A lack of engineering support, specifically licensed engineers on type, means that work required on the aircraft necessitates restrictions on the SAR recurrency training taking place. This has a direct influence on the standard of service being offered to the client. • Simulator items need to be signed off as soon as the simulator is available for each pilot. Some pilots are close to their 36 month limit.
Bristow SAR Flight Standards	3-7 October 2005	• G-JSAR is the only version of this type of aircraft in the company. • They have a high turnover of aircrew, requiring a nearly constant training remit. This, in turn, increases the difficulty of maintaining currency for the already qualified crews. The spin-off benefit is that crews are regularly referring to training-related publications resulting in above-average knowledge of the publications and adherence to SOPs. The priority must remain the currency of the crews. • Ground training records should be computerised. Aircrewmen should have their own sheet rather than a continuous hand-written sheet.
Bristow SAR Flight Standards	2-6 October 2006	• The version of questionnaires carried out during investigation must be recorded in each individual's training records. • Some rear crewmembers have not taken the initial CRM or Dangerous Goods course. • The points from the last audit have largely been eradicated.

APPENDIX G: UK CIVIL AVIATION AUTHORITY AUDITS FROM BRISTOW

During the period from 2004 to 2006, the UK CAA performed several audits from Bristow of the (Den Helder) SAR base and Bristow headquarters in Aberdeen. This appendix presents a summary of the findings obtained in those audits. The information was provided by the UK CAA.

Auditee	Date	Findings
Den Helder SAR unit	12 May 2005	• The night time flights had expired for a G-JSAR pilot. • The recording and checking of the pilot's recency on all qualifications did not function too well. Bristow introduced a new system and was confident that this situation would not occur again. • Line Check Forms were not being annotated as SAR line checks. All Bristow SAR Line Training captains were informed about the need to state clearly on Line Check Forms that the check was for SAR. During the audit the G-JSAR equipment was also "seen and checked". *Result: CAA UK was satisfied.*
Den Helder SAR unit	19-21 June 2006 8 August 2006	• Significant evidence of the fact that the company Quality System was not applied: - a number of pilots did not receive CRM training; - Den Helder base was not aware of findings of Bristow internal audits; - no planning was available to resolve these problems. Result: CAA UK expects Bristow to respond to the problems that have generated a level 2 finding. Response Bristow: • All Quality and HSE policies form an integral part of the company SMS and are documented in a variety of company procedures available at the base and on the intranet. • An audit and Quality briefing to Ops Management is scheduled for 8/9 August 2006, during a Q&S Department visit/Ops audit. All audits have been reported to the base. The company Flight Safety Officer has issued a reminder to all the bases of the need to hold regular Flight Safety Briefs. • CRM training will be completed in October/November 2006 *Result: CAA considered it to be appropriate to follow this issue up during the visit to Aberdeen in October and concluded these findings with the remark that the Quality system would be further discussed during the annual inspection in October 2006.*
Aberdeen	October 2006	A finding was raised against the Quality System during the annual audit of the head office in October 2006, because it was not yet fulfilling its required functions. • The Quality and Safety part of the company was neglected, in particular Operations. Response from Bristow: With the addition of two new personnel since the previous audit in 2005 and by utilising existing lead auditor experience, the internal audit programme for 2006 has been recovered. Ongoing training and development of staff and a closer working relationship with training pilots utilised in Flying Standards audits has enhanced the scope and depth of audits conducted to date. In addition, training is actively being sought in the JAR-OPS field to be concluded during early 2007, together with the development of a closer working relationship with Operations management. *Result: With the replacement of Bristow's Quality and Safety Manager and the employment of additional staff to address the issues raised, the CAA accepted this action as being positive and over the forthcoming year it was evident that Bristow was making progress and conducting comprehensive internal auditing of its operation. This response was considered sufficiently robust by the CAA to conclude the finding*

Auditee	Date	Findings
Aberdeen	September 2007	A further finding was raised against the Quality System: • The Quality Assurance system, procedures, and programmes have not been published in any visible form and there is evidence that internal quality audit findings are not being correctly addressed by the individuals nominated to follow up and action the findings. Response from Bristow: The top level Quality processes and procedures are contained in QID 155 SMS Manual. This manual has been adopted as the top level QS manual for BHL EH and all relevant Operations publications are to be updated by the end of November 2007. The audit process and handling of findings raised as a result are published in QID 052 and administered through the audit database, which is web-based and available to all management staff, including guidance regarding its use.

APPENDIX H: SUMMARY OF BRISTOW TRAINING INFORMATION AND CREW TRAINING DATA

Part D of the Bristow Operations Manual is called the Training Manual. The Training Manual is for the use of Bristow personnel who have been appointed to carry out training and/or checking duties in respect of flight crew. This appendix contains relevant training information and the training carried out by the G-JSAR crew. Amendments dated after the accident are shaded.

Bristow Training Policy
In its training policy Bristow states that:

> *"Training personnel have a responsibility to ensure that the records they are required to submit are accurate and complete. Each item of training has an objective which should be completely understood. Each Training Captain, Instructor, Chief Pilot and trainee must be aware of the objectives and standards required".*

The policy continues with:

> *"All aircrew employed by the Company will be trained, both initially and recurrently, to standards which meet or exceed the minimum requirements of the regulatory Authorities. Particular emphasis will be placed on Human Factors, the development of team training and performance. Training staff will be of the highest calibre, carefully selected and trained to role model high personal standards. They will be thorough in their management of Company flying, both operational and training and of a high standard in their execution of training duties. All aircrew will be encouraged and expected to display self discipline and self awareness at all times and to strive for the highest levels of flying knowledge and performance."*

Recurrent Training
On the issue of Recurrent Training, the Training Manual required that:

> *"The ground and refresher training shall include:*
> *Helicopter systems*
> *Operational procedures and requirements including ground de/anti-icing and/or pilot incapacitation*
> *Accident/Incident and Incident review*
> *Amendments and changes to procedures and documents.*
> *Air test Procedures*
>
> *Knowledge of ground and refresher training shall be verified by means of a questionnaire or other suitable method.*
>
> *Recurrent training and checking provides an opportunity for the practice of emergency procedures which rarely arise in normal operations and are part of a structured programme of recurrent training. This training will be carried out in a flight simulator whenever possible and may be combined with the Operator Proficiency Check. The training programme shall be established such that all major failures of helicopter systems and associated procedures will be covered within a three year period."*

Since Amendment 9, dated February 2007 (three months after the accident), the Training Manual also requires the following:

"Training Captains shall include recurrent training within their checking programmes. This should consist of technical refresher discussions between the Training Captain and candidate on the systems that will be checked during the OPC/LPC (usually 2 - 3 systems per OPC/LPC). This will be reinforced in the aircraft or simulator during the abnormal and emergency sections of the OPC/LPC (which fulfils the checking requirement), together with systems and emergency training in the aircraft or simulator (which fulfils the training requirement). Ground and refresher training is recorded in section 6 of the OPC file form. A tick against an item in section 6 indicates that the above training and checking has been satisfactorily completed."

Emergency and Safety Equipment Training
On the issue of Emergency and Safety Equipment Training the Training Manual required that this training:

"(…) shall take place whenever practicable in conjunction with cabin crew doing similar training, with emphasis on co-ordinated procedures and two-way communications. On completion of Emergency and Safety Equipment training, the flight crew member will undergo the annual Emergency and Safety Equipment Check."

Since Amendment 9, dated February 2007, the Training Manual requires that this training:

"(…) shall take place in conjunction with cabin crew or rear crew doing similar training with emphasis on co-ordinated procedures and two-way communications. Where emergency equipment, such as externally mounted life rafts, can be operated from both cockpit and cabin, responsibilities for each crew member shall be trained. The Emergency and Safety Equipment training programme may be combined with Emergency and Safety Equipment checking, but crew members must demonstrate knowledge and competency on completion of the training programme.

For new crew members, or as applicable on conversion, the Training Manual stated at the time of the accident that:

"a comprehensive drill to cover all ditching procedures will be practiced where flotation equipment is carried. This will include practice of the actual donning and inflation of a life jacket, together with a demonstration or film of the inflation of life rafts and associated equipment, or demonstration and use of the life rafts where they are fitted for over-water operations. Where life rafts are fitted for extended over-water operations such as sea pilot transfer, offshore operations and coast to coast over-water operations, a comprehensive wet drill to cover all ditching procedures should be practiced by aircraft crews. This wet drill is to include, as appropriate, practice of the actual donning and inflation of a life jacket, together with a demonstration or film of the inflation of the life rafts. Crews should board the same (or similar) life rafts from the water whilst wearing a life jacket. Training should include the use of all survival equipment carried on board life rafts and any additional survival equipment carried separately on board the aircraft.
In addition, Helicopter Underwater Escape Training (HUET) should be practiced by aircraft crews. This practice will, on an initial conversion course, be conducted using the equipment in water, although previous certified training with another operator or the use of similar equipment will be accepted in lieu of further wet-drill training."

Furthermore, the Training Manual required:

"Instruction regarding the location of emergency and safety equipment, correct use of all appropriate equipment, and procedures that could be required of air crew in different emergency situations."

Since Amendment 9, dated February 2007, paragraph 5.3 of the Training Manual states that:

"For new crew members, or as applicable on conversion, the following shall be addressed: (…)

d. Initial and annual Emergency and Safety Equipment training shall cover the location and use of all emergency and safety equipment carried on the helicopter. During training, reference should be made to the Aircraft Flight Manual and Operations Manual Part B, with particular emphasis on ditching and evacuation procedures covered in Part B Section 3 and EOPs. The training and checking shall be conducted in the helicopter or a suitable alternative training device and shall include both theoretical and practical elements, together with individual practice using touch drills, and must include all items listed on the back of the EMS Check Form with particular emphasis on the following:
    - I. Donning of a life jacket and knowledge of equipment carried.
    - II. Instruction on the location and use of all types of exits, including the use of touch drills for all operating handles.
    - III. Instruction on the location, deployment and use of the life rafts, including the use of touch drills for all operating handles. Where external life rafts can be activated externally whilst in the water, training shall include demonstration or a film of the removal of access panels and location of the deployment handle.
    - IV. Practicing the evacuation drill using "talk through" and touch drills. Where crew other than flight crew are routinely carried, this shall be conducted with both flight and cabin crew present.
    - V. Instruction regarding the location and use of all other emergency and safety equipment carried on the helicopter.

e. A comprehensive Wet Dinghy Drill to cover all ditching procedures will be practiced where flotation equipment is carried. This practice will be conducted using the equipment in water, although previous certificated training with another operator will be accepted in lieu of further wet-drill training, provided that equipment of the same type was used. The Wet Drill shall include:

- I. A dry drill to familiarise crews with the use and contents of the life jackets, life rafts and associated emergency equipment and packs including the first aid kits.
- II. Individual practice of the actual donning and inflation of a life jacket of the type used. The life jacket should be fitted with representative dummy equipment which should be located and removed from pockets to simulate any difficulties in accessing the equipment with the jacket inflated.
- III. Demonstration or film showing the use of the life rafts, including the method of deployment from onboard the helicopter and from the water for externally mounted life rafts.
- IV. Demonstration or film showing the inflation of the type of life rafts fitted to the helicopter.
- V. Wet drill using the equipment in water during which crews shall board the type of life raft fitted to the helicopter (or similar) from the water whilst wearing a life jacket and practice erecting the life raft canopy and righting following capsize.
- VI. Helicopter Underwater Escape Training (HUET) shall be practiced by aircraft crews.
- VII. Training shall include the use of all survival equipment carried on board life rafts and any additional survival equipment carried separately on board the aircraft.

f. Actual operation of all types of exits on the helicopter and instruction on the location of emergency and safety equipment carried, including the correct use of all appropriate equipment, and procedures that could be required of flight crew in different emergency situations.

g. On completion of Emergency and Safety Equipment training, the flight crew member shall undergo the following checks; Emergency and Safety Equipment Check (EMS), Emergency Exit Jettison Check (EEJ), Wet Dinghy Drill/HUET Check (WDD/HUET), Fire Extinguisher Drill Check (FED) and, if required, Smoke Drill Check (SDC)."

Emergency and Safety Equipment Training Programme for flight crew members
At the time of the accident, the training programme might be combined with emergency and safety equipment checking and should cover the location and use of all emergency and safety equipment carried on the helicopter.[119] The training and checking should be conducted in a helicopter or a suitable alternative training device. Every year, the emergency and safety equipment training programme must include the following:

- Donning of a life jacket (where required)
- Donning of smoke protection equipment, if carried
- Handling of fire extinguishers of the type used
- Instruction on the location and use of all types of exits
- Instruction on the location and use of all emergency and safety equipment carried aboard the helicopter
- Security procedures.

These items would be included in the annual Emergency and Safety check or Line check, as appropriate. Every three years, the programme of training must include the actual operation of all types of exits and a demonstration and practice in the use of the life rafts where fitted.

Since Amendment 9, dated February 2007, the Training Manual states that:

> *"(…) The training and checking shall be conducted in a helicopter or a suitable alternative training device and shall include both theoretical and practical elements, together with individual practice using touch drills where appropriate. Every year, the emergency and safety equipment training programme must include the items covered in Part D Section 5.3 d. These items will be included in the Annual EMS Check or Line Check, as appropriate. Every three years, the programme of training must include (…) actual operation of all types of exits (See Part D Section 5.3 f.)" and "demonstration and practice in the use of the life rafts where fitted (See Part D Section 5.3 e). These items will be included in the three yearly checks (WDD/HUET, FED, EEJ, SDC)"*

Approved simulators
Since Amendment 9, dated February 2007, the Training Manual states that the AS332L2 simulator at the Helisim Simulator Training Facility in Marseille, France (ID code UK/BO-316) has been approved by the UK CAA as a JAR-STD 1H level D simulator. Bristow mentions in its table 4.4.4 of the Training Manual that this simulator allows training and checking of all training and checking items. Every OPC/LPC may be conducted in this flight simulator.

119 Subsection 8.4 *Emergency and Safety Equipment*, section 8 *Recurrent training*, Bristow Training Manual.

Training SAR Winchmen
For winchmen, no description of recurrent training and checking on the issue of Emergency and Safety Equipment was found in the text of the Training Manual valid at the time of the accident. There are only references to requirements of this kind for "aircrewmen" in the table which has been reproduced. A definition of an aircrewman was not found in the Operations Manual.
The specifications of the training elements for ab initio winchmen are divided into an extensive list of ground instruction items and some 20 flying sorties with a total of 25 flight hours.[120] The details of the flying sorties make no mention of ditching and evacuation procedures. Ground subjects will be given either as lectures or as comprehensive briefings prior to each flying sortie and will be tailored to suit the candidate winchman. The ground instruction item "Safety Equipment and Drills" mentions:

- Helirafts Survival Packs - Drills,
- Life jackets in current use
- Emergency Locator Transmitters
- SAR beacon
- Automatically Deployable Emergency Locator Transmitter (ADELT) Acoustic Beacons
- Aircraft Emergency Exits
- Emergency lighting
- First Aid Packs (aircraft)
- Passenger Briefing.

As it is common practice within current UK SAR commercial and UK military operators, Bristow SAR rear crew do not receive diver training either.
Since Amendment 9, dated February 2007, paragraph 7.10.1 of the Training Manual states that:

"The following applies to Cabin Attendants, and Aircrewmen carried for the purpose of Helicopter Hoist Operations, External Load Operations or Search and Rescue Operations.

a. The period of validity of recurrent training and the associated check shall be 12 or 36 calendar months in addition to the remainder of the month of issue. If issued within the final three calendar months of validity of a previous check, the period of validity shall extend from the date of issue until 12 or 36 calendar months from the expiry date of that previous check.
b. Crew members other than flight crew shall undergo recurrent training which may be combined with recurrent checking. Recurrent training shall cover the actions assigned to each crew member in normal and emergency procedures and drills relevant to the type(s) and/or variant(s) of helicopter on which they operate. The instruction shall include both theoretical and practical instruction, together with individual practice using touch drills where appropriate.
c. Every year, the recurrent training and checking programme shall include the following:
    I. Emergency procedures including pilot incapacitation;
    II. Normal opening and closing of doors;
    III. Items specified in Part D 5.3 d."
    IV. Elements of CRM shall be integrated into appropriate phases of the recurrent training, and each crew member shall undergo specific modular ground CRM training. Crew members shall complete recurrent training of the core elements of the initial CRM course as detailed in Appendix C over a period not exceeding 3 years. The successful resolution of helicopter emergencies and operational contingencies requires effective co-ordination between flight crew and cabin crew. Combined training will be provided for flight and cabin crew, as applicable.
    There will be an effective liaison between flight crew and rear crew training departments, to promote consistency of drills and procedures and provision will be made for flight and rear crew instructors to observe and comment on each other's training. Emphasis will be placed on the importance of effective co-ordination and two-way communication between flight crew and rear crew in various emergency situations. Initial and recurrent. CRM training will include joint practice in helicopter evacuations so that all who are involved are aware of the duties other crew members must perform. When such practice is not possible, combined flight crew and rear crew training will include a joint discussion of emergency scenarios.
d. Every three years, recurrent training shall also include:
    I. Emergency Exit Jettison training in accordance with Part D 5.3 f.
    II. Fire Extinguisher Drill training in accordance with Part D 5.3 b.
    III. Smoke Drill training (where applicable to the helicopter type) in accordance with Part D 5.3 b.
    IV. Wet Dinghy Drill and Helicopter Underwater Escape Training in accordance with Part D 5.3 e.

120 Appendix O to the Bristow Training Manual.

Cockpit Resource Management and Multi-crew co-operation training
At the time of the accident, every Bristow aircrew member should complete a two-day company Crew Resource Management awareness course. Multi-crew co-operation (MCC) training was required:

"for pilots undertaking their first multi-pilot type rating course and this should be combined with the type rating course. The MCC course shall comprise 25 hours of theoretical knowledge instruction and 15 hours of practical MCC training. The contents of the MCC course should cover theoretical knowledge training, practice as both the pilot flying and the pilot not flying and feedback regarding:
a) The non-technical skills of co-operation, leadership and managerial skills, situational awareness, decision-making and communication;
b) The use of checklists;
c) Briefs;
d) Mutual supervision, monitoring and standard call-out procedures;
e) Crew duties regarding operation of the aircraft and its systems, setting of radio and navigation aids etc."

Since Amendment 9, dated February 2007, paragraph 5.4 of the Training Manual (CRM Training) states that:

a. "A crew member shall complete a two-day Company CRM Awareness course. This course shall be completed within twelve months of first joining the Company, except in the case of pilots who have never operated as part of a multi-crew aircraft and who therefore require MCC training. They will complete the CRM Awareness course before commencing the flight or simulator training phase of a multi-pilot type rating course. The syllabi for CRM courses are the responsibility of the Chief CRM Instructor and can be found in Appendix C to this Manual. The trainee will not be assessed during initial CRM Awareness training.
b. When a crew member undergoes a conversion course with a change of helicopter type and/or a change of operator, elements of the initial CRM awareness course should be covered as required and shall be integrated into the conversion course. A crew member should not be assessed when completing elements of CRM training which are part of the operator's conversion course.
c. Where crew other than flight crew are routinely carried, CRM training shall take place in conjunction with cabin crew or rear crew, with emphasis on co-ordinated procedures and two-way communications."

Appendix C to the Training Manual now states that:

"The initial CRM awareness course will cover the following syllabus over a period of two days, during which time crew members will not be available for other duties. Whenever possible, initial CRM training should be conducted in a group session outside the company premises so that the opportunity is provided for crew members to interact and communicate away from the pressures of their usual working environment. Alternatively, a suitable venue on the base but away from the operational environment may be used.

Initial CRM awareness training will include:
a. Human error and reliability, the error chain and actions to break the error chain, including the CRM loop and the notion of synergy.
b. Company safety culture and Bristow CRM Skills Standards. SOP's and the use of check lists, emphasising the multicrew concept and highlighting any specialist tasks.
c. Stress, stress management, fatigue and vigilance. Human physiology including discussion of fatigue and the management of stress.
d. Information acquisition and processing, situational awareness, workload management. Human perception, learning and information processing.
e. Decision-making.
f. Communication and co-ordination inside and outside the cockpit. Effective communication and co-ordination within flight crews and between crews and other operational personnel (Company operations staff, maintenance personnel, ATC etc.) Feedback and its effective use in communication and in the CRM loop to support a cause, present a view and help resolve conflicts.
g. Leadership and team behaviour synergy. Behavioural traits and personality types, leadership skills, delegation, motivation.
h. Automation, philosophy of the use of automation (may be covered during the type conversion training)
i. Case based studies. Statistics and examples of accidents relating to Human Factors.

All aircrew will undertake CRM recurrency training after completing the initial awareness course. All major topics of the awareness course syllabus will be covered during recurrency training over a period not exceeding three years and a further opportunity will be given to improve CRM skills in a non-assessable environment by integrating CRM training into all appropriate phases of recurrent training, for example during simulator Line Orientated Flight Training (LOFT).

Line Orientated Flight Training and Line Orientated Simulation (LOS) should be utilised to allow crews to practice CRM skills in realistic line flying scenarios. Where simulators are available, these will be utilised for the purpose of LOFT/LOS and where possible video recording will be used to assist crews and trainers to obtain maximum value from de-briefing of the exercise. Where suitable simulators are not available, CRMIs[121] are encouraged to utilise classroom exercises, with simulated cockpit materials, to further develop CRM and team training.

Where annual simulator training is completed, the recurrent CRM ground training will last for one day and aircrew will attend once every two years. Where annual simulator training is not completed, the CRM recurrency course will last for a half day and aircrew will attend once every year.

Assessment of CRM skills is the process of observing, recording, interpreting and debriefing a crew's performance and knowledge using an acceptable methodology in the context of overall performance. It includes the concept of self-critique, and feedback which can be given continuously during training or in summary following a check.

Assessments shall only be carried out during the Line Check, Operator Proficiency Check or License Proficiency Check but are not appropriate until the crew member has completed the initial CRM Awareness Course. A crew member should not be assessed when completing elements of CRM training which are part of recurrent training.
The Bristow CRM skills standards form should be used as the basis for the assessment, but should not be used as a check list during the flight. CRM assessment should not be conducted as an activity survey for each phase of flight, but should be carried out within the overall assessment of the flight or simulator check.
Assessment must be based on observable behaviour; it is what pilots do, say and write and what examiners can hear and see. Assessment of character traits will not be made because such ratings are subjective and can easily differ widely among examiners.
Need for technical consequences; a crew member should not fail a check (Line Check, OPC or LPC) due to CRM reasons alone, unless this is associated with a technical failure or leads to the compromising of the safety of the flight. A technical failure may be a failure to achieve a satisfactory standard during an OPC or LPC check item, or failure to comply with Operations Manual procedures or company SOP's during a Line Check. This does not prevent instructors and examiners from giving feedback on CRM issues where appropriate, even if there has not been an effect on the technical performance of the flight.
Assessment is based on repeatedly shown behavioural patterns and not isolated instances.
The crew and, where necessary, the individual shall be debriefed. The crew should be given the opportunity to discover what they are doing and the effect it has on others and the task, so that they can make the decision themselves to alter their behaviour or even reinforce any positive behaviour. Behaviour which is not in accordance with the Bristow CRM Skill Standards can be debriefed with the aim of changing. This contrasts with character traits which cannot be changed. This process should be made as easy as possible by effective facilitation by the CRMI. However, instructional style debriefing may still be appropriate in some circumstances.
De-identified summaries of CRM assessments should be used to provide feedback to update and improve CRM training."

Training Records
At the time of the accident, the Training Manual stated the following about training records:
"Once training and a check or test has been completed, the authorized person conducting the training or check is to forward all completed forms to the Training and Licensing Officer without delay excluding those in Australia, Nigeria and Trinidad. The Training Departments are to ensure that the forms have been completed correctly and a copy is retained on the individual flight crew member's file. The format of training and check forms is given in Volume 2 of the Company Operations Quality Exposition."

Since Amendment 9, dated February 2007, paragraph 9.2 of the Training Manual has stated that:
"Once training and a check or test has been completed for any operation with UK registered helicopters, the Chief Training Captain or his nominee shall ensure that the training records and check forms have been completed correctly and copies are retained in the individual flight crew member's

121 CRM Instructors.

file. For operations with UK registered helicopters, the person conducting the training or check is to then forward all completed check forms and a copy of the training records to the Aberdeen Training Administrator without delay. For worldwide operations without UK registered helicopters, the person conducting the training or check is to forward all completed forms to the applicable Business Unit Training Administrator without delay for entry into the CTRS or equivalent system."

Contractual Training requirements between Company Group and Bristow Helicopters Ltd
The contract between the Company group and Bristow, called Commercial Helicopter Search and Rescue Services in the Netherlands, states in Section IV, article 9, ("Qualified Personnel") some requirements with relevance to training. The more general requirement of 9.1.2 states that: "The CONTRACTOR shall ensure that the crew provided shall be fully qualified in their respective capacities and shall be in the possession of valid and appropriate licences and shall be experienced and in current practice on the HELICOPTERs to be used to perform the WORK." The same article 9 specifically mentions also the HUET and CRM training: "All aircrew engaged on the CONTRACT shall complete the Helicopter Underwater Escape Training (HUET) course and be in the possession of a valid certificate dated within the last three (3) years. All flight crew engaged on the CONTRACT shall complete Crew Resource Management (CRM) training. CRM refresher training for aircrew shall be completed annually." All other training requirements of the contract deal with the training of the more specific SAR elements only. This is specifically true for article 10, Training, of appendix A and for appendix B, entitled "Training Directive". Article 10 also calls for the contractor to keep continuous training records, which are to be made available to the Company group representative upon request.
Relevant to Part 1 of this investigation is the requirement for "JRCC familiarisation at the NCG", which is mentioned in the same Appendix B, article B 3 - Ground Training.

Line Training
At the time of the accident, the only reference to line training was found in section 5.9 of the Training Manual, called "Line Flying under Supervision". Differences between CAT and SAR are not mentioned. Section 5.9 refers to Appendix D of the Manual for the syllabi for line training. Appendix D contains no differentiation between CAT and SAR.

The Supplement to the Operations Manual Part D, also called "Conversion Training AS332L2-Super Puma MkII", contains a "record of Line Flying Under Supervision (Line Training) to be maintained by the Line Training Captain. Training specific to the role (eg SAR) is not included in this syllabus."

Since Amendment 9, dated February 2007, the Training Manual has contained a specific Section 11 entitled "SAR TRAINING". The preceding ten sections do not distinguish SAR from CAT with the exception of section "5.11.1.4 SAR Aircrewmen". This section refers the reader to the aforementioned section 11 for SAR training. Section "5.7 Line Flying under Supervision" also makes no distinction between CAT and SAR. The new section 11 starts with the following general section:

"SAR crews shall meet all CAT initial and recurrent training, checking and recency requirements as stated in Part D, apart from the fact that an Offshore Oil Support CAT Line Check is not required provided that the pilot holds a valid SAR Line Check and does not undertake CAT Offshore Oil Support operations. SAR crews shall also meet SAR specific initial and recurrent training, checking and recency requirements as stated in this section and the associated SAR Appendices."

Line Checking
At the time of the accident, the following lines of section 9.5 of the Training Manual were relevant for the line check requirements:

"Pilots appointed to dedicated SAR units are not required to complete a commercial air transport Line Check while serving on that unit but will complete a SAR Line Check which shall include a night time section, (see note 1). Flight Path Controller Check (FPCC) and a Winch Competence Check. SAR pilots should endeavour to practise night deck landings to a suitable landing site. Pilots at a SAR unit who are required to undertake commercial air transport operations must complete a Line Check as previously specified."

More details of the contents of a line check are given below:

Proficiency Line Check/SAR Role Proficiency Line Check

Introduction

A Company Commercial Air Transport (CAT) Line Check, or SAR Role Proficiency Line Check will be conducted by a Training Captain, Line Training Captain or designated Chief Pilot. The Contents of the CAT Line Check are as follows.

Content of a CAT Check:

Section A Pre-flight, including:

1 Weather assessment and minima
2 Flight planning and fuel/load computation
3 Load and balance and performance calculations
4 Route diversion and destination appraisal
5 External checks and pre-flight procedures.

Section B Handling, including:
1 Start up, ground procedures and taxi (as relevant to type)
2 Take-off and departure procedures
3 Cruise procedures and fuel management
4 Arrival procedures
5 Approach and landing techniques
6 Deck/Site procedures.

Section C General, including:
1 Adherence to ATC
2 Use of checklists
3 Use of radios
4 Altimeter settings
5 Anti-ice and turbulence procedures
6 Meteorology and alternates
7 Briefings and crew supervision
8 Operational decisions
9 CRM documentation
10 CRM
11 Use of area navigation aids
12 Aerad/Jeppesen charts and procedures
13 Passenger/freight management

Section D Area and role competence, including:
Knowledge of special areas and procedures
Adherence to appropriate rules and navigation procedures
Situational awareness
Climatic characteristics including performance criteria.

The Line Check form must show a Night DLP date for regency purposes, otherwise the pilot will be restricted to “Day Only”. The date of a valid night DLP from another current type is acceptable and may be entered.

Content of SAR Role Proficiency Line Check

For use by SAR Pilots, Winch Operators, Winchmen and CAT crews.
Appropriate sections to be completed as operationally required.

Section A Pre-flight, including:
1 Weather assessment and minima
2 Aircraft performance
3 Briefing
4 Aircraft and Equipment check

Section B Winch Competence (CAT crews only complete items marked *)

Section C Flight Path Controller Check

Section D Mountain Flying

Section E First Aid Check (SAR crew all items, CAT crews items marked *)

The Role Check Proficiency Line Form for SAR pilots must show a night time section, including either night winching, or a landing and take off at an approved onshore landing site, for night recency purposes."

Since Amendment 9, dated February 2007, the content of the SAR line check has been included in Appendix E to the Training Manual. The content is the same as mentioned above for the time of the accident. Only the above paragraph which starts with "The Role Check Proficiency Line Form for SAR pilots must show a night time section, etc." has been changed as follows:

"The SAR Line Check for pilots must include a night time section which should include night winching. Where operations to offshore decks are expected, an offshore night deck landing and take-off should also be included, which may be substituted by a night landing and take off at an onshore landing site with the approval of the CAA through SAR Standards."

Section "11.6.1.2 Annual SAR Line Check" states under c. "SAR pilots who are also required to undertake CAT flights must also complete a CAT line check."

APPENDIX I: BRISTOW CREW FLYING DUTIES AND RESPONSIBILITIES

This appendix contains information about (1) extracts related to crew flying duties and (2) specific crew responsibilities derived from Bristow Operations Manual Part A.

(1) Extracts related to crew flying duties

Operations Manual Part A - paragraph 4.5 Division of Duties
Pilot Flying (PF) Pilot not Flying (PNF): The pilot flying a particular sector is to assume the responsibilities and duties of the PF. These will include making decisions affecting the routine operation of the aircraft and its systems. When the PF is not the Commander he is to receive the Commander's approval of these decisions before actioning them. In an emergency he should complete the Immediate Actions and call for the Subsequent Actions from the PNF. The Commander retains overall responsibility for the aircraft whilst acting as PNF, and may revert to PF at any time by taking control from the Co-pilot in the normal manner.

Operations Manual Part A - paragraph 4.6 First Officer Handling the Aircraft
Whenever possible, and without prejudice to passenger comfort and safety, Commanders are to ensure that First Officers are given the opportunity to gain experience in handling the aircraft. The Commander is to carry out the duties of the First Officer, but retain full command responsibility. In the event of an emergency, the First Officer is to take any immediate action necessary and then hand over control should the Commander require it. On commercial air transport flights, First Officers will normally occupy the left hand seat. Pilots under training cleared for P1 U/S may occupy the right hand seat provided that the Commander has undergone an Operator Proficiency Check in the left hand seat. First Officers may handle the controls during take-off and landing; however, the Commander should retain control if he considers that conditions are approaching normal limitations bearing in mind turbulence, windshear and restricted deck space. First Officers are to be encouraged to give standard briefings when they are handling the aircraft, but the Commander is to brief the First Officer that the decision to abort a take-off or landing remains that of the Commander.

Operations Manual Part A - paragraph 8.3.3 Aircraft Checks
Specific checks are to be carried out in accordance with aircraft Normal Operating Procedures (NOPs) and Emergency Operating Procedures (EOPs). The Checklist may be used retrospectively to confirm completion of all in-flight checks. The term "Checklist complete" must be used upon the completion of all defined NOPs and EOPs by the PNF and acknowledged by the PF. Checks, on the ground or in the air, should be conducted in such a manner so as not to endanger the aircraft.

Operations Manual Part A - paragraph 8.3.3.1 Emergency Procedures
Immediate Actions are to be carried out from memory. Subsequent Actions should be carried out from the Checklist. However, in circumstances of high workload it may prove necessary to delay the Subsequent Actions for an unduly long period or to carry them out from memory. In such cases, the Checklist is to be consulted as soon as possible. It should be remembered that there is a difference between a Checklist and a Drill. Therefore the PF or Commander may action something without referring to the Checklist. It then follows that when the Checklist is called for, the PNF will simply confirm that the action has been taken.

(2) Specific crew responsibilities

Authority, Duties and Responsibilities of the Helicopter Captain

The captain shall:

a. Be responsible for the safe operation of the helicopter and safety of its occupants and cargo when rotors are turning.

c. Have the authority to give all commands he deems necessary for the purpose of securing the safety of the helicopter and of persons or property carried therein, and all persons carried in the helicopter shall obey such commands.

g. Ensure that all passengers are fully briefed on:
   The use of the seatbelt or harness
   The location and operation of emergency exits
   The method of locating and jettisoning windows
   The method of opening and emergency jettisoning of cabin doors
   The method of deploying life rafts and their subsequent operation
   Deployment and the use of the radio beacon (as applicable)
   Other types of specific safety features
   The need to read the passenger briefing card.

h. Ensure that all operational procedures and checklists are complied with, in accordance with the Operations Manual.

p. Take all responsible steps to ensure that before take-off and before landing the flight and cabin crew are properly secured in their allocated seats.
NOTE: Required cabin crew should be properly secured in their allocated seats during taxy except for when performing essential safety-related duties.

q. Take all reasonable steps to ensure that whenever the helicopter is taxying, taking off or landing, or whenever he/she considers it advisable (e.g. in turbulent conditions), all passengers are properly secured in their seats, and all cabin baggage is stowed in the approved stowages.

Emergencies
The Commander shall, in an emergency situation that requires immediate decision and action, take any action he considers necessary under the circumstances. In such cases he may deviate from rules, operational procedures, and methods in the interest of safety.

Publications
The Commander must maintain an up-to-date knowledge of the following publications and documents and carry out his/her duties in the air and on the ground in accordance with the provisions therein:

The Operations Manual
Base Instructions
Operations Circulars
The Aircraft Flight Manual
The Aircraft Crew Notes
Statutory Instruments, Aeronautical Information
Publications and Notams, Information Circulars,
Supplementary Bulletins.

Duties and Responsibilities of the First Officer/Co-pilot

Function
The First Officer/Co-pilot is responsible for assisting the Captain in the safe and efficient conduct of the flight. In the event of the incapacitation of the Captain, the First Officer will assume command. The First Officer/Co-pilot's Departmental Head to whom he/she is responsible when not reporting directly to a Captain, is his/her Chief Pilot.

General Responsibilities
The First Officer/Co-pilot must take all reasonable steps to:

c. Assist the Captain as requested with the administrative duties in relation to the planning and execution of the flight.

Specific Responsibilities
It is the specific responsibility of the First Officer/Co-pilot:

a. To carry out such duties concerning the flight, in accordance with Company Standard Operating Procedures, including procedures, limitations and performance relating to the specific helicopter type, as are allocated to him by the Captain.
b. To confirm the safe navigation of the helicopter, maintaining a continuous and independent check upon both the geographical position of the helicopter and its safe terrain clearance.
c. To volunteer such advice, information and assistance to the Commander as may contribute towards the safe and efficient conduct of the flight.
d. To seek and receive such information and/or explanation from the Captain as may be necessary to enable the First Officer to fulfil his function.
f. To support the Captain, by active example, in the development and maintenance of a high standard of professional expertise and morale amongst the crew, when carried.
g. On a flight where a cabin crew member is not carried, his responsibilities are those appropriate to the task as detailed in paragraph 1.7 of this section (duties of the cabin crew members).

Duties and Responsibilities of the Cabin Crew members

Function
Cabin crew members have a responsibility to the helicopter Captain and shall carry out his/her instructions and assist him/her in the safe operation of the aircraft.
A cabin crew member's departmental head to whom he/she is responsible when not reporting directly to a Captain, is his Chief Pilot.

General Responsibilities
Cabin crew members must take all reasonable steps to:

c. Assist the Captain as requested concerning administrative duties in relation to the flight.

Specific Responsibilities of a Cabin Attendant

a. Checking the availability and serviceability of passenger seats, seatbelts, safety and survival equipment.
c. Ensuring that passengers enter and leave the aircraft safely and in an orderly manner.
d. Supervision of the correct closure of doors, hatches etc.
e. Ensuring that passengers are seated in accordance with the load plan, and assisting them in the use and operation of seatbelts and lifejackets.
f. Giving passengers a full pre-flight briefing, when they have not viewed a pre-flight Video Briefing within the previous 24 hours. In cases where an audio briefing tape is available, the Cabin Attendant shall ensure all passengers wear their headsets to receive the safety briefing.
h. Maintaining intercom with the pilot and carrying out his instructions, and advising him of any incident which could affect the safety of passengers or aircraft.
i. The discipline and well-being of the passengers during flight.
m. On instruction from the Commander, the jettisoning of emergency exits, the launching of dinghies and other survival equipment, and the safe evacuation of passengers in the event of an emergency.

Specific Responsibilities of a Winch Operator
The Winch Operator is responsible for all the duties of a Cabin Attendant as listed above. His/her additional responsibilities are detailed in the Commercial Air Transport Winch Supplement to this Manual.

Specific Responsibilities of a Winchman
The Winchman is responsible to the Commander through the Winch Operator. He/she shall carry out his/her instructions and assist the Commander in the safe operation of the aircraft. His additional responsibilities are detailed in the Commercial Air Transport Winch Supplement to this Manual.

Specific Responsibilities of a Search and Rescue Crewman
Search and Rescue crewmen are responsible for all the duties of a cabin attendant as listed above. The specific responsibilities as an SAR crewman are detailed in the Search and Rescue Supplement to this manual.

Supplement to Bristow Operations Manual Part A - Search and Rescue Operations

Crew Responsibilities - Departure
Each member of the crew must be aware of his/her responsibilities in the pre-manning phase. These responsibilities shall be delegated by the Captain at the beginning of the duty period. On manning the aircraft the Captain shall nominate the Pilot Flying. The Captain shall also delegate the use of radios as necessary.

Crew Responsibilities - En route
At the top of climb, the Captain will delegate crew responsibilities.
These will include:

Pilot Flying - normally Co-pilot
Navigation and Comms - normally Pilot not Flying.
Follow navigation and manual plot - normally crewman
Radio log and FM Comms - normally crewman
The Commander should delegate as much as possible, leaving himself free to monitor the cockpit and assess the overall situation.

Crew Responsibilities - Maritime Searches (specific for searches)

Crew Responsibilities - The Rescue (specific for winching)

Crew Responsibilities - Recovery
The Captain will delegate various functions among the crew, which will include, but not be limited to:

Pilot Flying
Navigation and communications
Follow nav. and plotting
Care of survivors
FM communications
In extreme situations the Captain may have to consider releasing the Co-pilot to assist with providing medical attention to the survivors. This discretion should not be exercised until the helicopter is established in a stable flight condition and cockpit workload is contained by one pilot.

APPENDIX J: NAM CONCLUSIONS, RECOMMENDATIONS, AND FOLLOW-UP

NAM performed its own investigation of the incident. The scope of the NAM investigation included the decision to evacuate, the performance of safety equipment and emergency procedures, rescue, recovery and emergency response processes. The scope excluded the power failure on K15-FB-1 platform and the technical failure of the helicopter. The relevant conclusions and recommendations from the NAM report, including the follow-up actions, are reported concisely below.

Decision to evacuate

Conclusions:

1) There was no real emergency on K15B (nor on the Noble George Sauvageau) which warranted an evacuation of non-essential staff after 21.00 with the G-JSAR helicopter:
   a) well-being of staff was the main driving force for transport to shore;
   b) the risk of helicopter flying was insufficiently taken into account in the decision making process;
   c) the specific risk of using G-JSAR for transportation was not understood.
2) There was consensus by those involved in the decision to transport non-essential staff to shore by G-JSAR:
   a. although the HCO was formally accountable for this decision, it is unclear who really felt accountable to take the final decision to evacuate;
   b. the decision was supported by existing practices and policies:
      - the "no hot-bedding" practice on the NGS is seen as a policy and was not challenged; nor were alternative forms of an overnight stay accepted (e.g. in the recreation room);
      - there is a policy in place that scheduled that flying stops after 21:00 hrs.
3) NAM's infrastructure is dependent on regular flying and flying risks and mitigation measures are included in high-level risk analyses (e.g. as used for Safety Cases and Rescue at Sea analyses). There is, however, limited evidence of trend monitoring or periodic evaluation of the helicopter risks with the ultimate goal to confirm ALARP.
4) There was insufficient challenge (and intervention) to prevent the use of G-JSAR to transport staff to shore.

Recommendations:

1) Gather data on flying patterns and exposure to gain insights if total risks are managed to ALARP and aligned with the Safety Case and Rescue at Sea analyses and:
   a) increase hurdles for the approval of any flights incremental to the planned flight schedule;
   b) include exposure data for management review (e.g. at Business Performance Review meetings).
2) Use this incident as an example.
3) Reconfirm and clearly communicate the policies regarding Southern North Sea (SNS) normal flight times, airport opening times and SAR usage (including agreed exceptions). This is to be aimed at all those who manage and control offshore activities in the SNS.
4) Develop guidance and communicate under which emergency conditions, unplanned hot-bedding or other bedding arrangements are permissible to maintain ALARP (NL sector only).

Follow-up:

1) Data was gathered on patterns and exposure and analysed by technical safety. Helicopter risks (IRPA) vary within the assessed population between 5*10-5 to 3*10-4 and match reasonably with HSE case assumptions apart from specific trades or individuals in the large population. Technical Safety concludes that helicopter logistics in ONEgas appear to be adequately organised and well documented. Summarising: the risks are managed to ALARP:
   a) The flight scheduling unit has been instructed to not accept additional flights without ONEgas Head of Operations approval;
   b) Discussed which data to include, however meaningful data for management review has not yet been finalised.
3) E-mail sent to offshore community and area managers explaining and clarifying airport opening hours, Shell EPE air logistics operating hours in the SNS area. SAR availability is regularly updated and all interested parties informed.
4) Guidance on hot bedding is developed and approved by the line. Uploaded within the Corporate Management System.

Survival at sea and rescue

Conclusions:
1. The aircraft carried three life rafts, of which only one was deployed successfully. Only two out of the 17 passengers and crew managed to board this life raft.
2. There are mixed beliefs regarding whether a helicopter landing with floats deployed will capsize immediately after landing and a lack of clarity regarding whether passengers/crew should remain onboard until life rafts are deployed, or evacuate immediately to sea.
3. Some Personal Protective Equipment did not perform to, or deviated, from the industry standard, or was not used effectively by the survivors:
    a) the passengers' survival suits ranged from soaking wet through to relative dryness;
    b) the hoods were not used.

Recommendations:
1. Investigate the failure to deploy the life rafts and propose improvement actions. Extend this investigation to life rafts on other helicopter types depending on the nature of the findings.
2. Develop an aligned view for crew/passenger recommended actions after ditching. Incorporate the outcome into crew instructions, Helicopter Underwater Escape Training (HUET) and passenger briefings.
3. Improve the effectiveness of Personal Protective Equipment:
    a) continue to investigate the passenger suits to determine why some of the passenger suits leaked and develop a follow up programme. There is concern about the neck/wrist seal fit;
    b) review the design for hoods and gloves carried within the pockets of the survival suit for ease of donning in the water and investigate why some of the lights on the life jackets did not function;
    c) increase the practice of donning hoods/gloves and using buddy lines/spray hoods during training.
    d) use LAPP life jackets in the SAR aircraft (e.g. via a grab bag) for cases when there is time to use them (e.g. during precautionary de-manning). Align with NOGEPA and the SAR operator;
    e) ask suit/life jacket manufacturers to consider solutions to slippery suits in relation to recovery of survivors from the water.
4. Propose to SAR aircraft operators that they determine how to provide SAR helicopter safety briefings to passengers before flights (dependent on the circumstances and time available). e.g. during precautionary de-manning.

Follow-up:

1) Bristow has carried out refresher training for all the rear crew in their SAR aircraft. In addition, SAI in conjunction with all SNS operators have investigated the release mechanisms and maintenance requirements on all external life rafts on aircraft operates in the SNS and two small deficiencies have been identified. These have been taken up with the manufacturers and rectified. Eurocopter have also issued a Service Bulletin to inspect the life raft release on all AS332L2 aircraft to ensure that it is in full working order.

2) Bristow have reviewed the rear crew training and EPE Air Operations have briefed/discussed the circumstances behind it with OPITO. The conclusion was that there was no need to change the standard crew change passengers briefing. Bristow along with the other SAR providers have discussed briefings and have added this into their rear crew training.

3a) There have been extensive tests carried out on the suits with no conclusive results. NAM now feels that it has gone as far as it can with the testing on the suits and is satisfied that there is no issue with the seals. NAM has also issued the Safety Notice to highlight checking the suits at check in and reinforce the need to check suits given to all travelling passengers. The suit manufacturer agrees with the NAM and SAI conclusion and thinks there is nothing further to be gained by more testing and has also passed this on to the UK AAIB and Dutch Safety Board. NAM also looked at the option of alternate neoprene seals, but Shark has misgivings about inspecting these for serviceability over a long term and does not want to change the current ones, which NAM accepts.

3b) Design reviewed with suit manufacturer. The current design has been developed over a considerable period of time. Hoods designed to be fitted as part of helicopter ditching drill. Glove design being reviewed with consideration being given to fitting coloured panels or reflective tape to back of gloves to assist with identification. This has been covered with the manufacturer and will be developed in future

3c) This was studied in conjunction with OPITO and as well as highlighting that all of these items are included in the syllabus, the following responses were received:
Hoods - During Ditching Drill Helmets are worn for HSE reasons, so it is not possible to don hoods during a drill when they should be donned in a real emergency, i.e. on Brace, Brace,

Brace, command from the pilot. Note - In the G-JSAR it appears that this command was not given
Buddy Line; Again, due to HSE reasons this is not practical, as you could have 6 feet of line hanging out of your life jacket impeding your exit.
Gloves; These are not fitted to the suits used in training and OPTIO felt that this would have very limited value, as it would be necessary to keep a box of these on the pool side and ask the trainees to put them on
Spray Hood: These are regularly used in training. These items were all covered very well in a full BOSIET course training.
After review, it was agreed that Shell Aircraft should write to OPITO on behalf of EPE and the wider Shell Group highlighting the issues found during the investigation. Shell requires all passengers to be trained to OPTIO standard for HUET.

3d) Actions have taken place.

3e) This problem was brought to the attention of the manufacturers and is also being discussed with Shell Aircraft and AAIB in the overall context of suit design.

4) Discussed with Bristow and an agreement made that they will always provide a safety briefing wherever circumstances permit this.

APPENDIX K: BRISTOW SPECIAL BULLETIN

After the G-JSAR accident, Bristow drafted a Special Bulletin, because significant problems with regard to survivability were revealed in the early stages of its internal investigation. What is more, the entire Operation Manual Part D (Training Manual) was rewritten as a result of learning of the accident. This appendix contains the Special Bulletin and information regarding the new aircraft evacuation drill training during initial and recurrent training for flight crew and rear crew.

Eastern Hemisphere Flight Safety Office - Special Bulletin

ACCIDENT

Aircraft Type and Registration:	AS332L2, G-JSAR
Manufacturers Serial Number:	2576
No and Type of Engines:	2 Turbomeca Makila 1A2 engines
Year of Manufacture:	2002
Date and Time (UTC):	21st November 2006 at 22:17 (tbc)
Location:	Approx 12nm Northwest of Den Helder
Type of Flight:	SAR
Persons on Board:	17
Injuries:	Nil
Nature of Damage:	Aircraft Ditched
Commander's Licence:	ATPL(H)
Commander's Age:	33 yrs
First Officer's Age:	39 yrs
Commander's Flying Experience:	Approx 3.500 hrs of which approx 600 were on type
First Officer's Flying Experience:	Approx 1,200 hrs of which approx 200 were on type
Information Source:	Field Investigation in co-operation with state investigation.

All times in this report are UTC
Local time is UTC + 1hr

History of the Flight

Bristow Helicopters provides a Search and Rescue (SAR) helicopter at Den Helder airport in the Netherlands. The aircraft is funded by a consortium of oil companies and placed, as a 'declared' SAR asset, under the operational control of the Dutch Coastguard.

At approx 21:00, the Netherlands Coastguard contacted the Commander of G-JSAR, the SAR helicopter based at Den Helder, tasking the aircraft to proceed to the position of the K15-B platform [53° 16.6'N 003° 52.4'E] where, due to a power failure on the platform, the workforce had moved onto the adjacent, connected, 'jack-up' rig, the Noble George. This exodus had resulted in the Noble George becoming overmanned by 13 persons and G-JSAR was to return those people to Den Helder.

G-JSAR departed Den Helder at 21:35 climbing on track to 2000ft en-route the Noble George receiving an Air Traffic Control service from Den Helder approach. An uneventful landing was made on the Noble George at 22:00.

The passengers were provided with lifejackets and boarded under the supervision of the two cabin crew members. Using the aircraft's public address system, the Commander gave the passengers a flight brief, checks were completed and the aircraft departed Nobal George for Den Helder at 22:10 climbing to 3000ft with an estimated time of arrival at Den Helder of 22:30 once again under an air traffic service from Den Helder approach. During the return flight, the aircraft suffered an engine malfunction followed by an intermittent jamming of the cyclic flying control. The crew decided to ditch the aircraft and it entered the water approximately 12nm NW Den Helder. The weather reports indicated a southerly wind of some 25kts which was driving the sea into 2-3 metre waves. It was dark with no moon

Initial investigation

After the ditching, all passengers and crew vacated the aircraft with no injuries and were picked up later by surface vessels. Nevertheless significant problems have been revealed during the early stages of the investigation and which deserve publicity before the interim Company report or the formal DSB reports are published.

Survivability

Cabin evacuation.
Once on the water, the aircraft motion caused the rear crew, fearing an imminent capsize to evacuate the passengers into the water. In CAT aircraft passengers are briefed before every flight on the actions to be taken in the event of a ditching, however, when rear crew are carried it is natural that the pax will turn to them for instructions. Evacuation drills, specific to each aircraft type, are not practiced by rear crew authorised to operate the type.

> *It is thus recommended that the E&S check for rear crew include a cabin evacuation utilising live persons.*

Dinghy deployment
One member of the rear crew attempted to deploy the dinghy housed in the starboard sponson by the alternate deployment method. Whilst attempting this, that dinghy's main deployment handle was within 3ft of the crew member but was not used. The second rear crew member re-entered the cabin in order to retrieve the 'air droppable' dinghy and whilst doing so, noticed the port cabin door emergency jettison handle, thought that it was a means of deploying the port sponson dinghy and pulled it. As the door was already open, nothing happened and he continued to recover the air droppable dinghy.

Although both rear crew were aware of the location of the normal operating handles for the main dinghies and the cabin doors, in the stress of a real ditching this knowledge was forgotten.

> *It is therefore recommended that, in order to reinforce the academic learning, E&S checks be amended to require the candidate to physically pull those handles which would be required to be activated in a real ditching.*

The attempt to deploy the sponson dinghy by its alternate means was severely hindered by a lack of familiarity of the contents of that stowage and in the darkness, the crew member was unable to locate the alternate firing handle.

It is thus recommended that E&S Training in aircraft with sponson mounted dinghies with a means of deployment contained within the stowage, be expanded to require the visual identification (and touch drill) of that deployment handle.

Application to other aircraft types.
The dinghy deployment system of the EC225 is virtually identical to that on G-JSAR. The handles on the G-JSAR are contained within a housing, painted yellow, in an area of the aircraft painted black. They thus stand out well. Similar handles on the EC225 are painted dull red in a dark blue housing in an area of the aircraft painted dark blue - they are thus effectively camouflaged.

It is recommended that the housing of the EC225 handle be painted a colour which contrasts with the airframe making them easier to identify.

Differing colour schemes are effective in daylight but are ineffective in darkness.

It is thus recommended that all primary deployment handles of sponson mounted dinghies are illuminated whenever the floatation equipment is activated.

EH Flight Safety Office
22 Dec 06

APPENDIX L: EUROCOPTER PRELIMINARY INTERNAL ACCIDENT INVESTIGATION REPORT

eurocopter
an EADS Company

Marignane le mardi 28 novembre 2006

ESTC225 N° 7487/06

DIRECTION TECHNIQUE SUPPORT
13725 Marignane Cedex
tél. 42.85.97.31 - Fax 42.85.99.66
Télex 420 506 F/ST

ACCIDENT D'HELICOPTERE EUROCOPTER
INFORMATION PRELIMINAIRE

DESTINATAIRES

Interne

Président & CEO
EADS/AEROASSURANCE
ET
ETX → ETXF → ETXFPN →ETXFPS
ETXC→ETXC(225)
ETI → ETIA ETIS ETASM
EKL → EKLS
EFFI
EH→EH(225)
EC → ECR → ECRB
EE
EXF
ED → EDI
ES
ESR
ESC → ESC (225)
EST
ESTA
ESTC →ESTC (225)
ESTI →ESTIA → ESTIO
ESTS ESTV
ESTD →ESTDI
ESRPT
HELISIM
Eurocopter Training Service
® Rayer les mentions inutiles

Externe

X = Systématiquement
O = Cocher si concerné

	MILITAIRE FRANCE	MILITAIRE EXPORT	CIVIL
BEA			X
DGAC/SFACT/N			X
BEA-Défense			O
SPAé/HE			X
DGA/DRI			
GSAC (Paris)			X
GSAC(Marign)			X
DPM/SQ (Marign)			
OGA			O
OFEMA			O
TURBOMECA			X
ALLISON			O

TYPE	N° DE SERIE	IMMAT.	OPERATEUR
AS332 L2	2576	G-JSAR	Bristow Helicopters Ltd

DATE	HEURE	LIEU
21/11/2006	23H (UTC)	Au large de Den Helder (Hollande)

CIRCONSTANCES :

En vol de croisière, mission SAR, après avoir réduit l'altitude de l'hélicoptère suite à un allumage du voyant Diff NG, l'équipage rapporte des points durs dans la commande cyclique et décide, après avoir lancé un Mayday, de procéder à un amerrissage d'urgence. L'amerrissage s'effectue après que la flottabilité de secours ait été déployée. L'évacuation s'effectue par canot de sauvetage. L'appareil dérive et s'échoue sur une plage.

CONSEQUENCES :

EQUIPAGE	4	PASSAGERS	13
Equipage	N	Identités non communiquées	N
F = FATAL - Blessures : G = GRAVES, L = LEGERES - N = NEANT			

HELICOPTERE	FEU	TIERS :
Structure et PdeQ endommagées + dommages liés à la pénétration de l'eau de mer dans la cabine au cours de la dérive	Non	Non

ENQUETE PAR :

Deutsch Safety Board
BEA
AAIB
Eurocopter

STC

APPENDIX M: EUROCOPTER TELEX INFORMATION

eurocopter
an EADS Company

T.F.S. No. 00000461 of 11/06/2008
EUROCOPTER - MARIGNANE - TLX 42506F

INFORMATION TELEX

AIRCRAFT:	**AS 332**	Civil versions: Military versions:	**C, C1, L, L1, L2** **B, B1, F1, M, M1**
AIRCRAFT:	**AS 532**	Military versions:	**A2, U2, AC, AL, SC, UC, UL, UE**
AIRCRAFT:	**SA 330**	Civil versions: Military versions:	**F, G, J** **Ba, C, Ca, Ea, H, JM, L, S1, Sm**
AIRCRAFT:	**EC 225**	Civil version:	**LP**
AIRCRAFT:	**EC 725**	Military version:	**AP**

ATA: 67

SUBJECT: ROTORS FLIGHT CONTROL

CAUTION

THE INFORMATION CONTAINED IN THIS INFORMATION TELEX IS INTENDED FOR MAINTENANCE PERSONNEL AND CREWS.

Dear Customer,

EUROCOPTER has been told and would like to inform you of the following events that occurred in service on an AS332L1 helicopter.

During the flight, the crew noted that the flight controls felt stiffer, with discontinued inputs, with noise of "jarring" coming from the hydraulic cabinet, and without "AP.HP" indicator light illumination. Then, the crew cut off the autopilot unit hydraulic system and limited the duration of the flight.

The investigations conducted by EUROCOPTER reveal that this situation is probably the result of the following actions:

--- No particular crew action, except collective lever inputs.
--- Failure of one of the 2 autopilot hydraulic unit switches on the collective levers.
--- Uncontrolled and repeated activation of the autopilot hydraulic unit solenoid valve.

T.F.S. No. 00000461 of 11/06/2008
EUROCOPTER - MARIGNANE - TLX 42506F

Repeated activation of the solenoid valve may generate discontinued inputs to the flight controls. These discontinued inputs were felt through the cyclic stick, collective lever and the yaw pedals, at intervals that do not cause illumination of "AP.HP" light on the MK1 ("AP.HYD" light on the SA330 or "AP.P" light on the MK2, EC225) on the warning-caution panel.
Due to the fact they are time-delayed, these indicator lights will come on only approximately 0.7 seconds after a decrease in the hydraulic pressure has been detected.

This situation may be not permanent. However, it may occur again randomly without inducing noise similar to "jarring".

The phenomenon may stop with the solenoid valve remaining in its stable open position, which will cause the illumination of the "AP.HP" light on the MK1 ("AP.HYD" light on the SA330 or the "AP.P" light on the MK2, EC225), requiring the crew to handle the helicopter with no autopilot hydraulic assistance.

In any cases, the control inputs will not exceed those required with no autopilot hydraulic unit assistance. However, discontinued inputs will produce more or less discomfort to the pilots depending on the type of helicopter.

Such situation shall be treated according to the instructions related to the failures defined in Flight Manual (PMV) Section 3.2

- SA330: § Abnormal Operation of hydraulic systems and associated systems “Illumination of the AP.HP light”.
- MK1: § Autopilot Hydraulic System Failure "Illumination of the AP.HP light".
- MK2, EC225, and EC725: § Hydraulic System Failure "Illumination of the AP.P light".

As a consequence, in the event of such situation, please refer to these instructions.

APPENDIX N: HEALTH AND SAFETY INFORMATION BULLETIN

The State Supervision of Mines did not conduct a separate investigation, but instead took part in the investigation carried out under the control of the NAM. The results of the investigation were issued in a Health and Safety Information Bulletin.

Staatstoezicht op de Mijnen

Veiligheid - en Gezondheids informatiebulletin

Nr. : 01/07 (Rev. 1)
Datum : 20 maart 2007.
Onderwerp : Onderzoek naar de noodlanding van de NOGEPA reddingshelikopter[1]

Beschrijving van het voorval
In verband met een algehele stroomstoring op een mijnbouwinstallatie in de avond van 21 november 2006 werden 13 personen van de installatie naar Den Helder geëvacueerd, vanaf de mobiele boorinstallatie die naast de mijnbouwinstallatie stond (en hiermee met een brug verbonden was). De hiervoor ingezette NOGEPA reddingshelikopter (roepletters G-JSAR) moest tijdens de evacuatie omstreeks 23.30 uur door technische problemen een noodlanding maken op zee, op ongeveer 12 zeemijlen Noordwest van Den Helder. Alle passagiers en de twee piloten verlieten de helikopter door in zee te springen. De twee andere bemanningsleden konden nog een klein reddingsvlot activeren en hiervan gebruik maken. Na 75 minuten waren alle passagiers, piloten en bemanningsleden gered en naar een veilige plaats gebracht, door een toevallig in de buurt aanwezig schip van Rijkswaterstaat, een reddingsboot van de KNRM en SAR helikopters van de marine. Eén van de passagiers vertoonde lichte onderkoelingsverschijnselen en werd naar het ziekenhuis in Alkmaar overbracht; na enkele uren werd hij uit het ziekenhuis ontslagen.

Onderzoek
Direct na het voorval werden er meerdere onderzoeken gestart, nl. door de Onderzoeksraad voor Veiligheid (OVV), de Dienst Luchtvaartpolitie van de KLPD en de betrokken mijnonderneming. Een inspecteur van Staatstoezicht op de Mijnen (SodM) heeft deelgenomen aan het onderzoek van de mijnonderneming, waardoor het aantal afzonderlijke onderzoeken werd beperkt. Het doel van de deelname van SodM was om te leren van dit voorval en belangrijke bevindingen z.s.m. te delen met de industrie in zijn geheel. De aandachtspunten voor het onderzoek betroffen de beslissing tot het evacueren van de mijnbouwinstallatie, het functioneren van de veiligheidsuitrusting (persoonlijke beschermingsmiddelen) en de noodprocedures, alsmede de reddingsoperatie en de activiteiten van de bij het voorval betrokken calamiteitenorganisaties.
De technische problemen van de reddingshelikopter (waarvoor SodM geen bevoegdheid heeft) zijn niet bij dit onderzoek meegenomen; dit wordt onderzocht door de OVV en de KLPD.
In het kader van ons onderzoek zijn interviews gehouden met de passagiers en andere betrokkenen, zijn logboeken en documentatie doorgenomen en is de veiligheidsuitrusting onderzocht. De gegevens zijn door het onderzoeksteam geanalyseerd. Daarbij is gebruik gemaakt van de TRIPOD methodiek.

Samenvatting van de conclusies, aanbevelingen en aandachtspunten
Hieronder zijn wat SodM betreft de voornaamste conclusies, aanbevelingen en aandachtspunten weergegeven, die belangrijk zijn voor de industrie in zijn geheel. Deze aanbevelingen en aandachtspunten zouden bij voorkeur industriebreed moeten worden opgevolgd, daar waar nodig samen met de helikopter operators en andere dienstverlenende instanties.

Conclusies:

1. Hoewel de beslissing tot evacueren is genomen met de beste bedoelingen voor het personeel en de beslissing ook is afgestemd met alle leidinggevenden, had de NOGEPA reddingshelikopter achteraf gezien niet gebruikt moeten worden voor deze evacuatie. Er was geen sprake van een directe noodsituatie, het personeel had – hoewel geïmproviseerd en wat ongeriefelijk – op de mobiele boorinstallatie kunnen blijven.
2. De twee extern gemonteerde reddingsvlotten van de reddingshelikopter konden niet worden ingezet / geactiveerd. Een derde (kleiner) vlot is later door de bemanningsleden ingezet maar is snel van de helikopter afgedreven, waardoor er geen passagiers of piloten aan boord konden worden genomen.

[1] De reddingshelikopter is onder contract bij NOGEPA (Nederlandse Olie en Gas Exploratie en Productie Associatie), om te voldoen aan artikel 3.37v van het Arbobesluit.

3. Er bestaan verschillende opvattingen over het gedrag van een helikopter nadat deze te water is geraakt en de drijflichamen zijn geactiveerd. Ook is er onduidelijkheid of passagiers en bemanning aan boord moeten blijven of direct uit de helikopter in zee moeten gaan. In het geval van de reddingshelikopter ging men ervan uit dat deze zou omslaan, wat in werkelijkheid niet is gebeurd.
4. Sommige persoonlijke beschermingsmiddelen hebben niet optimaal gefunctioneerd of zijn niet effectief gebruikt. Zo hadden enkele dompelpakken water doorgelaten, zijn de capuchons en handschoenen niet door iedereen gebruikt en werkte bij sommigen de verlichting van de reddingsvesten niet.
5. Hoewel de calamiteiten organisaties van de mijnonderneming resp. de (hoofd)aannemer volgens plan zijn gemobiliseerd was de onderlinge wisselwerking en coördinatie niet optimaal, o.a. t.a.v. het informeren van de familie van de passagiers, de opvang van de passagiers in Den Helder en het regelen van vervoer voor de passagiers van Den Helder naar huis.
6. Omdat de Kustwacht en andere hulpdiensten prioriteit geven aan het beheersen van de noodsituatie boven het informeren van 'derden', heeft het ongeveer 40 minuten geduurd voordat de mijnonderneming over het voorval werd geïnformeerd. Hierdoor duurde het enige tijd voordat het crisisteam van de mijnonderneming was gemobiliseerd.

Aanbevelingen:
1. De huidige procedure en praktijk voor het inzetten van Search and Rescue (SAR) middelen (inclusief "medevacs") dient opnieuw bekeken te worden en er moet worden gezorgd dat daarover overeenstemming bestaat tussen de Kustwacht en NOGEPA.
2. Mijnondernemingen dienen zeker te stellen dat de onderhoudsprocedures en –systemen van de (door hen ingehuurde) helikopteroperators naar behoren werken, zodat reddingsvlotten van helikopters altijd functioneren c.q. beschikbaar zijn.
3. Onderzoek c.q. verbeter de effectiviteit van persoonlijke beschermingsmiddelen (en het gebruik ervan), zoals dompelpakken, capuchons, handschoenen, alsmede 'buddy lines', gelaatschermen en verlichting van de reddingsvesten.
4. Mijnondernemingen dienen de onderlinge relatie tussen de eigen calamiteitenorganisatie en die van de (hoofd)aannemer(s) te verduidelijken, te optimaliseren en te oefenen.
5. Stem met de Kustwacht af hoe mijnondernemingen sneller geïnformeerd kunnen worden over een voorval, opdat een vertegenwoordiger van de mijnonderneming zo spoedig mogelijk aanwezig kan zijn in het Kustwachtcentrum tijdens de afhandeling van een voorval.

Aandachtspunten:
1. Er bleek onduidelijkheid te bestaan over wat de acties van piloten, bemanning en passagiers moeten zijn na een noodlanding van een helikopter op water. Breng hier duidelijkheid in en neem dit dan op in de HUET trainingen en de instructies voor piloten, helikopterbemanningen en passagiers.
2. Passagiers van de reddingshelikopter hebben gebruik gemaakt van drie typen reddingsvesten, waarvan er twee afweken van het normaal door de industrie gebruikte type. Er dienen afspraken gemaakt te worden tussen NOGEPA en de operator van de reddingshelikopter over het gebruik van het standaard type reddingsvest, rekening houdend met de omstandigheden van de noodsituatie.
3. Bij het redden van de passagiers uit het water bleken de dompelpakken glad te zijn. Er dient met de fabrikanten van de dompelpakken (en reddingsvesten) te worden overlegd welke oplossingen hiervoor mogelijk zijn.
4. De passagiers van de reddingshelikopter hebben geen specifieke veiligheidsinstructie gehad voor aanvang van de vlucht. Er dient met SAR operators te worden overlegd op welke wijze instructie gegeven kan worden aan passagiers (voor aanvang van een vlucht, daar waar tijd en omstandigheden dat toelaten).

NB: De overige onderzoeken (van de OVV en de KLPD) zullen later worden afgerond en betreffen ook andere onderwerpen zoals bijvoorbeeld de technische problemen van de helikopter. Daar waar de gebieden van deze onderzoeken het onderhavige onderzoek overlappen zullen de conclusies en aanbevelingen hoogstwaarschijnlijk aanvullend, maar meer gedetailleerd zijn.

Vervolgacties SodM:
Staatstoezicht op de Mijnen heeft NOGEPA over de conclusies en aanbevelingen geïnformeerd en gevraagd ons over de opvolging c.q. voortgang hiervan op de hoogte te houden. Dit zelfde zal t.z.t. gelden voor de conclusies en aanbevelingen die uit de andere onderzoeken zullen voortkomen.

APPENDIX O: RELEVANT JAR-OPS PART 3 SUBPARTS

This appendix presents a summary of the details of the relevant JAR-OPS 3 requirements.

SUBPART B - GENERAL

JAR-OPS 3.005 General
(a) An operator shall not operate a helicopter for the purpose of commercial air transportation other than in accordance with JAR-OPS Part 3.
(b) An operator shall comply with the requirements in JAR-26 applicable to helicopters operated for the purpose of commercial air transportation. Until formal adoption of JAR-26, current national aviation regulations will apply.
(c) Each helicopter shall be operated in compliance with the terms of its Certificate of Airworthiness and within the approved limitations contained in its Helicopter Flight Manual.

JAR-OPS 3.010 Exemptions
The Authority may exceptionally and temporarily grant an exemption from the provisions of JAR-OPS Part 3 when satisfied that there is a need and subject to compliance with any supplementary condition the Authority considers necessary in order to ensure an acceptable level of safety in the particular case.

JAR-OPS 3.035 Quality System
(a) An operator shall establish one Quality System and designate one Quality Manager to monitor compliance with, and the adequacy of, procedures required to ensure safe operational practices and airworthy helicopters. Compliance monitoring must include a feedback system to the Accountable Manager to ensure corrective action as necessary.
(b) The Quality System must include a Quality Assurance Programme that contains procedures designed to verify that all operations are being conducted in accordance with all applicable requirements, standards and procedures.
(c) The Quality System and the Quality Manager must be acceptable to the Authority.
(d) The Quality System must be described in relevant documentation.

JAR-OPS 3.037 Accident prevention and flight safety programme
(a) An operator shall establish an accident prevention and flight safety programme, which may be integrated with the Quality System, including:
(1) Programmes to achieve and maintain risk awareness by all persons involved in operations; and
(2) An incident reporting scheme to enable the collation and assessment of relevant incident and accident reports in order to identify adverse trends or to address shortfalls in the interests of flight safety. The scheme shall protect the identity of the reporter and include the possibility that reports may be submitted anonymously; and
(3) Evaluation of relevant information relating to accidents and incidents and the promulgation of related information, but not the attribution of blame; and
(4) The appointment of a person accountable for managing the programme.
(b) Proposals for corrective action resulting from the accident prevention and flight safety programme shall be the responsibility of the person accountable for managing the programme.
(c) The effectiveness of changes resulting from proposals for corrective action identified by the accident prevention and flight safety programme shall be monitored by the Quality Manager.

SUBPART C - OPERATOR CERTIFICATION AND SUPERVISION

JAR-OPS 3.175 General rules for Air Operator Certification and Supervision
(a) An operator shall not operate a helicopter for the purpose of commercial air transportation otherwise than under, and in accordance with, the terms and conditions of an Air Operator's Certificate (AOC).
(f) An AOC will be varied, suspended or revoked if the Authority is no longer satisfied that the operator can maintain safe operations.
(g) The operator must satisfy the Authority that:
  (1) Its organisation and management are suitable and properly matched to the scale and scope of the operation; and
  (2) Procedures for the supervision of operations have been defined.
(h) The operator must have nominated an accountable manager acceptable to the Authority who has corporate authority for ensuring that all operations and maintenance activities can be financed and carried out to the standard required by the Authority.

(i) The operator must have nominated post holders, acceptable to the Authority, who are responsible for the management and supervision of the following areas,
(1) Flight operations;
(2) The maintenance system;
(3) Crew training; and
(4) Ground operations.
(see ACJ OPS 3.175(i)).

(j) A person may hold more than one of the nominated posts if acceptable to the Authority but, for operators who employ 21 or more full time staff, a minimum of two persons are required to cover the four areas of responsibility. (See ACJ OPS 3.175(j) &(k).)

(l) The operator must ensure that every flight is conducted in accordance with the provisions of the Operations Manual.

(m) The operator must arrange appropriate ground handling facilities to ensure the safe handling of its flights.

(n) The operator must ensure that its helicopters are equipped and its crews are qualified, as required for the area and type of operation.

(p) The operator must provide the Authority with a copy of the Operations Manual, as specified in Subpart P and all amendments or revisions to it.

(q) The operator must maintain operational support facilities at the main operating base, appropriate for the area and type of operation.

JAR-OPS 3.185 Administrative requirements

(a) An operator shall ensure that the following information is included in the initial application for an AOC and, when applicable, any variation or renewal applied for:
(1) The official name and business name, address and mailing address of the applicant;
(2) A description of the proposed operation;
(3) A description of the management organisation;
(4) The name of the accountable manager;
(5) The names of major post holders, including those responsible for flight operations, the maintenance system, crew training and ground operations together with their qualifications and experience; and
(6) The Operations Manual.

SUBPART D - OPERATIONAL PROCEDURES

JAR-OPS 3.200 Operations Manual

An operator shall provide an Operations Manual in accordance with JAR-OPS Part 3, Subpart P for the use and guidance of operations personnel.

JAR-OPS 3.205 Competence of operations personnel

An operator shall ensure that all personnel assigned to, or directly involved in, ground and flight operations are properly instructed, have demonstrated their abilities in their particular duties and are aware of their responsibilities and the relationship of such duties to the operation as a whole.

JAR-OPS 3.210 Establishment of Procedures

(a) An operator shall establish procedures and instructions, for each helicopter type, containing ground staff and crew members' duties for all types of operation on the ground and in flight.

(b) An operator shall establish a checklist system to be used by crew members for all phases of operation with the helicopter under normal, abnormal and emergency conditions as applicable, to ensure that the operating procedures in the Operations Manual are followed. The design and utilisation of checklists shall observe human factors and CRM principles.

SUBPART K - INSTRUMENTS AND EQUIPMENT

JAR-OPS 3.695 Public address system

(a) [Except as in (c) below,] an operator shall not operate a helicopter with a maximum approved passenger seating configuration [(MAPSC)] of more than nine, unless a public address system is installed.

(b) The public address system required by this paragraph must:
(1) Operate independently of the interphone systems except for handsets, headsets, microphones, selector switches and signalling devices;
(2) Be readily accessible for immediate use from each required flight crew member station;
(3) Be readily accessible for use from at least one cabin crew member station in the cabin, and each public address system microphone intended for cabin crew use must be positioned adjacent to a cabin crew member seat that is located near each required floor

level emergency exit in the passenger compartment;
(4) Be capable of operation within 10 seconds by a cabin crew member at each of those stations in the compartment from which its use is accessible;
(5) Be audible and intelligible at all passenger seats, toilets and cabin crew seats and work stations; and
(6) Following a total failure of the normal electrical generating system, provide reliable operation for a minimum of 10 minutes.

(c) For helicopters with a maximum approved passenger seating configuration (MAPSC) of more than nine but less than 19, the Public Address System is not required if:
(1) the helicopter is designed without a bulkhead between pilot and passengers; and
(2) the operator is able to demonstrate that when in flight, the pilot's voice is audible and intelligible at all passengers' seats.]

JAR-OPS 3.730 Seats, seat safety belts, harnesses and child restraint devices

(a) An operator shall not operate a helicopter unless it is equipped with:
(1) A seat or berth for each person who is aged two years or more;
(2) For helicopters first issued with an individual Certificate of Airworthiness, either in a JAA member state or elsewhere up to and including 31 July 1999 a safety belt, with or without a diagonal shoulder strap, or a safety harness for use in each passenger seat for each passenger aged two years or over;
(3) For helicopters first issued with an individual Certificate of Airworthiness, either in a JAA member state or elsewhere on or after 1 August 1999, a safety belt, with a diagonal shoulder strap, or a safety harness for use in each passenger seat for each passenger aged two years or over;
(4) A restraint device for each passenger less than two years of age;
(5) A safety harness for each flight crew seat, incorporating a device which will automatically restrain the occupant's torso in the event of rapid deceleration; and
(6) A safety harness for each cabin crew member's seat.
Note: This requirement does not preclude the use of passenger seats by cabin crew members carried in excess of the required cabin crew complement.
(7) Seats for cabin crew members located, where possible, near a floor level emergency exit. If the number of required cabin crew members exceeds the number of floor level emergency exits, the additional cabin crew seats required shall be located such that the cabin crew member(s) may best be able to assist passengers in the event of an emergency evacuation. Such seats shall be forward or rearward facing within 15° of the longitudinal axis of the helicopter.

(b) All safety harnesses and safety belts must have a single point release. A safety belt with a diagonal shoulder strap is permitted if it is not reasonably practicable to fit the latter.

JAR-OPS 3.825 Life Jackets (See IEM OPS 3.825)

An operator shall not operate a helicopter for any operations on water or on a flight over water:
(1) When operating in Performance Class 3 beyond autorotational distance from land; or
(2) When operating in Performance Class 1 or 2 at a distance from land corresponding to more than 10 minutes flying time at normal cruise speed; or
(3) When operating in Performance Class 2 or 3 when taking off or landing at a heliport where the take-off or approach path is over water,

unless it is equipped with life jackets equipped with a survivor locator light, for each person on board, stowed in an easily accessible position, with safety belt or harness fastened, from the seat or berth of the person for whose use it is provided and an individual infant flotation device, equipped with a survivor locator light, for use by each infant on board.

SUBPART N - FLIGHT CREW

JAR-OPS 3.940 Composition of Flight Crew

(a) An operator shall ensure that:

(…)

(3) All flight crew members hold an applicable and valid licence acceptable to the Authority and are suitably qualified and competent to conduct the duties assigned to them;

(…)

JAR-OPS 3.943 Initial Operator's Crew Resource Management

(a) When a flight crew member has not previously completed initial Operator's Crew Resource Management (CRM) training (either new employees or existing staff), then the operator shall ensure that the flight crew member completes an initial CRM training course. New employees shall complete initial Operator's CRM Training within their first year of joining an operator.

(b) Initial CRM training shall be conducted by suitably qualified personnel.
(c) Initial CRM training is conducted in accordance with a detailed course syllabus included in the Operations Manual, and shall contain at least the following items:
  (1) Human error and responsibility, error chain, error prevention and detection;
  (2) Company safety culture, Standard Operating Procedures (SOPs), organisational factors;
  (3) Stress, stress management, fatigue and vigilance;
  (4) Information acquisition and processing, situational awareness, workload management;
  (5) Decision making;
  (6) Communication and co-ordination inside and outside the cockpit;
  (7) Leadership and team behaviour, synergy;
  (8) Automation and philosophy of the use of Automation (if relevant to the type);
  (9) Specific type-related differences;
  (10) Case based studies;
  (11) Additional areas which warrant extra attention, as identified by the accident prevention and flight safety programme (see JAR-OPS 3.037).

JAR-OPS 3.945 Conversion Training and checking
(a) An operator shall ensure that:
  (1) A flight crew member completes a Type Rating course which satisfies the applicable requirements of JAR-FCL when changing from one type of helicopter to another type for which a new type rating is required;
  (2) A flight crew member completes an operator's conversion course before commencing unsupervised line flying;
  (i) When changing to a helicopter for which a new type rating is required; or
  (ii) When changing operator;
(3) Conversion training is conducted by suitably qualified person[nel] in accordance with a detailed course syllabus included in the Operations Manual [ ].
(4) The amount of training required by the operator's conversion course is determined after due note has been taken of the flight crew member's previous training as recorded in his training records prescribed in JAR-OPS 3.985;
(5) The minimum standards of qualification and experience required of flight crew members before undertaking conversion training are specified in the Operations Manual;
(6) Each flight crew member undergoes the checks required by JAR-OPS 3.965(b) and the training and checks required by JAR-OPS 3.965(d) before commencing line flying under supervision;
(7) Upon completion of line flying under supervision, the check required by JAROPS 3.965(c) is undertaken;
(8) Once an operator's conversion course has been commenced, a flight crew member does not undertake flying duties on another type of helicopter until the course is completed or terminated, unless otherwise approved by the Authority (See IEM OPS 3.945(a)(8)); and
(9) [Elements of CRM] training [are integrated into] the conversion course.
  (b) In the case of changing helicopter type, the check required by 3.965(b) may be combined with the type rating skill test required by JAR-FCL.
  (c) The operator's conversion course and the Type Rating course required by JAR-FCL may be combined.

JAR-OPS 3.965 Recurrent Training and Checking
(a) General. An operator shall ensure that:
  (1) Each flight crew member undergoes recurrent training and checking and that all such training and checking is relevant to the type or variant of helicopter on which the flight crew member operates;
  (2) A recurrent training and checking programme is established in the Operations Manual and approved by the Authority;
  (3) Recurrent training is conducted by the following personnel:
  (i) Ground and refresher training - by suitably qualified personnel;
  (ii) Helicopter/flight simulator training - by a Type Rating Instructor (TRI) or a Flight Instructor (FI) with the appropriate type rating, or, in the case of the flight simulator content, a Synthetic Flight Instructor (SFI), providing that the TRI or the SFI satisfies the operator's experience and knowledge requirements sufficient to instruct on the items specified in [paragraphs] (a)(1)(i)(A) and (B) [of] Appendix 1 to JAR-OPS 3.965;
  (iii) Emergency and safety equipment training - by suitably qualified personnel; and
  (iv) Crew Resource Management (CRM) training - by suitably qualified personnel.
  (4) Recurrent checking is conducted by the following personnel:

(i) Operator proficiency checks - by a Type Rating Examiner [(TRE)], or a Flight Examiner [(FE)] with the appropriate type rating, [nominated by the operator and acceptable to the Authority or, a Synthetic Flight Examiner (SFE) if the check is conducted in a flight simulator approved for the purpose;] and
(ii) Line checks - [by suitably qualified] commanders [trained in the assessment of CRM skills] nominated by the operator and acceptable to the Authority;
(5) Each flight crew member undergoes operator proficiency checks as part of a normal flight crew complement.

(b) Operator Proficiency Check.
(1) An operator shall ensure that:
(i) Each flight crew member undergoes operator proficiency checks to demonstrate his competence in carrying out normal, abnormal and emergency procedures; and
(ii) The check must be conducted without external visual references, as appropriate, when it is likely that the crew member will be required to operate under IFR.
(2) The period of validity of an operator proficiency check shall be six calendar months in addition to the remainder of the month of issue. If issued within the final three calendar months of validity of a previous operator proficiency check, the period of validity shall extend from the date of issue until six calendar months from the expiry date of that previous operator proficiency check. Before a flight crew member, without a valid instrument rating, may operate VMC at night, he will be required to undergo a proficiency check at night. Thereafter, each second proficiency check shall then be conducted at night.

(c) Line Check.
An operator shall ensure that each flight crew member undergoes a line check on the helicopter to demonstrate his competence in carrying out normal line operations described in the Operations Manual. The period of validity of a line check shall be 12 calendar months, in addition to the remainder of the month of issue. If issued within the final three calendar months of validity of a previous line check, the period of validity shall extend from the date of issue until 12 calendar months from the expiry date of that previous line check.

(d) Emergency and Safety Equipment training and checking.
An operator shall ensure that each flight crew member undergoes training and checking on the location and use of all emergency and safety equipment carried. The period of validity of an emergency and safety equipment check shall be 12 calendar months, in addition to the remainder of the month of issue. If issued within the final three calendar months of validity of a previous emergency and safety check, the period of validity shall extend from the date of issue until 12 calendar months from the expiry date of that previous emergency and safety equipment check.

(e) [CRM.
An operator shall ensure that:
(1) Elements of CRM are integrated into all appropriate phases of the recurrent training, and;
(2) Each flight crew member undergoes specific modular CRM training. All major topics of the initial CRM training shall be covered over a period not exceeding three years;]

(f) Ground and Refresher training.
An operator shall ensure that each flight crew member undergoes ground and refresher training at least every 12 calendar months. If the training is conducted within three calendar months prior to the expiry of the 12 calendar months period, the next ground and refresher training must be completed within 12 calendar months of the original expiry date of the previous ground and refresher training.

(g) Helicopter/flight simulator training.
An operator shall ensure that each flight crew member undergoes helicopter/flight simulator training at least every 12 calendar months. If the training is conducted within three calendar months prior to the expiry of the 12 calendar months period, the next helicopter/flight simulator training must be completed within 12 calendar months of the original expiry date of the previous ground and refresher training.

JAR-OPS 3.985 Training Records.
(a) An operator shall:
(1) Maintain records of all training, checking and qualification prescribed in JAR-OPS

3.945, 3.955, 3.965, 3.968 and 3.975 undertaken by a flight crew member; and
(2) Make the records of all conversion courses and recurrent training and checking available, on request, to the flight crew member concerned.

SUBPART O - CREW MEMBERS OTHER THAN FLIGHT CREW

JAR-OPS 3.988 Applicability (See Appendix 1 to JAR- OPS 3.988)
An operator shall ensure that all crew members, other than flight crew members, assigned by the operator to duties in the helicopter, comply with the requirements of this Subpart, with the exception of cabin crew members who will comply only with the requirements in Appendix 1 to JAR-OPS 3.988.

JAR-OPS 3.995 Minimum requirements
(a) An operator shall ensure that each crew member:
  (1) Is at least 18 years of age;
  (2) Has passed an initial medical examination or assessment and is found to be medically fit to carry out the duties specified in the Operations Manual (see ACJ OPS 3.995(a)(2)); and
  (3) Remains medically fit to carry out the duties specified in the Operations Manual.
(b) An operator shall ensure that each crew member is competent to perform his duties in accordance with procedures specified in the Operations Manual.

JAR-OPS 3.1005 Initial training (See ACJ OPS 3.1005)
An operator shall ensure that each crew member successfully completes initial training [(which shall include appropriate elements of JAR-OPS 3.943)], accepted by the Authority, and the checking prescribed in JAR-OPS 3.1025 before undertaking conversion training.

JAR-OPS 3.1015 Recurrent training (See ACJ OPS 3.1015)
(a) An operator shall ensure that each crew member undergoes recurrent training, covering the actions assigned to each crew member in normal and emergency procedures and drills relevant to the type(s) and/or variant(s) of helicopter on which they operate.
(b) An operator shall ensure that the recurrent training and checking programme accepted by the Authority includes theoretical and practical instruction, together with individual practice.
(c) The period of validity of recurrent training and the associated checking required by JAR-OPS 3.1025 shall be 12 calendar months in addition to the remainder of the month of issue. If issued within the final three calendar months of validity of a previous check, the period of validity shall extend from the date of issue until 12 calendar months from the expiry date of that previous check.
(d) An operator shall ensure that:
  (1) Elements of CRM are integrated into all appropriate phases of the recurrent training; and
  (2) Each crew member undergoes specific modular CRM training. All major topics of the initial CRM training shall be covered over a period not exceeding three years.]

JAR-OPS 3.1025 Checking (See ACJ OPS 3.1025)
(a) An operator shall ensure that during or following completion of the training required by JAR-OPS 3.1005, 3.1010 and 3.1015, each crew member undergoes a check covering the training received in order to verify his proficiency in carrying out normal and emergency safety duties. These checks must be performed by personnel acceptable to the Authority.
(b) An operator shall ensure that each crew member undergoes checks as follows:
  (1) Initial training. (See ACJ OPS 3.1005);
  (2) Conversion and Differences training. (See ACJ OPS 3.1010); and
  (3) Recurrent training. (See ACJ OPS 3.1015).

JAR-OPS 3.1035 Training records
An operator shall:
(1) Maintain records of all training and checking required by JAR-OPS 3.1005, 3.1010, 3.1015, 3.1020 and 3.1025; and
(2) Make the records of all initial, conversion and recurrent training and checking available, on request, to the crew member concerned.

SUBPART P - MANUALS, LOGS AND RECORDS

JAR-OPS 3.1040 General Rules for Operations Manuals
(a) An operator shall ensure that the Operations Manual contains all instructions and information necessary for operations personnel to perform their duties.

(b) An operator shall ensure that the contents of the Operations Manual, including all amendments or revisions, do not contravene the conditions contained in the Air Operator's Certificate (AOC) or any applicable regulations and are acceptable to, or, where applicable, approved by, the Authority.

JAR-OPS 3.1045 Operations Manual - structure and contents

(a) An operator shall ensure that the main structure of the Operations Manual is as follows:

Part A. General/Basic

This part shall comprise all non helicopter type-related operational policies, instructions and procedures required for safe operation.

Part B. Helicopter Operating Matters

This part shall comprise all helicopter type-related instructions and procedures required for safe operation. It shall take account of any differences between types, variants or individual helicopters used by the operator.

Part C. Route/Role/Area and Heliport Instructions and Information

This part shall comprise all instructions and information needed for the area of operation.

Part D. Training

This part shall comprise all training instructions for personnel required for safe operation.

(b) An operator shall ensure that the contents of the Operations Manual are in accordance with Appendix 1 to JAR-OPS 3.1045 and relevant to the area(s) and type(s) of operation.

(c) An operator shall ensure that the detailed structure of the Operations Manual is acceptable to the Authority. (See IEM OPS 3.1045(c).)

APPENDIX P: NAM HEALTH, SAFETY AND ENVIRONMENT DOCUMENTS

This appendix provides information about safety management and the applicable Health, Safety and Environment documents ("VGM-documents").

NAM Safety management system
For Shell EPE, a general Corporate Management System was developed, included in the Common Management Manual. This system and manual are applicable to NAM ONEgas as well. Although NAM is incorporated in the Shell management structure, NAM still has its own legal entity and responsibility.

Introduction to Safety Management in ONEgas
The identification and analysis of hazards, the mitigation of these hazards and the approach to dealing with the resulting risk for NAM ONEgas operations and projects, is covered in safety cases, entitled "VGM-Documenten" (Veiligheid, Gezondheid en Milieu documenten - Health, Safety and Environment documents or HSE documents).

The HSE documents and the risk management process in NAM are based on a systematic process of identifying, analysing and controlling risk called the Hazard and Effect Management Process (HEMP). This is used for both design and development, as well as for production and for the health and safety aspects of projects. All operational aspects of the health and safety care system are checked at least every three years as part of the audit and review programme. Four of these HSE documents are of main interest to this study and form a frame of reference based on the safety case principle. Therefore, the Safety Board describes the essentials of these NAM documents in the following paragraphs.

VGM Document Asset ONEgas (NL) - Generic part

Management system of HSE
The generic VGM document for ONEgas Asset shows the way ONEgas takes responsibility for risk management, by using a systematic approach, in complying with rules and regulations and through the continuous improvement of health and safety performance. The goal is to minimize risk in accordance with ALARP through the management of the business processes. The management of processes is described in the Common Management System. The health and safety aspects of management are described in the VGM documents.

The generic VGM document outlines the basics of the management system and the position of the VGM-documents within the (Safety) Management System. All ONEgas activities are captured in a business process, described in a Process Management System. For this report, the process A-09 Design, Construct, Modify or Abandon Wells and A-71 Operate Wells and Facilities are of specific interest. The first requires a specific VGM-document called Concurrent Operations Script (COS). The second calls for VGM document specific for the location, so for this review this concerns K15-FB-1.

The way in which planning, monitoring and corrective action is organised is important to the management system. Projects are appointed based on the Business Plan, which covers a five year period. For these projects, safety studies are planned to cover the HSE-risk of the project. From year plan to three-monthly plan, plans become more detailed. A Hoofd Mijnbouw Installatie (HMI - Offshore Installation Manager - OIM) is always representing the installation involved in the final discussions. Progress in HSE plans and performance is given to Asset Management on a quarterly basis. Additional to the normal report-back structure, incidents and increased risk are reported in a database and discussed weekly by Asset Management.

An audit and review of all sections of the HSE-system is done at least once every three years, through a structured audit and review plan. Recommendations from audit and review sessions are collated in a database. Follow up and compliance with recommendations is monitored by management. Finally, the results of the HSE-management system are reviewed by management as well. The management reviews also involve contractor reviews.

Offshore installations
The offshore operations of ONEgas comprise the production and treatment offshore of natural gas and oil as well as some residual products, mostly condensate and water. The transportation of personnel to and from offshore installations by air is a necessity. That logistics process is part of the EPE organisation. Drilling and well maintenance are also organised through EPE. These processes are covered in separate HSE-documents. The generic VGM document describes the installations that are part of the generic part of the HSE-documents.

Hazard Analysis
Hazards are defined as anything that has the potential to damage people, including injuries and damage to health. In order to prevent damage, measures are taken to mitigate hazards. However, there is still a probability of undesirable events occurring with adverse effects, for example if one of the mitigating measures fails. This is called risk. Further reduction of risk is always for the objective. When residual risk is accepted, the risk is considered to be ALARP. The primary goal of HSE-documents is to demonstrate that hazards are identified and risk is ALARP. To demonstrate ALARP, NAM uses their specific HEMP process.

The hazard analysis process starts with a hazard identification process, by using a hazards checklist. A specific NAM checklist is put together based on the Shell checklist. Hazardous events and potential scenarios are mentioned for each hazard source. Based on the Maximum Credible Accident scenario, the potential effect is determined in group sessions. These judgements are made for safety purposes, health purposes as well as for the environment. Effects categorised as high, are further studied by the use of a bow-tie diagram. For other effects, the mitigation measures are elaborated on through t he use of industrial expertise and feedback loops.

Safety-critical systems
Safety-critical systems are systems that are necessary as essential barrier or mitigating measure in a bow-tie of hazards with large effects. These systems are documented in a Work Management System or, for instance, a Structural Integrity Management System. Safety-critical systems are subject to certain quality criteria. For the Technical Integrity Management System for instance, the Technical Integrity Performance Indicators are used. These could be maintenance schedules for Pressure Safety Valves. Safety-critical activities, which support the effect of safety-critical systems, are controlled in the same way.

Assessment
The final chapter of the generic VGM document explains the assessment process to determine whether the risk for installations or processes is ALARP. NAM uses the following acceptance criteria. The first criterion is to comply with applicable legislation, rules and regulations, permits, contracts and (internal) agreements. The second criterion is the identification and analysis of hazards, by using the general NAM hazards checklists. The third criterion is to set the (quantitative) risk acceptance criteria for individual risk and risks to society. Finally, part of ALARP acceptance is the involvement and information of personnel regarding hazards and mitigation measures.

On an installation level, according to the document, another three acceptance criteria are added. Acceptance of risks in relation to the effort and success of further mitigation is evaluated by Asset Management. Mitigation measures on a local level are to be implemented by using an implementation plan and the process will be monitored. Dependant on the outcome of assessments, a decision will be made as to whether operations are suspended or temporary measures need to be taken.

Revision
This document was revised in October 2003. Part of the revision was executed due to changes in the system. In this process it was decided to update HSE-documents on a yearly basis. Part of the updates includes the incorporation of the Rescue of people at Sea study, issued by NOGEPA.[122] The requirements of the NOGEPA state that the maximum acceptable time to be in the water for persons with proper survival suits is two hours. A maximum of 20 minutes later, all persons involved must have been brought to safety.

VGM Document Asset ONEgas - Location K15-FB-1

Introduction
This specific HSE document addresses K15B, K15C and K15K. The revision of the document is dated 16 October 2003 and includes the installation of K15K and the modifications to receive gas from K15K on K15B. The document describes the various installations, pipelines and processes. Section 3 describes the 'installation-specific hazard analysis.' However, this installation-specific analysis encompasses three specific installations. This decision is founded by the remark that although not all hazards are applicable to the two satellites, the hazards of the satellites are also applicable to K15B. Furthermore, the document describes the installation and process description of K15B.

122 *Rescue of people at Sea*, Working in the Mining Industry on the Dutch Continental Shelf, revision 8, NOGEPA.

Installation-specific hazard analysis
Chapter 3 of the HSE-document for K15B refers back to the generic document for the identification of hazards checklist and for the explanation of the high risk hazards. The standard safety studies (HEMP studies) are summarised in chapter 4. Middle sized and smaller hazards are managed through procedures and instructions and are subject to continuous improvement.

In case circumstances deviate from the planned situation as a result of the unavailability of safety-critical systems, mitigation measures are taken. The Matrix of Permitted Operations (MOPO) determines what technical or operational measures need to be taken to mitigate this increased risk.

The major hazards for K15B are listed in a table. They include hydrocarbons in the process installation, X-mas tree[123] and pipelines. Potential scenarios include the loss of containment followed by fire and explosion. Transportation hazards include scenarios like ship collision and helicopter crash. A second table lists deviations from the generic bow-ties for K15B. For the emergency power system (the diesel generator) it is concluded that an explosion in the glycol regeneration or process area could affect the diesel generator. Chapter 4 gives further information on the HEMP Studies. In these studies, means of evacuation include escape by Free Fall Life Boat (FFLB) or scramble nets and life rafts. Quantification of the risk shows that risk in general for K15B is ALARP.

K15B Safety Systems
In normal operations, two gas generators take care of the power supply for the installation. When the gas generators are not available, the diesel generator will supply energy to the safety-critical systems, like the fire and gas detection systems and the firewater pumps. In the systems design, it will take a minute at the most for the diesel generator to start after the gas generators stop. A 'No-Break' system protects the critical systems against a power dip as a result of the gas generator disengaging and the diesel generator coming into operation. Essential systems such as emergency lighting, navigation lights and even the fire and gas detection systems, are backed-up with a battery, to provide the availability of those systems in case of the unavailability of power supply. According to NAM, the emergency lighting is designed to last for 90 minutes, the backup batteries of the fire and gas detection systems are designed to last for about three hours. Based on this lay-out, it may not be expected that systems are still operational after this designed backup period. Firewater pumps do not have a backup facility. If the diesel generator fails during a black out, no firewater is available.

At the moment that the facility is going to operate outside a set operating envelope, a safety system will automatically activate: safety valves protect the wells; riser isolation valves isolate the risers (incoming and outgoing pipelines) from the installation. On Emergency Shutdown (ESD), isolation valves shut down, wells are isolated and the valves to the vent stack open. Thus, the platform will be closed-in (isolated from wells and pipelines) and depressurised (hydrocarbons emitted through vent stack). Although high pressure hydrocarbons systems are depressurised, vessels and pipelines still contain hydrocarbons at atmospheric pressure. What is more, the diesel generator starts running to provide power to safety-critical systems as fire and gas detection systems and firewater pumps.

K15B safety logic on black out
The logic of cause and effects is supposed to render the installation 'fail safe'.[124] On failure of a (safety) critical system, the operations and the installation will fail in the safe mode. On K15B, failure of the power supply caused an ESD. To restart the installation after an ESD, power from the diesel generator is needed, since the gas supply to the gas generators is isolated.

Other failure modes are described in the Matrix of Permitted Operations (MOPO). This manual contains a matrix, by which the outcome of risk analysis and safety studies is translated to normal operations. The matrix shows what activities are permitted, whilst certain safety-critical systems fail or are taken out for maintenance and what action should be taken if a system is unavailable. The following relevant failure - action conditions in the table are stated in the MOPO:

123 The top of the well bore is outfitted with a collection of valves called the X-mas tree. These valves are e.g. to control flow, isolate the well or to accommodate well completion.
124 'Fail safe' means that in case of failure, the failure mode is a safe mode.

Failure condition	Action required
emergency diesel generator	close-in and depressurise the installation and review all activities on the installation
unavailability of firewater	no operations are permitted, helicopter operations are still allowed
fire and gas detection systems are not available	stop all operations, including helicopter operations, and assign a standby fireman in the accommodation room[9]
unavailability of evacuation or escape facilities (lifeboat and life rafts)	down-manning of non-essential staff

Table: relevant failure-action conditions from the Matrix of Permitted Operations.

Concurrent Operations Script K15-FB-1 and Noble George Sauvageau Well K15-FB-107

At the time of the incident, concurrent operations were ongoing. These concurrent operations are outlined in the Concurrent Operations Script (COS). The concurrent operations comprised of the production of all six existing wells on K15B, as well as the drilling of an additional well K15-FB-107 by the Noble George Sauvageau (Noble George). Apart from the new well being drilled, the deluge system is being replaced area by area. The document describes both installations. As part of the script, chapter 6 states the concurrent operations agreement.

Chapter 7 contains a Concurrent Operations Matrix 'Drilling and Production during drilling Well K15B-FB-107'. In the situation "Loss of Primary and Backup Power Supply" performing "Normal Drilling Activities as to DDP" is subject to the decision of the Head of Concurrent Operations.

The Concurrent Operations Script provides a tool, which recognises the need for change to previously developed work task instructions, and which provides a defined process for dealing with the change. A need for change has to be 'flagged' to identify the gravity of the situation.

Flagging the need for change
Planned work processes, which are covered in approved project documentation, shall have been subject to a full Hazard and Operability Study (HAZOP) and Risk Assessment process and therefore any deviations from the planned process cannot be undertaken lightly and must be subject to a rigorous process of evaluation and approval. A need for change can result from a variety of situations but it is not within the scope of the Script to identify all of them. Six specific classes are identified however, to illustrate the type of situation where change may be flagged up, who is responsible for notification of a change and who should be notified of the change, in the first instance. In the following six classes of change the HCO has to be notified:

Type of changes
1. Environmental changes impacting on barge or ship installation configuration - weather, access, anchor patterns, etc.
2. Worksite not as expected - changed layout, debris, access problems, seabed conditions, etc.
3. Risk Assessment - identifies new risk, way of reducing risk, etc.
4. Risk Assessment/toolbox talk - identifies new risk, way of reducing risk, etc.
5. Failure of equipment or process.
6. Third party on site requests for change to workscope/procedure.

Assessing the criticality of the change
NAM has set five levels of criticality, which the HMI/HCO has the responsibility to assess. The criteria are specified below:

Minor (level 1 / NAM Risk Matrix)
- Changes have not been planned but are well within the scope of normal operations (no unique processes). The work task is well within the capability and competence of people undertaking the activity.
- The revised method is fully covered by an existing generic work procedure and generic risk assessment, which must show a low risk factor after controls have been specified (both documents must be available at the worksite).

Significant (level 2 & 3 / NAM Risk Matrix)

- Changes are not covered by the planned approved procedures and may deviate from normal operations. The key parts of the revised work are not covered by generic procedures and generic risk assessments that are available on the particular barge, ship or worksite. The assessment of the work task must be within the capability and competence of people undertaking the activity.

Major (level 4 & 5 / NAM Risk Matrix)

- The changes require further assessment by the onshore project team because the engineering work performed during the onshore engineering phase or the equipment mobilised cannot accommodate the required change. The re-engineering cannot be undertaken and checked by the people at the worksite.

The approval authority for each of the criticality levels of change is given in the table below.

Level	NAM Internal		Project Representative	
	Operations Manager	HMI/HCO	Project Rep. Onshore	Project Rep. Offshore
1 Minor	Information	**Approval***	Information**	Information
2 & 3 Significant	**Approval**	Originate	Information**	Acceptance
4 & 5 Major	**Approval**	Identify	**Approval**	Information

Table 2: approval authority for each of the criticality levels of change.

* It is recognised that because of shift work, the HMI/HCO may not always be immediately available to approve the change. In this minor category case, HMI/HCO may delegate his/her authority to his/her senior supervisor to approve the change. The person delegated the responsibility to approve the change must be clearly identified to others at the work site and must have the approval of the Operations Manager

** The NAM Project Manager will be notified by the HMI/HCO or NAM work site representative.

In the Minor level, which is relevant for this investigation, the Head of Concurrent Operations has to approve the actions to be taken and the Operations Manager has to be informed.

Besides the results of a Hazard and Operability Study (HAZOP), the document shows a table bridging the safety case scenarios of both the K15B and the Noble George. One of the scenarios is the Abandon Platform Procedure.

VGM Document Transport, NAM

The HSE Document on transportation is dated 8 November 2004. The document describes the NAM Management System, in the same way this is described under the Generic HSE Document for ON-Egas. The Logistics Department comes under the Production Director of Shell EPE. HSE support for the Logistics Department is partly delivered by the HSE department and partly by the HSE-staff of the Logistics Department.

The Logistics Department comprises of four work streams. These are air logistics, marine logistics, supply and transportation and waste management. The HSE document on transportation covers air, marine and land transportation. For this report of the Dutch Safety Board, attention is focused on air logistics. The HSE document also lists hazard identification based on the general NAM hazard identification checklist and the effects based on the Maximum Credible Accident.

Appendix 3 of the document shows a bow-tie and additional table of transportation by air. In this bow-tie, the possible causes and effects of a helicopter crash as a top-event (landing on water, crash in sea or crash on installation) are determined. The document sets requirements for the presence of safety appliances. The document does not discuss the need for transportation by helicopter.

APPENDIX Q: BRISTOW AS332L2 CONVERSION STUDY GUIDE

This appendix contains information about extracts related to crew flying duties from the Bristow Helicopters Training School - Eurocopter AS332L2 Conversion Study Guide.□

FAM 1
- STARTS AND STOPS

Crew duties
The normal practice is for the PF to carry out the start checks whilst the PNF obtains the weather and start clearance. The radio telephone is normally the duty of the PNF; however during conversion, your Training Captain will usually ask you to do some of the radio work to ensure you are familiar with the operation of the station boxes and local R/T procedures. When making extended communications on one radio box, the PF should be asked to monitor the other frequency.

FAM 2 - START EMERGENCIES

Crew duties
The PF should initiate any emergency procedures required during start, including initiating or calling out any immediate actions required. The PNF will carry out any immediate actions as directed, then consult the appropriate EOP when called to do so by the PF, in order to carry out the subsequent actions by challenge and response.

FAM 3 - FAMILIARISATION

Crew duties
The standard division of crew duties during various phases of flight is detailed in Ops Man Part A 4.5. The duties of the PF during the profiles are given in the diagrams in normal text and the PNF duties are in the italicised text.

FAM 4 - GENERAL HANDLING

Crew duties
The PF acts as captain and assumes the lead role in the decision-making process, although he may not be the aircraft commander.

FAM 5 - SINGLE ENGINE PROFILES

Checklist use
EOP Immediate actions are carried out from memory as soon as the nature of the emergency has been identified. The NOPs and EOP subsequent actions are carried out by reference to the checklists once safely established in the climb above 500 ft agl. The NOP checklist is usually completed before the EOP subsequent actions in order to configure the aircraft for the following phase of flight. There may be occasions however, when it would be better to complete the EOP subsequent actions first, if the crew consider that a delay would be detrimental to the aircraft or its systems. When carrying out EOPs from the checklist, first review immediate actions to ensure these are complete, then carry out subsequent actions

Crew duties
The PF will fly the aircraft, initiate the immediate actions and call for the subsequent action checklist at the appropriate times. The PNF will monitor the flying, confirm the nature of the failure and carry out checklist actions under the direction of the PF.

FAM 6 - EMERGENCIES

Aim
To learn how to deal with emergencies in the multi crew environment.

Airmanship
Knowledge of all Immediate Actions. Systems knowledge. CRM aspects.

Air exercise (simulator)
Carried out in classroom discussion using an EOP checklist
1. How to use the EOP checklist.
2. Degrees of emergency i.e. Land Immediately, Land as soon as possible or Land as soon as practicable.
Dealing with emergencies
Gain control of the aircraft and gather information
Review the warnings
Analyse the malfunction - discuss as a crew
Decide on the problem and carry out the EOP immediate actions, if required
Evaluate the next course of action. Carry out normal checks as required, then subsequent actions from EOPs - confirm correct procedure by matching warnings in the cockpit with the EOP.

Checklist use
The EOP checklist should always be stored in its container with the front page of the Emergency Procedures uppermost, so that it is ready for use when necessary.

Having reviewed the cockpit indications, decided on the nature of the emergency and carried out any necessary immediate actions from memory, the PF will direct the PNF to consult the appropriate EOP checklist.

The most efficient method is to look in the expanded index under the appropriate system for the description that most closely matches the malfunction that has been identified.

Having found the relevant page, the warnings suggested in the checklist should be matched to the cockpit indications to confirm that the correct procedure is being used. Should the warnings not match, then either the checklist covers more than one variation of the failure, in which case more information may be found further down or in the considerations, or the wrong procedure is being used. In the latter case the cockpit warnings should be reviewed again to re-assess the malfunction.

If the warnings do match, the next step is to confirm that all of the immediate actions have been carried out correctly before proceeding to the subsequent actions.

During engine securing procedures, to avoid shutting down the wrong engine, the PNF is to place his hand lightly on the lever, switch, etc., when the PF directs him to do so; the PF then confirms that it is the correct control before the PNF moves it.

The considerations in the EOPs provide additional information for the benefit of the crew.

Handling of the emergency must be incorporated in the normal course of the flight and the execution of the NOPs. The EOP immediate actions must be completed first from memory, as they are necessary for safe continuation of flight. The NOPs are usually completed next, followed by the EOP subsequent actions. This is not a hard and fast rule and the crew may exercise their discretion to complete the subsequent actions before the NOPs if they consider it appropriate.

Crew duties
The PF acts as the aircraft captain, although he may not be the commander, and will initiate the immediate actions, which are carried out by challenge and response. The failure diagnosis is by crew discussion, with the PF taking the leading role. The PNF will, when directed, carry out the subsequent actions by challenge and response.

When dealing with emergencies, it is important not to develop a mindset on the cause, but to question the initial diagnosis at each stage to ensure that the correct procedure is being used.

USE OF THE AFCS UPPER MODES

The AS332L2's upper modes are quite sophisticated and full familiarity with their operation is an important part of the course. During the course, the training captain will indicate periods when full use should be made of the upper modes, and other periods when these may not be used. The following notes apply to use of the AFCS upper modes:

Selected Heading Hold
Before engagement, ensure that the heading bug is on the desired heading. For major changes in heading, use the knob on the AFCP. For minor corrections to heading, use the cyclic lateral beep trim.

Altitude Hold
Trim altitude datum using the collective beep trim. For "not below" altitudes, ensure datum is 40' or so above to prevent altitude busts.

Altitude acquire
You can use PNF to set up an altitude datum, but you should remember that they might not be on the same altimeter setting as you and allow for that. Don't forget to cross check any set altitudes, as otherwise a mistake is likely to go unnoticed until you have made an altitude bust. When setting an altitude datum, add 70' or so for descents, subtract 70' or so for climbs so that the inevitable overshoot doesn't cause an altitude bust. Once the altitude hold has captured, you can use the collective beep trim to adjust the datum. During an approach procedure, try to stay ahead as much as possible by resetting the altitude acquire to the next altitude as soon as alt hold has captured.

IAS hold
Use IAS hold when permitted to ensure that the aircraft remains within your stated speed - typically 110kts in a procedure or hold. Use cyclic beep trim to adjust the speed datum if required.

Vertical speed hold
Set the vertical speed datum to 600'/min descent or so prior to making an approach. However, when altitude acquire etc is not required, it is better to set the datum to zero, whereupon it disappears, therefore rendering the display less cluttered.

Coupling to a VOR
Use the NAV button for en-route coupling and the APP button for final approach. You must be displaying the appropriate nav source on your NMD before you can select for coupling. Remember that pressing in the course button centres the beam bar in the "to" direction.

Coupling to the ILS localiser
Use the APP button to arm the localiser. This should be done once closing the localiser with a steady localiser signal in the correct sense.

Coupling to the ILS glidepath
Use the G/S button to arm the glidepath. This should be done once approaching the localiser with steady g/s signal in the correct sense.

Go-around
Use the go-around button on the collective to initiate the go-around. This sets a speed datum of 75kts ias and a vertical speed of 500'/min up. However the system is not aware of the rotor rpm, so in the event of an engine failure, the upper modes should be cancelled and the aircraft flown manually.

Cancelling all upper modes
Use the left-hand cyclic button to simultaneously disengage all upper modes.

APPENDIX R: BRISTOW AOC OPERATIONS SPECIFICATIONS

General
This Appendix contains relevant information of the Operations Specifications applying to the Bristow UK Air Operator's Certificate. Bristow is in the possession of a special authorisation/approval for Helicopter Offshore Operations. The Bristow UK AOC is granted on the assumption that Bristow complies with all those provisions contained in JAA requirements for Commercial Air Transport, Helicopters (JAR-OPS Part 3) with effect from 1 April 1995, except for any such provisions as specified under the heading JAR-OPS Non-compliances of the Operations Specification and subject to any Authorisations, Special Authorisations/Approvals and Limitations set out in the same Operations Specification.

Helicopter Offshore Operations

For Helicopter Offshore Operations, Bristow need not comply with JAR 3.135(a)(2), carriage of technical log offshore, when operating to and between offshore installations.

SAR Operations
For SAR Operations, Bristow need not comply with the following JARs:

- 3.430 and 3.465: The non compliance permits the helicopter to take-off, approach and land on an operational flight without complying with the aerodrome operating minima established in accordance with JAR-OPS 3;
- 3.605(d), 3.620 and 3.625: The non-compliance permits the load sheet to contain particulars relating only to the weight of the disposable load on an operational flight;
- the whole of Sub Parts G and H: The non-compliance permits the helicopter to fly below an altitude which would enable it, in the event of a failure of an engine, to reach the place at which it could safely land at a height that is sufficient to enable it to do so;
  but shall comply with the Special conditions for Search and Rescue.

For SAR Training, Bristow shall comply with the whole of JAR-OPS 3 and the Special conditions for search and rescue.

Special Conditions for Search and Rescue

- A flight for the purpose of SAR is defined as "an operational flight", a flight for the training of persons in carrying out of an operational flight is defined as "a training flight".
- No person shall be carried on a training flight except for members of the flight crew and persons who are either employed by the operator or whose carriage is authorised by the UK Maritime and Coastguard Agency or the Netherlands Coastguard and who, in either case, are carried for the purpose of undertaking or witnessing such training.
- No person shall be carried on an operational flight except for members of the flight crew and persons who are either employed by the operator or whose carriage is authorised by the UK Maritime and Coastguard Agency or the Netherlands Coastguard and who, in either case, are carried to undertake duties connected with the carrying out of the flight.
- On a training flight, there shall be a certificate of airworthiness in the transportation category in force in respect of the helicopter and all conditions of the certificate of airworthiness shall be complied with, save for any such condition which prohibits the picking up, raising or lowering of any person, animal or article.
- On an operational flight there shall be a certificate of airworthiness in force in respect of the helicopter and every condition of the certificate of airworthiness shall be complied with, save for any such condition which prohibits the picking up, raising or lowering of any person, animal or article or which requires the installation of passenger seats in the aircraft.
- The Operator and Captain shall ensure that all passengers carried are provided with a handhold.

Exemptions from the provisions of the UK Air Navigation Order 2005

Bristow is exempted when conducting SAR Operations and SAR Training:

- Article 8, 65(6), 66(2) and 67(1). The exemption from the articles is to enable a helicopter to pick up, raise or lower or train any person authorised by the UK Maritime and Coastguard Agency or the Netherlands Coastguard, in picking up, raising or lowering any person, animal or article even if the certificate of airworthiness relating to the helicopter does not include any express provision that the helicopter may be used for that purpose. Any training for such picking up, raising or lowering by means of a winch shall be carried out only by persons who are either employed by Bristow or whose carriage is authorised by the UK Maritime and Coastguard Agency or the Netherlands Coastguard.

- The exemption of article 8 also permits a helicopter to operate without passenger seats (contrary to a condition in the flight manual) but only when the helicopter is on an operational flight.

The Bristow captain is exempted when conducting SAR Operations:
Articles 8, 65(6), 66(2) and 67(1) as mentioned above for Bristow as an operator.
In addition the captain is exempt from:

- Article 52(e). The exemption enables the captain to take off a helicopter without having satisfied himself that sufficient fuel, oil and engine coolant (if required) are carried for the intended flight, and that a safe margin has been allowed for contingencies, and, in the case of a flight for the purpose of public transport, that the instructions in the operations manual relating to fuel, oil and engine coolant have been complied with.
- Article 54(6). The exemption means that the captain need not ensure that all passengers are properly secured in their seats provided that the helicopter is provided with a handhold for use by any passengers.

Conditions subject to which exemptions from the provision of the UK Air Navigation Order 2005 is granted

The captain shall comply with the following provisions of JAR-OPS 3:

- 3.090. All persons carried in the helicopter shall obey all lawful commands given by the captain.
- 3.290(b)(11). The mass of the helicopter, at the commencement of take-off, will be such that the flight can be conducted in compliance with JAR-OPS Part 3, Subparts F to I as applicable.
- 3.405. How to apply weather minima at the commencement and during an instrument approach.
- 3.420(d)(4). If an in-flight emergency occurs and the situation permits, a captain shall inform the appropriate air traffic service unit of any dangerous goods on board.
- 3.455(b). How to prepare for Low Visibility Operations.
- 3.460(b). Requirements for the status of the helicopter and for the relevant airborne systems during Low Visibility Operations.
- 3.625. Requirements for mass and balance documentation.

Exemptions from the provisions of the UK Air Navigation (General) Regulations 2005

Bristow is exempt from the following:

- Regulation 4: Every load sheet required by article 43(5) shall contain a number of particulars.
- Regulation 5: Weighing requirements for passengers, crew and hand baggage.
- Regulation 6: Weighing requirements for hold baggage and cargo.
- Regulation 7: Additional provisions for the loading of hand baggage.

APPENDIX S: OPPLAN-SAR EMERGENCY PHASES AND PROCEDURES

[translation] This appendix contains part of chapter 2 of the OPPLAN-SAR containing the different states of emergency and the subsequent procedures for the Netherlands Coastguard.

2. EMERGENCY PHASES

2.1 Introduction

A SAR incident is commenced after receiving a report or alarm from the JRCC Den Helder. This report or alarm can be accomplished in different ways (by means of radiotraffic, by telephone, fax etc.) After verification of the information contained in this report or alarm, an assessment is made of the gravity of the situation. The incident is subsequently classified according to the three phases of emergency that apply at an international level.

- Uncertainty Fase - INCERFA
- Alert Fase - ALERFA
- Distress Fase - DETRESFA

Depending on the gravity of the situation, classification to a higher phase is possible. The incident of the different emergency phases should not necessarily be in the sequence as indicated. Furthermore, reclassification may be made.

Uncertainty Phase
This phase occurs if there is uncertainty regarding the safety of an aircraft or vessel and/or person(s). An assessment of the situation must be made and information must be collected. This phase could be started with a "communication search". The dispatch of assets are not 'yet' required.

With regard to an aircraft, commencement of this phase is indicated:
- if the aircraft did not arrive within 30 minutes of its scheduled arrival time at destination
- 30 minutes after the point in time at which the aircraft neglected to give an expected position report or an "operations normal" report;
- from the point in time at which attempts have been made to contact the aircraft to no avail

With regard to vessel(s) and/or person(s) this phase is indicated:
- if arrival at the point of destination is overdue;
- if the provision of an expected position report (within a specified period of time as agreed) is neglected

Alert Phase
Commencement of this phase is indicated if an aircraft or vessel and/or person(s) is experiencing difficulties but is not yet in immediate danger. SAR assets could be dispatched and assistance provided if it is suspected that the situation will deteriorate. If information regarding the progress or position of an aircraft or vessel and/or person(s) is overdue, a search operation by SAR assets can be initiated and anybody in the area will be requested to keep due watch and provide information regarding any reports made and render assistance if required.

- following the uncertainty phase, if attempts to establish contact with an aircraft or vessel and/or person(s) is without any success;
- if collecting any information regarding the status of the aircraft, vessel and/or person(s) has been to no avail;
- if information has been received that the operational performance of the aircraft, vessel or person(s) is giving reasons for concern, but not yet to such a degree that an emergency situation is indicated;
- if an aircraft does not actually land within 5 minutes after having received a clearance to land and subsequent communication is not possible either;
- if the aircraft or vessel is known or suspected to be being operated unlawfully;
- if a vessel is under attack or threat by pirates or raiders;

Distress phase
Commencement of this phase is indicated if information has been received that an aircraft or vessel and/or person(s) is being threatened by serious and immediate danger and immediate assistance is required. Or this phase commences if, regarding an aircraft or vessel and/or person(s), no information has

been received at all and therefore can be regarded as overdue and sufficient reasons exist for concern regarding the safety of the aircraft vessel and/or person(s).

- if, following the alert phase, further attempts to establish contact with the aircraft or vessel and/or person(s) are still unsuccessful;
- if, after further investigation, information is provided that shows that it is likely that the aircraft or vessel concerned is in distress;
- after information has been received assuring that the sea- or airworthiness of the vessel or aircraft concerned has been deteriorated to such a degree that establishing the distress phase is justified (with regard to an aircraft this, in any case, is the point in time at which the fuel quantity on board can be considered to be definitely consumed);
- the aircraft was forced to land unless it is clear the aircraft and persons aboard do not require immediate assistance;
- an aircraft that has been forced to land is located by means of an emergency radio beacon.

2.2 Procedures for JRCC Den Helder

General
With regard to every report as indicated above, the JRCC at Den Helder must prepare an incident file. The main and standard part of this file is the "incident report", which will be generated in the "Action Data System (ADAS)". ADAS is a computer program for support, registration and processing of SAR incident information. The purpose of ADAS is:

- adequate performance of SAR operations;
- assurance of a correct distribution of information to parties involved;
- applying standard processing procedures for SAR incidents;
- effective preparation of files;
- simplifying the preparation of info for third parties.

Utilising ADAS, SAR incidents are:

- recorded in journals every minute;
- included in emergency and urgency messages ;
- included and forwarded in briefing sheets;
- included in monitoring the status of the assets that are dispatched;
- included and forwarded in situation reports (SITREP's);
- included in final reports that are generated (complete and short versions)

Since experience has shown that no two SAR incidents are identical to each other, the design of a standard and comprehensive procedure that would be applicable in every situation is not possible. Outlines can be established. Established procedures may be applied with some flexibility. If deemed necessary, deviation from established procedures may be allowed.

2.2.1 Procedures during the uncertainty phase

If "INCERFA" is established, the JRCC Den Helder will:
a. undertake the role of SAR Mission Co-ordinator (SMC);

b. if required, verify the report/information as received and endeavour to retrieve subsequent information from the aircraft, vessel and/or person(s):

  - name and call sign;
  - last (known) position;
  - point in time at which the last exchange of communication took place;
  - any further details such as information regarding the time and place of departure, planned route and estimated time of arrival and destination.

Note: a report regarding an aircraft in possible distress will usually be received by one of the air traffic control centres first. These centres are supposed to forward the information as this is received (via the Air Traffic Control Centre Amsterdam or the Military Air Traffic Control Centre Nieuw Milligen) to the JRCC Den Helder immediately.

b. plot a map containing all of the information as collected;
c. endeavour to establish contact with the aircraft or vessel using any suitable means of communication; for aircraft this will be accomplished via the air traffic control centres;
a. transmit an urgency (PAN) message through which maritime traffic in the area concerned

will be requested to keep a look out and, if possible, provide additional information;

b. forward a notice of attention regarding the vessel concerned to the applicable customs- or police surveillance services in harbours with border patrol;

c. generate an incident report regarding the incident in ADAS;

d. consider if a warning message to SAR units is required.

If the aircraft or vessel appears not to be in a difficult situation, the incident will be closed. The original reporter and all other parties concerned will be informed accordingly by means of a “final sitrep”.

If uncertainty regarding the safety of the aircraft, vessel and/or persons continues, then the situation will be upgraded to the alarm phase.

2.2.2 Procedures in the alarm phase.

After establishing the “ALERFA” the JRCC in Den Helder will:

a. undertake the role of SAR Mission Co-ordinator (SMC).

b. generate an incident report regarding the incident in ADAS;

a. verify the information;

b. endeavour to establish contact with the aircraft or vessel by every suitable means of communication;

c. notify maritime traffic in the vicinity by transmitting an urgency (PAN) message;

d. plot all relevant details in a chart with an aim to establish the most likely position of the aircraft or vessel and its range;

e. try to collect all available information about the aircraft or vessel from any source;

f. inform the applicable services and authorities with regard to the emergency.

Depending on the nature and scope of the incident the following services and authorities can be alarmed:

- the SAR units of Navy Air Station De Kooy (MVKK), the SAR Lynx and/or the G-JSAR and/or Naval Air Station Valkenburg (MVKV) by intervention of their respective operations department;
- relevant units of the KNRM, normally by intervention of a Regional Alarm Centre (RAC) and the stand by officer of the KNRM;
- the maritime traffic control post or traffic centre of the operational area where the emergency occurred;
- the appropriate rescue brigades of the Royal Netherlands Association for the Rescue of Survivors (KNBRD);
- the Information and Communication Centre of the Police services (AICP) and the North Sea Unit of the KLPD;
- appropriate offshore companies and offshore installation crews;
- adjacent (M)RCC’s;
- owner/operator/agent of the vessel or aircraft in the case of emergency (in the latter case via an air traffic control centre (LVB)).

For alarming schematics please refer to appendix C24.

If information is received that the aircraft, vessel or person(s) are not in distress the incident will be closed and all authorities concerned will be informed accordingly. But if, after all actions are taken contact is still not established with the aircraft or vessel, then the aircraft must be considered to be in immediate danger and the situation will be upgraded from the Alarm phase to the Distress phase.

2.2.3 Procedures during the distress phase.

After declaring the distress phase (DETRESFA) JRCC in Den Helder will:

a. start or continue with the actions taken as indicated in the uncertainty and alarm phases. JRCC will take up the role of SMC;

b. by means of emergency radio traffic, all maritime traffic in the vicinity will be requested to report their position and to indicate if they are capable of providing assistance. In the latter case, information is to be provided regarding: course, speed, estimated time of arrival (ETA) at the incident location;

c. continue to collect as much information as possible in order to enable an appropriate assessment of the emergency situation;
d. establish a search area (ref. to paragraph 4 of this part) on the basis of the actual information;
e. decide on the manner in which the SAR action will be executed and the units that will be dispatched accordingly;
f. report the actual situation to the applicable units and services by means of situation reports (SITREP's);
g. consult with the appropriate services and authorities regarding further actions to be taken;
h. inform the owner/operator/agent with regard to the actions as intended and the subsequent developments;
i. appoint an On Scene Co-ordinator (OSC) if required;
j. establish an action plan (SEARCH ACTION PLAN, refer to appendix C25) based on the actual information and communicate this, via the OSC if applicable, to the available units.
k. contact (M)RCC's of neighbouring states if their assistance is required for the execution of the SAR action plan;
l. if this is deemed to be of additional value for a successful execution of the action, request assistance from aircraft, vessels and offshore installations;
m. inform the appropriate authorities of the state of registry of the aircraft or state of flag of the vessel (via the appropriate RCC or consulate) with regard to the nature and scope of the incident.

If the aircraft or vessel in distress has been located and the persons have been rescued, the SAR action will be concluded. All authorities concerned will be informed accordingly; please refer to chapter 5 in this regard.

APPENDIX T: STANDARD OPERATIONAL PROCEDURE G-JSAR

This appendix contains relevant parts of the mutual agreement between the Netherlands Coastguard and Bristow. Appended to this SOP ("Annex 1") are the SAR call-out priority definitions.

Tasking
- Primary tasking: Offshore industry-related SAR/Offshore industry-related MEDEVAC.
- Secondary tasking: Life threatening circumstances other than those that are offshore-related, as judged by the Director of the Netherlands Coastguard.

The G-JSAR employment is complementary to the Royal Netherlands Navy (RNLN) Lynx helicopter.

SAR/MEDEVAC
- Offshore SAR operations (e.g. helicopter ditch, fire and/or explosion, well blow out, ship collision, man overboard, evacuation etc.) require immediate G-JSAR employment.
- Offshore MEDEVAC operations that require immediate medical assistance from a doctor will be executed by the RNLN Lynx, the Lynx SAR crew always has a military doctor on stand by. Offshore and offshore-related MEDEVAC, which does not require assistance from a doctor, may be operated by the G-JSAR crew. The simplified sequence of MEDEVAC units is divided into 'ambulance' or 'taxi'.

For G-JSAR 'ambulance' employment, there are three call-out definitions to be used in case of medevac (see below) and are explained in annex 1 to this SOP:

'AMBULANCE'	'TAXI'
Transportation of patient accompanied by a doctor	Transportation of a stabilised patient
Lynx + Doctor G-JSAR - Casevac immediate - Casevac urgent - Medevac Other	Inter platform Shuttle helicopter G-JSAR Lynx KNRM (lifeboats) Other

ACCOUNT/REPORTS
- After each SAR sortie, the G-JSAR captain will send a First Impression Report (FIR) to the JRCC by e-mail. This document should comment on the critical success factors required and/or used during the mission [e-mail address Netherlands Coastguard and one of the Company Group operators]. This report is to be included in the incident file.
- The Coastguard will provide an incident report in which the full incident is described, including the specific reasons for selecting the G-JSAR, especially in the event that the incident is NOT related to the Oil & Gas Offshore industry. Report to be issued to Operators and G-JSAR.
- After each four-week period, the G-JSAR Chief Pilot will pass a summary report of details by e-mail to the Coastguard [e-mail address Netherlands Coastguard and one of the Company Group operators]. This report will be passed on in the agreed excel format.

DELIBERATION

A G-JSAR representative may be consulted for the bi-annual (twice a year) POSO meeting (Periodical Operational SAR deliberation). These SAR meetings are attended by the Coastguard, Royal Netherlands Navy, Royal Netherlands Air Force, Department of Transportation and the Royal Netherlands Sea Rescue Institution (KNRM).
Any lessons learned are to be passed on in the First Impression Reports (preferably) or by any other means suitable for the occasion.

[Annex 1 on next page]

ANNEX 1 SAR CALL-OUT PRIORITY DEFINITIONS

It is the responsibility of the contracting agency to ensure that the necessary qualified members of staff are available in the alerting system to categorise emergency requests, so that when the commander is advised of the flight requirement, he is in no doubt as to what discretion he is to exercise.
Strict guidance is provided to commanders as to when reduced operating limitations are permitted to be used. A list of standard phraseology follows.

CASEVAC IMMEDIATE
The immediate recovery of a person, either following an accident or a person suffering from a severe medical disorder, requiring immediate medical attention without which there is a serious risk to life.
The establishment of this category of flight at night, or during daylight hours when normal flying operations have ceased due to bad weather, requires confirmation by qualified medical opinion following consultations between the parties concerned.

Flights under this category give commanders full discretion.

CASEVAC URGENT
Similar conditions to a casevac immediate but the life of the individual is not in immediate danger, although there may be a grave risk of the loss of limbs etcetera over a protracted period of time. When a casevac urgent flight is requested, it must be established beforehand what the protracted period of time would be before it became a casevac immediate requirement. If requested at night in marginal weather conditions, consideration should be given as to whether the flight could be carried out at first light without endangering the patient's life, or whether the vessel could steam towards an installation to enable the helicopter crew to have better visual references for winching. The establishment of this category requires the same medical consultation as for a casevac immediate case.

Flights under this category must comply with company minima, though the alternate may be at normal landing company minima rather than full IFR alternate minima. Normal fuel reserve requirements must be met before the flight can commence.

MEDEVAC

Evacuation of an injured or sick person who requires medical attention but whose life or limbs are not in immediate danger.

No discretion can be exercised on weather minima, fuel reserves, minimum departure standards or alternate requirements by the commander.

APPENDIX U: SAR ALARM PROCEDURES

[translation]
Agreement with regard to the search and rescue operations of the SAR helicopter G-JSAR at Aerodrome De Kooy.

G-JSAR can also be dispatched outside of the opening hours of the Naval Air Station De Kooy:
The following procedure is to be applied in this case:

1. The JRCC (duty officer KWC) will assess the requirement for dispatch of the G-JSAR. This concerns offshore-related SAR dispatches in situations (for instance a helicopter ditching, fire or explosion, well blow out, offshore medical evacuation (MEDEVAC), ship collision, man overboard, evacuation) that will likely result in loss of life if immediate dispatch is postponed.
2. If the duty officer decides that dispatch of the G-JSAR is required, an alert will be given as indicated in the SOP G-JSAR under “Alerting Protocol”. This means for MARHELI:
   a. Informing of OPS MARHELI (operations officer) and providing an alert containing the reasons for this;
   b. OPS MARHELI will occupy OPS and will give an SAR alert for at least the airport services and inform the fire brigade and other services that might be available regarding the situation by telephone; the fire brigade will assume a stage of readiness as applies during opening hours of the aerodrome; depending on the situation (as indicated by the KWC), an alert is also to be provided for dispatch of the Lynx;
   c. OPS MARHELI will inform AMSTERDAM ACC/DUTCH MILL about SAR and request the regional QNH North Sea;
   d. OPS MARHELI will provide weather information with regard to the SAR area;
   e. The G-JSAR crew will provide AMSTERDAM ACC/DUTCH MILL with the position of the “Scene of SAR” (“standing flight plan”) by R/T;
   f. During recreational operations at NADK, OPS MARHELI will inform the flight coordinator of the recreational co-users of the airport, about the SAR situation and will give the command: clear the air traffic circuit;
   g. The runway lighting is switched on by MAR HELI;
   h. No runway inspections will be performed;
   i. OPS MARHELI will occupy “De Kooy Tower freq” and HF “PFC” and provide G-JSAR with regional QNH North Sea and, if available, provide further relevant information such as wind direction and strength and traffic information;
   j. The G-JSAR will establish contact with MAR HELI via “De Kooy Tower freq”. The G-JSAR will execute its take off from spot 8 at the civil platform; from spot 8 the aircraft will taxi to helipad 3 or 4;
   k. The G-JSAR will proceed via dedicated routes (if runway 22 is in use, via “Foxtrot” and if runway 04 is in use, via “Hotel”). After departure, J-SAR will establish radio contact with air traffic control, AMSTERDAM ACC or if applicable DUTCH MILL, as soon as possible;
3. In case of emergency, OPS MARHELI initiates a crash state according to its own observations or in accordance with reports that are received from third parties.

APPENDIX V: DEPARTMENTAL INVOLVEMENT WITH SEARCH AND RESCUE

Several representatives of departments of the Ministry of Transport, Public Works and Water Management are involved in search and rescue issues. The representatives take part in the governmental organisations/bodies: North Sea Task Force and Coastguard Triumvirate. This appendix provides background information regarding the North Sea Task Force and the Coastguard Triumvirate.

History
In 2002, one of the pilot unions[125] in the Netherlands expressed its concern to the Ministers of Transport, Public Works and Water Management, Economical Affairs, and Defence about a lack of safety in the North Sea airspace, in particular in offshore helicopter operations. This concern initiated a study under the direction of the Transport and Water Management Inspectorate, together with the parties involved within North Sea airspace operation.

North Sea Task Force
The study identified the lack of sufficient search and rescue capacity for the North Sea area as one with the highest risks. Thirteen safety recommendations were formulated to enhance the safety in the North Sea airspace.[126] One of the recommendations was to establish an interdepartmental working group North Sea Task Force (Task Force Noordzee) in order to take care of the implementation of the other 12 recommendations. The North Sea Task Force was established in December 2003 and placed under the direction of the ministry.[127] Subsequently the Task Force established a workgroup to work out a SAR helicopter performance standard for the Netherlands.

SAR Helicopter Policy and Performance Standard
On 21 November 2006, coincidentally on the day of the accident that took place with the G-JSAR, the North Sea Task Force established the SAR Helicopter Policy and Performance Standard to increase the SAR helicopter capacity and capability for the Netherlands. The new standard was the product of the Taskforce's Workgroup SAR Performance Standard.

With the new SAR performance standard and the enhanced knowledge of SAR operations over recent years, the Task Force concluded that the SAR capacity for the Dutch Continental Shelf was not sufficient and advised the Ministry of Defence and the Ministry of Transport, Public Works and Water Management to take the following actions immediately:
- to extend SAR operating times;
- to reduce SAR response time during daylight;
- to have the structural disposal of a second Navy SAR Lynx helicopter instead of the current optional disposal of a second Lynx helicopter, and;
- to arrange backup SAR capacity with Rescue Coordination Centres abroad in case the SAR capacity in the Netherlands is insufficient.

Relations with the Netherlands Coastguard
The Netherlands Coastguard carried out tasks on the North Sea for six ministries at the time of the accident.[128] These tasks consisted of operational and enforcement tasks. The assets for these tasks are mainly provided by the Ministry of Defence and the Ministry of Transport, Public Works and Water Management.

For a good relationship between policy and implementation, consultations take place on a periodic basis between the Netherlands Coastguard, the Ministry of Transport, Public Works and Water Management and the Permanent Contact Group Enforcement North Sea (Permanente Kontaktgroep Handhaving Noordzee - PKHN), called the Coastguard Triumvirate. The organisations which co-operate with the Netherlands Coastguard are represented in the Coastguard Triumvirate by the Director of the Netherlands Coastguard, the Chief Engineering Director of the Directorate General for Public Works and Water Management - North Sea, and the chairman of the PKHN (a Public Prosecutor) respectively.

125 Onafhankelijke Vliegersvereniging Nederland.
126 *Operaties luchtruim boven de Noordzee*, deelproject 2, Project, 16 december 2003.
127 The North Sea Task Force consists of the following party representatives: Netherlands Civil Aviation Authority, Air Traffic Control the Netherlands, Royal Netherlands Air Force, Royal Netherlands Navy, Royal Netherlands Meteorological Institute, Dutch Aviation Police, NAM, CHC (successor of Schreiner), Bristow, employer- and pilot unions.
128 Ministry of Transport, Public Works and Water Management, Ministry of Defence, Ministry of Finance, Ministry of Agriculture, Nature and Food Quality, Ministry of the Interior and Kingdom Relations, Ministry of Justice. Also the Ministry of Economic Affairs as of 1 January 2007.

With effect on 1 January 2007, a new complex set of governmental oversight parties were installed for the Netherlands Coastguard. The main change is the establishment of a Netherlands Coastguard Board (Raad voor de Kustwacht), that advises the Minister of Transport, Public Works and Water Management on the policy, enforcement-, service-, control-, information-, and financial plans with regard to coastguard duties. Representatives of the seven ministries involved are members of the Coastguard Board. The Coastguard Triumvirate is responsible for the daily execution of the tasks of the Netherlands Coastguard Board and monitors the preparation, the execution, and the justification of the plans from the Netherlands Coastguard.

Provision of SAR assets
The Dutch Safety Board did not investigate the present Dutch SAR capacity, because that is beyond the scope of this investigation. The mobilisation of flying SAR units has always been a task for the Dutch government. Up to 1 January 2008, the flying SAR units were provided by the Ministry of Transport, Public Works and Water Management (mainly search assets), together with the Ministry of Defence (search and rescue assets) for the Netherlands Coastguard. Up to 1 January 2008, within the Ministry of Transport, Public Works and Water Management, the responsibility for water- and air SAR units was divided between two different directories, respectively the Directorate-General for Public Works and Water Management - North Sea and the Transport and Water Management Inspectorate. As of 1 January 2008, all the flying SAR units fall under the Ministry of Defence.

The plan is to replace the Navy Lynx SAR helicopters with NH90 SAR helicopters which have a larger performance and payload capacity than the present Lynx helicopters. This will increase the SAR helicopter capacity. According to the Royal Netherlands Navy, the delivery of the NH90 SAR helicopters is delayed until 2013.

APPENDIX W: TRIPOD ANALYSIS

Tripod analysis
This study used Tripod-Beta as an accident analysis tool. Tripod Beta is based on the Tripod theory which has been developed to explain and control human error in incidents and accidents. The Tripod theory is based on two assumptions: (1) to a large degree, accidents are the direct result of human error, and (2) human errors are shaped and provoked by upstream workplace and organisational factors. In other words, according to the Tripod theory, humans err because the work setting or working conditions invite them to do so.

The Tripod Beta accident analysis tool assists researchers in answering the following questions.

- What happened?
  Tripod Beta accident analysis starts by identifying the Top Event (unwanted final event such as a potential death as a result of hypothermia) and the undesirable events that preceded the final unwanted event. An unwanted event in Tripod Beta is the direct result of a "hazard" (e.g. cold water) which harms or alters a "target" (e.g. passengers and crew). Accordingly, in the subsequent step of Tripod Beta analysis, the corresponding hazards and targets are identified for each undesirable event. The event and corresponding hazard and target constitute a HET-trio.

- How did this happen?
  In order to prevent the "hazard" from harming the "target", organisations erect barriers that control the hazard or defend the target. For instance, the barrier that may control the hazard "G-JSAR ditches" from harming or altering the target "passengers and crew" is the "deployment of life rafts before evacuation". According to Tripod Beta, accidents will occur only when all barriers fail (i.e., failed barrier) or are not in place (i.e., missing barrier). Accordingly, in the next step of Tripod Beta accident analysis, are identified for each HET-trio the missing and/or failing barriers.

- Why did this happen?
  According to Tripod Beta, barriers fall short because of an active failure or immediate cause. Active failures or immediate causes are technical or human errors as a result of which the barrier, as implemented by the organisation, falls short. In the present case, for instance, the barrier "deployment of life rafts before evacuation" failed because the crew directly evacuated the helicopter after the ditch. In the next step of Tripod Beta accident analysis, these active failures are identified and scrutinised. Subsequently, the preconditions that may explain the incident of the active failure (e.g. "the crew's lack of knowledge regarding the helicopter's floating capabilities") are identified in Tripod Beta. Finally, the structural shortcomings or latent failures at an organisational level (e.g. "the lack of regulations to differentiate SAR from public transport operation") that are responsible for the preconditions are identified and examined.

Illustration 1 (next page) depicts the results of the Tripod analysis in a simplified diagram. More specifically, the sequence of events and corresponding hazards and targets (HET-trio's) which, eventually resulted in the top event are presented. Furthermore, illustration 1 indicates which barrier could have prevented the undesirable event for each HET-trio (1) and the active failure that formed the immediate cause for the barrier to fail (2). For both barriers, the present report describes how and why these "controls" failed. In this respect, and in agreement with Tripod Beta, the report distinguishes between preconditions (mainly section 7) and latent failures at an organisational level (mainly section 8). To uphold the legibility of the diagram, the preconditions and latent failures are not included in illustration 1.

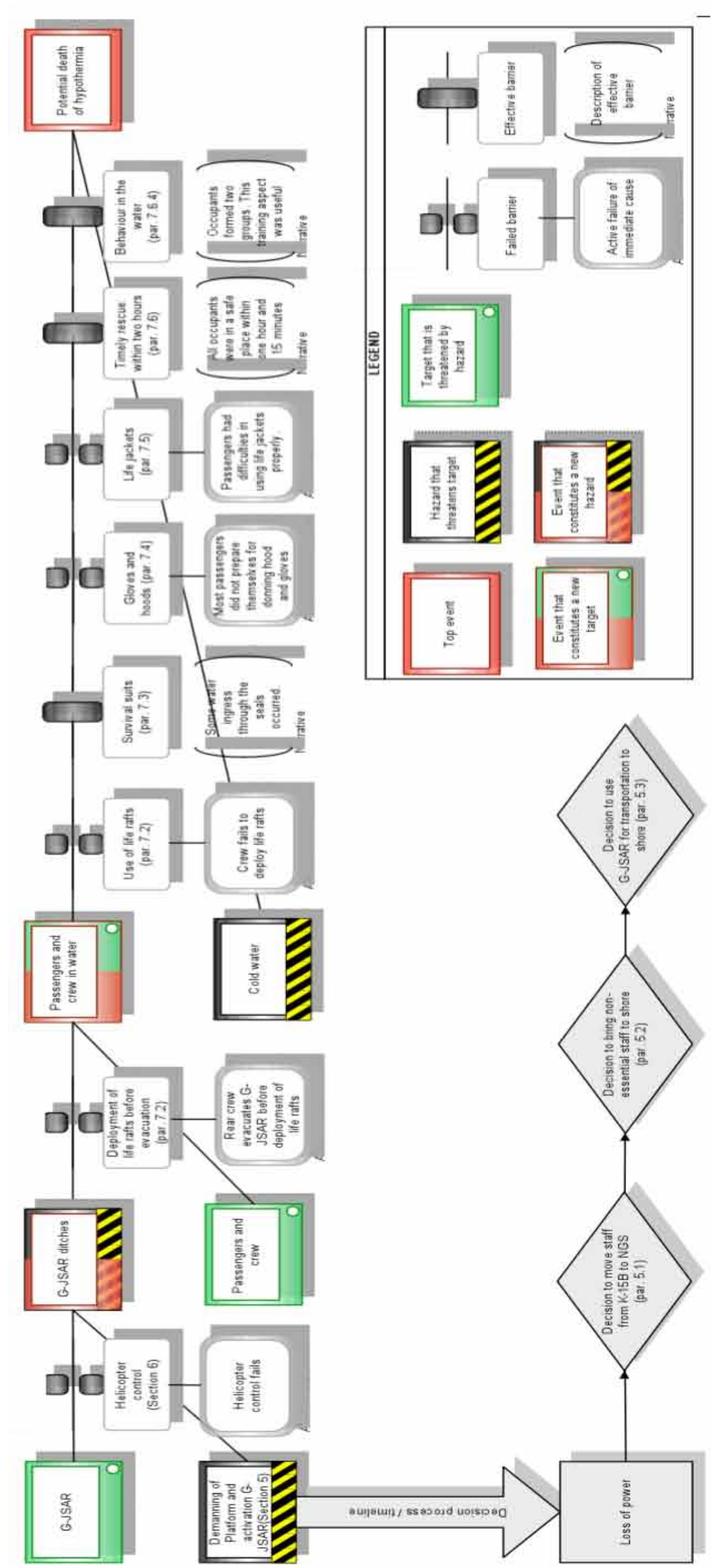

Illustration 1. Simplified diagram of the Tripod analysis of the emergency landing in the north sea made by the search and rescue helicopter G-JSAR on 21 November 2006.

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