



THE DUTCH
SAFETY BOARD



Emergency landing after bird strike

Boeing 737-4B6, Amsterdam Schiphol Airport,
6 June 2010

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The Hague, November 2011 (project number 2010034)

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The aim in the Netherlands is to reduce the risk of accidents and incidents as much as possible. If accidents or near-accidents nevertheless occur, a thorough investigation into the causes of the problem, irrespective of who is to blame for it, may help to prevent similar problems from occurring in the future. It is important to ensure that the investigation is carried out independently from the parties involved. This is why the Dutch Safety Board itself selects the issues it wishes to investigate, mindful of citizens' position of dependence with respect to public authorities and businesses.

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This report is published in Dutch and English. In the event of any difference in interpretation the Dutch text must be regarded as binding.

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CONSIDERATION

In the evening of 6 June 2010, a Royal Air Maroc Boeing 737-4B6 encountered a bird strike at Amsterdam Airport Schiphol. The Dutch Safety Board has conducted an investigation into this serious incident and its consequences. This report contains the results of that investigation.

The Boeing 737-4B6 is a two-engine civil aircraft. There were six crew members and 156 passengers on board. The flight was executed by a cockpit crew from Atlas Blue, an airline owned by Royal Air Maroc.¹

During the take-off from runway 18L, the aircraft collided with multiple Canada geese at a height of approximately 16 feet. The left engine was severely damaged as a result, with thrust reduced to approximately 45%. The nose gear indication was also “unsafe” as the landing gear was being retracted. The crew decided to return to Schiphol airport immediately. The crew made a mayday call and requested assistance from air traffic control. The aircraft’s climb capability was limited as a result of the bird strike. The aircraft flew over the built-up area around Vijfhuizen, Haarlem and Amsterdam’s western harbour area at a low altitude. A safe landing was then executed on runway 18R. Nobody on the aircraft was harmed.

The Safety Board’s investigation focuses on the following aspects:

1. the crew’s response to the engine failure;
2. aircraft flying over the built-up area around Schiphol at a low altitude during emergencies;
3. the problem of birds and bird strikes at and around Schiphol airport.

1. The crew’s response to the engine failure

After the bird strike had taken place, the crew made the correct decision and returned to Schiphol airport. The bird strike resulted in a multiple failure: thrust loss in the left engine and an “unsafe” indication for the nose gear.

However, the decision to return was not executed in accordance with commonly applied standard operations procedures as defined in the operations manual used by Atlas Blue and Royal Air Maroc. The crew diverged from these procedures in the following respects:

- instead of climbing straight ahead to the designated ‘clean up’ altitude with retracted landing gear, the aircraft made a right turn with a bank angle of up to 37.5 degrees at an altitude of 280 feet;
- the landing gear was extended after having been retracted during take-off;
- the crew reduced the thrust of the undamaged right engine instead of utilising its maximum thrust.

As a result, the aircraft had a limited rate of climb and could not reach the necessary safe altitude. Communication and crew resource management between the crew members during the flight was not in accordance with the internationally accepted standard for airline pilots. As a result of the immediate right turn and limited rate of climb, the crew members were under increased pressure as the autopilot may not be engaged at altitudes below 1000 feet. The pilots had to look outside to identify obstacles. The crew was also forced to deal with complications such as (system) warnings in the cockpit and an unstable flight path (variable heading, altitude, flight speed and rate of climb). As a result, both pilots did not carry out their tasks - such as the execution of (follow-up) procedures and completion of checklists - according to procedure. This caused an increased risk to the aircraft, its occupants and the surrounding area.

1 Atlas Blue merged with Royal Air Maroc on 1 March 2011.

2. Aircraft flying over the built-up area around Schiphol at a low altitude during emergencies

According to the outcome of an investigation by Air Traffic Control the Netherlands in response to the 1992 aircraft disaster in Amsterdam Bijlmermeer, it is unfeasible to use 'passageways' through unbuilt areas in view of the high density of the built-up area around Schiphol and the fact that civil aircraft are difficult to manoeuvre as a result of their high flying speeds. Based on this conclusion, Air Traffic Control the Netherlands determined that built-up areas should not be presented on the radar screen. A decision was also made not to present all high obstacles on the radar screen. Aircraft in distress must use existing runway arrival and departure routes where possible, since these routes were selected to ensure an optimal balance between safety, efficiency and environmental concerns, minimising flights over built-up areas.

Under extraordinary circumstances such as the Royal Air Maroc incident, Air Traffic Control the Netherlands also applies the internationally recognised 'assist principle'. According to this principle, the captain is responsible for safe flight operation and the air traffic controller must support decisions taken by the cockpit crew. In the interests of flight safety, Air Traffic Control is expected to provide such support to the fullest possible extent.

As a result of the emergency situation, the crew diverted from the existing departure route and flew over Vijfhuizen and Haarlem at an altitude of 380 to 480 feet. The route was within one kilometre of a 479-foot tower located on the outskirts of Haarlem. The aircraft also flew close to high obstacles (up to 587 feet) above Amsterdam's western harbour area.

The Royal Air Maroc flight reached a maximum altitude of 730 feet. Flight altitudes were thus well below the 1200 feet minimum vectoring altitude of the Schiphol control zone, which provides obstacle clearance during air traffic control. As a result, the crew itself was responsible for avoiding obstacles. Flight visibility was approximately seven kilometres at sunset, a distance within accepted limits for visual meteorological conditions.

Air traffic controllers supported the crew during the flight by providing headings for the landing. No information was provided regarding the presence of the aforementioned high obstacles, as these obstacles were not presented on the air traffic controllers' radar screen. Two other high obstacles have been featured on the radar screen for several years, but they did not play any role in this incident as they were not located along the aircraft's flight path.

The fact that these high obstacles are not visible on air traffic control radar screens increases the likelihood of collisions with a high obstacle when aircraft in distress are given headings while flying below the minimum vectoring altitude.

3. The problem of birds and bird strikes at and around Schiphol airport

The number of birds in the area around Schiphol airport that represent a risk to flight safety has almost doubled over the past ten years. This applies especially to the number of geese. The more so the number of sightings of migrating geese increases each year. In 2010, the number of aircraft taking off and landing at Schiphol airport remained the same as the number in 1998-1999. However, the number of geese in 2010 was four to seven times as large as the number in 1998-1999. As a result, the risk of bird strikes has increased significantly. In 2011, the number of aircraft take-offs and landings is expected to rise by 5% in comparison with 2010. In view of the expected long-term increase in the number of aircraft take-offs and landings, this risk will increase further if control measures to reduce the number of birds in the area around Schiphol airport are not implemented and intensified.

It has become clear that the parties responsible for managing the bird population at Schiphol airport are taking every possible measure allowed within the current legislative framework. Unfortunately, the measures needed to effectively control this bird population would have to be taken largely outside of the airport grounds, where these parties have no statutory powers.

There has been long-standing international and national agreement as to the required approach for controlling the risk of bird strikes. This approach consists of four specific focus areas:

- Population reduction.
- Limiting the number of foraging areas in the airport's surrounding area.
- Limiting the number of resting and breeding areas in the airport's surrounding area.
- Technical measures aimed at enabling radar detection of birds and bird movements.

Although agreement has been reached on the aforementioned measures, our investigation showed that as yet there is no agreement as to the exact level of danger these measures would help to control. As a result, there are also differing views as to the implementation of these measures. This especially applies to the question of which measures should be implemented in the short term. Population reduction is now regarded as necessary and inevitable.

In order to ensure aviation safety, the risk of bird strikes will have to be considerably reduced as soon as possible. In view of the fact that three of the four aforementioned focus areas will only yield results over a longer time period, population reduction remains the only effective potential measure in the short term. The Safety Board thus calls for vigorous implementation of this measure. These problems affect all of the parties involved, and an effective response will require centralised supervision from the Ministry of Infrastructure and the Environment, the body responsible for aviation safety. This ministry is responsible for aviation safety and is thus effectively the 'problem owner'.

The Safety Board is aware of the public debate on goose population management in the Netherlands. In part, this debate was sparked by the damage to agricultural plots and natural areas caused by large goose populations. Current discussions partly revolve around a recommendation from seven civil-society organisations, including various environmental organisations, united in the "Goose 7" (Ganzen-7). The recommendation outlines several measures to reduce and stabilise the populations of various species of geese in the Netherlands. However, the danger these geese pose to aviation safety has played an insubstantial role in the social debate. Implementation of the recommendation in the short term would help reduce the risk of bird strikes. Due to the high level of urgency involved, there is no time to wait for the outcome of ongoing pilots to assess alternative control measures. However, the development of more structural risk management measures, such as limiting the number of foraging areas, developing technical measures to enable radar detection and the scaring off of birds should also be intensified.

The Dutch Safety Board has formulated the following recommendations with regard to this serious incident:

Royal Air Maroc

The Safety Board recommends that Royal Air Maroc demonstrate to the Moroccan Ministry of Transport that:

1. the procedures for communication and crew resource management between crew members have been harmonised with the international standard for airline pilots.
2. pilot training has been expanded to include simulations of multiple unexpected failures.

Air Traffic Control the Netherlands and the minister of Infrastructure and the Environment

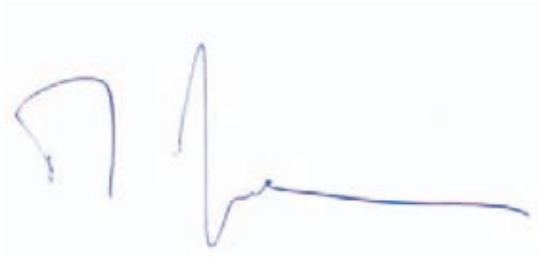
The Safety Board recommends that Air Traffic Control the Netherlands and the minister of Infrastructure and the Environment:

3. ensure that aircraft in distress flying under the minimum vectoring altitude are informed about high obstacles in the Schiphol control zone.

Minister of Infrastructure and the Environment

The Safety Board recommends that the minister of Infrastructure and the Environment, responsible for aviation safety:

4. take proactive measures to ensure the minimisation of bird strike risks.
5. with the greatest possible urgency and vigour implement effective measures to reduce and stabilise the population of various goose types in the Netherlands at a certain level in accordance with the "Goose 7" recommendation in order to reduce the risk of bird strikes.
6. ensure that the interests of aviation safety are safeguarded within the various relevant policy domains, by preparing enforceable emergency measures that allow for intervention if the risk of bird strikes becomes too great.
7. conduct studies to assess the potential of technical measures to reduce the risk of bird strikes.

A handwritten signature in blue ink, consisting of a large, stylized 'J' followed by a series of loops and a long horizontal stroke.

T.H.J. Joustra
Chairman of the Dutch Safety Board

A handwritten signature in blue ink, featuring a stylized 'M' followed by a long, sweeping diagonal stroke.

M. Visser
General Secretary

LIST OF ABBREVIATIONS

AAS	Amsterdam Airport Schiphol [the organisation]
AIP	Aeronautical Information Publication
AFM	Aircraft Flight Manual
AGL	Above Ground Level
AIS	Aviation Information and Services
AMvB	General Administrative Order
ATC	Air Traffic Control
ATPL(A)	Airline Transport Pilot Licence (Aeroplane)
BEA	Bureau d'Enquêtes et d'Analyses (Authority responsible for investigations into civil aviation accidents or incidents in France)
CAP	Civil Aviation Publication (from the UK Civil Aviation Authority)
CFR	Code of Federal Regulations (United States of America)
CRM	Crew Resource Management
CSN	Cycles Since New
CTR	Control Zone
CVL	Aircraft Bird Strike Committee (Commissie Vogelaanvaringen Luchtvaartuigen)
CVR	Cockpit Voice Recorder
DEGAS	Dutch Expert Group Aviation Safety
DGAC	Directorate-General for civil aviation of a particular state
DGCA	Directorate-General for civil aviation of a particular state
DGLM	Directorate-General of Aviation and Maritime Affairs (Netherlands)
EASA	European Aviation Safety Agency
ECAC	European Civil Aviation Conference
EG	European Community
EHAM	Amsterdam Schiphol Airport
EU	European Union
FAA	Federal Aviation Administration (United States of America)
FAR	Federal Aviation Regulations
FBE	Fauna Management Unit (Faunabeheereenheid)
FCOM	Flight Crew Operations Manual
FCTM	Flight Crew Training Manual
FDR	Flight Data Recorder
FL	Flight Level
GE	General Electric company
GMMW	Nador International Airport
GMT	Greenwich Mean Time
GPWS	Ground Proximity Warning System
HPC	high-pressure compressor
HPT	high-pressure turbine

IATA	International Air Transport Association
IBIS	International Bird strike Information System
IBSC	International Bird Strike Committee
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IOSA	IATA Operational Safety Audit
IR(A)	Instrument Rating (Aeroplane)
IVW	Inspectorate of Transport, Public Works and Water Management
JAA	Joint Aviation Authorities (Europe)
JAR	Joint Aviation Regulations
JAR-FCL	Joint Aviation Requirements for Flight Crew Licensing
JAR-OPS 1	Joint Aviation Requirement for the operation of commercial air transport
KNMI	Royal Netherlands Meteorological Institute
KLM	KLM Royal Dutch Airlines
LIB	Airport Planning Decree
LPC	low-pressure compressor
LPT	low-pressure turbine
LTO	Federation of Agriculture and Horticulture (Land- en Tuinbouworganisatie)
LVNL	Air Traffic Control the Netherlands
MATS	Manual of Air Traffic Services
MEL	Master Minimum Equipment List (airline company)
MSA	Minimum Sector Altitude compared to mean sea level
MSL	Mean Sea Level
NOTAM	Notice to Airmen
NRV	Dutch Bird Strikes Control Group (Nederlandse Regiegroep Vogelaanvaringen)
NTSB	National Transportation Safety Board (United States of America)
QRH	Quick Reference Handbook
RAM	Royal Air Maroc
RPM	Revolutions Per Minute
SBC	Schiphol Bird Strike Committee
SID	Standard Instrument Departure
SOP	Standard Operational Procedures
SPL VOR	Schiphol VHF Omnidirectional radio Range
STAR	Standard Instrument Arrival Route
TMA	Terminal Control Area
TRI(A)	Type Rating Instructor (Aeroplane)
TSN	Time Since New
VDV	Air Traffic Control Rules and Instructions (Voorschriften Dienst Verkeersleiding)
VEM	Safety, Efficiency and Environment (Veiligheid, Efficiency en Milieu)
VMC	Visual Meteorological Conditions
VNV	Dutch Airline Pilots Association (Vereniging van Nederlandse Verkeersvliegers)
VpS	Schiphol Safety Platform (Veiligheidsplatform Schiphol)
WBE	Game Management Unit (Wildbeheereenheid)
3PR	third party risk

1 INTRODUCTION

1.1 GROUNDS

In the evening of 6 June 2010 a Boeing 737-4B6 of Royal Air Maroc was en route from Amsterdam Schiphol Airport² to its destination of Nador International Airport in Morocco. The flight was executed by a cockpit crew from Atlas Blue, a subsidiary of Royal Air Maroc. During the take-off from runway 18L the aircraft collided with a flock of geese, which resulted in serious damage to the left engine. The crew decided to return immediately to Schiphol airport and made a right turn. The crew declared an emergency and requested support from air traffic control. After the bird strike the aircraft had limited climbing capability. The aircraft flew low over the built-up area of Vijfhuizen, Haarlem, and the western harbour area of Amsterdam and passed a number of high obstacles. It eventually landed safely. None of the passengers sustained any injuries.

The fact that the aircraft flew above a built-up area in the vicinity of high obstacles resulted in a number of research questions. The Board investigated how, in the case of flights whereby the crew has given notice of an emergency situation (hereinafter referred to as an 'emergency flight'), the crew and air traffic control determine the heading/route and take account of the safety risks for local residents. The relevant general – international and Dutch – points of departure were formulated. The Board then investigated which considerations the crew and air traffic controllers weighed up during the flight of Royal Air Maroc, including the decision to return directly to Schiphol airport and to make a right turn immediately after the start. These were the decisions that caused the aircraft to fly low over the built-up area.

The Board is aware of the social unrest which the incident with Royal Air Maroc caused.³ Media reports stated that the occurrence caused fear among residents in the vicinity of Schiphol airport and reminded people of the flight of the El Al aircraft that crashed into the Bijlmermeer on 4 October 1992. Following that accident the parliamentary committee of inquiry recommended at the time that the risk of emergency flights for third parties (referred to as 'external safety') should be restricted as much as possible, in particular after technical malfunctions as in this case. With a view to placing the events of this flight in the proper context, the Board assessed how the recommendation by the parliamentary committee of inquiry was followed. Another aspect investigated was how the control of bird population at and around Schiphol airport is organised.

1.2 THE INVESTIGATION

1.2.1 Goals

The investigation has two objectives. Firstly the Board intends to ascertain the cause of the serious incident. A second objective is to draw lessons learned for the parties involved and thereby prevent any repetition of such a serious incident. Research into blame or liability is explicitly not part of the Board's investigation.

2 Amsterdam Schiphol Airport is referred to hereafter as Schiphol airport.

3 Because of the low flying over the built-up areas the Safety Board received 13 reports from residents around Schiphol and 93 complaints from residents were received by the Residents Schiphol Reporting Point (Bewoners Aanspreekpunt Schiphol - BAS), www.bezoekbas.nl.

1.2.2 Research questions

The research questions for this investigation are:

1. What is the cause that led to the emergency situation?
2. What explanation is there for the chosen heading/route of the flight?
 - What considerations played a role during the flight as regards the choice of heading/route? What was the role of the crew or air traffic control in this specific case?
 - What is the international and national policy regarding the choice of heading/route in the immediate vicinity of an airport?
3. To what extent is it possible, from safety point of view, to avoid flying low over a built-up area in emergency situations?
 - To what extent and how has Air Traffic Control the Netherlands identified the risks of flying low over a built-up area around Schiphol airport during emergency situations?
 - To what extent do crew members and air traffic controllers have resources to deal with these risks?
 - How successful was the recommendation by the 1999 Bijlmer Disaster Parliamentary Committee of Inquiry as regards measures being implemented to prevent aircraft flying over built-up areas in emergency situations?
4. To what extent can the risk of bird strikes be managed effectively in the basis of current regulations, agreements and the actions that parties carry out?

1.2.3 Scope and procedure

The investigation describes and analyses the facts from the beginning of the flight until shortly after the landing on runway 18R at Schiphol airport. Another aspect investigated was the practice of flying over a built-up area in emergency situations and bird control at and around Schiphol airport. See explanation of the investigation in Appendix A.

1.3 READING GUIDE

This report consists of six chapters. Chapter two describes the actual cause of the serious incident and the other relevant facts. It also contains a short description of relevant terms and (aircraft) systems. Chapter three describes the parties involved, discussion forums, associations and their responsibilities. Chapter four describes the underlying factors of the serious incident and contains an analysis of the facts relating to the bird strike. Chapter five formulates the conclusions that resulted from the investigation.

The international Civil Aviation Organisation (ICAO) has, on behalf of investigations into accidents and serious incidents in civil aviation, set standards and recommended practices. The same applies to the way the report is structured. These are included in Annex 13, 'Aircraft Accident and Incident Investigation' of the Chicago Convention. The Board's report is structured in the same way, except that a chapter has been added with a description of the parties involved and their respective responsibilities.

2 FACTUAL INFORMATION

2.1 INTRODUCTION

On 6 June 2010, the Dutch Safety Board was notified that a serious incident had occurred at 21.42 hours⁴ during the take-off from runway 18L of Schiphol airport, involving an aircraft of the type Boeing 737-4B6 owned by Royal Air Maroc. The investigation was started immediately. This chapter provides the main facts that are important to determine the causes of the serious incident. In section 2.2 a few relevant terms and concepts are briefly discussed. Section 2.3 discusses the history of the flight. Data originating from interviews with the pilots and air traffic controllers, the flight data recorder and the cockpit voice recorder was used for the history of the flight. The remaining information is provided in the following paragraphs.

2.2 IMPORTANT TERMS AND CONCEPTS

The division of roles in the cockpit

The flight crew of a commercial aircraft normally consists of two pilots: a captain and a first officer. One pilot controls the aircraft (pilot flying) and the other has a supporting task (pilot monitoring). The most important supporting tasks of the pilot monitoring are monitoring the flight path, the flight condition and the aircraft systems, reading checklists aloud, communicating with air traffic control and positioning the flaps and the landing gear. Every airline company has its own standard operations procedures or uses those of the aircraft manufacturer, that specify which tasks must be performed by whom and when. The captain is often the most experienced pilot and has final responsibility for a safe execution of the flight. During flight preparation the captain decides who will act as the pilot flying and who will be the pilot monitoring.

Air traffic control

Air traffic control consists of area control, approach control and aerodrome control. Traffic that departs from Schiphol airport is controlled by aerodrome control which guides the aircraft in the control zone, that is the airspace immediately around the airport and on the aerodrome itself. The ground controller is responsible for controlling the traffic in the maneuvering area (including taxiways) with the exception of runways available for take-off and landing. The runway controller is responsible for controlling local traffic (departing from and landing on the runways) with the exception of traffic under the control of the ground controller. The approach controller guides the departing and arriving aircraft in the terminal control area.

Flaps

The flaps are extendable components on the leading and trailing edges of a wing that causes the surface area of a wing and the wing profile to change. The flaps are extended in steps and positioned downwards before the take-off and the landing, which means that the wing area and the curvature of the wing become larger and larger in steps. By doing this the lift of the wings can be maintained at a lower speed. The different flap positions are referred to with numbers, for example, 1, 5, 15 and 40. Those numbers refer to the degree the flaps are extended. By using flaps the drag usually increases.

For the Boeing 737-4B6 flap positions 5 till 15 can be used for take-off. Flap positions 30 and 40 are normal landing flap positions. The appropriate take-off flap position is calculated before each take-off, on the basis of tables. Runway length and condition are taken into account when deciding for a landing flap setting.

4 All times used in this report are local Dutch times unless otherwise specified.

Landing gear

The Boeing 737 is equipped with a tricycle landing gear. There are two main wheel assemblies under the wings and a third smaller wheel assembly at the nose of the aircraft.

To decrease drag in flight the undercarriage can be retracted into the wings and fuselage. The gear is normally retracted and extended hydraulically.

Landing gear status

The gear position is shown on the landing gear panel in the cockpit by landing gear indicator lights for the nose wheel and the two main gears; see illustration 1.

Legend for illustration 1

1. Illuminated red lights indicate that the landing gear is not down and locked or the related landing gear is in disagreement with the landing gear lever position (in transit or unsafe).
2. Illuminated green lights indicate that the related gear is down and locked.
3. Landing gear lever. The landing gear is retracted in the up position (UP) and extended in the down (DN) position.

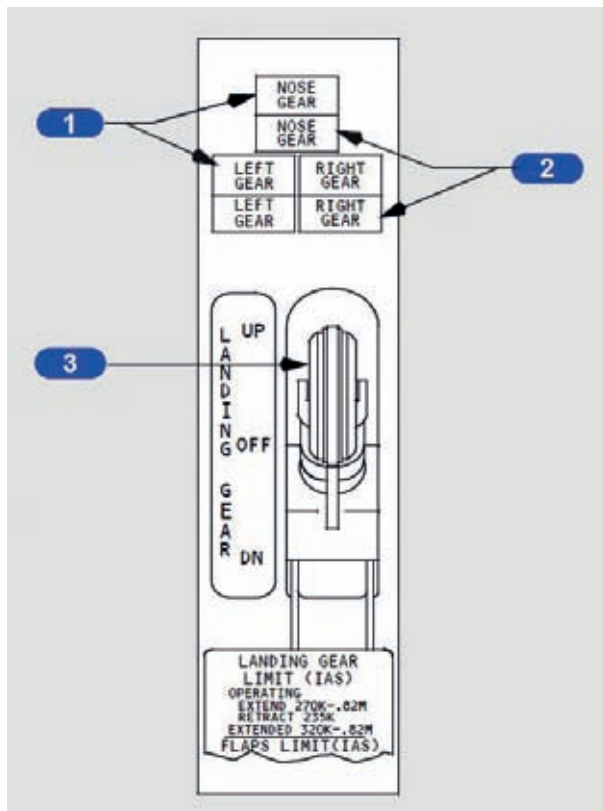


Illustration 1: landing gear panel

Nose landing gear viewer

A nose landing gear viewer is present in the cockpit to observe whether the nose landing gear is down and locked. The cover plate for the nose landing gear viewer is located on the cockpit floor just before the door. The wheel well light switch must be on to observe if the nose landing gear is down and locked.

Landing gear warning horn

A steady warning horn is provided to alert the flight crew whenever the aircraft is in a landing configuration and any gear is not down and locked.

Ground proximity warning system (GPWS)

The GPWS provides alerts for potentially hazardous flight conditions. To the extent GPWS warnings are installed, they warn of imminent impact with the ground, excessive descent rate, altitude loss after take-off, and glide slope deviation.

The GPWS alerts are based on radio altitude and combinations of barometric altitude, airspeed, glide slope deviation, and aircraft configuration. Below several alerts are described:

- excessive descent rate ("SINK RATE");
- excessive terrain closure rate ("TERRAIN");
- altitude loss after take-off or go-around ("DON'T SINK");
- unsafe terrain clearance when not in the landing configuration ("TOO LOW GEAR", "TOO LOW FLAPS", "TOO LOW TERRAIN");
- excessive deviation from the ILS glide slope ("GLIDE SLOPE").

Standard Instrument Departure

This is the published route which the aircraft has to follow after departing from an airport, based on a flight plan submitted to air traffic control in accordance with instrument flight rules. The route followed guides the aircraft to a point on the desired air traffic route. Standard instrument departure routes are designed in such a way that aircraft overflying populated areas is limited.

Minimum sector altitude

A minimum sector altitude (MSA) applies. This altitude is 1,000 feet above the highest obstacle in a certain sector and is indicated on the approach charts for Schiphol airport. For the area in which the flight of Royal Air Maroc took place the MSA is 1700 feet.

Minimum vectoring altitude

Air Traffic Control the Netherlands issues flight heading instructions to aircraft in the Schiphol control zone from an altitude of 1200 feet and higher. 1200 feet, the so-called minimum vectoring altitude, is the minimum altitude at which aircraft still receive obstacle-free flight heading instructions. (This altitude is based on a minimum obstacle clearance of 500 feet in the aerodrome control zone approach area.) Below 1200 feet, the captain is himself responsible for avoiding obstacles and for flying over the built-up area, based on heading advice.

Speeds

Speeds V_1 , V_r , and V_2 are important during take-off. The speed V_1 is used during take-off to aid the pilots decision making process in the event of an engine failure or other significant problem. Below V_1 , the aircraft is able to stop within the available runway distance. The speed V_r is the speed at which the pilot flying starts pulling on the controls causing the aircraft to pivot around the axis of its main landing gears which are, at that time, on the ground. The speed V_2 is the minimum airspeed after take-off at which the aircraft has a margin to the stall speed that allows it to turn with maximum 40 degrees of bank angle. Under the prevailing conditions for this flight the values of speeds V_1 , V_r , and V_2 for the Boeing 737-4B6 for the take-off from Runway 18L at Schiphol airport were: $V_1 = 143$ knots; $V_r = 143$ knots; $V_2 = 157$ knots.

2.3 HISTORY OF THE FLIGHT

The Boeing 737-4B6, with registration CN-RMF, was scheduled for a flight (flight number RAM685R) from Schiphol airport (EHAM) to Nador International Airport (GMMW) in Morocco. There were 156 passengers and four crew members in the cabin. The cockpit crew consisted of two pilots. The captain who occupied the left cockpit seat acted as pilot flying. The first officer occupied the seat on the right as pilot monitoring. Prior to the flight there were no technical problems or other issues which could influence the flight operation.

The aircraft received the airway clearance for the flight from Schiphol to Nador to follow the route as it was filed in the flight plan. The flight was instructed to initially follow the standard instrument departure (SID) LEKKO for runway 18L; see illustration 2. This departure requires the aircraft to continue to fly on the runway heading after take-off until it reaches 500 feet.⁵ While following the SID the aircraft may climb above flight level 60⁶ if instructed to do so by air traffic control.

After engine start the ground controller instructed the crew to taxi to holding position E5 of runway 18L. Flaps 5 were selected and the preparations for take-off were completed. A moment later the runway controller instructed the flight to line up on runway 18L. Approximately one minute later the flight was cleared for take-off as soon as the crew was ready. Upon the take-off of the preceding aircraft on runway 18L, a Boeing 777, the cockpit crew had activated the stop watch to ensure they would take sufficient time to avoid the wake turbulence⁷ of this aircraft. This made the pilots commence their take-off one minute after receiving the take-off clearance, at 21.42 hours.

According to the data from the flight data recorder the aircraft lifted off at 21.42:54 hours. The airspeed was 171 knots, the aircraft pitch attitude was passing through 6 degrees nose up. The left and right engine RPM⁸ values recorded were 94.0% and 93.8% N1.⁹

At 21.42:58 hours, at a height of 16 feet the gear retraction was initiated. At this moment with a speed of approximately 175 knots the aircraft encountered a bird strike with multiple geese. This resulted in an immediate loss of almost all thrust on the left engine. The landing gear indication system displayed an unsafe nose gear indication.

At 21.43:04 hours at a height of 140 feet, the aircraft pitch attitude was 12 degrees nose up and the engine RPM were 45.5% and 93.8% N1. The left engine speed remained at approximately 45% N1 until the engine was shut down approximately four minutes later.

-
- 5 At 500 feet the aircraft must turn left to intercept radial 164 of the SPL VOR. At a distance of 6.5 NM from the SPL VOR, the aircraft should make a right turn to follow the 186 radial of the SPY VOR. The VOR signal allows the airborne receiving equipment to determine a magnetic bearing from the station to the aircraft (direction from the VOR station in relation to the Earth's magnetic North). This line of position is called the "radial" from the VOR.
 - 6 Flight level (FL) indicates the pressure altitude above a standard pressure datum of 1013.2 hPa. Flight levels are expressed in hundreds of feet calculating from this datum with an altitude of zero. FL60, means 6,000 feet above the datum.
 - 7 Wake turbulence is the turbulence that occurs in the wake current of an aircraft. The heavier the aircraft, the greater the turbulence.
 - 8 RPM stands for revolutions per minute.
 - 9 % N1 is a measure for engine thrust expressed in percentage of the low-pressure rotor RPM. A derated take-off was performed. Therefore less than full engine thrust for take-off. This is done to save fuel consumption. In addition this decreases engine wear and exhaust emissions. The level of thrust reduction depends among others on field length, density altitude and aircraft weight.

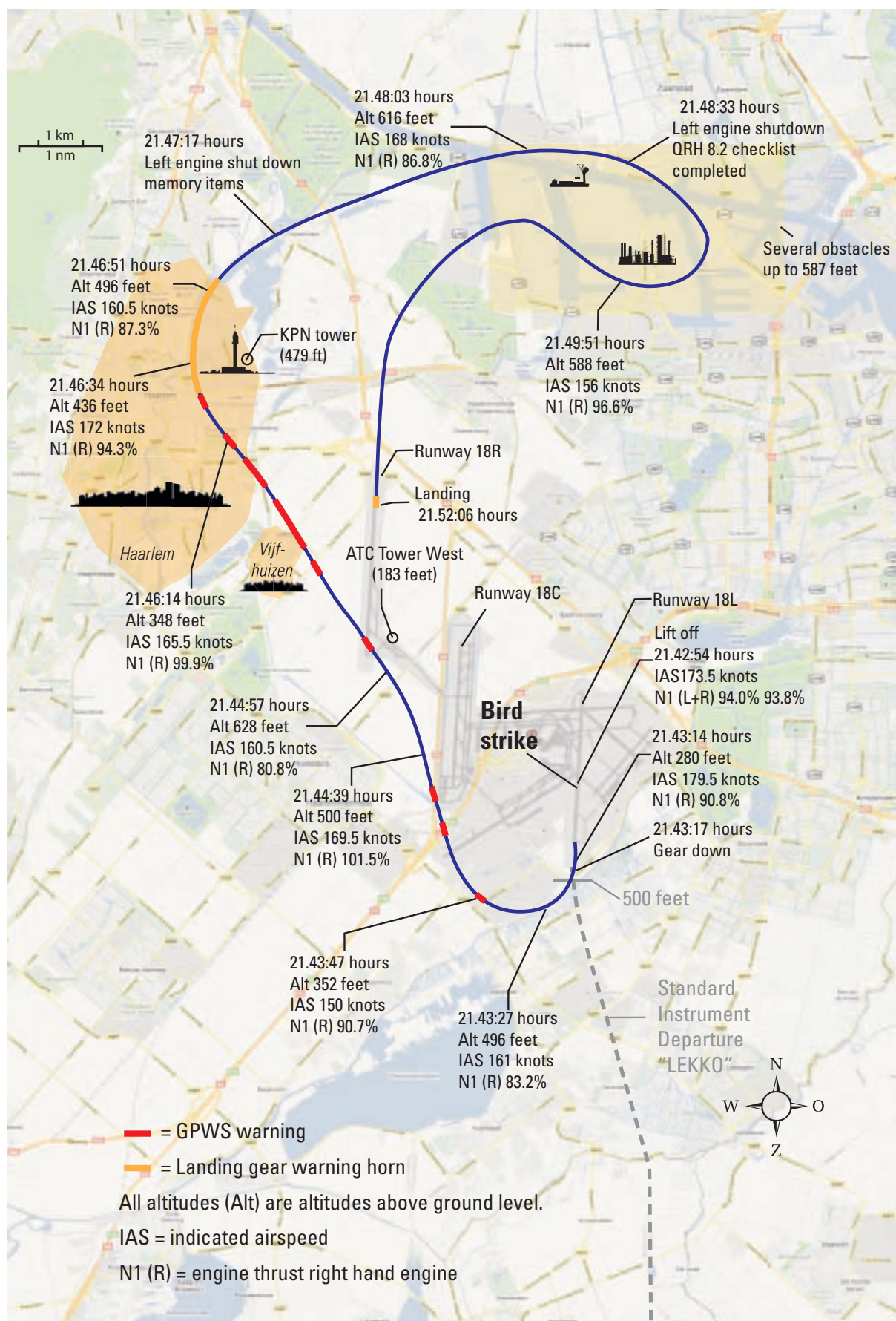


Illustration 2: flown route with the location of the bird strike and part of the standard instrument departure LEKKO

Immediately after the bird strike the first officer announced that engine one was damaged. This call was not confirmed by the captain. When interviewed about the serious incident, the captain stated that the aircraft was shaking violently and difficult to control during this phase of the flight. He had wondered whether both engines were damaged to the extent that they had insufficient thrust to continue the flight. This is why he decided to return immediately. The captain did not discuss his considerations with the first officer, as he felt the need to return was evident for both of them. Three seconds after the announcement of the first officer, the captain ordered to select the gear down and to declare an emergency to air traffic control. Without any discussion the first officer then selected the gear down. At the same time he contacted the runway controller and declared an emergency by issuing a mayday call.¹⁰ He informed the runway controller that they had experienced a bird strike and were returning to the airport and requested radar vectors. During the mayday call, at 21.43:14 hours at a height of 280 feet the captain initiated a turn to the right. After the gear was selected down, the nose gear indication remained unsafe.

By the time the mayday call transmission ended at 21.43:18 hours the aircraft's bank angle had increased to 21 degrees to the right. The runway controller stated that he saw that the aircraft was already in a right turn and instructed the crew to continue the turn and to roll out on a heading of 330 degrees. He informed the crew that they would receive further heading instructions for an approach to runway 18R. Immediately after this the runway controller instructed other traffic that was taking off from runway 24 to stop their take-off because it was in direct conflict with the flight path of the Royal Air Maroc Boeing 737. After the first officer acknowledged the instructions from the runway controller he repeated that engine one was damaged. The captain did not react to this statement. During the aircraft's turn the maximum recorded bank angle to the right was 37.5 degrees and the airspeed dropped from 179 to 156 knots.

At the same time the turn was initiated with the autothrottle¹¹ engaged, the right thrust lever was retarded manually. The engine RPM decreased from 93.8% to 82.0% N1. At 21.43:26 hours the autothrottle was disengaged but the thrust remained at values around 83% N1 for the right engine. The aircraft continued a slow climb to 496 feet and then entered a shallow descent. At time 21.43:44 hours a GPWS "DON'T SINK" warning was activated. Meanwhile the airspeed reduced further to 145 knots. Eventually the aircraft rolled out on a heading of 344 degrees at time 21.44:14 hours.

Meanwhile the captain asked the first officer to repeat the information the crew was given by the runway controller. The first officer answered the captain and then remarked that the nose gear was not up. This discussion was interrupted when the purser called the cockpit via the intercom¹² informing the crew that the left engine was on fire. The captain ignored this statement. Instead he ordered the first officer to inform the purser that they would be returning to the airport.

Then, between 21.44:13 and 21.44:36 hours several things happened simultaneously. The runway controller called the crew to ask whether they would be able to maintain their altitude and to give new heading instructions. While the first officer answered this call, the captain talked over the service interphone to the purser while flying the aircraft manually.

During this discussion the purser repeated that the left engine was on fire. Also the GPWS system was triggered several times. After the first officer ended his conversation with the runway controller the captain asked him to repeat what the controller had instructed.

After the GPWS warnings sounded the right thrust lever was moved forward and the right engine N1 increased to 101%. The aircraft stopped the descent at 352 feet and then started to climb again. The airspeed also increased. At 21.44:39 hours a height of 500 feet was reached and the airspeed had increased to 169.5 knots. At that time the first officer mentioned that the right engine had been at full thrust for two minutes since the start of the take-off roll. Two seconds later the right thrust lever was pulled back again. By that time the aircraft reached 628 feet. The first officer then asked the captain if he should call the purser and let the cabin prepare for an emergency

10 A radiotelephony distress signal consisting of the spoken word MAYDAY means that grave and imminent danger threatens, and immediate assistance is requested.

11 The autothrottle regulates the engine thrust and is switched on during take-off.

12 Service (attendant) interphone system.

landing because the nose landing gear could fail upon touchdown. The captain agreed and also requested that the purser be asked to enter the cockpit to check if the nose wheel was down and locked.¹³

The aircraft again entered a shallow descent. While GPWS "DON'T SINK" warnings were issued almost continuously, the aircraft continued to descent until the warning changed to "TOO LOW TERRAIN" at 21.46:13 hours and a height of 348 feet was reached. Meanwhile at 21.45:13 hours the purser entered the cockpit. The first officer asked him to look through the nose gear viewer window to confirm whether the nose gear was down or not. Simultaneously the first officer answered a call from the runway controller to contact the arrival controller.¹⁴ They were transferred to a so called, discrete frequency, a frequency which is not used by other traffic. After looking through the viewer the purser confirmed that the nose gear was down and locked.

The captain then increased thrust on the right engine to just below maximum thrust settings and the aircraft started to climb. At 21.46:20 hours the GPWS warnings had ceased but were replaced by the continuous sound of the landing gear warning horn until 21.47:07. While the flight crew discussed this new warning the arrival controller gave the crew a heading of 350 degrees as a downwind leg to lead the aircraft to runway 18R. The controller also asked the crew if the aircraft was able to climb. The crew responded that they could not. When the landing gear warning horn ceased the aircraft was just north of the buildup areas of the cities Vijfhuizen¹⁵ and Haarlem.¹⁶ These areas were overflown at a height between 380 and 500 feet. See illustration 2. Until this time all heading instructions given by air traffic control were followed more or less accurately.

The arrival controller then instructed the flight crew to follow a new heading of 100 degrees and reported they were four miles from touchdown. The crew concluded that they could not silence the landing gear warning horn. The captain turned the aircraft towards the new heading but rolled out on heading 065. At 21.47:17 hours the left engine was shut down according to the memory items¹⁷ of the "Engine Fire or Engine Severe Damage or Separation" checklist (Quick Reference Handbook chapter 8.2). During this procedure the arrival controller informed the crew to fly heading 160 degrees. This information was not read back nor followed. A moment later the arrival controller gave a heading of 210 degrees which was not followed either. Only a very shallow right turn was initiated. By the time the flight crew had completed and confirmed the recall items of the checklist, the aircraft was positioned north of the airport, crossing the extended centre line of runway 18L.

At 21.48:03 hours the arrival controller instructed the crew to fly heading 270 degrees in order to direct the aircraft back towards runway 18R. After this instruction the crew completed the remainder of the "Engine Fire or Engine Severe Damage or Separation" checklist and completed programming the flight management computer.

At 21.48:47 hours, when the aircraft was passing heading 110, the first officer asked for further heading instructions. The arrival controller repeated to fly heading 270. The flight crew asked the controller if it was possible to land on runway 18L. The controller indicated that this was not possible due to obstacles (a buildup area) just north of runway 18L. The crew discussed that the aircraft was difficult to control during this phase of the flight. Despite the fact that the remaining engine generated maximum continuous thrust the crew stated that it was difficult to maintain airspeed while maneuvering. According to the flight data recorder the airspeed fluctuated between 160 and 170 knots.

13 For this purpose a nose landing gear viewer is present located in the cockpit floor.

14 The arrival controller is responsible for controlling the inbound traffic to Schiphol Airport, that is handed over to him.

15 The city of Vijfhuizen had a population of 4258 in 2010 (source: website municipality Haarlemmermeer).

16 The city of Haarlem had a population of almost 150,000 on 1 January 2010 (source: website municipality Haarlem).

17 Some parts of checklist procedures first have to be performed from memory and must later be confirmed by reading the actual checklist.

At 21.49:57 the first officer warned the captain that the speed was getting low. The speed at that moment was 156 knots. The captain adjusted the thrust lever and remarked that the right engine was operating at full thrust. Following the remark of the first officer, the engine was running at full thrust (103,9% N1) during five seconds. However, just before and after the remark the right engine operated only at 94% N1 and 97% N1 respectively.

A moment later the flight crew asked the arrival controller if they could use runway 18C. This was approved but the crew abandoned this idea and decided to stick to their original plan to land on runway 18R. Hereafter the arrival controller asked the crew on which heading they were flying. The first officer replied they were on a heading of 310 degrees. The arrival controller then advised to fly heading 215. The first officer read back the information and then assisted the captain verbally with the turn. A manual instrument landing system (ILS)¹⁸ category I approach for runway 18R was executed with the flaps in position 5.

During the final part of the approach the first officer asked the captain if he should inform the purser that they would be landing shortly and that the cabin should be prepared. The captain replied that he did not want the cabin crew to start an evacuation procedure on the ground. Instead he told the first officer to inform the purser that they would be making a hard landing. The first officer did not pass this message to the purser as at that moment the aircraft started the final part of the approach. Instead he assisted the captain with monitoring the initiation of the descent. During the descent the first officer remarked that the auto brakes did not work whereupon the captain instructed to switch the auto brake system off. Just before touchdown the first officer suggested to the captain that he should try to keep up the nose wheel during the landing as long as possible. A safe landing was made. During the landing roll the captain told the first officer that no evacuation would be initiated if there were no signs of fire.

At 21.52:06 hours the aircraft landed with flaps 5 and a speed of approximately 175 knots. The aircraft stopped on the runway where the right engine was shut down. Immediately after the landing the aircraft was inspected by the airport fire department and no signs of fire were detected. The tires of the right main landing gear were deflated.¹⁹ Bird remains were found in the left main landing gear, see illustration 3, the nose landing gear and in the electronic bay. The passengers vacated the aircraft via stairs, provided by the airport authorities.



Illustration 3: bird remains found in the left main landing gear

18 A radio navigation system with which a precision approach to a landing runway can be performed. The system provides the pilot with an accurate picture of the position of the aircraft with regard to the runway axis and angle of descent to a landing runway. The system will also give an indication of the distance up to the runway threshold.

19 Brake temperature levels were reached which caused the wheel fuse plugs to melt and deflate the tires in order to vent the overpressure condition.

2.4 INJURIES TO PERSONS

None of the occupants suffered injuries during the incident.

2.5 DAMAGE TO THE AIRCRAFT

Inspection of the aircraft after the serious incident indicated the following visible damage:

- dents in the underside of the fuselage near the aircraft nose;
- a dent in the leading edge of the vertical stabilizer;
- dents and a crack on the cowling of the left engine (see illustration 4) and inside the left engine cowling;
- in the left engine, three consecutive fan blades had outer panel separations at approximately 40-50% span height, causing consequent fragmentation damage to all other fan blades in that engine due to the released material;
- soot and oil traces were visible on the left side of the left engine;
- oil traces were present on the fuselage;
- jammed brakes of the right main landing gear.

A following inspection of the left engine revealed the following components were damaged:

- Low and high pressure compressor.
- Combustion chamber and high pressure turbine nozzle guide vanes.
- High pressure turbine rotor blades and low pressure turbine nozzle guide vanes stage 1.
- Low pressure turbine first to fourth stage.

2.6 OTHER DAMAGE

Oil contamination was reported in a small portion of marina De Rietpol in Spaarndam- West (municipality Haarlem). The investigation and inquiry, performed by the municipalities Haarlem, Haarlemmerliede and Spaarnwoude showed that in the area which was flown over by the aircraft no other contaminants were observed and/or reported. The origin of the oil contamination was not determined during the investigation.



Illustration 4: damaged left engine cowling

2.7 PERSONNEL INFORMATION

The cockpit crew consisted of a captain and a first officer.

2.7.1 Captain

Spanish nationality; 36 years of age; employed via a broker with Atlas Blue²⁰ since 16 March 2009.

Licence:	JAR ATPL(A), valid until 3 December 2011.
Ratings:	Boeing 737-300/900, valid until 13 September 2010 IR(A), valid until 13 September 2010. TRI(A) Boeing 737-300/900, valid until 2 July 2011.
Captain check/rating:	3 September 2006.
Boeing 737 type rating:	21 April 1999.
Boeing 737 captain:	3 September 2006.
Medical certificate:	Class 1; valid until 21 December 2010.
Flying experience:	Total: 7540 hours. Boeing 737: 7200 hours. Boeing 737 as captain: 2410 hours. Total within Atlas Blue: 1218 hours. Last 90 days: 217 hours. Last 24 hours: 6.52 hours.
Activities last 72 hours:	4 June 2010: none working day. 5 June 2010: working day, total flight time 6.27 hours. 6 June 2010: working day, total flight time 3.53 hours.

2.7.2 First officer

Spanish nationality; 28 years of age; employed via a broker with Atlas Blue since 30 November 2007.

Licence:	JAR ATPL(A), valid until 30 September 2014.
Ratings:	Boeing 737-300/900, valid until 12 September 2010 (restriction first officer). IR(A), valid until 12 September 2010.
Boeing 737 type rating:	12 September 2006.
Medical certificate:	Class 1; valid until 25 July 2010.
Flying experience:	Total: 2730 hours. Boeing 737: 2308 hours. Total within Atlas Blue: 2147 hours. Last 90 days: 250 hours. Last 24 hours: 6.52 hours.
Activities last 72 hours:	4 June 2010: none working day. 5 June 2010: working day, total flight time 6.27 hours. 6 June 2010: working day, total flight time 3.53 hours.

²⁰ Atlas Blue was a subsidiary established by Royal Air Maroc in 2004 to service the low-cost market. Atlas Blue merged with Royal Air Maroc on 1 March 2011. See chapter 3.2.

2.8 AIRCRAFT INFORMATION

The Boeing 737 is a two-engine transport aircraft. The Boeing 737-4B6 falls under the 737 Classic series and came in service in October 1988.

The "load & trim sheet"²¹ that was used by the pilots was in accordance with the prescribed limits for the aircraft weight and the centre of gravity.

The maintenance documents of the aircraft did not contain any defects or technical complaints that still had to be resolved before the flight.

Type:	Boeing 737-4B6.
Construction year:	1990.
Registration:	CN-RMF.
Serial number:	24807.
Cabin subdivision:	162 seats (economy).
Maximum take-off weight:	68,038 kilogram.
Certificate of registration:	Date of issue: 25 July 2008.
Certificate of airworthiness:	Date of issue: 8 April 2005.
Engines (two):	CFM56-3C-1 turbofan.
Certification date engines:	1984.

General information regarding the CFM56 turbofan engine is contained in Appendix C.

2.9 METEOROLOGICAL INFORMATION

For the flight the crew used departure ATIS message "X-ray".²² The message reported the main take-off runway 24, the wind 220 degrees 9 knots, visibility 7000 metres, clouds 2200 feet broken, temperature 16 degrees Celsius, dew point 14 degrees Celsius, QNH 1009 hectopascal.

A weather report of the Royal Netherlands Meteorological Institute (KNMI) indicated that the wind near the ground came from direction 230 degrees with 8 knots. The visibility was 7 kilometres. There were few clouds at a height of 1000 feet and broken clouds at 2200 feet.

The daylight period ended at 22.10 hours.²³

2.10 AIDS TO NAVIGATION

Runway 18R is equipped with an instrument landing system category III and with distance measuring equipment.

At the time of the incident, the instrument landing system of runway 18R was fully operational category III.²⁴

21 A 'load & trim sheet' is the form that provides crew with information about, for example, the weight of the aircraft, the passengers, luggage and fuel distribution and the centre of gravity location.

22 Automatic terminal information service (ATIS) is a radio service offered to departing and arriving air traffic at the larger airports. ATIS consists of an automatic message which is continually transmitted on one or more frequencies. The message is updated every half hour, unless rapidly changing circumstances mean a speedier update is required. Successive messages are indicated with different letters in alphabetic sequence. The message contains information on, for example, the current weather situation at the airport and operational details.

23 15 minutes after sunset time.

24 This means that the instrument landing system was also fully operational for a category I approach that was executed by the pilots. For a category I approach a higher decision height is applied than for a category III approach.

2.11 COMMUNICATIONS

During the flight the crew was in radio contact with different air traffic controllers. Recordings of all the conversations between the crew and air traffic control were available for the investigation.

2.12 AERODROME INFORMATION

2.12.1 General information

Schiphol airport is used for civil air traffic. The airport has one central terminal for passenger handling. The airport is located eleven feet below mean sea level.

There are four main runways around the terminal. A fifth main runway (18R) is situated on the west side of the airport. A secondary runway mainly used by private or business aviation is located on the east side of the airport.

At the time of the serious incident runways 18L and 24 were in use for take-off and runway 18R for landing.

2.12.2 Amsterdam Airport Schiphol Bird Control department

Amsterdam Airport Schiphol has a Bird Control department which implements the control measures to prevent collisions between aircraft and birds during the take-off and the landing on the landing area. One of the key measures is to make the landing area unattractive for birds. To that end the grass in the landing area is allowed to grow long and kept at a length of at least 15 centimetres. This makes the area unattractive for most birds due to the poor view they then have of their surroundings and of predators. The area is also unattractive to birds of prey because the long grass makes it difficult to find prey. The landing area is also drained to prevent pools of water that might attract birds.

The Bird Control department has fifteen birdwatchers who work round the clock, a fauna manager, a policy advisor and a manager. During daylight hours at least two birdwatchers are on duty at any one time. The birdwatchers and the policy advisor have acquired knowledge of flora and fauna management through training and practical experience. If a runway has not been used for at least twenty minutes, it has to be checked by the birdwatcher. The entire length of the runway is then checked for the presence of birds and to prevent foreign object damage before it can be used again. Birdwatchers use various resources to chase birds away, such as air guns, gas cannons, sound systems, cages, green laser beams and falcons (trial session fourth quarter 2009 and in 2010).

The birdwatchers have a vehicle and are in radio contact with air traffic control. They can decide to take action themselves or be requested to do so by air traffic control if birds are reported with a view to chasing them away or in the event of a bird strike on or near a runway. Appendix D contains an overview of the various control measures taken in recent years.

In addition to the aforementioned bird control measures, ad hoc decisions are regularly made to assign aircraft to a different runway or shut down a runway altogether if the level of bird activity is unsafe. The birdwatchers surveilling the runways are generally responsible for the decision to halt normal procedures. They are most effectively positioned to assess the birds' behaviour.

In some cases, an aircraft crew will report bird activity. The birdwatchers will then check the area.

In 2009-2010 an average of seven bird strikes were reported per 10,000 aircraft manoeuvres. In the past, Schiphol aimed to achieve a target of four reported bird strikes²⁵ per 10,000 aircraft manoeuvres, see table 1. This target value was based on experience and Schiphol claims it was not exceeded. In 2005 Schiphol changed its bird control policy to a 'zero tolerance' policy, meaning that the aim was a total absence of birds in the landing area. According to Schiphol, this target has

25 A bird strike is the generic term for physical contact between a bird and an aircraft during a flight.

turned out to be unrealistic.²⁶ In subsequent years the number of reported bird strikes has increased every year compared to the old target value, partly due to improved feedback and reporting by pilots and the birdwatchers.

Year	Schiphol
2007	5.5
2008	4.2
2009	7.1
2010	7.2

Table 1: number of bird strikes per 10,000 flight movements at Amsterdam Schiphol Airport [Source: Shared Skies, Initial Policy Document drawn up by the Dutch Bird Strike Control Group (Nederlandse Regiegroep Vogelaanvaringen), dated 4 August 2010]

Since 2010 Bird Control has no longer applied any relative objective as regards the number of reported bird strikes, but instead an objective linked to the number of bird strikes per year. For 2011 Bird Control's policy was aimed at a maximum of 117 bird strikes, which is 10 percent less than the 130 reported bird strikes in 2010.

The illustration below shows the number of bird strikes per month and trend in the period medio 2005 till medio 2011 at Schiphol airport (all sorts of birds).

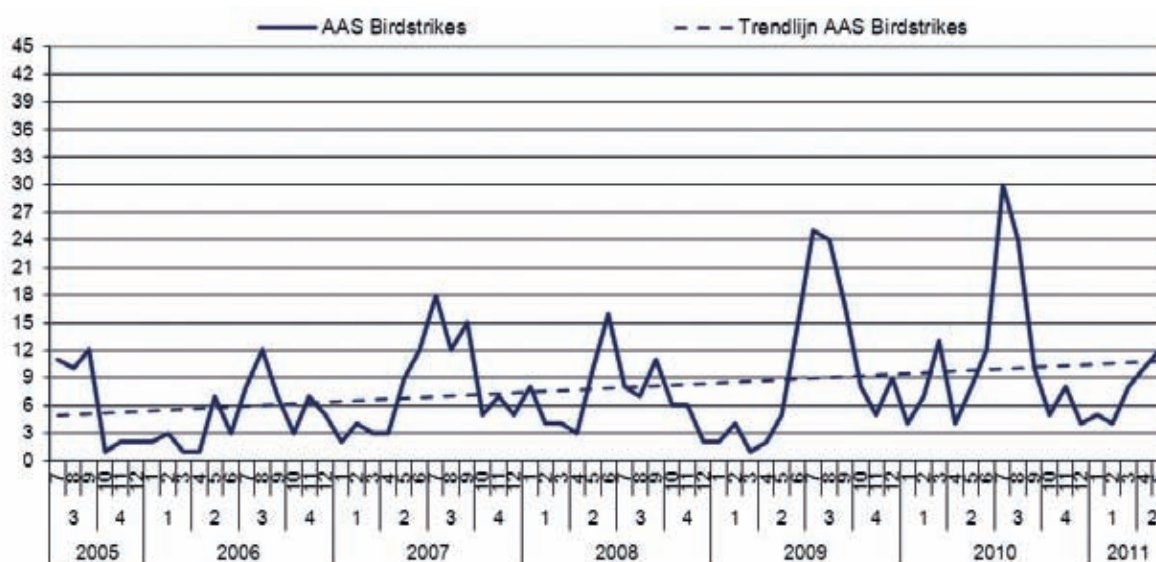


Illustration 5: number of bird strikes per month over the period medio 2005 till medio 2011 at Schiphol airport (all sorts of birds) during landing below 200 feet and during start up to 500 feet [Source: Amsterdam Airport Schiphol]

2.13 FLIGHT RECORDERS

The aircraft was equipped with a cockpit voice recorder and a flight data recorder. Both recorders were found in an undamaged condition.

Twenty-five hours of flight data had been recorded on the flight data recorder. The flight data recorder data was read out and analysed using Boeing documentation. Appendix E contains a plot with the relevant data used in this investigation.

²⁶ This is an area covering 2500 hectares.

The cockpit voice recorder that was installed had a storage capacity of approximately two hours. The sound was of good quality and usable for the investigation.

Investigation of the cockpit voice recorder also revealed a wiring problem. Where, according to the aircraft's specifications, the sounds picked up by the cockpit area microphone should be recorded for two hours these were only recorded for 30 minutes. Instead of the required 30 minutes recording of the cabin public address this was now recorded for two hours. This, however, had no influence on the investigation; all relevant data were recorded.

2.14 MEDICAL AND PATHOLOGICAL INFORMATION

The pilots held valid medical certificates, which were issued in Spain.

2.15 FIRE

The flight data recorder did not show any indications that pointed towards a fire during the flight. However some witnesses, the purser, passengers and the runway controller in control tower west,²⁷ observed flames coming out of the left engine. Soot and oil traces were found on the left side of the left engine.

2.16 SURVIVAL ASPECTS

After the landing on runway 18R the fire brigade first performed an external inspection of the aircraft, after which the captain shut down the right engine. After the fire brigade considered it safe for the passengers to disembark, they left the aircraft via the forward left and the aft left cabin doors by using stairs.

2.17 TESTS AND RESEARCH

2.17.1 *Biological bird material sampling and identification*

At around 21.45 one of the on-duty birdwatchers of the Amsterdam Airport Schiphol Bird Control department received notification from air traffic control that a bird strike might have occurred on Runway 18L. At the request of air traffic control he first drove down Runway 27 from the side of Runway 09 and then Runway 18L. He found the remains of more than seven dead Canada geese on the runway at the top of Runway 24 near 'Postrijk' and the aircraft fuel depots. After the Royal Air Maroc Boeing 737 had landed another on-duty bird watcher drove down Runway 18R. He did not notice anything unusual on the runway.

The remains of the geese on the runway and on the aircraft were collected and secured. On 9 June 2010 the bird remains were submitted for identification to the Zoological Museum at the University of Amsterdam. This involved using a comparative collection of down preparations and skin of European bird species present there. According to the Zoological Museum the investigation, which involved the use of a photomicroscope, unmistakably revealed, on the basis of the submitted feathers, the down to be from a representative of the biological family of ducks, geese or swans known as Anatidae. A comparison of the feathers with birds in the skins collection, which includes all known species of geese type birds, indisputably showed that the feathers submitted are those of a large Canada goose, *Branta canadensis*. However, the size of the feathers means larger specimens of Hutchins' Canada goose, *Branta hutchinsii*, cannot be excluded. This is a species which, like large Canada geese, live locally in the Netherlands as a wild park bird. The mass of medium-sized to large Canada geese (like the birds involved in the bird strike) is around 3 - 5 kilogram in the summer.

27 Air traffic control tower west is situated next to runway 18R/36L, see illustration 2.

2.17.2 Simulator sessions performed by Royal Air Maroc

Royal Air Maroc carried out two flight simulator sessions on its own initiative to analyse the flight. The results and conclusions of these simulator sessions were submitted to the Dutch Safety Board. The performance of the simulator model appears to correspond with the actual flight. The Dutch Safety Board has not independently verified these results.

2.17.3 Performance analysis by Boeing

Boeing performed a performance analysis, based on the flight data recorder data. This analysis showed that the aircraft's performance was as expected both prior to and after the bird strike. Following the bird strike the crew extended the landing gear and allowed the aircraft's airspeed to decay to near the V_2 speed. Both of these actions contributed to the aircraft's inability to gain significant altitude.

2.18 ORGANIZATIONAL AND MANAGEMENT INFORMATION

Chapter 3 includes details on the parties involved, consultative bodies, associations, and their responsibilities.

2.18.1 Training

Both pilots were employed by Atlas Blue and were hired by Royal Air Maroc. At the time of the serious incident aircrew training at Atlas Blue was organized according to standards set by Royal Air Maroc. According to Royal Air Maroc and Atlas Blue managers all training manuals were identical for both companies.

The flight crew for Atlas Blue was initially recruited via brokers. The captain of the incident flight was recruited in 2009 and the first officer in 2007. Before they joined Atlas Blue they had been flying on the Boeing 737 for Futura International Airways. After the crew passed the selection process they were trained by Atlas Blue on the Boeing 737. Since then all required proficiency checks and type recurrent training had been completed at Atlas Blue.

Type recurrent training is a simulator training/check which has to be completed twice a year by all pilots. During such a training all possible aspects of a line flight can be trained, ranging from standard operating procedures, emergency procedures, system failures, winter operations, etcetera. The recurrent training can involve various emergency scenarios. These scenarios are based on the events which are flagged by Royal Air Maroc's safety management system, as events with a high risk and with a high probability of reoccurring on Royal Air Maroc flights.

Scenarios for recurrent training can also be based on high profile accidents and accident reports in worldwide aviation. For example, the report regarding the Turkish Airlines accident at Amsterdam Schiphol Airport was used as a basis for recurrent training.

Training scenarios regularly involve engine failures. However due to the vast amount of engine failure scenarios it is possible that crews train bird strikes only once every few years. When a bird strike is trained at Atlas Blue or Royal Air Maroc, only a single event is trained. This means that the bird strike which is trained results in an engine failure which has to be dealt with by the crew, there will be no additional failures. Well before these trainings the crew will be briefed on which failures they can expect during the recurrent training.

2.18.2 Safety management system Royal Air Maroc

Royal Air Maroc has set up a program for the prevention of accidents and incidents to enhance flight safety. This program contains a system by which both Atlas Blue and Royal Air Maroc crew members report incidents, to make it possible to collect and assess reports and identify unfavorable trends or to tackle shortcomings that adversely affect flight safety. There is a system for crew members to report anonymously. Royal Air Maroc also evaluates their flights by means of flight data monitoring. On a regular interval aircraft data recorders are downloaded from the aircraft and the data is analysed and screened for exceedences.

All safety reports and flight data is ran through Royal Air Maroc's risk analysis program using event severity and probability of reoccurrence to determine the risk category. All these events are submitted in a database. The top three type of events are then selected and put on the management priority list for reduction. Every quarter an extract of the reported events and a list of the most frequent events is published in a booklet and distributed among all pilots of Atlas Blue and Royal Air Maroc.

During the time the bird strike event took place the safety management system top three areas of attention were:

- Contaminated runway surfaces.
- Non stabilized approaches.
- Weight and balance problems.

Bird strikes were events that were monitored closely but had no status that required extra attention or training at that time.

2.18.3 Bird control at and around Schiphol airport

A total of twenty-one interviews were held with parties involved and associations regarding bird control and control measures to reduce the risk of bird strikes at and around Schiphol airport. In this context the current arrangements, agreements and actions by these parties involved were assessed. The results of this investigation is described in paragraph 4.7 and several supporting illustrations can be found in Appendix F.

2.19 ADDITIONAL INFORMATION

This paragraph describes two occurrences where the aircraft flew over densely populated areas after the bird strike had occurred and another relevant occurrence after a bird strike, and the subsequent investigations.

2.19.1 Occurrence 1²⁸

On 1 October 2000, a DC-10-30F suffered a bird strike with a grey heron (average mass 1.6 kilogram) shortly after take-off from Shannon Airport, Ireland. The bird strike caused severe damage to the left engine and caused some large nacelle components to separate from the engine. These parts struck and damaged the left inboard aileron and flap before falling to the ground. The aircraft diverted to London Heathrow Airport for inspection and repair. Given the adverse weather conditions at Shannon, the captain's decision not to return for a one-engine inoperative landing was reasonable according to the report. In the course of the approach to runway 27R at London Heathrow Airport the aircraft flew over the large built-up areas in and around London. The manual of Air Traffic Services (MATS) Part 1, section 5, states that it is desirable that aircraft in emergency should not be routed over densely populated areas. In order to provide guidance to air traffic controllers on how best to advise flight crew of any problems associated with their intended routing it was recommended that the Civil Aviation Authority should include in the provisions relating to 'Handling Aircraft Emergencies' in MATS Part 1 instructions for air traffic controllers to inform the pilot of an aircraft in emergency if it is known that an intended route takes the aircraft over densely populated areas.

The relevant section of the MATS Part 1 was amended by the inclusion of new text stating that, when the most expeditious routing is not required, suggestions of alternative runways or airports, which avoid the need for flight over densely populated areas, shall be passed to the pilot, together with the rationale for such action, and his intentions requested.

2.19.2 Occurrence 2²⁹

On 15 January 2009 a bird strike occurred between several Canada geese and an Airbus A320-214 at 3000 feet altitude during the climb from New York-La Guardia Airport in New York, United States of America. Both engines lost power after which the captain decided to make an emergency landing in the Hudson River. All occupants survived the accident. The NTSB conducted an investigation.

28 AAIB Bulletin 9/2001, Ref: EW/C2000/10/1, Category 1.1.

29 Aviation Accident Report NTSB/AAR-10/03.

The findings of the NTSB investigation of the engines and the engine certification requirements were also used for the investigation of the Dutch Safety Board into the Royal Air Maroc bird strike occurrence. A summary of the NTSB investigation regarding the engine bird ingestion protection devices is contained in Appendix G.

The NTSB report describes that in preliminary reports the effectiveness of various bird hazard mitigation strategies, including pulsating lights, lasers, and weather radar, suggest that these techniques have potential as bird repellents and may be helpful in keeping birds away from an aircraft's flight path. However, according to witnesses at the public hearing organized by the NTSB, the effectiveness of these methods is not well understood, and further research in these areas is needed. The NTSB believes that it is important to pursue all potentially useful approaches to bird hazard mitigation and is particularly interested in those that use aircraft systems to repel birds away from aircraft. The NTSB concluded that research on the use of aircraft systems such as pulsating lights, lasers, and weather radar may lead to effective methods of deterring birds from entering aircraft flight paths and, therefore, reduce the likelihood of a bird strike. The NTSB recommended to the United States Department of Agriculture to develop and implement, in conjunction with the Federal Aviation Administration, innovative technologies that can be installed on aircraft that would reduce the likelihood of a bird strike.

2.19.3 Occurrence 3³⁰

On 9 October 2009, after take-off from runway 04R at Copenhagen Kastrup airport, the pilots of the CRJ900 noticed a flock of birds in the aircraft headlights. A few seconds later, at an altitude of 256 feet, the right engine was struck by one or more barnacle geese (mass 1.5 – 2 kilogram), causing the aircraft to vibrate violently. As a result of these vibrations, the pilots were unable to read the engine instruments. However, they could read the vibration level of the right engine, which was fluctuating close to its maximum values. The pilots were unsure as to whether the left engine had been hit, and initially hesitated to shut down the right engine. As the vibrations in the right engine did not cease entirely when they closed the throttle, the pilots decided to shut down the engine. The left engine functioned normally for the remaining duration of the flight. The incident took place in darkness while the aircraft was flying under visual meteorological conditions.

The incident was observed from the ground and the control tower. At the time of the incident, the on-duty bird and game hunter was located at approximately 800 metres east of the crossing between runway 04R and taxiway I. He heard a loud bang originating from the departing aircraft, and subsequently saw flames and sparks emanating from the right engine as the aircraft passed taxiway I while being airborne. The air traffic controller in the tower also saw flames emanating from the right engine immediately after take-off. After having been notified of the bird strike by the pilots, the air traffic controller offered them the opportunity to choose a runway. The pilots then turned the aircraft around and flew visually to runway 04R with a tailwind from the right, where they landed without further incident.

Based on the outcome of the investigation, a recommendation was submitted to the European Aviation Safety Agency. The rapidly growing goose population is spreading out along the Baltic Sea and North Sea coast. This poses a potential threat to air traffic from and to Copenhagen Kastrup airport, which is located near the birds' migratory routes.

The fact that migrating birds flying above a certain altitude cannot be seen from the ground at night or under reduced visibility conditions is regarded as a general risk to flight safety. Recommendations have been issued for the competent authorities to assess the potential for technical measures to identify migrating birds and send out warnings during darkness and reduced visibility conditions, including the option of configuring and applying radar equipment for this purpose.

3 PARTIES AND THEIR RESPONSIBILITIES

The overview below shows the parties that played a role in the serious incident. A distinction has been made between the parties involved only in aviation aspects, in both aviation aspects and the management of the risk of bird strikes and only in the management of the risk of bird strikes. Also the relevant parties are described that were not (directly) involved, like consultative bodies and associations.

AVIATION

3.1 CREW FLIGHT RAM685R

Captain

The captain is responsible for a safe flight execution. During the flight, he may deviate from the airline regulations, operational procedures and methods if he deems this necessary in the interest of safety.

First officer

The first officer is responsible for offering assistance to the captain in his task of executing a safe flight. He will observe the instructions of the captain with regard to this. The first officer must monitor the critical phases of the flight (when he is pilot monitoring) and inform the captain about any deviations from the rules. If required, he must question the decision of the captain in the interest of safety. If the captain should be taken ill, the first officer will take over the tasks of the captain.

Cabin crew

The cabin crew is, under the management of the purser, responsible for the safety of the passengers during the flight. The members of the cabin crew will assist passengers and will prepare them for a possible evacuation should there be an emergency situation.

3.2 ATLAS BLUE

Atlas Blue was established in 2004 by Royal Air Maroc as a low-cost airline. As the crew's employer Atlas Blue is responsible for the standard operational procedures and for crew training. The company has an IATA³¹ Operational Safety Audit (IOSA) certificate.³² All Atlas Blue operational and training procedures are identical to those of Royal Air Maroc. All senior management positions are filled by Royal Air Maroc officials.

Atlas Blue merged with Royal Air Maroc on 1 March 2011. The companies are now doing business under the name of Royal Air Maroc.

3.3 ROYAL AIR MAROC

Royal Air Maroc is an airline company that was established in 1957 and is headquartered in Casablanca. It is the national airline company of Morocco and flies to well over 83 destinations in Africa, Asia, Europe and North America. The home base is Mohammed V International Airport in Casablanca. At the time of the serious incident the company had a fleet of 53 Airbus, ATR and Boeing aircraft, including six Boeing 737-400 aircraft.

31 International Air Transport Association.

32 The IATA Operational Safety Audit (IOSA) program is an internationally recognized and accepted evaluation system designed to assess the operational management and control systems of an airline. IOSA's quality audit principles are designed to conduct audits in a standardized manner.

As the holder of an air operator's certificate, pursuant to JAR-OPS 1 and JAR-FCL (for explanation see Appendix H), Royal Air Maroc is responsible for safe air operations, aircraft maintenance, flight crew and cabin crew training. Since 1998 the airline's operations have been in accordance with JAR-OPS 1. All staff jobs and responsibilities are described in the Royal Air Maroc Operations Manual part A. Since June 2005 the company has had what is referred to as an IOSA certificate. This certificate was last renewed in 2009.

3.4 MINISTRY OF TRANSPORT (MOROCCO)

The Directorate-General of Civil Aviation (DGCA) of the Moroccan Ministry of Transport is the responsible authority for civil aviation safety in Morocco and responsible for, amongst other things, the oversight of Royal Air Maroc and Atlas Blue. The DGCA checks whether the airlines meets Moroccan and JAR regulations. It is also responsible for issuing licences to Atlas Blue crews, certificates of airworthiness and certificates of aircraft registration of Royal Air Maroc aircraft.

3.5 BOEING

Boeing is the manufacturer of, amongst others, the Boeing 737-4B6. Boeing is responsible for the construction of aircraft, parts and related systems, and the continuing airworthiness. Boeing voorziet eigenaren en/of gebruikers van Boeing vliegtuigen van de vliegtuighandboeken (AFM en FCOM) en het trainingshandboek (*FCTM*).

3.6 CFM INTERNATIONAL

Engine manufacturer CFM International is responsible for the design and production of the CFM56-3C-1 turbofan engines with which the aircraft was fitted. CFM is a partnership between General Electric Company (GE) in the United States of America and Société Nationale d'Étude et de Construction de Moteurs d'Aviation (Snecma) in France.

3.7 FEDERAL AVIATION ADMINISTRATION

The Federal Aviation Administration (FAA) is the responsible authority for aviation safety in the United States of America and has specific regulatory and implementing tasks in aviation safety. The FAA is charged with the certification of American aviation products and the organisations that are involved in the design, production and maintenance of those products as well as other issues. These certification activities are a basis to safeguard that the standards for airworthiness and environmental protection are met. The FAA is responsible for the certification of Boeing products including the Boeing 737-4B6 as well as other issues. Together with the EASA, it is also responsible for the certification of CFM56-3C-1 engines, with which the Royal Air aircraft was equipped.

3.8 EUROPEAN AVIATION SAFETY AGENCY

The European Aviation Safety Agency is an agency of the European Union (EU) with specific regulatory and implementing tasks regarding aviation safety. The Agency is charged with the certification of European aviation products and organisations that are involved in the design, production and maintenance thereof as well as other issues. These certification activities are a means to safeguard that the standards for airworthiness and environmental protection are met.

The FAA Boeing 737-400 certification has been validated by the Joint Aviation Authorities (JAA).³³ The EASA has accepted the results of JAA-validation. The validation of the FAA certification for the CFM56-3C-1 engines has been performed by the French Directorate General of Civil Aviation (DGAC). The Agency has accepted the results of the DGAC-validation.

AVIATION AND BIRD CONTROL

3.9 AMSTERDAM AIRPORT SCHIPHOL

Schiphol airport is located in the municipality of Haarlemmermeer and is approximately fifteen kilometres to the southwest of Amsterdam. The airport is owned by the Schiphol Group (legally registered name: 'N.V. Luchthaven Schiphol', in this report addressed with Amsterdam Airport Schiphol), with its shareholders being the Dutch State and the municipalities of Amsterdam and Rotterdam.

Amsterdam Airport Schiphol is responsible for, among other things, making runways and taxiways available free of obstacles to Air Traffic Control the Netherlands. The point of departure applied is that the landing area has to be kept clear (as much as possible) of fauna by taking measures to prevent or limit fauna incidents. This procedure covers fauna incidents which occur during landing at altitudes of less than 200 feet and during take-offs up to an altitude of 500 feet. Amsterdam Airport Schiphol has been granted dispensation from the province of Noord-Holland to chase away and, if necessary, kill all protected animals which may represent a danger to aviation.

In addition to the airport grounds, Schiphol airport also owns land in the airport's surrounding area. Schiphol airport ensures that no infrastructure with the potential to attract birds is built on this land and that no activities with the potential to attract birds are conducted there. The Bird Control department issues guidelines for development and usage to this end. These guidelines are incorporated into the instructions issued to private parties using the grounds.

The Amsterdam Airport Schiphol Bird Control department executes the control measures to prevent collisions between aircraft and birds during the take-off and landing of aircraft on the landing area. These control measures include the issue of NOTAMs³⁴ and the (temporary) closure of runways in response to the presence of birds.

3.10 MINISTRY OF INFRASTRUCTURE AND THE ENVIRONMENT

Government oversight of air traffic in the Amsterdam flight information region is the responsibility of the Inspectorate of Transport, Public Works and Water Management of the Ministry of Infrastructure and the Environment - previously the Ministry of Transport, Public Works and Water Management.

The Inspectorate of Transport, Public Works and Water Management is charged with oversight of Air Traffic Control the Netherlands and Schiphol airport. The Inspectorate assesses procedures against national and international legislation, and carries out audits to assess daily operations at Air Traffic Control the Netherlands and Amsterdam Airport Schiphol.

In addition to the oversight, the Inspectorate of Transport, Public Works and Water Management also helps to promote aviation safety by issuing licences and certificates.

33 The Joint Aviation Authorities (JAA) was a partnership between the national aviation authorities of a number of countries including all European countries. The goal of the JAA was to develop and implement common safety standards and procedures for European aviation. It, in fact, involves an elaboration of the ICAO regulations within a European setting. The JAA was phased out and its tasks were taken over by the European Aviation Safety Agency (EASA) ultimately in 2009.

34 Notice to Airmen (NOTAM): notification with information regarding the setting, state or changes to any aviation facility, service, procedure, danger which operational aviation personnel have to find out about in time.

The ministry has a number of Directorates-general, including the Directorate-General of Aviation and Maritime Affairs. In so far as the following tasks are assigned to the minister of Infrastructure and the Environment, the Directorate-General of Aviation and Maritime Affairs is, in accordance with the minister's instructions:

- charged with the policy for ocean shipping, ports, inland navigation, aviation and airports, at both the national and international levels;
- responsible for the coordination and quality of the international actions by the Ministry of Infrastructure and the Environment and for promoting cohesion in international policy development for the entire ministry.

The minister of Infrastructure and the Environment is obliged to set up a national procedure to monitor and report on collisions between animals and aircraft (pursuant to Annex 14 "Aerodromes", part I, paragraph 9.4.1, section a) and to report thereon to the ICAO (pursuant to Annex 14, paragraph 9.4.2).

The minister of Infrastructure and the Environment grants, as requested by the operator of an airport, a safety certificate if the rules are fulfilled as issued by the minister regarding the construction, design, equipment and use of airports, such with a view to order and safety at those airports and the rules concerning the safety certificate, the safety management system and the airport operator's manual.

3.11 AIR TRAFFIC CONTROL THE NETHERLANDS

Air Traffic Control the Netherlands is an independent administrative body that falls under the responsibility of the Dutch Minister of Infrastructure and Environment. Air Traffic Control the Netherlands mainly focuses on air traffic services for civil air traffic in the Amsterdam flight information area. This area extends over the Dutch territory and a large section of the North Sea. Air traffic services are provided in the interest of general aviation safety and the safe, orderly and smooth processing of air traffic. When air traffic services are provided at Schiphol airport the rules for route and runway use must be fulfilled and Air Traffic Control the Netherlands has a shared duty to care with regard to distributing the noise load over statutory enforcement points around the airport. Air traffic services consist of three tasks: air traffic control, flight information and emergency services.

BIRD CONTROL

3.12 NOORD-HOLLAND FAUNA MANAGEMENT UNIT

The legislator has stipulated that partnerships of authorised hunters and Fauna Management Units can be set up whose task it is to implement management of animal species or to combat damage caused by animals. Fauna Management Units are foundations and have existed since 2003. After they have been recognised by the Provincial Executive, Fauna Management Units implement state and provincial policy in the area of managing animal species and combating damage. The law demands that the control of animal species and the combating of damage takes place in a planned and effective way. To this end, the Fauna Management Unit draws up a five-year fauna management plan, which plan is to be approved by the Provincial Executive, following advice by the Fauna Fund (the Fauna Fund is described in paragraph 3.13). The Provincial Executive will then grant the Fauna Management Unit dispensation to implement the control measures referred to in the fauna management plan. The Fauna Management Unit can authorise people to use the dispensation, like Game Management Units,³⁵ terrain management organisations, and persons. This is how the measures referred to in the plan are implemented.

35 For the explanation of the Game Management Unit see paragraph 3.17.

The Noord-Holland Fauna Management Unit comprises the following organisations in the fields of nature conservation, agriculture, private property and the hunting sector: Land- en Tuinbouw Organisatie Noord, the Royal Dutch Hunting Association (Koninklijke Nederlandse Jagersvereniging), the National Forest Service (Staatsbosbeheer), Foundation Landscape Noord-Holland, Society for the preservation of nature in the Netherlands (Vereniging Natuurmonumenten), Waternet, PWN Waterleidingbedrijf Noord-Holland, Stichting Gooisch Natuurreservaat and Hollands Particulier Grondbezit. The Noord-Holland fauna management plan covers the entire province of Noord-Holland, with the exception of a number of areas which are not owned and/or managed by the parties in the Noord-Holland Fauna Management Unit, including Schiphol airport.

Fauna Management Units around Schiphol have received dispensation for cooperating on combating damage caused by various types of geese within a radius of ten kilometres around Schiphol airport. The granting of dispensation is made dependent on the fauna management plan. Various Game Management Units and terrain management organisations³⁶ have dispensation to kill various types of geese in connection with flight safety within a distance of six kilometres (for several years temporarily expanded to ten kilometres)³⁷ around the runways.³⁸

3.13 FAUNA FUND

The Fauna fund is an independent administrative body whose responsibilities include the allocation of contributions for damage caused by protected animal species. The tasks of the Fauna fund consist of: promoting measures to prevent and combat damage by certain designated animal species; awarding contributions for damage suffered which has been caused by protected native animal species; advising the Provincial Executives on the execution of tasks assigned to them by virtue of the Flora and Fauna Act; advising the minister of Economic Affairs, Agriculture and Innovation on the design of general governmental decrees and ministerial regulations. The Fauna fund also commissions scientific research and promotes the provision of information.

3.14 MUNICIPALITY OF HAARLEMMERMEER

The municipality of Haarlemmermeer has the authority to decide on the spatial planning and the zoning of areas in the Haarlemmermeer. To this end the municipal council determines the zoning plan in which binding uses are allocated to specific areas. This may, for example, relate to land designated for agricultural or nature use. The municipal council must adhere to the spatial planning frameworks specified in national and provincial legislation, and thus has limited freedom to use land as it sees fit.

3.15 MINISTRY OF ECONOMIC AFFAIRS, AGRICULTURE AND INNOVATION

The secretary of state of Economic Affairs, Agriculture and Innovation has the ultimate responsibility for the implementation of European nature protection treaties and directives in the Netherlands.³⁹ The directive obligations were converted into national law via the Nature Conservancy Act (Natuurbeschermingswet) 1998 and the Flora and Fauna Act. The secretary of state designates Natura2000 areas.

36 Staatsbosbeheer, Amsterdamse Bos (Municipality of Amsterdam), Directorate-General for Public Works and Water Management, Groengebied Amstelland, Schiphol Group and Landscape Noord-Holland.

37 According to the Province of Noord-Holland, the exemption for the 10-kilometre radius will be continued. However, distinctions will be made in terms of the scope (number of exempted species and legal means) of exemptions for the Schiphol airport terrain, within a 6 and 10-kilometre radius.

38 During the 2008-2010 period, the Province of Noord-Holland directly granted exemptions to various game management units and terrain management organisations without the involvement of the Noord-Holland Fauna Management Unit. At the time, the Province claims, there was no fauna management plan to serve as a basis for exemptions. In view of flight safety and the urgency of the matter, the exemptions were issued directly to the executive organisations. As of 2012, exemptions for the 10-kilometre zone around Schiphol airport will (once again) be issued via the relevant province's Fauna Management Unit.

39 The Ramsar Convention; Bird and Habitat Directives.

As the party with authority to grant permits the minister can ensure that suitable measures are taken to prevent degradation of natural habitats and species habitats. The minister of Economic Affairs, Agriculture and Innovation can instruct the Provincial Executive regarding the decision on an application for a permit or to specify a management plan.

Under the Flora and Fauna Act, native animal species can be designated whose survival is not threatened or which are not endangered that cause damage throughout the entire country. Via a ministerial regulation dispensation can then be granted from the prohibitory stipulations of the Act for the combating of these animal species that cause damage to crops, cattle, woods, commercial fishing and waters, or damage to fauna. If no other satisfactory solution is available, the population of the designated protected native animal species can be restricted on grounds designated by the Provincial Executive. The secretary of state specifies the list of native animal species whose populations can be reduced.

According to the Flora and Fauna Act the secretary of state of Economic Affairs, Agriculture and Innovation can grant a dispensation for a ban on the killing of protective birds if no other satisfactory solution is available with regard to aviation safety. The secretary of state draws up the list of resources which can be used to catch or kill animals.

3.16 PROVINCIAL GOVERNMENT OF NOORD-HOLLAND

The Provincial Executive, the daily management of the province, specifies a management plan for certain areas after consulting with municipalities and water boards in the territory to which the management plan relates.⁴⁰ In the event of provincial cross-border management plans, decisions have to be taken in consultation with the Provincial Executives of the other provinces.

If no other satisfactory solution exists the Provincial Executive can restrict the numbers of protected native animal species designated by ministerial regulation in the interest of aviation safety.

The Provincial Executive grants the dispensation for the benefit of control and damage limitation and the use of 'banned' resources, pursuant to the Animal Control and Prevention of Damage Decree. The Provincial Executive has the authority to decide on damage prevention and control when recognising Fauna Management Units and approving fauna management plans, and granting dispensations.

3.17 GAME MANAGEMENT UNIT

A game management unit is a partnership (usually an association or foundation) of hunters, farmers, land and forest owners, dog owners and nature enthusiasts. The tasks of a game management unit are related to maintaining, protecting and caring for the fauna present and responsible hunting practices. There are around 300 game management units in the Netherlands, each with a work area of around 5,000 hectares or more. The majority of these are affiliated or members of the Royal Dutch Hunting Association (Koninklijke Nederlandse Jagers Vereniging) or the Dutch Organisation for Hunting and Estate Management (Nederlandse Organisatie voor Jacht en Grondbeheer). These are organisations which work to preserve hunting and game management in the Netherlands. These Game Management Units work together, or at the behest of terrain management organisations operating in the area around Schiphol airport: Staatsbosbeheer, Amsterdamse Bos (Municipality of Amsterdam), Directorate-General for Public Works and Water Management, Groengebied Amstelland, Schiphol Group and Landscape Noord-Holland.

The Haarlemmermeer Game Management Unit operates in an area of approximately 19,000 hectares and covers the entire Haarlemmermeer polder. This area includes Schiphol airport. The Haarlemmermeer Game Management Unit consists of approximately 190 hunters.

40 Not obligatory for national nature reserves. Obligatory for Natura2000 areas.

RELEVANT CONSULTATIVE BODIES AND ASSOCIATIONS

3.18 AIRCRAFT BIRD STRIKE COMMITTEE

The Aircraft Bird Strike Committee (Commissie Vogelaanvaringen Luchtvaartuigen) was active in the Netherlands from September 1997.⁴¹ The committee was set up for an indefinite period of time by the former minister of Transport, Public Works and Water Management and the minister of Defence. In addition to representatives of the Inspectorate of Transport, Public Works and Water Management and the Ministry of Defence, the committee members included the former Ministry of Agriculture, Nature and Food Quality, Air Traffic Control the Netherlands, Amsterdam Airport Schiphol, KLM Royal Dutch Airlines, the Dutch Airports Association (Nederlandse Vereniging van Luchthavens), Dutch Airline Pilots Association, and Netherlands Society for the Protection of Birds. The committee's tasks included:

- Analysing and publishing details on bird strikes.
- Promoting and coordinating activities and (arranging) the execution of studies to reduce the risk of bird strikes.
- Maintaining national and international contacts.
- Making solicited or unsolicited recommendations to, and informing the director-general of the civil aviation authority or the commander-in-chief of the Royal Netherlands Air Force and the commander-in-chief of the Royal Netherlands Navy regarding measures to be taken and provisions to be implemented to prevent, or limit, bird strikes with aircraft and the associated risks.
- Issuing progress reports regarding the work carried out.

The committee is chaired by an official from the Inspectorate of Transport, Public Works and Water Management with the secretariat duties being fulfilled by the Ministry of Defence.

The committee published the Dutch Airports Bird Strike Prevention Handbook (Handboek Vogelaanvaringspreventie Nederlandse Luchthavens) in November 2006.

In 2007, the committee sent a letter to the then Ministry of Transport, Public Works and Water Management (Directorate-General for Aviation and Maritime Affairs) and Ministry of Defence highlighting the risk of bird strikes due to geese (for the contents of this recommendation, see chapter 3.1 of annex F).⁴²

The committee was discontinued on 11 June 2010 following the establishment of the Dutch Bird Strikes Control Group (Nederlandse Regiegroep Vogelaanvaringen).

3.19 LANDSCAPE NOORD-HOLLAND

Landscape Noord-Holland is a foundation which maintains and develops nature reserves, landscapes and cultural history in the province of Noord-Holland. This is done in around 85 of its own areas, covering 4,300 hectares. Landscape Noord-Holland gives advice and performs research in the field of ecology, landscape and nature, and on sustainable nature and landscape management. Among other things Landscape Noord-Holland counts and records bird numbers in the province of Noord-Holland. Landscape Noord-Holland participates in the Schiphol Consultation set up in 2008 by the provincial government of Noord-Holland and Amsterdam Airport Schiphol in response to the rising number of bird strikes.

41 Decree establishing the Aircraft Bird Strike Committee of 1 September 1997.

42 Letter of 5 November 2007 from the Aircraft Bird Strike Committee to the Minister of Transport, Public Works and Water Management and the Minister of Defence entitled [translated] 'Goose population growth and its consequences in terms of flight safety'.

3.20 FEDERATION OF AGRICULTURE AND HORTICULTURE NOORD

Federation of Agriculture and Horticulture "Noord" (Land- and Tuinbouworganisatie Noord) is the agricultural trade organisation in nine provinces north of the river Maas.⁴³ The organisation aims to reinforce the economic and social position of its members, farmers and market gardeners. One of its core activities is to promote interests in the field of environmental policy - spatial planning, water, the environment and area processes.

3.21 SOCIETY FOR THE PRESERVATION OF NATURE

The goal of the members of the Society for the Preservation of Nature (Natuurmonumenten) in the Netherlands is to care for nature in the Netherlands. Natuurmonumenten in the Netherlands acquires and manages 355 nature conservation areas with a joint surface area of more than 100,000 hectares. Natuurmonumenten has thirteen districts: the twelve provinces plus Amsterdam. Members can have a say via the district committees. The district committees together make up the society's council. Together with the board, the council joins in the planning, discussions and decision-making on the main elements of the policy.

3.22 DUTCH BIRD STRIKE CONTROL GROUP

In 2009 the then minister of Transport, Public Works and Water Management decided to set up a platform participated in by all authorities, knowledge institutes and nature and environmental organisations involved in bird strike issues. This platform was established on 11 June 2010 for a period of three years and is referred to as the Dutch Bird Strike Control group (Nederlandse Regiegroep Vogelaanvaringen). The aim of the Dutch Bird Strike Control group is to promote cooperation between the many parties involved and to control the many activities (research and measures) carried out and/or prepared within this framework.

In a concrete sense the task of the Dutch Bird Strike Control group is to limit the risk of bird strikes in the Netherlands. The control group does this by increasing knowledge and the exchange of information on the issue of aircraft bird strikes and by promoting cooperation between authorities and bodies active in the field of reducing the risk of bird strikes. The Dutch Bird Strike Control group consists of representatives of the ministry of Infrastructure and Environment, the Provincial Executive of Noord-Holland, Society for the preservation of nature (Natuurmonumenten), Ministry of Defence, Land and Tuinbouw Organisatie Noord-Holland, Amsterdam Airport Schiphol, the Dutch Airline Pilots Association, and the Netherlands Society for the Protection of Birds (Vogelbescherming Nederland). The ultimate goal is for the parties involved to take the initiative themselves as regards the control measures for reducing the risk of bird strikes. Later, the group also came to include the Municipality of Haarlemmermeer (2010) and Air Traffic Control the Netherlands (2011). Eventually, the parties involved will assume responsibility for control measures to reduce the risk of bird strikes.

3.23 SCHIPHOL GOOSE ROUNDTABLE

In 2007, it became clear that the goose population in the area around Schiphol airport was growing. In response, the Province of Noord-Holland and Amsterdam Airport Schiphol jointly initiated a pilot project in the form of the Schiphol Goose Roundtable. The Schiphol Goose Roundtable was established to reduce the risks of bird strikes involving geese in the short term. In the longer term, the objective is to develop a provincial implementation framework for goose control measures in consultation with the parties involved. The Roundtable also aims to improve harmonisation between the parties involved. The Schiphol Goose Roundtable does not have any powers itself.

⁴³ The nine provinces are: Drenthe, Flevoland, Friesland, Gelderland, Groningen, Noord-Holland, Overijssel, Utrecht, and Zuid-Holland.

It plays a central role in implementing control measures and controlling damage by geese in the area around Schiphol airport. The Schiphol Goose Roundtable is made up of representatives of the following organisations: Game Management Units,⁴⁴ terrain management organisations,⁴⁵ Schiphol Bird Control, the Province of Noord-Holland, the Fauna Management Unit Noord-Holland and the Municipality of Haarlemmermeer. As of the fall of 2011, the Provinces of Utrecht and Zuid-Holland will also join the roundtable. The Fauna Fund and the Ministry of Infrastructure and the Environment's Directorate-General of Aviation and Maritime Affairs also attend meetings on matters that concern them directly.

All participating parties have indicated that they wish to continue the pilot project after the evaluation in 2011.

3.24 SCHIPHOL SAFETY PLATFORM AND SCHIPHOL BIRD STRIKE COMMITTEE

All companies that play a role in the aviation process at Schiphol airport are represented on the Schiphol Safety Platform (Veiligheidsplatform Schiphol - VpS). The VpS was established in 2003. The main aim of the VpS is to achieve integral coordination between the safety systems of the companies involved within the entire process where that is useful and possible. The execution and implementation of improvement activities is the responsibility of the companies themselves. Amsterdam Airport Schiphol chairs the VpS and arranges the programme management. To this end a number of expert groups have been formed to advance progress on certain safety issues. One of these issues is the reduction of bird strikes at and around Schiphol airport. The Schiphol Bird strike Committee (SBC) was set up in 2009 to carry out this task. The SBC identifies risks, looks for trends, conducts analyses and makes recommendations to the VpS steering committee to prevent bird strikes with aircraft on the basis of specific research and information exchange. The SBC also draws up multi-annual programmes and work plans for the realisation of the proposed bird control measures at and around Schiphol airport. The SBC implements these programmes and plans after approval by the VpS steering committee. The companies that participate in the SBC have responsibilities at operational and/or policy level regarding safety and/or bird control. Representatives of two Dutch airlines sit in the SBC. The SBC is chaired by a representative of Amsterdam Airport Schiphol.

3.25 THE NETHERLANDS SOCIETY FOR THE PROTECTION OF BIRDS

The Netherlands Society for the Protection of Birds (Vogelbescherming Nederland) is a member-based national nature protection organisation. It was set up in 1899 with the aim being to protect wild birds and their habitats in the Netherlands. The Netherlands Society for the Protection of Birds is the Dutch partner of BirdLife International, the organisation which protects birds and their habitats worldwide.

⁴⁴ Haarlemmermeer, Wijckerveer, Amstelland, Spaarnwoude and Zaanstreek.

⁴⁵ Staatsbosbeheer, Amsterdamse Bos (Municipality of Amsterdam), Directorate-General for Public Works and Water Management, Groengebied Amstelland, Schiphol Group and Landscape Noord-Holland.

4 ANALYSIS

4.1 INTRODUCTION

This chapter analyses the incident. The following issues are dealt with: the flight operations with an examination of the actions of the pilots and air traffic controllers after the bird strike, crew resource management, training aspects, resources to prevent birds entering engines and bird strikes involving aircraft, the follow-up to the recommendation by the Bijlmermeer Air Disaster Parliamentary Board of Inquiry regarding the avoidance of aircraft in emergency situations above built-up areas, the route flown at low altitude above built-up areas process, and the bird control measures at and around Schiphol airport. The chapter ends with a description of the measures taken after the serious incident. The analysis made use of the assessment framework as shown in Appendix H.

4.2 FLIGHT OPERATION

4.2.1 *Flight preparation, take-off and engine shutdown*

Up until the take-off the cockpit crew followed the standard operating procedures and performed their required duties and checklists correctly.

The standard engine failure procedure requires the aircraft to climb straight ahead until the obstacle clearance altitude is reached. For runway 18L at Schiphol airport this altitude is 1700 feet. Any required deviations to the prescribed engine failure profile for a specific airport will be shown on the performance calculation tables⁴⁶ available to the crew. For Schiphol airport no deviations for runway 18L are prescribed

Just after rotation at a speed of approximately 175 knots the aircraft encountered a bird strike with multiple Canada geese. The crew stated they only saw the birds shortly before or during rotation. At that moment the decision to continue the take-off had already been taken, because the decision speed V_1 (143 knots) was passed, so the aircraft was not able to stop anymore within the remaining runway distance. Therefore an attempt to abort the take-off at this stage was no option.

At the moment of the bird strike the data on the flight data recorder was found garbled for approximately four seconds for unknown reasons. After the recorder resumed normal operation the recorded left engine parameters revealed a loss of RPM and severe engine vibration while the right engine parameters remained normal. The severe vibration remained until 21.47:17 hours, the moment the left engine was shut down. The nose gear indication remained "unsafe" after the gear handle was positioned to the "UP" position. The main gear indications indicated that it had been retracted.

The cockpit crew initially thought that both engines were affected by the bird strike. They were confronted with the noise of the bird strike, abnormal engine indications, airframe vibration, the sound of the rough running left engine, the smell of burned bird remains entering the cockpit and the unsafe nose landing gear indication. The cockpit crew stated they had serious doubt whether the aircraft would be able to remain airborne and that reading the instruments and controlling the aircraft were hampered by the airframe vibrations.

46 Performance calculation tables are used by pilots to determine thrust settings for take-off. Atlas Blue has provided their crews with a Route Performance Manual which contains tables for all runways at their destination aerodromes.

The 'take-off – engine failure' procedure in the Flight Crew Training Manual (chapter 3.27) prescribes: *"If the engine failure occurs at or after lift-off apply rudder and aileron to control heading and keep the wings level. The following 'initial climb – one engine inoperative' procedure (chapter 3.30) prescribes that the landing gear should be retracted after a positive rate of climb is indicated on the altimeter. The initial climb attitude should be adjusted to maintain a minimum of V_2 . If an engine fails at an airspeed between V_2 and V_2 plus 20, climb at the airspeed at which the failure occurred.*

Indications of an engine fire, impending engine breakup or approaching or exceeding engine limits, should be dealt with as soon as possible. Accomplish the appropriate memory checklist items as soon as the airplane is under control, the gear has been retracted and a safe altitude (typically 400 feet above ground level or above) has been attained. Accomplish the reference checklist items after the flaps have been retracted and conditions permit."

The procedure then continues to describe how the aircraft should be configured and ultimately states: "(...) continue the climb to the obstacle clearance altitude."

Immediately after the bird strike the recorded flight data shows that the right engine instruments remained stable and the engine responded normally to thrust lever inputs. This fact was not immediately recognized by either crew member. A moment later the captain ordered the first officer to declare an emergency with air traffic control and to inform the runway controller that they would return to the airport. At the same time at 280 feet the aircraft started to turn right and the gear was selected down again. The data confirms that the captain initiated the right turn by rudder and aileron input.

Although the 'immediate turn after take-off – one engine inoperative' procedure in the Flight Crew Training Manual (chapter 3.30) is not applicable at Schiphol airport runway 18L it does provide an insight into the performance limitations when maneuvering on one engine at low altitude:

"Obstacle clearance or departure procedures may require a special engine out departure procedure. If an immediate turn is required, initiate the turn at the appropriate altitude (normally at least 400 feet AGL) and maintain V_2 to V_2 plus 20 knots with take-off flaps while maneuvering.

Note: Limit bank angle to 15 degrees until $V_2 + 15$ knots. Bank angles up to 30 degrees are permitted at $V_2 + 15$ knots with take-off flaps

After completing the turn, and at or above acceleration height,⁴⁷ accelerate and retract flaps."

The most striking fact about the incident flight was the early right turn with a bank angle up to 37.5 degrees. In the captain's view the decision for the right turn was a necessary and obvious choice to be able to return to the airport immediately. According to the captain, the steep bank angle was the result of difficulties in controlling the aircraft. Flight data confirms that the aircraft was difficult to control, and that the extreme bank angle was corrected almost immediately and reduced to under thirty degrees. When taking off from runway 18L most of the airport's other runways are situated on the aircraft's right side and rear.

With the decision to turn at 280 feet the crew deviated from the standard instrument departure and the standard engine failure procedure. By deviating from the engine failure procedure at this low altitude the crew took an unnecessary risk because the prescribed engine out flight path also provides obstacle clearance in the climb out area. In combination with the higher than normal bank angles the aircraft operated near the edge of the performance envelope. Paragraph 4.2.5, Crew resource management, focuses on the crew's decision in greater depth.

The runway controller noticed the turn and advised the crew to continue the turn to guide the aircraft to runway 18R. Both pilots stated that during the turn the autopilot was not used because the minimum altitude for autopilot engagement after take-off is 1000 feet. This means that the pilot flying had to dedicate his attention to controlling the aircraft with one engine inoperative.

47 The acceleration height is 1000 feet above field elevation.

For the engine problems the crew experienced, the QRH contains a procedure to shutdown the engine:

"8.2 'Engine Fire or Engine Severe Damage or Separation'

Condition: One or more of these occur:

- Engine fire warning
- Airframe vibrations with abnormal engine indications
- Engine separation"

The crew did not shut down the left engine immediately. During the first three minutes after the bird strike the engine may have delivered some thrust. Flight data recorder data shows that the right thrust lever was manually retarded several times during the initial climb. First for 20 seconds and later for more than one minute, the right engine thrust was set at approximately 80% N1 instead of the maximum setting being 104% N1. During the first 20 seconds the aircraft's pitch attitude was increased in an attempt to continue climbing. As a result the airspeed decreased from 179 knots to 145 knots. The right thrust lever was then positioned forward again and the right engine responded accordingly. The aircraft regained speed and started to climb again. However during the second period of reduced thrust the aircraft actually descended from 600 feet to 348 feet.

The above mentioned actions indicate that the crew struggled flying the aircraft and they were not certain what the aircraft's capability was at the time.

At 21.47:17 hours, more than four minutes after the bird strike occurred, the crew shut down the left engine according to the memory items of the above mentioned checklist. The engine was shutdown successfully. At 21.47:24 hours the checklist items were confirmed by reading the actual checklist. These checklist items were completed at 21.48:33 hours.

During the final part of the flight the 'one engine inoperative landing' checklist (QRH chapter 7.26) should have been performed. On the cockpit voice recorder the execution of this checklist could not be heard.

On the cockpit voice recorder it can be heard that the crew mentioned the right engine was at take-off thrust for two minutes. Flight Crew Operations Manual part I chapter "Limitations" states that an engine is allowed to be set at take-off thrust levels for five minutes. After these five minutes the thrust should be reduced to "maximum continuous thrust" which was approximately 91% N1. This procedure is designed to prevent engine wear. Based on the above, it can be concluded that the crew reduced the thrust prematurely.

It is concluded that the flight crew deviated from the standard procedures, by initiating a right turn at a too low altitude and by selecting the gear down again. No failure assessment was performed by the crew during this phase of the flight. This in combination with the selection of less than maximum thrust and the too high bank angle during the initial part of the flight resulted in a low energy state of the aircraft (altitude and airspeed) which made it difficult to climb. The aircraft overflew the cities Vijfhuizen and Haarlem at a too low altitude. Following the standard procedures would have resulted in a safer and more stable flight execution and a better climb gradient.

4.2.2 Gear indications

In order to reduce drag and thus improve climb performance the landing gear should be retracted after take-off as soon as a positive rate of climb is indicated in the cockpit. It takes approximately fifteen seconds to fully retract the landing gear. Under normal circumstances, the green landing gear indicator lights will then switch off. The red lights will then switch on and subsequently switch off.

Once the crew had set the landing gear to retract, the corresponding red main landing gear indicator lights switched off, indicating that this part of the landing gear had been successfully retracted. However, the red nose landing gear indicator light remained lit. Almost immediately, and without consulting with the first officer, the captain then gave the order to select the landing gear down. The first officer complied with his instruction. The captain has subsequently stated that he feared the landing gear would not extend properly. A deviating nose gear indication may indicate that the nose landing gear is not in its proper position or that the sensor used to read this position is not functioning properly.

In order to handle either of the two situations the “gear disagree” procedure” (QRH chapter 14.6) should be performed. This is a potentially lengthy procedure that does not contain any memory items and should therefore not be performed during critical phases of flight. The crew did not perform this procedure, which they subsequently attributed to time constraints.

The main landing gears could be retracted normally, reducing the landing gear drag by more than two thirds.⁴⁸ Even if the nose landing gear had remained fully extended under these circumstances, this would have been the optimum landing gear configuration for initial climb that the crew could have achieved in this case. Despite this the captain ordered the landing gear down once he noticed the unsafe nose landing gear indication. His analysis of the landing gear’s position - which had been set to retract - failed to take into account the consequences of selecting the landing gear down again.

Aircraft manufacturer Boeing has calculated the climb capability of an aircraft with extended nose landing gear under various conditions. According to Boeing, if the gear had remained retracted after the bird strike, the climb capability would have been increased from 200 to 480 feet per minute. If the airspeed had been maintained at 175 knots after the bird strike with the gear selected down, the climb capability would have increased from 200 to 260 feet per minute. If both the gear had been left retracted and the speed of 175 knots had been maintained, the climb capability would have increased from 200 to 600 feet per minute.

Technical investigation after the flight revealed that the nose gear sensor was damaged by the impact with a Canada goose. If no signal is being emitted by the nose gear sensor, the corresponding red indicator light will be lit. This means that the nose gear indication is “unsafe” despite the actual position of the landing gear. A few minutes after landing the nose gear indication changed from unsafe to a green gear down indication.

After the gear was selected down again, the nose gear indication remained unsafe. When the normal indication system fails the only way to ascertain if the nose gear is down and locked is by a visual check through a viewer window that is located in the cockpit floor just before the door. This check is mentioned in QRH chapter 14.16 “manual gear extension”. During the investigation representatives of Royal Air Maroc stated that the gear viewer windows are mentioned during flight crew training. The viewer windows are shown to crew members during training and also make up part of the pre-flight check. As a part of this check, crew members check whether the viewer windows are clean and whether the lighting in the nose landing gear compartment is working properly. Cabin crew is not formally trained to check the landing gear position but they are allowed to have a look through the viewer window when such an occasion arises. During the investigation it became apparent that a considerable number of both cockpit and cabin crew at Royal Air Maroc and Atlas Blue are under the false impression that cabin crew is qualified to perform such a check. The crew asked the purser to visually check the position of the nose gear. After looking through the viewer the purser confirmed that the nose gear was down and locked.

It is concluded that following the bird strike the crew extended the landing gear, which increased the drag significantly and with that the climb gradient decreased unnecessarily.

4.2.3 GPWS and landing gear warning horn

QRH chapter 15.1 contains the procedure ‘ground proximity alert’ which prescribes that when a GPWS warning is activated the crew should “(...) *correct the flight path or the airplane configuration.* *Note: If an alert occurs when flying under daylight VMC conditions, and positive visual verification is made that no hazard exists, the alert may be regarded as cautionary and the approach may be continued.*”

The note appears to be contradictory to FCTM chapter 7.21 which states that “*terrain warning-level alerts always require immediate action*”. However it should be emphasized that the note in QRH chapter 15.1 is meant exclusively for the approach phase of the flight and not for low level manoeuvring after take-off.

48 The aircraft is equipped with a left and a right main landing gear and a nose landing gear.

At 21.43:44 hours after the right turn at low altitude had been made, a GPWS "DON'T SINK" warning was generated during a descent from 496 feet to 352 feet, indicating an altitude loss after take-off. This caused an additional distraction for the crew.

The warning "DON'T SINK" can be heard several times on the cockpit voice recorder. This warning stopped after the aircraft started to climb again, this time to a height of 628 feet. When the aircraft started to overfly a build-up area the GPWS warnings "TERRAIN" and "PULL UP" were triggered and later the landing gear warning horn also sounded. The captain asked the first officer to silence the GPWS warnings but there was no discussion regarding the cause of the warnings and how the crew should respond to them. The crew later stated that they were allowed to ignore GPWS warnings as long as they were in visual contact with the surrounding terrain. The visibility was seven kilometers at dusk.

It is concluded that, although the flight crew had limited options to respond to the GPWS warnings, they did not discuss the warnings nor did they correct the flight path or the aircraft configuration.

The landing gear warning horn is activated to alert the flight crew any time the aircraft is in a landing configuration and any gear is not down and locked. The warning is active when the flaps are in a position between 1 and 10 and either or both thrust levers are between idle and approximately 10 degrees thrust lever angle position. This warning can be silenced by pressing the landing gear warning horn cutout switch. This warning does not require immediate crew action.

During the flight the nose gear indication remained unsafe. In combination with the low altitude the aircraft was flying at, the warning was activated after the left engine was shutdown and the affected throttle was closed (throttle angle below ten degrees). Illustration 2 in paragraph 2.3 shows that the warning stopped when the aircraft climbed above 500 feet. Just before landing it was activated again after the crew closed the right engine throttle lever.

4.2.4 Use of flaps

During the flight the crew left the flaps in the "5" (five degrees) position. The 'flap retraction – one engine inoperative' procedure (FCTM chapter 3.31) states that "(...) *the minimum altitude for flap retraction with an engine inoperative is 400 feet above ground level.*"

This procedure was not followed and the flaps remained in the "5" position. The crew later stated that this was a deliberate choice. The captain did not want to change the configuration because he was afraid the aircraft would become uncontrollable if the flaps would extend asymmetrically during the landing preparations. The CVR recording did not reveal any discussion about this topic. However, it is not uncommon to leave the flaps in the take-off position during the 'initial climb - one engine inoperative' procedure (FCTM chapter 3.30).

When a landing must be made with one engine inoperative the 'one engine inoperative landing' checklist (QRH chapter 7.26) must be performed. This was not done by the crew. This checklist requires among others extension of the flaps to the "15" position during approach and landing. A decision not to do so is usually the result of a flap system failure. Any asymmetry during the flap extension would have been detected by the asymmetry protection system.⁴⁹ The flap extension would then stop automatically and the crew would be required to perform the appropriate QRH checklist. The choice to land with flaps 5 had several implications. Most importantly it required a higher than normal approach speed. Apart from this GPWS warnings and the landing gear warning horn were triggered and the landing distance increased significantly.

It is concluded that there was no reason to land with a flaps 5 configuration.

49 When a flap asymmetry develops, hydraulic power is removed from the flap drive unit. The flap position will be displayed as a needle split on the flap position indicator.

4.2.5 Crew resource management

Crew resource management (CRM) is the use of all available resources to achieve a safe and efficient flight operation. The importance of proper CRM has been recognized by the industry over the years and training programs have been developed to teach crews how to improve decision making, communication, leadership and management skills. These capabilities should effectively interact with standard operating procedures to get to a dominant effect on crew efficiency during routine and non routine operation. The aim is an optimal performance by the crew as a whole and should be practiced during training and during day to day operation. In this way a crew is prepared to function as a team during high-workload stressful circumstances. This will highly improve handling of these situations. There is consensus in the aviation community about the standard in CRM. References can be found in various ICAO documentations. Various Royal Air Maroc manuals also contain CRM descriptions, best practices and procedures based on the international standards. More CRM background information is contained in Appendix I. This paragraph assesses the crew's CRM on the basis of the events and their analysis as described in the above paragraphs.

In principle, the crew are allowed to deviate from procedures and take any actions they deem necessary. However, they may only do so after having gained sufficient insight into the situation at hand. Effective CRM is thus based on a structured approach to problems and contributes to effective management of situations even if they are not covered by standard procedures. The crew's impulsive response to the problems and the lack of coordination between the captain and first officer suggest the absence of any such structured response. It should also be pointed out that the flight manuals outline all relevant standard procedures for each of the problems encountered by the crew.

When properly used, CRM can avoid task saturation to a large degree. Task saturation can be defined as having too many tasks to attend to at any one moment, increasing the potential for a person to miss important inputs or cues in a dynamic situation. There are basically two causes for task saturation. The first is information overload, where the sheer mass and number of sensory inputs overwhelms the human brain's ability to sort and comprehend. The second type is slightly more complicated and occurs when someone fails to adequately prioritize inputs, resulting in a situation where he or she is unwisely and unnecessarily sharing attention between important and unimportant tasks. With the second type the human brain often tends to find a single focus to stabilize the situation. Both types of causes for task saturation can exist at the same time.

In this part of the analysis a closer look is taken at aspects during the incident flight related to crew resource management and task saturation.

According to their statements and voice recorder data the crew had the impression that the aircraft was severely damaged and that an immediate return to the airport was essential for the safety of the flight. With that in mind it is explainable that the captain elected to turn right in order to facilitate an immediate return. However this decision was based on the severity of the impact and its phenomena and not on actual information regarding the technical and operational status of the aircraft. This lack of information was leading the crew to a false perception of reality. The crew did not assess the situation properly and acted impulsively.

By starting a turn at low altitude the crew created a situation in which it became difficult to control the flight path. The flight turned unstable. This can be observed by an incidentally high bank angle and the variations in airspeed and rate of climb. Also the captain inadvertently reduced the right engine thrust several times. He stated that the engine was running at full thrust while in fact it was mostly running 10 to 15% below the maximum RPM. Especially during the first part of the flight the captain asked the first officer several times to repeat information. The captain had to focus on his primary task, flying the aircraft, and had no time to take in other information.

There is a standard procedure for engine failures during take-off (see paragraph 4.2.1). This procedure gives the best opportunity to remain within the flight envelop and safeguards obstacle clearance and that all required actions are completed. This is the basis for a structured operation and creates time for assessment, failure management and planning. The procedure is initiated by standard calls and, for runway 18L at Schiphol airport, involves a straight climb until 1700 feet above mean sea level.

The role of the first officer as pilot monitoring is to assist the pilot flying among others by calling out deviations of the intended flight path. However these calls were rarely given and when these were given the captain did not respond. In turn the first officer did not sufficiently stress the importance of the information he was giving to the captain and was interrupted by air traffic control, the purser, several warnings and also by the captain himself.

In deciding to initiate a right turn at 280 feet with the aircraft at a steep bank angle, the crew failed to realise the consequences in terms of the aircraft's ability to avoid obstacles under moderate visibility conditions. Time was spent on the gear indication without a conclusive solution. During the turn, as a result of variations in vertical speed, the terrain warning "DON'T SINK" was triggered several times with no proper response from the crew. Later on during the flight heading instructions from air traffic control were periodically not followed. It took about two minutes before the failed engine was shut down. The engine fire severe damage checklist was initiated but not completed. Flaps were left at 5 degrees for landing without justification. During the final part of the flight the crew discussed several useful ideas concerning cabin preparation and flight techniques but none of these ideas were acted upon.

The turn and the associated controllability problem put a lot of pressure on the flight crew. Communication in the cockpit was hampered by the lack of standard and disrupted by calls from the cabin, air traffic control, and GPWS warnings. No opportunity could be found by either crewmember to gather information and assess the situation properly. Thus the crew remained unaware about the extent of the engine damage and the origin of the gear warning. It took a relatively long time before recall items were completed. After that the flight crew was occupied by the circumstances for the return and did not find a moment to review the situation. There was no planning. The progress of the flight determined the crew's actions.

The events illustrated suggest that the flight crew was affected by task saturation. The captain was occupied by controlling the flight path and had limited resources left to manage the flight. The first officer had to divide his attention between the instructions from the captain, instructions from air traffic control and talking to the purser. Meanwhile both had to cope with several loud audio warnings from the GPWS system. This indicates that there were obviously numerous sensory inputs to contribute to the flight crew's workload. However the main reason for the task saturation was the lack of failure analysis and a failure to prioritize tasks.

It is concluded that the standard of CRM during the flight was not on the required level for airline pilots. The decision to return immediately was based on a false assumption and apparently taken impulsively. This led to a disrupted crew cooperation and task saturation. The flight crew became not sufficiently aware of the operational situation. Standard procedures were not used. Failure management was not adequate. Crew communication and crew interaction was poor. Together this led to an increased risk for the aircraft, its occupants and for the environment.

It is the view of the Safety Board that compliance with procedures and standard flight operation combined with crew resource management offers the most effective method of controlling safety risks under all flight situations.

4.2.6 Atlas Blue and Royal Air Maroc flight crew training

A bird strike is not an uncommon occurrence. In fact the NOTAMs (notices to airmen) for Schiphol airport explicitly warned for geese migration especially during dusk and dawn periods. The flight crew stated they were aware of this information before the incident occurred.

The bird strike resulted in a multiple failure: thrust loss in the left engine and an unsafe nose landing gear indication. When the flight crew was asked if they received training for incidents like this they replied that an incident like this could not be trained and for that reason they did not receive such training. The training manager and fleet manager of Royal Air Maroc were asked the same question and they replied that multiple failures were only trained during the training for captain. Until the incident flight, crews were not confronted with multiple failures during recurrent training.

The investigation revealed that the relevant Atlas Blue and Royal Air Maroc manuals contained all information needed for situations just like this serious incident. The training manuals contained general guidance needed to address the incident in a structured manner and the QRH and FCOM contained all relevant procedures that would have been needed to address the actual damage. Despite this the flight crew was convinced that they had encountered a unique occurrence.

According to Royal Air Maroc representatives, Atlas Blue and Royal Air Maroc flight crews are not only informed about the training goals, but also informed of the failures that will be presented to them before a training session is started. For an initial (captain's) training process this practice can have added value. However, it does not adequately prepare crews for real life situations. It is considered good practice to give flight crews the opportunity to prepare for a training session in a generic way by specifying several study items. However crews should preferably not be informed of the details of a training session beforehand. Training sessions should also contain a certain element of surprise to ensure that crews stay sharp and complacency is eliminated as much as possible.

As indicated in the QRH itself "(...) *it is not possible to develop checklists for all conceivable situations*". This implies that crews should be trained to handle unexpected situations in a generic manner. To a certain extent this includes the training of failure combinations. Especially combinations that are likely to occur such as additional damage to an aircraft after a bird strike.

It is concluded that Atlas Blue and Royal Air Maroc pilots were not trained to handle multiple failures at the time of the bird strike occurrence. However the training manuals contained general guidance needed to address this serious incident in a structured manner and the QRH and FCOM contained all relevant procedures that would have been needed to address the actual damage. After the serious incident Atlas Blue and Royal Air Maroc stated their intention to include such failures in their (recurrent) training.

4.3 ENGINES

4.3.1 Fire indication

The purser mentioned that the left engine was on fire and some witnesses, passengers and an air traffic controller observed flames coming out of the left engine. However, the cockpit crew did not respond to the purser's warning. They were too busy flying the aircraft and dealing with the various warning signals. The flight data recorder did not show any indications that pointed towards a fire during the flight. An inspection conducted after the flight did not identify any traces of fire damage on the aircraft other than those in the engine itself. This confirms the assumption that the fire was limited to the rear section of the engine.

- Although the engines are equipped with a fire detection system, this system did not generate a fire warning. This can be explained by the location of the fire sensors, which are placed to detect fires only in critical areas of the engine. These critical areas are located at in the centre section of the engine. The engine's internal fire extinguishing system is designed to protect these critical parts against fire. Fires in the rear section of the engine cannot be extinguished during flight. The engine's exhaust section is basically fire resistant and any fires in this section will die down of their own accord due to the lack of any flammable materials (such as kerosene or oil). However, if an engine is heavily damaged (in the wake of a bird strike, for example) such a fire may continue to burn due to leakages in the engine's oil or fuel system. The only option at the crew's disposal will then be to return immediately to the airport. It should be pointed out that the likelihood of an engine fire is small once the memory checklist has been completed (meaning that the fuel feed has been closed).
- The Safety Board concludes that the fire that was observed could not have been detected by the existing warning systems, and that the crew had given priority to steering the aircraft and landing as soon as possible.

4.3.2 Certification

The bird ingestion requirements have undergone several changes since 1974 when they were originally introduced.⁵⁰ A list of amendments that altered the engine bird ingestion regulations is shown in Appendix J.

The CFM56-3 engine was certified to withstand ingestion of a single 4-pound (1.81 kilogram) bird. The latest large bird ingestion certification criterion for CFM56 sized engines is a single 6-pound (2.75 kilogram) bird. The mass of a Canada goose in the summer is 3 – 5 kilogram.

It is concluded that the mass of the Canada goose ingested by the left engine well exceeded the past and current bird-ingestion certification standards.

4.3.3 Bird ingestion protection devices for engines

In 2010 the NTSB reported in its investigation report on the bird strike between several Canada geese and the Airbus A320 that engine design changes and protective screens have been used or considered in some engine and aircraft designs to protect the engine against bird ingestions. In the report the following is described. For example, certain small turbofan engines incorporate a hidden- or partially hidden-core inlet. The hidden-core inlet design hides the inlet guide vanes behind the fan hub rather than placing them directly into the airflow path; thus, all foreign objects pass over the inlet guide vanes into the bypass duct and cannot be ingested into the core. However, the hidden-core inlet design results in significant design compromises that increase as the size of the engine increases. The design requires that the engine becomes longer and heavier because the core inlet duct must be longer to direct the airflow into the core without separation from the duct walls and because the structure, bearings, and shafts must be lengthened. Additionally, the associated engine attachment structure and the aircraft structure itself must be strengthened to account for the weight increase, resulting in an increase in fuel consumption. Another compromise the design creates is a non-optimum relight envelope, which requires that the aircraft be put into a steep dive, an undesirable behavior in a passenger aircraft, to build up sufficient static pressure in the inlet to maintain engine core rotation for a successful emergency relight.

In addition, protective screens are currently used on some modern turbo propeller aircraft and on some turbo shaft helicopter engines; however, the type of protective device used on these engines cannot be incorporated into turbofan engines because of the engine construction layout. No manufacturer has developed an inlet screen to protect turbofan engines, such as the CFM56-3 engine, from bird ingestion. Several technical issues related to performance, weight, and reliability must be considered to determine whether protective screens can be used effectively and safely on turbofan engines, and these issues are summarized in Appendix G.

The Safety Board concurs with the NTSB's conclusion that available means of protecting aircraft engines against bird ingestions, such as changes to the engine design or protective screens, are not suitable for turbofan engines such as those involved in this serious incident.

4.4 AIRCRAFT BIRD DETERRING SYSTEMS

The NTSB reported in its final report on the bird strike of an Airbus A320 with several Canada geese in 2009 that preliminary reports the effectiveness of using various bird hazard mitigation strategies, including pulsating lights, lasers, and weather radar, suggest that these techniques have potential as bird repellents and may be helpful in keeping birds away from an aircraft's flight path. It seems, however, that the effectiveness of these methods is not well understood, and further research in these areas is needed. The NTSB believes that it is important to pursue all potentially useful approaches to bird hazard mitigation and is particularly interested in those that use aircraft systems to repel birds away from aircraft. The NTSB findings concur with the Dutch Safety Board's conclusions (this will be continued in paragraph 4.7.3).

50 Code of federal regulations (CFR) are modified from time to time in response to changes in technology, design philosophy, in-service data, incidents or accidents.

In addition to the above mentioned methods the use of radar to prevent bird strikes is also recommended in the Dutch Airports Bird Strike Prevention Handbook (see also paragraph 4.7.3).

It is concluded that research on the use of aircraft systems such as pulsating lights, lasers, and weather radar may lead to effective methods of deterring birds from entering aircraft flight paths and, therefore, reduce the likelihood of a bird strike.

4.5 INVESTIGATION OF FOLLOW-UP TO RECOMMENDATION BY THE PARLIAMENTARY BOARD OF INQUIRY

This paragraph describes what happened in response to the recommendation of the Bijlmermeer Air Disaster Parliamentary Board of Inquiry to take measures to prevent aircraft in emergency situations from ending up above built-up areas. Attention is also focused on a verification survey by the Inspectorate of Transport, Public Works and Water Management (IVW) that investigated the extent to which Air Traffic Control the Netherlands (LVNL) applies specific procedures to aircraft in emergency situations to avoid built-up areas.

4.5.1 Recommendation by the Bijlmermeer Air Disaster Parliamentary Board of Inquiry

Following the accident with the El Al Boeing 747 in the Bijlmermeer in 1992, a parliamentary inquiry was held in 1999. Among other things the parliamentary Board of Inquiry investigated the procedures used during emergency situations and the relation with external safety. External safety means the management of air traffic risks for the surroundings, both for other air traffic and for people on the ground in the vicinity of Schiphol airport.

In its final report the Bijlmermeer Air Disaster Parliamentary Board of Inquiry included the following passage [translated]: *'The chance of civilian casualties can be reduced if the built environment is taken into account in decisions that have to be taken when guiding an aircraft in an emergency. Examples of how the built environment is included when handling an emergency flight are when, in emergency situations, the built environment is visible on the radar, or when pro-active emergency routes are mapped out which also take account of the surrounding area'*.⁵¹

Continuing on from this, one of the committee's recommendations at the time was the following: [translated] *'The committee recommends that emergency situations should be taken into account when assessing external safety. Additional possibilities need to be investigated for concrete interpretation of what is known as recommendation 10 by the Netherlands Aviation Safety Board in relation to external safety'*.⁵² *Particular consideration can be given to displaying quickly the surrounding built-up area on controllers' radar screens in the event of an emergency situation'*.⁵³

After the Parliamentary Board of Inquiry had finished its final report the then Ministry of Transport, Public Works and Water Management, which was responsible for flight safety, implemented this recommendation together with LVNL by carrying out an investigation. The investigation and its results are described in the next paragraph.

4.5.2 LVNL investigation and informing the Lower House of the Dutch Parliament

In consultation with the Directorate-General of Aviation and Maritime Affairs (DGLM), LVNL performed a *'study of the possibilities for implementing the recommendations of (...) the Bijlmermeer Air Disaster Parliamentary Board of Inquiry regarding taking account of the risk for third parties during the handling of emergency flights'*.⁵⁴

51 Bijlmermeer Air Disaster Parliamentary Board of Inquiry, final report, Chapter 2.6.

52 The Netherlands Aviation Safety Board recommended: "Expand the training of pilots and ATC personnel to include the awareness that in the handling of emergency situations not only the safety of airplane/passengers but also the risk to third parties especially residential areas should be considered." Netherlands Aviation Safety Board, Aircraft Accident Report 92-11, recommendation 4.10, 24 February 1994.

53 Bijlmermeer Air Disaster Parliamentary Board of Inquiry, final report, Chapter 8.2.

54 Letter from LVNL to the IVW, ref. R&D/2003/1624, 20 March 2003.

LVNL conducted a study to this end, entitled "*Reduction of Third Party Risk (3PR) during handling of Emergencies*". The 3PR investigation assessed the safety effectiveness – reduction in the routing of aircraft in distress over densely populated areas – and practical feasibility of presenting densely populated areas on the radar screen. LVNL presented the outcomes of the 3PR investigation to the Transport, Public Works and Water Management Inspectorate on 20 March 2003. This study comprised:

- A 'concept of operation': the formulation of the problem and solution strategies.
- Safety, efficiency and the environmental (VEM) effect report: the safety, efficiency and environmental goals and an estimate of the effects of each solution strategy on VEM.
- Legal effect report: estimate of the legal aspects per type of solution.
- Acceptance risk analysis: an estimate of the acceptance risks for operational personnel of each solution strategy. This method is intended to investigate the effects of changes in the air traffic control system in a structured manner and in advance. The method examines people, machines and procedures in connection with each other.

During the investigation five alternatives were evaluated for taking account of the risk for the surrounding area during emergency situations. These alternatives were:⁵⁵

- *Runway suggestion*:
 - Procedure concerning classification of runways for emergency situations (preferred emergency landing runway).
- *Route suggestion*:
 - Information about populated areas on the controller's radar screen.
 - Flight routes for emergency situations on the controller's radar screen.
 - Determined routes.
 - Best practices.

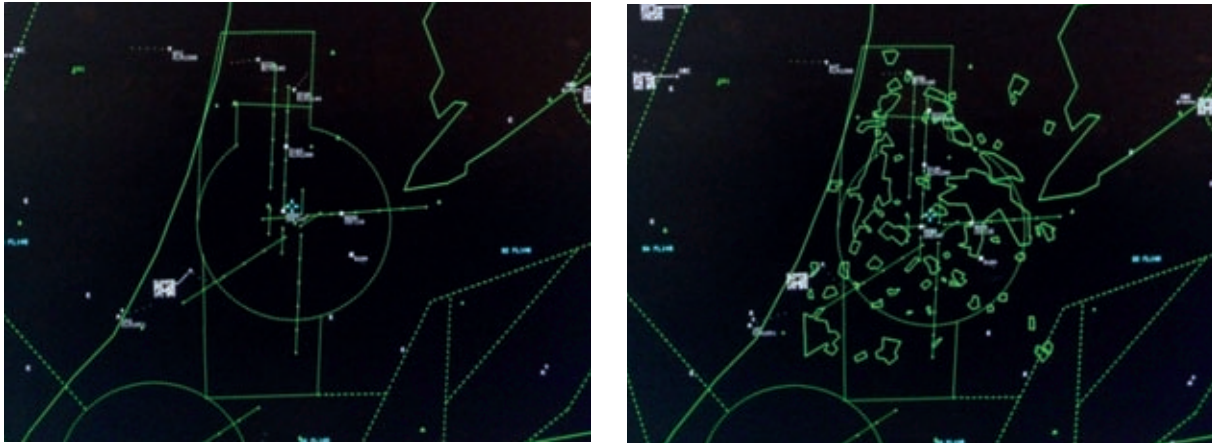
The investigation included substantiations for each solution strategy. The main points of the investigation are contained in Appendix K.

The 3PR-investigation by LVNL involved practising with various alternatives in air traffic control simulators. It appeared that there are few options as regards ensuring that aircraft avoid built-up areas in an emergency. In emergency situations there are all kinds of reasons why it is impossible for a crew to comply with flight heading instructions due to the emergency situation itself. In such instances the crew themselves are best positioned to assess the (im)possibilities such as the aircraft's manoeuvrability, the situation in the cockpit (smoke production, et cetera).

Besides that the 3PR investigation showed that it is impossible for commercial aircraft to avoid built-up areas in practice, taking account of the airspeed and the turn radius of such aircraft. In addition, the manoeuvrability of aircraft in an emergency is generally poorer than in normal circumstances.

The presentation of built-up areas in the Schiphol control zone on the radar screen, as developed during the 3PR investigation, is still a feature of the radar system. However, not all the controllers are aware of this and neither can they call up the image directly. The capacity to show the built-up areas was developed in 2000 and does not show the built-up areas around Schiphol as they are today. The built-up area around Schiphol airport has significantly increased over the years. The following illustration is of a radar screen which does not and one that does show the built-up areas.

55 Reduction of Third Party Risk (3PR) during handling of Emergencies, D/R&D 02/063, 5 February 2003, p.16.



Illustrations 6 and 7: radar screen with Schiphol airport in the middle, normal (on the left), radar screen with built-up areas in 2000 (on the right)

The outcome of the 3PR investigation was that although it may be technically possible to show populated areas on radar screens, neither pilots nor air traffic controllers believe it is effective or practical to do so.

Based on the results of the 3PR investigation, LVNL and DGLM consulted in order to determine the procedure for responding to aircraft in an emergency situation and flying over built-up areas. They defined the assist principle⁵⁶ in combination with 'best practices' (see below) as the correct policy framework for guiding aircraft in an emergency. The assist principle is an ICAO guideline further developed by Eurocontrol and assumes an allocation of roles whereby the captain is responsible for the flight operation and the air traffic controller assists the flight crew. The Directorate-General of Aviation and Maritime Affairs supports this position, as it prioritises flight safety in accordance with government policy.

According to the outcome of the 3PR investigation of 'best practices', aircraft in distress situations should use existing runway arrival and departure routes wherever possible. This will limit the amount of flying over densely populated/built-up areas. This offers an added advantage in that aircraft in distress situations will use the same routes they would under normal circumstances.

As a result of this policy framework, densely populated areas are not presented on the air traffic controller's radar screen. Evidently, a decision was also made not to present high obstacles on the radar screen either. Paragraph 4.6.2 will focus on the presentation of high obstacles on the radar screen.

LVNL has commented that air traffic controllers do not support the idea of presenting densely populated areas on the radar screen during emergencies, in view of the potential consequences with regard to liability. The origin of this position can be found among others in the criminal prosecution in 2000 of air traffic controllers in the so-called "Delta-incident".⁵⁷ The Safety Board notes that because of the [translated]: "*Directive for tracing and prosecution regarding occurrence reporting in the civil aviation*" from the council of prosecution, the risk of prosecution has been diminished considerable. There will be no prosecution against persons regarding violations that are committed unintentional or out of carelessness. Prosecution could take place in case of intention or gross negligence.

⁵⁶ The assist principle is described in Appendix G, under Manuals, Air Traffic Control the Netherlands.

⁵⁷ On 10 December 1998 a serious incident occurred at Schiphol airport. Air traffic control cleared a Delta Airlines Boeing 767 for take-off from Runway 24. At the same moment a towing tug with a Boeing 747 crossed the same runway, also with clearance from air traffic control. The Delta Airlines flight crew commenced the take-off roll, but aborted these when they saw the Boeing 747 in front of them crossing the runway. In October 2000 the public prosecutor in Haarlem decided that all three involved air traffic controllers would be prosecuted individually. In November 2002 the court gave a verdict in higher appeal. The court held the breaking of article 5.3 of the Aviation Act (translated): "It is forbidden to take part in air traffic in such a manner or to provide air traffic control that this could endanger people or matters" valid and convincingly proven for all three controllers, but without imposing punishment.

On behalf of the state secretary of the then Ministry of Transport, Public Works and Water Management, the IVW notified LVNL in a letter that the 3PR investigation involved a detailed examination of [translated] *'the possibilities for concrete interpretation of the recommendations of the Bijlmer Disaster Parliamentary Board of Inquiry (...). You also investigated - beyond the scope of the recommendations (...) - the possibilities within the air traffic management system. (...) I [the secretary of state] therefore assume that the quality and safety objectives were sufficiently taken into account'*.⁵⁸

This was reported on in a letter from the state secretary of the then Ministry of Transport, Public Works and Water Management to the Lower House of the Dutch Parliament.⁵⁹ In this letter the specified procedure was clarified as follows [translated]:

'In the event of emergency landings air traffic control follows international rules, with the emphasis on operational circumstances and flight safety. The priority is to provide as much support to the captain as possible. The preferred runway is determined on each separate occasion. Depending on the nature of the emergency situation, the wind direction, the presence of other traffic, et cetera, a decision is taken as to which runway is most suitable. With regard to the arrival route the controller acts according to circumstances, depending on the actual situation, but with due regard for a number of arrival routes which have been designated as 'best practices' for emergency landings. The procedures for these 'best practices' are related to the procedures for normal circumstances, so that the procedures for the captain are also clear and workable in emergency situations. The 'best practices' are determined in such a way that flying over built-up areas is limited. It is also important that, in the restricted areas beyond the runways, restrictions apply to the built-up areas in connection with external safety. Beyond this, air traffic control does not take account, in the procedure for emergency situations, of the surrounding built-up areas. (...) The captain's preference will be to make an (emergency) landing at the airport as soon as possible and with as few risks for flight safety as possible. That consideration may lead to a longer route being chosen. Ultimately the safety of the flight also determines the safety on the ground.'

The Safety Board observes that the investigation conducted by LVNL in response to the recommendation by the Committee of Inquiry on the Bijlmermeer Aircraft Disaster (suggesting that measures should be taken to ensure that aircraft in an emergency situation are not routed over densely populated areas) has resulted in a policy framework on the supervision of aircraft in distress situations and on flying over densely populated areas. According to this policy framework for aircraft in distress situations, the captain is responsible for flight operation while the air traffic controller provides assistance to the cockpit crew. Aircraft in distress must use existing runway arrival and departure routes where possible. These routes were selected to ensure an optimal balance between safety, efficiency and environmental concerns, limiting the number of flights over densely populated areas. The Directorate-General of Aviation and Maritime Affairs has approved the aforementioned policy framework. As a result of this policy framework, densely populated areas and high obstacles are not presented on air traffic controllers' radar screens.

4.5.3 Verification survey by IVW for DGLM

In the period 2004-2006, in response to a number of incidents⁶⁰ parliamentary questions were asked which resulted in a request by DGLM to IVW to carry out a 'verification survey' to establish to what extent LVNL uses specific procedures for aircraft in emergency situations to avoid built-up areas.⁶¹ The request also intended to establish how often aircraft in an emergency fly over built-up areas and whether action is taken to limit the risks for the surrounding area. The outcomes of this investigation were as follows [translated]:

- "Flights investigated (with PAN PAN emergency distress calls)⁶² in the period of December 2008 to May 2009 flew the shortest route to the closest runway. The aircraft involved did not deviate,

58 Letter from the IVW to LVNL, ref. DL/Infra/04.540291, 4 March 2004.

59 TK 2005-2006, No. 1508: questions by member of parliament Gerken (SP).

60 Emergency landing with an escort of F16 fighter planes by aircraft which are the object of a terrorist threat (unlawful interference).

61 Letter from the IVW to the DGLM, Aviation Safety Department, ref. VENW/IVW-2010/8410, 12 July 2010.

62 PAN PAN (three times); an internationally used emergency call to indicate that the sending station is going to transmit a very urgent message relating to the safety of a means of transport or a person.

or scarcely deviated, from the standard arrival routes. In that period twelve flights issued an emergency distress call on a total of more than 152,000 flights.

- LVNL has regulations for guiding air traffic in emergencies; however, there are no special procedures regarding the routing of aircraft in an emergency to avoid built-up areas.
- LVNL operates in accordance with the internal procedures of the assist principle: support for the captain as he requests so that the aircraft can land as safely and quickly as possible. The regulations are in line with international frameworks.”

The outcomes of the verification survey by the IVW were therefore consistent with the procedures previously established by the DGLM.

4.6 FLYING LOW OVER A BUILT-UP AREA IN AN EMERGENCY SITUATION

4.6.1 Route flown over built-up area

The need for the flight crew to return to the airport is undisputed in this case, as shown by paragraph 4.2. Given the engine failure, followed by the crew’s decision to initiate a right turn immediately at a too low altitude and return to the airport and to select the gear down, it was inevitable that people on the ground would be confronted by an aircraft flying too low. This would also have been the case, as example, if the aircraft had immediately taken a left turn rather than a right turn. The standard departure route the crew was instructed to take was in a southerly direction. If the crew had flown on in a southerly direction (keeping to the runway direction) after the bird strike, the standard route would have offered better obstacle-free clearance. However, the aircraft would still have had to turn back and it would have been likely that a similar situation – flying too low over the built-up area- would have occurred.

As described in paragraph 4.5.2, the assist principle in combination with best practices is the policy framework for handling aircraft in an emergency. Statements show that, in an emergency situation, air traffic control ensures separation from other traffic with a greater emphasis on keeping other traffic away (rather than on guiding the aircraft in an emergency). It is the captain of the aircraft in an emergency who ultimately chooses an approach route. The QRH of LVNL states that separation is important due to unexpected behaviour by the aircraft in an emergency: “*Maintain additional lateral and/or vertical separation (aircraft may behave unexpectedly)*”. The Air Traffic Control Rules and Instructions (Voorschriften Dienst Verkeersleiding) and the QRH do not contain any special procedures regarding the issuing of instructions concerning the route to be followed by the aircraft in an emergency.

The fact that the given flight headings were not immediately followed during the execution of the ‘engine fire or engine severe damage or separation’ checklist illustrates the fact that the crew was very busy coping with the immediate tasks. On the one hand the way this incident developed seems to illustrate the outcomes of the 3PR investigation, which showed, among other things, that in ‘Mayday’ or ‘Pan Pan’ situations the aircraft’s predicament can be very time-critical. On the other hand, the policy assumes that the crew always takes the right decision in an emergency situation. The serious incident with the Royal Air Maroc Boeing 737 proves the opposite.

The policy framework does not take into account deviations from standard flight routes over populated areas. In such cases, the air traffic controller only has the option of providing advice and information to the crew (assist principle). Pilots are not obliged to adhere to advice or information that is solely aimed at routing flights away from built-up areas and does not prioritise the safety of the flight itself. The consequence is that, even in a case like this, the (external) ‘residual risk’ of the presence of the aircraft in an emergency above a built-up area is determined by the crew.

It can be concluded that, given the cause of the emergency situation –the bird strike, the initiated right turn and selecting the gear down- flying over the cities of Vijfhuizen and Haarlem was virtually unavoidable. Turning back to the airport was the only possible option open to the crew. The threat of this situation for the residents around Schiphol was mainly caused by the crew not observing the ‘initial climb – one engine inoperative’ procedure.

4.6.2 *Flight below the minimum vectoring altitude*

The crew declared an emergency to air traffic control and requested radar vectors to return to Schiphol airport. The runway controller responded by giving the crew the initial heading 330 degrees. Since the aircraft flew at a lower altitude than the minimum vectoring altitude in the Schiphol control zone of 1200 feet, this heading was advisory only and the pilots were responsible for avoiding obstacles. Due to the high workload of the pilot flying the aircraft actually rolled out on heading 345. The controller advised the crew to steer left heading 320. The crew confirmed the heading however the aircraft did not follow the advised heading. Thereafter the crew was instructed to contact the arrival controller on a discrete frequency on which they remained until the landing was completed.

The aircraft overflowed the cities Vijfhuizen and Haarlem between 380 and 480 feet height. From interviews it became clear that neither the crew nor the air traffic controllers appeared to realize that the aircraft flew to within one kilometre distance of a 479 feet high tower located on the city perimeter of Haarlem. From the cockpit voice recorder it became clear that the first officer was aware of some obstacles in the western harbour area of Amsterdam. He advised the captain about these obstacles.

The Board's investigation showed that two obstacles are displayed permanently on the air traffic controller's radar screen: one obstacle for the Schiphol control zone near the city of IJmuiden and one obstacle for the terminal control area near Lopik. These obstacles are shown by a symbol without obstacle height. LVNL has indicated that these obstacles have been displayed on the screen for some considerable period of time. Other high obstacles in the Schiphol control zone, including the tower on the outskirts of Haarlem and objects in Amsterdam's western harbour area, are not displayed on the radar screen. As a result, the air traffic controller does not have any information on high obstacles in the aircraft's flight path.

It is noted that the two obstacles that are presented permanently on the controller's radar monitor have no relation with the incident flight because they are situated beyond the aircraft's flight path. These obstacles are unrelated to the 3PR investigation.

Based on the above, the Safety Board concludes that LVNL's policy with regard to the presentation of high obstacles on the radar screen is inconsistent. As a result, air traffic controllers cannot provide pilots with advice on the location of these obstacles when necessary.

The pilots indicated that the aircraft could not climb and that they had difficulties controlling the aircraft. The visibility during the incident flight was 7 kilometres at dusk. Although the visibility was within the limits of visual meteorological conditions, the visibility was moderate. The incident flight illustrates that the 3PR-investigation did not include the risks of advising aircraft in distress below the minimum vectoring altitude. In particular when the visibility becomes outside the visual meteorological conditions. In this respect the absence high obstacles on the radar screen increased the imposed risk during the emergency situation. Air Traffic Control the Netherlands has no procedure for air traffic controllers that allows for guidance to aircraft in distress in such a situation. Air Traffic Control the Netherlands has not considered the risks of assisting aircraft in distress that are flying below the minimum vectoring altitude in the Schiphol control zone.

LVNL refers to the ICAO guidelines, which state that it is not possible to prepare procedures ensuring the adequate handling of every possible type of emergency situation, and that efforts should be based on the air traffic controller's best judgement.⁶³

Although the Safety Board basically agrees with the ICAO's conclusion that it is not possible to design procedures for every possible type of emergency, it points out that this does not mean no measures need to be taken. It is important to put in place measures that will enable the captain and air traffic control to resolve emergency situations as effectively as possible. This includes carefully considering any information that could affect flight safety in advance, such as the presence

63 "The various circumstances surrounding each emergency situation preclude the establishment of exact detailed procedures to be followed. The procedures outlined herein are intended as a general guide to air traffic services personnel. Air traffic control units shall maintain full and complete coordination, and personnel shall use their best judgement in handling emergency situations." Document 4444, paragraph 15.1.1.1.

of high obstacles. Once this information has been provided, the crew can determine whether flight safety is at risk and assess whether additional measures – such as adjusting the heading – will be needed.

Furthermore, the Safety Board does not concur with LVNL's definition of 'the air traffic controller's best judgement'. The investigation has established that air traffic controllers do not know the (exact) location and height of high obstacles in the Schiphol control zone, or cannot know this information because it is not presented on their radar screens. However, controllers do provide headings to aircraft in distress that are flying below minimum vectoring altitude, regardless of the visibility conditions. As a result, aircraft that are flying outside visual meteorological conditions could, if the worst comes to the worst, collide with a high obstacle. In other words, in such a case the 'assist' principle would not have contributed to preventing a collision. Although the likelihood of such an emergency is small, the potential consequences are huge, rendering the risk level unacceptable. The fact that crew members do not always follow the instructions and advice provided by air traffic control during an emergency does not diminish this conclusion. In this connection it should be pointed out that British air traffic controllers at London Heathrow also give advice to pilots in emergencies when the aircraft's planned route is over densely populated areas (see section 2.19.1).

From the heading instructions, the transfer to a discrete frequency, and the offer to land on an alternate runway as described in paragraph 2.3, it can be concluded that the air traffic controllers assisted the crew in the best possible way under the circumstances.

The Safety Board also concludes that the analysis of measures implemented in response to the 3PR investigation (initiated in response to the recommendation by the Bijlmermeer Air Disaster Parliamentary Board of Inquiry) failed to take sufficient account of the risks caused by aircraft in distress situations flying below the minimum vectoring altitude. These aircraft are given headings in the Schiphol control zone, although air traffic controllers do not have information on the presence of the high obstacles in the flight path. This unnecessarily increases the risk of a collision. This problem is all the more urgent when the aircraft is flying outside visual meteorological conditions. Furthermore, the fact that the radar screen only presents two high obstacles – of which one is located in the Schiphol control zone – although the number of actual obstacles is far greater in reality, should be further evaluated by LVNL.

4.7 BIRD CONTROL AT AND AROUND SCHIPHOL AIRPORT

This paragraph describes the results of the investigation regarding bird control measures to reduce the risk of bird strikes. The investigation regarding bird control has been described in Appendix F.

4.7.1 Bird strike risk

Bird strikes with aircraft are a fact of life. Most occur during the take-off and landing phases of the flight. The International Civil Aviation Organization (ICAO) does not prescribe in detail how the bird strike risk has to be controlled, neither with respect to the acceptable risk as regards the presence of birds in aircraft flight paths, nor as regards exactly which measures have to be taken. ICAO places the emphasis on a structured and cyclical approach to the bird strike issue and on the need for measures to be taken if a hazardous situation occurs *"to decrease the number of birds constituting a potential hazard to aircraft operations"*.

The risk of bird strikes is not quantified. However, the number of (near) bird strikes is recorded, observations are made and reports issued. The very dangerous zone is the area lower than 600 feet within a distance of five kilometres from the runways.⁶⁴ In connection with aircraft climb and descent angles and the altitude at which birds fly, the chance of a collision – and therefore the risk to flight safety – is greatest in this zone. Large mass birds and birds that fly in groups are a danger to aircraft due to the considerable total mass. This particularly applies to geese due to their considerable mass and because they fly in groups. In the event of a collision the potential consequences can vary between very serious to catastrophic.

64 According to a working group at the former Ministry of Transport, Public Works and Water Management in the 1980s and according to Schiphol airport.

The numbers of birds that can constitute a risk for bird strikes in the 10-kilometre area around Schiphol airport have been recorded. Illustration 8 shows that the number of waterfowl representing a risk to flight safety has almost doubled over a ten-year-plus period. This increase is almost entirely attributable to the rapidly rising number of geese in the area around Schiphol airport. See illustrations 9 and 10. Observations have also established that the number of migrating geese flying over Schiphol airport is on the rise. If efforts to control the bird population are not intensified, these numbers can be expected to rise further still.

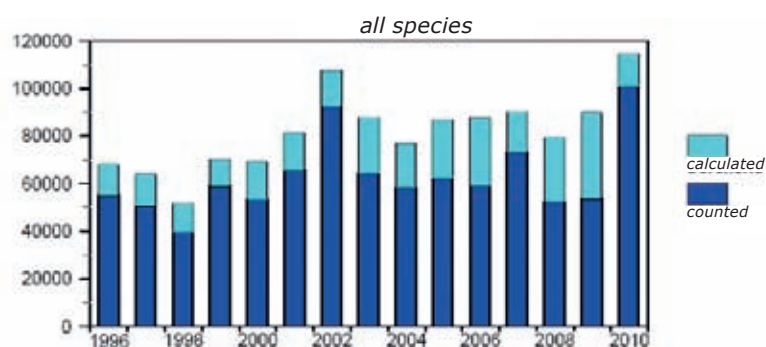
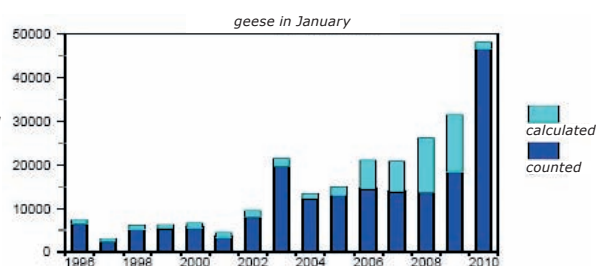
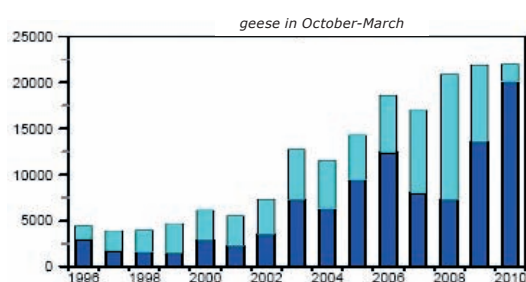


Illustration 8: numbers of water fowl (all species) representing a risk to flight safety within the 10-kilometre zone around Schiphol airport in the 1996-2010 period [source: SOVON]



Illustrations 9 and 10: numbers of geese in 10-kilometre zone at Schiphol airport in the period 1996-2010. [source: SOVON]

Since the 1990s also the number of aircraft movements at Schiphol airport has drastically increased. See table 2 below. In 2009 and 2010 there was a decrease compared to 2008 caused by the economic downturn.⁶⁵ According to Schiphol airport, a slight recovery is expected for 2011 with 5% growth in the number of aircraft movements compared to 2010. The expectation is that the number of aircraft movements will increase in the long term.

year	number of aircraft movements	year	number of aircraft movements	year	number of aircraft movements
1997	372,658	2002	417,111	2007	454,354
1998	397,162	2003	408,280	2008	446,689
1999	414,214	2004	418,612	2009	406,975
2000	432,459	2005	420,733	2010	402,000
2001	432,056	2006	440,155	2011	422,000

Table 2: number of aircraft movements at Schiphol airport [source: CBS]

65 Source: Statistics Netherlands (Centraal Bureau voor de Statistiek - CBS).

The number of aircraft movements in 2009 and 2010 is at the level of 1998-1999. The number of geese in 2010 was four to seven times greater than in 1998-1999. The increase in the number of geese combined with (the long-term increase in) the number of aircraft taking off and landing inevitably entails an increase in the chance of geese-related bird strikes and with that the risk of such bird strikes (the high-risk presence of birds in an aircraft's flight path).

The risk of bird strikes can be represented by means of the bird strike ration, the number of bird strikes per 10,000 air transport movements. Interviews have established however that the parties involved attribute fluctuations in this ratio to different factors: the success of risk management measures, or changes in the scale of the risk itself. While some parties demand a definition and registration which is as exact as possible, others prefer to focus on the joint process of taking measures. Despite differences of interpretation regarding the bird strike ratio, it can be concluded that:

- The bird strike ratio at Schiphol is higher than the norm of 4 per 10,000 which used to apply (table 1, paragraph 2.12.2).
- The absolute number of bird strikes including suspected strikes rose in the period 2005-2010 (illustration 5, paragraph 2.12.2).
- Although the share of geese involved in bird strikes as a whole is small, it is increasing (see table 10, Appendix F). The potential consequences of a bird strike involving geese are extremely serious to catastrophic, in view of the birds' high body weight and tendency to fly in large groups (flocks).

It is concluded that, given the figures above, the risk of a bird strike at Schiphol airport or in its direct vicinity has been increased because of the increasing number of geese. The result is that flight safety is compromised.

4.7.2 Bird control efforts at Schiphol airport

As regards the efforts Amsterdam Airport Schiphol has made within its own grounds, see paragraph 2.12.2. Geese fly over Schiphol airport at different altitudes and do not land there. This means the measures which Amsterdam Airport Schiphol can take against geese on the airport grounds are limited.

In 2008 investigation had been carried out by the province of Noord-Holland in cooperation with Amsterdam Airport Schiphol of the number of bird movements in a flat surface per unit of time. For this purpose an experimental radar in combination with an observer on the ground was used.

Schiphol airport's Bird Control unit conducted an investigation of the number of fauna-related incidents in relation to the time of day during the 2005-2010 period. According to Bird Control, the outcome did not yield consistent conclusions that could serve as a basis for flight planning adjustments (inbound and outbound peaks). In practice, however, the majority of bird strikes take place during the day, with a relative light peak during morning hours (dawn) that coincides with one of Schiphol airport's busiest daytime operational period.

In practice, if bird activity is intensive, flights are designated to different runways on an ad hoc basis. It should be pointed out that it is more difficult to visually observe bird activity during limited visibility conditions and in the dark. The closure or reassignment of runways is a regular occurrence, and is conducted in collaboration with LVNL and other parties. In 2008 and 2009, active runways were closed for a total of twenty minutes to one hour as a result of bird activity.

According to Amsterdam Airport Schiphol, twelve interruptions took place due to bird activity (of which seven with geese) in 2010. The most recent data shows a total of ten interruptions in 2011 of which eight with geese. The interruptions had a duration of one to five minutes, depending on the amount of time it took the birds to fly over the runway area.

As of 2003, Schiphol airport has served as chair of the Schiphol Safety Platform (VpS) and assumed responsibility for programme management. In 2009 VpS took the initiative and the investigations into geese migration patterns and into rendering the Haarlemmermeer free of grain were, in part, initiated. Amsterdam Airport Schiphol chairs the VpS and arranges the programme management. In 2009 the VpS warned the then Minister of Transport, Public Works and Water Management⁶⁶ and the then Minister of Agriculture, Nature and Food Quality⁶⁷ about the increasing risk to aviation safety as a consequence of the fast-growing geese population in the Netherlands and around Schiphol.⁶⁸ The VpS therefore proposed that, under the auspices of the then Ministry of Transport, Public Works and Water Management, a task force should be set up to investigate the geese problem relating to Schiphol airport and to advise on possible solutions. The following parties were supposed to participate in the task force: the (current) Ministry of Infrastructure and the Environment and the (current) Ministry of Economic Affairs, Agriculture and Innovation, the provincial governments involved (Noord-Holland, Zuid-Holland, Utrecht, and Flevoland) and members of the VpS. The VpS also asserted that the task force should have the necessary resources and a decisive independent chairperson in order for the problems outlined to be tackled successfully. This resulted in the establishment of the Dutch Bird Strike Control Group and the initiation of official preliminary control group consultations in 2010. For further information, see paragraph 4.7.3.

It can be concluded that Amsterdam Airport Schiphol has taken the risks of collisions between aircraft and birds, in particular with geese, quite seriously and has itself taken initiatives in this regard. Due to the limited scope of the control measures which Amsterdam Airport Schiphol can take, cooperation with other parties involved has been sought and found.

4.7.3 Bird control efforts around Schiphol airport

Amsterdam Airport Schiphol informed the Inspectorate of Transport, Public Works and Water Management about the problem and, at the end of 2008, a meeting of experts was held to discuss the geese problem. This meeting was chaired by the Inspectorate of Transport, Public Works and Water Management (Schiphol regional office). The most important insights generated by this meeting are:

- Research needs to be carried out into the migration patterns of geese so that knowledge can be gained as to which measures can be taken to combat the geese problem.
- An attempt has to be made to eliminate the most important source of food for geese, namely the cultivation of grain, from the Haarlemmermeer polder.
- The current activities and the two investigations referred to should be accompanied by measurements to assess the effectiveness of measures to reduce the geese population.

Amsterdam Airport Schiphol and the province of Noord-Holland also commissioned a number of studies to identify the flying pattern between the geese sleeping, brooding, moulting and feeding areas so that more specific measures can be taken. An investigation was also initiated to study the potential for 'eradicating all grain' from the Haarlemmermeer.

In 2008, Schiphol airport initiated a project in conjunction with the Province of Noord-Holland and the various Game Management Units and terrain management organisations united in the Schiphol Goose Roundtable in order to harmonise and improve the implementation of goose control measures in the 10-kilometre zone around Schiphol airport. The resulting measures include treating goose eggs with an agent that prevents them from hatching, and the culling of geese. This approach was continued in 2009, 2010 and 2011.

66 Now the Minister of Infrastructure and Environment.

67 Now the Minister of Economic Affairs, Agriculture and Innovation.

68 Schiphol Safety Platform, letter number VpS.U_090002 of 5 March 2009.

In 2009, the then Minister of Transport, Public Works and Water Management decided to establish a platform representing all government agencies, knowledge institutions and environmental organisations involved in the issue of bird strikes. This resulted in the establishment of the Dutch Bird Strike Control Group (NRV) in 2010. The NRV has been assigned to reduce the risk of bird strikes in the Netherlands. In order to address the goose problem, official control group preliminary consultations were initiated in collaboration with the NRV. Action points for the 2010-2011 consultations period include the following relevant projects:

- A trend and risk analysis of geese species in relation to flight safety.
- Measures to influence landscape design in the vicinity of Schiphol airport.
- The monitoring of overflying geese (origin and numbers).
- The chasing away and reduction of the population through the use of falconers and hunters.
- The testing of adapted arable land cultivation schemes.⁶⁹

The above projects link up with the focal areas formulated by the Dutch Bird Strike Control Group which facilitate an effective approach to mitigating the risk of bird strikes, namely:

- Population reduction.
- Restriction of foraging areas in the vicinity of the airport.
- Restriction of rest and brooding areas (water and nature) in the vicinity of the airport.
- Technical measures aimed at the radar detection of birds and bird movements.

Interviews have shown that the parties involved recognise both the bird strike risk as such and the need to reduce this risk. However, the parties involved cannot agree on the nature and scope of the bird strike risk, and specifically as regards geese. As a result, there continues to be a lack of clarity regarding the risk to be managed, the required control measures and their (cost) effectiveness. The primary cause of this lack of agreement is that parties reason along fundamentally different lines:

- Reduction in the size of geese populations will also reduce the risk.
- The risk in terms of place, time and type of goose must be known exactly before very specific and effective action can be taken to reduce the known risk.

There has been overall consensus on the above focal areas for a long time now, including at international level. However, there is no clear (proven) prioritisation sequence for the implementation of these focal areas. Implementation of the above measures will not rule out accidents, but can merely reduce risks by an unknown factor. In the long term, radar detection could prevent bird strikes, providing the number of birds and runway crossings are manageable (due to measures implemented as part of the other three focal areas). This means there is still uncertainty as to the optimal combination and sequencing of measures implemented as part of the focal areas. This uncertainty is partly attributable to the limited amount of reliable knowledge and insight with regard to bird behaviour and the reasons for differences between the behaviour of different goose species. Furthermore, there is insufficient knowledge and insight when it comes to the effects and side effects of measures (such as substitution effects, displacement effects, et cetera). As a result of this limited knowledge and insight, measures with far-reaching social and economic consequences (such as the adjustment of agricultural land use and the adjustment of agricultural and environmental policies in relation to the second and third focal areas) lack broad social support. The same applies to the large-scale reduction of goose populations (first focal area).

The bird strike issue reflects a dilemma in terms of risk management. Some parties are calling for further research in order to determine the exact nature of the risk with greater accuracy. Other parties are calling for action in the short term. The desire to identify 100% of all unknown factors before taking effective action can lead to new risks and/or limit the amount of available measures. The interviews also established that this situation has not changed in the wake of the serious incident (see F, annex 2).

69 Accelerated ploughing back of grain stubble or accelerated processing of grain stubble so that green manuring crops can be sown.

Despite the bird control measures implemented over the past few years (including disruption, nest treatment and culling), the number of geese has continued to grow. As a result, the risk of bird strikes at Schiphol airport and in the surrounding area has risen to a level where it represents a threat to aviation safety. Structural resolution of the bird strike problem is thus urgent. In addition to regularly closing or reassigning runways in the event of excessive bird activity, population management remains the only proven method of achieving short-term results.

In order to ensure aviation safety, the risk of bird strikes will have to be considerably reduced as soon as possible. At minimum, this will require reducing the dangerous presence of large birds and/or bird flocks (including geese) within the flight paths. In view of the fact that three of the four aforementioned focus areas will only yield results over a longer time period, population reduction remains the only effective potential measure in the short term.

Seven civil-society organisations united in "The Goose 7" (De Ganzen-7) recently prepared a joint national and regional strategy. The strategy outlines several measures to reduce and stabilise the population of various types of geese in the Netherlands to a certain level.⁷⁰ The strategy was recently presented to, among others, the State Secretary of Economic Affairs, Agriculture and Innovation in the form of a recommendation. Implementation of the recommendation in the short term in conjunction with the scheduled measures would help reduce the risk of bird strikes. However, the recommendation has not yet been implemented, as the State Secretary is yet to formulate a clear position. The fact that the volunteer hunters within the various Game Management Units refuse to implement the recommendation also plays a role in this regard.

In view of the urgent need for population reduction, the Safety Board feels it could be considered to employ the services of professional hunters. In the longer term, habitat management - including the reduction of foraging, resting and breeding grounds - in the area around Schiphol airport could also be an effective way of reducing the risk of bird strikes. In addition, improvement of the measures currently used to detect and scare off birds could help structurally reduce the risk of bird strikes.

As regards measures in the area of radar detection of birds, the Safety Board would like to point out the following. Although interviews have shown that radar is increasingly used around the world to detect birds, the operational implementation of radar technology as a preventative measure against bird strikes is still in its infancy. The bird strike suffered by the Royal Air Maroc Boeing 737 during take-off and above the airport terrain clearly illustrates the need to initiate a study on the operational implementation of radar detection at civil aviation airports. Schiphol airport's Bird Control unit employs fifteen birdwatchers working around the clock to respond to increased bird activity near runways. The deployment of these birdwatchers did not prevent the bird strike. This is mainly due to the limited scope for visual observation during reduced visibility conditions. The serious incident took place at sunset. Visibility was moderate, but within the limits of visual meteorological conditions. The Safety Board refers to an investigation into a bird strike involving one or more barnacle geese and a civil aircraft, shortly after take-off from Copenhagen Kastrup airport in Denmark in 2009 (see paragraph 2.19.3). The bird strike took place in darkness while the aircraft was flying under visual meteorological conditions.

70 *Nederland Ganzenland, Een gezamenlijke landelijke en regionale visie.* [Translated *The Netherlands land for the Goose, A joint national and regional vision*] The Goose-7: The 12 Landschappen, Dutch Federation for Private Landownership, Federation of Agriculture and Horticulture Noord, Society for the Preservation of Nature, Stichting Agrarisch en Particulier Natuur- en Landschapsbeheer Nederland, State Forest Service, The Netherlands Society for the Protection of Birds. Final version, 23 May 2011. The recommendation formulates the following objectives:

- Reducing the greylag goose population to a total of approximately 100,000 within five years.
- Stabilising the summer barnacle goose population at 2011 levels.
- Eliminating introduced species* and domestic geese within the shortest possible transition period to the extent these birds are currently causing damage or will do so in future.

(*) Including: swan goose, emperor goose, bar-headed goose, Canada goose and Hutchins' Canada goose, barnacle goose, Egyptian goose.

The (Danish) investigation showed that migrating birds flying above a certain altitude cannot be seen from the ground at night or under reduced visibility conditions.⁷¹

The Safety Board is of the opinion, therefore, that further studies should be conducted to assess the operational implementation and applications of radar detection at civil aviation airports. This should also include efforts to identify the responsibilities of the parties involved in radar bird detection, and the extent to which these parties are authorised and at liberty to intervene in flight operations in order to reduce the risk of bird strikes.

The Safety Board concludes that effective management of bird strike risks will require a rapid response to early warnings of potential danger. This will require: the willingness and ability to work with incomprehensive (uncertain) data and apply mitigation measures on a trial and error basis. Many of the parties involved currently regard population reduction as a necessity. The Safety Board supports the use of this bird control measure: the reduction of goose population numbers will reduce risk levels, and represents the most effective measure in the short term. Due to the high level of urgency involved, there is no time to wait for the outcome of ongoing pilots to assess other control measures that would yield results in the longer term. However, the development of more structural measures, such as limiting the number of foraging areas, developing technical measures to enable radar detection of birds and bird movements and the scaring off of birds should be continued.

The Safety Board also concludes that the parties involved did not implement additional or more effective bird control measures in the period leading up to the serious incident with the Royal Air Maroc Boeing 737 on 6 June 2010. Nor have any structural measures been taken since the incident, and there is still no clear division of responsibilities or centralised direction.

The bird strike issue falls within the scope of multiple policy areas covered by two different ministries, which could explain the government's failure to take urgent action: the interests of both the Ministry of Infrastructure and the Environment (aviation safety) and the Ministry of Economic Affairs, Agriculture and Innovation (economics, agriculture and the environment) are at stake. These interests do not overlap sufficiently when it comes to reducing the risk of bird strikes. Furthermore, the coordination of efforts to mitigate the risk of bird strikes extends beyond Schiphol airport and the Province of Noord-Holland, and will also require the involvement of the provinces of Zuid-Holland, Utrecht and Flevoland.

In view of the fact that the risk of bird strikes represents a threat to aviation safety, the Dutch Safety Board believes the Minister of Infrastructure and the Environment should take responsibility for addressing the problem, as it did when volcanic ash clouds from Iceland threatened aviation safety in 2010. In the view of the Dutch Safety Board, the Minister of Infrastructure and the Environment is the designated "problem owner" when it comes to aviation safety, and thus the risk of bird strikes. In other words, the Ministry is ultimately responsible for prompting the various parties to take action.

4.8 MEASURES TAKEN AFTER THE SERIOUS INCIDENT

Royal Air Maroc announced to take the following measures after the serious incident:

- to adapt their recurrent simulator training to include multiple failures;
- to inform their pilots with a circular about the findings with regard to the bird strike at Schiphol airport on 6 June 2010.

For the bird control measures taken by Amsterdam Airport Schiphol after the serious incident, see paragraph 4.7.

71 In response to the study, the Danish Air Accident Investigation Board issued the following recommendation to the European Aviation Safety Agency: [translated and summarised] "*We recommend that the competent authorities assess the potential for technical measures to identify migrating birds and send out warnings during darkness and reduced visibility conditions, including the option of configuring and applying radars for this purpose.*"

The Ministry of Infrastructure and the Environment has included the ambition to reduce the risk of bird strikes in its Aviation Policy Agenda for 2011-2015. The ambition is formulated as follows (summarised): *"reducing the number of bird strikes, with a focus on large (high-risk) species"*. The ministry has formulated the following indicators to this end: *"25% less resting areas in the airport's surrounding area; 50% less foraging areas in the airport's surrounding area; a 50% population reduction; and a total of 50 air traffic interruptions on the basis of radar warnings"*.

In 2011, the entire Province of Noord-Holland was granted an exemption for greylag goose population control.⁷² This exemption was intended to provide a legal basis for population reduction.

Before the summer the Ministry of Economic Affairs, Agriculture and Innovation published an amendment to the Animal Control and Damage Reduction Decree that widens the scope for the use of biocides. The Lower House carried a motion requesting the minister to postpone the implementation of the decree until after this subject has been debated in Parliament. However, the use of biocides will also have to be permitted within the regulatory frameworks for biocides, the primary responsibility for which rests with the Ministry of Infrastructure and the Environment. To that end, carbon dioxide will have to be included in the appendices to the European Biocidal Products Directive. This is a European legislative process.

72 Schiphol airport has a separate exemption for this purpose.

5 CONCLUSIONS

Causal factors

1. Shortly after take-off a bird strike occurred which caused damage to the left engine and reduced thrust to approximately 45%. The flight crew then took the right decision to return to Schiphol airport.
2. However, this decision was not executed in accordance with standard operational procedures. The deviations from the standard operational procedures after an engine failure were:
 - The initiation of a (right) turn at 280 feet with a bank angle of up to 37.5 degrees instead of climbing to the prescribed 'clean up' altitude with retracted landing gear.
 - Selecting gear down at very low altitude after it had first been selected up.
 - Reducing the thrust on the undamaged right engine from 94% N1 to 83% N1 instead of selecting maximum thrust.

These deviations from the standard operational procedures resulted in the aircraft only being able to achieve a limited rate of climb, causing it to be unable to achieve the required minimum safe flying altitude. The flight crew had difficulty controlling the aircraft and were distracted by various audio and visual warnings in the cockpit which were the consequence of incorrectly completed cockpit procedures.

Contributing factors

3. During the flight the crew resource management and crew communication were not in accordance with the international standard for airline pilots.
 - The immediately initiated right turn and the marginal remaining flying performance made the tasks more difficult and led to complications which meant that both pilots were unable to fulfil their tasks, such as the completion of cockpit procedures and checklist readings, in the prescribed manner. This in turn led to new complications such as unnecessary warnings and an unstable flight path.
4. During the refresher training for Atlas Blue and Royal Air Maroc pilots, they were not trained to deal with multiple malfunctions during the flight.
 - Prior to every recurrent training pilots of Atlas Blue and Royal Air Maroc were taught about the specific malfunctions that would occur. This is not unusual in the context of flight training practice, but the consequence was that the pilots did not learn how to respond to unexpected effects.
 - Dealing with multiple malfunctions featured only in the initial training for captains.
 - Although the Flight Crew Training Manual and the Flight Crew Operations Manual contain the procedures and checklists required for the adequate tackling of malfunctions which occurred during this flight, the flight crew and the training managers of Atlas Blue and Royal Air Maroc regarded this serious incident as a unique event which pilots cannot be trained in.
5. The analysis of measures implemented in response to the 3PR investigation (initiated in response to the recommendation by the Bijlmermeer Air Disaster Parliamentary Board of Inquiry) failed to take account of the risks caused by aircraft in distress situations flying below the minimum vectoring altitude. These aircraft are given headings in the Schiphol control zone, despite the fact that air traffic controllers do not have information on high obstacles in the flight path. This unnecessarily increases the risk of a collision. This problem is all the more urgent when aircraft are flying outside visual meteorological conditions.

- The investigation conducted by Air Traffic Control the Netherlands in response to the recommendation by the Bijlmermeer Air Disaster Parliamentary Board of Inquiry has resulted in a policy framework on the supervision of aircraft in distress situations and on flying over densely populated areas. According to this policy framework for aircraft in distress situations, the captain is responsible for flight operation while the air traffic controller provides assistance to the cockpit crew. Aircraft in distress must use existing runway arrival and departure routes where possible, which limits the amount of flying over densely populated areas. The Directorate-General of Aviation and Maritime Affairs has approved the aforementioned policy framework. As a result of this policy framework, densely populated areas are not presented on air traffic controllers' radar screens.
 - Schiphol airport is practically surrounded by a great number of populated/built-up areas. The consequence is flying lower than the minimum vectoring altitude. This is particularly the case when flying outside visual meteorological conditions.
 - The maximum height above the ground of the aircraft during the flight was 730 feet and this was well under the minimum vectoring altitude for Schiphol of 1200 feet.
 - Only two obstacles are displayed on the radar screen, of which one is in the Schiphol control zone. In the Schiphol control zone there are a number of other obstacles which might pose a risk to aircraft flying lower than the minimum vectoring altitude. This is particularly the case when flying outside visual meteorological conditions.
6. The presence of one or more birds with a large total mass in the flight path of an aircraft is a risk to flight safety. This particularly applies to geese due to their considerable mass and because they fly in groups. Most bird strikes occur during the take-off and landing phases of the flight.
 7. The investigation has shown that parties that have a direct influence on bird control at Schiphol airport have exhausted their options. Except for the closing of active runways more often, it is up to other parties, therefore, to take further measures to reduce the safety risk caused by bird strikes.
 8. All the aviation, agricultural, and bird and environmental protection parties acknowledge the bird strike risk as such and the need to reduce this risk. Although the parties agree on the necessary measures, there is no such consensus with regard to their effect. As a result, there are also differing views as to the (cost-)effective implementation of these measures.
 9. Due to the high level of urgency involved, there is no time to wait for the outcome of ongoing pilots to assess alternative control measures that would yield results in the longer term. The reduction of goose populations represents the most effective short-term measure. In the longer term, habitat management and improvement of the measures to detect and scare off birds could also help structurally reduce the risk of bird strikes.
 10. Seven civil-society organisations united in the "Goose 7" recently prepared a joint national and regional recommendation, outlining measures to reduce and stabilise the population of various types of geese in the Netherlands at a certain level. The implementation of this recommendation as a short-term measure will require the approval of the State Secretary of Economic Affairs, Agriculture and Innovation, which approval thus far has not been forthcoming.
 11. The Ministry of Infrastructure and the Environment, responsible for aviation safety, has not sufficiently coordinated measures aimed at reducing the risk of bird strikes.

6 RECOMMENDATIONS

Royal Air Maroc

The Safety Board recommends that Royal Air Maroc demonstrate to the Moroccan Ministry of Transport that:

1. the procedures for communication and crew resource management between crew members have been harmonised with the international standard for airline pilots.
2. pilot training has been expanded to include simulations of multiple unexpected failures.

Air Traffic Control the Netherlands and the minister of Infrastructure and the Environment

The Safety Board recommends that Air Traffic Control the Netherlands and the minister of Infrastructure and the Environment:

3. ensure that aircraft in distress flying under the minimum vectoring altitude are informed about high obstacles in the Schiphol control zone.

Minister of Infrastructure and the Environment

The Safety Board recommends that the minister of Infrastructure and the Environment, responsible for aviation safety:

4. take proactive measures to ensure the minimisation of bird strike risks.
5. with the greatest possible urgency and vigour implement effective measures to reduce and stabilise the population of various goose types in the Netherlands at a certain level in accordance with the "Goose 7" recommendation in order to reduce the risk of bird strikes.
6. ensure that the interests of aviation safety are safeguarded within the various relevant policy domains, by preparing enforceable emergency measures that allow for intervention if the risk of bird strikes becomes too great.
7. conduct studies to assess the potential of technical measures to reduce the risk of bird strikes.

Parties to be issued a recommendation by the Dutch Safety Board should notify the Board of all implemented and proposed measures within 90 days of receiving the recommendation, and – if necessary – of the time required to implement these measures or, in the event that no measures are implemented, of the reason for this decision. If the recommendation is not addressed to the minister of Infrastructure and the Environment, the minister must be sent a copy of the involved party's response to the recommendation.

After the response term has elapsed the Dutch Safety Board will publish the responses received on the report on its website: www.onderzoeksraad.nl.

If no response is provided, this will be reported on the aforementioned website.

APPENDIX A: INVESTIGATION EXPLANATION

Notification of and investigation by the Dutch Safety Board

On 6 June 2010, the Dutch Safety Board was notified that a bird strike had occurred involving an aircraft of the type Boeing 737-4B6 owned by Royal Air Maroc during take-off from Runway 18L at Schiphol airport. The Safety Board immediately started the investigation. A serious incident with civil aircraft qualifies as an obligatory investigation.⁷³

In accordance with Annex 13, "Aircraft Accident and Incident Investigation", Chapter 4 "Notification", contact was established with the states involved: Morocco (the state in which the aircraft was registered, and the state in which the airline company is located), the United States of America (the state of the aircraft and engine manufacturer and the design) and France (the state of the engine manufacturer). The parties and organisations involved from these states then contacted the Dutch Safety Board. These included among others the National Transportation Safety Board (NTSB) and Royal Air Maroc. The American engine manufacturer General Electric Aviation represented the French engine manufacturer CFM.

The following investigations and activities were carried out in 2010:

- 6-7 June 2010: initial fact finding, Schiphol airport.
- 22 June 2010: damage fact finding, Schiphol airport.
- 23 July 2010: inspection of the Boeing 737-4B6, CN-RMF, at Schiphol airport.
- 10 June 2010: readout of the flight data recorder and the cockpit voice recorder at the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) in Paris, France.
- 10-11 November 2010: visit to Royal Air Maroc, Operations Department in Casablanca, Morocco.
- 25 November 2010: attendance of inspection of left engine, Royal Air Maroc, Casablanca Airport, Morocco.
- March-April 2011: interviews with parties involved regarding bird control at and around Schiphol airport.
- 22 July 2011: draft final report sent to parties involved for their substantiate comments.

Scope

The investigation by the Dutch Safety Board focused on establishing the causes or presumed causes, the underlying factors which led to, and the possible structural safety failures which lay at the bottom of, the serious incident. The Safety Board decided not just to investigate the serious incident itself but also the extent to which it is effectively possible, from the safety point of view, to avoid flying low over built-up areas in emergency situations. Another aspect investigated was how the control of bird population at and around Schiphol airport is organised by the parties involved. The specific research questions are dealt with in paragraph 1.2.2.

Interviews

Within the framework of the investigation, interviews were conducted with, among others, the pilots involved, managers and pilots of Royal Air Maroc, personnel of Air Traffic Control the Netherlands and the parties involved in bird control at and around Schiphol.

73 The investigation was carried out in accordance with the relevant regulations pursuant to the Safety Investigation Board Act (Rijkswet Onderzoeksraad voor Veiligheid), with due regard for the European regulation and ICAO directives relating to the investigation of civil aviation accidents and serious incidents.

Project team

J.W. Selles Investigation Manager

Core team

K.E. Beumkes Project Manager/Investigator in Charge

G.J.M. Oomen Senior Investigator

M.L.M.M. Peters Senior Investigator (until April 2011)

Dr. N. Smit Investigation Advisor

Support

P. Blommers Project Assistant

W.F. Furster Investigator

M.J. Schuurman Investigator

The following people were added to the project team under the auspices and responsibility of the Dutch Safety Board:

B. Bonke Dutch Airline Pilots Association, Accident Investigation Group

R.J. van den Brand Investigator, KplusV organisatie-advies

R.J.M. van Diemen The Netherlands guild of air traffic controllers

Dr. H.P. Potman Investigator, KplusV organisatie-advies

External legal support:

L. Boerema Advisor environmental law, Eelerwoude BV

A.W. Noppe Noppe Management Consultancy

External support for bird research:

Dr. M. Liefthing SOVON Bird research the Netherlands (SOVON Vogelonderzoek Nederland)

The Bird Control department of Amsterdam Airport Schiphol submitted the bird remains to the following expert for identification purposes:

C.S. Roselaar Ornithology expert at the Zoological Museum of the University of Amsterdam

Due to international involvement support was given by the following accredited representative:

R. Benzon Senior Air Safety Investigator, National Transportation Safety Board, United States of America

APPENDIX B: COMMENTS PARTIES INVOLVED

A draft final report was submitted to the parties or individuals involved for perusal, in accordance with the Dutch Safety Board Act. These parties or individuals were then requested to check the report for any errors and ambiguities. The draft version of this report was submitted to the following parties or individuals:

- Amsterdam Airport Schiphol
- Air traffic controllers involved
- Air Traffic Control the Netherlands (LVNL)
- Boeing
- Fauna Fund
- Flight crew flight RAM685R
- General Electric Aviation
- Haarlemmermeer Game Management Unit
- Minister of Economic Affairs, Agriculture and Innovation
- Minister of Infrastructure and Environment
- Ministry of Transport (Morocco)
- Municipality of Haarlemmermeer
- National Transportation Safety Board, United States of America
- Noord-Holland Fauna Management Unit
- Provincial government of Noord-Holland
- Royal Air Maroc

All parties and individuals approached in this manner responded to the draft version. The responses were handled as follows:

- Where relevant, the Safety Board incorporated the additional information and corrections in detail as well as the editorial comments. The passages concerned have been adjusted in the final report. These responses have not been individually included.
- In cases where the Safety Board has decided not to include a response, the decision is explained in the below table. The table indicates the relevant chapter for each response, the party or individual responsible for submitting the response, the verbatim contents of the response and the Safety Board's rationale for not including the response in the report.

Hoofdstuk	Partij / reactie / verwerking
Appendix A	<p><i>Air Accident Investigation Bureau of Morocco</i></p> <p>(...) the contact was established with the states involved: Morocco (the state in which the aircraft was registered, and the state in which the airline company is located) but the Moroccan Air Investigation Bureau was not notified by the Dutch Safety Board when this event happened in order to designate the accredited representative to attend the part of the investigation.</p> <p><i>Safety Board:</i></p> <p>After the occurrence the Dutch Safety Board notified the Direction Générale de l'Aviation Civile in Morocco. The link on the ICAO website (http://legacy.icao.int/icao/en/m_links.html) shows the Ministry of Transport and the National Airport Office of Morocco. There was no information available of the Moroccan Air Investigation Bureau.</p>

Hoofdstuk	Partij / reactie / verwerking
2.18.1	<p><i>Captain:</i> No access to all training manuals as part of them were not given to us or given to us after training was completed months after.</p> <p><i>Safety Board:</i> According to Royal Air Maroc, the crew was based in Nador and Atlas Blue was headquartered in Marrakesh. It could be possible they were not in possession of a hardcopy on time but the electronic English version was always available and crews could always ask for the hardcopy.</p>
2.18.1	<p><i>Captain and first officer:</i> Training for expat pilots (non Moroccan pilots hired via broker agency) was poor. Simulator recurrent checks and ground school training were rostered many times one day in advance with no previous notification. Usually very impolite as some times it was given to us in French language like CRM (We do not speak French). No threat and error management training, no CRM management model training and no management model culture in the airline policy.</p> <p><i>Safety Board:</i> Royal Air Maroc has stated that the Atlas Blue CRM ground courses were given by four company accredited CRM type rating examiners. Two examiners gave the course in English for English speaking crews and the other two in French with the official company's CRM course from the training department that are in French language. On some occasions, English speaking crews could find themselves in a CRM French course. Crews were expected to indicate that they would like to be re-scheduled to the English course. The instructors indicated that, before the course started, they asked if anybody felt uncomfortable taking the course in the French language. Royal Air Maroc indicated that they had no recorded information of any complaints regarding this issue.</p>
4	<p><i>Captain:</i> The use of existing flaps during all phases of flight was decided due to uncontrollability of the aircraft and I did not want to make the situation worse with possible asymmetry putting the aircraft in a more complex situation.</p> <p><i>Safety Board:</i> The flap system is equipped with an asymmetry protection to prevent a split flap situation. During the flight there was no discussion regarding the flap position.</p>

Hoofdstuk	Partij / reactie / verwerking
General	<p><i>Air Traffic Control the Netherlands:</i></p> <p>[translated] Pages 33 and 50 [of the draft final report] conclude that the decision to return to Schiphol airport was not in accordance with standard procedures. With the benefit of hindsight we can conclude that this increased risk levels in terms of the aircraft's performance and obstacles on the ground, but it also follows from the report that the situation as it was perceived by the pilots at the time of the decision may well have been different. Page 31 states that the pilots initially believed both engines had been damaged by the bird strike. This conclusion, in combination with the vibrations, stench and unsafe nose gear indication lead the pilots to doubt whether the aircraft would remain airborne. Based on these assumptions, it is understandable that the pilots decided to return to the airport as quickly as possible.</p> <p>LVNL feels the pilots' deliberations and underlying considerations should have been highlighted in the analysis. Various sections of the report provide suggestions as to the pilots' rationale for certain actions. An explanation by the pilots themselves might have been more enlightening. For example, the pilots could have answered the following questions:</p> <ul style="list-style-type: none"> • Why was a steep turn initiated immediately and at low altitude? • Why was the landing gear extended and were no further efforts made to adjust the configuration? • Why did the pilots barely respond to the system warnings and instructions issued by air traffic control? • Why was the N-1 procedure not initiated? • How did the pilots deal with nearby obstacles when flying at low altitude? <p><i>Safety Board:</i></p> <p>The above questions were among those put to the pilots over the course of the investigation. The pilots' statements were incorporated into the report. The decision to make a steep turn at low altitude after the bird strike and extend the landing gear was taken without prior consultation between the crew members. By way of explanation, 4.2.5, Crew resource management, was supplemented with the below paragraph.</p> <p>In principle, the crew are allowed to deviate from procedures and take any actions they deem necessary. However, they may only do so after having gained sufficient insight into the situation at hand.</p> <p>Effective CRM is thus based on a structured approach to problems and contributes to effective management of situations even if they are not covered by standard procedures. The crew's impulsive response to the problems and the lack of coordination between the captain and first officer suggest the absence of any such structured response. It should also be pointed out that flight manuals outline standard procedures for most of the problems encountered by the crew.</p>

Hoofdstuk	Partij / reactie / verwerking
General	<p><i>Air Traffic Control the Netherlands:</i> [translated] The Safety Board has generally represented the outcomes of the 3PR investigation accurately. However, based on further inspection of the analysis and conclusions regarding obstacles, it is conceivable that the Board considers including a recommendation on the role of Air Traffic Control in avoiding obstacles during emergencies. As the 3PR investigation establishes, such measures will be difficult to implement in practice. The following factor is also significant in this regard. Paragraph 2.3 establishes that the pilots did not respond to four different flight heading instructions from approach control, or failed to carry out the instructions according to procedure. This is typical of the high workloads pilots are faced with and the limited manoeuvrability of aircraft during emergency situations, as confirmed in paragraph 4.6.2. Crew Resource Management is based on the principle that air traffic controllers and pilots cooperate on the basis of the same plan. The party with the most detailed information on the situation and the clearest overview of the aircraft's possibilities and limitations should take the lead. This is the basis for the ASSIST principle applied by LVNL. The fact that pilots are incapable of following some of the instructions issued by Air Traffic Control is not unique to this emergency and directly confirms Air Traffic Control's limited capabilities when it comes to avoiding obstacles or built-up areas.</p> <p>Various passages in the report claim that the emergency procedures applied by LVNL do not take into account flights below the minimum vectoring altitude. The ICAO issues guidelines on the development of procedures for air traffic control support to aircraft in distress. ICAO document 4444 (section 15.1, "Emergency procedures") states that it is not possible to prepare detailed guidelines ensuring the adequate handling of every possible type of emergency situation, and that efforts should be based on the operational staff's best judgement.</p> <p>"15.1.1.1 The various circumstances surrounding each emergency situation preclude the establishment of exact detailed procedures to be followed. The procedures outlined herein are intended as a general guide to air traffic services personnel. Air traffic control units shall maintain full and complete coordination, and personnel shall use their best judgement in handling emergency situations."</p> <p>As the report concludes, the LVNL controllers handled this emergency according to their best judgement, in accordance with the above principle. This type of emergency situation is an extremely rare occurrence. In view of the fact that the likelihood of such an event occurring again in future is small, there would appear to be little added value in preparing specific emergency procedures for flight handling below the minimum radar vectoring altitude. As the emergency itself demonstrates, the added value of such procedures would be limited, if we take into account that Air Traffic Control has few means at its disposal with which it could influence the course of events.</p> <p><i>Safety Board:</i> LVNL refers to the ICAO guidelines. These guidelines state that it is not possible to prepare procedures ensuring the adequate handling of every possible type of emergency situation, and that efforts should be based on the air traffic controller's best judgement. Although the Safety Board basically agrees with the ICAO's conclusion that it is not possible to design procedures for every possible type of emergency, it points out that this does not mean that no measures need to be taken.</p>

Hoofdstuk	Partij / reactie / verwerking
	<p>Furthermore, the Safety Board does not concur with LVNL's definition of 'the air traffic controller's best judgement'. The investigation has established that air traffic controllers do not know the exact location and height of high obstacles in the air traffic control zone around Schiphol airport, or cannot know this information because it is not presented on their radar screens. However, they do provide headings to aircraft in distress, regardless of visibility conditions. As a result, aircraft that are not flying under visual meteorological conditions could theoretically collide with a high obstacle. In other words, the air traffic controllers' 'best judgement' could result in a collision. Although the likelihood of such an event is small, the potential consequences are huge, rendering the risk level unacceptable. The fact that crew members do not always follow the instructions and advice provided by Air Traffic Control during an emergency does not diminish this conclusion.</p>
4.7.3	<p><i>Ministry of Economic Affairs, Agriculture and Innovation</i> [translated] This is a simplification of the actual situation. Even if hunters agreed to the 'goose covenant', the culling of 100,000 geese could not be realised 'in the short term'. The number of birds is simply too great.</p> <p><i>Safety Board:</i> In view of the urgency of the problem, the Safety Board believes the goose population must be reduced in the shortest possible term. The Minister of Infrastructure and the Environment (charged with aviation safety) should determine the most effective method of achieving this goal.</p>
Appendix F	<p><i>Ministry of Economic Affairs, Agriculture and Innovation</i> [translated] The way in which this paragraph is formulated implies that the rising number of geese is solely attributable to the policy of providing shelter to geese during winter.</p> <p><i>Safety Board:</i> The paragraph below states that the geese are also attracted by nearby farmland, rather than the designated foraging areas alone.</p>
1	<p><i>Ministry of Infrastructure and the Environment:</i> [translated] The term 'passed' suggests that the aircraft flew past obstacles, rather than over them. It would be more accurate to replace the term 'passed' by 'flew over', in accordance with the formulation on page 38.</p> <p><i>Safety Board:</i> The aircraft actually did pass obstacles at an altitude that was almost equal to or lower than the height of the obstacles.</p>
4	<p><i>Ministry of Infrastructure and the Environment:</i> [translated] Use of the terms 'inadequately' and 'acted impulsively' constitutes a value judgement and requires further substantiation.</p> <p><i>Safety Board:</i> These statements are supported by both the previous paragraphs and the factual data. By way of further explanation, an additional paragraph has been added to the chapter on crew resource management.</p>

Hoofdstuk	Partij / reactie / verwerking
4	<p><i>Ministry of Infrastructure and the Environment:</i> [translated] This paragraph also contains qualitative conclusions and value judgements that require further substantiation. Line 21 “required standard”, lines 22/23 “incorrect assumption” and “impulsive”.</p> <p><i>Safety Board:</i> These statements are supported by the previous text and the flight crew operating manual (FCOM).</p>
4	<p><i>Ministry of Infrastructure and the Environment:</i> [translated] “no centralised direction”: A clear understanding of this conclusion will require further analysis of the necessary changes (inadequacies) in terms of the NRV’s composition and working methods.</p> <p><i>Safety Board:</i> The Safety Board investigation is limited to the actions of the parties involved and stakeholders’ organisations prior to the serious incident and the measures implemented in response to the serious incident. The report does not assess the composition or working methods of the NRV.</p>
5	<p><i>Ministry of Infrastructure and the Environment:</i> [translated] In our view, this conclusion is incorrect. The four-track approach (population reduction, reduction of the number of foraging areas in the airport’s surrounding area, reduction of the number of resting and breeding areas in the airport’s surrounding area and technical measures aimed at enabling radar detection of birds and bird movements) is supported by all parties. Furthermore, action plans developed after the bird strike were based on the four-track approach.</p> <p><i>Safety Board:</i> Although the four-track approach is supported by all NRV members, the interviews established that some members have called for further studies in order to establish the exact risk of bird strikes. Other parties are calling for action in the short term. As a result, no effective measures to reduce the risk of bird strikes had been taken until the serious incident or afterwards, at the time of the interviews in March-May 2011.</p>

Hoofdstuk	Partij / reactie / verwerking
4.7.3	<p><i>Province of Noord-Holland:</i> [translated] Population reduction is highly relevant, but is inextricably linked to results in the area of foraging facilities and breeding and rest areas. Culling is little more than a waste of time if no efforts are made to reduce the amount of grain cultivated in the surrounding area, which will continue to attract new birds. Population control has been the only area of focus over the past few years. As a result, this option has been pushed to its limits. It is true that the other focus areas defined by the NRV will also have an effect in the long term. However, this was already the case in 2007 at the time of the Alterra report entitled "Minimising the risk of bird strikes between geese and aircraft in the area around Schiphol airport". Despite the conclusions drawn in this report, efforts to change the cultivation pattern and limit the number of breeding and resting areas have been minimal. We are working on the assumption that both aspects fall within the scope of 'habitat management', as referred to in the draft report.</p> <p><i>Safety Board:</i> In principal, the Safety Board agrees with the Province and has partially adjusted the wording of the report. In view of the urgency of the risk of bird strikes, however, the Safety Board still believes population reduction is the only feasible short-term measure. This should not be taken to mean that no attention should be devoted to habitat management, including the reduction of foraging, resting and breeding areas in Schiphol airport's surrounding area. In view of the experimental status of these habitat management measures, they cannot be realised at shorter notice than population reduction. This also applies to measures such as radar detection and the assessment of methods to scare off birds.</p>
4.7.3	<p><i>Province of Noord-Holland:</i> [translated] The report places a great deal of emphasis on the G7 agreement. As a result, the focus of the report has already been surpassed by current developments, since the government has presented ideas on the approach to goose population management that do not coincide with the G7 agreement. Although we feel it is appropriate that the report refers to the existence of this agreement, the amount of attention devoted to it is undue. The outcome of the debate is unclear at the time of writing. The further decentralisation of the Fauna Fund and fauna policy is also affecting the course of events. Even if agreement is reached on implementation of the agreement, this will not constitute actual implementation. The covenant can only be implemented if the necessary exemptions have been issued. This will require adjusting the fauna management plan and applying for new exemptions. Even if the hunters decide to join, it will be some time before the covenant can be implemented in practice. However, the target figures specified in the recent exemption for the entire province of Noord-Holland can be achieved in the short term. This exemption will allow for a reduction of the greylag goose population (which remain in the area during summer) to a total of 11,000 (now +/- 42,000)</p> <p><i>Safety Board:</i> See the above comment and the comments on implementation. The Province itself has indicated that there is no legal restriction against providing organisations with exemptions that are not based on the fauna management plan, and that a well-substantiated application will suffice. This is described in further detail in paragraph 4.2 of annex F. The interests and urgency of aviation safety should serve as sufficient substantiation. The recent exemption for the entire province of Noord-Holland is described in paragraph 4.8 of the report.</p>

Hoofdstuk	Partij / reactie / verwerking
4.7.3	<p><i>Province of Noord-Holland:</i> [translated] The deployment of professional hunters is up for consideration. The Province recognises that this would offer advantages. Especially in terms of efforts to catch geese. As regards normal control measures under the current situation, we would like to take this opportunity to highlight some of our doubts which we feel should be featured in the report. The Flora and Fauna Act is based on the voluntary deployment of hunters. This dependency on volunteers is primarily rooted in the act itself. However, the act does allow for the deployment of professional hunters. As regards Schiphol airport, the deployment of professional hunters should be linked to locations or species that require intensive culling. Professional hunters are already being deployed within the Schiphol grounds. The deployment of professional hunters does not necessarily guarantee a higher culling rate. Geese are highly adaptive and intelligent animals. The culling of large numbers within a single day has proven difficult in practice. Hunters have a mutual sense of solidarity. This was demonstrated last year in the Province of Noord-Holland, when hunters (with the exception of the 10-kilometre zone around Schiphol airport) decided no longer to assist in the implementation of fauna management. A decision to outsource wildlife management in the area around Schiphol airport to professional hunters will most likely cause unrest amongst hunters in the entire province, and could reduce their overall willingness to contribute to wildlife management efforts. This would have a negative impact on wildlife management in the area around Schiphol airport. As we have argued in our letter, there is sufficient scope for further professionalisation of the current volunteer hunters.</p> <p><i>Safety Board:</i> The Safety Board does not disagree with the province's doubts as to implementation and its consequences, but feels these comments should not be featured in the report. The Minister of Infrastructure and the Environment - responsible for ensuring aviation safety - must oversee implementation with the greatest possible amount of care, in collaboration with the parties involved.</p>
Appendix F	<p><i>Province of Noord-Holland:</i> [translated] This conclusion appears to be based on the assumption that little to no action was taken with regard to goose population management in the area around Schiphol airport over the past few years. As we have indicated above, the description of actual measures is incorrect and incomplete in several areas. If these inaccuracies and omissions are taken into account, a different overall picture emerges with regard to the measures implemented over the past few years.</p> <p><i>Safety Board:</i> The report has been adjusted in response to these comments. However, the Safety Board stands by its conclusion that the parties involved have taken insufficient measures over the past few years to control the rampant growth of the goose population (a development identified as early as 2007). This is partly due to the lack of active centralised direction from the minister responsible for aviation safety.</p>

Hoofdstuk	Partij / reactie / verwerking
Appendix F	<p><i>Province of Noord-Holland:</i> [translated] In addition to greylag geese and Egyptian geese, the problem of bird strikes also extends to barnacle geese and Canada geese (the species responsible for this particular incident).</p> <p><i>Safety Board:</i> This sentence is a quote from the analysis conducted by the Schiphol Safety Platform prior to the serious incident with the Royal Air Maroc Boeing 737.</p>
General	<p><i>Province of Noord-Holland:</i> The report does not mention that the collision with the Royal Air Maroc involved Canada geese. A nationwide exemption has been issued for this species, allowing for a wide range of control measures. The species may thus be culled throughout the country without any legislative restrictions. This means delays in terms of determining the scope of the fauna management plan or insufficiently substantiated applications do not play a role in this regard. This report does not focus on the culling or population development of this species.</p> <p><i>Safety Board:</i> The collision between the Royal Air Maroc Boeing 737 and the Canada geese formed the impetus for the Safety Board's investigation to assess the bird strike risk and corresponding control measures applied by the parties involved. This is not diminished by the fact that the collision involved Canada geese, a species with a relatively small population within the Netherlands that is nationally exempted in terms of control measures. Geese represent a serious potential threat to aviation safety due to their relatively large body mass and habit of flying in flocks. The investigation established that the total number of geese in the area around Schiphol airport has grown exponentially over the past few years, increasing the risk of bird strikes. As a result, aviation safety has been compromised. The investigation established that the control measures applied in response have been insufficiently adaptive in order to effectively address the growing risk.</p>
5	<p><i>Royal Air Maroc:</i> As a result of our 4th remark above on page 35 lines 38 to 41 [draft final report], although Training managers did mention they've regarded the incident as a unique event, they certainly never thought they couldn't train our pilots more efficiently to handle similar situations involving multiple failures with unexpected effects. On the contrary, at the safety meeting after the event, they all recognized such a flaw in the recurrent training syllabus decided unanimously to adapt recurrent simulator training to include multiple failure handling through adequate CRM as depicted in the FCTM Manual (at this time this is fully implemented). We are still however debating at each quarterly safety meeting to what extent the crews shouldn't be informed of the failures to be presented to them before a recurrent training simulator session training is started.</p> <p><i>Safety Board:</i> The conclusions are drawn with regard to the actual event. Although the Safety Board commends the fact that Royal Air Maroc has decided to adjust their training after the incident this information is not a part of the chapter conclusions. It is however mentioned in paragraph 4.8.</p>

APPENDIX C: ENGINES - GENERAL

Note: parts of the text and illustrations were copied from Aviation Accident Report NTSB/AAR-10/03.

The Boeing 737-4B6 with registration CN-RMF was equipped with two CFM International CFM56-3C-1 dual-rotor, turbofan engines rated at 23,500 pounds of thrust. The engines were jointly designed and manufactured in the United States and Europe. The CFM56 product line name is a combination of the two parent companies' commercial engine designations: GE's (General Electric) CF6 and Snecma's M56.

The left engine, serial number 857523, was manufactured on 4 March 1993, and installed on the aircraft on 22 May 2008. At the time of installation, the left engine had accumulated 39.908 hours (TSN) and 19.980 cycles since new (CSN). At the time of the serious incident, the left engine had accumulated 46.335 hours and 22.710 cycles since new, and 6427 flight hours and 2730 cycles since its last maintenance inspection (shop visit).

The right engine, serial number 857804, was manufactured on 3 May 1994, and installed on the aircraft on 3 May 2006. At the time of installation, the right engine had accumulated 32.437 hours and 16.573 CSN. At the time of the serious incident, the right engine had accumulated 45.638 hours and 22.139 CSN.

The CFM56-3C-1 engine comprises an inlet area, which contains a gas-turbine-driven ducted fan, a 3-stage⁷⁴ low-pressure compressor (LPC), a 9-stage high-pressure compressor (HPC), a combustor, a single-stage high-pressure turbine (HPT), a 4-stage low-pressure turbine (LPT) and an exit exhaust nozzle. Illustration 11 shows a cutaway of a turbofan engine.

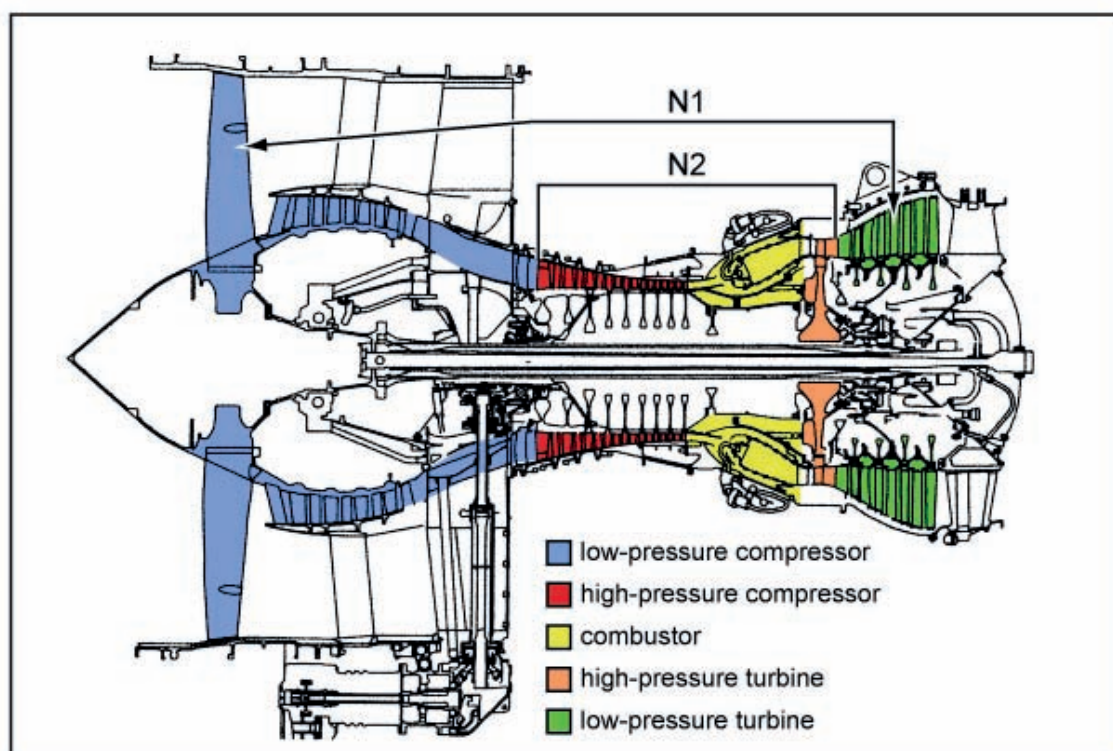


Illustration 11: cutaway of a turbofan engine (not a CFM56-3 engine) showing the LPC, HPC, combustor, HPT, and LPT (source: Aviation Accident Report NTSB/AAR-10/03)

74 A stage comprises a row of stationary vanes and a row of rotating blades.

Air enters the engine inlet area, passes through the ducted fan, and is then channeled to two distinct flow paths. Most of the air bypasses the engine core and is directed through the bypass duct, providing about 70 percent of the engine's overall thrust. The remaining air enters the engine core, where it is compressed; mixed with fuel; combusted; expanded through the LPT, providing rotational power to the fan; and then exhausted, supplying about 30 percent of the engine's overall thrust. Illustration 12 shows the two airflow paths through the turbofan engine.

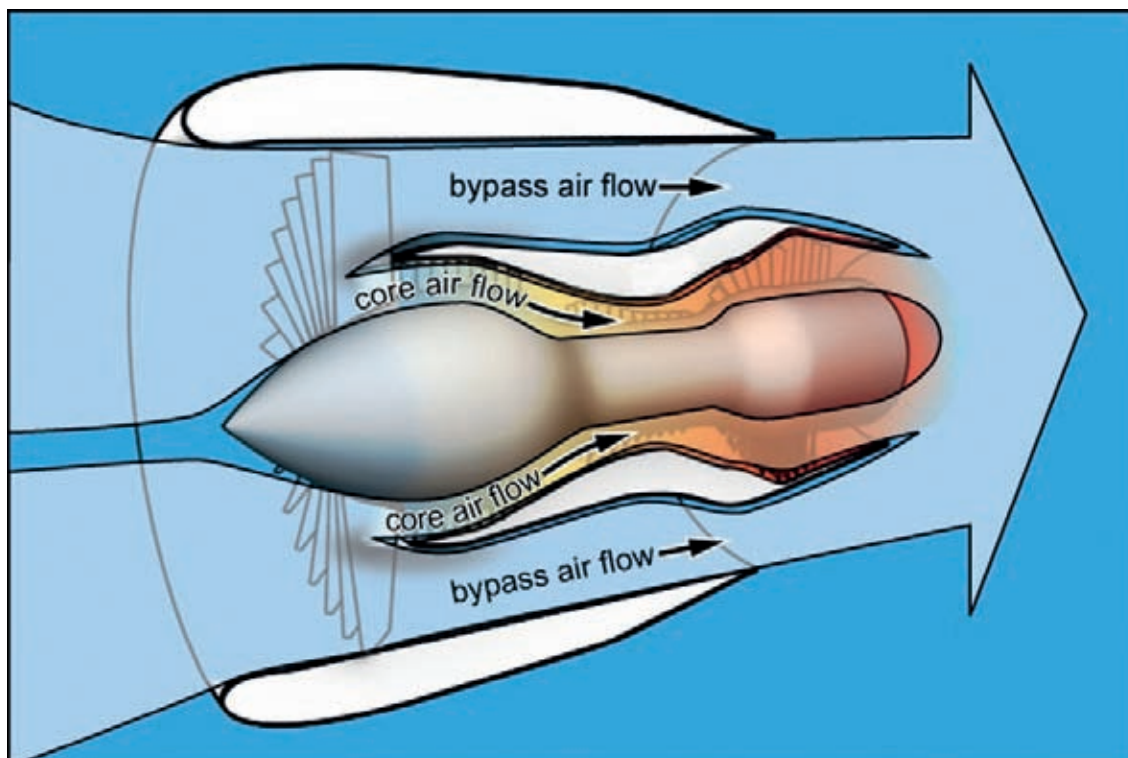


Illustration 12: a diagram showing the two airflow paths through the turbofan engine (source: Aviation Accident Report NTSB/AAR-10/03)

A bird may strike any part of the engine inlet area. If a bird enters the inlet near the outer radius, it will most likely strike only the fan blades, continue along the bypass duct, and be ejected at the rear of the engine. In this case, the fan blades may exhibit some form of leading edge impact damage and may bend and fracture. Debris continuing downstream can damage the bypass duct and fan outlet guide vanes. All of this damage negatively affects thrust production; however, typically, the engine will still be able to operate at a lower thrust level.

If a bird enters the inlet near the inner radius close to the spinner, a portion of the bird may be ingested by the engine core, possibly damaging the internal components, including the inlet guide vanes, LPC and HPC vanes and blades, or the combustor. If the damage is sufficient, the engine may stall or flame out,⁷⁵ rendering it unable to produce appreciable thrust.

⁷⁵ A stall is a local disruption of the normal air flow through the engine compressor, which can be caused by an internal component failure, including a broken vane or blade. A flameout is an engine failure caused by the extinction of the flame in the combustion chamber.

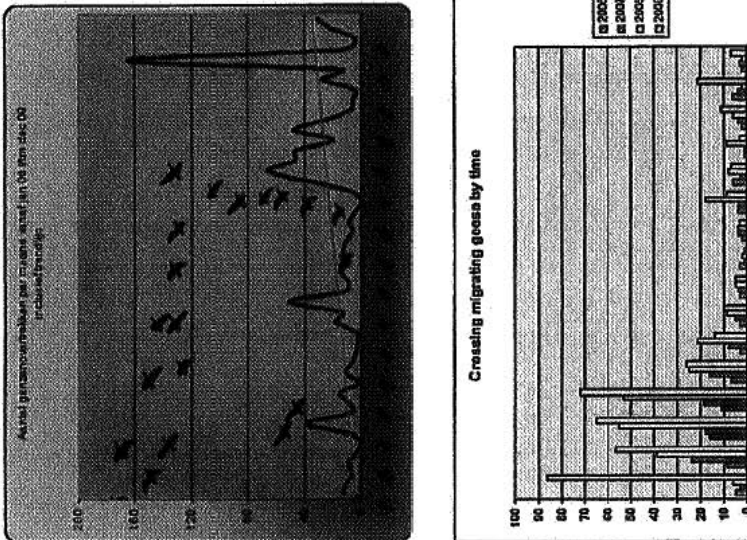
APPENDIX D: BIRD CONTROL AMSTERDAM AIRPORT SCHIPHOL

Overview of bird control measures reported by Amsterdam Airport Schiphol at the time of the serious incident (only available in Dutch). Additional comments:

- The stationary green laser became operational in June 2010.
- The Bird Control unit employs a total of 15 birdwatchers.
- In 2011, the Municipality of Haarlemmermeer initiated a large-scale study to assess the options for reducing the amount of foodstuffs available to geese (>100 hectares between Runway 18R and Runway 18C).

BEHEERSMAATREGELEN OM DOELSTELLING 2009 TE REALISEREN:
C= control; G=guide; I=influence

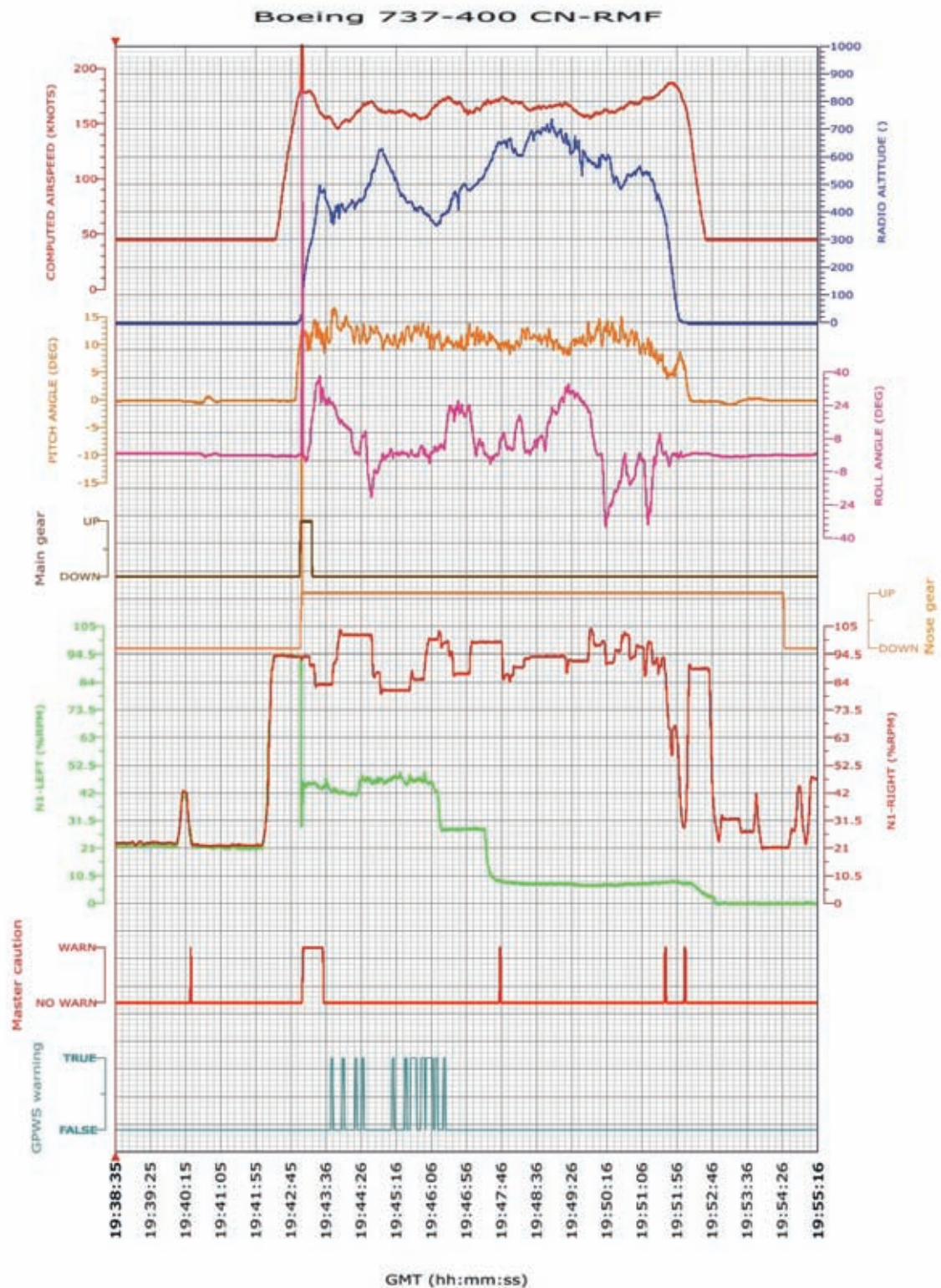
Bestaande Beheersmaatregel	Beheersmaatregel 2009	Acties	Evaluatie
Vogelwachters: vanaf medio 2007 bezetting aangepast, waarbij de V dienst met één medewerker is verhoogd. Toepassen diverse verjagingsmiddelen: Momenteel bestaat het arsenaal uit diverse attributen die door vogelwachters in het terrein op gepaste momenten wordt uitgezet. O.A.: Fly away Peters, stationary robot valk, irritape, handheld groene laser, angskreten, gaskanonnen, div knalffecten dmv seinpistolen.	Medio 2009 onderzoek naar individueel rooster, om vogelwachters nog flexibeler in te zetten en betere kennisdeling collega's onderling. (C)	Individueel rooster invullen. Goedgekeuring rooster HR / OR. Implementatie	Er is nog geen nieuw rooster voor BC, dit wordt gemaakt als de nieuwe (management)structuur van de afd. Bird Control
	Uitbreiding verjaag equipement: Er wordt gebruikt gemaakt van wat op de markt te koop cq verkrijgbaar is. (C)	Aanschaffen van scarrymans. Inzetten op: - op ingezaaide velden, - locatie waar Kieviten willen verzamelen en rusten, en - naast percelen waar ganzen willen gaan zitten. Plaatsen van een stationaire groene laser langs de 18L-36R, de baan met het hoogste ratio-getal, als test van één jaar, zodat alle seizoenen beoordeeld kunnen worden. Bij gebreken geschiktheid wordt laser aangeschaft.	Er zijn 5 scarrymans aangeschaft en ingezet op: - op ingezaaide velden, - locatie waar Kieviten willen verzamelen en rusten; - locatie waar weldevogels willen broeden; - bij wakken in het ijs, waar veel vogels zitten.
	Afschot: uitbreiding aantal vogelwachters met vergunning tot het plegen van afschot als verjagen geen optie meer is. (C)	Uitbreiding inzet robotvogel (ornithopter) dmv inhuur. Gebruiken voor lastig te verjagen species, zoals spreeuwen en Kieviten op nabij gelegen percelen die vanaf Luchthaventerrein actief verjaagd worden met "natuurlijke" vijand.	De stationaire groene laser is in december geplaatst langs de 18L – 36R. De stationaire groene laser zal begin 2010 operationeel zijn Dit is niet direct na het plaatsen gebeurd, uitgesteld in verband met ict problemen.
		Bepalen welke 3 vogelwachters vergunning moeten halen en aanvragen vereiste ontheffing. Vereiste lessen te "Biddinghuizen" vellige omgang hagelgeweer voor 3 vogelwachters regelen en laten volgen.	De inzet van de robotvogel is gestopt. Het rendement was te gering. De inzetbaarheid blijft door de benodigde menskracht (altijd met 2 personen) en weersomstandigheden te gering.
			In het vierde kwartaal zijn 3 vogelwachters toegevoegd aan de vogelwachters die afschot mogen plegen. Zij hebben de lessen gevolgd en zijn voorzien van jachttakte en vergunning.

Bestaande Beheersmaatregel	Beheersmaatregel 2009	Acties	Evaluatie
		<p>Onderzoek naar mogelijkheden tot beperken van voedsel voor ganzen (graan) in omgeving van Schiphol.</p> <p>Beleidsbeïnvloeding overheden door nauw overleg met overheden (om maatregelen te</p>	 <p>Met DGLM onderzoek naar de mogelijkheid om graanteelt te beperken in de Haarlemmermeer uitbesteed aan LTO Noord, die hiervoor het Centrum voor Landbouw en Milieu heeft ingeschakeld. Onderzoek heeft vertraging opgelopen omdat de financiering meer tijd kostte dan gepland. Resultaten in maart 2010 bekend.</p> <p>Vanuit VpS ganzenproblematiek onder aandacht gebracht van de ministers van Verkeer & Waterstaat en Landbouw, Voedselkwaliteit en Natuurbeheer.</p>

Bestaande Beheersmaatregel	Beheersmaatregel 2009	Acties	Evaluatie
		stimuleren waardoor de populatie binnen straal van 10 km rondom luchthaven afneemt).	<p>Heeft geresulteerd in een regiegroep Vogelaanvaring, als vervanger van de CVL. De regiegroep gaat haar aandacht het eerst richten op de ganzenproblematiek rond Schiphol.</p> <p>Vanuit VpS een Schiphol Birdstrike Committee ingesteld, waarin de sector samenwerkt om de vogelproblematiek aan te pakken. Hierin wordt in eerste instantie de aandacht gericht de ganzen en wordt de inzet in de Regiegroep voorbereid.</p> <p>Project met provincie Noord-Holland voor verkleinen populatie Grauwe ganzen voortgezet in 2009.</p>
Centraal opslaan gegevens / grafieken Tot 2009 alles verspreid over veel bestanden	Alles in één map, zodat de gegevens éénvoudig terug te vinden zijn door een ieder. (C)		Uitgevoerd, gegevens in deze rapportage opgenomen.

APPENDIX E: FLIGHT DATA RECORDER DATA ROYAL AIR MAROC FLIGHT RAM685R

A plot has been created showing relevant data from the flight RAM685R data recorder. The horizontal axis shows the time in GMT (Greenwich Mean Time) in [hours.minutes:seconds]. GMT is local time minus two hours.



APPENDIX F: INVESTIGATION INTO BIRD CONTROL AT AND AROUND SCHIPHOL

Following a serious incident involving a bird strike with a Royal Air Maroc Boeing 737-4B6 on 6 June 2010, the Dutch Safety Board launched an investigation into the control of bird populations (bird control) at and around Amsterdam Airport Schiphol. The bird control investigation is described in this appendix.

1 FACTUAL INFORMATION

1.1 THE RESEARCH QUESTION EXPLORED

The aim of bird control is to keep the runways on the ground and the climb-out and descent routes in the air free of birds as far as possible in order to minimize the risk of a bird strike.

Bird control has been a compulsory element of the management of Amsterdam Schiphol Airport's⁷⁶ grounds for over thirty years. As far back as in the 1980s, the then Ministry of Transport, Public Works and Water Management acknowledged that bird control cannot be effective unless a protected area outside the airport grounds is also taken into account. The protected area should be implemented in terms of the spatial layout of the area around airports, in this case the area around Amsterdam Schiphol Airport, and thus into land use (see section 3).⁷⁷

Bird control therefore extends beyond simply the measures that can be taken within the aviation sector (i.e. the Ministry of Infrastructure and the Environment /Directorate-General of Aviation and Maritime Affairs (DGLM), the Transport, Public Works and Water Management Inspectorate (IVW), the Amsterdam Airport Schiphol (AAS) organisation, the airlines and air traffic control services). Land use in the airport environs must also be taken into account, i.e. agriculture, nature reserves, water, recreational activities and development (residential and commercial).

This means that parties who do not operate within the aviation sector are also involved in bird control, namely provincial authorities, municipal authorities, water boards and organisations whose activities relate to agriculture, the natural environment, recreational activities and other types of land use that affect the risk of bird strikes.

During the early stages of its investigation the Dutch Safety Board established that bird strike prevention has been a focus area for both the aviation sector parties at Schiphol and the parties located in the environs of Schiphol, including various authorities, for a long time now and since prior to the incident on 6 June 2010. AAS and the IVW have both maintained records of the frequency at which bird strikes occur for many years. These records show that bird strikes occur at Schiphol every year. In view of the severity of the incident on 6 June 2010 combined with the potentially severe consequences of bird strikes if they result in engine failure, the decision was taken to examine the actual regulations and measures taken to control this risk at and around Amsterdam Airport Schiphol in greater depth.

76 This is mandatory for the Amsterdam Airport Schiphol airport authority pursuant to the 1944 Chicago Convention, which imposes an obligation on states to implement the rules via national regulations. Annex 14 stipulates that, and how, the appropriate authorities should ensure bird hazard reduction and provide a long-term bird control programme at a national level.

77 In 1985 the Task Force for the Prevention of Bird Strikes with Civil Aviation Aircraft (Werkgroep ter Voorkoming van Aanvaringen tussens Vogels en Civiele Luchtvaartuigen) advised that the Aviation Act be amended and that a protected zone be established around the airport grounds within which no bird-attracting activities would be permitted. The advice was submitted in an enclosure to a letter dated 18 December 1985 from the Netherlands Civil Aviation Authority regarding the first draft of a legislative text relating to protected areas surrounding airport grounds. This ultimately resulted in the Airport Planning Decree (Luchthavenindelingsbesluit, LIB).

The key question in this sub-investigation is as follows:

To what extent is it possible to effectively control the risk of bird strikes based on the current regulations, agreements and actions performed by the relevant parties?

The Safety Board is particularly interested in the safety management by the parties involved (see section 2). In order to answer this question, the Safety Board first of all examined how the system of regulations, agreements and actions performed by the relevant parties works (section 3). It then went on to look at the impact of these regulations, agreements and actions in practice and their impact in terms of safety management (section 4).

1.2 BIRD STRIKES: STATISTICS AND TRENDS

Amsterdam Airport Schiphol and the Transport, Public Works and Water Management Inspectorate each record the number and types of bird strikes that occur at the airport (see Attachment 1).

The number of reported bird strikes at Schiphol has risen in recent years. The frequency of bird strikes for every 10,000 air transport movements (referred to as the bird strike ratio) is as follows according to airport figures:⁷⁸

Year	Schiphol
2007	5.5
2008	4.2
2009	7.1
2010	7.2

Table 3: number of bird strikes per 10,000 air transport movements at Amsterdam Airport Schiphol [Source: Shared Skies, Initial Policy Document drawn up by the Dutch Bird Strike Control Group (Nederlandse Regiegroep Vogelaanvaringen), dated 4 August 2010]

On the basis of figures from the IVW Occurrence Analysis Bureau (IVW Analysebureau Luchtvaartvoorvallen), in 2007 0.1% of air transport movements involved a bird strike (10 in 10,000) followed by 0.09%, 0.13% and 0.11% in the subsequent years (the bird strike ratio was 9, 13 and 11 in every 10,000 air transport movements in 2008, 2009 and 2010 respectively). This includes sightings of suspected bird remains and non-verified reports. In the past, Schiphol applied an annual standard of four bird strikes in every 10,000 air transport movements. Schiphol ceased to apply a relative target to the number of reported bird strikes (ratio) in 2010, and has since used a target figure that is linked to the total number of bird strikes each year.

However, interviews with Amsterdam Airport Schiphol staff involved in bird control activities and with IVW and KLM staff have revealed that the number of reported bird strikes only partly reflects the actual number of these incidents. The reliability of the statistics is partly determined by the reporting behaviour of pilots and the airlines, and whether or not bird remains have been found.⁷⁹

78 Bird strike indicators are as follows:

- A bird strike reported by a crew member.
- Maintenance staff identify aircraft damage resulting from a bird strike.
- Ground staff witness the occurrence of a bird strike and report it.
- Bird remains are found on the asphalted airside area of the airport within 70 metres of the runways and bird strike is the only possible explanation.

79 Amsterdam Airport Schiphol makes a distinction between fauna incidents and bird strikes. See footnotes 152 and 153 for the definitions of these two terms. If a bird strike has been reported but no bird remains have been found, a bird strike can still be recorded if it is likely that one has occurred. This is because it is important to also know about those bird strikes that do not have detected or serious consequences as in the case of the serious incident involving the Royal Air Maroc Boeing 737. If traces of birds or bird remains have indeed been found, these may also relate to a fauna incident. Where a bird strike is reported and traces or remains have been found and a bird strike is likely to have occurred, bird strikes occurring during an aircraft landing below 200 feet and during an aircraft take-off up to a height of 500 feet are counted as an 'on airport' bird strike.

The number of bird strikes is therefore a limited reflection of the problem as a whole for reasons of principle and the registration methods used. Nevertheless, it is clear that:

- The graph below shows the trend in the number of bird strikes per month over the period from mid-2005 to mid-2011 (all species of bird).



82 During interviews it emerged that it is for this reason that the Flight Safety Expert Group involved in the Schiphol Safety Platform debate in 2007 concerning the exact registration method therefore decided to focus entirely on strategy and measures. The decision was taken to establish a clear numerical indication of bird strikes. AAS only uses the term bird strike if bird remains are also found, however strikes also occur where no remains are left behind. The Schiphol Safety Platform has decided to apply the parameters used by KLM.

1.3 NUMBER OF GEESE AND GEESE MOVEMENTS: TRENDS

Rising number of geese

During meetings the Dutch Safety Board held with the authorities and experts involved, it emerged that the number of geese in the environs of Schiphol and the number of goose movements above Schiphol have risen sharply since 2000. See also Attachment 1.

The increase in the number of geese of various species in the Netherlands has been verified by studies conducted by parties such as Landscape Noord-Holland and the Alterra Research Institute (part of Wageningen University and Research Centre).⁸³ The table below gives a summary of the number of geese in the immediate environs of Schiphol and in the Province of Noord-Holland.

Year	'Maximum numbers of greylag geese sighted in the Schiphol environs in August' ⁸⁴ 20 km radius	'Estimated population of greylag geese within a 20 km radius of Schiphol' ⁸⁵ 20 km radius	'Goose count (all species) within a 10 km zone around Schiphol in summer' ^{86*} 10 km zone	'Greylag goose count in the Haarlemmer-meer polders in August' ⁸⁷	'Greylag goose count in Noord-Holland, counted in April' ⁸⁸
Season 2001/2002	'a few dozen'				
2006			2,500	2,500	20,585
2007					44,037
2008	4,700		7,200		47,932**
2009	7,300	35,700 – 38,400	8,000		27,618**
2010	8,600	42,800 – 46,000	10,000		39,121**

* Mainly greylag geese (85%).

** The count area varied from 2008. The number per 100 hectares was 58.7 (2008), 28.2 (2009) and 35 (2010).

Table 4: summary overview of sources consulted stating the number of geese in the immediate environs of Schiphol and in the Province of Noord-Holland.

The available statistics may not be complete – the definitions and measurements differ – but they clearly show growing populations. Moreover, for years now the studies have established an explicit link between the rising number of geese and the risk of bird strikes.

The Fauna Management Unit Noord-Holland conducted counts that included the number of geese in the Province of Noord-Holland on 16 July 2011. Of the more than 97,700 geese counted, over 78,900 were greylag geese, more than 4,700 Canada geese, more than 7,300 barnacle geese and around 3,000 Egyptian geese.

83 Schiphol Safety Platform debate in 2007 concerning the exact registration method therefore decided to focus entirely on strategy and measures. The decision was taken to establish a clear numerical indication of bird strikes. AAS only uses the term bird strike if bird remains are also found, however strikes also occur where no remains are left behind. The Schiphol Safety Platform has decided to apply the parameters used by KLM.

84 [Translated] *Origin of greylag geese that can be found in the environs of Schiphol in late summer. Distribution and area use of collared greylag geese carrying transmitters in the period 2009-2010.* Bureau Waardenburg, 1 June 2011. Study conducted on behalf of Schiphol and the Province of Noord-Holland. The area studied was the 20-kilometre zone around Schiphol.

85 Same as footnote 84.

86 [Translated] *Wintering and summering geese in the 10-km zone around Schiphol. Winter 2009 – summer 2010, Landscape Noord-Holland, 2011.* Study conducted on behalf of the Province of Noord-Holland.

87 [Translated] *How to minimize the risk of goose strike around Schiphol*, Alterra report 1478, March 2007.

88 Additional information supporting the application for an exemption in respect of geese and wigeons, FBE Noord-Holland, FBE/PvH 150, 24 March 2011.

Researchers established as far back as in 2007:⁸⁹ [translated] *"The number of geese wintering in the Netherlands has increased tenfold since 1970, and there has also recently been a sharp rise in the number of geese brooding in the Netherlands. Large birds are known to present a risk to aviation, and the significant rise in the numbers of geese naturally increases this risk. (...) Since 2000, more and more instances have been observed [at Amsterdam Schiphol Airport] of near collisions between these birds and aircraft".* This report recommends *"that the geese within a 10 - 25 km radius in the Haarlemmermeer are closely monitored and that any culling, deterrence and other measures are recorded, as well as the impact of these measures on the numbers of geese".*

In 2009, the Province of Noord-Holland issued instructions for the systematic monitoring of the goose population in the environs of Schiphol. The aim of this research was to monitor and gain a greater insight into the populations on a long-term basis, in view of the risk to flight safety. The summering⁹⁰ (brooding) greylag geese are the largest in number and their presence constitutes a risk in the summer months. The geese forage on corn plots in the Haarlemmermeer over the period from July to October.⁹¹

The first report⁹² on this monitoring study provides an overview of the numbers of geese according to species in the period April to August 2009 within a 10-kilometre radius of Schiphol. This study shows [translated] *"that a significant proportion of the goose population feeding on the harvest remnants in the Haarlemmermeer come from outside the 10 km zone around Schiphol".*

The second report⁹³ commissioned by the Province of Noord-Holland plainly states: [translated] *"The background to this study is that the brooding goose populations in the immediate environs of Schiphol are rising sharply. There is a risk to flight safety around Schiphol".*

The most recent report⁹⁴ states: [translated] *"There has been a marked increase in the number of brooding greylag geese in the Province of Noord-Holland over the past few years, whilst the numbers of wintering greylag geese have also risen. The flight movements of these birds are placing flight safety at Schiphol at risk".* The aim of this study was to provide information on the origin of the greylag geese. The table below presents a summary of the results:

Greylag geese studied, from:	Risk of foraging in the Haarlemmermeer in the environs of Schiphol in late summer
Westbroekplas, Penningsveer, Spaarnwoude and Vijfhuizerplas	"major risk"
Amsterdamse Bos and Fort aan de Drecht	"moderate risk"
Vinkeveen, Nieuwkoop, Rijnsaterwoude and Rijkpwetering	"limited risk"
Guisveld, Kalverpolder, Ouderkerkeplas and Loenderveen	"very small risk"

Table 5: origin of greylag geese results summary

89 [Translated] *How to minimize the risk of goose strike around Schiphol*, Alterra report 1478, March 2007.

90 Summering geese are geese that spend the months from April to August in the Netherlands.

91 [Translated] *Towards a goose-safe Schiphol. Possibilities for alternative crop schemes*. CLM Research and Advice, report 730-2010, April 2010. Study on behalf of the Ministry of Transport, Public Works and Water Management/DGLM and Amsterdam Airport Schiphol.

92 [Translated] *Geese in the 10 km zone around Schiphol in 2009*, Landscape Noord-Holland, January 2010.

93 [Translated] *Wintering and summering geese in the 10 km zone around Schiphol. Winter 2009 – Summer 2010*, Landscape Noord-Holland, January 2011. Study conducted on behalf of the Province of Noord-Holland.

94 [Translated] *Origin of greylag geese that can be found in the environs of Schiphol in late summer. Distribution and area use of collared greylag geese carrying transmitters in the period 2009-2010*. Bureau Waardenburg, 1 June 2011. Study conducted on behalf of Schiphol and the Province of Noord-Holland. The area studied was the 20-kilometre zone around Schiphol.

Since 2006, Amsterdam Airport Schiphol has recorded “visually observed flyovers” of geese above the airport and has commissioned research into overflying geese using a marine radar. Schiphol’s records of the number of goose flyovers can be found in figure 20, Attachment 1. Schiphol concludes in a trend analysis⁹⁵ of this data that:

- the number of groups of overflying geese is increasing every year
- the geese come from various directions
- the average group size is 20 geese, however there have also been occasional sightings of large groups of more than 2,500 geese
- 85% of overflying greylag geese fly at an altitude of 50 to 300 metres, making deterrence measures impossible; this is also a dangerous altitude for aircraft that are taking off or landing
- greylag goose movements peak sharply in the early morning (just after sunrise) with a second, somewhat smaller, peak at the end of the day (around sunset). The morning peak in particular coincides with the peak outbound time for aircraft leaving Amsterdam Schiphol Airport.

The number of goose flyovers observed in 2010 is shown in figures 21 to 24 inclusive, Attachment 1.

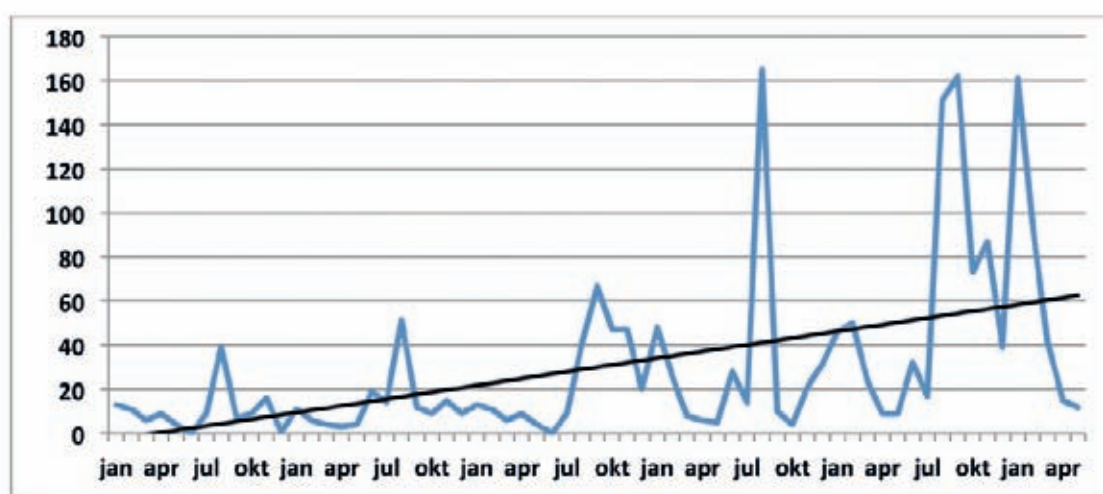


Figure 14: number of sightings of geese flying over Amsterdam Airport Schiphol from January 2006 to April 2011 inclusive and trend line [source: Amsterdam Airport Schiphol]

Causes of population growth

Based on information from the abovementioned research agencies, there is a reasonable degree of consensus regarding the causes behind the rising number of geese. Under European bird protection policy, the Netherlands has been granted responsibility as a host country for wintering geese. Foraging areas (pasture land) have been designated and policy is pursued in this context. In addition, the number of resting and brooding areas in the Netherlands has increased as a consequence of nature policy.⁹⁶

Taking into account a drift distance of 20 to 30 km between foraging areas and resting areas, the wider environs of Schiphol incorporate various (marshy) areas that serve as resting, moulting and brooding areas. There are also agricultural areas (protein-rich pasture land, farming land used for corn, potatoes and beetroot) in the environs of Schiphol that attract foraging geese.

One factor that has contributed towards the population growth is that goose hunting has only taken place on a relatively limited scale in the Province of Noord-Holland over the past few years. What is striking is that there has recently been a sharp rise in the number of geese culled and eggs treated. In the case of the most common species, namely the greylag goose, 3,288 birds were culled in winter 2006 and 741 in summer 2006 (4,029 in total) for the purpose of damage control, whilst in

⁹⁵ Source: Schiphol Safety Platform records, 17 March 2010.

⁹⁶ Incidentally, the use of land as new natural habitat areas is not legally permitted within a 6-kilometre radius of Schiphol under and since the entry into force of the Airport Planning Decree (LIB). See section 3.2 for further information.

2008 these numbers were 11,383 and 15,198 respectively (26,581 in total) in the Province of Noord-Holland.⁹⁷ The table below shows the number of geese culled and the number of eggs treated⁹⁸ in nests in the Province of Noord-Holland from 2004 to 2010 inclusive.

Geese culled and eggs treated	domestic geese	barnacle geese	Canada geese	greylag geese	white-fronted geese	Egyptian geese	Total culled	Geese eggs
2004/2005	-	-	-	1,020	93	-	1,113	-
2006	2,458	-	195	4,029	1,099	1,902	9,683	-
2007	977	142	819	14,364	1,198	3,791	21,291	16,739
2008	821	164	675	26,581	3,591	2,262	34,094	43,228
2009	5	0	307	3,231	37	719	4,299	91,549
2010	112	203	648	20,455	2,569	2,069	26,056	122,397

Table 6: goose culling and treatment of goose eggs in the Province of Noord-Holland [source: Noord-Holland Fauna Management Unit]

According to the Fauna Management Unit, culling for the purpose of controlling summering geese in the Province of Noord-Holland did not take place according to the Fauna Management Plan in 2009. One exception was the control of different species of geese within the 10-kilometre zone around Amsterdam Schiphol Airport. See below for more information.

Goose control around Amsterdam Schiphol Airport

The statistics for nests found, eggs treated and geese culled are shown for each species below. These figures are also included in table 6.

jaar	Grauwe ganzen			brandganzen			boerenganzen / hybriden		
	nesten	eieren	afschot	nesten	eieren	afschot	nesten	eieren	afschot
2008	1229	7103	3309	8	48	0	28	250	106
2009	2201	14265	3151	38	207	0	142	989	3
2010	3161	18389	4958	54	462	0	80	481	84

jaar	Canadese ganzen			Nijlganzen			Rietgans		
	nesten	eieren	afschot	nesten	eieren	afschot	nesten	eieren	afschot
2008	7	42	56	85	530	461	0	0	2
2009	21	118	23	190	1556	719	0	0	0
2010	8	54	81	110	798	820	0	0	9

jaar	kolganzen		
	nesten	eieren	afschot
2008	0	0	8
2009	0	0	2
2010	0	0	65

Table 7: treating of eggs and culling of geese species in the 10-kilometre zone around Amsterdam Schiphol Airport in 2008-2010 [source: Noord-Holland Fauna Management Unit]

97 Noord-Holland Fauna Management Unit Foundation, Annual Fauna Management Plan Implementation Reports for 2009 and 2010.

98 The FBE Noord-Holland reports that the most common treatment method involves piercing a small hole in the eggshell; an alternative method involves immersing eggs in corn seed oil.

Key:	
jaar = year	rietgans = bean geese
grauwe ganzen = greylag geese	kolganzen = white-fronted geese
brandganzen = barnacle geese	nesten = nests
boerenganzen/hybriden = domestic geese/hybrids	eieren = eggs
Canadese ganzen = Canada geese	afschot = culled
nijlganzen = Egyptian geese	

At the Dutch Safety Board's request, the SOVON Dutch Centre for Field Ornithology (abbreviated as SOVON) has gathered information about the number of birds that cause a risk of bird strike in the 10-kilometre zone around Amsterdam Schiphol Airport. Details can be found in Attachment 1. This shows that there has been a sharp rise in the goose populations around Schiphol over the period from 1996 to 2010.

Number of air transport movements at Amsterdam Schiphol Airport

The table below shows the number of air transport movements (aircraft take-offs and landings) at Amsterdam Schiphol Airport over the period from 1997 to 2009. The figures show that the number of aircraft takeoffs and landings has increased over the years. The number of air transport movements is expected to rise by 5% in 2011 compared to 2010.

Year	number of air transport movements	year	number of air transport movements	year	number of air transport movements
1997	372,658	2002	417,111	2007	454,354
1998	397,162	2003	408,280	2008	446,689
1999	414,214	2004	418,612	2009	406,975
2000	432,459	2005	420,733	2010	402,000
2001	432,056	2006	440,155	2011	422,000

Table 8: number of air transport movements at Amsterdam Schiphol Airport [source: Statistics Netherlands]

Risk perception amongst the parties involved

There has been an awareness of the growth in the goose populations around Schiphol and the risk this presents to flight safety since at least 2007.⁹⁹ No indications have been found that this population growth will be curbed through natural causes. There is also evidence that concerns about the increase in the risk posed by geese to aviation safety as a result of the population growth are broadly shared by the parties. However, there is a lack of consensus about the precise nature and scale of the risk.

The Safety Board has concluded that the goose population has grown in the Netherlands and also around Schiphol over the past few years. This trend will continue if no direct action is taken. When combined with the anticipated increase in the number of aircraft taking off from and landing at the airport, the risk of bird strikes involving geese is inevitably growing. The Board concludes that this has led to a significant increase in the risk of bird strike, specifically involving geese, with potentially serious consequences at Amsterdam Schiphol Airport and in the airport's immediate environs, thus endangering flight safety.

99 Alterra report from 2007: [translated] "The number of geese around Schiphol is rising. Collisions between aircraft and birds of this size flying in groups can have disastrous consequences. Greylag geese in the summer months in particular, but also white-fronted geese and bean geese in the winter months, currently regularly cross the flight routes of aircraft that are landing or taking off (...) The airport rightly views the situation as dangerous".

2 THE PROBLEM: BIRD STRIKE PREVENTION AS AN INTERFACE ISSUE

2.1 THE BIRD STRIKE ISSUE: UNDESIRABLE COLLISIONS, UNDESIRABLE PRESENCE OF BIRDS, OR UNDESIRABLE CROSSING OF THE FLIGHT PATH?

According to a recent definition, a bird strike is [translated] *"unintentional physical contact between an airborne aircraft and one or more airborne birds, with potentially harmful consequences for both"*.¹⁰⁰ There are a wide range of factors that affect the risk of bird strike. The risk of a collision depends on the ecology of the region in which the airport is situated, the volume of air traffic and measures taken by the parties involved to reduce this risk. Moreover, the risk of bird strike also depends on the species of bird and the behaviour of this species and the (group of) birds involved.¹⁰¹

The size of the bird caught up in the engine generally has a major impact on the severity of the consequences of bird strikes. This means that large birds (such as geese, swans and a number of birds of prey) constitute a risk, as do birds that fly in large flocks (such as starlings). Geese are not only large and heavy birds, but fly in relatively large flocks.

The consequences of a bird strike naturally depend on the precise circumstances and the extent to which the bird strike affects the further course of the flight. According to Transport Canada¹⁰² the nose of the aircraft, wings and engine are the parts most likely to be affected (in 19%, 13% and 13% of bird strikes respectively in the USA and Canada in the 1990s). These are followed by the fuselage (11%), the landing gear (9%) and the cockpit window (7%). Out of all bird strikes in which the flight phase was reported, 90% took place during the takeoff or landing phase of the flight. The Dutch Task Force for the Prevention of Bird Strikes with Civil Aviation Aircraft concluded as early as in the 1980s¹⁰³ that 98% of bird strikes occur below an altitude of 3,000 feet and around 88% below 600 feet. A majority of 70% of all bird strikes occur below 100 feet.

The issue of bird strikes around Schiphol is not unique in the sense that every airport faces risks associated with wildlife (in a broad sense: bird species and other wildlife) and bird strikes. What is unique to Schiphol is the combination of factors: the features of this particular airport, the physical environment, the ecology and land use in the Haarlemmermeer and its environs: the Netherlands as a whole and the Haarlemmermeer Polder are attractive natural habitats for birds, due to an abundance of food and water.¹⁰⁴ In 2007, the Aircraft Bird Strike Committee (*Commissie Vogelaanvaringen Luchtvaartuigen*, CVL)¹⁰⁵ called for special attention for the goose problem specific to the Netherlands: [translated] *"Bird control units at Dutch airports are logging more and more sightings of geese flying over the runways. However, the Dutch airports cannot influence the flight movements of these overflying geese, as their resting and foraging areas lie outside of the airport terrain and often also at a considerable distance from the airport."*

100 Dutch Bird Strike Control Group, Shared Skies, Initial Policy Document, 11 June 2010.

101 The serious incident on 6 July 2010 involved a collision with Canada geese. The interviews conducted by the Dutch Safety Board have also shown that the risk must not be interpreted too strictly according to species.

102 McKinnon et al, Sharing the Skies, An Aviation Industry Guide to the Management of Wildlife Hazards, Transport Canada, 2001. This publication contains an in-depth exploration of safety improvement strategies and measures, based on a 'system safety approach'. The document focuses extensively on both the behaviour of various species of wildlife, including birds, and the types of measures that parties (involved in aviation) can take.

103 Recommendation by the Task Force for the Prevention of Bird Strikes with Civil Aviation Aircraft on protected areas surrounding airport terrain, Netherlands Civil Aviation Authority, 26 January 1987.

104 Experts consulted by the Safety Board and the parties involved that were interviewed about the bird strike issue agree in this regard.

105 Set up in 1997 by the then Minister for Transport, Public Works and Water Management and Minister of Defence, by Decree of 1 September 2007, no. DGRDL/LI/97.800370, Government Gazette no. 183 dated 24 September 1997.

2.2 NATURE OF THE BIRD STRIKE ISSUE

During its investigation, the Dutch Safety Board came across various perceptions of the bird strike issue amongst the relevant parties located in the environs of Schiphol,¹⁰⁶ such as:

- Bird strikes as a control problem based on figures, such as the bird strike ratio.
- Bird strikes as a problem caused by the presence of (large numbers of) birds, particularly geese.
- Bird strikes as a dynamic question of separating aircraft from (groups of) birds that present a risk to aircraft.

The existence of several problem definitions is typical of the bird strike issue. The Safety Board therefore characterises the prevention of bird strikes at and around Amsterdam Schiphol Airport first and foremost as an interface issue.¹⁰⁷ Interfaces are necessary links between relevant parties that are essential in order to limit or prevent a safety risk, in this case collisions between birds and aircraft.¹⁰⁸ The parties liaise by means of these links in the areas of overlap between their individual activities, responsibilities and powers.

The extent to which risks occur is partly determined by the extent to which the interfaces between the safety systems of the parties involved function effectively. The risk of bird strike is unusual in that it does not just affect the aviation sector, but also other sectors: parties involved in nature and nature policy, agriculture and agricultural policy and spatial planning. Judging by the 'set' boundaries between the policy areas involved, interfaces are essential to coordination, as all those involved hold the key to part of the solution (powers and resources). For an effective safety strategy, interfaces can also mean making additional efforts or taking on additional responsibilities in order to achieve the joint goal, which is not the primary goal of the individual organisation.

The figure below illustrates the risk chain for the bird strike issue (top), the intervention chain (centre) and the relevant policy areas (bottom).¹⁰⁹ Each of these policy areas has its own separate control system of laws, rules and parties involved.

The Safety Board shares the view of the ICAO¹¹⁰ that bird strikes are ultimately a matter of the "dangerous presence" of large birds or flocks (mass with critical consequences in the event of a collision) within aircraft flight paths. This is the danger to be avoided and on which efforts must be focused. This means that the bird strike issue can only be resolved if efforts are made in all areas, as illustrated in figure 15.

If birds are in, or at risk of entering, an aircraft's flight path, action can be taken in the form of last-minute measures. An integrated preventive approach requires the use of measures that target several of these links in the risk chain: from measures in the immediate vicinity of the runways, to measures on the airport terrain as a whole, to measures in the environs (control and spatial planning). Further towards the left of the risk chain, measures have a larger geographical scope.

106 These perceptions can be inferred from the available documentation and interviews conducted. These problem perceptions were also addressed during the Bird Strike symposium organised by the Dutch Bird Strike Control Group at Schiphol on 10 March 2011.

107 Dutch Expert Group on Aviation Safety (DEGAS) recommendation 2010-034 Interface Management, June 2010.

108 The recommendation issued by the DEGAS advisory board on safety in civil aviation to the former minister of Transport, Public Works and Water Management on interface management, states: [translated] "*The aviation system is characterised by cooperation and coordination between various (groups of) organisations and (...) this coordination critically depends on the frequent exchange of information between these organisations. Safety can be endangered if information is not passed on correctly from one organisation to another*". DEGAS calls for properly functioning interfaces between the parties in the sector. The key to this is creating cohesion between the safety management systems of individual organisations.

109 The model is based on the "Swiss cheese model" concept and the essential cornerstones identified by the Dutch Bird Strike Control Group (NRV) as barriers in order to prevent bird strikes. See Reason, 1990, quoted in: Causal model for air transport safety, Final Report, Ministry of Transport, Public Works and Water Management, Directorate-General for Civil Aviation and Maritime Affairs, 2 March 2009.

110 Part 3 of the Airport Services Manual accompanying ICAO Annex 14 provides practical guidelines for airport authorities and airport operators. And: ICAO document 9137 AN/901 Part 3, par. 3.6.1

They are also shrouded by a considerably larger degree of uncertainty, as the link between the aircraft flight path and populations, in this case geese in the wider environs of Schiphol, is only indirect. After all, there is no way of knowing for certain whether, when and which bird or bird groups will actually cross the flight paths.

The possible measures and measures taken in practice are in the hands of players operating within various areas: flight operations (alerting and separating), airport management (keeping the airport terrain free of birds), land use and terrain management in the environs as well as fauna management in the wider environs, and finally spatial planning (avoiding land use that attracts birds). International and national policy in the field of nature policy, water and agriculture and the associated laws and regulations. Parties in various sectors are needed to coordinate and implement or organise the implementation of the measures.

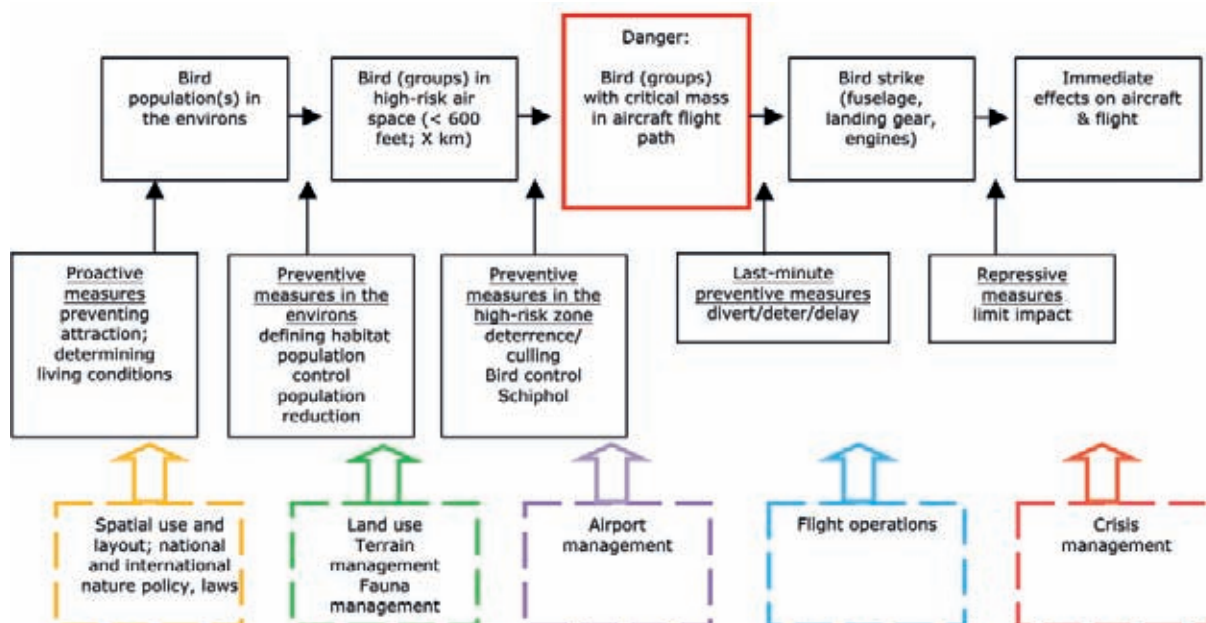


Figure 15: bird strike risk chain and intervention chain

Figure 15 illustrates the two key aspects of the bird strike issue:

- It is an interface issue: none of the parties can control the risk of bird strike on their own as it has areas of overlap with various sectors: spatial policy, nature, agricultural and wildlife policy and aviation safety policy. Liaison, collaboration and coordination are essential.
- It is a problem that is surrounded by a very large number of (partly uncertain) variables, such as the impact of soil use, nature policy and fauna management on the actual risk.

The Safety Board investigated how the parties involved implement bird control in practice at and around Schiphol and the extent to which mutual cooperation and coordination was successful.

3 THE APPROACH: REGULATION AND ORGANISATION OF BIRD CONTROL

A large number of parties are involved in controlling the bird population at and around Amsterdam Schiphol Airport. This section provides further information on these parties and their responsibilities.

The activities for the purpose of regulating and organising bird control at and around Schiphol can be broken down into activities within the airport terrain under the responsibility of Amsterdam Airport Schiphol (section 3.2) and activities outside of the Schiphol terrain, in which various different parties are involved (section 3.3). But first the history of the bird control agenda will be briefly looked at (section 3.1).

3.1 DEVELOPMENT OF THE BIRD STRIKE ISSUE AT AND AROUND SCHIPHOL: HISTORY

Bird strikes have been a point of concern within the aviation sector for many decades. They are encompassed in the risk described in the 1944 Chicago Convention posed by wildlife to aviation safety. Since then, efforts have been made in the context of both civil aviation and military aviation to limit the risk of bird strikes, particularly by means of preventive measures.

Airports are obliged to take action to limit the risk of bird strike in the form of measures on their own grounds. This traditionally involves things like bird watching, avoiding attracting birds, deterring and where necessary culling birds on the terrain, soil use, terrain management and spatial planning and so on.¹¹¹ Amsterdam Airport Schiphol has had a separate Bird Control Unit since 2005.

In the Netherlands, attention was drawn in the 1980s to the impact of activities outside airport terrain on the risk of bird strikes.¹¹² The official Task Force for the Prevention of Bird Strikes with Civil Aviation Aircraft issued a recommendation in 1985 [translated] *"on protected areas surrounding the grounds of airports"*. In this, the Task Force stated: [translated] *"The current situation and the options for preventive, long-term measures outside the boundaries of the airport grounds contrast sharply with the situation within the airport terrain themselves"*. The Task Force pointed to the bird problems experienced by Schiphol and to the fact that these were [translated] *"caused by the presence of areas with a high concentration of birds in the vicinity (...). Areas with a high concentration of birds and the indirect effects of these areas present a risk to those parts of the landing and takeoff routes in which aircraft are flying at a lower altitude. These indirect effects render activities to prevent bird strikes within the boundaries of the airport terrain partly or entirely ineffective"*.

Amongst other things, the Task Force's recommendation led to amendments to the Aviation Act in 2002 and the creation of a basis for the Airport Planning Decree (LIB).¹¹³ The Airport Planning Decree sets out the area designated for use as an airport and the surrounding area to which restrictions apply in relation to safety and noise levels. It sets out restricted areas at Schiphol in relation to the aspects external safety, noise levels, altitude and bird-attracting activities. It lays down rules for the use and designation of the land in these areas.

The Airport Planning Decree applies a 6-kilometre zone around Amsterdam Airport Schiphol in which new¹¹⁴ bird-attracting activities¹¹⁵ are restricted.

Before the Airport Planning Decree entered into force, the bird-attracting effect of designated land use around airports was investigated on a voluntary basis. The first example of the incorporation of a proposal designed to be less attractive to birds in a land-use plan as a result of these measures was at Eindhoven Airbase/Eindhoven Airport in 1999.¹¹⁶

111 Part 3 of the Airport Services Manual accompanying ICAO Annex 14.

112 Under the Chicago Convention, the obligation to avoid land use that attracts birds is already set out in the accompanying ICAO Annex 14, paragraph 9.4.4: *"The appropriate authority shall take action to eliminate or to prevent the establishment of garbage disposal dumps or any such other source attracting bird activity on, or in the vicinity of, an aerodrome unless an appropriate aeronautical study indicates that they are unlikely to create conditions conducive to a bird hazard problem."* ICAO Annex 14 paragraph 9.4.4. adds a note to this: *"Note.— Due consideration needs to be given to airport operators' concerns related to land developments close to the airport boundary that may attract birds/wildlife."*

113 Decree of 26 November 2002, establishing an Airport Planning Decree for Amsterdam Schiphol Airport (Schiphol Airport Planning Decree).

114 The explanatory memorandum on these restrictions: the addition of objects or activities that exert a strong attraction on birds can have a negative impact on the situation at and around the airport. Article 2.2.3 therefore stipulates that new instances of the use or designation of land that fall within these categories are prohibited. Use or designation within the aforementioned categories is permitted, however, if such use or designation is lawful at the time the Airport Planning Decree enters into force.

115 This concerns the following activities according to Article 2.2.3 paragraph 1 of the Airport Planning Decree:

- a. industrial activities in the food sector involving outdoor storage or transfer
- b. fish farms with outdoor basins
- c. storage or processing of waste materials involving outdoor storage or processing
- d. wildlife sanctuaries and bird sanctuaries
- e. marshland and surface water covering an area of more than 3 hectares.

116 Airport Decrees (together with bird restrictions zone) have not yet been adopted for the earlier regional airports and Lelystad airport, and this type of assessment still only takes place on a voluntary basis.

Urgency: recent focus

Bird control at and around Schiphol has been a focus point for management and politics on several occasions in recent years, and prior to the serious incident on 6 June 2010.

Interviews with the relevant aviation authorities have revealed that a greater focus on tackling the issue of bird strikes was placed on the agenda by initiatives by the Aircraft Bird Strike Committee (CVL) and Amsterdam Airport Schiphol. In 2007, in a letter to the then Ministry of Transport, Public Works and Water Management (Directorate-General for Civil Aviation and Maritime Affairs) and the Ministry of Defence the CVL called for attention to the risk of bird strikes posed by geese.¹¹⁷

In 2008 the Lower House raised questions¹¹⁸ about [translated] *"air collisions involving birds"*. The then Minister of Agriculture, Nature and Food Quality (LNV) briefly summarised the responsibilities in her response¹¹⁹ as follows: [translated] *"Amsterdam Airport Schiphol is responsible for combating the presence of birds on the airport terrain. The Province of Noord-Holland is responsible for controlling and managing bird populations in the environs of Schiphol. The Fauna Management Units and game management units are responsible for implementing control measures. They are granted exemptions for deterrence measures and culling from the provincial authorities for this purpose."*

In late 2008, an expert meeting with 'goose experts' was arranged under the auspices of the IVW (Schiphol regional office) in order to discuss the problem and necessary solutions. Proposed solutions included: research into goose migration patterns, reduction of corn as a food source in the Haarlemmermeer polder and the evaluation of population reduction measures. In response, Schiphol commissioned a study into the effects of the faster ploughing under of corn stubble in the summer on the attraction of geese.

In 2009, Schiphol sent a letter¹²⁰ to the then minister of Transport, Public Works and Water Management and minister of Agriculture, Nature and Food Quality, also on behalf of the Schiphol Safety Platform, reiterating the risks of bird strikes: [translated] *"We hereby wish to draw your attention to the increasing risk to flight safety presented by the sharp rise in the goose population in the Netherlands and around Schiphol (...). As a result of their size and flight behaviour, geese constitute a major risk to flight safety and the growing goose population is leading to an ever increasing risk of an accident at Schiphol"*. The letter specifically requested the introduction of a [translated] *"task force (...) under the auspices of the former Ministry of Transport, Public Works and Water Management with responsibility for studying the goose problem in the environs of Schiphol and advising on potential solutions"*. The proposed composition of the task force was as follows: two ministries (the Ministry of Transport, Public Works and Water Management and the Ministry of Agriculture, Nature and Food Quality), three provinces and the members of the Schiphol Safety Platform. The task force should fall under the authority of the Ministry of Transport, Public Works and Water Management.

117 Letter of 5 November 2007 from the CVL to the Minister of Transport, Public Works and Water Management and the Minister of Defence on the topic of 'The growth of the goose population and its impact on flight safety'. In concrete terms, the recommendation called for:

- the Ministry of Agriculture, Nature and Food Quality to take aviation risks into account in its goose policy
- an initiative to develop policy in relation to fauna management in the environs of airports
- research into how information about bird mobility can be used by bird control units and air traffic controllers and the role that a bird detection system can play in this process.

118 The members Schreijer-Pierik and Haverkamp (CDA).

119 Letter in response to Parliamentary questions on bird strikes from the Minister of Agriculture, Nature and Food Quality dated 14 January 2008, reference DN. 2007/3675.

120 Letter from the chairman of the Schiphol Safety Platform, the Executive Vice President & Chief Operations Officer of Schiphol Group, and the Airport Manager of Amsterdam Airport Schiphol to the Minister of Transport, Public Works and Water Management and the Minister of Agriculture, Nature and Food Quality, on 5 March 2009, on [translated] *"Reducing the risk to flight safety presented by the increase in the goose population in the environs of Schiphol"*. Copies of the letter were sent to the members of the Schiphol Safety Platform Steering Committee and the provincial authorities of Noord-Holland, Zuid-Holland, Utrecht and Flevoland.

Dutch Bird Strike Control Group

In response to Schiphol's specific request, the Director-General for Aviation¹²¹ stated that a coordination group would be set up as a [translated] "*forum for all parties involved in the bird strike issue*" with the aim of [translated] "*gaining a better understanding of the issue of bird strike and promoting the exchange of information. The purpose of the platform is also to encourage cooperation and to coordinate between authorities and nongovernmental organisations involved in reducing the risk of bird strikes. Sharing local issues at a national level will help to create mutual added value in terms of strategies for combating bird strikes (best practices)*". The exchange of letters included discussions regarding the independent chairmanship and the mandate of the coordination group to be set up.

In response to Schiphol's request, the then Ministry of Transport, Public Works and Water Management took the initiative to introduce the Dutch Bird Strike Control Group (NRV). The NRV encompasses parties from the aviation sector and parties operating in the agricultural and wildlife sectors (see section 3.4).¹²² The first meeting of the NRV took place on 11 June 2010. The municipality of Haarlemmermeer organised a working conference on bird strikes in November 2010, while the NRV held a symposium entitled "Bird-free aviation" on 10 March 2011.

In view of the goose problem, an official preparatory committee of the control group was set up in collaboration with the NRV. This committee's action plan for 2010–2011 included the following relevant projects:

- Trend and risk analysis of goose species in relation to flight safety.
- Influencing of land planning in the environs of Amsterdam Schiphol Airport.
- Monitoring of overflying geese (origin and numbers).
- Deterrence and population reduction through the use of falconers and hunters.
- Adapted crop scheme trial for arable land.

In order to immediately tackle the problem, the Schiphol Safety Platform applied for and received a subsidy from the DGLM in August 2010 to support the "geese and corn" pilot.¹²³

3.2 BIRD CONTROL ON THE AIRPORT GROUNDS

Under the 1944 Chicago Convention¹²⁴ Amsterdam Airport Schiphol is obliged in the context of reducing collisions with animals to:

- gather information about the presence of animals at and around the airport that could potentially pose a risk to aircraft operations
- continuously review wildlife risks
- take measures to reduce the risk of collisions
- take measures to prevent or eliminate the creation of sources that attract animals to the airport.

As stated in the previous section, Amsterdam Airport Schiphol set up a Bird Control Unit in 2005. The unit consists of a policy adviser, a wildlife manager, and fifteen bird controllers. Since 2005, the unit has worked in five shifts on activities entirely dedicated to the deterrence of birds. Three bird controllers (two as a minimum) are active during the daylight hours, with one bird controller covering the night shift.

121 Letter from the Director-General of the DGLM to the chairman of the Schiphol Safety Platform on 6 May 2009.

122 At the same time as the creation of the NRV, the CVL was formally disbanded by means of repealing the decision to establish the committee.

123 Subsidy in the context of activities relating to geese and flight safety at Amsterdam Schiphol Airport, decision in favour of Schiphol Safety Platform on 2 August 2010.

124 Convention on international civil aviation, Annex 14, Part I (Aerodrome Design and Operations).

Bird control by Amsterdam Airport Schiphol consists of the following elements:

- preventing birds from settling on or around Schiphol's runways by means of habitat management: mowing policy, grass management, water management and management of shrubs and trees
- continuous deterrence (24 hours per day, 365 days per year) using stationary and mobile deterrents
- researching and developing methods of making the terrain unattractive to birds and more permanent deterrents
- as a last resort: shooting birds that cannot be deterred and that present a continuous risk to flight safety, on the basis of an exemption granted to Amsterdam Airport Schiphol for this purpose under the Flora and Fauna Act.

The Bird Control Unit also keeps a record of bird strikes and maintains the necessary contact with Air Traffic Control the Netherlands, airlines and ground staff. If bird remains are found on aircraft, experts are called in to identify the species of bird involved.

The Schiphol Company Manual refers to and describes "Fauna incident prevention" by the airport.¹²⁵ In this, Schiphol states: [translated] *"AAS is responsible for ensuring that runways and taxiways are made available to air traffic control without obstacles. The area stipulated in the airport planning decree is the target area for the implementation of fauna incident prevention (...) Fauna incidents that occur during landing below 200 feet and during takeoff up to an altitude of 500 feet are classed as 'on airport' and therefore fall within the scope of this procedure"*. Schiphol has its own wildlife policy plan on the basis of which fauna incident prevention is carried out and the exemption from the Flora and Fauna Act was granted.

In practice, the Bird Control Unit works in close cooperation with the Game Management Unit for the Haarlemmermeer and its surroundings,¹²⁶ the provincial Fauna Management Unit and the provincial authorities. An operational committee has been set up to this end: the Schiphol Goose Roundtable. The working area for the collaboration corresponds with the area to which the exemption granted to Schiphol and the Fauna Management Unit applies. In February 2008, the exemption granted to the Fauna Management Unit for the purpose of tackling the goose problem was increased from a 6-kilometre to a 10-kilometre zone around the airport.

The Schiphol Safety Platform drew up a [translated] *"2010-2011 Schedule for tackling the goose problem at Schiphol"* at the start of 2010, comprising activities in the following areas: policy development (for the longer term up to 2015 together with the administrative control group), monitoring and research (for instance into the origin of geese, counts within the 10-kilometre zone and monitoring of overflying geese), deterrence and population reduction (operational bird control and encouraging population reduction by provincial authorities) and tackling goose food sources (the corn pilot).

The IVW monitors compliance with the aviation regulations by Amsterdam Airport Schiphol, Air Traffic Control the Netherlands and the airlines. As part of this, the IVW also supervises the airport's bird control activities. The Inspectorate has the power to take enforcement measures. No bird control audits have as yet been carried out in practice.

3.3 RELEVANT ACTIVITIES IN THE ENVIRONS OF SCHIPHOL

With regard to bird control in the environs of Schiphol, it is important to make a distinction between population control (fauna management) and the land use that affects the bird population and bird movements around the airport.

125 AAS Company Manual, version dated 2 January 2011, p. 105 et seq. Based on the statutory principles set out in Part 3 of the ICAO Airport services manual and Part 8, chapter 9 of the ICAO Airport services manual.

126 Hereinafter referred to as WBE Haarlemmermeer.

Fauna management

The Noord-Holland Fauna Management Foundation¹²⁷ is authorised to carry out bird control in the form of fauna management. The provincial authorities have granted an exemption allowing the Fauna Management Unit to combat, deter and hunt goose populations for the purpose of damage control. In practice this is carried out by game management units, which actually implement the control measures.

The provincial authorities are responsible for implementing the Flora and Fauna Act in accordance with policy. The following frameworks apply to the goose problem around Schiphol and the options for taking control measures:

National: the national Fauna Management Policy Framework was drawn up in 2003 (revised in 2004) in consultation between the then Ministry of Agriculture, Nature and Food Quality, various civil society organisations¹²⁸ and the Fauna Fund in agreement with the Association of Provincial Authorities. This concerns policy in relation to wintering geese. The aim of the Policy Framework is the long-term preservation of wintering geese and wigeons, arising from the Netherlands' international responsibility for protected species (Birds Directive). The Netherlands has designated habitat areas for wintering geese. The Policy Framework also sets the preconditions for control (deterrence and culling), for the limitation of agricultural damage caused by these birds.¹²⁹ The policy framework also includes a section about summering geese. This Policy Framework was reviewed in 2009, and the Lower House was informed of the outcome.¹³⁰ The section on summering geese in the policy framework led to the [translated] "Summering geese" guide¹³¹ and was sent to the provincial authorities by the then Minister of Agriculture, Nature and Food Quality with the request for its inclusion in fauna management plans. This guide supports provinces and fauna management units to formulate policy in relation to summering geese at a local level. The main aim of the policy is not to control the goose populations, but to prevent damage caused by summering geese by taking damage limitation measures.

127 The following take part in the governance of the Fauna Management Unit Noord-Holland: Federatie Particulier Grondbezit (Federation of Private Landowners), Staatsbosbeheer (the Netherlands National Forest Service), Natuurmonumenten (Society for the Preservation of Nature in the Netherlands), Koninklijke Nederlandse Jagersvereniging (Royal Dutch Hunting Association), Landscape Noord-Holland, LTO (Federation of Agriculture and Horticulture), NV PWN Waterleidingbedrijf Noord-Holland (Noord-Holland Water Supply Company), Gemeentewaterleidingen Amsterdam (Amsterdam Municipal Water Supply Organisation) and Goois Natuurreservaat (Gooi Nature Reserve Foundation).

128 Including the Federation of Agriculture and Horticulture (LTO), the Royal Dutch Hunting Association and the Netherlands Society for the Protection of Birds.

129 [Translated] *Implementation of the Fauna Management Policy Framework in relation to wintering geese and Wigeons from 1 October 2004 (revised version)*, Ministry of Agriculture, Nature and Food Quality, October 2004. Amongst other things, this document states: [translated] "On 1 December 2003 almost all provincial authorities made it possible to deter geese and wigeons, supported by culling, on plots sensitive to damage containing arable crops, rich soil produce or newly sown grass (first phase of the Policy Framework). In addition, goose habitat agreements have been concluded with the Fauna Fund in respect of around 15,000 hectares, mainly in the north of the country, to provide deterred animals with resting and foraging areas."

130 [Translated] *Review of 2005-2008 habitat policy for wintering geese and wigeons*, Ministry of Agriculture, Nature and Food Quality and Fauna Fund, July 2009. The review states: [translated] "The reduction of damage outside the habitat areas has been unsuccessful: the damage level remained the same during the period studied. The designated foraging areas and nature conservation areas provide a welcome habitat for around 60% of the goose population. (...) However, 40% of the goose population still remain outside of these areas. The current suppression and deterrence policy has not yet led to a higher concentration in the habitat areas."

131 [Translated] *Guide to policy in respect of summering geese*. Guidelines on summering geese for provinces and fauna management units. Ministry of Agriculture, Nature and Food Quality, September 2007.

Provincial: the provincial authorities have set out their policy in the Flora and Fauna Act Policy Document for Noord-Holland.¹³² The provincial flora and fauna unit for the Province of Noord-Holland drew up an additional Noord-Holland Goose Policy Implementation Framework in 2009. The purpose of this is to describe the measures and their sequential order for the purpose of combating damage by geese in the Province of Noord-Holland with due consideration for the importance of protection. This is described as follows: [translated] *"On drafting this Goose Policy Implementation Framework, efforts were made to achieve a balance between protection and damage control. The motto is to first take the least drastic measures."* A summary can be found in Attachment 3.

Implementation: the Noord-Holland Fauna Management Plan is required by law and provides a framework for the actual granting of exemptions under the Flora and Fauna Act. The Fauna Management Unit submits this plan to the Provincial Executive for approval. The Fauna Management Plan stipulates 'population targets' for relevant species of wildlife, including geese. These are the minimum populations for the preservation of the species, based on the protection objective.

In practice, the Game Management Units (*Wildbeheereenheid*, WBE) are groups of often volunteer hunters. They notify the provincial authorities in advance of any plans to make use of the exemption and take action. It is important to note that the exemptions do not make implementation compulsory. They confer a right that may or may not be used. The Fauna Management Unit coordinates the target stipulated in the fauna management plan with the Game Management Units. The Fauna Management Unit provides feedback on actual hunting activities to the provincial authorities. In 2009, except for in the 10-kilometre zone around Schiphol, the Game Management Units did not cull any geese in the Province of Noord-Holland.¹³³ Birds were indeed culled in the other years.

Several Game Management Units operate in the environs of Schiphol.¹³⁴ To allow these Game Management Units to carry out their work, the Provincial Executive granted 46 exemptions¹³⁵ each year from 2005 to 2010 inclusive. The Haarlemmermeer Game Management Unit covers the entire Haarlemmermeer polder; an area of 18,500 hectares. Amsterdam Schiphol Airport falls within this zone. The Haarlemmermeer Game Management Unit consists of around 190 hunters.

Land use

A number of types of land use around Schiphol are relevant in the context of preventing bird strikes,¹³⁶ such as (types of) agricultural, nature conservation and water areas.

Many parties have an influence on actual land use and management in the wider environs of Schiphol, depending on landownership and the primary objectives of landowners and managers. The main parties are: agricultural companies, terrain management organisations such as the Society for the Preservation of Nature in the Netherlands, Landscape Noord-Holland and water management organisations. Authorities such as the Municipality of Haarlemmermeer, neighbouring

132 Flora and Fauna Act Policy Document for the Province of Noord-Holland, November 2007. This policy document is a review of the document adopted in 2002 and partly amended in 2006. Page 18 of the document states: [Translated] *"The Minister of Agriculture, Nature and Food Quality has not issued a general exemption for summering geese. The Provincial Executive feels that the goose problem has grown to such an extent that a fauna management plan on its own is insufficient. A separate policy framework will therefore be drawn up for summering geese. This policy framework will set out specific policy and measures in respect of the problem of summering geese. The Provincial Executive will draft the policy framework in collaboration with the relevant parties in the field, including the Fauna Management Unit, agriculture, wildlife conservation, Schiphol, the Fauna Fund, neighbouring provinces, the Ministry of Agriculture, Nature and Food Quality and the Directorate-General for Public Works and Water Management"*.

133 Noord-Holland Fauna Management Unit Foundation, Annual Fauna Management Plan Implementation Report for 2009, August 2010.

134 WBE Haarlemmermeer and environs; WBE Amstelland, WBE Spaarnwoude, WBE Zuid-Kennemerland, WBE Duin- and Bollenstreek, WBE Aarlanden and Oud Ade.

135 The law stipulates a sequential order for animal control measures: deterrence, disturbing, trapping and culling. The requirement for preventive measures does not apply in the environs of Schiphol, and it is possible to proceed directly to culling. A distinction is made between exemptions for population control and exemptions to prevent damage to a plot. Consequently, the land user is entitled to combat damage to his plot himself using a gun. Source: interview with the provincial authorities of Noord-Holland.

136 See for instance the underlying recommendation for the drafting of the Airport Planning Decree of the Dutch Task Force for the Prevention of Bird Strikes with Civil Aviation Aircraft and (international) publications by the International Bird Strike Committee, amongst others.

municipalities and the Province of Noord-Holland have a direct influence on this based on the normal spatial development frameworks.

The restrictions on bird-attracting activities in the 6-kilometre restricted zone around Schiphol (under the Airport Planning Decree) have a direct effect. This means that municipalities and provincial authorities cannot issue licences for the development of new bird-attracting activities. The IVW supervises this and assesses any applications for 'Certificates of No Objection' on the Minister's behalf.¹³⁷

The strategic, tactical and operational activities carried out by the parties (from spatial planning to land use and management and control of damage by birds) have primary objectives that are not bird control, but are indeed relevant to the issue of bird control.

3.4 CURRENTLY INVOLVED PARTIES, CONSULTATIVE BODIES, INTEREST GROUPS AND STRATEGY OF THE DUTCH BIRD STRIKE CONTROL GROUP

Figure 16 shows the network of parties involved in bird control at and around Schiphol. The figure is set up around the existing consultation forums the Dutch Bird Strike Control Group (NRV – red) and the Schiphol Safety Platform (SSP – blue).¹³⁸ On the left side of the figure are aviation-related authorities (blue) and on the right land use-related authorities (green).

The authorities coloured orange are authorities that can perform actual management activities. The other authorities are involved in a regulatory or policy-related capacity and/or as dialogue partners.

AVIATION/AVIATION SAFETY

LAND USE: NATURE MANAGEMENT/ AGRICULTURE/WATER

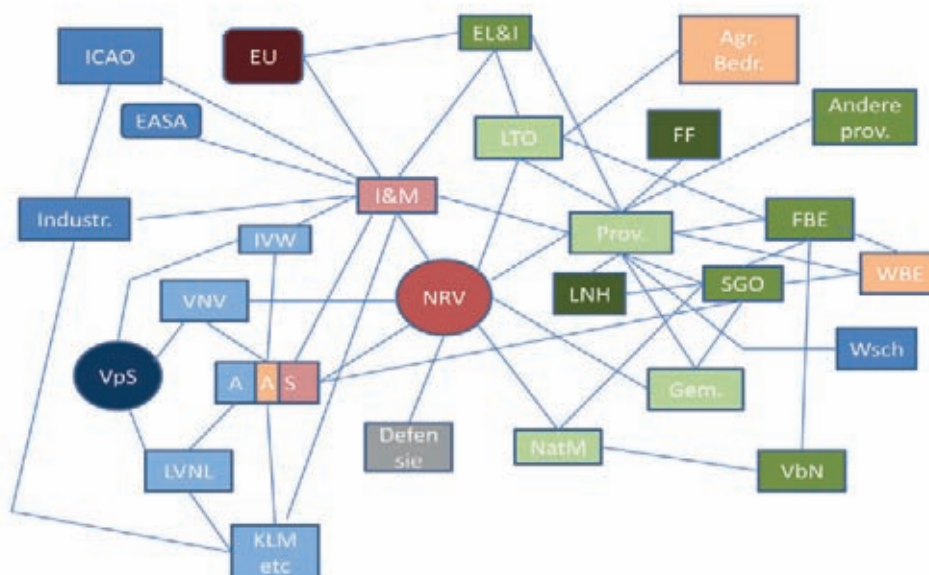


Figure 16: authorities involved in bird control at and around Amsterdam Schiphol Airport

137 Airport Planning Decree, Article 2.2.3 paragraph 3. The Aviation Act sets out the grounds on which a Certificate of No Objections can be refused: 8.9 paragraph 4. A certificate of no objection relating to airport grounds can be refused in view of the use of this area as an airport. 8.9 paragraph 5. A certificate of no objection relating to a restriction zone can be refused in view of safety and noise levels in connection with the proximity of the airport.

138 Attachment 4 contains an organisation chart showing the relationship between the Schiphol Safety Platform and the Dutch Bird Strike Control Group, at the time of Amsterdam Airport Schiphol's request for the introduction of a task force to the former Ministry of Transport, Public Works and Water Management, by letter dated 5 March 2009.

Aviation and aviation safety		Land use	
abbreviation	name	Abbreviation	name
ICAO	International Civil Aviation Organization	EL&I	Ministry of Economic Affairs, Agriculture and Innovation
EASA	European Aviation Safety Agency	Prov.	Province of Noord-Holland
I&M	Ministry of Infrastructure and the Environment	Gem.	Municipality of Haarlemmermeer
VNV	Vereniging van Nederlandse Verkeersvliegers (Dutch Airline Pilots Association)	Andere prov.	Province of Zuid-Holland; Province of Utrecht
Industr.	Aircraft manufacturers	Agr. bedr.	Agricultural companies in the environs of Schiphol
AAS	Amsterdam Airport Schiphol	Wsch	Rijnland Water Board
LVNL	Air Traffic Control the Netherlands	NatM	Natuurmonumenten (Society for the Preservation of Nature in the Netherlands)
KLM	KLM Royal Dutch Airlines	LNH	Landscape Noord-Holland
Defensie	Ministry of Defence	Land use: management, advice, lobbying	
VpS	Schiphol Safety Platform	LTO	Federation of Agriculture and Horticulture
IVW	Transport, Public Works and Water Management Inspectorate	FF	Faunafonds (Fauna Fund)
NRV	Dutch Bird Strike Control Group	FBE	Fauna Management Unit Noord-Holland
Coordination of safety/land use		WBE	Game Management Units
SGO	Schiphol Goose Roundtable	VbN	Netherlands Society for the Protection of Birds

Table 9: legend and explanation of abbreviations used in figure 16

The authorities are shown as a network, as a large number of parties are involved in the bird strike issue. Each party has its own position in this network based on its normal powers and responsibilities (see figure 16). They seek to coordinate their activities within the NRV, which has been set up especially to tackle this issue. The NRV therefore appears at the centre of this network.

The Dutch Bird Strike Control Group (NRV) met for the first time on 11 June 2010 and is a platform for coordinating strategies to reduce the risk of bird strikes around Schiphol. The NRV has set itself the goal of [translated] "(...) *helping to improve aviation safety and reduce the risk of bird strikes by jointly coordinating the various particular interests of aviation, agriculture and nature conservation, and achieving a balance between these interests.*"¹³⁹

The NRV is a consultative body with an independent chairman. The NRV does not have any powers that are separate or additional to those of the participating parties. Attachment 5 contains a description of what the NRV considers to be its powers and responsibilities. The NRV has been set up for three years, whereby [translated] "*The emphasis lies in the first instance on sharing awareness of the risk of bird strikes for air traffic safety and on drawing up long-term policy with measures to control and reduce this risk (...) The focus for the coming period is on Schiphol, with four categories of specific measures*".¹⁴⁰

The participants in the NRV are committed to the strategy for Schiphol. The essence of the NRV's strategy is to tackle the bird strike issue, focusing on preventing the dangerous presence of birds outside the airport terrain and limiting the number of overflying (runway crossings by) birds. The NRV's strategy for Schiphol comprises four cornerstones that the NRV believes must be combined and implemented in the following order:¹⁴¹

1. Population reduction (continued deterrence and hunting of geese geared towards a 'learning effect').
2. Limitation of foraging areas and possibilities in the airport's environs (prevention through cultivation of agricultural land and crop diversification).
3. Limitation of resting and brooding areas in the airport's environs (no new wildlife development within a specific radius of Schiphol).
4. Technical measures aimed at (radar) detection of birds and bird movements.

These cornerstones largely correspond with the focus areas for an effective approach set out, for instance, by the IBSC and international frameworks. It has also been established that the forerunner of the NRV, the CVL, had identified and was propagating these strategies for a long time prior to the Royal Air Maroc serious incident on 6 June 2010. It is important for the Dutch Safety Board to establish to what extent these cornerstones were actually implemented prior to this serious incident.

139 Dutch Bird Strike Control Group, initial policy document 11 June 2010. The following parties take part in the NRV: DGLM, Director for Aviation; Province of Noord-Holland, member of the Provincial Executive; Schiphol, Executive Vice President and COO, as well as the Director of Airport Operations; Dutch Airline Pilots Association, board member; Royal Netherlands Air Force, Commander of the Royal Netherlands Air Force; Society for the Preservation of Nature in the Netherlands, director; Federation of Agriculture and Horticulture LTO Nederland, chairman for LTO Noord. The following parties are informal members: the Provinces of Utrecht and Zuid-Holland, Ministry of Economic Affairs, Agriculture and Innovation, and the Netherlands Society for the Protection of Birds.

140 Dutch Bird Strike Control Group, Initial Policy Document, 11 June 2010.

141 Dutch Bird Strike Control Group, Initial Policy Document, 11 June 2010.

4 ANALYSIS

4.1 SAFETY MANAGEMENT: INTERNATIONAL STANDARDS AND RECOMMENDATIONS

Aviation authorities in the Netherlands are obliged to control the risk of bird strike based on internationally agreed standards laid down by ICAO. ICAO stipulates that countries and airports themselves must identify, structure and take measures to combat wildlife risks.¹⁴² This can involve a very wide range of conditions (depending on habitat, ecology, airport, land use and so on). ICAO grants states a great deal of scope and leaves room for an airport-specific and country-specific interpretation, including the question of which player(s) must take a leading role in controlling the risk of bird strike. ICAO therefore refers to “responsible authorities” to allow scope for national differences.

It is important to note that ICAO does not describe in detail how the risk of bird strike should be controlled, the acceptable risk presented by the presence of birds in aircraft flight paths, or the precise measures that need to be taken. ICAO places an emphasis on a structured and cyclical strategy to tackle bird strike and stresses that measures must be taken when a dangerous situation occurs *“to decrease the number of birds constituting a potential hazard to aircraft operations”*.¹⁴³

The foregoing means that there is no strict ‘standard’ that could be used to assess the bird control strategy at and around Schiphol. Considerable efforts have been made at an international level to elaborate the best possible bird control strategy in the form of recommendations, including by the International Bird Strike Committee (IBSC).¹⁴⁴

The safety management aspects that the Dutch Safety Board considers to be important bear a strong resemblance to the ICAO requirements and recommendations. The key is to identify the risk, take measures, monitor and assess their effectiveness in terms of the risk to be managed,

142 ICAO Annex 14 *Aerodrome design and operations*, chapter 9 *Bird hazard reduction*. ICAO Doc 9137 Part 3 – *Birdcontrol and Reduction*. ICAO Doc 9332 *International Birdstrike Information System (IBIS) Manual*. Main points from these documents:

- ICAO Annex 14: “*The bird strike hazard on, or in the vicinity of, an aerodrome shall be assessed through: a) the establishment of a national procedure for recording and reporting bird strikes to aircraft; and b) the collection of information from aircraft operators, airport personnel, etc. on the presence of birds on or around the aerodrome constituting a potential hazard to aircraft operations.*”
- ICAO Annex 14: “*When a bird strike hazard is identified at an aerodrome, the appropriate authority shall take action to decrease the number of birds constituting a potential hazard to aircraft operations by adopting measures for discouraging their presence on, or in the vicinity of, an aerodrome*”
- ICAO Annex 14: “*The appropriate authority shall take action to eliminate or to prevent the establishment of garbage disposal dumps or any such other source attracting bird activity on, or in the vicinity of, an aerodrome unless an appropriate aeronautical study indicates that they are unlikely to create conditions conducive to a bird hazard problem.*” In the Netherlands these rules are set out in the Schiphol Airport Planning Decree (LIB).
- ICAO Doc 9137, chapter 10: The spatial restrictions are: “*fish processing, agriculture, cattle feed lots, garbage dumps and land fill sites, factory roofs and parking lots, theatres and food outlets, wildlife refuges, artificial and natural lakes, golf-, polo-courses, animal farms, slaughter houses*”. In the Netherlands these rules are set out in the Schiphol Airport Planning Decree (LIB).
- ICAO Doc 9137: “*Effective wildlife control policies and programmes should be centrally administered by the national authority responsible for airports*”.

143 ICAO Annex 14, 9.4.3.

144 International Bird Strike Committee (IBSC): Recommended practices; *Standards For Aerodrome Bird/Wildlife Control*, Oct. 2006. These rules are not compulsory, but instead a ‘best practices guideline’. A number of key international recommendations include:

- IBSC, recommendation 9: “*Where national laws permit, airports, or airport authorities, should seek to have an input into planning decisions and land use practices within the 13 km bird circle for any development that may attract significant numbers of hazardous birds/wildlife. Such developments should be subjected to a similar risk assessment process*”.
- Research has been conducted in the United States of America into effective methods of making the land around airports less attractive to birds: Federal Aviation Agency (FAA); Airport Cooperative Research Program (ACRP) Report 32, *Guidebook for Addressing Aircraft/ Wildlife Hazards at General Aviation Airports*, Washington D.C., 2010. This document contains the recommendation: “*Avoid production of cereal grains and sunflowers. Weigh the cost of wildlife control and potential accidents against the income produced by the crops*”.

effective control, fine-tuning and communication. Chapter 2 of this appendix has already stated that the issue of bird strikes around Schiphol must be kept under control by a network of players and that coordination is essential here in the areas of overlap between their individual activities and powers.

A number of findings with regard to bird control at and around Schiphol, as carried out by the relevant parties in recent years (section 4.2), are first set out below. Then is established the extent to which the network takes a coordinated approach (section 4.3) and the possibilities for effective control of the bird strike risk (section 4.4).

4.2 FINDINGS

Schiphol endeavours to combat the risk of bird strike through the Bird Control Unit. In this context, the airport collaborates with game management units within the existing laws and regulations. Schiphol (AAS) tackles and implements bird control on the airport terrain via a separate unit. The company carries out round-the-clock activities designed to deter birds and prevent bird strikes.

Policy and regulations

The Airport Planning Decree (LIB) is the only policy framework that is partly tailored to controlling the bird populations around Schiphol. The Airport Planning Decree sets out a list of specific activities and land use that are prohibited within a 6 kilometre zone. The Decree does not provide for types of agricultural land use that affect the attractiveness of fields for geese.

In addition, the Flora and Fauna Act states aviation safety as a ground for exemptions from the ban on disturbing, trapping or culling birds. However, in terms of exemptions, the Flora and Fauna Act and the Fauna Management Policy Framework focus primarily on preventing damage to agricultural crops by geese.

The remaining policy frameworks do not address the issue of bird control:

- Spatial development policy (Spatial Planning Act).
- Nature policy: the Policy Framework in relation to wintering geese and wigeons. The emphasis here lies on nature conservation objectives, including maintaining minimum populations of protected goose species.
- Agricultural policy: economically sound agriculture.

Schiphol has a direct and indirect influence on spatial planning and management in its wider environs (via consultations, lobbying, participation, objections and appeals). The company does not have a direct influence on land use that attracts birds on private property in the airport's environs. Schiphol has stated that it monitors the land that it owns within the immediate environs of the airport grounds. Schiphol ensures that no bird-attracting infrastructure or activities occur on this land. The Bird Control Unit issues guidelines to this end for the spatial planning and use of this land, which are included in contracts with private parties that use the land.

It is not possible to determine via the existing frameworks which agricultural crops can and which cannot be cultivated and how they should be managed (mowing, ploughing).

Policy and regulations are in place for the use of carbon dioxide as a method of stunning and culling animals in the context of population and damage control. The legal precedents show that this method cannot be of use for geese.¹⁴⁵

145 See the ruling under National Case-Law Number BP2285, District Court of Utrecht, SBR 10/2852, ruling on 02-02-2011. The case concerned an appeal by the Fauna Management Foundation against the Provincial Executive of Utrecht, in relation to an [translated] "exemption for the trapping of white-fronted geese using trap-cages, the gassing of Canadian geese and the trapping using trap-cages and subsequent gassing of greylag geese, barnacle geese, Egyptian geese and domesticated geese that have gone wild". The District Court concludes (in 2.8) [translated] "that insofar as the goose species referred to in the contested decision are protected under the Birds Directive, the contested decision lacks a sound legal basis (...) for the use of carbon dioxide as a culling method".

Implementation

Schiphol has been granted an exemption under the Flora and Fauna Act, which allows the Bird Control Unit to deter dangerous wildlife (in a broad sense) and cull animals where necessary, amongst other things. In 2007, Schiphol and the Province of Noord-Holland specifically addressed the bird strike risk presented by geese. Parties within the Schiphol Goose Roundtable have reached agreements for the purpose of reducing the number of geese in the 10-kilometre zone around Schiphol. This committee shares the generally accepted view that local hunting alone (within the 10-kilometre zone) is no longer sufficient to control the risk of bird strike, due to the size of the populations in the airport's wider environs.

The culling of geese around Schiphol has taken place on a more limited scale in recent years than provided for in the Fauna Management Plan. The first exemption for province-wide population control under the 2005-2009 Fauna Management Plan was not granted to the Noord-Holland Fauna Management Unit until 2007. A paradoxical situation occurred in which population growth was accompanied by an increase in the culling of geese and later also the treating of eggs in the Province of Noord-Holland in the years 2005 - 2008. The year 2009 was an exception because at that time, apart from in the 10-kilometre zone around Schiphol, no goose culling took place.¹⁴⁶ Goose culling has increased in this zone and there was a sharp rise in the number of eggs treated in the years 2008 - 2010.

Over the past few years, wildlife protection organisations, particularly the Fauna Protection Foundation (Stichting Faunabescherming), have filed objections and lodged appeals against the exemptions granted by the provincial authorities. Around 50% of exemptions have been successfully challenged in court. As a result, exemptions are granted on a more limited scale than was envisaged.

Legal precedent concerning exemptions from the Flora and Fauna Act.

Court rulings have mainly been based on the following considerations:

- Have the provincial authorities been able to produce sufficient evidence that there are no other satisfactory solutions in terms of population-reducing measures than those proposed here? The provincial authorities must be able to demonstrate that there are no other solutions, for instance by showing that preventive measures have also been taken.
- Has the exemption been granted for legally permitted methods and means? If not, this contravenes the Bird Directive (insofar as the case relates to birds that fall within the scope of the Birds Directive) and an exemption therefore cannot be granted under the Flora and Fauna Act. For instance, gassing with carbon dioxide is not explicitly permitted by law and an exemption therefore cannot be granted for this (unless the case relates to birds that do not fall within the scope of the Birds Directive).¹⁴⁷
- No actual damage needs to have been caused. What is relevant is whether there is a plausible risk of major damage.
- Sufficient grounds must be put forward to support a specific risk of damage.

The provincial authorities themselves must verify that there are no other satisfactory solutions and cannot leave this assessment to the party to whom they are granting the exemption. Moreover, this assessment must be carried out before the decision as to whether or not to grant an exemption is taken.

¹⁴⁶ Noord-Holland Fauna Management Unit Foundation (FBE), Annual Fauna Management Plan Implementation Report for 2009. The FBE established that: [translated] "*The management of the FBE has ascertained that the impact of restrictive exemptions from 2005 and interventions resulting from court rulings have made it impossible to successfully implement provincial policy. The intention behind the policy to exercise restraint in the culling of animals has led to undesirable growth of the greylag goose population and unnecessarily high numbers of animals culled and to be culled*".

¹⁴⁷ It should be noted that the Province of Utrecht has appealed against this interpretation of the Birds Directive and that the case is being reviewed by the Council of State.

Incidentally, the courts do indeed take aviation safety into consideration. In a ruling by the court in preliminary relief proceedings in a case brought against the Provincial Executive in relation to the exemption granted to Schiphol for the 10-kilometre zone, the court decided in favour of the provincial authorities.¹⁴⁸

According to case law, many cases after 2007 have been judged in favour of the authority that granted the contested exemption(s). Nevertheless, these legal disputes have severely delayed and impeded the adoption of timely measures in the interest of aviation safety.

In 2009, the Noord-Holland Fauna Management Unit, apart from within the 10-kilometre zone around Schiphol, did not make use of the exemption for combating damage by geese: no actual culling took place.¹⁴⁹ The game management units objected to the exemption system and its practicability.

According to the provincial authorities, however, the grounds put forward by the Fauna Management Unit in the 2009 Fauna Management Plan et seq. supporting the need to hunt specific species of animals, including geese, was insufficient. The provincial authorities stated that the basis for Schiphol's exemption is straightforward in view of the local danger and the low bird flyovers.

The provincial authorities felt that the link between the populations and aviation safety within a larger radius had not been legally demonstrated to a sufficient extent. The authorities therefore required the Fauna Management Unit to put forward a stronger argument with regard to aviation safety.

The number of geese has risen sharply in recent years for various reasons. According to many of the parties interviewed, culling in the context of damage control was still only having a limited effect at the time of the serious Royal Air Maroc incident due to the large numbers. Larger-scale methods such as trapping and the use of carbon dioxide had proven effective in other regions (Texel, 2008), but had been rejected by the court in Utrecht.

The efforts of the parties involved largely focus on removing birds in the airport's environs that constitute a potential risk. These efforts are reactive. A more proactive approach through population control is impeded by policy and regulations (use of carbon dioxide) and by administrative and social factors. Public opposition to large-scale population control measures has been considerable. This has taken the form not only of legal proceedings but also (death) threats sent to the addresses of provincial administrators who advocate population control.

Provincial policy and its implementation has been limited to the Province of Noord-Holland, while the growth in the goose population and its impact on goose movements is an issue that affects several provinces, namely Noord-Holland, Zuid-Holland, Utrecht and Flevoland.

148 National Case-Law Number: BD2863, court in preliminary relief proceedings of the District Court of Haarlem, AWB 08-2700 and 08-2703, ruling dated 27 March 2008. Amongst other things, the court found that: [translated] *"It has been established that there was a rise in the number of collisions between geese and aircraft in the environs of Schiphol in 2007. In this context and following a recommendation to this effect by the Fauna Fund, the respondent granted a request from the Fauna Management Unit for an exemption under articles 68 and 72, paragraph five, of the Flora and Fauna Act for the culling of greylag geese and domesticated geese that have gone wild, as well as for the destruction of nests and gathering of eggs of greylag geese and domesticated geese within a 10-kilometre radius of Schiphol for the period from 1 February 2008 to 1 January 2009. According to the decisions, the respondent argues that there are no other satisfactory solutions and that the successful conservation of this species will not be placed at risk. (...) Although it has not yet been established with certainty that the geese that cross Schiphol's airspace actually come from the 10-kilometre zone around the airport - a study has now been launched to determine this - the court in preliminary relief proceedings considers that it cannot be said that the respondent could not reasonably have granted the contested exemptions. It is important to note that aircraft engines, except for the very latest models, are not guaranteed to withstand impact from geese and that the consequences of goose strikes can (therefore be) exceptionally serious."*

149 Noord-Holland Fauna Management Unit Foundation, Annual Fauna Management Plan Implementation Report for 2009, August 2010.

Feedback from implementation to policy

The government has been alerted on a number of occasions to the problem of bird control in the environs of Schiphol. Schiphol raised the issue of the increasing risk of bird strikes several times with the then Ministry of Transport, Public Works and Water Management, certainly since 2007 and resulting in an incendiary letter to the minister in 2009.

This letter specifically asked the government to address those aspects of the bird strike issue that lie outside the authority and scope of Schiphol's exemption for the purpose of taking its own bird control measures. The Fauna Fund stated to the minister of Economic Affairs, Agriculture and Innovation (EL&I) that provincial powers under the Flora and Fauna Act were unclear with regard to the use of carbon dioxide as a method for culling greylag geese, in connection with the significant damage caused by the growing population. The provincial authorities also called to the government to change the regulations on the use of carbon dioxide.

It has been concluded that there is a need for a sound mechanism for feedback on and the adjusting of the wildlife management strategy. The population targets in the wildlife management plan are not performance targets, but instead benchmarks based on the conservation objective for the sound preservation of populations.

Wildlife management around Schiphol is in principle bound by the same administrative requirements and preconditions that apply to damage and population control. This also means voluntary, thus non-enforceable, implementation. Warning signs issued by the Haarlemmermeer Game Management Unit and the Fauna Management Unit that the wildlife management plan was not being implemented, which was also in the interest of aviation safety, did not immediately prompt the provincial authorities to make changes. According to the provincial authorities, applications for exemptions were not always adequate, and there was no adequate wildlife management plan for 2008. This led to a delay in the granting of exemptions for combating agricultural damage. Conversely, exemptions for the purpose of protecting aviation safety are not granted via the Fauna Management Unit and are issued and used directly. The provincial authorities also report that exemptions were occasionally issued too late and the procedure they were required to follow was too long.

The provincial authorities point out that under the Flora and Fauna Act, they are not entitled to apply for exemptions that they themselves are responsible for granting. This would lead to a conflict of interest. The Schiphol Goose Roundtable set up in 2008 has enabled the parties to better coordinate implementation and their policies in relation to bird control around Schiphol airport. This trend of bringing more structure to implementation and policy within the Schiphol Goose Roundtable is continuing.¹⁵⁰

The provincial authorities must take a wide range of interests into consideration: spatial planning in the environs of Schiphol, based on the normal policy and spatial planning frameworks. The economic development of the region also plays an important role. Moreover, the provincial authorities themselves are also required (by law) to preserve species and also grant exemptions for wildlife management in the context of aviation safety. The above activities are not aimed at aviation safety.

The Ministry of Economic Affairs, Agriculture and Innovation acknowledges the need for bird control, but despite warning signs in practice does not feel that it needs to play a direct role in tackling this problem as the Provincial Executive is responsible for population control. The ministry acknowledges that it is not clear whether the regulations or wildlife policy are satisfactory in view of the court rulings. A General Administrative Order is therefore being prepared in respect of the use of biocides that will amend the Animal Control and Damage Reduction Decree.¹⁵¹ The ministry does not take a position regarding the problem that it affects several provinces.

150 [Translated] *Schiphol Goose Roundtable Review*, Tauw, 20 July 2011.

151 The VROM Inspectorate classes the use of carbon dioxide to cull birds in the context of population and damage control as an acceptable biocide application. For this to be permitted, the minister of Infrastructure and the Environment must issue an exemption or approval to the party carrying out the goose trapping activities under the Plant Protection Products and Biocides Act.

In 2007 and 2009, the CVL and the Schiphol Safety Platform asked central government to take measures to limit the risk of bird strikes. They called for a task force to tackle the problem. The government (Ministry of Infrastructure and the Environment) responded by setting up a coordination platform: the NRV (2010). This platform does not have any independent powers or overriding authority. It is used to coordinate the activities of existing organisations with existing powers.

4.3 SAFETY STRATEGY WITHIN THE BIRD CONTROL NETWORK

As stated, private and public organisations from various policy areas are involved in the issue of bird control: aviation, nature management, agriculture and spatial planning. The investigation has shown that the parties involved have different views on the nature and scope of the bird control issue and of the required solutions and measures. Attachment 2 contains a summary of these views as revealed by the Board's investigation.

The interviews show:

- that bird strikes are broadly recognised to be a problem
- that definitions of the causes differ and vary widely:
 - excessively large goose populations in the environs of Schiphol, thus increasing the chance of bird strike
 - the problem is not the size of the populations, but instead goose movements (runway crossings)
 - the problem is a lack of coordination of air transport movements based on observed goose movements (in this case the inability to delay take-off procedures for financial reasons)
- that different causes are cited for the increased number of geese around Schiphol
 - an effect of nature policy that has established resting and brooding areas at and around bodies of water
 - an effect of the development of agricultural land use
 - an effect of inadequate population control (insufficient use of various methods: hunting, disturbing nests, trapping and the use of carbon dioxide)
- that parties have different interpretations of the scope of their own powers and the powers of other parties:
 - the provincial authorities have free rein to carry out effective population control versus the provincial authorities are restricted by legal frameworks and are therefore ineffective
 - agricultural and nature policy can only be changed by the Ministry of Economic Affairs, Agriculture and Innovation versus Economic Affairs, Agriculture and Innovation does not play a role or have powers in this context due to the decentralisation of wildlife and nature policy
- that parties are seeking solutions along fundamentally different lines of reasoning:
 - reducing the size of the goose populations helps to reduce the risk
 - the risk must be precisely determined according to the location, time and species of goose before highly targeted and effective action can be taken to reduce the risk identified
- that there are differing views on the possible measures:
 - agricultural measures are financially undesirable
 - control methods are undesirable: side effects of disturbing nests on other ecological values; harmful effect of the use of carbon dioxide on animals
 - limited opportunity for the application of nature management in a national and international context.

The investigation has revealed that there is no consensus between the parties involved regarding the nature and scale of the bird strike risk, specifically in the case of geese. This means that there is still a lack of clarity regarding the risk to be controlled, the possible control measures and their effectiveness.

Considerable public opposition to the culling of geese, in the form of legal opposition and anonymous threats addressed to administrators elaborating such measures, has at least partly impeded efforts to tackle the bird strike risk (in terms of population reduction).

Coordination within the network

The different views have been largely represented within the Dutch Bird Strike Control Group (NRV) and its predecessor the Aircraft Bird Strike Committee (CVL). By establishing this network, the Ministry of Infrastructure and the Environment has introduced a coordination mechanism for the issue of bird strikes. The coordination and liaison relates to possible actions within the powers of the participating parties.

Coordination at the time of the CVL prioritised gaining a greater insight into the problem over actual action to adjust, fine-tune and pursue a concrete strategy. Efforts to coordinate action on the basis of equality between the parties have not led to a focus on and prioritisation of measures. The parties still have differing views on which measures are (cost) effective, feasible and desirable and need to be taken in the short term. It is striking that many of the parties involved now describe population reduction as a necessary measure. In the Board's view, the same level of risk applied in 2009. Despite this, there was no increase in the structural use of the available bird control measures either in 2009 or 2010.

The purpose of the current NRV is to [translated] *"gain a greater insight into the issue of bird strikes and to encourage the exchange of information. The purpose of the platform is also to encourage cooperation and to coordinate between authorities and organisations, nongovernmental or otherwise, involved in reducing the risk of bird strikes."* The Dutch Safety Board's investigation has also revealed that the participating parties involved have differing views on the NRV's position and options. Whereas one feels that the "control group has been set up to determine who can be given control", others assert that the government needs to take decisive action on the issue of bird strike. The NRV claims that aviation safety is a problem for all the parties represented.

The investigation has shown that most of the parties argue strongly for participation of the Ministry of Economic Affairs, Agriculture and Innovation in generating solutions. Many parties within the network reject the Ministry's argument that this is a matter of decentralised policy, in view of the seriousness of the issue and the direct role that the Ministry of Economic Affairs, Agriculture and Innovation can play.

The provincial authorities of Noord-Holland emphasise the importance of proper legal instruments to enable them to meet their responsibilities for wildlife management in the context of bird strikes. Others point to central government in view of the complex balancing of interests required, the range of powers involved, Schiphol's national importance and the geographical scale of the ecology of the goose populations, which transcends administrative boundaries. In a broad sense, there is a strong call from the parties involved for clearly defined 'control' or 'ultimate responsibility'.

4.4 POSSIBILITIES FOR AN EFFECTIVE SAFETY STRATEGY TO TACKLE BIRD STRIKES AT SCHIPHOL

The effectiveness of coordination of the safety strategy to tackle bird strikes at Schiphol depends on:

- the scope of the powers and room for manoeuvre of the parties involved under the laws and regulations
- the availability of objective and reliable knowledge that can be shared by various parties in order to harmonise perceptions and views.

Insufficient powers and a lack of knowledge (uncertainty) mean that the perceptions of the problem, measures to be taken and anticipated effects are subject to debate. The issue and its solution are then passed back and forth between the players (from the government to provincial authorities, from nature to agriculture, from wildlife conservation to hunting).

Powers: failure to adapt legislation to changes

It is concluded that there has been a failure to adapt the laws and regulations in respect of nature and wildlife policy aimed at conserving goose populations in response to changes. These frameworks do not take into account the dynamic nature of the issue of bird strikes in the environs of Schiphol. The regulations focus on reactive measures: culling and deterrence instead of preventing excessive population growth.

The laws and regulations are insufficient because they do not permit the larger-scale control methods (such as the use of carbon dioxide) that may be required in the particular interest of aviation safety. The Flora and Fauna Act, or its current interpretation (see the legal precedents concerning exemptions in section 4.2), calls for a burden of proof in the case of applications for exemptions that cannot be met on the basis of existing knowledge about geese and the relationship between goose populations and the risk of bird strike. This has placed the lawfulness and implementation of large-scale population control under pressure.

Uncertainty: limited objective and reliable knowledge

An effective strategy to reduce the risk of bird strikes consists of four cornerstones:

- Reduction of the populations.
- Restriction of foraging areas in the airport's environs.
- Restriction of resting and brooding areas (water and nature) in the airport's environs.
- Technical bird detection measures.

There has been a national and international consensus regarding these cornerstones, or focus areas, for a long time now. However, there is no identifiable, definite (proven) sequential order in the strategy. Implementation of the individual measures does not guarantee that an accident will be prevented, but merely reduces the risk to an unknown extent. Radar detection could ultimately prevent a bird strike, provided that the numbers of birds and runways crossings are on a manageable scale (as a result of measures based on the other three cornerstones). There is therefore some uncertainty regarding the optimum combination and optimum order of implementation of the measures from the cornerstones. This uncertainty is partly due to the limited availability of reliable knowledge and insight into bird behaviour and causes of differences in behaviour between species of goose. There is also insufficient knowledge and insight into the effects and side effects of measures (for instance substitution effects, displacement effects and so on). This limited knowledge and insight means that measures with far-reaching social and economic consequences (such as changes in agricultural land use and changes to agricultural policy and nature policy in the context of the second and third cornerstones) can count on little public support. The same applies to the large-scale reduction of the goose populations (first cornerstone), although the basis of support for this approach is gradually growing.

The bird strike issue illustrates a risk management dilemma: the desire to first have a complete overview of unknown quantities before taking effective action can introduce risks and/or limit the available measures. Despite the measures taken in 2008 - 2010 partly as a result of the newly established Schiphol Goose Roundtable (including the disturbance, treatment of nests and culling of geese in the 10-kilometre zone around Schiphol), the Safety Board's investigation has revealed that this dilemma still persists (see Attachment 2). Some parties are calling for more research to determine the precise risk, while other parties are pressing for short-term action.

It is concluded that the risk of bird strike requires a quick response to early warnings about the possible danger. This means: being willing and able to work with insufficient (uncertain) knowledge and a trial and error approach to risk control measures, in terms of operations (for instance bird control on the airport grounds) but also in terms of policy (e.g. trapping methods, changes in policy and so on). This response relies on clear-cut problem ownership of the bird strike risk as described by ICAO. The introduction of the NRV has not yet achieved this.

It is concluded that the bird strike issue around Schiphol has been "caught up in its own urgency" for a long time: it is a difficult issue that has been passed back and forth between the parties involved for too long. Both knowledge about the bird strike issue and the consideration process for measures to be taken have been subject to debate. This has stood in the way of an effective safety strategy.

Despite the bird control measures taken (including disturbance, treatment of nests and culling), the number of geese has continued to rise in recent years. The risk of bird strike at Amsterdam Schiphol Airport and in its immediate environs has consequently risen to a level that places flight safety at risk. This makes resolution of the bird strike issue a pressing matter that requires quick action. Up until now, population control is the only method that has been proven to achieve short-term results. In view of the urgent nature of the problem, it is not possible to await the results of pilot studies into other control measures such as the restriction of the foraging areas in Schiphol's environs. Nevertheless, these types of measures are also not ruled out.

ATTACHMENT 1

BACKGROUND INFORMATION: FACTS AND FIGURES

Data from the Occurrence Analysis Bureau – Transport, Public Works and Water Management Inspectorate (IVW)

The graph below shows the total number of bird strikes reported in the Schiphol control zone and Schiphol terminal control area and the airspace around Schiphol, for all species of bird, including suspected bird strikes and near collisions in the years 2007 -2010 [source: Occurrence Analysis Bureau, IVW].

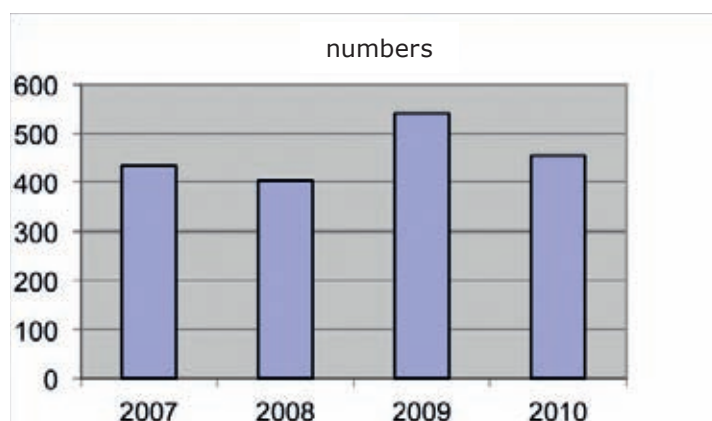


Figure 17: number of bird strikes reported in the Schiphol control zone and terminal control area in years 2007 - 2010

The figure below shows the statistics according to flight phase for bird strikes in the Schiphol control zone and Schiphol terminal control area [Source: Occurrence Analysis Bureau, IVW]

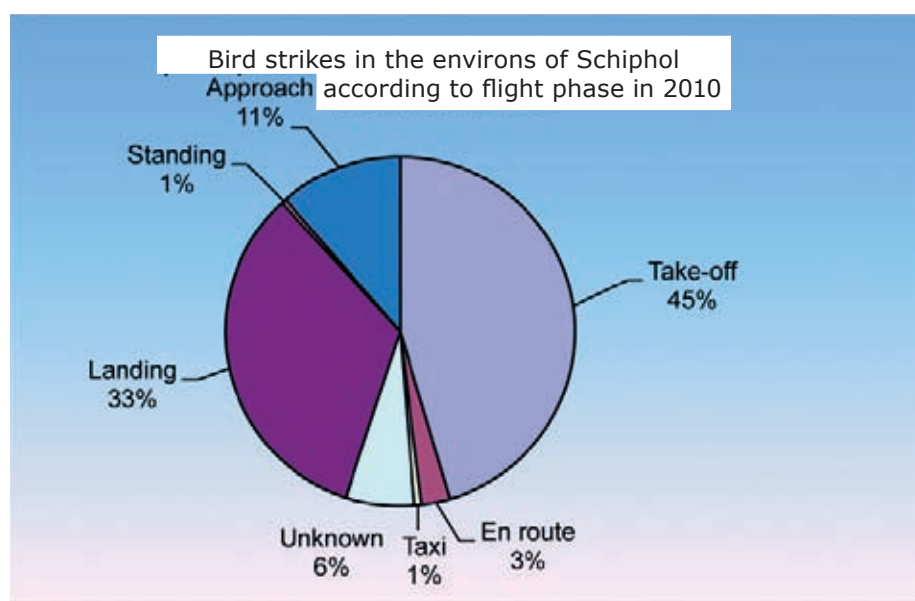


Figure 18: statistics according to flight phase for bird strikes in the Schiphol control zone and terminal control area in 2010

The figure below shows the trend in the number of bird strikes in the Schiphol control zone and Schiphol terminal control area (all birds) and distribution across the months (years 2007-2010). [Source: Occurrence Analysis Bureau, IVW]

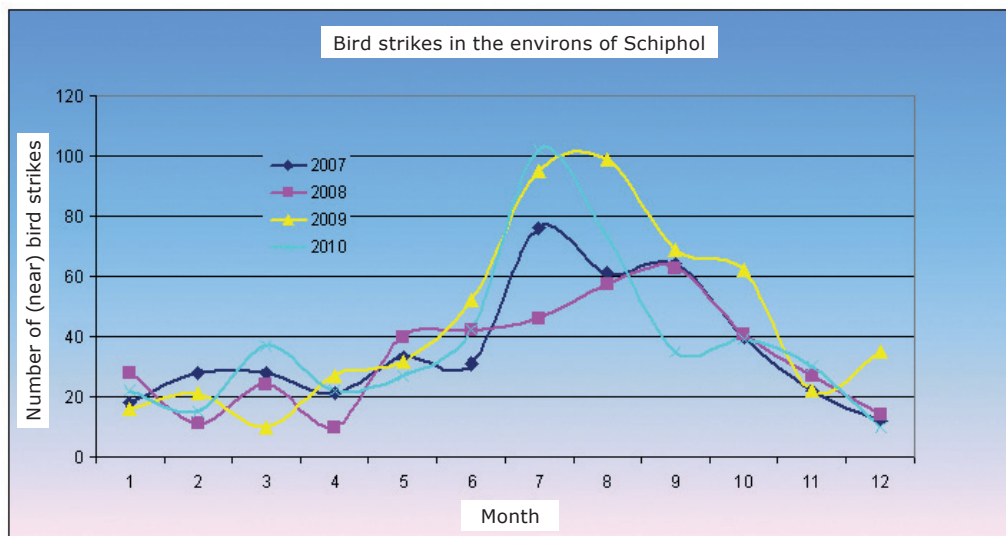


Figure 19: trend in the number of bird strikes in the Schiphol control zone and terminal control area (all birds) and distribution across the months (years 2007-2010)

Schiphol Safety Platform Analysis

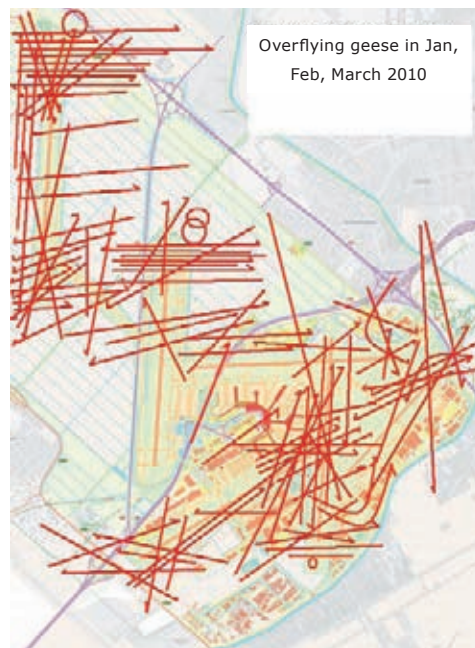
The analysis below of bird strikes involving geese at Schiphol was carried out by the Schiphol Safety Platform (17 March 2010, translated and summarised):

"The last few years have seen a rise in the number of geese flying over the airport. These are currently primarily greylag geese, however there were also regular sightings of overflying Canada geese in 2009. The geese do not enter the airport terrain themselves, but instead fly over it. They fly from brooding and resting areas outside the Haarlemmermeer to the corn fields inside the Haarlemmermeer. This mainly occurs in the period when the corn is ripe (July to October inclusive), but also in January and February when there is little food available in the pasture land around the Haarlemmermeer. The Schiphol bird controllers have recorded sightings of overflying geese since 2006. In addition, Bureau Waardenburg carried out research in 2008 into overflying geese using a marine radar.

The figures below show sightings of overflying greylag geese in 2008 and 2010. Each line represents a group of overflying greylag geese, with the arrow indicating the direction of flight [source: Schiphol Safety Platform].



Figure 20: sightings of overflying greylag geese in the third quarter of 2008



Figures 21 and 22: sightings of overflying greylag geese in the first and second quarters of 2010



Figures 23 and 24: sightings of overflying greylag geese in the third and fourth quarters of 2010

Incidents involving geese at Schiphol

A number of bird strikes involving geese, namely greylag geese and Egyptian geese, have occurred in recent years. This led to aircraft damage in a number of cases. In addition, runways were taken out of use for a period of time (20 minutes to an hour) on a number of occasions in 2008 and 2009 because large groups (800 to 2500 geese) were flying overhead."

The table below shows the number of fauna incidents¹⁵² and bird strikes¹⁵³ involving geese above ground level at Schiphol airport, according to species of goose.

	Year	Date	Time	Animal sort	Count	Incident type
1	2005	05-FEB-2005	13.05	Egyptian goose	1	Bird strike
2		11-NOV-2005	09.40	Egyptian goose	1	Bird strike
3	2006	08-SEP-2006	04.00	other geese	1	Fauna incident
4	2007	10-AUG-2007	22.20	other geese	1	Fauna incident
5		22-NOV-2007	10.30	greylag goose	1	Fauna incident
6		11-DEC-2007	07.37	other geese	1	Bird strike
7	2008	26-APR-2008	07.40	Egyptian goose	1	Bird strike
8		28-AUG-2008	18.40	greylag goose	1	Fauna incident
9		14-SEP-2008	09.21	greylag goose	1	Fauna incident
10	2009	20-OCT-2009	17.42	greylag goose	2	Fauna incident
11		12-DEC-2009	20.00	other geese	1	Fauna incident

¹⁵² Incidents where one or more dead birds or other animals were found within the runway strip.

¹⁵³ Incidents where, following a report from or via air traffic control, traces of a bird were found on an aircraft or within a runway strip and where it is likely that the incident occurred within the following height restrictions:

- During the approach and landing: lower or equal to 200 feet.
- During the take-off and initial climb: lower or equal to 500 feet.

	Year	Date	Time	Animal sort	Count	Incident type
12	2010	21-JAN-2010	11.30	Canada goose	1	Fauna incident
13		10-APR-2010	08.10	Canada goose	2	Fauna incident
14		06-JUN-2010	21.42	Canada goose	7	Bird strike
15		01-JUL-2010	21.24	Egyptian goose	1	Bird strike
16		20-SEP-2010	08.40	greylag goose	2	Bird strike
17		02-DEC-2010	13.00	Egyptian goose	2	Fauna incident
18		07-DEC-2010	18.10	barnacle goose	1	Fauna incident
19	2011	15-JAN-2011	13.00	greylag goose	1	Fauna incident
						Total count FI: 19 Total count BS: 7

Table 2: number of fauna incidents and bird strikes involving geese above ground level at Schiphol airport, according to species of goose [Source: Amsterdam Airport Schiphol]

Closure/change of runway due to increased bird activity

The Amsterdam Airport Schiphol Bird Control Unit has conducted research into, amongst other things, the number of fauna incidents in relation to the time of day in the years 2005 - 2010. According to Bird Control the results do not present a clear picture that could serve as a basis for changes to flight planning (inbound and outbound peak). Practice has shown, however, that most bird strikes occur during the day, with a relative light peak during morning hours (dawn) that coincides with one of Schiphol airport's busiest daytime operational period.

In practice, if bird activity is intensive, flights are designated to different runways on an ad hoc basis. It should be pointed out that it is more difficult to visually observe bird activity during limited visibility conditions and in the dark. The closure or reassignment of runways is a regular occurrence, and is conducted in collaboration with Air Traffic Control the Netherlands and other parties. In 2008 and 2009, active runways were closed for a total of twenty minutes to one hour as a result of bird activity. According to Amsterdam Airport Schiphol, twelve interruptions took place due to bird activity (of which seven with geese) in 2010. The most recent data shows a total of ten interruptions in 2011 of which eight with geese. The interruptions had a duration of one to five minutes, depending on the amount of time it took the birds to fly over the runway area.

Study conducted by SOVON

At the Dutch Safety Board's request, the SOVON Dutch Centre for Field Ornithology (abbreviated as SOVON) has gathered information about the numbers of birds that cause a risk of bird strike in the 10-kilometre zone around Amsterdam Schiphol Airport.

Available information

SOVON focused on the groups of species that are known to present a potential risk to flight safety around Schiphol (Smits & Boudewijn 2011), namely: cormorants, herons, geese, swans, dabbling ducks, diving ducks (and other ducks), coots, waders and gulls. The study covered all count areas within the 10-kilometre zone around Schiphol.

Many species of bird do not occur in the same numbers in the Netherlands throughout the year. Many species migrate between brooding and wintering areas and can only be found in the Netherlands for part of the year. The Netherlands is a popular wintering location for most geese and other waterfowl, with these birds migrating back to their brooding areas in the summer period. A number of geese also brood in the Netherlands, and these numbers have risen in recent years. SOVON coordinates a project that involves monitoring waterfowl in the Netherlands, in which most counts are carried out in the winter half year. In order to gain a greater insight into the goose populations in the summer, Landscape Noord-Holland has studied the number of geese within a 10-kilometre radius of Schiphol (within the Province of Noord-Holland) since 2008 (Raes et al. 2010, van de Riet & Visbeen 2011). These count statistics are also included in the SOVON Dutch Centre for Field Ornithology database.

The following information is available for the abovementioned risk groups within the 10-kilometre zone:

- The average number of geese and other waterfowl counted in January in the years 1996 to 2010 inclusive.
- The average number of geese in the summer period (May-August) over three seasons (2008-2010).

METHODOLOGY

Monitoring by SOVON Dutch Centre for Field Ornithology

The monitoring of waterfowl species takes place in count areas in which counts are performed. These count areas are geographical units with fixed boundaries. In addition to count areas in which all waterfowl are counted (often areas with large or numerous expanses of water), geese and swans are also specifically counted within agricultural count areas. The counts are performed according to standardised methods (van Roomen *et al.* 2003). Guidelines have been drawn up regarding the time at which counts must be performed, at which locations, what behaviour should be noted and so on.

Naturally the aim is to achieve a 100% count cover rate, but this is not always feasible. Counts can be omitted for various reasons, particularly over very long time periods. A statistical method has therefore been developed in collaboration with Statistics Netherlands (Centraal Bureau voor de Statistiek) in order to 'estimate' missing counts, which is also referred to as imputing. The imputation process is carried out according to a set method. Omitted counts are imputed based on the ratio between the average numbers in the count area and the other areas, the ratio between the average numbers in the omitted month and the other months and the ratio between the average numbers in the omitted year and the other years in the series. This leads to a complete series of counts that are used to calculate trends (for a more detailed explanation of imputation see Hornman *et al.* 2011).

Summer and winter counts by Landscape Noord-Holland (Raes *et al.* 2010, van de Riet & Visbeem 2011). Geese are regularly counted throughout the 56 count areas within the 10-kilometre zone around Schiphol.

The area within the 10-kilometre zone is split into six regions that comprise the SOVON waterfowl count areas. The regular counts are performed halfway through the month at the same time as the national SOVON counts, and all count areas are counted every two weeks in summer (mid June to the end of August).

Explanation of the statistics on birds in the 10-kilometre zone

Two figures have been produced that show the average number of waterfowl in January in 1996-2010 and the average number of summer birds in 2008-2010. To place the statistics within a long-term context, a number of bar charts have been produced that show the winter averages for each year. Both the winter average for geese based on the January count and a winter average over the months October to March are also included. The effect of the harsh winter in 2010 was very noticeable during the January count, however the numbers over the winter season as a whole bear a greater resemblance to those in the previous year. This shows that the distribution of geese during the winter months is reasonably flexible.

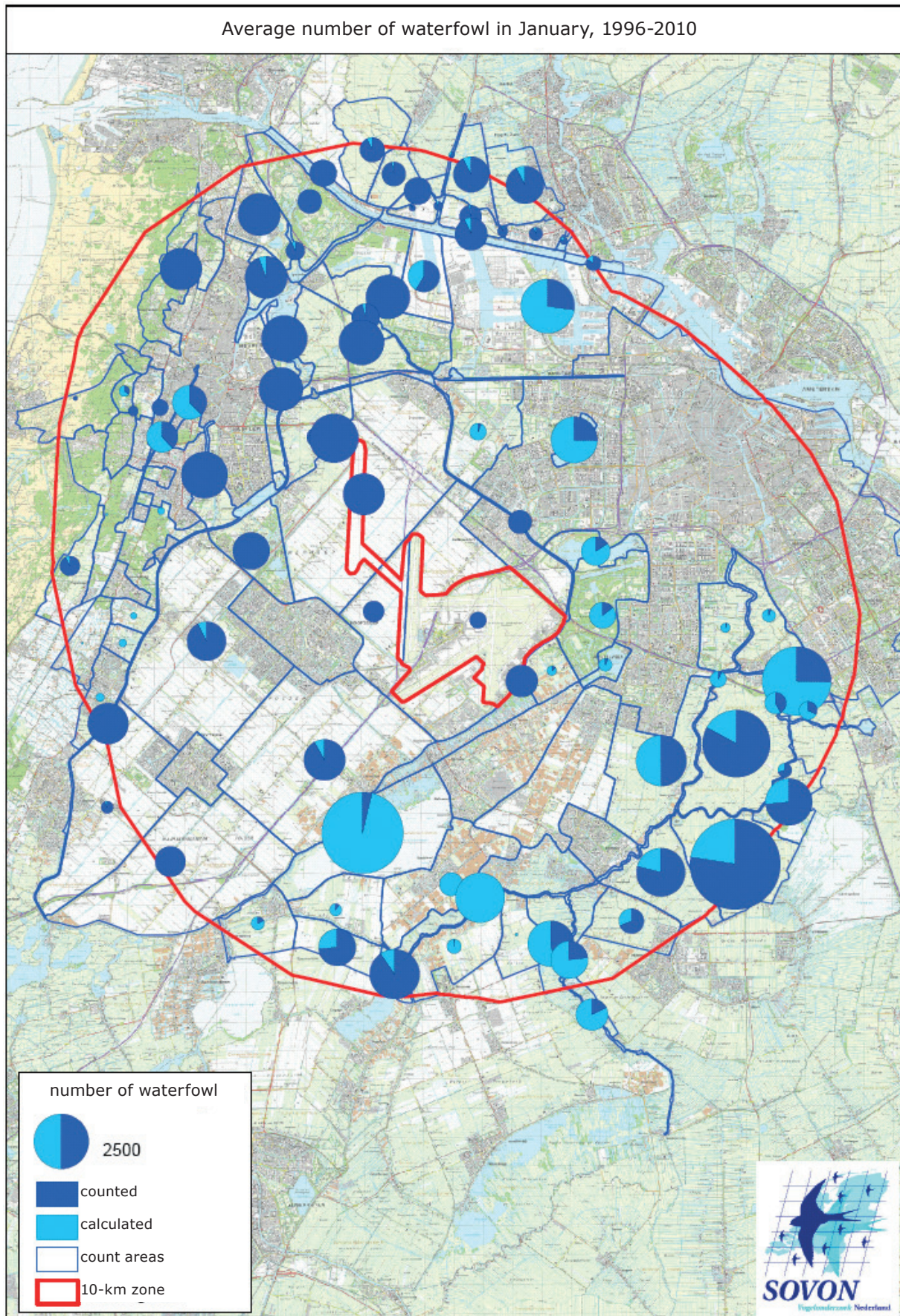


Figure 25: location and average number of waterfowl in the 10-kilometre zone around Schiphol airport in January 1996-2010 [Source: SOVON]

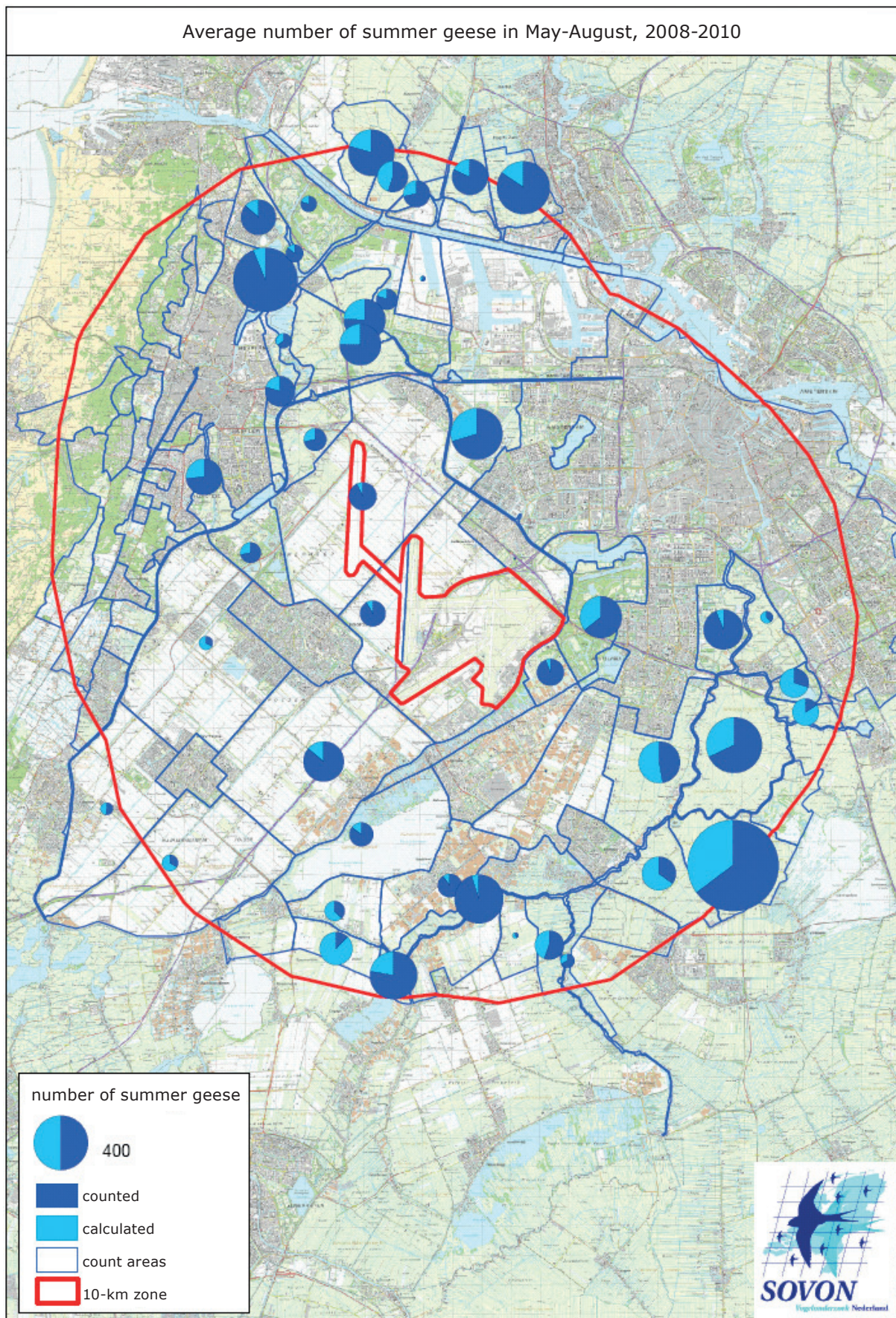
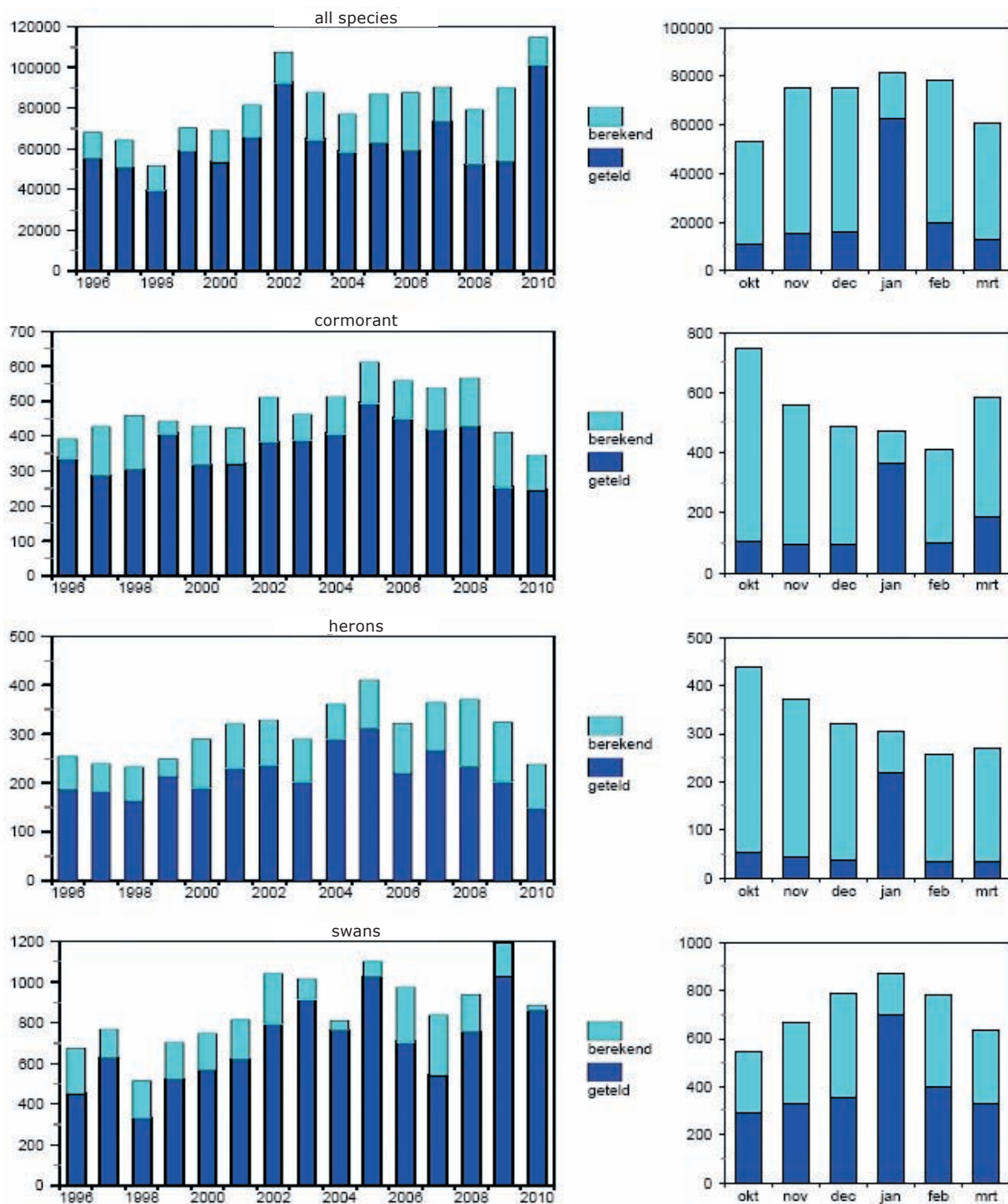
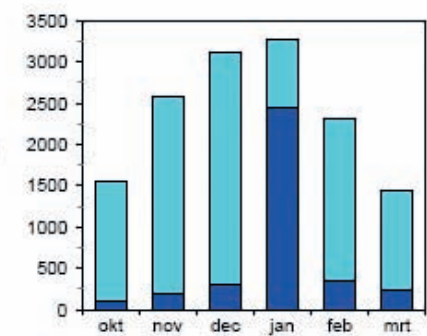
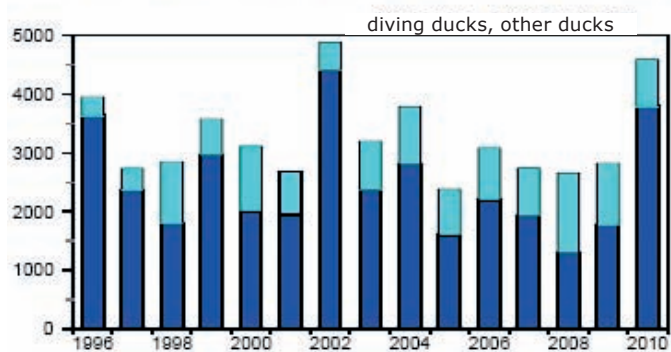
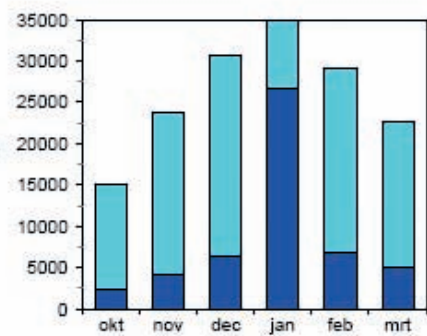
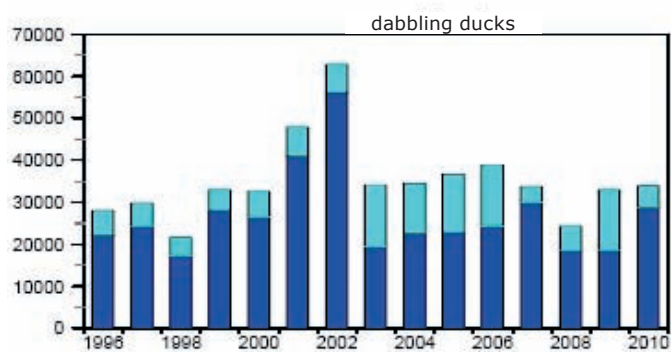
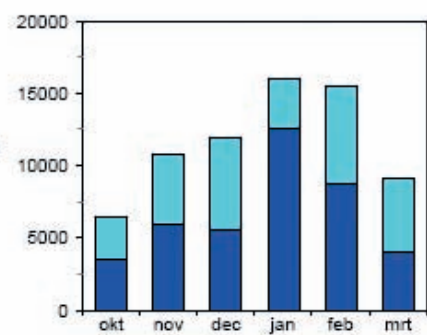
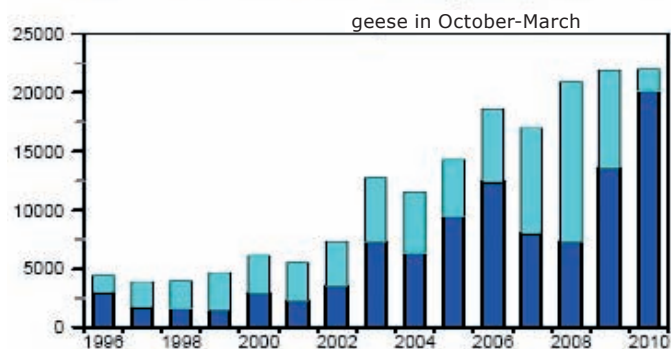
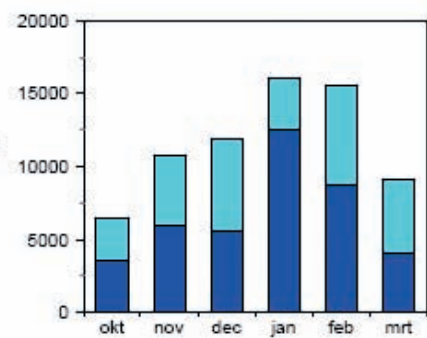
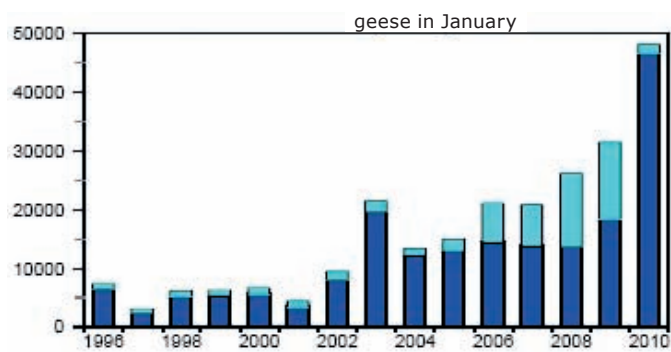
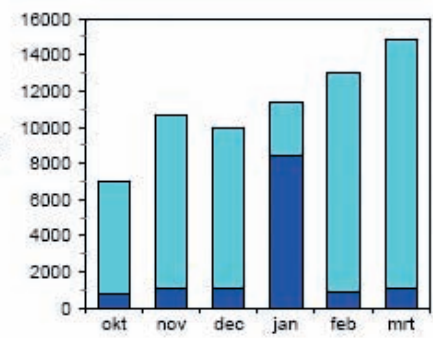
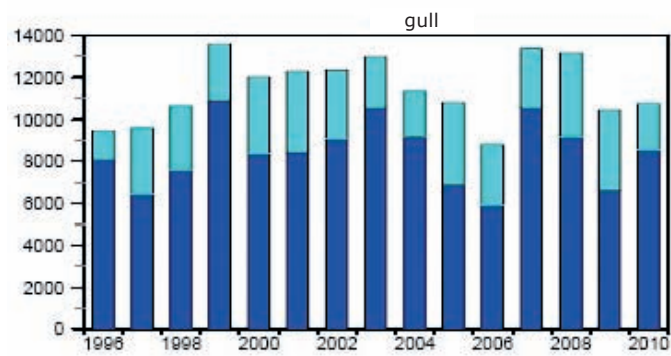
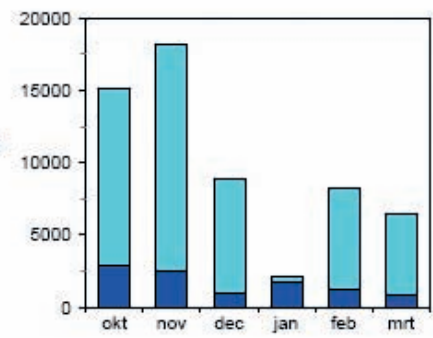
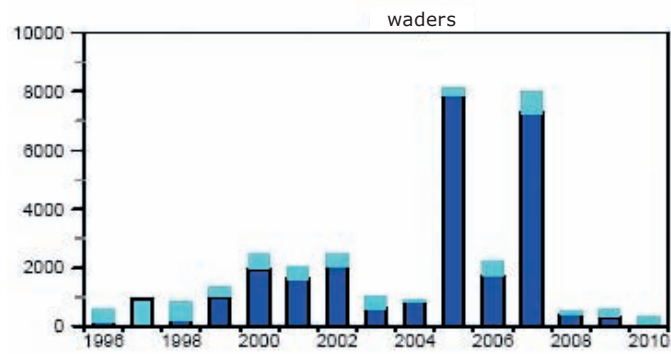
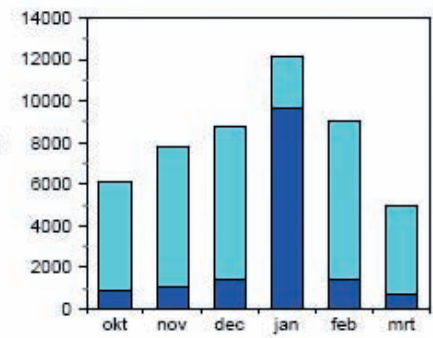
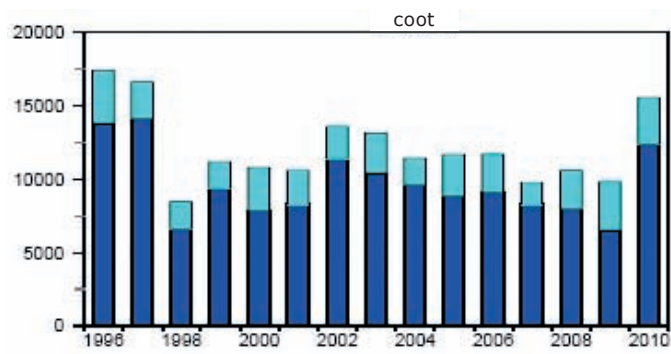


Figure 26: location and average number of summer geese in the 10-kilometre zone around Schiphol airport in May-August 2008-2010 [Source: SOVON]

The figures below show the counted (geteld) and calculated (berekend) waterfowl in the 10-kilometre zone around Schiphol airport from 1996-2010 [Source: SOVON].







ATTACHMENT 2

Views of parties within the network on the bird strike risk and the measures required

Overview of the positions adopted by the actors within the bird control network¹⁵⁴ based on their views on the bird strike risk and measures required. The parties are grouped according to theme:

- aviation and aviation safety
- land use, terrain management and wildlife management
- spatial planning.¹⁵⁵

Party	View on the bird strike risk	View on measures required (frameworks; instruments; CVL/ NRV 4-cornerstone approach)
Parties in the field of aviation and aviation safety		
Ministry of Infrastructure and the Environment, DGLM	<p>Risk of bird strikes is no longer acceptable</p> <p>Not all species of goose are problem species.</p>	<p>Airport Planning Decree (LIB) imposes frameworks for spatial development in the restricted 6-km zone. The airport itself must also influence spatial development in its environs in accordance with ICAO.</p> <p>Radar detection: current numbers of geese are an obstacle to the successful use of this method. Population reduction: must be substantiated by the 'site-specific' risk of bird strike.</p> <p>Issue features on the agenda of the Improving Flight Safety Steering Committee (Stuurgroep Versterking Luchtvaartveiligheid) and the NRV.</p>
Transport, Public Works & Water Management Inspectorate (IVW)	<p>Bird strike is a top 3 risk at Schiphol. Risk is increasing due to more geese and more flight movements.</p> <p>The Netherlands is very attractive to summering geese. More geese are being attracted due to continuing development of nature conservation areas, also immediately outside the 6-km zone around Schiphol.</p>	<p>Bird-attracting activities need to be investigated in the 13-km¹⁵⁵ zone, however this has not taken place.</p> <p>The four cornerstone strategy is right. There is a great deal of emphasis on population reduction, and relatively less on spatial planning/bird-attracting activities.</p>

¹⁵⁴ This table is based on information obtained through interviews with the relevant key people.

¹⁵⁵ ICAO prescribes a 13 kilometre zone.

Party	View on the bird strike risk	View on measures required (frameworks; instruments; CVL/ NRV 4-cornerstone approach)
Flight Safety Expert Group, Schiphol Safety Platform and LVNL	<p>Bird strike has been a top 3 risk for the Schiphol Safety Platform since 2003. Population growth is a major contributing factor.</p> <p>The sector has raised the risk as an issue and is partly responsible, but cannot resolve the problem without help from government authorities.</p>	<p>Radar detection severely interferes with proven procedures and potentially with airport capacity. Need for sound substantiation for the use of radar for last-minute separation.</p> <p>A more proactive/preventive strategy is needed. Population reduction is necessary, supported by many parties but faces opposition in practice. Most preventive approach is via nature policy (development and management of nature conservation areas).</p>
AAS Schiphol Airport Operations	<p>Bird strike is a top 3 risk; current level is unacceptable. Population growth is a major contributing factor. Summer period in particular (summering geese/foraging) is a problem. The development of nature conservation areas outside the 6-km zone is increasing the potential risk.</p> <p>Schiphol therefore sent an incendiary letter to the former Ministries of Transport, Public Works and Water Management and Agriculture, Nature and Food Quality following a round of discussions within the network.</p>	<p>Responsibilities for population reduction and control must be established more clearly/met.</p> <p>Control over the solution extends beyond Schiphol's boundaries and the boundaries of the Province of Noord-Holland due to goose ecology.</p> <p>Solutions should also be sought among aircraft manufacturers and in the field of spatial planning in the longer term.</p>
Schiphol Bird Control (BC) Unit	<p>Number of sightings of geese flying over Schiphol runways is rising (2010). Populations are not being controlled.</p> <p>Rise in the number of birds and aircraft is leading to an increased risk. The risk (dangerous runway crossings) is therefore growing.</p>	<p>Continuous bird control is required on the airport grounds; continuous improvement is required.</p> <p>In the airport's environs: population control is currently non-enforceable. Population control must focus on the summer population (greatest risk). Population reduction and restriction of foraging areas (bird-attracting corn cultivation) around Schiphol is expected to achieve the quickest results. Radar technology will take longer.</p>

Party	View on the bird strike risk	View on measures required (frameworks; instruments; CVL/ NRV 4-cornerstone approach)
Parties in the field of land use, terrain management, wildlife management		
Ministry of Economic Affairs, Agriculture and Innovation	<p>Acknowledges the risk of bird strike, but is not the problem owner.</p> <p>Geese are problematic insofar as undesirable damage is caused to agricultural and nature conservation objectives</p>	<p>Powers and strategies in relation to wildlife management and spatial planning to reduce the risk of bird strike lie with the provincial authorities.</p> <p>Focus should obviously be placed on population reduction. A General Administrative Order is being drafted that will permit the use of carbon dioxide to cull birds for the purpose of population and damage control. Also spatial planning (resting and foraging areas alongside one another without the risk of crossing Schiphol). Bird mobility and system response time mean that radar technology is a difficult measure.</p>
Province of Noord-Holland	<p>Risk of bird strike is not currently acceptable. Political urgency is increasing at all levels.</p> <p>Population reduction encountered public opposition.</p> <p>Risk varies for different species (greylag and Canada geese) and populations; requires a great deal of research. Indicative: greylag goose populations in Spaarnwoude and South/ South-East Utrecht.</p>	<p>Clear ultimate responsibility for the issue of bird strike is required.</p> <p>Goose control affecting Schiphol now extends beyond the Province of Noord-Holland.</p> <p>Airport Planning Decree with 6-km 'restricted land use zone' is a rigid framework and allows a limited balancing of interests and is less cost effective with regard to the bird strike issue.</p> <p>Population reduction is now necessary and cost effective and can only be achieved by trapping geese. Policy in respect of resting/foraging areas offers no short-term impact on the risk. Crop diversification is not a cost effective method of tackling the bird strike risk; initiative lies with the sector. Radar technology requires a long preparation time.</p> <p>Wildlife management exemptions outside the 10-kilometre zone must be upheld and implemented more effectively. Population targets must be linked to objectives and enforceable results of wildlife management in the context of aviation safety</p>

Party	View on the bird strike risk	View on measures required (frameworks; instruments; CVL/ NRV 4-cornerstone approach)
Landscape Noord-Holland	<p>Bird strike is a 'low likelihood, high impact' risk.</p> <p>10-kilometre zone is not substantiated, no actual link to goose behaviour and risk of bird strike.</p>	<p>A greater focus must be placed on foraging areas to lure geese away from the Haarlemmermeer (bird-attracting activities elsewhere).</p> <p>Population reduction and control only on the basis of individual arrangements and substantiated risk presented by individual groups of birds.</p>
Fauna Fund	<p>Risk of bird strike has increased due to goose population: both wintering and summering geese. Summering geese present the greatest risk. Differentiation according to species.</p>	<p>Three-pronged solution:</p> <p>(1) Population reduction requires a coordinated approach, including steering towards implementation;</p> <p>(2) Limitation of foraging areas in corn fields should be enforceable for farmers in high-risk areas, for instance through the inclusion of a provision to this effect in the General Municipal By-law;</p> <p>(3) Provision of food stocks in resting areas to avoid foraging flights over Schiphol.</p>
Federation of Agriculture and Horticulture (LTO) Noord	<p>Risk of bird strike has increased with drastic population growth since the 1990s.</p> <p>Foraging flights are the main problem due to the presence of food stocks in brooding/ nature conservation areas.</p>	<p>Population reduction is required but only effective if followed up with (continuous) population control. A large-scale approach is needed in the short term.</p> <p>The use of radar technology to control the residual risk is advisable in the longer term. Food stocks should also be provided in nature conservation (brooding) areas.</p>
Society for the Preservation of Nature in the Netherlands	<p>There is no demonstrable link between populations and the risk of flight path crossings.</p> <p>Risk varies according to period, location and bird species, but is not clear-cut.</p> <p>Populations have grown sharply in connection with food sources provided by agricultural land use.</p>	<p>Emphasis on spatial planning and changes to bird-attracting activities (foraging areas).</p> <p>Population reduction should only be carried out in the event of extreme (demonstrable) need and once a (currently lacking) statutory basis has been established for culling methods.</p>

Party	View on the bird strike risk	View on measures required (frameworks; instruments; CVL/ NRV 4-cornerstone approach)
Netherlands Society for the Protection of Birds	<p>Bird strike risk is acknowledged.</p> <p>Nature and scale of the risk is not clear and depends on bird species. Population size is irrelevant.</p> <p>The serious Royal Air Maroc incident bore no relation to a large greylag goose population; it involved Canada geese outside the Haarlemmermeer.</p>	<p>Population reduction, the mass culling of birds, is not a solution. Radar technology should be investigated as a first step. Make foraging unattractive within the 6-km zone by imposing enforceable conditions on farmers; make areas outside this zone more attractive.</p>
Fauna Management Unit (FBE)	<p>Risk of bird strike has increased with the rise in the number of runway crossings and population growth.</p> <p>The risk can only be rationalised by a government whose position transcends that of the various parties involved.</p>	<p>The required measures are known. Actual implementation requires ultimate responsibility and steering towards implementation in the interest of aviation safety.</p> <p>Implementation of wildlife management must be improved outside the 10-kilometre zone around Schiphol. Less emphasis is needed on the precise relationship between individual groups of birds and the risk.</p>
Haarlemmermeer Game Management Unit	<p>Greylag geese by their number present the greatest risk to aviation safety compared to other species.</p> <p>Goose populations have grown drastically under the influence of international growth, the attractiveness of the Netherlands as a whole, hunting restrictions and obstacles to implementation.</p>	<p>Population reduction is necessary. Radar detection is also required to cover the residual risk.</p>

Party	View on the bird strike risk	View on measures required (frameworks; instruments; CVL/ NRV 4-cornerstone approach)
Parties in the field of spatial planning		
Municipality of Haarlemmermeer	<p>The risk of bird strike is currently one of the greatest risks to aviation.</p> <p>Runways crossings constitute a risk, and are related to foraging flights by geese.</p> <p>The issue extends beyond the municipality's powers.</p>	<p>The cost-effectiveness and feasibility of generic policy by means of spatial planning and agricultural management to combat the risk of bird strike is very uncertain. The Airport Planning Decree is not sufficient because it is too static.</p> <p>Changes to foraging areas (crop diversification) are very important but can only take place on a voluntary basis.</p> <p>Solutions can only be achieved with action by joint authorities (together with the provincial authorities and the government) and clarity regarding cost allocation.</p>
Province of Noord-Holland	<p>The risk of bird strike is determined by time/location and depends on a specific group of birds (geese).</p> <p>Acceptable risk level must be determined by the government.</p>	<p>The effectiveness of the Airport Planning Decree in terms of reducing the risk of bird strike is unknown and is not being investigated. Information on the bird strike issue in 2011 was not available on the drafting of the Airport Planning Decree.</p> <p>Spatial planning via designated land use is a too static approach. The main focus should be placed on operational control plans in relation to geese (foraging areas) on a larger geographical scale than the Province of Noord-Holland. Also wildlife management targeting specific high-risk populations.</p>

ATTACHMENT 3

Summary of the Noord-Holland Goose Policy Implementation Framework

In principle, all the measures listed in chapter 3.3 can be carried out in the Province of Noord-Holland where there is good reason to do so. However, the Flora and Fauna Act is a protective law that only permits the culling of animals under certain circumstances.

In keeping with this goal to protect animals, the Provincial Executive has stated that the least drastic measures must be carried out first. More far-reaching measures can only be taken if this has already taken place or if there is a clear argument as to why these measures cannot be applied or are ineffective. Measures must be applied in the following sequential order:

- preventive measures (deterring and driving away, screening off foraging and brooding areas, encouraging predation and so on)
- deterrence supported by shooting
- population control via the treatment of nests
- population control via trapping
- population control using guns.

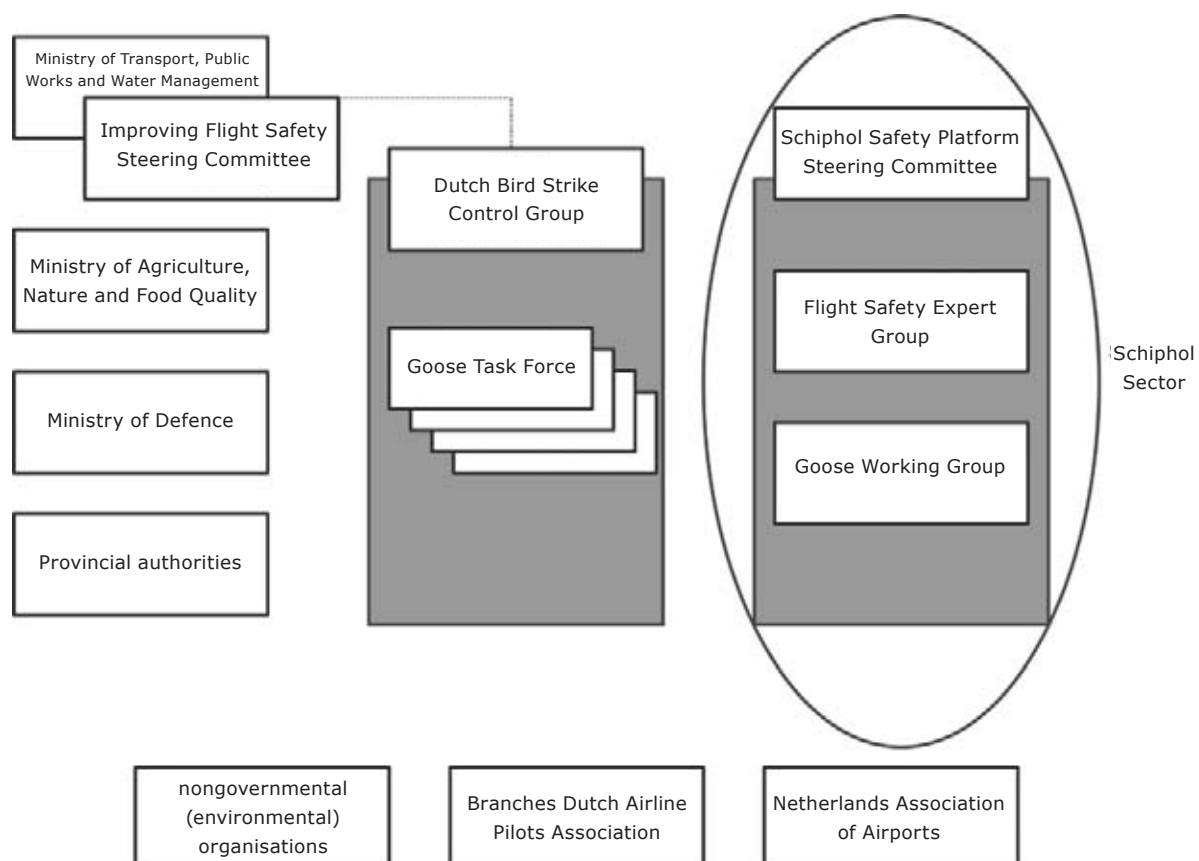
The rule is that preventive measures are taken first, followed by shooting to support deterrence, and finally population control measures. These last resort measures are often carried out at a different location to that where the damage occurred.

The Provincial Executive considers the wildlife management unit to be responsible for planning where and which measures are required, starting with the least drastic.

ATTACHMENT 4

Amsterdam Airport Schiphol's view of the proposed consultative structure of the Dutch Bird Strike Control Group (NRV) in relation to the Schiphol Safety Platform as regards the strategy for tackling the goose problem (source: Schiphol Safety Platform, 5 March 2009).

Please note that the *Goose Task Force* and *Goose Working Group* as appear in this figure do not exist under these names, but instead under the joint name [translated] *NRV Control Group preparatory body*.



ATTACHMENT 5

Powers and responsibilities of the Dutch Bird Strike Control Group

Dutch Bird Strike Control Group Terms of Reference (extracts). See below for a number of extracts from the description of the Dutch Bird Strike Control Group taken from the group's initial policy document dated 11 June 2010.

Powers

The NRV has the power to take administrative decisions on proposals from the underlying knowledge exchange working group and the task forces. The NRV can also help to resolve administrative issues. The control group's independent chairperson can exercise his/her decisive influence on the ministers and other parties involved. The control group is action-oriented.

Responsibilities and objectives

Partly in accordance with Annex 14, chapter 9, the platform's tasks, objectives and responsibilities are:

- to encourage the drafting and maintenance of national procedures for recording and reporting (in the ICAO Bird Strike Information System: IBIS) of aircraft bird strikes;
- to promote a system to determine the presence of birds at and around airports and in the airspace (aeronautical information);
- to promote the use of measures, physical or otherwise, by the competent authority to reduce the number of birds at and around airports that constitute a risk to aviation. This should preferably take place by means of a coordinated planning process, thus creating a structure for tackling the problem of bird strikes at and around the airport. This is a case of reducing the risk of bird strike, and is not to say that reducing the number of birds is the most efficient way of achieving this;
- to promote the exchange of information and transfer of knowledge regarding aircraft bird strikes;
- to coordinate research into the prevention of bird strikes;
- to contribute towards preparing and developing policy;
- to promote cooperation between the relevant authorities and other parties involved;
- to reinforce the leading role at an administrative level of the relevant ministries in relation to preventing bird strikes;
- to maintain national and international contracts;
- to organise an annual bird strike conference/symposium. The control group's annual plan is also presented at the conference.

Organisation and participants

- As a minimum, the parties taking part in the control group must include the Ministry of Defence and the Ministry of Transport, Public Works and Water Management, the provincial authorities, the airport sector and at least one nongovernmental organisation (NGO);
- The chairperson must naturally have a sound knowledge of the subject matter, and should preferably be independent;
- The control group coordinates the various activities that are being carried out or that are set up as regards bird strikes, via task forces or otherwise, by the participating organisations and makes proposals for the introduction of new desirable activities. The activities can be performed at various levels. The most effective organisational form is chosen for each activity taking into account the participating parties, the person ultimately responsible and finances, amongst other things. Activities can be local but also interregional.
- The control group meets at least twice every year.
- The Ministry of Transport, Public Works and Water Management will bear the costs of the chairperson. The first secretary of the control group will be provided by the Ministry of Defence and the second secretary by the Ministry of Transport, Public Works and Water Management. The parties within the control group are themselves responsible for submitting documents, status reports and so on.
- The control group will review its own performance after three years (what has been achieved and what are the next steps).

APPENDIX G: BIRD INGESTION PROTECTION DEVICES FOR ENGINES

On 15 January 2009 a bird strike occurred between several Canada geese and an Airbus A320-214 at an altitude of 3000 feet during the climb from New York-La Guardia Airport in New York, United States. The final report was published in 2010. The results of the NTSB investigation to the engines and the engine certification requirements were also used for the investigation of the Dutch Safety Board. A summary of the NTSB investigation regarding the engine bird ingestion protection devices is contained in this appendix.

The technical issues related to performance, weight, and reliability that must be considered to determine whether protective screens can be used effectively and safely on turbofan engines, are summarized as follows:

Impact on engine performance

Screens can block, impede, or distort the airflow just in front of the engine, negatively impacting engine performance and exhaust emissions. Screens can cause erratic engine behavior in crosswind or gusty conditions, increasing the likelihood of a stall.

Impact on in-flight restart envelope

Screens can require a higher aircraft restart airspeed to reach the desired engine windmilling rotor speeds, which reduces the restart envelope of the aircraft.

Impact of vibration stresses

Screens can disturb the upstream airflow into the engine and induce airflow oscillation, resulting in high airfoil vibrations within the engine and causing premature fatigue and fracture of the fan blades or other airfoils in the engine.

Impact of icing behavior

Screens can accrete ice very easily when they pass through a moist, cool atmosphere. Unless the screens are electrically heated to prevent ice formation, a high risk of screen ice blockage exists. The heat required to deice a screen in extreme icing conditions would require additional generator capacity and large, heavy electrical hardware to deal with the extra power requirements.

Impact of screen and additional structural weight

During informal discussions with investigators from the NTSB and engineers from Honeywell and Boeing, it was estimated that the addition of a screen, support structure, electrical harness, and generator would add at least 1000 pounds (454 kg) per engine installation. Further, the size of the pylon and wing structure would also need to be increased to accommodate the additional weight of the engine, resulting in even more weight being added to the airframe to structurally accommodate an inlet screen.

Screen failure

The reliability of any component can never be 100 percent; therefore, the risk of a screen failure and its subsequent ingestion in the engine inlet must be considered in any design. If a screen were ingested into the engine, it could cause more damage than bird ingestion, leading to a catastrophic engine failure. Damage to the flight control surfaces on the wing or rudder/stabilizer is also a possible hazard.

APPENDIX H: FRAME OF REFERENCE

GENERAL

An assessment framework is an essential part of an investigation of the Dutch Safety Board. It provides a description of the situation as may be expected based on regulations, guidelines and the specific details of our own responsibility. Insight can be gained into where improvement is possible and/or additions are required by testing based on this and by identifying abnormalities.

The assessment framework of the Board consists of three parts. The first part concerns legislation and regulations that are in force for civil aviation. The second part is based on the international and national guidelines from the sector as well as internal corporate guidelines, manuals and management systems. The third part describes the expectations of the Board with regard to the manner in which the involved parties provide the details for their own responsibility for safety and safety management.

This section makes a distinction between, on the one hand, binding legislation and regulations and, on the other hand, non-binding standards. Many of the international regulations are not binding directly but become binding when the regulations are implemented in national legislation. This type of international regulations is grouped under the first category of binding legislation and regulations because the referred to implementation takes place nearly continuously in European countries.

LEGISLATION AND REGULATIONS

The regulations of civil aviation are strongly focused on an international level. The basis for this part of the reference framework is, therefore, mainly formed by international regulations.

INTERNATIONAL REGULATIONS

The international regulations relevant to this investigation include:

1. The 'Standards and Recommended Practices' in the annexes with the Chicago Convention of the International Civil Aviation Organization (ICAO)
2. Regulations of the Joint Aviation Authorities (JAA) with regard to the use of aircraft for commercial air transport
3. Certification requirements of the Federal Aviation Administration (FAA)

Item 1: The annexes related to the Chicago Convention

Nearly all countries in the world joined the Convention on International Civil Aviation (also referred to as the Chicago Convention). The Convention contains principles and regulations about innumerable issues that are important to the development of international civil aviation. It is also a part of the legal basis for the establishment of ICAO. The Chicago Convention has a large number of annexes in which various topics are arranged with a large degree of details. These annexes are not binding to the same extent as the Convention itself but do play a large role within the regulations of international civil aviation. The annexes contain, amongst others, so-called Standards and Recommended Practices. The contracting states are, in any case, obliged to implement the Standards as meticulously as possible in their national legislation. They are required to notify ICAO of any differences between their national regulations and practices and international Standards contained in an annex and any amendments thereto. A member state can include a Recommended Practice in its national legislation. There is, however, no obligation to do so and not including the recommended practice does not need to be reported but it is recommended.

Annexes relevant to this investigation:

- *Annex 2 - Rules of the Air*
- *Annex 4 - Aeronautical Charts*
- *Annex 11 - Air Traffic Services*
- *Annex 14 - Aerodromes*

Annex 2 – Rules of the air

The main international aviation regulations and guidelines for air traffic controllers are based on the guidelines in Annex 2 and the guidelines and recommended procedures in Annex 11, application of the Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM)' (document 4444) and the Regional Supplementary Procedures – Rules of the Air and Air Traffic Services (document 7030). Document 7030 outlines supplementary regional procedures.

The chapter relevant to this investigation is:

- *Chapter 2, applicability of the rules of the air*

Amongst other stipulations, this annex specifies that aircraft guided by Air Traffic Control must maintain the allocated heading and altitude, and that the crew must inform Air Traffic Control of the aircraft's position. It is essential that crews adhere to the general rules of the air and either heed the visual flight rules (VFR) or instrument flight rules (IFR). Most airlines almost exclusively fly under IFR. This means their aircraft use "air traffic control service, air traffic advisory service or flight information service".

Annex 4 - Aeronautical Charts

Annex 4, Aeronautical Charts outlines which detailed information must be made available to aircraft crews with regard to the immediate surrounding area around runways and the broader zone around the airport. This also includes information on the height of obstacles. The above information is categorised in terms of individual runways. A summary of the Annex:

"The heights of obstacles around airports are of critical importance to aircraft operations. Information about these are given in detail on the Aerodrome Obstacle Charts — ICAO, Types A, B, and C. These charts are intended to assist aircraft operators in making the complex take-off mass, distance and performance calculations required, including those covering emergency situations such as engine failure during takeoff. Aerodrome obstacle charts show the runways in plan and profile, take-off flight path areas and the distances available for take-off run and accelerate-stop, taking obstacles into account; this data is provided for each runway which has significant obstacles in the take-off area. The detailed topographical information provided by some aerodrome obstacle charts includes coverage of areas as far as 45 km away from the aerodrome itself."

As regards Schiphol airport, this information is updated and provided by LVNL, in accordance with the ICAO Annexes.

Annex 11 – Air Traffic Services

Annex 11 features guidelines and recommended procedures with regard to Air Traffic Control. This annex covers airspace classifications and air traffic control services designed to ensure the safe, orderly and expedient handling of flights. The guidelines and recommended procedures outlined in this annex apply to airspace zones under the jurisdiction of affiliated states in which air traffic control services are provided. The following chapters are relevant to this investigation:

- *Chapter 2 General*
- *Chapter 3 Air traffic control service*
- *Chapter 6 Air traffic services requirements for communication*

The annexes feature guidance material on subareas, including the determination and definition of standard arrival and departure routes.

Annex 14 – Aerodromes

The operator must ensure that the construction, design, fitting out and use of an airport comply with the guidelines and recommendations set out in part I (Aerodrome Design and Operations) of Annex 14 to the treaty, with the exception of specific items.¹⁵⁶ As regards the reduction of collisions with animals, the operator must:

- the collection of information from aircraft operators, airport personnel, etc. on the presence of birds on or around the aerodrome constituting a potential hazard to aircraft operations. (Annex 14, 9.4.1, part I, section b).
- ensure that expert staff continually evaluate the dangers posed by wild animals.
- take action to decrease the number of birds constituting a potential hazard to aircraft operations by adopting measures for discouraging their presence on, or in the vicinity of, an aerodrome (Annex 14, part I, 9.4.3).
- take action to eliminate or to prevent the establishment of garbage disposal dumps or any such other source attracting bird activity on, or in the vicinity of, an aerodrome unless an appropriate aeronautical study indicates that they are unlikely to create conditions conducive to a bird hazard problem.

Contrary to the specifications in Annex 14, part I, the airport operator is not obliged to ensure that the surrounding area around the airport is free of waste that could attract animals (Annex 14, part I, 9.4.4).¹⁵⁷

The Minister of Infrastructure and the Environment is responsible for the establishment of a national procedure for recording and reporting bird strikes to aircraft (Annex 14, part I, 9.4.1, section a) and reporting on these incidents to ICAO (Annex 14, 9.4.2).¹⁵⁸

OTHER ICAO DOCUMENTS

Document 4444 'Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM)'

In addition to Annex 11, ICAO document 4444 'Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM)' also contains further provisions with regard to air traffic control procedures. PANS-ATM is a supplement to Annex 11. The following chapters of this document are relevant to the investigation:

- Chapter 2 ATS safety management
- Chapter 4 General provisions for air traffic services
- Chapter 6 Separation in the vicinity of aerodromes
- Chapter 7 Procedures for aerodrome control services
- Chapter 8 ATS surveillance services
- Chapter 15 Procedures related to emergency situations, communication failure and contingencies

For a detailed elaboration of aviation procedures in supplement to Annex 2 and Annex 11, see the international *recommendations* in ICAO document 'Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM)'.^{159 160} For example, PANS-ATM outlines the methods for separating air traffic, minimum distances, prioritisation, runway selection, communication between air traffic control tower and crew, etc.

Chapter 15 outlines the various emergency procedures. These include the procedure for separating an aircraft in distress from other air traffic, and the communication procedures involved in this process. This chapter sets out the basic international principles for emergency response in a range of situations, such as:

- emergency situations during flight over oceanic airspace;
- emergency situations as a result of air-ground communication failures;

156 Regulation on the safe use of airports and other areas, article 10.

157 Regulation on the safe use of airports and other areas, article 10.

158 Regulation on the safe use of airports and other areas, article 11, part p.

159 ICAO Document 4444 ATM/501, 15th edition, 22 November 2007.

160 Unlike the standards featured in the Annexes, this document is not legally binding.

- emergency situations occurring during the flight such as fuel dumping, interception, lost aircraft or aircraft that have deviated from their flight route.
- emergency situations at Air Traffic Control.

Relevant sections of this document concern the relationship between the crew of aircraft in distress and Air Traffic Control¹⁶¹, in situations such as *"inability to maintain assigned flight level due to (...) aircraft performance (...)"*. The document continues: *"The pilot's judgment shall determine the sequence of actions to be taken, having regard to the prevailing circumstances. Air traffic control shall render all possible assistance"*.¹⁶²

In emergency situations, the crew will send out a MAYDAY distress signal or PAN PAN urgency signal. Air Traffic Control will then provide support. According to the ICAO document: *"Subsequent ATC action with respect to that aircraft shall be based on the intentions of the pilot and the overall air traffic situation"*.¹⁶³

Pans-ATM specifically describes the procedure for flying at dangerously low altitudes in cases where a 'minimum safe altitude warning' applies. These warnings are generated by a system that monitors the aircraft's altitude in relation to the ground. Such systems are mainly used by Air Traffic Control organisations operating in hilly terrains. LVNL does not have such a system, as Schiphol airport is located on level ground.

Document 8168 'Procedures for Air Navigation Services - Aircraft Operations'

In addition, document 8168 'Procedures for Air Navigation Services - Aircraft Operations' Volume 1 Flight Procedures describes operational procedures that serve as recommended guidelines for flight operations staff and aircraft crews. The following chapter of this document is relevant to the investigation:

- Chapter 5 Final approach segment

Item 2: Regulations of the Joint Aviation Authorities

The Joint Aviation Authorities (JAA) is a partnership between the national aviation authorities of a number of countries including all EU countries and Turkey. The JAA is an organ linked to the European Civil Aviation Conference (ECAC). ECAC is an inter-European partnership within ICAO. The goal of the JAA is to develop and implement common safety standards and procedures for European aviation. It, in fact, involves an elaboration of the ICAO regulations within a European setting. The JAA issues Joint Aviation Requirements (JARs). The JARs are themselves not enforceable: this enforceability is only created when the JARs are implemented into national or European regulations. EASA is now the authorised party as the European aviation authority with regard to part of the original working area of the JAA.

JAR-OPS 1 contains regulations for commercial air transport operation. JAR-FCL regulates the training and licensing of pilots, and features the requirements for this type of qualification training. The OPS 1 (Regulation EC 859/2008) came into effect on 16 July 2008 and replaced JAR-OPS 1. OPS 1 directly applies within the EU Member States.

Morocco is not an EU Member State. As a result, EASA does not apply in Morocco. For the purposes of this investigation, JAR-Operations 1 (JAR-OPS 1) and JAR-Flight Crew Licensing (JAR-FCL) are regarded as the basis of national Moroccan legislation on the operation of commercial air transportation.

JAR-OPS 1 – Commercial Air Transportation (Aeroplanes)

The 'Applicability' chapter in JAR-OPS 1 states:

"JAR-OPS Part 1 prescribes requirements applicable to the operation of any civil aeroplane for the purpose of commercial air transportation by any operator whose principle place of business and, if any, registered office is in a JAA Member State."

161 ICAO Document 4444 ATM/501, chapter 15, paragraph 15.2 Special procedures for in-flight contingencies in oceanic airspace.

162 ICAO Document 4444 ATM/501, chapter 15, paragraph 15.2.1 Introduction, article 15.2.1.2.

163 ICAO Document 4444 ATM/501, chapter 15, paragraph 15.2.2 General procedures, article 15.2.2.2.

The following JAR-OPS 1 guidelines are especially relevant to this investigation:

- JAR-OPS 1.005 General
- JAR-OPS 1.035 Quality system
- JAR-OPS 1.037 Accident prevention and flight safety programme
- JAR-OPS 1.085 Crew responsibilities
- JAR-OPS 1.090 Authority of the commander
- JAR-OPS 1.230 Instrument departure and approach procedures
- JAR-OPS 1.943 Initial operator's crew resource management (CRM) training
- JAR-OPS 1.945 Conversion training and checking
- JAR-OPS 1.965 Recurrent training and checking
- JAR-OPS 1.975 Route and aerodrome competence qualification

JAR-FCL - Flight Crew Licensing (Aeroplane)

Joint Aviation Requirements on Flight Crew Licensing (JAR-FCL) have been developed for all types of pilot's licences and ratings in order to allow for their use in all JAA member states without the need for additional (national) formalities.

The following JAR-FCL guidelines are relevant to this investigation:

- JAR-FCL 1.240 Type and class ratings – Requirements
- JAR-FCL 1.245 Type and class ratings – Validity, revalidation and renewal
- JAR-FCL 1.262 Type and class ratings – Skill
- JAR-FCL 1.295 Skill (ATPL).

JAR-E Engines, Change 2

These JAR outline the airworthiness requirements for engines:

- JAR-E C3-2 (1.4.1)(1.4.2)
- JAR-E C3-4 (20).

Item 3: Certification requirements of the Federal Aviation Administration (FAA).

The basis on which the Boeing 737 was approved follows from the United States Federal Aviation Regulations (FAR 25). The requirements that must be met to certify an aircraft are specified in these FARs. The FAR 25 (Airworthiness standards: Transport category airplanes) is the document on which certification of the Boeing 737 has been based. The engines have also been individually certified.

Because the CFM56-3C-1 engine was jointly designed and manufactured in the USA and Europe, certification was also under a bilateral agreement between the US Federal Aviation Administration (FAA) and the French Direction Générale de L'Aviation Civile (DGAC). The FAA certification was in accordance with Code of Federal Regulations 14 CFR Part 33 while the DGAC certification was based on Joint Aviation Authorities (JAA) Joint Aviation Regulations–Engines (JAR-E) requirements, jointly referred to as Part 33. At a minimum, all of the FAA requirements had to be met for certification, and, if a JAA requirement was more stringent than an FAA requirement, then the more stringent standard had to be met for certification. The CFM56-3C engine received a type certificate on 18 December 1986; at that time, 14 CFR Part 33 Amendment 6 and JAR-E Change 2 were the basis for compliance.

The following CFRs (Codes of Federal Regulations) are relevant to this investigation:

14 CFR 33.77 'Foreign Object Ingestion'

Title 14 – Aeronautics and space, part 33 – Airworthiness standards: aircraft engines, 77 – Foreign object ingestion.

NATIONAL LEGISLATION

This concerns the Dutch Aviation Act ('Luchtvaartwet') and the Act Dutch Aviation ('Wet Luchtvaart') and the related regulations. The Dutch Aviation Act is gradually being replaced by the Act Dutch Aviation and is irrelevant within the framework of this accident. Both the Dutch Aviation Act and the Act Dutch Aviation have set standards in multiple phases, that is to say, that in addition to general provisions, these acts further elaborate issues in implementing regulations.

The Act also specifies that an 'Airport Planning Decree' (Luchthavenindelingbesluit) must be prepared for Schiphol airport.¹⁶⁴ This airport planning decree defines the airport area and restriction zone. The airport area is defined as the area designated for use as an airport. The restriction zone is defined as the area in which restrictions must be applied to the zoning or use of land near the airport area in view of safety and noise impact.

When preparing land use plans or management ordinances for areas within the airport area or restriction zone as a part of the 'Spatial Planning Act' (Wet ruimtelijke ordening), municipalities must adhere to the Schiphol Airport Planning Decree. As regards areas within the airport area or restriction zone for which no land use plan or management ordinance based on the Decree applies, the Decree will apply in the form of a preparatory decree in accordance with the Spatial Planning Act. The municipal council is obliged to prepare the definitive land use plan or management ordinance in accordance with the Act within a one-year period after the Schiphol Airport Planning Decree takes effect.¹⁶⁵

At minimum, the Schiphol Airport Planning Decree should contain guidelines on:¹⁶⁶

- The zoning and use of land with regard to external safety risks related to airport air traffic.
- The zoning and use of land with regard to noise impact due to airport air traffic.
- The maximum height of objects in, on or above the ground, in connection with airport air traffic safety.
- Any forms of land use that attract birds, in connection with airport air traffic safety.

The provisions that are important to this investigation are laid down in the Dutch Aviation Act:

- Section 5: Air traffic, air traffic control and air traffic control organisation.
- Section 8: Airports.

Air Traffic Regulations

The regulations with regard to air traffic services have been further elaborated in an elaboration of the Air Traffic Regulations: the Air Traffic Services Regulations. The arrival and departure procedures of Schiphol airport are, for example, laid down in these Regulations.

164 Aviation Act, article 8.4.

165 Aviation Act, article 8.8.

166 Aviation Act, article 8.7, second paragraph.

MANUALS

BOEING

Aircraft Flight Manual (AFM)

The Boeing 737-400 comes with an Aircraft Flight Manual (AFM) that has been approved by the American Federal Aviation Administration (FAA). This contains, amongst others, a description of the aircraft, the normal and emergency procedures and the aircraft performance.

Boeing 737-400 Flight Crew Operations Manual (FCOM)

Boeing also publishes the Flight Crew Operations Manual (FCOM) for the Boeing 737-400 type based on the AFM. The goal of the FCOM is:

- To issue operational procedures, performance and system information that the cockpit crew requires for a safe and efficient flight execution with a Boeing 737.
- To use as extensive manual during conversion training for the Boeing 737.
- To use as a reference book during recurrent and proficiency checks.
- To issue the required operational data from the Aircraft Flight Manual.
- To define standard procedures and applications to promote Boeing's policy regarding flight execution.

The FCOM consists of two parts and the Quick Reference Handbook (QRH). Part I contains general information, normal procedures, complementary procedures and information for the flight crew when no flight support is available from the ground. Part II contains aircraft and systems description. The QRH contains all checklists for normal and non-normal procedures, and performance information for during the flight. For this investigation some relevant items are addressed below.

Relevant chapters in the QRH are:

- Non-Normal Checklists
 - Paragraph 7 Engines, APU
 - Paragraph 14 Landing gear
 - Paragraph 15 Warning systems
- Checklist Instructions
- Manoeuvres

Chapter Checklist Instructions

Paragraph 2.2 Non-Normal Checklist Operation

While every attempt is made to supply needed non-normal checklists, it is not possible to develop checklists for all conceivable situations. In some smoke, fire or fumes situations, the flight crew may need to move between the 'Smoke, Fire or Fumes' checklist and the 'Smoke or Fumes Removal' checklist. In some multiple failure situations, the flight crew may need to combine the elements of more than one checklist. In all situations, the captain must assess the situation and use good judgment to determine the safest course of action.

Chapter Manoeuvres

Chapter 1 Non-normal manoeuvres

Paragraph 1.3 Terrain Avoidance

If a terrain caution occurs when flying under daylight VMC, and positive visual verification is made that no obstacle or terrain hazard exists, the alert may be regarded as cautionary and the approach may be continued.

Chapter 2 Flight patterns

Paragraph 2.1 Take-off

Describes the take-off procedure, including the procedure to be followed after an engine failure. Any required deviations to the prescribed engine failure profile will be shown on the performance calculation tables available to the crew. For Schiphol airport no deviations are prescribed.

Flight Crew Training Manual

The Flight Crew Training Manual (FCTM) contains information and recommendations regarding manoeuvres and techniques. It contains information in support of the procedures that are written in the FCOM and techniques to support the pilot to execute these procedures safely and efficiently. The FCTM is only used during type qualification training and possibly during the recurrent training, it is not used during the flight. For this investigation some relevant items are addressed below.

The FCTM contains advices about the following relevant subjects for this serious incident:

- Chapter 1 General Information
- Chapter 3 Take-off and Initial Climb
- Chapter 5 Approach and Missed Approach
- Chapter 7 Manoeuvres
- Chapter 8 Non-Norma Operations

Chapter 1.2 Crew Resource Management

Contains general guidelines on how to analyze, prioritize and handle failures. Amongst others this chapter describes that the first priority for the crew should be to control the flight path. As soon as the aircraft is under control, properly a failure analysis should be made. Only then memory items and checklists should be performed.

Chapter 7.20 Terrain Avoidance

Terrain warning-level alerts always require immediate action. The most appropriate crew actions regarding aircraft bank angle and track during a terrain avoidance manoeuvre depend on where the manoeuvre is initiated. Operators should determine the most appropriate course of action for each leg of the procedure, if necessary, so crews are prepared to react correctly at all times.



Initial Climb - One Engine Inoperative

The initial climb attitude should be adjusted to maintain a minimum of V_2 and a positive climb. After liftoff the flight director provides proper pitch guidance. Cross check indicated airspeed, vertical speed and other flight instruments. The flight director commands a minimum of V_2 , or the existing speed up to a maximum of $V_2 + 20$.

If the flight director is not used, attitude and indicated airspeed become the primary pitch references.

Retract the landing gear after a positive rate of climb is indicated on the altimeter. The initial climb attitude should be adjusted to maintain a minimum of V_2 . If an engine fails at an airspeed between V_2 and $V_2 + 20$, climb at the airspeed at which the failure occurred. If engine failure occurs above $V_2 + 20$, increase pitch to reduce airspeed to $V_2 + 20$ and maintain $V_2 + 20$ until reaching acceleration height.

The flight director roll mode commands wings level or HDG SEL (as installed) after liftoff until LNAV engagement or another roll mode is selected. If ground track is not consistent with desired flight path, use HDG SEL/LNAV to achieve the desired track.

Indications of an engine fire, impending engine breakup or approaching or exceeding engine limits, should be dealt with as soon as possible. Accomplish the appropriate memory checklist items as soon as the airplane is under control, the gear has been retracted and a safe altitude (typically 400 feet AGL or above) has been attained. Accomplish the reference checklist items after the flaps have been retracted and conditions permit.

If an engine failure has occurred during initial climb, accomplish the appropriate checklist after the flaps have been retracted and conditions permit.

Immediate Turn after Takeoff - One Engine Inoperative

Obstacle clearance or departure procedures may require a special engine out departure procedure. If an immediate turn is required, initiate the turn at the appropriate altitude (normally at least 400 feet AGL). Maintain V_2 to $V_2 + 20$ knots with takeoff flaps while maneuvering.

Note: Limit bank angle to 15° until $V_2 + 15$ knots. Bank angles up to 30° are permitted at $V_2 + 15$ knots with takeoff flaps. With LNAV engaged, the AFDS may command bank angles greater than 15° .

After completing the turn, and at or above acceleration height, accelerate and retract flaps.



Autopilot Engagement - One Engine Inoperative

When at a safe altitude above 1,000 feet AGL with correct rudder pedal or trim input, the autopilot may be engaged.

Flap Retraction - One Engine Inoperative

The minimum altitude for flap retraction with an engine inoperative is 400 feet AGL. During training, Boeing uses 1,000 feet AFE as a standard altitude to initiate acceleration for flap retraction.

On airplanes with FMC U10.7 and earlier, at engine out acceleration height, select flaps up maneuvering speed on the MCP. Engine-out acceleration and climb capability for flap retraction are functions of airplane thrust to weight ratio. The flight director commands a near level or a slight climb (0-200 fpm) flap retraction segment. Accelerate and retract flaps on the flap-speed schedule.

On airplanes with FMC U10.8 and later, at engine out acceleration height, if VNAV is engaged, a near-level climb segment is commanded for acceleration. Retract flaps on the flap-speed schedule.

On airplanes with FMC U10.8 and later, If VNAV is not engaged, leave the pitch mode in TO/GA and select flaps up maneuvering speed on the MCP. Engine-out acceleration and climb capability for flap retraction are functions of airplane thrust to weight ratio. The flight director commands a near level or a slight climb (0-200 fpm) flap retraction segment. Accelerate and retract flaps on the flap-speed schedule.

If the flight director is not being used at acceleration height, decrease pitch attitude to maintain approximately level flight while accelerating. Retract flaps on the flap-speed schedule.

As the airplane accelerates and flaps are retracted, adjust the rudder pedal position to maintain the control wheel centered and trim to relieve rudder pedal pressure.

Flaps Up - One Engine Inoperative

On airplanes with FMC U10.7 and earlier, after flap retraction and at flaps up maneuvering speed, select LVL CHG, set maximum continuous thrust (CON) and continue the climb to the obstacle clearance altitude.

On airplanes with FMC U10.8 and later, after flap retraction and at flaps up maneuvering speed, with VNAV engaged and flaps up the FMC commands a climb at flaps up maneuvering speed. Set maximum continuous thrust (CON) and continue the climb to the obstacle clearance altitude. If VNAV is not engaged, select LVL CHG.

ATLAS BLUE

General

Pursuant to JAR-OPS 1 (Aeroplanes), Royal Air Maroc has published a number of documents in which the standard company procedures are described. These include the Atlas Blue Operations Manual (in which, amongst others, the Standard Operational Procedures are described) and the Boeing 737 Minimum Equipment List. Both documents have been approved by the Moroccan DGCA.

Operations manual

Pursuant to JAR-OPS 1.200 Royal Air Maroc has published the Atlas Blue Operations Manual. This manual is divided into four chapters in accordance with JAR-OPS 1.1045:

- Part A – General/basic information
- Part B – Standard Operating Procedures
- Part C – Route- and airport instructions and information
- Part D – Training Manual

Part A describes, amongst other things, the set-up of the organisation and the general flight procedures. The sections of Part A that are relevant to this investigation are:

- Section 1 Organisation and responsibilities
- Section 2 Operational control and supervision
- Section 3 Quality system
- Section 4 Composition of the crew
- Section 5 Qualification requirements
- Section 8 Operational procedures

Part B describes the Standard Operational Procedures for the use of all aircrafts within Atlas Blue. Section A describes the standard procedures that are not type dependent. Section B describes the standard procedures per aircraft type, in this case, the Boeing 737-400. The sections of Part B that are relevant to this investigation are:

- Section 1 Restrictions
- Section 2 Normal procedures
- Section 3 Deviating and emergency procedures
- Section 4 Performance
- Section 9 Minimum equipment list
- Section 11 Evacuation procedures
- Section 12 Aircraft systems

Part C refers to manuals (Jeppesen, FCOM, ICAO, JAR-OPS) that may contain relevant information and instructions regarding routes and airports.

Part D specifies the internal guidelines and regulations with regard to the training of both cockpit and cabin crews of Royal Air Maroc. The sections of part D that are relevant to this investigation are:

- Section 1 General
- Section 2 Training of cockpit personnel
 - section 9 Line training and checks
 - section 10 List of training sessions
- Section 3 Training of cabin personnel
- Section 5 Procedures for training and checks

AMSTERDAM AIRPORT SCHIPHOL

Company manual Amsterdam Airport Schiphol

The company manual contains a procedure with the purpose to limit the number of bird strikes on the airport terrain as much as possible, in particular in the landing area. This procedure has been written in chapter 5.1.1.6 [translated] Fauna incident prevention – PE. The procedure contains the following subjects: purpose, owner, basic legal principles, background information, conditions, responsibilities, activities, and references.

The regulations and procedures for Air Traffic Control the Netherlands are, in addition to the standards and recommended practices of the International Civil Aviation Organization ICAO, specified in European regulations, national legislation and internal guidelines. In addition, Air Traffic Control the Netherlands publishes the Aeronautical Information Publication Netherlands (AIP) on behalf of the Dutch aviation authorities.

ASSIST principle for air traffic controllers dealing with aircraft in distress.

In 1996, the European organisation for the safety of air navigation (Eurocontrol) organised a working conference for air traffic controllers on correct procedure during emergency situations. This conference resulted in the Guidelines for Controller Training in the Handling of Unusual/Emergency Situations' (subsequently referred to as Guideline). The Netherlands is a member of Eurocontrol and took part in this working conference.

The document introduces various abbreviations and acronyms in order to help air traffic controllers remember the immediate actions required in the event of an emergency. For example: the direct response to a Mayday call. Most individual air traffic controllers will rarely encounter such a situation. The guideline introduces the ASSIST principle, providing air traffic controllers a clear procedure for emergency situations. At the time the guideline was published, the ASSIST principle had already been introduced by German Air Traffic Control (Deutsche Flugsicherung). The ASSIST principle was also introduced by LVNL (see below). The acronym ASSIST stands for:

- **A**cknowledge the emergency call;
- **S**eparate: separate the aircraft in distress from other air traffic and offer it the space it needs;
- **S**ilence on the frequency: set up a separate radio frequency for the aircraft in distress in order to ensure that pilots are not distracted by unnecessary information;
- **I**nform: inform officials responsible for providing necessary assistance; this can also include informing (external) emergency services;
- **S**upport: provide support to pilots where possible. This may include providing alternative routes upon request;
- **T**ime: give pilots the time they need to gain a clear overview of the situation and determine which actions can be taken.

Rules and instructions air traffic control (Voorschriften Dienst Verkeersleiding)

All procedures, practices, rules and regulations that Air Traffic Control the Netherlands staff, carrying out the work, require to ensure they can perform their tasks safely and efficiently, are summarised in the Rules and instructions air traffic control (VDV). This is an internal document. The VDV prescribes how air traffic control must be executed in the Netherlands by Air Traffic Control the Netherlands. The VDV comprises eight parts. The part that applies to this investigation is VDV 2: Schiphol Tower/Approach. The relevant sections of the VDV 2 are:

- Section 2 General
- Section 7 Runway control
- Section 8 Approach control
- Section 10 Emergency procedures

The VDV covers:

1. the various types of distress signal an air traffic controller may encounter (including Mayday and Pan Pan) and other indications of emergencies – such as deviations in terms of the allocated altitude, or the loss of radar contact or radar tracking failure;
2. the behaviour of an aircraft in distress; the VDV outlines which type of flight behaviour and emergency signal the air traffic controller can expect in each type of emergency situation;
3. general guidelines, consisting of: general guidelines in accordance with the ASSIST principle. This type of assistance generally involves providing the pilot with space, rest, information and time. According to the VDV, [translated] "the degree of separation from other traffic must be increased, while the number of instructions and radio communications with the aircraft in distress must be limited to a minimum";
4. specific guidelines for emergency situations such as: loss of radio contact, fuel dumping, unlawful interference (such as hijackings), unauthorised air transport movements, et cetera, and in the event of a (pending) aircraft accident at or near the airport;

5. the Schiphol airport emergency plan, including the alarm phases for aircraft accidents at Schiphol airport, VOS 1 to 7 inclusive and evacuation procedures.

The VDV emergency procedures have been elaborated into operational instructions for air traffic controllers, in the form of a Quick Reference Handbook (QRH). This handbook is also based on the general ASSIST principle. It also specifies which actions air traffic controllers are expected to take in the event of various emergency situations, such as bird strikes, braking problems, bomb threats, engine failure, emergency landings and the like.

Aeronautical Information Publication

The Aeronautical Information Publication (AIP) is the aviation guide for all flight crew members. Dutch legislation and regulations, flight procedures and information about airports and aerodromes, including air traffic control procedures and arrival and departure procedures can be found in the AIP as well as other issues. Each change/modification to regulations, procedures or information is processed in the AIP.

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) – BIRD CONTROL

*Airport Service Manual*¹⁶⁷

The Airport Service Manual recommends the establishment of a national committee that can serve as a central hub for the analysis of animal collisions and airport inspections and act as an intermediary between the airport and airlines, also with regard to research and development issues. The committee should consist of representatives of the Ministry of Infrastructure and the Environment, the Ministry of Defence, key airport operators, pilots' associations and engine manufacturers. The manual also recommends the inclusion of representatives from environmental and agricultural organisations and recommends that authorities charged with airport policy develop guidelines and standards in consultation with regional authorities and a national bird control committee.

The airport manager should be granted the responsibility for taking any actions needed in order to implement policies and minimise the number of bird strikes. Airport operators should appoint a wildlife coordinator, bird hazard officer and wildlife committee, charged with implementing a special programme.

*Manual on the ICAO Bird Strike Information System*¹⁶⁸

This manual emphasises the importance of effective reporting of bird strikes by means of the Bird Strike Information System (IBIS). The manual contains forms explaining proper reporting procedure. The manual also contains suggestions on setting up a bird strike control programme and dealing with the airport's surrounding environment. Finally, the manual features examples of deterrent equipment and methods.

AIRCRAFT BIRD STRIKE COMMITTEE¹⁶⁹

Manual for Bird Strike Prevention at Dutch Airports

In November 2006, the Aircraft Bird Strike Committee published the Manual for Bird Strike Prevention at Dutch Airports. Part I of the manual describes the nature of the bird strike risk at airport grounds, bird strike prevention management/wildlife management and operational procedures. Part II contains detailed information on the most effective methods of preventing birds from entering airport grounds. Part III contains background information on bird species.

Various chapters of the manual focus on the airport's surrounding area and the observation of birds outside of the airport grounds. Amongst other measures, the manual recommends the use of

167 Doc 9137-AN/901 Part 3, Airport Services Manual, Bird control and reduction, 1991 (ICAO).

168 Doc 9332-AN/909, Manual on the ICAO bird strike information system (IBIS), 1989 (ICAO).

169 Succeeded by the Dutch Bird Strike Control Group on 11 June 2010.

radar detection. The authors conclude that there are already a wide range of available technical measures. In order to apply such measures effectively, it is crucial to determine the relevant preconditions and responsibilities.¹⁷⁰

ASSESSMENT FRAMEWORK CONCERNS DUTCH SAFETY BOARD

Safety management refers to the way in which the details are provided with regard to organisations' responsibilities in relation to safety in addition to defining this through the available legislation, regulations, standards and guidelines. For example, the way in which risks are mapped for those involved and the way in which risks are controlled in a structural manner. The organisation requires a structure to ensure that the whole process can be executed and made transparent and to create possibilities for continued improvement. This structure is called the safety management system. Various previous incidents have shown that the safety management system structure and the elaboration of the system by the various parties involved plays a crucial role in the management, assurance and continued improvement of safety.

The Dutch Safety Board bases its investigations on five general safety principles. These principles are used to determine whether and how the parties have fulfilled their own responsibilities with regard to safety. The Dutch Safety Board informed the Dutch Ministry of the Interior and Kingdom Relations about this through a letter.

1. *Acquiring demonstrable insight into safety risks as the basis for the safety approach*

The starting point to achieve the required level of safety is:

- exploration of the entire system; and
- making an inventory of the related risks.

This information is used to determine which risks must be controlled and the related preventive and repressive measures.

2. *Demonstrable and realistic safety approach*

A realistic and practical safety approach, i.e. a safety policy, must be defined to prevent and control undesired events. This safety approach is based on the following:

- relevant legislation and regulations in force (section 3.2);
- available standards, guidelines and best practices from the sector, personal insights and experiences from the organisation and the safety targets specifically defined for the organisation.

3. *Implementing and enforcing the safety approach*

The implementation and enforcement of the safety approach and controlling identified risks takes place through:

- a description of the method in which the used safety approach is realised focussing on specific goals and plans including the preventive and repressive measures that arise from this approach;
- transparent and unambiguous subdivision of responsibilities with regard to the safety on the work floor that is accessible to all for the implementation and enforcement of safety plans and measures;
- clear definition of the required staff deployment and expertise for the various tasks;
- a clear and active central coordination of safety activities;
- realistic practising and testing the safety approach.

170 According to the manual, the Netherlands Society for the Protection of Birds (Vogelbescherming Nederland) contributed to the realisation of the manual but does not subscribe to all statements, recommendations and interpretations described in it.

4. *Making the safety approach stricter*

The safety approach must be continuously assessed and fine tuned based on:

- the regular performance of (risk) analyses in the area of safety, observations, inspections and audits and, in any case, every time a basic principle changes (proactive approach);
- a monitoring system and investigation of near accidents and incidents in the complex and an expert analysis thereof (reactive approach).

Based on this, assessments are made and improvement issues are brought to light that can be used to actively steer.

5. *Management steering, commitment and communication*

The management of the involved parties/organisation must:

- take care internally for clarity and realistic expectations with regard to the safety ambition, ensure there is a climate of continuous improvement of safety on the work floor;
- clearly communicate externally about the general working method, the verification method thereof, procedures with regard to deviations and exceptions, etcetera, based on transparent and defined agreements with the environment.

APPENDIX I: 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.

Contents of Crew Resource Management training

Operating aboard an aircraft/helicopter where duties are divided between more than 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.

APPENDIX J: CERTIFICATION REQUIREMENTS - ENGINES

List of amendments that altered the engine bird ingestion regulations:

- Amendment 33-6, effective on October 31, 1974 introduced paragraph 33.77 that incorporated foreign object ingestion as a certification requirement. Foreign objects were defined as birds, debris, ice and blade fragments. This is the bird ingestion standard to which the serious incident engine model was certified. Additionally a requirement for medium bird strike was added, requiring engines to operate after bird ingestion with no more than a 25% loss of thrust for five minutes, demonstrate no hazard¹⁷¹ to the aircraft and cause no change in handling characteristics.
- Amendment 33-10, effective on March 26, 1984 added details and refined the definition of foreign objects to just water, hail, ice and birds. Debris such as metal and tires was removed. The definition of 'inlet area' was refined and a detail about 'critical locations' in the inlet areas was added. The medium bird ingestion criterion for CFM56 sized engines was five to eight 1.5-pound birds volleyed¹⁷² into the engine in less than one second. The large bird ingestion criterion was a single 4-pound bird.
- Amendment 33-20, effective on December 13, 2000 created a new section 33.76, titled 'Bird Ingestion' (section 33.77 was dedicated to ice ingestion). Bird ingestion requirements were expanded significantly over previous amendments in this major revision. The medium bird ingestion criterion for CFM56 sized engines was a combination of one 2.5 pound bird and three 1.5 pound birds volleyed into the engine in less than one second with no more than 25% thrust loss for a 20-minute run-on. The large bird ingestion criterion was a single 6-pound bird for CFM56 sized engines. This amendment also establishes nearly uniform bird ingestion standards for aircraft turbine engines certified by the United States under FAA standards and by the Joint Aviation Authorities (JAA) countries under JAA standards, thereby simplifying airworthiness approval for import and export.
- Amendment 33-24, effective on November 16, 2007 revised section 33.76 by introducing a new class of bird for testing, the large flocking bird whose weight requirement was 4 pounds, 4.5 pounds, and 5.5 pounds depending on engine size, and the run-on test (as a decreasing sliding scale) from 90% maximum takeoff power for 20 minutes after ingestion. The large flocking bird test is not applicable to CFM56 sized engines.

Aircraft engine certification process

The aircraft engine certification process consists of many certification tests or analyses that demonstrate that the engine is compliant with its type certification basis. Due to the number and complexity of the testing required, not all the certification tests are performed at once, but rather are performed in stages until all the FAA and JAA requirements have been satisfied. The engine Type Certificates were issued upon successful completion of all the certification requirements. The bird strike analysis and tests are a small component of the overall engine certification process.

At the time the original CFM56-3 engine was certified in 1984, 14 CFR Part 33 Amendment 6 and JAR-E Change 2 contained the airworthiness standards that engines were required to comply with to obtain an FAA and JAA (now: EASA) Type Certificate.

171 Engine hazards at that time were defined as fire, uncontained debris, mount failure, and inability to shutdown.

172 Volley means shooting the birds into the engine as defined by critical ingestion parameters that include bird speed, critical engine target location, fan speed, and into the engine in a specified time within the normal flight operations up to 1500 feet above ground level, but not less than V_1 minimum for the aircraft.

The FAA bird strike regulations were not a stand-alone requirement but were part of a larger requirement – 14 CFR 33.77 titled 'Foreign Object Ingestion'. Section 33.77 stated, in part, the following:

1. Ingestion of a 4-pound (large-sized) bird ...may not cause the engine to—
 - a. Catch fire;
 - b. Burst (release hazardous fragments through the engine case);
 - c. Generate loads greater than those ultimate loads specified in Sec. 33.23(a)¹⁷³; or
 - d. Lose the capability of being shut down.
2. Ingestion of 3-ounce birds or 1.5-pound (medium-sized) birds ...may not—
 - a. Cause more than a sustained 25 percent power or thrust loss;
 - b. Require the engine to be shut down within 5 minutes from time of ingestion; or
 - c. Result in a potentially hazardous condition.

According to Section 33.77, the medium-sized bird ingestion criterion for CFM56-3 sized engines was five 1.5-pound birds volleyed into critical areas of the engine (one bird was volleyed at the spinner and four birds were volleyed into the fan blade area, two at 45% span and two at 75% span) in rapid sequence to simulate a flock encounter. To comply with these requirements, the CFM56-3 engine was subjected to a medium-bird test, which was intended to test the fan blades, structure, and core machinery for resistance to impact from, and ingestion of, multiple medium-sized birds. The test was performed with a bird speed equal to the initial climb speed of a typical aircraft and the engine at 100-percent take-off power. A summary of the test report stated that, after the medium-bird ingestion test, twelve fan blades showed deformation but no material loss was reported. During the test the engine lost approximately 3% of thrust compared to 25% allowable. No engine ratings or limitations were exceeded during the test.

The large-bird ingestion criterion for CFM56-3 sized engines was a single 4-pound bird fired into a critical area of the fan but not in the core area. To comply with these requirements, the CFM56-3 engine was also subjected to a large-bird test, which was intended to test the fan blades, flammable fluid lines, and support structure for resistance to impact from, and ingestion of, a single, large bird. The test was performed with a bird speed equal to the maximum climb speed of a typical aircraft and the engine at maximum cruise power. Four separate tests were performed with the goal of showing that large-bird ingestion was less severe than fan blade-out and tire ingestion. A summary of the test report stated that, the damage caused by the bird-ingestion test was less severe than the damage caused by the fan-blade out test in all cases.

JAR-E C3-2(1.4.1)(1.4.2) is specific to bird ingestion:

1.4.1 The Engine shall be designed so that the ingestion of foreign matter that is likely to affect more than one engine in a multi-engined aeroplane in any one flight, (e.g. rain, hail, ice, gravel, sand, small birds) is not likely to hazard the aeroplane as a consequence of (a) immediate or subsequent loss of performance, or (b) unacceptable deterioration of engine handling characteristics during the flight.

- JAR-E C3-4(20) describes the requirements for CFM56-3 sized engines as three 1.5-pound birds.

1.4.2 The engine shall be designed so that the ingestion of foreign matter that is likely to affect one Engine only in a multi-engined aeroplane in any one flight, (e.g. cleaning cloths, hand tools, rivets, bolts and screws, compressor blades, large birds) is not likely to hazard the aeroplane.

- JAR-E C3-4(20) describes the requirements for CFM56-3 sized engines as one 4 pound bird.

Since the JAA bird ingestion requirements were less stringent than the FAA requirements, the FAA and the French DGAC jointly approved the results of the FAA tests.

173 Title 14 CFR 33.23(a), "Engine Mounting Attachments and Structure," states, "the maximum allowable limit and ultimate loads for engine mounting attachments and related engine structure must be specified."

APPENDIX K: MAIN POINTS OF THE 3PR INVESTIGATION

The investigation covered the safety effectiveness –reduction of flying above the built environment– and the feasibility in practice of the measure known as ‘built-up areas on radar’ in emergency situations. On 20 March 2003 the report of the investigation carried out by Air Traffic Control the Netherlands entitled “*Reduction of Third Party Risk (3PR) during handling of Emergencies*” was submitted to the Inspectorate of Transport, Public Works and Water Management. The outcome of the 3PR investigation was that, although the display of populated areas on radar screens is technically possible, it was considered neither effective nor practical by both pilots and air traffic controllers. The investigation included a substantiation for each solution strategy. The following is a summary of the main points of the 3PR investigation:

- In MAYDAY or PAN PAN situations the aircraft’s situation is very time-critical. At the same time, pilots do not always send these international emergency signals but use other terms instead. An air traffic controller is dependent on the pilots’ signals as regards determining the extent to which the situation is time-critical. At the moment that the situation is time-critical, pilots have a very high workload as they try to cope with the situation. Pilots stated that it would be undesirable to have to engage in additional radio communication regarding suggestions or instructions to discuss risks on the ground. If a situation ‘apparently’ offers enough time, extending the flight due to a runway suggestion because of a third party risk can still make the situation time-critical and dangerous.
- The effectiveness of alternative runway suggestions for the safety on the ground is intrinsically limited. At the moment that an alternative suggestion is chosen which does not involve flying over built-up areas, the potential risk –the possible crash location– logically shifts to built-up areas further on. The related lack of accuracy increases in the case of emergency flights as the altitude, speed and distance to the runway increase.
- The preferred Schiphol runway system for noise is identical to that for external safety. As a result this system is ‘intrinsically’ focused on the lowest possible risk for third parties.
- Of the alternatives investigated for route suggestions, fixed routes and the displaying of built-up areas on radar screens have hardly any effect in terms of avoiding built-up areas. What is more, pilots in time-critical situations are unable to process any additional instructions and they therefore regard these alternatives as unfeasible. The investigation established that the ‘best practices’ measure for making route suggestions to aircraft in an emergency has the best safety effect, namely less flying over built-up areas.
- The captain is responsible for the passengers on board. No international frameworks exist for weighing up the risks for people on the ground. According to the investigation, Air Traffic Control the Netherlands cannot take any independent measures which would affect the safety of crew and passengers, in the context of weighing up their safety in relation to people on the ground. According to the investigation findings, only national and international regulators have the authority to do this.

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