

**Investigation into the cause of the
fast ferry Voskhod 605 accident
on 18 October 2003
in Amsterdam**

The Hague, May 2005

The final reports of the Dutch Safety Board are open to the public for inspection.
All reports are available via the website: www.onderzoeksraad.nl

The DUTCH SAFETY BOARD

The Dutch Safety Board was established by Kingdom Act and is responsible for investigating and establishing the causes or probable causes of individual or categorical incidents or accidents in all sectors. The sole purpose of these investigations is to prevent future accidents or incidents and if the results of the investigation require so, to issue recommendations. The organisation consists of a Board of five permanent Board members and in addition to this, it has ten permanent committees. For specific investigations special advisory committees are set up. The Board is assisted by a bureau consisting of investigators, secretary-reporters as well as supporting staff.

The Dutch Safety Board is the legal successor of the Dutch Transport Safety Board. The present investigation has been carried out by the Dutch Transport Safety Board but is issued under the responsibility of the Dutch Safety Board. An investigation account is set out in the appendix.

Board

Chairman: *mr.* Pieter van Vollenhoven
mr. J.A. Hulsenbek
Ms A. van den Berg
Dr. *ing.* F.J.H. Mertens
Dr. *ir.* J.P. Visser

Shipping Committee

Chairman: *mr.* J.A.Hulsenbek
Prof. *ir.* A. Aalbers
mr. B.C. De Savornin Lohman,
Esq.
mr. D.M. Dragt
P.M.J. Kreuze
Ms M.J. Torpstra
H.J.G. Walenkamp
L.P.A. de Winter
Secretary: *drs.* H.J.A. Zieverink

Bureau management

General interim secretary
Head of recommendations department
Head of investigation department
ir. D.A. van den Wall Bake
drs. J.H. Pongers
H.J. Klumper

Project team

ing. G.Th. Koning
(project manager)
W. Boutkan

Visiting address: Anna van Saksenlaan 50
2593 HT Den Haag

Postal address: Postbus 95404
2509 CK Den Haag

Telephone: +31 (0)70 333 7000
The Internet: <http://www.onderzoeksraad.nl>

Fax: +31 (0)70 333 7077

TABLE OF CONTENTS	3
SUMMARY	5
ACRONYMS and ABBREVIATIONS	9
1 GENERAL INFORMATION	11
1.1 <i>Location and circumstances</i>	11
1.2 <i>Technical details of hydrofoil fast ferry VOSKHOD 605</i>	12
2 FACTUAL INFORMATION	13
3 PRIMARY ANALYSIS	19
3.1 <i>Infrastructure</i>	19
3.2 <i>Reconstruction of the accident</i>	19
3.3 <i>Introduction</i>	21
3.4 <i>Electric and electronic components and connections</i>	22
3.5 <i>Steering gear – installation and maintenance status</i>	22
3.6 <i>Steering gear – hydraulic components</i>	23
3.7 <i>Propulsion system</i>	23
3.8 <i>General maintenance of the vessel and previous failures</i>	24
3.9 <i>Summary</i>	25
4 SECONDARY ANALYSES	27
4.1 <i>Subsequent investigation</i>	27
4.2 <i>Naco Ferries/Connexxion</i>	27
4.3 <i>Connexxion Holding N.V.</i>	27
4.4 <i>Personnel aspects</i>	29
4.5 <i>Government control: statutory provisions (shipbuilding- and mechanical requirements)</i>	31
4.6 <i>Exemption by Centraal nautisch beheer Noordzeekanaal [central nautical management Noordzeekanaal]</i>	33
5 CONCLUSIONS	35
6 RECOMMENDATIONS	39
APPENDICES	
<i>Appendix 1: Investigation account</i>	41
<i>Appendix 2: Organisation chart Connexxion Holding N.V.</i>	43

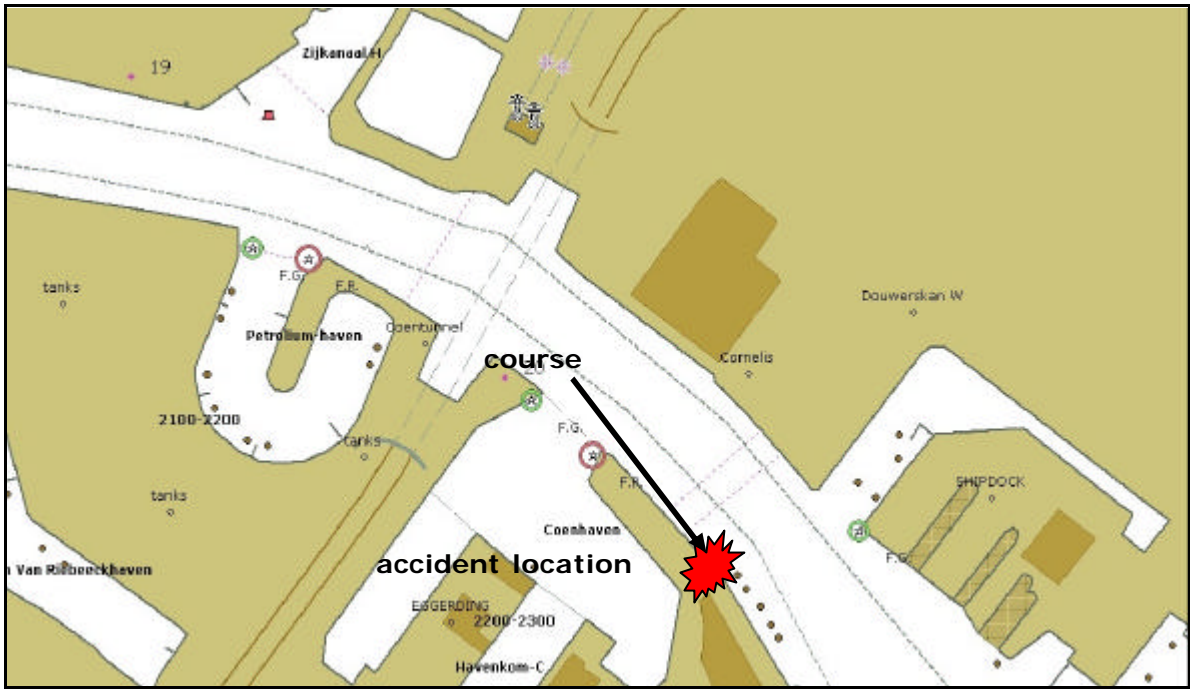


Figure 1a: Location of the collision on the Noordzeekanaal in Amsterdam

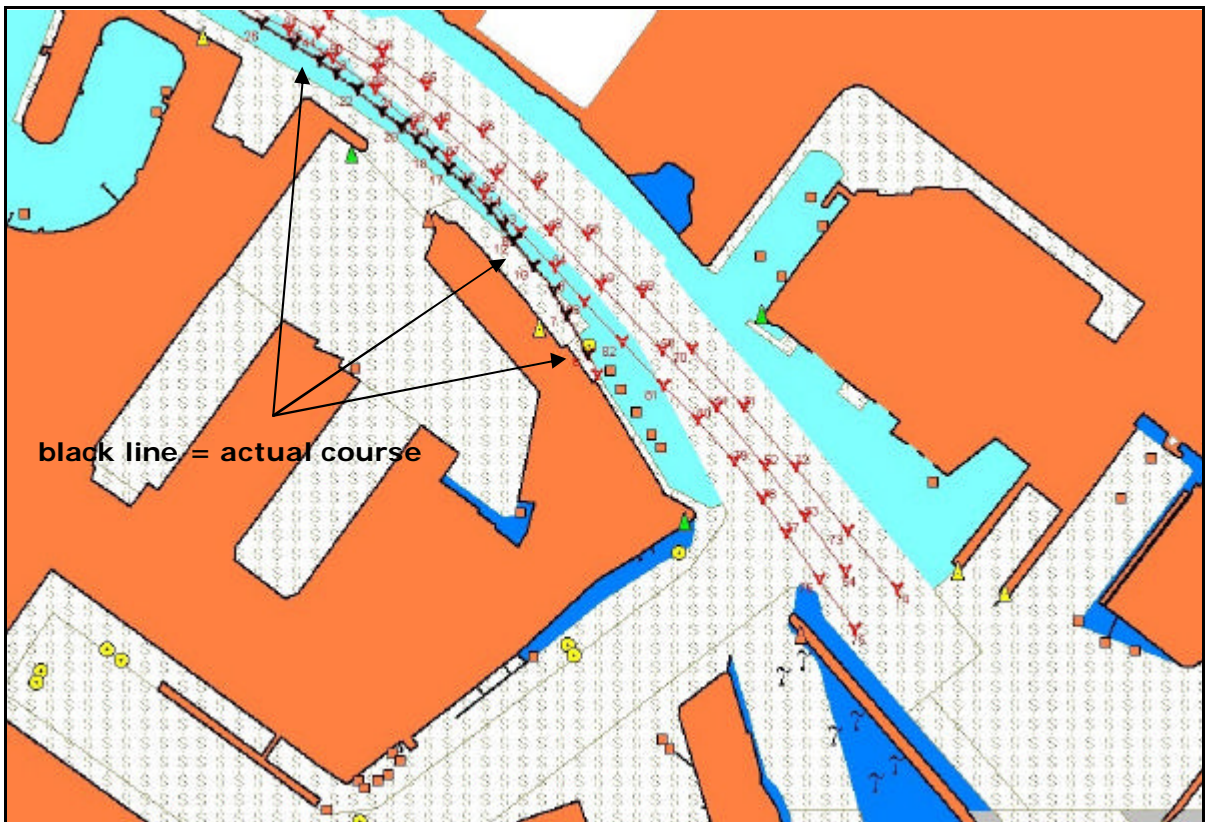


Figure 1b: Course of the Voskhod 605 prior to the accident¹

¹ The black line is a reconstruction of the distance covered on the basis of the positions recorded in the installed Global Positioning System. NB: the symbols in the line bear no relation to velocity, distance covered or GPS point of measurement. The other red track lines bear no relation to the accident.

SUMMARY

On 18 October 2003 at 1250 hours an accident occurred with the fast ferry Voskhod 605, which ran into the quay at approximately 60 km/h just beyond the Coenhaven in Amsterdam (see figure 1). 21 people were injured in the accident and the fast ferry was badly damaged. Looking back it must be concluded that the outcome has been relatively good, because in the collision the hull appeared to have been torn open right in the longitudinal direction of the corridor where no passengers were, and where the aluminium hull had absorbed the collision forces well by crumpling.

Investigation into the circumstances of the collision has shown that the accident could occur because the crew did not notice the dangerous course development in time. The specific sailing characteristics of hydrofoils, such as high speed, long stopping distance and large turning circle imply that the speed of these hydrofoils has very few safety reserves.

At the time of the accident the master and the second master, as well as three passengers as their guests, including one child, were present in the wheelhouse. To what extent their presence has been the cause of possible distraction of the master cannot be proved on the basis of the available investigation findings. It appears from the statements that during their presence there was not much conversation. A detailed demonstration or explanation was not given, either. Similar circumstances, in which passengers stay close to the drivers or persons steering, also occur regularly in other modes of transport.

It cannot be ruled out that the master was having a moment of inattention as a result of a period of light workload (understimulation), because they were steering on autopilot at which usually few corrections are necessary and he was well acquainted with behaviour and performance of the vessel. He was also well acquainted with both the navigational area and the route. This does not alter the fact that the presence of passengers in the wheelhouse during the trip is not allowed.

The investigation has not shown an underlying technical problem to be the cause of the accident. All relevant systems have worked properly until the moment of the collision. The maintenance status found on board the Voskhod 605, however, has seriously worried the Board. The steering gear showed some serious latent defects each of which could easily have caused failure of crucial systems at any time.

An example of these latent defects is that the main connectors for the steering valves had been fitted without the required securing bolts and rubber gaskets, due to which the connectors might easily have come loose due to vibration underway. Besides, threaded ends of the hydraulic cylinders – that are the connection to the rudder – were found, which had almost completely become loose. Furthermore, the voltage received by the steering valve was too low, due to which much of the characteristics of such a valve will get lost.

Finally, there were several minor oil leaks on board as well as seriously damaged and almost decayed sheaths of electric cables.² Although these defects did not play an active part in the cause of the accident described here, it cannot be excluded that they did play a part in the many failures and some (near) accidents of the Voskhod 605 in the past. The Board had already notified the management of Connexxion Tours en Water in writing before, in connection with this alarming maintenance status.

NACO Ferries/Connexxion management is responsible for the entire organisation of the fast ferry service. It has appeared that this management has taken insufficient responsibility in realising this mode of transport by water in a safe and responsible manner. A responsible management may be expected to pay careful attention to the special requirements that must be imposed on crewmembers, equipment and maintenance of the vessels as well as the organisation involved. This appears inter alia from reacting insufficiently adequately to – and drawing conclusions from previous incidents and accidents. Besides, earlier requests from crewmembers for extra training were ignored. As a result of this, the Board has considered it necessary to make a recommendation to Naco Ferries/ Connexxion, which reads as follows:

Naco Ferries/Connexxion are recommended to ensure that by means of safety- and quality systems the general safety- and quality level is increased, so that safe and reliable transport of passengers is guaranteed.

This applies in particular to:

- a. maintenance, equipment and technical state of the vessels,*
- b. training and instruction of crewmembers,*
- c. the manner of putting crewmembers into service, including working hours and rest periods,*
- d. safety precautions for passengers.*

It also appears from the investigation that Connexxion Holding N.V., of which the State of the Netherlands holds all the shares and which Naco Ferries/Connexxion forms part of, has not in any way exercised influence on the safety policy. Until early 2005 there was no safety management system whatsoever at the Holding.

As a result of this, the Board has considered it necessary to make also a recommendation to Connexxion Holding N.V., which reads as follows:

Connexxion Holding N.V. are recommended to take stock of the safety- and quality policy of the companies accountable to her and to change this into a recognisable and uniform safety- and quality system.

² In November 2004 the Board published the “Themastudie naar roeruitval op binnenschepen” report. This safety study gives a detailed analysis of the backgrounds and causes of rudder failure on inland navigation vessels.

Also legislation and regulations pertaining to the operation of hydrofoils have appeared not to keep in step with the development of this relatively new mode of passenger transport. This is a matter of a passive attitude of the legislator. As from the introduction of this type of vessels on the Noordzeekanaal no rules have been formulated pertaining to e.g. the necessity or desirability of sailing with two masters in the wheelhouse when riding on the foils. Neither are there any additional rules formulated pertaining to the qualities, training and skills required for crewmembers. The law only prescribes a commercial vessels master's certificate. For high-speed craft on waterways where the Shipping Police Regulations (BPR) apply, no rules pertaining to the above-mentioned aspects have been formulated.

On the basis of the findings, the Board has considered it necessary to make a recommendation to the parties that are directly involved in sailing with high-speed passenger vessels, which reads as follows:

The Minister of Transport, Public Works and Water Management is recommended to conduct with all parties involved a risk analysis of the operational aspects of sailing with high-speed passenger vessels, with the objective of taking short-term measures in order to guarantee the safety of passengers and crew.

The investigation shows that with respect to sailing with high-speed craft, the legislator has adopted a wait-and-see attitude. Furthermore, Naco Ferries/Connexxion have taken insufficient initiatives to create a safe operational situation and for keeping the vessel – given the specific navigation – in optimal condition.

It appears from the investigation that for the exemption granted, local authorities (municipalities situated on the Noordzeekanaal harbours), Amsterdam Port Authority as well as the national government (Directorate-General for Public Works and Water Management) have borne responsibility. The Board is of the opinion that at granting an exemption, all parties involved, united in the Centraal Nautisch Beheer Noordzeekanaal [Central nautical management committee Noordzeekanaal], ought to realise – more than they have in the present case – that this cannot be done light-heartedly. Formulating requirements without any form of supervision or including unrealistic conditions, such as the stopping distance of two ship's lengths, is extremely undesirable and may have far-reaching consequences for all parties involved. This applies in a general sense, but in particular in the case of a public transport facility where large amounts of passengers must be transported in a safe and responsible manner.

This has given the Board cause for making a recommendation to Centraal nautisch beheer Noordzeekanaal [central nautical management Noordzeekanaal].

Centraal nautisch beheer Noordzeekanaal is recommended to ensure that the starting points set at the issue of the exemption to Naco Ferries/Connexxion for the operation of fast ferries on the Noordzeekanaal are properly checked. If Naco Ferries/Connexxion cannot meet the starting points, Centraal nautisch beheer Noordzeekanaal must either withdraw this exemption or reformulate the starting points with the objective to increase safety considerably.

Broadly speaking it must be concluded that Naco Ferries/Connexxion has observed practically all statutory regulations prescribed for this navigation. The investigation, however, shows that conforming to all statutory (minimal) requirements cannot provide an adequate basis for a safe and sound navigation just like that. In addition to observing the statutory requirements, an organisation will always have to take its own responsibility in order to guarantee safety by taking additional measures or making provisions where necessary. This is inter alia expressed in how the Voskhod 605 is equipped. The law neither prescribes a safety belt installation on the present high-speed passenger vessels, nor does it set requirements for the chairs to be crash-proof. With regard to these aspects the Board is of the opinion that it is highly desirable that both the owner and the legislator conduct an investigation into the necessity of all this and/or give special attention to it, in order to prevent accidents like this one with high-speed craft in the future. The main responsibility for safe navigation remains with the owner/master at all times. It is and will always be their task where necessary to set higher (safety) requirements than strictly required by law. The investigation has shown that Naco Ferries/Connexxion has insufficiently done so.

mr. Pieter van Vollenhoven

Chairman of the Board

ir. D.A. van den Wall Bake

interim General secretary

ACRONYMS AND ABBREVIATIONS

Dutch

ARBO	- Occupational Health and Safety
BPR	- Binnenvaartpolitiereglement [national inland waterways police regulations]
BSB	- Binnenschepenbesluit [national inland waterway vessels decree]
BSW	- Binnenschepenwet [national inland waterway vessels act]
CvO	- CvO Certificate [certificate of inspection]
IVW, DS	- Transport and Water Management Inspectorate, Shipping Division (formerly Shipping Inspectorate)
GHA	- Amsterdam Port Authority
GPS	- Global Positioning System
HSC	- High-Speed Craft
ISO	- International Organization for Standardization
OvV	- Dutch Safety Board
RI&E	- Risk Assessment and Evaluation
ROSR	- Reglement onderzoek schepen op de Rijn 1995 [regulations for the inspection of vessels for the Rhine Navigation]
RPR	- Rijnvaartpolitiereglement 1995 [Rhine navigation traffic regulations 1995]
RvTV	- Dutch Transport Safety Board
RWS	- Dutch Directorate for Public Works and Water Management
SVW	- Shipping Traffic Act

1 GENERAL INFORMATION

1.1 Location and circumstances

Place accident	: Noordzeekanaal Amsterdam
Date accident	: 18 October 2003
Time of accident	: 1250 hours (local time)
Type of accident	: Collision
Ship type	: Hydrofoil fast ferry (legally typified as: round-trip day boat)
Passenger capacity	: 71 persons (79 maximum)
Number of Crew	: 2
Visibility	: good (>10,000 m)
Wind	: Northeast 4 Bf
Tide	: none
Current	: none



Figure 2: Photo of the Voskhod 605

1.2 Technical details of hydrofoil fast ferry Voskhod 605

Year of construction	: 1993
Ship's number	: 2015105
Date of issue certificate	: October 2002
Length overall	: 27.60 m
Beam	: 6.30 m
Displacement	: 62,092 m ³
Draft in stopped position	: 1.90 m
Draft on foils	: 0.74 m
Propulsion	: V12 MTU 2000
Power	: 788 kW
Propeller	: right-handed
Service speed	: 60 km/h
Maximum speed	: 65 km/h
Turning circle	: 980 m over port, 860 m over starboard
Time required to stop the vessel	: 31 seconds
Capacity	: 79 passengers
Sole shareholder	: Connexxion Tours B.V.
Operator	: Naco Ferries/Connexxion

2 FACTUAL INFORMATION

On Saturday 18 October 2003 at 1250 hours the fast ferry Voskhod 605 crashed at approximately 60 km/h into the quay wall of transshipment company Amfert situated along the Noordzeekanaal, municipality of Amsterdam.

The fast ferry Voskhod 605 is one of a series of three fast ferries of public transport company Naco Ferries/Connexxion that operate on a regular service between Velsen-Zuid and Amsterdam Central Station. They have a daily schedule, consisting of either a 30-minute service or an hourly service, depending on time of the day and season. The route follows the Noordzeekanaal and the IJ. The permission to exceed the speed limit – there is a speed limit for shipping traffic of 18 km/h – is regulated by exemption, issued by Amsterdam Port Authority.

Both masters of the hydrofoil were doing their first trip that day at 1000 hours from Velsen-Zuid according to schedule. After the first return trip an employee of the maintenance department came on board to deal with a heating problem on board the vessel. In consultation with the maintenance department they bunkered after the second return trip in Velsen where also a new part for the heating system was taken on board.

Subsequently, the fast ferry departed at approximately 1230 hours from the landing stage in Velsen for the scheduled destination, the landing stage behind the Central Station in Amsterdam.

Upon departure, the 71 passengers were informed that there were problems with the heating system but that it could probably be repaired during the trip. Halfway the trip to Amsterdam the maintenance department had dealt with the problem and the heating system was functioning properly again.

Shortly after departure the Voskhod 605 was sailing at service speed (~60 km/h) on the starboard side of the Noordzeekanaal. Among the 71 passengers there were several acquaintances of the crew's. They were given the opportunity to take a look at the Voskhod wheelhouse during the trip. Given the confined space in the wheelhouse, a four-year-old child was seated in the second control seat that was free at that moment and her grandfather sat behind her. A female passenger was standing between the two control seats. The second master was standing, partly lower on the stairs, behind the chair of the first master.

The first master was navigating while seated in his chair on the starboard side of the vessel. At that moment he was using the autopilot and was steering by means of the tiller that was placed on the right armrest. They were not talking much. As appears from the statements made by witnesses, the atmosphere in the wheelhouse was relaxed.

Just before Coenhaven in the Amsterdam dock area a sailing vessel was overtaken on the port side. Simultaneously the radar was switched from stand-by position to the ON position to show how it works to the people present. Shortly after this, the second master drew the attention of the master to a dangerous course they were steering. The master looked up and reacted immediately, but he did not get a rudder response fast enough when moving the tiller. According to the master, he has tried, by switching to the tiller-position-dependent system³, to get a quicker rudder response.

³ With steering gear adjusted to the **route-dependent system (follow-up)**, the rudder is in the same position as the tiller in the wheelhouse.

Even then the vessel's response was insufficient. Thereupon the master once again pressed the push button to activate the operation of the tiller on the armrest of the chair. The second master saw that course and speed did not change noticeably. He then went to the passenger compartment and warned the passengers to hold on tight because "there was a blackout of all systems". Thereupon the vessel ran into the quay at service speed, approximately 60 km/h.

The child's grandfather was holding the child from behind the back of the chair. Due to the strength of the collision the back of the chair broke off and he first fell headfirst and then backwards between the chair and the bulkhead. The female passenger was pushed against the centre console. The first master got quite seriously injured because his knee hit the steering console hard. He was also slightly injured near his eye. The child was not injured, but she was completely upset. Because he was thrown hard backward against a row of chairs in the front compartment, the second master sustained injuries to his leg and his shoulder was dislocated. 23 persons in total were injured. These injuries were caused because they were thrown forward as a result of the sudden blow. At this, chairs broke off at their fastening points and they deformed under the weight of falling passengers. An employee of the maintenance department was still in the engine room at the moment of the collision. Due to his staying in the engine room, he was – unlike the other people – not informed of the imminent danger and he was therefore not able to prepare for the collision.

In the collision he was thrown violently against the engine room bulkhead and as a result of that he has been unconscious for some time.

The quay wall the Voskhod 605 collided into is on the sailing route in a bend on the south bank of the Noordzeekanaal. The quay protrudes several meters from the bank. The quay is used for sea-going and inland navigation vessels that are moored inter alia to mooring posts in the water alongside a transshipment vessel for that purpose.

On the quay rails have been constructed for a crane to ride, which is used for loading and discharging vessels. At the end of the rail section a steel stopper was placed.

At the collision, the fast ferry Voskhod 605 was pushed onto the quay, at which the stopper tore open the bottom of the vessel along several meters, exactly in the walking space between the chairs (see figures 3, 4 and 5).

A crane driver of the crane that was placed on the transshipment vessel witnessed the accident from his cabin and warned the personnel of the company, after which assistance was called in.



Figure 3: Photo of the quay wall and a rail that have torn open the mid-section, taken from the front passenger compartment of the Voskhod 605.



Figure 4: Photo of the deforming of the ship's hull of the Voskhod 605 as a result of the forces exerted at the collision.

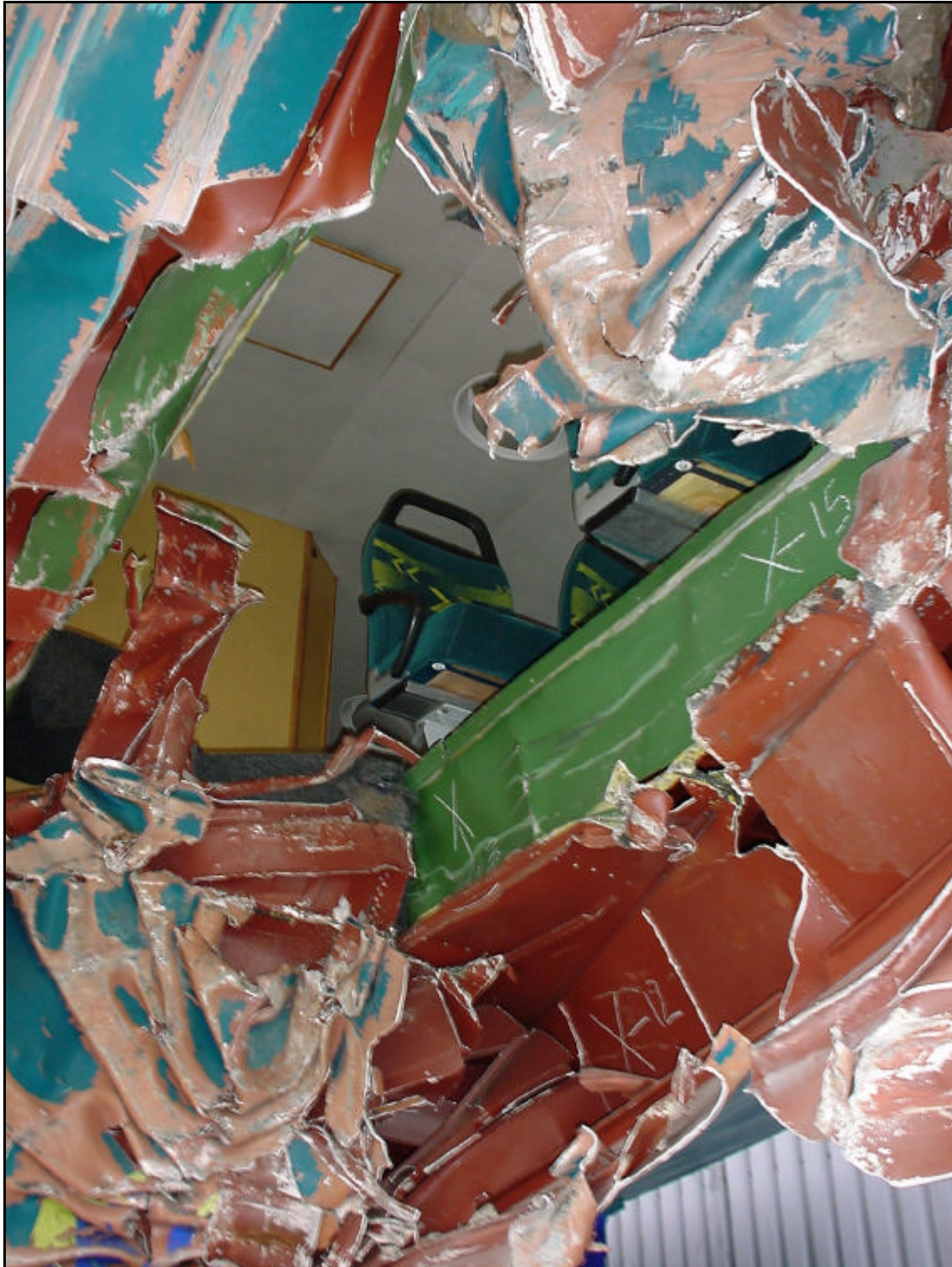


Figure 5: View of the front passenger compartment of the Voskhod 605 through the torn-open ship's hull.

3 PRIMARY ANALYSIS

3.1 Infrastructure

The accident took place on the boundary between Noordzeekanaal/Afgesloten IJ. The Noordzeekanaal/Afgesloten IJ is the connection between North Sea, the Amsterdam harbours and the hinterland. On either side the fairway is bounded by locks. The distance between the locks is approximately 30 kilometres. The distance for the fast ferries to cover between point of departure and destination is approximately 22 kilometres. The place of the accident, kilometre section 20.5/20.6, is in a slight bend (the sailing direction when looking starboard), where the Noordzeekanaal changes into Afgesloten IJ. The fast ferry, coming from Velsen-Zuid, passed two harbour entrances in this bend, Petroleumhaven and Coenhaven. At the place of the accident, named Noorderhoofd, there is a company that has inter alia a quay, a mooring buoy, mooring posts and a transshipment vessel that lies approximately 30 meters off the bank. That stretch of fairway is approximately 250 meters wide. The investigation has not shown that the situation on that stretch had recently changed. On-site observations have shown that the overall view of the fairway was good.

3.2 Reconstruction of the accident

It appears from the interviews that the situation on board the fast ferry on the day of the accident was not different from other trips. It was not unusual that passengers would come in the wheelhouse. This was in spite of the fact that the presence of passengers in the wheelhouse is not permitted, which was indicated by means of a prohibitive sign at the entrance. Relatives, acquaintances or other interested people could come and have a look, if they wanted. Also the fact that somebody from the maintenance department was doing repair work, in this case on the heating system, was not unusual.

The two crewmembers were not unambiguous in their statements on the facts of the accident and what was actually done to prevent the collision with the quay. The reason can be that the second master was standing behind the chairs and partly on the stairs and had no clear view of the instruments. Besides, the first master was steering the autopilot by means of the tiller on the armrest of his chair, which went practically unnoticed for the other people present.

After a sailing vessel had been overtaken, the radar was switched on, upon the request of one of the people present. Shortly after it had been switched on, the second master brought it to the first master's attention that the vessel was steering a dangerous course.

Because the vessel was turning to starboard, the first master immediately gave counter-rudder to port by using the tiller on his armrest. According to the master, the vessel did not respond immediately. In order to be able to turn faster, the master used his left hand to switch to the route-dependent (follow-up) system on the steering console of the autopilot. The usual setting of the onboard autopilot implies that steering movements are damped. The route-dependent system does not have this damping, which makes faster rudder responses possible. Immediately after that, he once more selected the

operation of the rudder by means of the tiller on the armrest of the chair. The emergency steering system has not been engaged. The master has neither, or only hardly perceptibly, reduced speed, either.

In the latest statement the master made before the RvTV⁴, he indicated that he has considered slowing the vessel down by giving her (a kick astern). According to him he realised almost immediately that the vessel would become entirely uncontrollable in that case. If the engine is brought from full ahead immediately to full astern, it will stall, which causes failure of all systems, with the exception of the emergency steering gear. He dismissed the option of pressing the emergency steering button and started steering with it, because emergency steering would imply a much slower rudder response, compared to the direct steering system which was already at his disposal. It takes no less than 20 seconds to swing the rudder from port hardover to hardover starboard (or the other way round) by means of the emergency steering gear. The same manoeuvre by means of the autopilot is three times faster and takes 6 seconds. The second master realised that a collision with the bank was inevitable and jumped off the stairs, stepped into the passenger compartment and warned the passengers for the imminent collision.

The above reconstruction of the last seconds before the accident is mostly based on the similarities from the various statements. It has remained unclear what has been the direct cause of the vessel veering off course and for the master not noticing the course deviation in time. This, however, can have many causes. It seems most likely that the number of passengers in the wheelhouse has been the logic and most obvious source of distraction. However, there is no indication whatsoever for this in the statements. None of the people present have mentioned either a lively conversation in the wheelhouse or a detailed explanation about one thing or the other. One of the people present even described the master during the trip as a quiet, silent man. In fact, the impression was given that the people present were mainly enjoying the view from the wheelhouse. Investigation into accidents in the transport sector has shown that inattention/negligence is not necessarily linked to the presence of other persons. Inattention/negligence can also occur in the absence of other people. This appears inter alia from the many hard-shoulder accidents in which cars or lorries are involved, lorries driving into stationary cars or queues of cars, and engine drivers ignoring the distress signal. It has not been established with certainty in the investigation whether the actions mentioned by the master have been conscious choices or actions performed in a panic.

The investigation has produced the following facts and circumstances:

- The fatal course deviation has not been noticed in time by the master,
- Shortly before the accident the radar was switched from standby position to the ON position on the request of one of the people present,
- Five people in total were present in the wheelhouse (two crewmembers, two adult passengers and one child),
- Prior to the accident the master appeared to be relaxed, according to the people present in the wheelhouse,

⁴ The RvTV was discontinued as from 1 February 2005, at which tasks were transferred to the Dutch Safety Board (OvV).

- As from the introduction of the fast ferries, the master had worked on the Voskhods and consequently was very familiar with the specific sailing characteristics of these particular vessels,
- The master was well acquainted with the navigational area,
- Immediately preceding the collision the master was sailing on autopilot,
- The master was not (over)tired,
- There was not much conversation by the people present in the wheelhouse,
- The presence of passengers in the wheelhouse during the trip is prohibited by law.

Almost immediately after the accident the first on-site investigation was mainly concentrated on finding out the working and general condition of the hydraulic, electric and electronic components of the vessel. The reason for this was that in the first statements it was alleged that either the vessel or the steering gear had not reacted on helm orders.

For the purposes of the investigation several parts, including the GPS navigation system and a steering valve were taken for further analysis. The GPS navigation system has been important for the reconstruction of the vessel's track.

It appears from the information that the hydrofoil initially seemed to have sailed in a slight bend in the direction of the bank.

Given the initial velocity of approximately 60 km/h, the time from the moment that the dangerous heading was noticed up to the eventual impact was 16 seconds at the most. This corresponds to a distance of 250 to 300 meters to the place of the impact.

3.3 Introduction

Failing system components are usually the first sign of a technical problem. Steering gear is designed in such a way that in case of a failure or incorrect response an acoustic alarm sounds and also an optical alarm is visible in the wheelhouse. It is not just the alarms that are visible and audible; there is also a display that shows what technical problem there has been. When a failure in the steering gear is established, the emergency button can be pressed by which the emergency steering gear is operational. By using the accompanying joystick the emergency gear – which is placed separately from the main steering gear – the emergency steering gear can immediately be used for steering. Consequently, in the event of a problem with the steering gear, the master can steer his vessel again within seconds and gain control of the vessel.

In the event that the vessel deviates from its course due to rudder failure and is in danger of colliding with other shipping traffic, other objects or the bank, it is also possible to reduce the speed by means of throttling back.

3.4 Electric and electronic components and connections

The technical investigation has shown that at the time of the accident the entire steering gear was functioning properly and met the requirements prescribed by law, but that it was in such an alarming maintenance status, that failures in the steering engine and related systems could easily have occurred at any other time.

This alarming state was expressed inter alia in the fact that several sheaths of electric cables were damaged at many places at the time of installation and/or due to chafing. The cable insulation was also cut in several places, which could easily lead to a short circuit. A number of minor oil leaks in the engine room were also quite noticeable. In several areas, the cables had been affected by the leaking hydraulic oil to such an extent that the inner cable was reduced to a material resembling chewing gum.

3.5 Steering gear – installation and maintenance status

It was observed that in general the standard of installation of the steering gear was alarming, as was its maintenance status. The valves in the hydraulic system of the steering gear were controlled by a 24 V system. The installation included proportional valves to operate the hydraulic system of the steering gear. These proportional valves were controlled with variable control currents. A proportional valve allows gradual control, i.e. not just open or closed, but all intermediate positions as well. A minor steering correction results in a low control current, resulting in a small opening, allowing a low oil flow. However, the 24 V system included a 12 V proportional valve. Additionally this proportional valve was controlled with a control voltage limited to 6 V. Due to this control, however, a large part of the characteristics of the proportional valve are lost which could lead to insufficient or slow opening of the valve. If the proportional valve does not operate properly or if the rudder response is inadequate these valves will receive a steadily increasing voltage until the maximum power (and maximum) opening are reached. Due to the limitation to 6 V the valve could not be controlled with the maximum power. If this is not possible this may, specifically, have serious consequences if rapid or large rudder excursions are required. The nuts on the connecting pieces between the steering cylinders and the rudder were not only inadequately locked but were almost completely loose due to vibration. Had this occurred it would have been almost completely impossible to control the vessel. In that case, switching to the emergency steering gear would not have had any benefit.

The electrical connectors of the solenoids of the proportional valve should be fitted with a gasket and secured with a central bolt. Both the gasket and the required securing bolt were missing. Experiments showed that the lack of the

securing bolt and vibration underway could easily lead to the connectors coming loose. This could cause an open contact leading to a loss of steering.

It was found that a minor movement of the connectors was enough to interrupt the contact. However, in that case, the steering gear will give an alarm after three seconds.

With respect to the screening against electromagnetic interference it was concluded that this did not meet the requirements. Bare conductors, loose contacts, etc. may lead to undesirable effects on the equipment due to electromagnetic fields. These may be caused by external sources outside the vessel, or by onboard equipment. However, the investigation did not show that the deviation from the course had been caused by electromagnetic interference.

3.6 Steering gear – hydraulic components

The hydraulic action of the hydraulic systems on board was controlled by valves. The main steering gear system was controlled by the proportional valve referred to earlier. The position of the control element (plunger) in the valve determines if the hydraulic oil is circulated (neutral position, no rudder movement), or sent to the left or right (rudder moves to port or starboard). Furthermore, the proportional action determines the speed of the rudder movement. The investigation showed that the plunger had many small grooves (scoring). It was also observed that after a few hours of operation, due to the temperature increase of the hydraulic oil, the plunger required an increasingly higher control current to operate.

It has appeared from the technical investigation that was carried out almost immediately after the accident that the steering gear was functioning properly. The fact that this was also the situation immediately before and after the accident is demonstrated by the fact that the rudder indicator showed a rudder angle of eight degrees to port after the impact.

When the Voskhod is riding on the foils (approx. 60 km/h) the maximum rudder angle in actual practice is 15 degrees. This is confirmed by the fact that none of the people present in the wheelhouse has either seen or heard any alarm. This rudder position cannot be due to the forces acting on the steering gear during the collision. Had this been the case then this would have resulted in damage. However, no damage to the installation has been observed. The rudder position does not only indicate a correct operation of the rudder but also indicates that the avoidance manoeuvre had already been initiated.

It will be obvious that the technical findings referred to above could have led to failures at any time. However, there are no reasons to assume that any of these latent problems occurred.

3.7 Propulsion system

The investigation by the Council showed that the engine stalled during an emergency procedure, common in shipping, during which the "full astern" command is given. As a result practically all essential systems failed. This is due to the forward speed of the vessel which means that the propeller slows down the engine which may result in the engine stalling. It was also found that the engine management system had a specific setting to protect the engine and drive line against damage when such a procedure is used. Similarly, for example,

when the engine control is rapidly moved to the neutral position, instead of “full astern”, this will not lead to an immediate response. In this case, the engine management system will gradually reduce the engine speed/power at a rate of approximately 250 revs. per second. When riding on the foils, the engine runs at approximately 2300 rpm. Consequently, it takes some seven seconds for the engine to reach idling speed (600 rpm). If an emergency stop is made when riding on the foils, the speed will quickly reduce from 60 km/h to approximately 20 to 25 km/h when the hull subsides, after which it comes to a full stop very slowly.

3.8 General maintenance of the vessel and previous failures

As from the moment the three present Voskhod hydrofoils were put into service in 2002, regularly recurring technical problems had to be dealt with. These problems were mostly electro technical problems and they were often related to the steering system of the vessel. In almost all cases the technical malfunction was dealt with by the internal maintenance department. It is remarkable that in many cases they have not been able to establish the cause. In only a few cases, such as the case concerning a rudder failure in which the vessel ran into the bank at a slow speed, for that matter, an external company was called in to investigate and solve the malfunction. In connection with the technical malfunctions, this external party made some recommendations to make the installation less susceptible to breakdown. In general, these recommendations were not followed by Naco Ferries/Connexion. This was also in view of the fact that the installation had already been approved by the Shipping Division Transport of Public Works and Water Management Inspectorate. In their opinion such modifications were not only unnecessary according to the maintenance department; they would even cause new problems.

The Board has noticed at the technical investigation that two sister vessels of Voskhod 605 had a different and in particular a more modern version of the steering gear. Also for the Voskhod 605 this new generation was planned to be installed at the first maintenance inspection. This new generation steering gear was installed on the Voskhod 605 after the accident.

The failures and defects were recorded in the vessel's maintenance book, but a relation between the malfunction and the design of the system was not observed. In table 1 below, it can be seen that on the Voskhod 605 there was often a rudder failure problem.

On the basis of the technical investigation carried out by the maintenance department of the company, it was generally not (very well) possible to give an adequate explanation for the failure of the steering gear and the vessel was usually released without further investigation, because the steering seemed or appeared to work properly again.

Worth mentioning in this connection is an incident of 10 September 2003, when the VHF had emitted smoke, due to a component getting overheated and catching fire. The starting fire in the VHF was extinguished with a powder extinguisher at the time. The extinguishing agent was only partly cleared afterwards. It appears from the investigation that the remainder of the extinguishing

agent at the time had found its way to the electric cabinet of the steering controls and was still there. Extinguishing powder is hygroscopic and can be disastrous for electronic components due to its corrosive effect. Extinguishing powder will also adhere to contact points due to which higher arcs can form. They result in faster burning in of the contacts, which may result in failures. The circuit boards had not yet been affected, however, but all this gives an insight into the general maintenance status.

2 March	Work on the autopilot by Radio Holland after failure
14 March	Batteries reported lower than 22V, steering engine failed to start
15 March	Steering gear failure, sailed on emergency steering
16 March	Steering gear problems
29 May	Autopilot failure
9 June	Rudder does not follow command, minor damage
10 September	Small fire VHF, powder extinguisher was used
19 September	Batteries replaced due to voltage problems
21 September	Rudder failure, continued on emergency steering, remainder of extinguishing powder is the reported cause, circuit boards were cleaned
13 October	Failure MTU reading out (engine) due to failure
18 October	Collision with Amfert quay

Table 1: Outline of failures in 2003 (source: Voskhod 605 ship's log)

3.9 Summary

The above reconstruction of the last ten minutes before the accident shows that the vessel, although the maintenance status of the steering gear in particular was alarming, at the time of the accident and during the entire evasive manoeuvre the vessel has responded properly to the helm orders. The distance to the quay, however, was too small and the speed the master was maintaining was so high that given the specific sailing characteristics of the Voskhod a successful evasive manoeuvre was no longer possible. At full speed, the fast ferry has a turning circle over port of 980 meters and in the event of an emergency stop will lie completely stopped in the water not until approximately 280 meters (~31 seconds), as has been established by the Board by experience. The option to throttle back completely so that the vessel will subside quickly and change from riding on the foils to a more conventional sailing, has not been chosen by the master. The result of this action would have been that the speed would relatively suddenly have been reduced to approximately 25 km/h. After the hull has completely subsided, it will take a considerable time to come to a complete standstill. Expectations are that this action could either have prevented the collision or limited the consequences. On the basis of the statements it can roughly be estimated that the time between establishing the dangerous heading and the eventual impact has been 16 seconds at the most. At a velocity of 60 km/h this corresponds to a distance of 250 to 300 meters to the impact.

4 SECONDARY ANALYSES

4.1 *Subsequent investigation*

In the previous section the causes and circumstances at the time of the accident have been described. The section below describes what processes and aspects have played a part either in the occurrence of the accident or in the outcome and consequences of the accident.

4.2 *Naco Ferries/Connexxion*

In 1998, under the name of the Transport, Public Works and Water Management project "Samen Werken Aan Bereikbaarheid" [meaning: working together towards accessibility] a start was made on the putting into service of the first series of five fast ferries on the Noordzeekanaal for the Velsen-Amsterdam stretch. These vessels belonged to the older generation of hydrofoils. With the help of a fast amendment of the Passenger Transport Act these and other newly planned liner services by water became subsidisable and attractive enough to experiment with this mode of passenger transport by water.

Specific inland shipping regulations for high-speed vessels did not exist at the time. From the national government additional requirements were not set for these vessels beforehand, either. The fast ferries, the hydrofoils on the Noordzeekanaal as well as the catamarans on the Nieuwe Maas between Rotterdam and Dordrecht, had to comply with the general legislation and regulations for Rhine navigation (ROSR) or the other waterways (BPR). Because the results of the liner service were beyond expectation, Naco Ferries/Connexxion ordered three new vessels to be built. The ships' hulls lay ready in Russia and they were completed under the supervision of the Shipping Division (Transport and Water Management Inspectorate). New (technical) regulations had not yet been implemented at that time, so that the vessels could be built according to the existing legal regulations for round-trip day boats. The specific sailing characteristics of the fast ferry did not explicitly have to be taken into account.

4.3 *Connexxion Holding N.V.*

Connexxion Holding N.V. (for organisation chart: see appendix 2) is the holding company of seven subsidiary companies (public limited companies and private limited companies), under which there are several dozens of companies (private limited companies). Some of the subsidiaries are 100% owned by the Holding N.V.; others come only partly under the Holding. The shares of Connexxion Holding N.V. are 100% held by the State of the Netherlands.

The Voskhod 605, from March 2004 sailing under the name of Catharina Amalia, sails under the responsibility of Rederij Naco B.V., which is 100% part of Connexxion Tours B.V., which is 100% subsidiary of Connexxion Nederland N.V.

The local management is established in Velsen for the purposes of the ferry service with the fast ferries and the ferry boats that sail inter alia on the Noordzeekanaal.

Some key figures of Connexxion Tours B.V. (source: Connexxion, 2003):

- Number of employees: 785
- Number of vehicles: 385
- Number of vessels: 16

The specific branch Naco Ferries/Connexxion, with 16 vessels (including the three Voskhod fast ferries) and 80 employees, has a modest share in the turnover of the total Connexxion Holding N.V.. To illustrate: the Holding has a total turnover of 945 million, to which Water contributes a turnover of EUR 7.5 million.

The branch Water, under the trade name Naco Ferries/Connexxion (Source: extract from the Chamber of Commerce), has independent authority in the management. The Holding mainly gives the outlines of the corporate identity and the expected operating figures. Neither the Holding nor the seven subsidiaries give policy directives for safety- and/or quality management. Not until October 2004, one year after the accident involving the Voskhod 605, the initial impetus was given for the safety management system. The initial impetus for such a management system was mainly given due to the fatal accident in Almelo on 12 December 2003, in which the driver of a Connexxion bus was crushed to death between the closing front doors. On 1 January 2005 a safety coordinator was appointed and a reporting- and registration system was put into operation. The structure of the many companies, whether or not for 100% controlled by the Holding, implies that it is true that Connexxion Holding N.V. is one company in name, but that in e.g. pursuing the safety policy the local management – at the time of the accident – was highly autonomous. Besides, within Connexxion, Naco Ferries/Connexxion has a special position. Another example of this autonomy is the fact that Naco Ferries/Connexxion, as the only one within the Connexxion group, has a Lloyd's Register ISO 9001:2000⁵ quality assurance certificate. Due to the lack of central guidelines a safety policy at the various companies will be different. It must be concluded that the management and organisation around operating the fast ferries was given considerable autonomy by Naco Ferries/Connexxion.

It must be established that the vessels of the liner service Velsen-Amsterdam, especially the three Voskhods, have a history of regularly recurring technical problems, varying from minor defects to, several times, a complete failure of the steering system.

Moreover, the shipping company has had to deal with several minor and more serious collisions, including running into a bank, a collision with a tug in fog and a collision between two hydrofoils of the shipping company. In all cases there

⁵ ISO 9001:2000 is a European standard in which quality management system-requirements are described. "This standard stimulates a process approach for developing, introducing and improving the effectiveness of a quality management system, in order to improve customer satisfaction by fulfilling the customer's requirements" (quotation) (source: Netherlands Standardisation Institute, 2000)

were passengers on board, but nobody got seriously injured in these collisions. According to the management, dealing with these cases claimed so much time that the company had no time for further developing the safety strategy. The company was meanwhile ISO certified, however, and a risk assessment and evaluation (RI&E) was carried out to comply with ARBO regulations (NB: the recommendations have not been followed up till now). This RI&E was carried out late 1998 and still concerned the forerunners of the present Voskhods. The assessment exclusively concentrated on the general safety of the employees within the established statutory frameworks. Moreover, attempts made to (partially) apply in practice these RI&E findings, regularly encountered resistance. On the one hand, the serious collision on 18 October 2003 highlights the end of a period in which no measures were taken upon previous accidents and on the other hand it marks the beginning of a period in which, on the basis of findings, attempts were made to take preventive measures. As a result of the investigation into the backgrounds and causes of the accident involving the Voskhod 605, the company philosophy with regard to safety has meanwhile been changed in more than one aspect in a positive sense.

The internal (initial) problems engrossed the local management in the first few years in such a way that in the development years other similar companies that maintain contact with high-speed vessels were not actively approached, either. Both management and employees thought they were almost unique in the world of high-speed vessels and did not or hardly see the limits of their own working methods and procedures. This does not only concern the manner of operational procedures and maintenance, but also for what this high-speed shipping traffic requires from crew and equipment on board. The request from the personnel to receive additional trainings, for example, was brought forward through the usual channels, but until 2003 it was in no respect complied with. The investigation has also shown that there was more than one weakness with regard to the management. These weaknesses mainly became manifest in poor maintenance, undesirable long working hours and short rest periods, drawing no conclusions from the RI&E findings and the lack of additional training and instruction for crewmembers. With regard to complying with legislation and regulations, however, it can be established both for the vessels and for the crew, that there has been no violation of this.

Several months after the accident arrangements were made with Nova College for instructions and trainings and (inter)national contacts were made and used to further develop the (local) organisation with regard to safety and quality procedures.

4.4 Personnel aspects

At first, the development of the hydrofoil liner service was mainly determined by several employees of the maintenance department and some regular captains. As it was the only organisation in the Netherlands with such an intensive schedule for hydrofoils there was a sense of pioneering. This feeling was increased by the regularly recurring technical problems at which often the inventiveness of the employees was appealed to. Besides, in the first few years

the masters would arrange the work schemes and circulation of the masters among themselves as well as the use of an extra vessel on busy days.

The employees' deep concern was appreciated by the management, but it implied that insufficient special attention was paid to quality, safety and economic circumstances.

Under those circumstances, the organisation arranged that masters of ferries on the Noordzeekanaal were voluntarily available for the fast ferries to stand in when there was a shortage of sailing personnel. At the moment of the collision of the Voskhod 605 the second master was a substitute who had little experience with the fast ferry.

Until recently, the management held the view that having a commercial vessels master's certificate was a sufficient safeguard for sailing with such vessels. From a legal point of view this is correct and also permitted.

In every day practice, however, it has appeared that passenger transport by high-speed vessels does indeed need extra attention in the form of additional training and facilities. These additional requirements are not prescribed by law. From an international point of view it has been customary for a longer time that crews of such vessels receive additional training, both theoretically and practice-based by using simulation exercises. In particular the difference in speed with the other shipping traffic is extensively dealt with during these trainings. This is because the high-speed vessel must give way if necessary, even though this is still not compulsory due to the lack of additional regulations.

Furthermore, attention must be given to dealing with all kinds of emergency situations, from fire to steering gear breakdown and passenger evacuation (crowd management). Not unimportant during these trainings is how they are taught to divide among themselves the tasks that must be carried out in the wheelhouse of the vessel to ensure a safe trip and also to monitor and assist each other. The well-known trainings in aviation for cockpit crews were in the early nineties translated to shipping. An accident survey showed that as much as 60% of the accidents was due to the lack of standard procedures, not following the procedures, persisting in erroneous assumptions relating to the cause of a technical problem and the lack of a proper mutual division of tasks.

Given the attitude adopted by the management at that time and the prevalence of a pioneering spirit in the company, training and instruction have been neglected too much for too long.

The accident on 18 October 2003, which was in fact a sequel to the series of previous less serious accidents in a period of regularly recurring technical problems, has more or less forced the organisation to adopt a more positive attitude with regard to the development of the safety policy. Before the accident there had been exploratory talks with the Nova College concerning additional training and instruction. The accident of 18 October 2003 has only sped up this process. All fast-ferry masters, including substitutes that are recruited from ferries, are now given further theoretical and practical training. For this additional training and instruction there is close cooperation with Nova College in IJmuiden, part of the Maritime Academy in Amsterdam.

As a consequence of the freedom of initiative prevailing in the company and other factors, fast-ferry masters would also arrange among themselves that they could make 15-hour working days.

Many masters were living a considerable distance from their station and in this way they could make short working weeks with relatively many days off. Moreover, it reduces the cost of commuter traffic.

Although these long working days were legally permitted for this kind of shipping, it is evident that, in spite of the fact that they take turns at steering the vessel, such long days will adversely affect their ability to concentrate. The nature of this shipping, the specific sailing characteristics and the characteristics of the waterway will even require full concentration under normal circumstances. In poor visibility or in heavy traffic situations this task will be even more arduous. In many modes of transport surveys have been conducted of the effects of long working days. On the basis of these studies it must be concluded that long working hours are not advisable for reasons of safety.

4.5. Government control: statutory provisions (shipbuilding- and mechanical requirements)

These fast-ferry regulations are prescribed by two statutory regimes, namely ROSR (for Rhine-navigation and large rivers) and BPR (other waterways). As a reference for determining the technical requirements for high-speed vessels, ROSR has used the HSC-code applicable for sea-navigation and has a statutory phased transition period (April 2006, April 2013 and April 2023). These technical requirements, however, do not apply to the Voskhods due to the current transitional arrangements, which will be introduced on a phased basis at the moment the Certificate of Inspection must be renewed. For the Voskhod 605 this will be October 2007.

Technical requirements for high-speed vessels have not yet been formulated in the BSB. Additional requirements for high-speed vessels, therefore, do not apply on waterways for which the BSB is in effect. Whether or not additional requirements are set is the responsibility of Transport and Water Management Inspectorate and of the fairway administrator. Eventually, the responsibility lies with the owner to make more arrangements than strictly required by law in order to guarantee the safety even more and where necessary to improve it. This applies in a general sense, but more in particular for the high-speed transport of passengers on a busy channel.

This has indeed been done by Naco Ferries/Connexxion, although to a limited extent. For example the wheelhouses have been made suitable for two masters (in Russia there is only one master on board in the originally smaller wheelhouse) and the vessel has partly been prepared for the adjustments in the new regulations. Furthermore, after the accident the Voskhod 605 was fitted with dual controls. In addition to this, a rule was issued in consultation with the fairway administrator stating that both masters must sit in the cabin while riding on the foils.

A good example of either the lack, or later, the implementing of regulations is the mounting of the chairs. By the force of the impact the fastening points broke off, as a result of which passengers got injured. The lack of shock-absorbing material has probably caused even more serious injuries. The photos below (figures 6 and 7) clearly show that many chairs, or parts of chairs, have broken off. They also show that the connection between the metal frame and the seats as well as the mounting of the frame to the floor has appeared insufficiently solid.



Figure 6: Photo of broken mountings of passenger seats



Figure 7: Photo of passenger seat torn off floor mounting.

The Naco Ferries/Connexion fast ferries were put into service in 2002 after they had been bought as ships' hulls in Russia. A substantial amount of the installation work of the engines and steering installation was done in Russia. This was also monitored by the Shipping Division in order to check whether the vessels were built in accordance with legal requirements. The basis for these legal requirements is the ROSR in this case, at which the keel laying is taken as the building date. As the ships' hulls of the Voskhods that were bought had been lying there from 1993, the former general ROSR-regulations still apply for these vessels. If these vessels are put into service on zone-2 waterways, additional requirements may apply.

In the past few years (1998 to 2004) the Ministry of Transport, Public Works and Water Management has carried out several investigations into high-speed vessels that were put into service and the effects of these vessels on the surrounding area. In the spring of 2000 – in anticipation of new regulations – this resulted in a letter with several recommendations to the parties concerned (shipping companies, fairway administrators, inspection). This letter, which was composed in consultation with the Minister, contained points of special interest concerning safety and how the vessels were technically equipped, but these recommendations were not actually prescribed.

In 2000/2001 it was also investigated whether or not it should be made obligatory to have two masters on the bridge of high-speed vessels.

The investigation shows that the Ministry of Transport, Public Works and Water Management had been informed about the technical problems of the fast ferries and that this Ministry considered breakdown of the steering gear to be a real risk. These investigations mainly concerned technical aspects. Relatively little attention was paid to the potential risk of sailing at high speed with many passengers.

In connection with the accident, the Shipping Division of the Transport and Water Management Inspectorate did not carry out an extensive accident inquiry themselves; they only drew up a technical report.

In December 2003 the Ministry concludes in a review that the investigation carried out in 2000/2001 has given too little substantiation for the scenarios described and that it does not give a definite answer about the necessity of sailing with two masters on the bridge.

In conclusion we can state that the Passenger Transport Act could be amended within six months in order to make the public transport lines by water subsidisable, but that eight years later and after several investigations, little has been legally defined in the field of technical regulations on a national level. Whether or not to sail with two masters on the bridge is still a subject of discussion.

4.6 Exemption by Centraal nautisch beheer Noordzeekanaal *[central nautical management Noordzeekanaal]*

The municipalities situated on the Noordzeekanaal and her harbours, Dutch Directorate for Public Works and Water Management and Amsterdam Port Authority are united in Centraal nautisch beheer Noordzeekanaal. The secretariat and the implementing tasks of this committee fall under the responsibility of Amsterdam Port Authority (GHA).

On the Noordzeekanaal there is a speed limit for shipping traffic of 18 km/h. As the high-speed vessels of the ferry service exceed this speed limit, an exemption for the speed limit was applied for when the first high-speed vessels were put into service. In compliance with basic starting points and under several specific conditions, Centraal nautisch beheer Noordzeekanaal, granted exemption for the speed limit for the purpose of the Ministry of Transport, Public Works and Water Management programme "Samen Werken Aan Bereikbaarheid" [meaning: working together towards accessibility].

It is remarkable that for granting the exemption the stopping distance has been an important condition. This stopping distance was translated into a maximum stopping distance of two ship's lengths. This specific condition was stated by

Naco Ferries/Connexxion themselves at the time, based on their experiences with their first generation (forerunner Voskhod) fast ferries. For the Voskhod this implies a distance of approximately 60 meters. If the Voskhod 605 had met this criterion, the accident would not have taken place. However, investigation by the Board has shown that the second generation vessels that were in service have never been able to meet this criterion. On trial trips after the accident on the IJsselmeer it has appeared that the stopping distance is at least 250 meters, much more than was stated in the exemption, but still within the legally permitted maximum distance defined in the ROSR and BSW.

At the time of the accident the Voskhod 605 appeared to be sailing under a general once-only one-month exemption, which had already expired for some time. This exemption dated from two years before the accident.

In a reaction, Centraal nautisch beheer Noordzeekanaal considers this to be an administrative omission. With regard to the stopping distance, Centraal nautisch beheer Noordzeekanaal takes the view that the Shipping Division should have informed her about this.

The Shipping Division, however, has nothing to do whatsoever with the issue of these exemptions. The legal department of the Ministry of Transport, Public Works and Water Management is of the opinion that the check on certificates is conducted by or by order of the exemption-issuing authority.

Recently, probably also as a result of the accident, but in any case due to the fact that the vessels were named, all exemptions were altered for each vessel separately. Not only has the validity been extended, but they also have some additional requirements now, in anticipation of the national regulations to be amended (BPR). These additional requirements concern: 1) reporting the number of passengers on board upon departure and 2) the presence of a second crewmember in the wheelhouse when riding on the foils. Reporting the number of passengers was already compulsory under the Shipping Traffic Act (SVW). However, the considerations that underlie the issued exemption are still based on the non-feasible stopping distance of two ship's lengths at the most (~60 meters). However, neither prior to the first issue of exemption, nor between times, has Centraal nautisch beheer Noordzeekanaal checked on this stopping distance which is explicitly mentioned in the conditions. Even in March 2004, on the occasion of the latest extension of the exemption (approximately five months after the accident), there was no checking of the stopping distance whatsoever as far as is known. Given the fact that Centraal nautisch beheer Noordzeekanaal, in any case at the time of the issue of the exemption in 2004, was fully informed about the non-fulfilling of the stopping distance requirement, it is now a matter of knowingly tolerating a derogation of one of the conditions in the exemption.

5 CONCLUSIONS

During part of the trip, apart from the two crewmembers also three passengers (two adults and one child) were present in the small wheelhouse. The presence of passengers during the trip is not permitted, which was indicated by means of a prohibitive sign at the entrance. The masters must observe this rule.

In the exemption the Amsterdam Port Authority adopted a condition that the vessel must come to a standstill within two ship's lengths if necessary. The Voskhod 605 cannot meet this requirement. Neither prior to the first issue of the exemption, nor between times, however, has Amsterdam Port Authority conducted checks on this stopping distance, which is explicitly mentioned in the exemption. At this, Amsterdam Port Authority has proceeded on the information provided to her by Naco Ferries/Connexxion.

Again in March 2004, on the occasion of the latest extension of the exemption (approximately five months after the accident), there was no checking of the stopping distance whatsoever as far as is known. Amsterdam Port Authority must check whether the stopping distance is in accordance with the exemption certificate. Neither Naco Ferries/Connexxion has at any time made it known that this starting point can and/or could not be met.

Centraal Nautisch Beheer Noordzeekanaal [Central nautical management committee], consisting of municipalities situated on Noordzeekanaal and harbours, Dutch Directorate for Public Works and Water Management and Amsterdam Port Authority, is responsible for the issue of the exemption for the operation of the fast ferries on the Noordzeekanaal. However, the Committee has insufficiently supervised the feasibility and/or the observance of the requirements that were set for issuing the exemption.

It has not appeared from the investigation that there has been a lively conversation or detailed demonstration of systems or equipment during the stay of the passengers in the wheelhouse.

Just before the accident, the master switched the radar from stand-by position to the ON-position upon the request of one of the passengers in the wheelhouse in order to show a radar picture.

The master himself has not noticed the dangerous course deviation in time. The reason for not noticing the deviation in time could not be established.

The moment that the second master drew the attention of the first master to the dangerous course, a collision – due to the high speed he was keeping knowingly or otherwise, the sailing characteristics of the Voskhod 605, the engine adjustment as well as the distance and time left to the quay – was inevitable. If the master had chosen the option to reduce the engine speed completely, but not to full astern, this could in the opinion of the Board either have prevented the collision, or limited the consequences due to a lower final speed.

Until the very last moment the master has tried to prevent the collision by giving hard aport. At the moment of the collision the rudder indicator showed a rudder angle of eight degrees to port. This, however, was not the maximum rudder angle attainable. The rudder response depends on the pressure exerted on the rudder surface. Given the high rate of speed the rudder pressure was high and consequently the response was relatively slow.

The engine power has not or only briefly been reduced by the master. Neither has the emergency steering been activated. The latter would have resulted in an even slower rudder response.

The investigation has not shown that the cause of the accident has been an underlying technical problem. It is therefore not surprising that, until the moment of the collision, all essential systems have worked properly. In addition, if the steering had either not functioned properly or had not functioned at all, this would have resulted in alarms. None of the people present in the wheelhouse has either seen or heard any alarm.

The fast ferries in a general sense and the Voskhod 605 more in particular have appeared to be very susceptible to breakdown in the period prior to the accident.

The Board is of the opinion that the technical state and/or maintenance status of the Voskhod 605 was alarming at the time of the accident. The many defects found and latent defects could have caused problems and system failures at any other time. It cannot be excluded that – given the high degree of susceptibility to breakdown – this has also been the case in the past. Although Naco Ferries/Connexion contests that this is a matter of poor maintenance of their vessels, the Board is of the opinion that significantly improving the technical state must be given highest priority.

The mounting of the chairs in particular appears not to be resistant to the forces exerted on it in the event of a collision at speed.

Naco Ferries/Connexion has grossly underestimated the specific requirements that must be imposed on crewmembers as well as organisation for the specific high-speed-vessel navigation. In addition to that, the company has taken little responsibility for carrying out the work and has left it up to the people who carried out work to take the initiative.

At the time of the accident the crewmembers had not yet been enabled to get additional training in the specific operational aspects of the vessels. Moreover, the crewmembers had never practiced how to carry out nautical emergency procedures.

Naco Ferries/Connexion must take their responsibility and have their crewmembers trained to deal with their tasks, including operational training, such as maritime emergency procedures, before the crewmembers start working on high-speed vessels.

With regard to the composition of crew, crew qualifications, working hours and rest periods as well as the equipment of the vessels, Naco Ferries/Connexion fulfilled all the requirements prescribed by law. It is true that the long working

hours of 15 hours per day are legally permitted, but, given the nature of the work, Connexxion should have decided for reasons of safety not to allow this.

Until more than one year after the accident, Connexxion Holding N.V. did not have a safety management system. This implied that Naco Ferries/Connexxion could decide on their safety system at her own discretion. As they are a company that bears the responsibility for part of the public transport, this is a very alarming conclusion.

Prior to the accident, the Ministry of Transport, Public Works and Water carried out several investigations in the period from 1998 to 2004. In 2000/2001, for example, an additional investigation was carried out into the requirements for crewmembers of high-speed vessels. It appeared inter alia from this investigation that the Ministry was well aware of the technical problems. This has not resulted in adjustment of legislation and regulations and/or a tightened regime of enforcement and control. This applies to crewmember requirements and crew composition as well as to equipment requirements. It must be concluded that at the time the Passenger Transport Act could indeed be amended within six months in order to make the public transport lines by water subsidisable, but that eight years later little has legally been defined in the field of technical regulations on a national level.

6 RECOMMENDATIONS

1. Connexxion Holding N.V. are recommended to take stock of the safety- and quality policy of the companies accountable to her and to change this into a recognisable and uniform safety- and quality system.
2. Naco Ferries/Connexxion are recommended to ensure that by means of safety- and quality systems the general safety- and quality level is increased so that safe and reliable transport of passengers is guaranteed. This applies in particular to:
 - a. maintenance, equipment and technical state of the vessels,
 - b. training and instruction of crewmembers,
 - c. the manner of putting crewmembers into service, including working hours and rest periods,
 - d. safety precautions for passengers.
3. Centraal nautisch beheer Noordzeekanaal is recommended to ensure that preconditions set at the issue of the exemption to Naco Ferries/Connexxion for the operation of fast ferries on the Noordzeekanaal are properly checked. If Naco Ferries/Connexxion cannot meet the starting points, Centraal nautisch beheer Noordzeekanaal must either withdraw this exemption or reformulate the starting points with the objective to increase safety considerably.
4. The Minister of Transport, Public Works and Water Management is recommended to conduct with all parties involved a risk analysis of the operational aspects of sailing with high-speed passenger vessels, with the objective of taking short-term measures in order to guarantee the safety of passengers and crew.

APPENDICES

Appendix 1: Investigation account

The Dutch Transport Safety Board (RvTV), the predecessor of the Dutch Safety Board, decided to conduct an investigation into the accident involving the fast ferry Voskhod on account of the seriousness of the accident and the circumstances under which it could occur. The passenger vessel ran into a quay wall at high speed and had 71 persons on board, of whom 21 sustained injuries.

Shortly after the accident had been reported, the Board started the investigation into the circumstances of the accident. The subsequent investigation has eventually had various investigative activities. For example a detailed investigation was carried out into the technical state and equipment of the vessel, the sailing characteristics, the maintenance status and the personnel aspects. Also the applicable legislation and regulations, the authority granting the exemption, and the parts that both the operator and Connexxion in a more general sense have played regarding the safety on board the vessels have been investigated.

In her investigation, the Board has paid considerable attention to *how and why* the accident could have occurred. Furthermore, the Board has investigated the underlying causes, structural factors in the organisation, policy, legislation and granting the exemption, which have created a situation in which the risks of this special mode of public transport, in which passengers are transported by water at high speed, were insufficiently reduced.

Fact-finding organisation

The investigation was carried out by a project team of the Dutch Transport Safety Board bureau. The investigation consisted of various components, at which internal and external experts were called in.

The (sub)investigations

The investigation has concentrated on the following two questions.

- The direct cause: what was the primary cause of the accident.
- The indirect factors: what factors have indirectly contributed to either the cause of the accident or the situation which has brought dozens of passengers in such a dangerous situation.

Direct cause

To find out the direct cause of the accident, the Board – apart from information from their own investigation – had information from documents from practically all organisations directly involved in the accident at their disposal, about various subjects (personnel aspects, maintenance, technical systems, legislation, exemption conditions etc.). Furthermore, Board bureau employees have conducted a detailed investigation, sometimes assisted by external experts who carried out technical investigations on the instructions of the Board.

Structural factors

The investigation into the more structural and/or indirect safety factors has almost completely been carried out by bureau employees of the Board.

The investigation has mainly concentrated on:

- what were the roles of Naco Ferries/Connexxion and Connexxion Holding N.V.,
- personnel aspects,
- government control: statutory provisions (shipbuilding- and mechanical requirements),
- the role of Amsterdam Municipal Port Authority (GHA) in granting the exemption

Final report of the Board

After the above (sub)investigations had been concluded, the final report was drafted under the guidance and direction of the Shipping Chamber.

In October 2004 the report was presented to the parties involved for inspection. The reactions that were received were assessed and incorporated in the draft report that was submitted to the Board on 16 December 2004. As a result of comments made by the Board the report was adjusted.

Due to the fact that the Dutch Transport Safety Board had ceased to exist, its tasks were transferred to the Dutch Safety Board on 1 February 2005 and the report was adopted by the Dutch Safety Board on 5 April 2005.

The composition of the Dutch Transport Safety Board and the Shipping Chamber is given below.

COMPOSITION OF HET BOARD AND OF THE SHIPPING CHAMBER (DISCONTINUED AS FROM 1 FEBRUARY 2005)

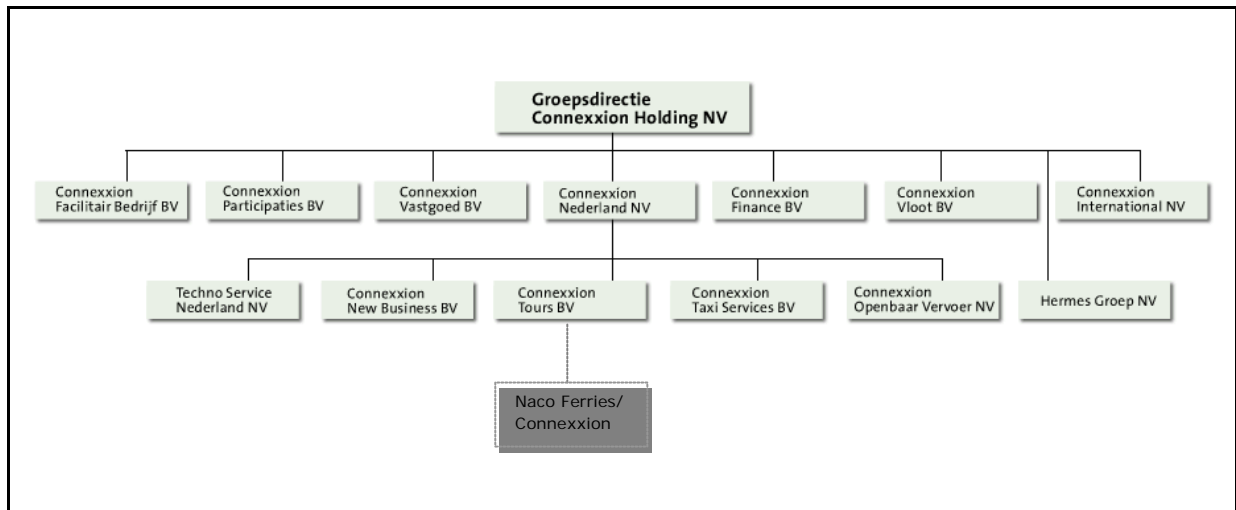
Board

Chairman: *mr.* Pieter van Vollenhoven
F.W.C. Castricum
J.A.M. Elias
B.M. van Balen
Ms *mr.* A.H. Brouwer-Korf
mr. D.M. Dragt
mr. J.A.M. Hendrikx
ir. K. Nije
Prof. Dr. U. Rosenthal
drs. F.R. Smeding
ing. D.J. Smeitink
Dr. *ir.* J.P. Visser
mr. G. Vrieze
Prof. Dr. W.A. Wagenaar

Shipping Chamber

Chairman: J.A.M. Elias
mr. D.M. Dragt
Prof. *ir.* A. Aalbers
mr. B.C. De Savornin Lohman, Esq.
K.J. van Dorsten
Dr. G.A. Egas Repáraz
P.M.J. Kreuze
Ms M.J. Torpstra
H.J.G. Walenkamp
L.P.A. de Winter
Secretary: drs. H.J.A. Zieverink

Appendix 2: Organisation chart Connexxion Holding N.V.



Source: Connexxion (Organisation chart based on the 2003 Connexxion annual report)

[Translator's note: The above English translation is faithful to the original Dutch text. If there is a difference of interpretation between the Dutch version and the translation thereof, the Dutch version will prevail.]