



THE DUTCH  
SAFETY BOARD



**Goods train derailment**  
**Amsterdam-Muiderpoort,**  
22 November 2008

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## THE DUTCH SAFETY BOARD

The Dutch Safety Board was established to investigate and determine the causes or probable causes of individual incidents or categories of incidents in all sectors. The sole purpose of a Dutch Safety Board investigation is to prevent future accidents or incidents and, if outcomes give cause to do so, issue associated recommendations. The organisation consists of a Board with five permanent members, a professional Bureau manned by investigators and support staff and a number of permanent committees. Guidance committees are set up to oversee specific investigations.

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## CONSIDERATIONS

### Facts, consequences and cause of the derailment

On November 2008 a goods train derailed at Amsterdam-Muiderpoort station. The train, comprised of an electric locomotive and twenty-five wagons loaded with chalk/quicklime, was on its way from Belgium to the steelworks in Beverwijk, the Netherlands. The train derailed at the moment that it was passing the Amsterdam-Muiderpoort emplacement. In the first instance the derailment was restricted to the front wheel set of the eleventh wagon. However, an escalation occurred about five hundred metres further on, when the other three wheel sets of this wagon derailed<sup>1</sup>. This occurred as the wagon passed over a set of points. The eight following wagons then also derailed. Some of the derailed wagons came to rest on the adjacent track and four of the wagons fell on their side.

Although there were no casualties, a large amount of damage was caused to the rail infrastructure and the derailed wagons. The direct financial damage to the infrastructure and rolling stock amounted to almost three million euros. The damage to the rail infrastructure caused an extensive and lengthy disruption of rail traffic in the Randstad conurbation that resulted in process damage of about 2 million euros<sup>2</sup>. Consequently, the total financial damage caused by the derailment amounted to almost five million euros.

At the time of the derailment the adjacent tracks were being used by passenger trains. One passenger train passed the location of the accident shortly before the derailment: two other passenger trains had approached to a relatively short distance from the derailment but were able to stop in time.

The Board, on the basis of the damage and the marks, concluded that the derailment was caused by an overheating axle box on the eleventh wagon<sup>3</sup> that in turn caused an axle journal to break off. The overheating of the axle box was caused by the seizure of one of the two bearings in the axle box. The Board was unable to reach a definitive conclusion on the cause of the seizure of the bearing due to the damage caused by the overheating. However, it is clear that the bearing cage failed at an early stage of the seizure process. The nature of the damage also excludes a number of potential causes (such as an assembly error, lack of lubrication and overloading).

### Structural safety problems

The primary question that arises with derailments of this nature is whether the defect that caused the derailment could reasonably have been avoided with better maintenance. However, this question cannot be answered for the Muiderpoort derailment since it was not possible to establish the cause of the failure of the bearing cage with certainty.

Nevertheless, it is clear that in another sense the Muiderpoort derailment was avoidable, since the investigation revealed that the overheating of the axle box could have been detected in time: the axle box had been overheating for at least 75 kilometres and possibly even a considerably longer distance. The defect could have been detected during the time in which the train travelled this distance if the section of track in question had been equipped with a HotBox detection system. Moreover, the overheating of the axle box could have been detected using another method. The train had passed a measurement point for the determination of the weight of the wagons more than 60 kilometres before the derailment. The measurements revealed an abnormal distribution of the weight over the four wheels of the relevant bogie (with the overheating axle box). However, this became apparent only on an analysis of the records that was carried out following the derailment. If this measurement system (QuoVadis) had been equipped with a real-time signalling system<sup>4</sup> then the rail traffic management could have warned the driver in time. In other words: in the absence of both a HotBox detection system alongside the track and a real-time warning system as part of the QuoVadis system the driver could not be warned in time and the overheating of the axle box ultimately resulted in the derailment of the wheel set.

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1 Each of these wagons has two bogies, each with two wheel sets. See also the explanation in Annex 2.

2 The process damage relates to the delays in passenger and goods traffic, see Annex 4.

3 The technical terms are explained in Annex 2.

4 A *real-time signalling system* transmits a warning signal to the traffic management immediately it detects an anomaly in the measurements.

The investigation also revealed that the safety risks arising from the Muiderpoort derailment could have been greatly reduced in a third manner, since the risk of a follow-on accident did not arise immediately after the actual derailment: this risk arose only after a further five hundred metres, when several wagons derailed as the train passed over a set of points and came to rest on the adjacent tracks. Before the escalation the derailed wheel set rode over the sleepers for a distance of about 500 metres. This caused severe juddering of the wagon. However, in the absence of the necessary equipment the driver was unable to detect neither this juddering nor the earlier overheating of the axle box: if the wagon had been equipped with a derailment detector the train would have been stopped automatically before it reached the set of points that resulted in the escalation.

These safety problems are not unique to the Muiderpoort derailment, namely:

a) *Frequency and severity of derailments*

On average, the derailment of a goods train due to a defective wheel set occurs about once a year in the Netherlands. The majority of these derailments not only result in a great deal of damage and severe disruptions of rail traffic, but also give rise to a real risk of escalation to a major follow-on accident (with injuries and, possibly, fatalities). Fortunately, the Netherlands has not been confronted with a follow-on collision of this nature for many years. Nevertheless, this is certainly a realistic probability: derailments are an uncontrolled process in which non-controllable factors (such as the points in the relevant section of track and the 'coincidental' presence of other trains in the vicinity) determine both the course and consequences of the derailment. This type of derailment has occurred on four occasions in the past five years (2004-2008): in all four instances passenger trains were travelling along adjacent tracks and in three instances the derailed wagons came to rest at a considerable distance from the track. Consequently, the majority of these derailments gave rise to a real risk of a follow-on collision. Two further goods-train derailments occurred during the investigation: on 23 March 2009, near Vleuten, and on 14 June 2009, near Venlo. Both instances also related to the escalating derailment of a goods train, with major damage and the real risk of a follow-on accident.

b) *HotBox detection*

The section of track used by the train involved in the Muiderpoort derailment is not the only section without HotBox detection. Although HotBox sensors were installed at six locations in the beginning of the nineteen-nineties, this trial was terminated in 2002<sup>5</sup>. In the years since then HotBox detection has been installed on just two new lines (HSL-Zuid and the Betuweroute). The rest of the rail network has not been equipped with the system. This contrasts with the situation in many countries neighbouring the Netherlands<sup>6</sup>, which have made widespread use of HotBox detection for many years. The HotBox detection system installed on the Betuweroute line has since prevented a derailment due to overheating axle boxes on at least two occasions.

c) *QuoVadis system*

The QuoVadis measurement point that recorded the anomalous distribution of the load over the wheels of the Muiderpoort train is part of a network of about forty measurement points. These measurement points are installed at strategic locations in the goods rail network and are primarily intended to measure the weight of goods trains to determine the fee the goods carriers pay for the use of the track. To date only one of these measurement points has been configured as a real-time warning system, namely the measurement point near the Best rail tunnel.

d) *Derailment detection*

The relevant wagon from the Muiderpoort train is not the only wagon without a derailment detector. To date these detectors have found only very limited use, both in the Netherlands and abroad. Switzerland, in response to a number of serious derailments, developed a system suitable for goods wagons about ten years ago. In the years after 2003 Switzerland has installed this system on more than six hundred goods wagons used to transport dangerous goods on the country's rail network. These systems have been installed pursuant to a covenant concluded between the Swiss government and the chemical industry. A small number of

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5 At the time ProRail gave the following reasons: extremely vulnerable to malfunctions, many false alarms and the unavailability of further spare parts.

6 HotBox detection is used in countries including Belgium, Germany, the UK, France, Italy and Sweden.

goods carriers in other countries also make limited use of the system on a voluntary basis<sup>7</sup>. At least one specific instance is known in which this equipment successfully prevented a derailment from escalating into a major accident.

e) *Dynamic maintenance management*

Dynamic maintenance management is also numbered amongst the control measures that are not currently used or used only on a limited scale. Dynamic maintenance management relates to the management of the maintenance of wheel sets on the basis of 'beginning defects' (such as flats on wheels and bent axles, etc.). The system is primarily intended to achieve the effective management of the maintenance process, although its use also reduces the risk of overheating axle boxes (and the resultant derailments). The Netherlands' NS Reizigers uses dynamic maintenance management to manage the maintenance of its passenger trains' wheel sets. The aforementioned QuoVadis sensors the infrastructure manager has installed in the track to measure the weight of passing trains<sup>8</sup> is used to detect defective wheel sets. According to NS Reizigers, the introduction of the system (in about 2000) has made a major contribution to the reduction of overheating axle boxes on their trains (from about 30 to about 3 instances a year). Railion and the other goods carriers do not use this (or a similar) system.

On the basis of an overall assessment the Board concludes that at least five of the six serious derailments of good trains caused by defective wheel sets that have occurred since the beginning of 2005 could have been prevented by adequate defect detection and that the consequences of three could have been substantially reduced by the use of derailment detection.

The Board has observed favourable developments on two fronts:

- ProRail has been working on plans for the upgrading of the QuoVadis system since 2007. The current equipment will be replaced by equipment that can also detect specific wheel set anomalies. In parallel to this, ProRail is developing a system that will provide access to the measurement data for the dynamic maintenance management of goods trains and transmit real-time alarms to warn the traffic management of specific wheel set defects. This project is being carried out at an accelerated pace in response to the Muiderpoort derailments and the two other serious derailments of goods trains in 2009. The project is scheduled for completion in 2013.
- On a European scale consideration is being given to the imposition of a mandatory requirement (possibly from 2013) for the installation of derailment detection on new wagons used to transport dangerous goods<sup>9</sup>.

The Board has a favourable view of these developments, but is of the opinion that they should have been initiated earlier. Within this context the Board wishes to point out that the frequency of this type of derailment has been remained approximately constant for at least ten years. In addition, HotBox detection and dynamic maintenance management have been available for at least ten years and derailment detection for about five years. The Board also observes that it is unclear whether the intended modification of the QuoVadis system will be sufficient to achieve adequate control of the derailment risk: it is possible that more and/or other measurement points will be required for adequate control of the derailment risk as compared to the current QuoVadis network (that is primarily intended to measure the weight of trains).

The Board is of the opinion that the criterion for the decision as to whether to implement safety measures for the reduction of safety risks should be the ALARP principle<sup>10</sup>. In essence, pursuant to this principle the implementation of measures that are explicitly prescribed should be supplemented with those measures that yield safety gains which justify the associated investments and any concomitant detrimental consequences.

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7 A total of several hundred goods wagons used to transport dangerous goods in Morocco and Slovenia (source: Knorr Bremse Group).

8 The measurement values are not made available to NS Reizigers immediately (in real-time): they are issued at periodic intervals.

9 The European Railway Agency (ERA) has carried out a study and concluded that it is improbable that the safety gains achieved with this measure will justify the necessary investments. However, the ERA has noted that the cost/benefit ratio could nevertheless become favourable if derailment detection is introduced for all goods wagons rather than solely wagons carrying dangerous goods.

10 ALARP is the abbreviation for 'as low as reasonably practicable'.



In other words: the companies/organisations that bear the responsibility should ensure that the available measures are implemented unless they can demonstrate that the costs and/or consequences of a measure are unreasonable.

Within this context the Board is supported by the Railways Act and government policy. The Railway Act prescribes that safety risks must be adequately controlled by suitable measures. The Second Railway Safety Framework Memorandum that lays down the government's railway safety policy makes use of the aforementioned ALARP principle as the criterion for the assessment of potential safety measures.

However, the Board's investigation has revealed that neither the Ministry of Transport, Public Works and Water Management nor the rail companies make use of a structural ALARP assessment in the review of the aforementioned technical safety nets.

## **Underlying problems**

### *The rail companies' opinion of their duties and their safety management*

Rather than using the ALARP assessment, the rail companies involved cite the following arguments for the decision not to implement the available control measures:

- Although ProRail does appreciate the potential safety net function of HotBox detection and an expanded/upgraded QuoVadis system the company is of the opinion that the carriers bear the primary responsibility for the control of the risk of train derailments due to wheel set defects. HotBox detection has been installed on two lines – the HSL-Zuid and Betuweroute lines – because the use of HotBox detection is mandatory with high-speed trains<sup>11</sup> and the risk analysis carried out specifically for the Betuweroute line<sup>12</sup> indicated that the detection was necessary. One of the approximately forty QuoVadis measurement points was upgraded to a real-time warning system to comply with the provisions of the permit for the use of the Best railway tunnel<sup>13</sup> close to the measurement point.
- According to Railion, due to competition considerations the goods carriers can only be expected to introduce derailment detection pursuant to an obligation imposed at a European level.
- Railion's opinion with respect to dynamic maintenance management is that the company lets the relevant wagons and that the lessor is responsible for the maintenance of the wheel sets. Within this context Railion also states that the company (in contrast to NS Reizigers) does not receive the relevant measurement values from ProRail.
- Although NS Reizigers endorses the importance of dynamic maintenance management for goods trains, HotBox detection and the upgrading of the QuoVadis system the company also states that the implementation of these measures is outside its direct sphere of influence.

In essence, this argumentation reveals that the rail companies appreciate the importance of the measures but feel responsible solely for the control of the safety risks they cause, i.e. the safety risks that are completely within their sphere of influence. The Board is of the opinion that the rail companies' standpoint is indicative of a too-limited concept of their personal responsibility for the safety of rail traffic and their duty/role within the rail sector. The joint control of safety risks, in particular, is given insufficient shape. The Board appreciates that the aforementioned control measures relate to different areas of duties (rail infrastructure - design of the wagons - maintenance of the wagons) and that the individual rail companies do not have direct or full control over all these areas of duty. However, the Board does expect each of the rail companies to make every possible effort to minimise rail traffic safety risks within their specific area of operations. In the Board's opinion this obligation also extends to the risks that are caused by companies other than the relevant company.

The Board is of the express opinion that the rail companies also bear the responsibility for the control of risks confronting their operations that are caused by others and/or require a joint approach.

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11 Vehicle-mounted HotBox detection is prescribed for high-speed trains (in the Interoperability Technical Specifications): since the Thalys trains (that date from before the relevant Interoperability Technical Specifications) are not equipped with HotBox detection this functionality has been installed on the track.

12 An Integral Safety Plan drawn up for the construction of this line includes an analysis of the safety risks and assessment of the available control measures. Within this scope it was decided to install HotBox detection on the track.

13 The requirements laid down in the permit for use were no longer met when the aforementioned HotBox detection was decommissioned on the relevant section of track. For this reason the absence of HotBox detection was compensated by expanding the functionality of the QuoVadis measurement point.

Within this context the Board is supported by the Railways Act and the management concession based on that Act, since these not only impose quality requirements on the various *system components* (such as the infrastructure, the rolling stock and the personnel) but also impose a 'duty of care' for the safety of the rail traffic. This duty of care is not limited to the risks arising from the specific duties of a given company that can be tackled without the involvement of other rail companies. On the contrary, pursuant to this duty of care the rail companies are required to make the maximum possible contribution to the control of all risks. This includes the modification of their activities, where relevant, to achieve adequate control of the risks caused by other companies. The risks can be adequately controlled only when each rail company requires the other rail companies to make the best possible use of the opportunities open to them. It is essential that they call each other to account for their joint duty of care and, where relevant, set consequences for their own activities.

The Board has investigated how the rail companies have specified the control of the derailment risk in their safety management. In the Board's opinion this issue has been given insufficient shape, in particular with respect to the preparation of inventories and analyses of the safety risks, and the assessment of potential control measures. The Board is also of the opinion that as a result the rail companies make insufficient use of the safety management system (SMS) as a means for the structural fulfilment of their duty of care.

#### *Direction and enforcement by the government*

The Board expects the government to call the rail companies to account for their duty of care by inspections to assess whether the rail companies actually do have adequate control of the safety risks and, when this is not the case, enforce the fulfilment of their duty. Once again, the Board is supported in its opinion by the Railways Act which, in essence, stipulates that the government bears the system responsibility for the safety of rail traffic. This system responsibility encompasses issues including the policy, allocation of the responsibilities and supervision/enforcement.

However, in view of the rail companies' limited opinion of their duty as discussed above the Board deems it necessary for the government to make arrangements for the following two issues:

- direction in the form of an adequate consultative and decision-making structure within the rail sector and explicit risk-reduction targets;
- results-oriented supervision and stringent enforcement with respect the rail companies' adequate control of the derailment risk.

The Board is of the opinion that the government has inadequately fulfilled this duty in terms of the following:

- The rail sector has a consultative body on safety issues, the Rail Company Safety Consultative Body, OVS, which is under the management of the Ministry of Transport, Public Works and Water Management and is comprised of representatives from all rail companies and the Inspectorate for Transport, Public Works and Water Management. However, the Board is compelled to conclude that this still has not resulted in the adoption of a dynamic approach to the derailment issue in the past few years. The Board also observes that although the Ministry of Transport, Public Works and Water Management has urged ProRail to make haste with the upgrading<sup>14</sup> of the QuoVadis system, the company implemented this only in mid-2009 in response to a number of serious derailments. In addition, the Board observes that the Ministry of Transport, Public Works and Water Management has not formulated specific targets for the reduction of derailment risks. Consequently, the Board is of the opinion that the government has not given sufficient direction to the consultative body or the decision-making on the reduction of the derailment risk.
- The Board has carried out an investigation of the government's assessment of the relevant rail companies' SMSs.

It should be noted that the Board also raised this issue in three earlier rail reports<sup>15</sup>. At the time the Board concluded that the government needed to increase the focus of its supervision on the SMSs and on their effectiveness in practice. The Board's Muiderpoort investigation reveals that although the situation has now improved to a certain extent the assessment is still too much of a 'paper

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14 See Section 5.5.2-b.

15 This relates to the reports of the derailment at Apeldoorn on 30-04-2003, the train collision at Amsterdam on 21-04-2004 and the derailment at Amsterdam on 10-06-2005.

exercise'. Consequently, the Board is of the opinion that the government makes insufficient use of the rail companies' SMSs for the supervision of the companies' fulfilment of their duty of care. This in turn results in the insufficient utilisation of an important means of promoting rail safety.

## **Conclusions**

The Board observes that derailments such the Muiderpoort derailment occur about once a year and can have extremely serious consequences. Nevertheless, and without valid arguments, only limited use is made of the available technical safety nets. The Board also observes that it has not been demonstrated that the intended modification of the QuoVadis system will reduce the derailment risks to ALARP level. The Board is of the opinion that this, in view of the severity of the potential consequences, is unacceptable.

The Board concludes that the standpoint of the rail companies and the government is indicative of a too-limited opinion of the relevant duties. The rail companies' joint approach to safety risks, in particular, is given insufficient shape. The Board is of the opinion that the rail companies need to further develop their safety management, in particular with respect to the preparation of inventories and analyses of the safety risks, and the assessment of control measures. In the Board's opinion the government has failed to take effective action to close (or arrange for the closure of) the resultant safety gap. The Board expects the Ministry of Transport, Public Works and Water Management to make arrangements for the necessary direction, formulate specific targets for the derailment risk and enforce the achievement of those targets.

The Board has the impression that the aforementioned standpoint of the rail companies and the government is in part influenced by the absence of serious casualties in accidents of this nature for many years. However, the absence of serious casualties - even during the course of many years - is not a valid criterion for safety levels. In complex processes such as rail traffic the severity and extent of the potential consequences can be evaluated in an appropriate manner solely on the basis of both a thorough inventory/analysis of the safety risks and a structural assessment of the available control measures. In the absence of insufficient attention to both of these issues the reduction of risks will be assigned the appropriate priority only in response to a major accident or a series of serious accidents.

## **Recommendations**

The shortcomings and underlying problems result in the Board's submission of the following two recommendations.

1. To the Minister of Transport, Public Works and Water Management:
  - a) Call the rail companies to account, in accordance with the Railways Act, for their individual and shared responsibility for rail traffic safety. This can be achieved by effective supervision and stringent enforcement of their duty of care for safety. In addition, require the rail companies to demonstrate that they have reduced the safety risks to ALARP level.
  - b) Achieve adequate control of the goods-train derailment risk by:
    - arranging for the direction of the consultations and the decision-making on the implementation of control measures;
    - imposing specific targets for the reduction of the derailment risk.
2. To Railion, ProRail and NS-Reizigers:
  - a) Extend the safety management to the risks to the relevant company's operations that are caused by other companies and/or require a joint approach.
  - b) Make sure that the available technical options for defect and derailment detection are used to reduce the goods train derailment risk to ALARP level.

*Supplementary investigation*

The Board is also of the opinion that the results from the investigation give cause to supplementary investigations by the relevant companies in two areas.

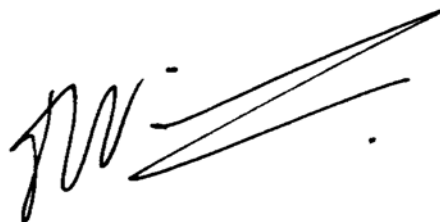
- The inspection of the defective axle box did not reveal any indications of maintenance shortcomings. Nevertheless, the Board is of the opinion that a critical evaluation of the maintenance regime is required for the following two reasons. Firstly, the derailment was caused by the failure of a bearing less than three years into the ten-year overhaul period. Secondly, the technical condition of one of the other twenty bearings from the derailed wagons that were examined for reference purposes gave cause for concern. The examination revealed chipping in the raceway that gave cause to the suspicion that the bearing would fail within the remaining term of the overhaul period.
- The examination of the other twenty bearings also revealed that a number of the bearings had current-flow damage. In the longer term damage of this nature can result in chipping of the raceway and, ultimately, the failure of the bearing. For this reason the Board is of the opinion that a further investigation of the cause of this damage is required. This investigation should also extend to the conditions in which the wagons are used, including those parts of the locomotive and rail infrastructure that can be of influence on the return current.

The Board is of the opinion that the performance of this supplementary investigation is the duty of the companies that bear the primary responsibility for the maintenance of the axle box bearings (Xpedys), the use of the wagons and the technical condition of the relevant locomotives (Railion) and the rail infrastructure (ProRail). For this reason the Board submits the following two recommendations:

3. To Xpedys:  
Evaluate the periodic maintenance of the axle boxes of the series of wagons involved in the Muiderpoort derailment, with due regard for the chipping damage encountered in one of the bearings of the derailed wagons.
4. To Railion and ProRail:  
Carry out an investigation of the current-flow damage to the axle box bearings observed with the wagons involved in the Muiderpoort derailment and make sure that the necessary measures are implemented to prevent this form of damage.



Pieter van Vollenhoven  
Chairman of the Dutch Safety Board



M. Visser  
General Secretary

## LIST OF ABBREVIATIONS

A	ALARP	As low as reasonably practicable
	ARR	Automatic Speed Registration
B	B	Belgium
C	CEN	Comité Européen de Normalisation
	CG	Clearance Gauge
	COTIF	OTIF Convention
	CR	Conventional rail
D	DB	Deutsche Bahn
	DDD	Derailment Detection Devices
	DVIS	Rail Safety and Interoperability Agency (B)
E	EC	European Community
	ERA	European Railway Agency
F	FOMV	Ministry of Transport (B)
G	GCU	General Contract of Use for Wagons
	GSM-R	GSM Rail - Global System for Mobile communication
H	HEATCO	Harmonised European Approaches for Transport Costing and Project Assessment
	HSL	High-speed line
I	ISO	International Organization for Standardization
	IVW – TER	Inspectorate for Transport, Public Works and Water Management – Rail Supervision Division
K	KLPD – VSR	National Police Services - Rail Traffic Specialists
N	NEN	Dutch standard
	NMBS	National Railway Company of Belgium
O	OTIF	Organisation intergouvernementale pour les transports internationaux ferroviaires
	OVS	Rail Company Safety Consultations
R	RI&E	Risk Inventory and Evaluation
	RID	Regulation Concerning the International Transport of Dangerous Goods by Rail
	RIV	Regolamento Internazionale dei Veicoli
T	TNTS	Train Number Tracking System
	TSI	Interoperability Technical Specifications
U	UIC	Union Internationale des Chemins de fer
S	SMS	Safety Management System
V	VPF	Value of Preventing a Fatality

### Explanation of (technical) terms

Annex 2 contains an explanation of a number of technical terms used in this report.

# 1 INTRODUCTION

## 1.1 REASON

A goods train derailed at Amsterdam-Muiderpoort at about a quarter to five in the afternoon of Saturday, 22 November 2008. The train was comprised of a locomotive and 25 wagons loaded with chalk and quicklime. There were no casualties. However, the derailment did cause a great deal of damage and resulted in the large scale and lengthy disruption of rail traffic in and around Amsterdam. Since some of the derailed wagons came to rest on adjacent tracks, other trains could have collided with the derailed wagons. Moreover, the wagons could have been loaded with dangerous goods.

A similar goods train, with the same type of wagons, had derailed at Boxtel three years earlier (on 8 December 2005). This derailment caused a number of casualties with slight injuries and destroyed more than one-and-a-half kilometres of track. The section of track was closed to rail traffic for four days. This gives cause to the question whether the same causes/problems were an issue with the Muiderpoort derailment and, if so, why inadequate safety lessons were learnt from the Boxtel derailment.

The above reasons (the extent of the damage, disruption of rail traffic, potential severity of derailments and the possibility that the same problems had been at issue in earlier accidents) gave cause to the Dutch Safety Board's decision to instigate an investigation into this derailment.

## 1.2 OBJECTIVE OF THE INVESTIGATION AND THE QUESTIONS TO BE ANSWERED

The Dutch Safety Board carries out independent investigations into the (presumed) causes of incidents, identifies learning points from the investigation and, when possible, submits recommendations for safety improvements. The objective of this investigation is in line with the above: conduct an investigation into the Muiderpoort derailment to identify learning points for the prevention of accidents of this nature or the restriction of their consequences.

The Board formulated the following questions to be addressed by the investigation:

- a) What was the technical cause of the Muiderpoort derailment and was this the same cause as that of earlier derailments with wagons from this series?
- b) What were the (potential) consequences of the Muiderpoort derailment, how often do derailments of this nature occur and what are the potential risks associated with these derailments?
- c) To what extent do the findings from the investigation give cause to the modification of the periodic maintenance of the relevant series of wagons and/or the amendment of the relevant legislation and regulations?
- d) Which supplementary means are available for the control of the risk of goods train derailments due to wheel set defects and to what extent could these prevent derailments of the nature of the Muiderpoort derailment or limit the consequences?
- e) How have the parties involved made arrangements for the responsibility of controlling the derailment risk and how do they fulfil this responsibility?

## 1.3 SCOPE OF THE INVESTIGATION

The investigation of the actual derailment focused on the facts and the cause: it did not extend to the control of the consequences or the approach to dealing with the consequences. The investigation of the underlying problems focused on the extent to which it is feasible to prevent accidents of this nature and on the extent to which these feasibilities are used to limit the consequences in practice.

## 1.4 THE CONTENTS OF THIS REPORT

Section 2 describes the facts of and background to the derailment, beginning with a description of the facts and the consequences. Section 2 also contains statistical data about the derailments that have occurred in the past ten years and information about a number of comparable derailments.

Section 3 summarises the assessment framework used for the investigation, which was comprised of the statutory regulations, instructions governing the rail sector and the general safety management assessment framework of the Safety Management Board. Section 4 summarises the parties involved and their responsibilities. Section 5 contains the analysis of the cause of the derailment, the frequency and consequences of derailments and the control of the derailment risk. Section 6 contains the conclusions and Section 7 the recommendations.

*Railion company name*

During the course of the investigation the Railion Nederland NV company name changed to DB Schenker Rail NV. For the purposes of the readability of this report the company is referred to as Railion throughout the document.

## 2 FACTS OF THE DERAILMENT AND BACKGROUND INFORMATION

This section gives the facts and circumstances of the Muiderpoort derailment, beginning with the facts and then moving on to the circumstances and the consequences. The section continues with a statistical overview of the derailments that have occurred in the Netherlands during the past ten years and concludes with a description of recent accidents similar to the Muiderpoort derailment.

### 2.1 FACTS, CIRCUMSTANCES AND CONSEQUENCES

#### 2.1.1 Facts

Goods trains carrying chalk travel from Hermalle-sur-Huy, Belgium, to the steelworks in Beverwijk, the Netherlands, every day. This was also the case on Saturday 22 November 2008, with a train of 25 loaded wagons. A B-Cargo wagon master carried out a technical inspection<sup>16</sup> before the train left and a Belgian train driver then drove the goods train to Sittard, the Netherlands. The train driver uncoupled both locomotives in Sittard. A Dutch Railion train driver took over the train. He positioned his locomotive in front of the wagons and carried out a quick brake test<sup>17</sup>. He walked around the train during this test and did not observe any irregularities. Subsequently the train left at about 13.20 and travelled via Roermond, Eindhoven, Den Bosch and Utrecht towards its final destination. After passing Amsterdam-Bijlmer station the train driver braked to a speed of 70 km/hour to comply with a temporary speed limit. The train driver then allowed the speed to drop further, as a result of which the train left Amsterdam-Muiderpoort station travelling at below the prevailing maximum speed of 60 km/hour at the location.

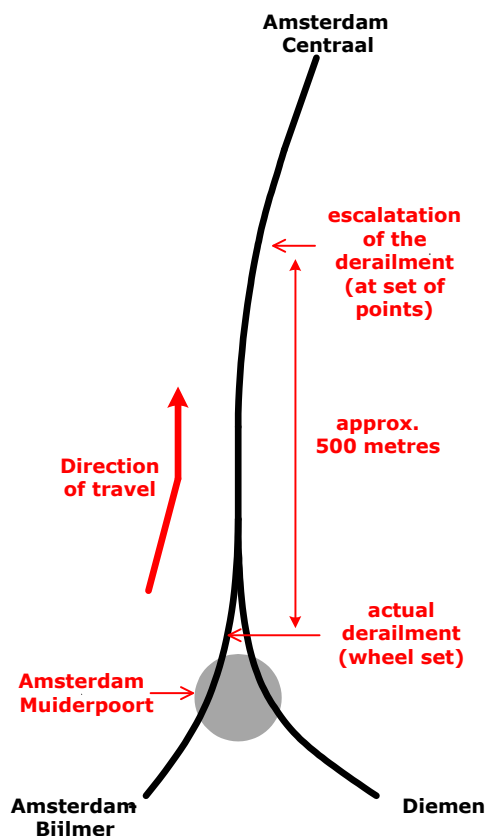


Figure 1: Diagram of track section

16 In essence, a technical inspection is comprised of a visual inspection for defects and wear on the exterior of the wagons, the position of the brake levers, the manner in which the wagons are loaded and the overhaul date (displayed on the exterior of each wagon).

17 A quick brake test checks that the brakes on the last wagon are working when the brakes are applied.



Just after the goods train passed the Amsterdam-Muiderpoort station the front wheel set of the eleventh wagon derailed. The train driver did not notice that the wheel set had derailed and the train continued on its journey. The derailed wheel set (that was no longer travelling over but alongside the rails) damaged the track. About five hundred metres further on the derailed wagon passed over a set of points and caused serious damage to the points. That in turn resulted in the derailment of the next eight wagons at the points. This was the beginning of the escalation of the derailment. The 11<sup>th</sup> and 12<sup>th</sup> wagons toppled to the left, fell onto the adjacent track and lost their loads. The train broke between the 12<sup>th</sup> and 13<sup>th</sup> wagons. The 13<sup>th</sup> wagon came to rest straddling three tracks. The 14<sup>th</sup> and 15<sup>th</sup> wagons toppled to the right and came to rest on the adjacent track. The 16<sup>th</sup> to 19<sup>th</sup> wagons derailed but did not topple over. The 20<sup>th</sup> to 25<sup>th</sup> wagons did not derail.

During this escalation the train driver suddenly felt a hard bump and severe juddering of the train. The train driver immediately applied the emergency brakes. Once the train had come to a standstill he looked through a side window to the rear of the train and saw the destruction. He switched on the locomotive's hazard lights and contacted the traffic management. It was then about 16:39.

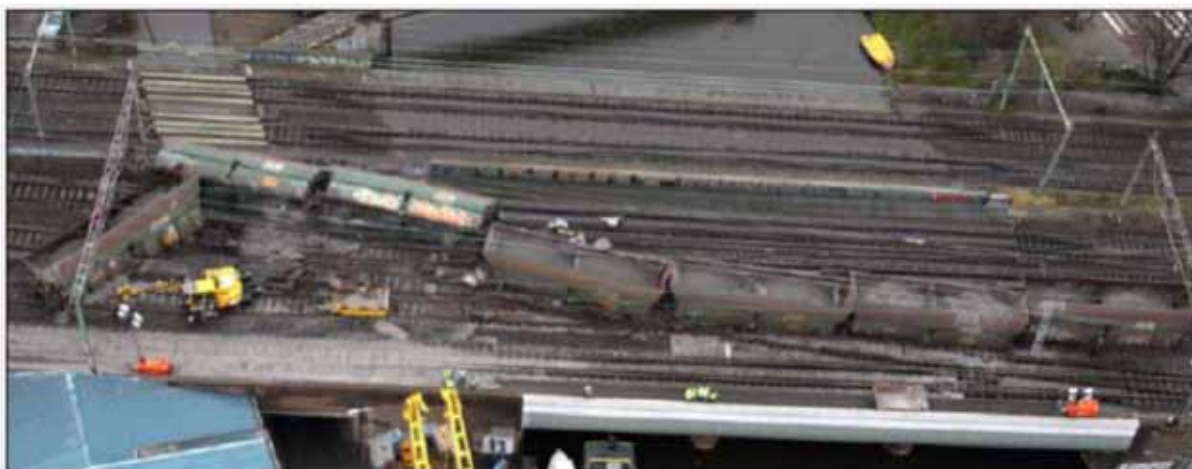


Figure 2: This photo shows the final position of some of the derailed wagons.

Other tracks are located alongside the track used by the goods train. NS Reizigers' passenger trains were travelling on these tracks shortly before the derailment: the international ICE train to Germany passed the goods train on the left-hand track and the intercity from Hoofddorp to Lelystad passed on the right-hand track in the same period. At the time of the derailment a third passenger train on one of the adjacent tracks was travelling towards the location of the derailment. The driver of this train saw his track signal change to red and was able to stop his train in time: he saw the escalation of the derailment taking place in front of his eyes.

#### 2.1.2 Situation and circumstances

##### a) Composition of the train

The goods train was comprised of an electric locomotive pulling 25 loaded wagons. The first seven wagons were of the Talns type, the following eighteen of the Falns type. Railion leased the first seven wagons from the German DB Schenker company and the following eighteen from the Belgian Xpedys company.

##### b) The train's approaching speed

Subsequent to the derailment it was discovered that the locomotive's Automatic Speed Registration (ARR) had not been working properly and that no records had been made of the train's speed during its journey<sup>18</sup>. However, it is possible to state the following about the train's speed.

The Train Number Tracking System (TNV) is used to record the route used by trains on the main rail net. The information from this system can be used to determine the interval between the times at which the train entered consecutive blocks of track. The length of the

18 When so requested the IVW stated that the ARR had not been functioning correctly either in a number of other recent incidents. The Board views this with concern since the availability of this information can be of great importance to the reconstruction/analysis of accidents.

blocks of track is also known. In combination, this information can be used to determine the train's average speed on a specific block of track. The Safety Board used this method to calculate the train's speed. This revealed that the goods train was travelling at between 48 and 58 km/hour when it approached the location of the derailment. This was below the prevailing maximum speed at the location (60 km/hour).

c) *Infrastructure*

Maintenance work had been carried out on the section of track where the derailment took place about two months previously. This work included the replacement of the sleepers. ProRail carried out inspection measurements of the track geometry before it recommissioned the track. This involved measurements of the radius of the curves and the canting along the track. The Safety Board used the measurement values to investigate whether the alignment of the track complied with the regulations. This revealed that one aspect of the track alignment did not comply with the relevant design regulations<sup>19</sup>: however, on the basis of simulation calculations the Board has established that the observed anomalies did not contribute to the derailment<sup>20</sup>.

d) *Weather conditions*

The weather was dry in Amsterdam and the surroundings at the time of derailment. The sky was overcast and visibility was normal. It was beginning to become dusk and the temperature was close to freezing point.

2.1.3 *Final situation and consequences*

a) *Final positions*

Nine wagons derailed, four of which toppled over and shed their load of chalk. The track was damaged over a distance of 500 metres. A set of points was also destroyed. Wagon 14 came to rest against a concrete section of the bridge over the Zeeburgerpad. The derailed wagons 16 to 18 inclusive sank into the bridge. A cyclist on the Zeeburgerpad escaped with a fright when concrete rubble from the bridge fell onto the cycle track behind him.

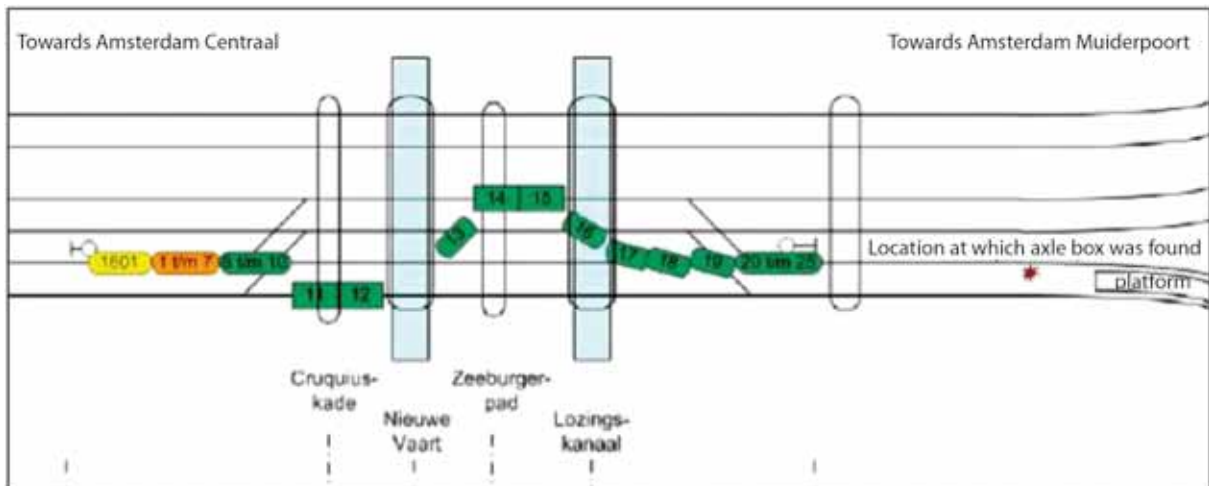


Figure 3: Diagram of the end position of the wagons.

b) *Consequences*

The consequences of the derailment were as follows:

- *Rolling stock*: eight wagons were completely destroyed and one wagon was severely damaged. This element of the damage amounted (according to an overall estimate made by the IVW) to about 0.5 million euros.

19 In one of the transitional curves the exceptional value for the tilting speed (which, according to ProRail's Alignment Design Regulations OVS0051-4.1 may not exceed 35 mm/s) was exceeded by 8 mm/s.

20 See explanation in Annex 3 (under 2).

- *Infrastructure*: According to ProRail the damage to the infrastructure amounted to about 2.3 million euros. This related to the destruction of a points complex and the damage of about 500 metres of track. A rail bridge was also severely damaged. In addition, it was necessary to divert one track so that rail traffic could be resumed.
- The *process damage* (see the explanation in Annex 4) amounted to about 2 million euros, as a result of which the total damage amounted to about 5 million euros.
- *Disruption of rail traffic*: no rail traffic was possible on four of the six tracks for one week. After provisional repairs trains were able to travel over three of the four damaged tracks. During the course of these repairs one track was diverted and joined up to an adjacent track, as a result of which one less track was available for trains travelling in the direction of Weesp.

## 2.2 HISTORICAL AND INTERNATIONAL PERSPECTIVE

The Safety Board requested the Inspectorate for Transport, Public Works and Water Management (IVW) to draw up a summary of the derailments that had occurred on the national rail network in the past ten years (1999-2008). The Board also examined what statistical information is available about the magnitude of the derailment problem in other European countries.

### 2.2.1 Netherlands

The IVW's summary reveals the following:

- 42 derailments occurred in the past ten years, of which 27 involved goods trains and 15 passenger trains. When the number of train kilometres is taken into account then goods trains derail more than 20 times more frequently than passenger trains.
- There were three basic causes of derailments: rolling stock (such as overheated axle boxes or detached tyres), rail infrastructure (such as defective points) and process (such as SPADS - signals passed at danger - or excessive speeds). The causes of the derailments that occurred during the past ten years are divided roughly equally between these three categories.
- 12 of the 27 goods train derailments that occurred during the past ten years were caused by rolling stock defects, 2 of which were overheated axle boxes<sup>21</sup>. The figures for the 15 passenger train derailments are 3 and 1 respectively.
- During the past ten years 1 goods train derailment resulted in these 4 casualties with minor injuries. During the same period 1 passenger train derailment resulted in casualties, namely 1 casualty with serious injury and 3 casualties with minor injuries.
- None of the 42 derailments that took place in the past ten years resulted in a follow-on collision. However, in principle this could have occurred in 30 of these instances. 10 derailments gave cause to a real risk of a follow-on collision and in 4 instances there was a real hazard of a collision in the sense that - as was the case with the Muiderpoort derailment - trains had passed or were approaching the location of the derailment. A passenger train was also passing at the time of the Vleuten derailment that occurred at the beginning of 2009 (see 2.3.3).
- About half (13) of the 27 goods train derailments that occurred in the past ten years resulted in major damage to the rolling stock and the rail infrastructure, as was the case in 2 of the 15 passenger train derailments.

Section 5.2.3 reviews the good train derailments in more detail.

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21 No information is available about the number of overheated axle boxes that did not result in a derailment.

## 2.2.2 Europe

The European Railway Agency (ERA) published its first report on derailments at a European level<sup>22</sup> in 2008. This relates to the number of significant derailments in each Member State in 2006<sup>23</sup>.

The Netherlands, with two derailments, compares favourably with Member States such as Poland (195) or Germany (52) derailments. This is also the case in terms of the number of derailments per train kilometre. However, the wide distribution of the numbers gives cause to the suspicion that the Member States did not use the same definition for their reports. For this reason it is probable that only limited value can be assigned to the numbers stated in the report.

## 2.3 OTHER ACCIDENTS

### 2.3.1 Earlier derailments of wagons from the same series (Boxtel 2005)

The wagons that derailed at Amsterdam-Muiderpoort belong to a series of one hundred identical wagons (of the Falns type) that Railion lets from Xpedys since 2001. Railion uses these wagons for chalk transports from Belgium to the steelworks in Beverwijk, the Netherlands. Enquiries with Dutch and Belgian Inspectorate (IVW and DVIS) revealed that the wagons from this series were involved in one other derailment during the past few years. This derailment occurred at Boxtel on 8 December 2005. The train, comprised of 28 loaded wagons, was on its way to Beverwijk. The last two wagons derailed between Boxtel and Vught. In the first instance the train driver did not notice the derailment. He was warned by the traffic controller, who had been notified by another train driver who was driving a local train in the opposite direction on an adjacent track and had passed the goods train (with the derailed wagons). The driver of the goods train then stopped the train at a distance of more than one-and-a-half kilometres from the derailment. A number of track workers working on this section had been injured by parts of the wagon that had come loose and stones flying up from the track. It transpired that the derailment had been caused by an overheated axle box on one of the wagons. The IVW's report concluded that the axle box had probably overheated because the bolts securing the bearings had come loose. This problem was also seen with other wagons, and for this reason all the axle boxes underwent a new overhaul. The maintenance regime was also modified.

### 2.3.2 Two overheated axle boxes on goods trains in 2009

The Muiderpoort derailment relates, as will be explained in more detail in Section 5, to the derailment of a goods train due to an overheated axle box. Two other recent incidents involving an overheated axle box are summarised below. However, in both these instances the train was stopped in time following a HotBox alarm<sup>24</sup>.

The first incident occurred on the Betuweroute line on 13 March 2009. The driver stopped the train after the traffic controller warned him that he had passed a HotBox detection point which had generated an alarm. When the driver walked along the stopped train he saw that one of the wagons had an overheated axle box: the axle box was hot and grease was leaking. The axle box cover was removed at the location. This revealed that the bearing cage of the outer bearing had broken apart and that the barrel rollers had already suffered considerable damage<sup>25</sup>. The axle journal was also badly damaged. The nature of the damage indicated that if the train had continued its journey then, in analogy with the Muiderpoort derailment, the axle journal would have failed and the train would have derailed.

The second incident occurred at Dordrecht on 20 November 2009. The goods train was travelling on the block of track used by goods trains and passenger trains between the Port of Rotterdam and the Betuweroute line. Once again, the driver stopped the train after the train services management warned him that his train had generated a HotBox alarm. An inspection once again revealed that one of the wagons had an overheated axle box. A derailment could have occurred if the train had continued its journey.

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22 The Railway Safety Performance in the European Union, European Railway Agency, Lille 2008.

23 More recent information is not yet available.

24 An explanation of the HotBox system is given in 5.4.3.

25 An explanation of the technical terms is enclosed in Annex 2.

### 2.3.3 *Two derailments of goods trains in 2009*

#### *a) Derailment of a goods train at Vleuten*

A goods train derailed on the track between Gouda and Utrecht on 23 March 2009. This derailment resembled the Muiderpoort derailment in that the subsequent escalation gave cause to a real risk of a follow-on accident. The goods train was comprised of a locomotive and 25 loaded wagons: the 8<sup>th</sup> and 9<sup>th</sup> wagons derailed. The train driver was completely unaware that the wagons had derailed. The damage the derailed wagons caused to the infrastructure disrupted the track safety system. The safety system then generated an alarm at the traffic control centre and the traffic controller warned the driver of the goods train via the GSM-R. When the driver looked out of the locomotive window he saw a large dust cloud next to his train. The driver immediately stopped the train, which came to a standstill shortly before the Utrecht-Terwijde halt. The train had travelled a distance of about 5 kilometres after the derailment.

The derailed train had passed the Vleuten halt between Harmelen-Aansluiting and Utrecht-Terwijde, where the derailed wagons had hit the edge of the platform and caused severe damage. The derailed train had also passed an NS Reizigers passenger train travelling in the opposite direction on an adjacent track: the ballast thrown up by the wagons and debris from the wagons damaged the passenger train and broke several windows. No-one in the passenger train, on the platform at the Vleuten halt or elsewhere along the track was injured. However, the infrastructure was severely damaged over a distance of 5 kilometres. A number of cars parked alongside the track were also damaged. The investigation into the cause of this derailment being carried out by the IVW and the Dutch Safety Board is still in progress. However, it has become clear that the handbrake of the relevant wagon had not been fully released and that this probably played a role in the events leading to the derailment.

#### *b) Derailment of a goods train at Venlo*

A goods train derailed on the Venlo emplacement on 14 June 2009. This derailment resembled the Muiderpoort derailment in that the derailment was also caused by an overheated axle box on one of the wagons. Although there were no casualties, the rail infrastructure was severely damaged (in particular, the damage caused by the derailed wagon hitting four catenary supports, one of which toppled over). The investigation into the cause of the overheated axle box being carried out by the carrier (in consultation with the wagon holder and the IVW) is still in progress.

### 2.3.4 *Derailment of a goods train at Viareggio*

A goods train derailed at Viareggio station (Italy) on 29 July 2009. The train was carrying LPG. One of the tank wagons was punctured by the derailment, causing a major fire. The accident caused at least 27 fatalities and a large number of casualties. The rail infrastructure and buildings in the surroundings also suffered severe damage.

The investigation is still in progress. However, it has now become clear that the derailment was caused by a broken axle on one of the wagons. The derailment resembles the Muiderpoort derailment in that both related to an escalated derailment caused by a defective wheel set on one of the wagons. However, the major differences are that the Muiderpoort train was not carrying dangerous goods and that the Viareggio wheel set defect (a broken axle) was not accompanied by an overheating axle box (which has consequences for the feasibility of detecting the defect in time, see Section 5.4).

### 3 ASSESSMENT FRAMEWORK

This section describes the assessment framework used by the Dutch Safety Board. This framework is comprised of three elements: the relevant legislation and regulations, the norms and standards governing the sector and the general principles the Board has formulated for safety management.

#### 3.1 LEGISLATION AND REGULATIONS

##### 3.1.1 Legislation

The Railways Act, 2003, arranges for train safety on the Dutch main rail network. This Act has been implemented by a large number of instructions, decrees and regulations. The Working Conditions Act is also applicable to the safety of train traffic.

##### a) Railways Act, 2003

The Railways Act, 2003, came into force for the main rail network on 1 January 2005. This Act is accompanied by a large number of implementation regulations and decrees relating to issues such as rail companies, rail traffic, rolling stock, the rail infrastructure, personnel, capacity and supervision. The Railways Act and accompanying regulations implement European directives that impose interoperability requirements on rail traffic, rolling stock and the rail infrastructure and prescribe the segregation of the management of the infrastructure from the operation of the train services. The European Directive on safety on the Community's railways (2004/49/EC) imposes requirements on safety. The Netherlands Railways Act and accompanying regulations also refer to a number of international conventions and agreements, in particular the RIV (Regolamento Internazionale dei Veicoli), COTIF (Convention pour le Transport International Ferroviaire) and GCU (General Contract of Use for Wagons).

A summary of the essence of the legislation and regulations of relevance to the derailment issue is given below.

- Rolling stock: Rolling stock must have been issued an EC declaration of verification or an approval certificate (issued on the basis of the COTIF) and a deployment certificate. Rolling stock must also comply (and continue to comply) with certain technical specifications<sup>26</sup> prescribed for safety, compatibility and interoperability.
- Transport companies: The transport companies bear a duty of care for the safety of rail traffic that, in essence, requires them to implement suitable measures for the adequate control of safety risks associated with their operations. The transport companies must also demonstrate that they have implemented adequate safety management (an adequate safety management system)<sup>27</sup> that complies with the statutory regulations (see the explanation below) and which assures the fulfilment of their duty of care. The transport companies may operate solely rolling stock that complies with the statutory requirements and when using that rolling stock must comply with the relevant instructions (relating to issues such as speed, signal positions, etc.).
- Infrastructure: The duty of care for the construction, management and maintenance is assigned to the Minister of Transport, Public Works and Water Management. A specific basic quality is prescribed for the design, equipment and technical properties. The Minister of Transport, Public Works and Water Management is required to grant a concession for the management of the infrastructure<sup>28</sup>. This management encompasses arrangements for the quality, reliability, availability, division of capacity and the traffic management. The management concession also encompasses a duty of care: the manager is required to analyse the safety risks associated with the use and management of the rail network and implement measures for their adequate control. In addition, the management concession stipulates that the manager shall have implemented an adequate safety management system (SMS) that complies with specific requirements (see the explanation below).

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26 These are laid down in the Interoperability Technical Specifications (TSI).

27 The Act also refers to a safety assurance system in this context.

28 ProRail has been granted the management concession for the main rail network for the period from 2005 to 2015.

### *Safety management (systems)*

As indicated above, both the transport companies and infrastructure managers bear a duty of care (pursuant to the Railways Act and the management concession respectively) for safety and are required to implement an adequate safety management system. In essence, these instructions lay down that:

The transport companies shall implement an adequate SMS that contributes to the assurance that they<sup>29</sup>:

- recognise the risks associated with their operations and implement suitable measures to achieve adequate control of those risks, whereby they are required to take account of the state of the art and the sector's knowledge and guidelines relating to safe operations;
- adopt and maintain procedures for the implementation of corrective measures in response to anomalies and incidents, as well as for continual improvements to the safety level from the perspective of changing circumstances and newly-acquired experience;
- provide for procedures governing third-party supplies of services to the rail company and goods relating to rail safety<sup>30</sup>.

The infrastructure manager must assure that<sup>31</sup>:

- he analyses the risks associated with the safety of the use and management of the main rail infrastructure and implements suitable measures, including shutting down part of the main rail network to achieve adequate control of the risks and whereby he takes account of the specific requirements the operations may be expected to impose and the state of the art;

His SMS complies with the relevant requirements imposed by the Railways Act<sup>32</sup>, including:

- procedures and methods for the assessment and control of risks when changes in the operating conditions or new equipment result in new risks to the infrastructure or operations;
- procedures to ensure that accidents, incidents, near misses and other hazardous occurrences are reported, investigated and analysed and that the necessary preventive measures are implemented;
- provisions for periodic internal audits of the safety management system.

The Second Railway Safety Framework Memorandum that lays down the government's railway safety policy makes use of the ALARP principle<sup>33</sup> as the criterion for the adequate control of safety risks. In essence, pursuant to this principle the measures that are explicitly prescribed for the reduction of safety risks are supplemented by all those measures that yield safety gains which justify the associated investments and any concomitant detrimental consequences. The onus of proof that this is not the case rests on the party that is responsible for the control of the relevant risks. The above implies that the rail companies must implement the measures available for the control of risks unless they can demonstrate that the costs and/or consequences of a measure are unreasonable.

### *b) Working Conditions Act*

The Working Conditions Act imposes obligations on employers and employees.

- The employer must ensure for the health and safety of the employees in all areas relating to their work and to this end must conduct a policy focused on the achievement of the best possible working conditions. The employer must organise the work in a manner that ensures that it is not detrimental to the employee's health and safety.  
In the first instance the employer must prevent hazards to and risks for the employee's health and safety at the source or limit them at the source. The employer must make effective and appropriate personal protective equipment available to the employee. Pursuant to the Working Conditions Act employers must also implement measures to protect third parties from potential hazards that could arise during the work in the company or in the immediate surroundings of the company.

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29 Railways Act, Article 33, second paragraph.

30 Rules safety certificate main railway network, Article 7.

31 Main rail infrastructure management concession, Article 3.

32 Main rail infrastructure management concession, Article 7, first paragraph.

33 ALARP is the abbreviation for 'as low as reasonably practicable'.

- The employees are under the obligation to ensure for their personal health and safety and that of other persons by taking action and refraining from taking action at the workplace in accordance with their training and the instructions issued by the employer.

### 3.1.2 Norms and standards

The railway legislation refers to norms and standards issued by external organisations, in particular the CEN and ISO standards and the standards issued by the UIC (Union Internationale des Chemins de fer). The norms, which relate to technical instructions for the quality and design of components, bogies, wheel sets, axle bearings and suspensions, etc., encompass EN norms and UIC numbers<sup>34</sup>.

## 3.2 SAFETY MANAGEMENT

Earlier investigations carried out by the Safety Board have revealed that the structure of the safety management systems within the relevant organisations and the practical detailing and implementation of those standards by the organisations and their employees are of essential importance to the control and improvement of safety.

### 3.2.1 Principles

The manner in which safety management is implemented by and within an organisation can be assessed from a number of perspectives. However, the Safety Board has formulated five principles that will in any case need to be implemented pursuant to the organisation's responsibility for safety. The Board is of the opinion that these five principles are justifiable since they are incorporated in both a large amount of national and international legislation and regulations and in a large number of generally-accepted and implemented standards.

The five principles are:

#### a) *Insight into risks as the basis for the safety approach*

The achievement of the required safety level begins with an exploration of the system followed by an inventory of the associated safety risks.

This inventory is used to identify the hazards that need to be controlled and the preventive and repressive measures that will be needed to achieve that control.

#### b) *Demonstrable and realistic safety approach*

The occurrence of undesirable incidents should be prevented and controlled by laying down a realistic, practicable safety policy and the principles of that policy. This safety approach must be adopted and managed at management level. This safety approach is based on:

- the relevant prevailing legislation and regulations;
- the available standards, norms and best practices from the sector; and
- personal insights and experiences of the organisation and the specific safety targets set for the organisation.

#### c) *Implementing and enforcing the safety approach*

The implementation and enforcement of the safety approach and the control of identified risks is carried out with and by:

- A description of the method in which the adopted safety approach is implemented, with attention to the specific targets and plans including the preventive and repressive measures arising from the safety approach.
- The transparent, unambiguous subdivision of responsibilities that is accessible to everyone for the implementation and enforcement of safety plans and measures at the workplace.
- The explicit definition of the required deployment of personnel and their expertise for the various tasks.
- The clear and active central coordination of the safety activities.

<sup>34</sup> EN 12080:2008 (axle boxes, rolling bearings), EN 12081:2008 (axle boxes, lubricating greases) and EN 12082:2008 (axle boxes, performance testing).



d) *Increasingly-stringent safety approach*

The safety approach should be made increasingly stringent. This should be based on:

- The proactive performance of (risk) analyses, observations, inspections and audits at periodic intervals and at least following every change in the principles.
- A reactive monitoring and investigative system for incidents, near-misses and accidents monitoring as well as an expert analysis thereof.

Assessments are made on the basis of the above and, where relevant, the management amends the safety approach. This also reveals points for improvement that can serve as an active plan of action.

e) *Management control, involvement and communication*

The management of the involved parties/organisation must:

- Internally provide for explicitly clear, realistic expectations of the safety ambition and provide for a climate of continual improvement of safety at the workplace by at least setting an example and, in conclusion, by making the necessary staff and resources available.
- Externally clearly communicate the general working method, the method used to test the working method and the procedures used to address conformances, etc., on the basis of explicit, specified agreements with actors in the surroundings.

### 3.2.2 *Safety level*

The Board appreciates that the assessment of the manner in which organisations implement safety management should take account of the nature and size of the organisation. For this reason the assessments can differ from instance to instance. However, the assessment is reached using the same approach and the aforementioned basic conditions continue to be applicable.

The Board is also of the opinion that public transport (including, self-evidently, rail transport) should achieve a relatively high safety level. For this reason the Board expects organisations active in the rail sector to have a highly developed safety awareness and a high level of ambition.

It should be noted that the rail sector (in contrast to some other sectors) is governed by statutory regulations (in particular, laid down in the Railways Act and the management concession based on that Act) that impose obligations on their safety management, the manner in which the safety management is implemented and the criteria to be used to test the safety management.

## 4 THE PARTIES AND THEIR RESPONSIBILITIES

This section contains a brief summary of the identity of the parties that were involved in the Muiderpoort derailment and their responsibilities.

### 4.1 THE PARTIES

Four elements are involved in this type of derailment: the goods train, the rail infrastructure, the traffic management and the other trains in the section. The parties that were involved can be classified into companies/persons and government bodies.

#### 4.1.1 Companies/persons

The following diagram shows the relevant companies/persons and their relationships.

This relates to:

- the operator of the goods train, Railion;
- the manager of the infrastructure that is also responsible for the traffic management, ProRail;
- the other carriers in the relevant section, with NS Reizigers as the largest;
- the lessor/keeper of the wagons, Xpedys;
- the shipper of the load carried by the wagons, Corus;
- the passengers in the passenger trains in the section;
- the lessors/keepers of other rolling stock in the section;
- the shippers of the loads carried by the other goods trains in the section.

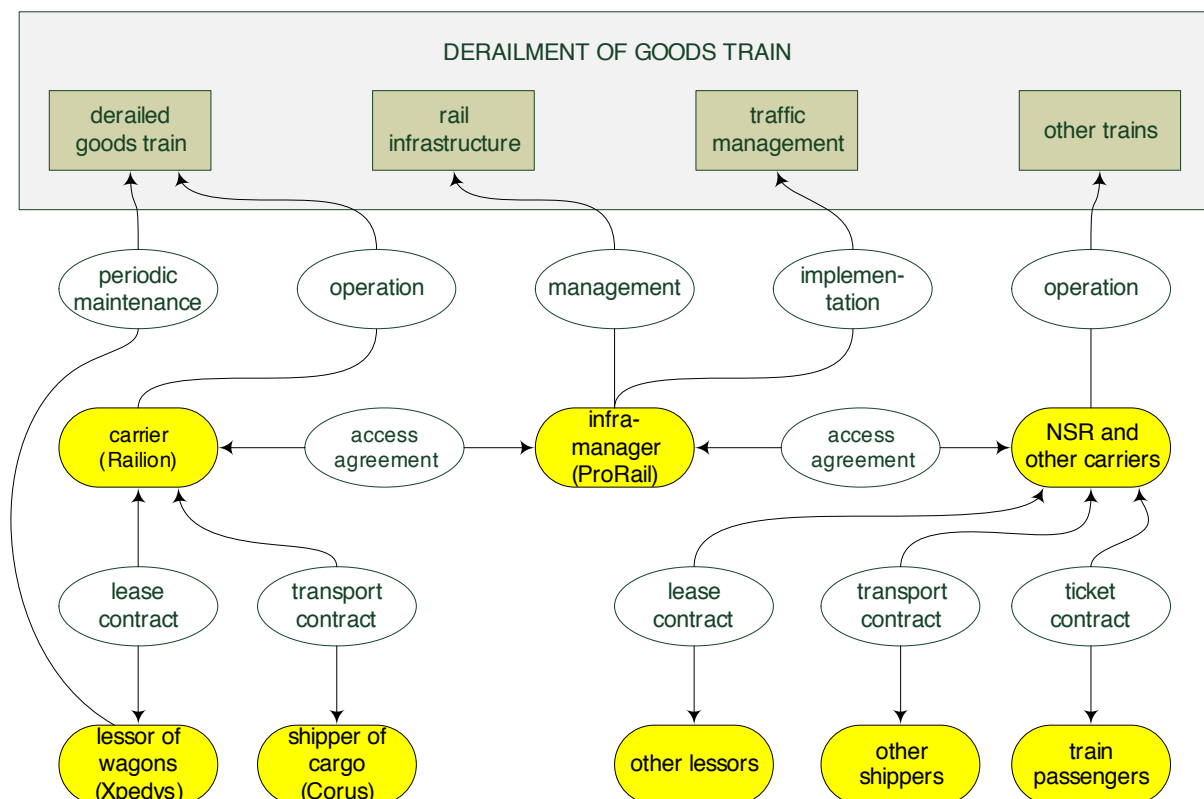


Figure 4: Diagram of the relevant companies/persons and their relationships.

#### 4.1.2 Government bodies

The carrier (Railion) let the derailed wagons from Xpedys, part of the NMBS Belgian rail company. For this reason both Dutch and Belgian government bodies are of importance.

The Netherlands:

- The Minister of Transport, Public Works and Water Management bears the system responsibility for the policy, legislation and regulations, assignment of responsibilities and supervision. The Minister also grants concessions and permits, and assesses the transport and control plans.
- The Inspectorate for Transport, Public Works and Water Management (IVW) issues the safety certificates, assesses the safety management systems and is entrusted with the supervision/enforcement of the safety regulations.

Belgium:

- The Ministry of Transport, FOMV grants the concessions and permits.
- The Rail Safety and Interoperability Agency, DVIS issues the safety certificates, assesses the safety management systems and is entrusted with the supervision/enforcement of the safety regulations.

#### 4.2 RESPONSIBILITIES

A distinction can be made between the various areas of responsibilities relating to the Muiderpoort derailment:

- the structural soundness (design/manufacture/assembly) of the wagon;
- the monitoring<sup>35</sup> of the technical condition of the wagon, whereby a distinction can be made between:
  - periodic maintenance (overhauls);
  - minor maintenance (interim lubrication, replacement of worn parts, etc.);
  - technical inspections (at the beginning of a train journey);
- the detection of any defects, where relevant, during a train journey and the implementation of the necessary adequate measures;
- the detection of a derailment and the implementation of the necessary adequate measures.

According to the legislation and regulations (explained in Section 3) the following responsibilities are linked to these areas of responsibility:

- The responsibility for the structural soundness (design/manufacture/assembly) of the wagon is borne by the keeper<sup>36</sup> (Xpedys).
- The responsibility for the periodic maintenance is also borne by the keeper (Xpedys).
- The responsibility for minor maintenance is borne by the carrier that uses the wagon in a train (Railion).
- The responsibility for the technical inspection (at the beginning of a train journey) is borne by the carrier that drives the train at the beginning of the journey (B-Cargo).
- The other two issues relate to the identification and anticipation of any defects that develop during the journey and defects. This aspect of risk control is, pursuant to their duty of care and the SMS regulations, the shared responsibility of the relevant carrier (Railion), the manager of the infrastructure (ProRail) and the other rail carriers (with NS Reizigers as the largest)<sup>37</sup>.

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35 The Railway Act does not refer to the soundness of the maintenance. However, the Railways Act does prescribe that the rolling stock must (continue to) comply with the prescribed technical regulations. This requires sound maintenance.

36 This report understands the 'keeper' as the company that operates the wagon (as the owner, or otherwise). This is in line with international regulations such as the COTIF).

37 The fact that the control of the derailment risk is the shared responsibility of all carriers and the infrastructure manager is explained in Section 5.5.1.

## 5 ANALYSIS

This section addresses the following issues:

- the technical cause of the Muiderpoort derailment and its relationship with earlier derailments of wagons from the relevant series (Section 5.1);
- the severity and extent of the relevant type of derailments (Section 5.2);
- the periodic maintenance of the relevant wagons and the applicable legislation and regulations (Section 5.3);
- the feasibilities available for the control of the derailment risk and their potential effect (Section 5.4);
- the responsibility for the control of the derailment risk and the fulfilment of that responsibility by the rail companies and the Ministry of Transport, Public Works and Water Management (Section 5.5).

### 5.1 CAUSE

*What was the technical cause of the Muiderpoort derailment and was this the same cause as that of earlier derailments with wagons from this series?*

#### 5.1.1 Technical cause

The investigation of the technical cause is described in Annex 3. The most important findings are summarised below.

*Cause of the derailment (see also Annex 3, under 1 and 2)*

The axle box of one of the wagons overheated and the axle journal broke off. The overheated axle box that had held the axle journal that broke off was recovered from the side of the track. The axle box lay close to the marks on the rail where the wheel had derailed. In view of the combination of these two facts it is probable that the overheating of the axle box and subsequent breakage of the axle journal was the direct cause of the derailment. The simulation calculations that the Safety Board requested following the derailment also reveal that a breakage of the axle journal could certainly be expected to result in a virtually immediate derailment in the given conditions. Moreover, the available information gives no reason to presume that other causes, such as an excessive speed, anomalies in the track or incorrect loading, made a contribution to the derailment.

*Cause of the overheated axle box (see also Annex 3, under 3)*

The Board requested a further technical examination of the overheated axle box to determine the cause of its overheating. This examination revealed the following:

- The axle box overheated because the outer bearing seized.
- As a result of the damage caused by the overheating it was no longer possible to establish the definitive cause of the seizure of the bearing.
- However, the technical examination did reveal that:
  - the bearings were of the prescribed make/type and were fitted correctly;
  - the fastening bolts had not become loose;
  - the bearings bore marks applied after the prescribed visual quality inspection at the time of the overhaul;
  - there were no indications of faulty lubrication;
  - there were no indications of overloading;
  - the bearing cage of the relevant bearing had failed at the beginning of the period in which the axle box overheated.

The derailment at Amsterdam-Muiderpoort was caused by the breakage of an axle journal on one of the wagons due to an overheating axle box. The overheating of the axle box was caused by the seizure of one of the bearings. The Board was unable to determine the definitive cause of the seizure of the bearing due to the damage to the bearing. However, it is clear that the overheating of the axle box began on the failure of the bearing cage. No indications were found for external factors (such as faulty lubrication, incorrect lubrication, or fastening bolts that had become loose).

#### 5.1.2 Relationship with the earlier derailment of the same type of wagon

The wagons that derailed at Amsterdam-Muiderpoort belong to a series of one hundred identical wagons that Railion lets from Xpedys since 2001. They are used for chalk transports from Belgium to the steelworks in Beverwijk, the Netherlands. Wagons from this series were involved in one earlier derailment during this period, as has been discussed in Section 2.3.1. This derailment occurred at Boxtel in 2005. This derailment was also caused by an overheated axle box on one of the wagons. The IVW investigated this derailment and came to the conclusion that the axle box had overheated because the bolts securing the bearings had become loose<sup>38</sup> (which was not an issue in the Muiderpoort derailment).

Wagons from the relevant series were involved in another derailment in the past nine years. This derailment had a different direct cause from the Muiderpoort derailment.

## 5.2 SEVERITY/MAGNITUDE OF THE PROBLEM

*What were the (potential) consequences of the Muiderpoort derailment, how often do derailments of this nature occur and what are the potential risks associated with these derailments?*

### 5.2.1 Magnitude of the damage caused by the Muiderpoort derailment

The Safety Board requested the parties to indicate the magnitude of the damage to the infrastructure and rolling stock caused by the Muiderpoort derailment. On the basis of this information the damage amounted to about 2.3 million euros and 0.5 million euros respectively.

In addition, the derailment also caused indirect damage due to the disruption of the rail traffic (the process damage); a rough calculation made by the Safety Board (see Annex 4) indicates that this damage amounted to about 2 million euros. Consequently, the total damage caused by the Muiderpoort derailment amounts to about 5 million euros.

The damage caused by the Muiderpoort derailment, including process damage, amounted to about five million euros. The derailment caused serious disruption to rail traffic in the Randstad conurbation which, in addition to financial damage, self-evidently caused the necessary hindrance.

### 5.2.2 Potential consequences

Some of the derailed wagons came to rest on adjacent tracks that were in use at the time. The two tracks immediately to the left and right of the track on which the goods train was travelling were in use by three passenger trains. Two trains (the ICE service from Amsterdam CS on its way to Germany and the Hoofddorp-Lelystad intercity service) passed the location of the accident about two minutes before the derailment. The third train (the lower train from Amsterdam CS to Weesp) was approaching the location of the accident at the time of the derailment. However, the driver saw his signal change to red and was able to stop the train in time.

<sup>38</sup> It transpired that other wagons also had this problem. At the time the keeper (Xpedys) gave all the wagons a new overhaul and amended the maintenance regime accordingly.

Consequently, in slightly different circumstances one or more passenger trains could have collided with the derailed wagons.

Derailements of this nature also result in indirect safety risks. These risks arise from the disruption of rail traffic caused by the derailment, since disruptions of the train services can result in the use of tracks other than the customary tracks and result in the larger-scale use of partial routes: both in turn result in an increased risk of SPADS and, consequently, of accidents. The Board raised this relationship in its earlier 'Through red in Amsterdam' report (published in 2005).

In slightly different circumstances passing passenger trains could have collided with the derailed goods wagons, with a real risk of casualties. Moreover, the extensive and lengthy disruption of rail traffic caused by the derailment increased the risk of accidents at other locations in the rail network.

### 5.2.3 Historical context

The IVW's accident database reveals that four serious derailments of goods trains caused by defective wheel sets have occurred in the past five years (2004-2008). The particulars of these derailments of importance to the Muiderpoort derailment are listed in the following table.

nr	place/date	direct cause	adjacent track in use	wagons outside CG <sup>39</sup>	carried on after derailment	damage to rail infra <sup>40</sup>	risk of follow-on accident
1	Amsterdam 06-06-2005	defective wheel tyre	yes	yes	?	€ 674,000	yes
2	Boxtel 08-12-2005	overheated axle box	yes	yes	1.600 m	€ 1,823,000	yes
3	Duiven 23-08-2007	wheel geometry	yes	no	450 m	€ 201,000	no
4	Muiderpoort 22-11-2008	overheated axle box	yes	yes	900 m	€ 2,300,000	yes

The Board notes the following:

- Four similar derailments also occurred in the previous five years (1999-2003). A statistical analysis of the data for the 1999-2008 reveals that the frequency of this type of derailment has not decreased significantly during the past ten years.
- Three of the four derailments that occurred in the past five years resulted in a real risk of a follow-on accident because:
  - all four derailments occurred on track with adjacent tracks and in three instances one or more derailed wagons came to rest at a considerable distance from the track;
  - in at least three instances the derailed train travelled a considerable distance after the actual derailment.

On average, derailments of the nature of the Muiderpoort derailment (of a goods train due to a wheel set defect and causing substantial damage) occur almost once a year. During the past years these derailments have resulted in only a small number of casualties with minor injuries. However, the majority of the derailments resulted in a real risk of a large-scale accident with casualties. The frequency of this type of derailment has not decreased significantly during the past ten years.

39 CG is the abbreviation for Clearance Gauge, the vertical and horizontal zone above and next to the rails within which train normally remain.

40 Damage amounts issued by ProRail.

### 5.3 PERIODIC MAINTENANCE

*To what extent do the findings from the investigation give cause to the modification of the periodic maintenance of the relevant series of wagons and/or the amendment of the relevant legislation and regulations?*

#### 5.3.1 Periodic maintenance of the relevant wagons

The fact that the axle box overheated due to a defective bearing raises the question whether the periodic maintenance of the relevant wagons was of the required quality. The Board notes the following:

- The wagons are equipped with a standard type of wheel set/axle box that has been used on many goods wagons for many years. The periodic maintenance of these wheel sets/axle boxes is comprised of an overhaul. The axle boxes are removed, the bearings are dismantled and the bearings are then subjected to a visual inspection to assess whether they can be returned for a further period or need to be replaced. The maintenance plan prescribes the frequency of the overhauls and the procedure that is to be used. The keeper of the wagon is responsible for the maintenance plan and its implementation.
- The Belgian Xpedys company is the keeper of the wagons. Xpedys has implemented a maintenance plan which stipulates that the axle boxes must undergo an overhaul in a NMBS workshop once every 10 years and after a maximum of 80,000 kilometres. The maintenance plan also specifies the procedure to be followed for the overhaul of the axle boxes and the makes/types of bearings that must be fitted in the axle boxes. NMBS is a formal 'rail company' and has been issued a safety certificate by the Belgian Inspectorate. The NMBS workshops comply with the Belgian regulations.
- The latest overhaul of the axle box concerned was carried out at the NMBS Gent-Brugge workshops in February 2006. Consequently, the prescribed overhaul period was not exceeded and the overhaul was not carried out at a workshop other than the prescribed workshops.
- The technical inspection of the overheated axle box also revealed that the prescribed make/type of bearings had been fitted and that they were assembled correctly. The fastening bolts had not become loose, the bearings bore marks indicative of the prescribed quality inspection and there were no indications of faulty lubrication.

Consequently, the inspection of the defective axle box did not reveal any indications of errors/shortcomings in the periodic maintenance. Nevertheless, the Board is of the opinion that a critical evaluation of the periodic maintenance of these wagons' axle boxes/wheel sets is necessary. There are two reasons for this evaluation. Firstly, the Muiderpoort derailment was caused by the seizure of an axle box bearing less than three years into the prescribed overhaul interval of ten years. Secondly, the Board's request for an inspection of twenty other bearings from the axle boxes of the derailed revealed that one of these twenty bearings exhibited chipping: the bearings experts who were consulted for this inspection indicated that this defect would probably have resulted in the failure of the bearing within the prescribed overhaul period<sup>41</sup>. These two reasons' give cause to the Board's opinion that the periodic maintenance needs to be subjected to an evaluation that should, in the Board's view, focus on a critical examination of the duration of the overhaul interval and the reuse of bearings on the basis of a visual inspection. This evaluation should also extend to the other bearings used in this series of wagons.

Within this context the Board also notes the following. The Board's inspection of the twenty other bearings of the derailed wagons revealed that a number of bearings exhibited current-flow damage<sup>42</sup>. In the longer term damage of this nature can result in chipping of the raceway and, ultimately, the seizure of the bearing. For this reason the Board is of the opinion that a further investigation of the cause of this damage is required.

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41 See explanation in Annex 3 (under 4).

42 Ditto.

This investigation should also extend to the conditions in which the wagons are used, including those aspects/components of the locomotive and rail infrastructure of relevance to the return current. The Board is of the opinion that the performance of this investigation is the duty of the companies that bear the primary responsibility for the periodic maintenance of the wagons (Xpedys), the use of the wagons including the locomotives (Railion) and the relevant rail infrastructure (ProRail). For this reason the Board issued the findings from the technical inspection to the relevant companies immediately after they became available in April 2009.

The findings from the Safety Board's technical inspection give cause to a critical evaluation of the periodic maintenance of the axle boxes of the relevant series of wagons. The current-flow damage to the bearings from other axle boxes of the wagons observed during this inspection also gives cause to an investigation of the conditions in which the wagons are used. The Board is of the opinion that the responsibility for these investigations is borne by Xpedys (periodic maintenance) and Railion/ProRail (current-flow damage).

### 5.3.2 *European regulations governing the periodic maintenance of wagons*

The Board also reviewed, in a more general sense, whether there are sufficient assurances for the quality and implementation of the maintenance plans, since the international use of goods wagons implies that appropriate quality assurance throughout Europe are required to ensure the safety of Dutch rail traffic. Within this context the Board notes the following:

- Pursuant to EU Directive 2008/110/EC the Member States are obliged to implement national legislation by the end of 2010 which stipulates the obligation that the national safety authority explicitly determines and makes records of the entity in charge of maintenance. The Directive also imposes requirements on the quality of the entities and the maintenance plans.
- The European Commission recently published a Memorandum of Understanding on the international requirements to be adopted for the certification of the relevant entities and the maintenance plans. Ten Member States (including the Netherlands and Belgium) have since signed this Memorandum. The Memorandum formulates specific requirements for the maintenance and the entities in charge of that maintenance<sup>43</sup>.

The Board has established that improvements are being made to international regulations governing the periodic maintenance of goods wagons.

## 5.4 AVAILABLE OPPORTUNITIES FOR RISK REDUCTION

*Which supplementary means are available for the control of the risk of goods train derailments due to wheel set defects and to what extent could these means prevent derailments of the nature of the Muiderpoort derailment or limit the consequences?*

### 5.4.1 *General*

The Board is of the opinion that the potentially very serious consequences of derailments give cause to the need to make use of the available opportunities for the restriction of the number of derailments and the reduction of the escalation risk accompanying those derailments that nevertheless occur.

The first opportunity available for the prevention of derailments caused by wheel set defects is the periodic maintenance discussed in the previous Section. Nevertheless, adequate maintenance cannot totally preclude the development of wheel set defects: in addition to errors/shortcomings in maintenance work, the wagons can be subjected to unforeseen loads that result in the development of wheel set defects within the maintenance interval.

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43 The Memorandum of Understanding is enclosed in Annex 5.



Some of the defects are identified during the visual inspections carried out within the scope of the prescribed technical inspections. However, these visual inspections cannot identify all types of defects and for this reason the available technical means also need to be used to ensure that the remaining *defects* are detected in good time.

Nevertheless, some defects (such as fatigue cracking) cannot be detected in time. Moreover, derailments can also have causes other than wheel set defects, for example rail defects or driving too fast through a curve or over points. For this reason it is also necessary to detect *derailments* in time so that measures can then be implemented to reduce the escalation risk (for example by stopping the derailed train or other trains as quickly as possible).

Consequently, supplementary to periodic maintenance and pre-departure inspections two types of technical safety net are available to control the risk that a wheel set defect results in a train derailment, namely *defect* detection and *derailment* detection.

This is shown in the diagram in Figure 5.

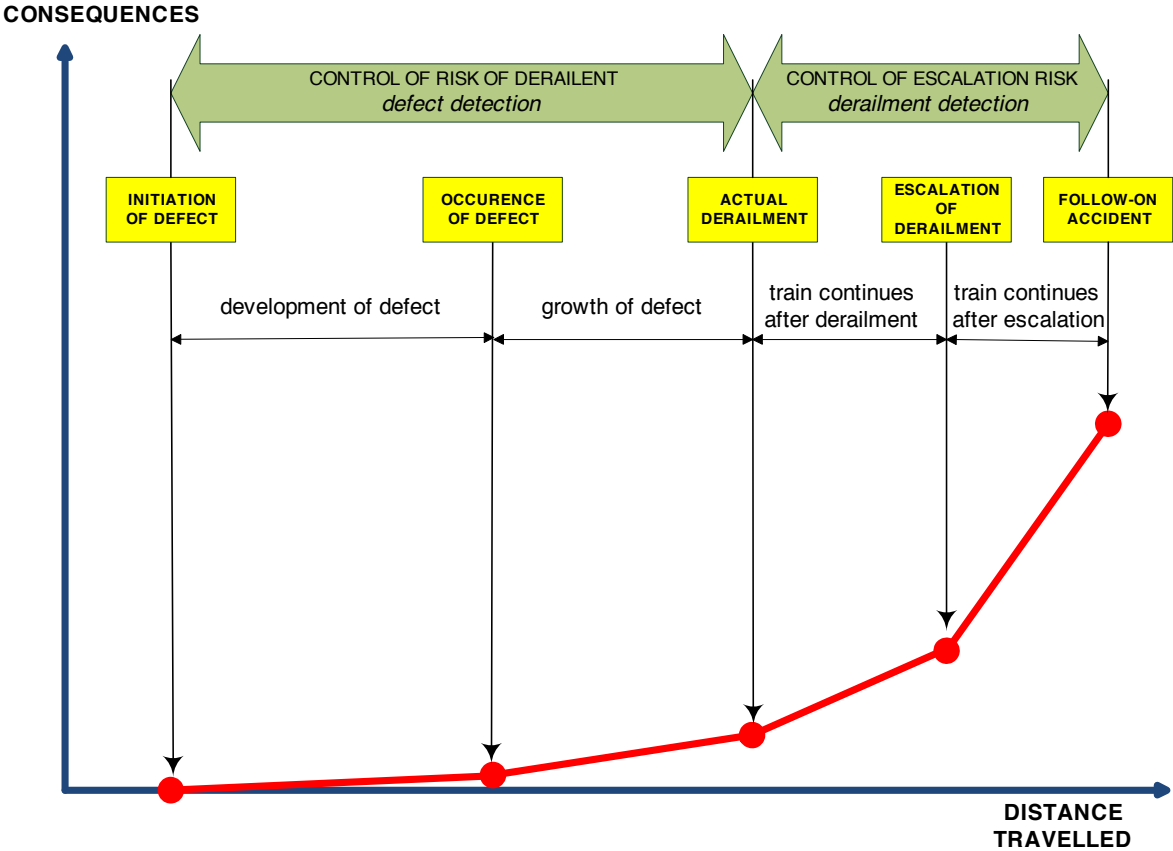


Figure 5: Diagram of the phases that can be distinguished in derailments caused by rolling stock defects and the means available to control the risks.

The following sections review the systems available for defect detection and derailment detection and the risk reduction that they may be expected to achieve.

#### 5.4.2 Defect detection

##### a) *Dynamic maintenance management*

Certain wheel anomalies (such as wheel flats and bent axles, etc.) can impose additional mechanical loads on the wheel set or other components (such as the axle boxes). The timely identification and rectification of anomalies of this nature can prevent the development of more serious/more expensive defects. This can be achieved using a method known as dynamic maintenance management. The Netherlands' NS Reizigers company uses this method to manage the maintenance of the wheel sets on its trains, whereby NS Reizigers identifies wheel set anomalies using what are referred to as QuoVadis measurement points. These are installed at strategic locations on the track and are primarily intended for the determination track access charge (a further explanation is given in 5.4.2-c). The measurements made by these points include the vertical forces imposed on the rails by the wheels of passing trains. A software application (Gotcha) used for dynamic maintenance management analyses the measurements from the QuoVadis-stations to determine the magnitude of anomalies indicative of wheel flats, bent axles, etc.

NS Reizigers uses these analyses to assess whether maintenance of or repairs to the wheel sets is necessary and, if so, the urgency. According to NS Reizigers this application/method, which was introduced in around 2000, has made a major contribution to the reduction of the number of overheating axle boxes on NS Reizigers' trains (from about 30 instances a year to about 3 instances a year).

The designs of passenger train wheel sets and axle boxes exhibit no material differences from those of goods wagons. For this reason the Board is of the opinion that dynamic maintenance management of the form reviewed about can be expected to make a major contribution to the control of the risk of axle boxes overheating on goods trains (and the derailments that they can cause). However, neither Railion nor the other goods carriers use Gotcha or an equivalent system to identify wheel set anomalies in good time (see 5.5.2).

NS Reizigers uses dynamic maintenance management (using the Gotcha system) for the management of the maintenance of the wheel sets of the company's passenger trains. The use of a similar system with goods trains can substantially reduce the risk of overheating axle boxes (as was the case at Muiderpoort).

##### b) *HotBox detection*

HotBox detection is based on the use of sensors installed 'in the track'<sup>44</sup> to detect hot axle boxes on passing trains. When a hot axle box is detected the driver of the train concerned is warned via the traffic controller.

HotBox detection is currently active in the Netherlands on just two 'new' lines, the Betuweroute and HSL-Zuid lines<sup>45</sup>. The system was also installed at six other locations in the main rail network at the beginning of the nineteen-nineties. However, ProRail decommissioned these installations in 2002. ProRail gave the following reasons: extremely vulnerable to malfunctions, many false alarms and the unavailability of further spare parts. However, many other countries (including Belgium, Germany, the UK, France, Italy and Sweden) have installed a HotBox detection system on their main rail networks.

The effectiveness of HotBox detection is illustrated by the two recent incidents on the Betuweroute line and the track to this line that were reviewed in Section 2.3.2.

44 Self-evidently, overheating axle boxes can also be detected by sensors installed in the train. This system (vehicle-mounted HotBox detection) is used with high-speed trains. However, this is not a realistic option for goods trains since the wagons are not equipped with an electrical system that can supply power to the sensors.

45 One HotBox detection point is also installed on the section of track between the Betuweroute line and the Port of Rotterdam area (at Dordrecht).

In these two incidents HotBox detection systems installed at the locations detected an overheated axle box on one of the wagons in a goods train. The traffic controller warned the driver in time.

HotBox detection systems are installed on the rail networks of a number of European countries. The Netherlands also began to use this system, although in a pilot trial that was ended in around 2002. HotBox detection is now used solely on the HSL-Zuid and Betuweroute lines. HotBox-detection systems installed throughout the rail network can prevent derailments such as the Muiderpoort derailment.

c) *QuoVadis system*

Measurements points have been installed at various locations in the main rail network to determine which trains pass, the number of axles and the magnitude of the axle loads (the weight per axle). These measurements are primarily intended<sup>46</sup> for the determination of the fee the infrastructure manager (ProRail) charges the carriers for the use of the track. This system, QuoVadis, is managed by ProRail. About forty measurement points have been installed to date. A number of these measurement points are also equipped with the Gotcha application discussed in Section 5.4.2-a.

In their current form the QuoVadis system and the Gotcha application are used solely for the determination of the track access charge and the management of the maintenance of the NS Reizigers passenger trains' wheel sets. However, the information obtained from the systems can also be used for other purposes:

- A further analysis of the axle loads measured by QuoVadis measurement points can provide an indication of defects such as an overheating bearing on the incorrect application of a brake, since defects of this nature result in an anomalous distribution of the relevant bogie's wheel loads. This phenomenon was observed in the Muiderpoort derailment: a further analysis of the data from the last of the five QuoVadis measurement points that the goods train had passed in the period before it derailed revealed an evident anomalous distribution of the relevant bogie's wheel loads (see the explanation in Annex 3, under 5). This data was obtained from the measurement point near Tricht, when the goods train was still about 60 kilometres from the location of the derailment. The same is applicable to the Vleuten derailment reviewed in Section 2.3.3, when a subsequent analysis of the data from a QuoVadis measurement point the train had passed before the derailment also revealed that an evident anomalous distribution of the axle loads of the relevant bogie had developed by that stage. Both examples demonstrate that the current QuoVadis system can form the basis of a real-time<sup>47</sup> detection system (that can warn the train driver of specific serious defects in good time).
- One of the QuoVadis measurement points, at Geldrop, has been used as a real-time detection system since 2005. The functionality of this measurement point was expanded to comply with the safety level prescribed in the permit for the use of the nearby rail tunnel (at Best). This requirement had originally been met by the use of HotBox detection equipment on this section of the track. When this system was decommissioned, as explained earlier, the functionality of the relevant QuoVadis measurement point (at Geldrop) was expanded so that on detecting specific anomalies the measurement point automatically transmits an alarm to the traffic management centre<sup>48</sup>.
- Other sensors that have now been developed can detect anomalous axle box vibration/noise or temperatures of passing trains and determine whether an axle box could be overheating or beginning to overheat. Sensors of this nature can also be installed at QuoVadis measurement points.

46 ProRail also uses the QuoVadis system to determine the mechanical load imposed on the rail infrastructure by train movements. This information is required to plan the maintenance work in the infrastructure.

47 Within this context 'real-time' means that on detecting an anomaly the system immediately transmits an alarm to the traffic management centre. The centre can then warn the train driver.

48 The goods train that derailed at Muiderpoort also passed this QuoVadis measurement point. However, at that point there was no material anomaly in the wheel loads of the relevant bogie.

QuoVadis measurement points installed throughout the rail network could prevent derailments of the nature of the Muiderpoort derailment.

#### 5.4.3 Derailment detection

Derailment detection relates to the detection of a derailment with the objective of preventing the escalation of the derailment to avoid extra damage and/or a follow-on accident. In principle, there are two forms of derailment detection: infrastructure-mounted and vehicle-mounted equipment.

Infrastructure-mounted derailment detection relates to equipment installed on the track that can detect one or more wheel sets of a passing train that are running next to the rail rather than on the rail. Since this involves the installation of advanced equipment in the infrastructure this form of detection is in fact suitable solely for specific locations such as tunnels, bridges, etc.

Vehicle-mounted derailment detection relates to sensors on the train that can detect one or more wheel sets rolling next to rather than on the rails, for example by detecting the resultant juddering. These systems are referred to with the abbreviation DDD (Derailment Detection Device). Within this context it should be noted that goods wagons are not equipped with electrical systems to supply power to this form of equipment. However, pneumatic systems are now also available that could be installed on goods wagons. Derailment detection systems are of even more importance on goods trains than on passenger trains since the driver of a goods train is, for a number of reasons, much less likely to notice a derailment than the driver of a passenger train: firstly, the juddering caused by one or more wheel sets that are no longer rolling on the rails is much less pronounced in the driver's cabin of a heavy goods train as compared to a lighter passenger train and, secondly, goods trains do not have passengers throughout the train who can feel the juddering and respond by pulling the emergency brake or warning the train driver.

Only limited use of vehicle-mounted derailment detection has been made to date. A number of serious derailments that occurred in Switzerland resulted in the development of a system suitable for goods wagons at the end of the nineteen-nineties. In the years since 2003 this system has, pursuant to a covenant between the Swiss government and the chemical industry, been installed on more than six hundred wagons used to transport dangerous goods in Switzerland, primarily on goods wagons used for national transports. A small number of goods carriers in other countries also make limited use of the system on a voluntary basis<sup>49</sup>.

At least one derailment is known in which vehicle-mounted derailment detection prevented the derailment from escalating into a major follow-on accident, namely the derailment of a goods train carrying dangerous goods at Switzerland's Corneaux station in March 2006.

If the wagons that derailed at Muiderpoort had been equipped with derailment detection then the escalation of the derailment could probably have been reduced or possibly even prevented.

#### 5.4.4 Potential risk reduction

The following table shows the extent to which, in the Board's opinion, the defect and derailment detection systems discussed above could have been effective in the six serious derailments of goods trains caused by wheel set defects that have occurred since the beginning of 2005.

<sup>49</sup> A total of several goods wagons used to transport dangerous goods in Morocco and Slovenia (source: Knorr Bremse Group).

**Table 2: Effectiveness of detection systems in six serious derailments in the period between 2005-2009**

Derailment	derailment could have been prevented with defect detection			escalation risk could have been reduced with vehicle-mounted derailment detection
	dynamic maintenance management	HotBox detection	QuoVadis with real-time warning	
Amsterdam 06-06-2005	yes	no	yes	?
Boxtel 08-12-2005	nee	yes	yes	yes
Duiven 23-08-2007	?	no	?	no
Muiderpoort 22-11-2008	no	yes	yes	yes
Vleuten 23-03-2009	no	yes	yes	yes
Venlo 14-06-2009	?	yes	yes	?

This assessment is based on the following assumptions of the risk reduction achieved by the systems:

- Dynamic maintenance management (based on the Gotcha or a similar system) can ensure that wheel flats, loose wheel tyres or bent axles can be rectified in time. However, these systems cannot ensure that axle boxes overheating due to an internal cause (such as loose bolts or broken bearing cages) can be detected and rectified in time.
- HotBox detection systems installed throughout the rail network can detect overheating wheels and/or axle boxes before a derailment occurs.
- QuoVadis measurement points installed throughout the rail network and equipped with a real-time warning system for anomalous measurement values can detect anomalous distributions of wheel loads (due to, for example, overheating axle boxes or brake friction) or loose wheel tyres before a derailment occurs.
- The risk of a derailment escalating to a follow-on accident could have been (substantially) reduced by the use of vehicle-mounted derailment detection in situations in which the train covered a distance after the actual derailment that was (considerably) longer than the distance required to stop the train.

At least five of the six serious derailments of good trains caused by defective wheel sets that have occurred since the beginning of 2005 could have been prevented by the technical safety nets discussed above and the consequences of three could have been substantially reduced.

#### 5.4.5 Obligation to use derailment detection with dangerous goods transports

The RIDCE (the RID's Committee of Experts<sup>50</sup>) discussed the feasibility of derailment detection at the end of 2007. These discussions resulted in the RIDCE's submission of a proposal stipulating the obligation to use vehicle-mounted derailment detection (DDD) when transporting specific types of dangerous goods with specific types of wagons as from 2011. The decision-making on the incorporation of the obligation in the RID has been deferred until the revision round in 2013. It is generally expected that any obligation will be applicable solely to new wagons.

Pursuant to this development the ERA<sup>51</sup> carried out a study of the potential benefits and consequences of this type of derailment detection.

50 The RID (Regulation Concerning the International Transport of Dangerous Goods by Rail) is an international convention governing rail transports of dangerous goods. The relevant RIDCE meeting took place in Zagreb.

51 ERA is the abbreviation of the European Railway Agency.

This study was concluded in mid-2009. The ERA's report of this study<sup>52</sup> concluded that it expects that the safety gains achieved at a European level by this measure will not justify the investments. The ERA also notes that the cost/benefit ratio could become favourable if this form of derailment detection is introduced for all goods wagons rather than solely wagons carrying dangerous goods. The ERA also recommends a further exploratory study of the feasibility of preventing derailments by means of defect detection.

It is possible that the RID will impose an obligation to make use of vehicle-mounted derailment detection on new wagons used for dangerous goods transports from 2013. The ERA recently published a report in which it concludes that it expects that the safety gains achieved by this measure will not justify the investments. The ERA recommends a supplementary study of the cost/benefits achieved by the general use of vehicle-mounted derailment detection and the feasibility of reducing derailments with defect detection.

## 5.5 ASSIGNMENT AND FULFILMENT OF RESPONSIBILITIES

*How have the parties involved made arrangements for the responsibility of controlling the derailment risk and how do they fulfil this responsibility?*

### 5.5.1 Assignment of responsibilities

The Railways Act requires rail companies to maintain demonstrably adequate control of rail safety risks. This duty of care is given shape by imposing the obligation to implement a safety management system that meets certain requirements and assures that the safety risks are adequately controlled (ALARP)<sup>53</sup>. The responsibilities of the carriers and the infrastructure manager are governed by the following:

- Pursuant to the Railways Act, the scope of the safety management system of the carriers encompasses 'the risks associated with the operations'. The carriers must also take account of the 'services third parties supply to the rail company' in their assessment of the risks. Consequently, goods carriers (such as Railion) also need to give consideration to risks such as the risk of a goods train derailment due to a technical defect of a wagon of which the carrier is not the owner/keeper. In addition, and in a more general sense, the control of the goods train derailment risk is also a responsibility of passenger carriers (such as NS Reizigers) since this risk is also associated with their operations.
- The management concession stipulates that the infrastructure manager must ensure that the risks associated with both the management and the use of the main rail network infrastructure are analysed and that suitable measures are implemented for the adequate control of the risks. These can also be risks that arise from defective wheel sets. The infrastructure manager is also obliged to take account of the specific requirements from the expected operations and the state of the art. The infrastructure manager's quality assurance system must also include procedures that ensure that the necessary preventive measures are implemented to prevent accidents. These can, self-evidently, also extend to derailments caused by defective rolling stock. The infrastructure manager's analysis of the risks must take account of the possibility of overheating axle boxes: the risk of accidents and their severity must be considered when assessing the potential control measures.

Pursuant to the above the carriers and ProRail need to assess, both individually and jointly, the extent to which they should make use of the available means to achieve adequate control of the derailment risk. They must cooperate as necessary.

Pursuant to the Railways Act both the carriers and the infrastructure manager are responsible for the control of the derailment risk. The companies must cooperate as necessary.

52 Impact Assessment on the use of Derailment Detection Devices in the EU Railway Systems, ERA (Lille 2009).

53 See Section 3.1.1.

### 5.5.2 Fulfilment of responsibilities

The Safety Board has investigated why the 'technical safety nets' discussed in Section 5.4 are not used or used to only a limited extent.

#### a) Opinion of the duties

The two companies directly involved put forward the following arguments - in essence - for the fact that the various systems are used on a limited scale or solely for passenger rolling stock but not for goods wagons:

- Railion pointed out that the company is the 'user' but not the 'keeper' of the wagons and, consequently, is of the opinion that - in contrast to the situation with NS Reizigers' passenger trains - it is not responsible for the periodic maintenance of the wheel sets. Railion also drew attention to the fact that the company, together with other goods carriers, has requested ProRail to supply the QuoVadis records but that ProRail has not yet responded to this request.
- ProRail stated that the installation of HotBox detection on the HSL-Zuid and Betuweroute lines arose from the obligation to use HotBox detection with high-speed trains<sup>54</sup> (HSL-Zuid line) and the risk analyses carried out specifically for the Betuweroute line<sup>55</sup>. The reason why one of the some forty QuoVadis measurements was upgraded to a real-time warning system was that this was necessary to comply with the permit for the use of the nearby rail tunnel (at Best)<sup>56</sup>.

In addition, interviews with officers of the two companies directly involved (Railion and ProRail) revealed that although the companies appreciate the potential safety net function of the systems they do not feel called or obliged to take the initiative for their introduction. Railion is of the opinion that ProRail bears the responsibility for any introduction of HotBox detection or expansion and upgrading of the QuoVadis system since both relate to 'track equipment'. ProRail, conversely, is of the opinion that the goods carriers bear the primary responsibility for the control of the risk of good train derailments caused by defective wagons. According to Railion, due to competition considerations goods carriers can only reasonably be expected to introduce vehicle-mounted derailment detection on the basis of a European statutory obligation. Railion and ProRail also pointed out that there is no statutory obligation to use any of these systems. NS Reizigers stated that although it endorses the importance of technical safety nets, the company is of the opinion that this falls outside of its direct sphere of influence.

Railion, ProRail and NS Reizigers appreciate the safety net function of defect and derailment detection but did not feel called, obliged or in a position to take the initiative for their introduction.

#### b) QuoVadis upgrade

At the end of 2007 ProRail, on the request of the Ministry of Transport, Public Works and Water Management, began a study of the most effective approach to the control of goods train derailments caused by overheating problems. This study, which was completed at the end of 2009, also examined the feasibility of an upgrade and expansion of the QuoVadis system into a real-time detection and warning system for specific types of rolling stock defects<sup>57</sup>. ProRail is of the opinion that further consultations on the division of responsibilities for this issue are required and expects the Ministry of Transport, Public Works and Water Management to play a 'pioneering role' in these consultations. In mid-2009 the Ministry of Transport, Public Works and Water Management informed ProRail<sup>58</sup> that it was opinion that the proposed discussions on the responsibility issue were unnecessary since, in the Ministry's view, the installation of defect detection systems in the infrastructure falls within the scope of the infrastructure manager's duty of care. The Ministry also stated that it expected ProRail

54 Vehicle-mounted HotBox detection is prescribed for high-speed trains (in the Interoperability Technical Specifications): since the Thalys trains (that date from before the relevant Interoperability Technical Specifications) are not equipped with HotBox detection this functionality has been installed on the track.

55 An Integral Safety Plan drawn up for the construction of the Betuweroute line includes an analysis of the safety risks and assessment of the available control measures. It was decided, in part of the specific risks, to install HotBox detection on the track.

56 The requirements laid down in the permit for use were no longer met when the aforementioned HotBox detection was decommissioned on the relevant section of track. For this reason the absence of HotBox detection was compensated by expanding the functionality of the QuoVadis measurement point.

57 *Hotbox-detectie, meetmethodieken en middelen* ('HotBox detection, methods and equipment') report, June 2009, Lloyd's Register Rail Europe BV

58 Letter VenW/DGMO-2009-7386.

to make haste with the intended upgrading/expansion of the QuoVadis system. In response, ProRail prepared a development and implementation plan which, in essence, lays down that the QuoVadis system will be modernised and that HotBox detection and signalling functionality will be integrated: the plan provides for phased introduction with completion in mid-2013.

Between 2007 and 2009 ProRail, on the request of the Ministry of Transport, Public Works and Water Management, carried out a study of the feasibility of the control of the risk of goods train derailments caused by overheating problems. The study reviewed the feasibility of an upgrade and expansion of the QuoVadis system into a real-time detection and warning system for wheel set defects. ProRail is of the opinion that consultations on the division of responsibilities need to be held between ProRail and the carriers, and that these consultations should be chaired by the Ministry of Transport, Public Works and Water Management. The Ministry has indicated that it is of the opinion that these discussions are unnecessary and that it expects ProRail to upgrade/expand the QuoVadis system as quickly as possible. ProRail has prepared a development and implementation plan that provides for phased introduction and completion in 2013.

c) *Cooperation/direction*

Paragraph a) stated that the carriers and ProRail are required to make a joint assessment of the utilisation of the means available to limit the derailment risk and that they, as necessary, they must cooperate in this assessment. The Railways Act does not include any regulations governing the initiation and coordination of this cooperation.

The Railways Act is currently being evaluated. The evaluation committee has summarised its findings in its *Spoor in beweging* ('Rail in Movement') report. Although this report has not yet been published, the formal response of the Netherlands' Council of Ministers is available<sup>59</sup>. In essence, the Council of Ministers states the following about this issue:

- The Council of Ministers makes a distinction between the system responsibility borne by the Minister of Transport, Public Works and Water Management and the responsibility borne by the parties directly involved in rail traffic. The Council of Ministers points out that pursuant to the selected arrangements and legislation the responsibility for the everyday implementation of rail safety has been assigned to the rail parties. According to the Council of Ministers this is also in line with the Railway Safety Directive. The Council of Ministers sees no reason to specify a further system responsibility or to assign this to one organisation.
- The Council of Ministers answers the question as to how the cooperation should be organised as follows: 'Cooperation is required in issues at the interface between the infrastructure and rail traffic. This is given shape with specific agreements and instruments such as the Integral Safety Plan. This cooperation is essential to rail safety. The railways have (traditionally) always been approached as a system in which all processes must interact to achieve a safe entirety. The responsibility for cooperation is laid down in the Railways Safety Directive and in the safety assurance systems of the infrastructure manager and the rail companies'. Consequently, the Council of Ministers assumes that the obligation to cooperate has been laid down for those issues at the interface between the infrastructure and rail traffic.
- The Council of Ministers also makes a distinction between cooperation in construction projects and the everyday operation of the rail network. Large amounts of public funds are often involved in construction projects, and regulations govern the direction and implementation of these projects. Explicit agreements must be reached for the everyday operations relation to the direction role and cooperation in issues relating to both the infrastructure and rail traffic.
- The Council of Ministers cites the Rail Company Safety Consultations, OVS as an example of cooperation between the parties on safety issues. The OVS is a platform in which the infrastructure managers, carriers, IVW and the Ministry of Transport, Public Works and Water Management's policy department are active participants and harmonise their plans, hold consultations, exchange information and assess plans for rail safety regulations.
- The Council of Minister's response to the evaluation does not answer the question as to whether the cooperative arrangements function correctly.

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59 House of Representatives, 2008–2009, 31 987, no. 1, part 6.3.



The derailment risk can be controlled adequately only when the carriers and the infrastructure manager adopt a joint approach. The Railways Act contains no explicit regulations governing the responsibility for the initiation and coordination of the cooperation. According to the government this duty is assigned to the Rail Company Safety Consultations, OVS.

### 5.5.3 Safety management

The Board has investigated how Railion, ProRail and NS Reizigers have incorporated the safety risk at issue in the Muiderpoort derailment (the derailment of a goods train caused by a rolling stock defect) in their safety management (systems).

Pursuant to the Railways Act both the carriers and the infrastructure manager are under the obligation to implement (a) safety management (system) that complies with the applicable requirements and can be used to assure that suitable measures are implemented to maintain the adequate control of safety risks.

#### a) Railion's SMS

Railion does not have a discrete safety management system. The quality management system also serves as the safety management system: it is supplemented with procedures for safety assurance, the performance of safety investigations and dealing with exceptional incidents. Railion has not carried out a specific risk inventory and evaluation (RI&E) for the SMS: this is covered by the RI&E carried out for work safety (within the context of the Working Conditions Act). This latter RI&E divides the employees' work process into what are referred to as task units. The associated risks and the measures that have been or are yet to be implemented are specified for each task unit.

Although 'goods train derailment' is recognised as a risk (or, in Railion's terminology, a failure mode) in the RI&E. However, 'the risk of 'derailment due to a rolling stock defect' is recognised solely as an element of 'travelling through a tunnel' or 'transporting dangerous goods'. Moreover, the relevant control methods are restricted to 'supervision of competence'.

No analysis has been made of a goods train derailment due to a rolling stock defect and, consequently, derailments of the nature of the Muiderpoort derailment fall outside the RI&E's scope. In addition, Railion's RI&E, as indicated above carried out within the context of the Working Conditions Act, relates solely to employee risks and not to safety risks for others (such as other rail users and passengers in other trains). Moreover, it is striking to note that the control measures Railion lays down for derailment risks that are recognised in the RI&E are limited to 'supervision of competence': measures such as defect detection or derailment detection are not included in the assessment. In addition, the prescribed targets and plans for the reduction of the derailment risk are lacking.

#### b) ProRail's SMS

ProRail has summarised the company's safety management system in the Safety Management System Manual. This Manual is integrated in ProRail's operational management system and contains many references to this system with respect to generally-applicable principles and points of departure (targets, conditions and performance indicators) and further details. The Manual describes ProRail's safety measures and the company's supervision of the effectiveness. The risk inventory and evaluation (RI&E) carried out specifically for the SMS makes use of a risk-assessment matrix. The individual incidents included in the matrix are scored in terms of the consequences for people, ProRail's core performance and infrastructure costs and the consequences for the environment, hinder to the surroundings and reputational damage (amongst the public, stakeholders and customers). The next step is an assessment of the probability that the scored incidents occur.

The probability is expressed on a five-point scale from improbable to extremely probable. The combination of the estimated consequences and the probability result in a classification of the risk, namely low, medium or high. The risk analysis is updated at least once every two years on the basis of incidents or changes in procedures and instructions. 'Derailment of a goods train' is listed amongst the risks, together with a number of potential causes including an axle or wheel developing a defect. When so requested ProRail stated that both the scoring of the risk matrix and the (ALARP) assessment

of the control measures have yet to take place<sup>60</sup>. However, experienced staff have made an estimate of the derailment risks. The company has indicated that the carrier is the 'problem owner' of derailment risks caused by rolling stock defects and that 'inspection' and 'rolling stock maintenance' are the appropriate control measures. ProRail's argument for this standpoint is that the relevant legislation and regulations stipulate that carriers may use solely rolling stock that has been issued certification and is maintained in condition.

In summary: ProRail has drawn up a broad RI&E that includes the risk of train derailments due to wheel set defects and provides for the necessary control measures. ProRail has also formulated targets for the reduction of this risk. However, the Board notes that Railion has included control measures implemented by third parties that are outside the company's control and that defect detection and derailment detection are not given consideration. In addition, the planned further assessment of the risks and the ALARP assessment of potential control measures have yet to take place.

#### c) *NS Reizigers' SMS*

NS Reizigers has summarised the company's SMS in a discrete document (with the title 'Safety Management System'). This document, which has 21 sections, describes the arrangements for the formulation and updating of the company's safety policy and the measures that have been implemented to control the identified safety risks. NS Reizigers' SMS states that an inventory is made of all safety-critical activities and that these measures are assessed to determine which measures need to be implemented to control the associated safety risks in accordance with the ALARP principle and/or to comply with the safety targets.

NS Reizigers' SMS addresses, alongside the support processes (design/modification and management of the material, design/modification of the train services, training/examinations and the procurement of products/services), fourteen separate production processes such as the preparation of trains for departure, the departure process, driving trains and shunting trains. The SMS also addresses the organisation and settlement of incidents/disasters, the organisation/provision of company emergency services and the investigation of accidents/incidents. The SMS specifies the design of the process for each issue and the various associated duties and responsibilities.

However, the prescribed inventory and analysis of the safety risks associated with the various processes is very brief, as is the assessment of the control measures.

The Board is of the opinion that NS Reizigers' SMS has not worked out the risk of a train derailment caused by a technical defect in sufficient detail. The same is also applicable to the risk that an NS Reizigers' train collides with debris from a derailed goods train. Consequently, NS Reizigers' SMS contains only a brief review of the safety problems associated with derailments such as the Muiderpoort derailment that are accompanied, as indicated earlier, by a tangible risk of follow-on accidents involving passenger trains: the SMS does not take technical measures to control the risks (such as defect and derailment detection) into account.

The safety management (systems) of Railion, ProRail and NS Reizigers do not contain sufficient detailing of the risk of goods train derailments caused by rolling stock defects.

#### 5.5.4 *Targets*

Adequate risk control can be achieved solely when specific targets have been set for the reduction of risks. The following reviews the extent to which Railion, ProRail, NS Reizigers and the Ministry of Transport, Public Works and Water Management have formulated specific targets for the reduction of the derailment risk.

- Railion and NS Reizigers have not formulated any such targets.
- However, ProRail has formulated targets for the reduction of derailment risks in general in 2009, as well as specific targets for the reduction of derailments caused by infrastructure derailments<sup>61</sup>,

60 ProRail has indicated, within the context of the comments round of the draft report, that the further assessment of the risks was carried out in 2009, and that the company intends to carry out the ALARP assessment in 2010.

61 ProRail has formulated a target for derailments caused by infrastructure defects which stipulates that the frequency shall be reduced to 'less than once every five years'.

but has not formulated any specific targets for the reduction of derailments caused by rolling stock defects.

- The Ministry of Transport, Public Works and Water Management has formulated tangible targets for the reduction of a number of specific risks, such as the reduction of collisions on level crossings and SPADS (signals passed at danger). However, the Ministry of Transport, Public Works and Water Management has not formulated any tangible targets for the reduction of derailments.

Neither the Ministry of Transport, Public Works and Water Management, Railion, ProRail nor NS Reizigers have formulated specific targets for the reduction of derailment risks caused by wheel set defects.

#### 5.5.5 Supervision

The Safety Board has investigated the IVW's approach, in its role of supervisor, to the earlier goods train derailments caused by rolling stock defects and to the incorporation of the derailment risks in the relevant companies' safety management (systems).

##### a) IVW accident investigations

The IVW's Rail Supervision Division conducts investigations of the facts and the cause of rail accidents. The IVW uses the results from these investigations to assess whether there was a violation and/or any shortcomings<sup>62</sup>. The IVW also uses the results from accident investigations to formulate what are referred to as 'signals', which the IVW understands as points for attention that have been revealed by the investigation but do not constitute a non-compliance with the standards or regulations.

It is striking to note that the IVW has issued 'signals' pursuant to two earlier goods train derailments which draw attention to the restriction of the derailment risk by the use of defect and derailment detection. These derailments occurred at Boxtel (in 2005) and Duiven (in 2007).

These signals are summarised below:

BOXTEL DERAILMENT, 08-12-2005	
signal 1	The derailment of goods wagons was not detected and the derailment subsequently resulted in major damage. Explanatory note: The damage caused after a derailment can be restricted when the derailment of a wagon is detected in good time. The rolling stock can, for example, be equipped with what are referred to as 'derailment detectors'. Is a study being carried out to examine the use of detectors of this nature or other means of detecting derailments at an early stage and, if so, what are the results from this study to date?
addressed to	Railion
signal 2	The overheating axle box of the goods wagon was not detected in time and this resulted in the derailment. Explanatory note: The Hotbox equipment installed to detect overheating axle boxes in good time was decommissioned in June 2002. No initiatives have been taken to replace the function of the HotBox detection system since then. Last year an announcement was made stating that the QuoVadis system could take over the function of the HotBox detectors. Is the case, and will the QuoVadis be used for this purpose? Apparently, new HotBox detectors have been installed on the Betuweroute line. Are these detectors suitable for use on other lines and will they be installed on other lines?
addressed to	ProRail

62 The IVW understands a violation as 'a situation or action contrary to the legislation' and a shortcoming as 'non-compliance with a requirement or expectation in the company regulations or underlying document'.

## DUIVEN DERAILMENT, 23-08-2007

signal 1	The data measured by ProRail's Gotcha/QuoVadis system cannot be monitored in real time and, as a result, cannot be used to give a warning of rolling stock defects in good time. Explanatory note: The data the Gotcha/QuoVadis system recorded for train 47719 revealed that the wheel tyre of the left wheel of the derailed wheel set suffered from a major defect at the time the train left Rotterdam. The data measured by ProRail's QuoVadis system is not monitored real time (with the exception of the data from the measurement point before the Best tunnel). The Gotcha/QuoVadis system could serve as a safety net for trains with specific rolling stock defects. Carry out a study to investigate the feasibility of modifying the Gotcha/QuoVadis system for this use.
addressed to	ProRail

Following an earlier derailment (Boxtel, 2005) the IVW drew Railion's attention to the feasibility of equipping wagons with derailment detection and ProRail's attention to the feasibility of installing HotBox detection on the main railway net. Following another derailment (Duiven, 2007) the IVW advised ProRail to investigate whether the QuoVadis/Gotcha system could be upgraded to real-time safety net for wheel set defects. In both instances the IVW formulated these findings as 'a signal' (and not as a shortcoming or violation) and did not enforce the changes.

### *b) The IVW's assessment of the safety management (systems)*

#### *Assessment of Railion's SMS*

The IVW assessed Railion's safety management (system) in 2006, within the context of the renewal of the safety certificate. The IVW carried out its assessment on the basis of the Railways Act and the European railway Safety Directive (in particular, Annex III). In the first instance, the inspection resulted in the issue of an instruction to Railion to make improvements. A follow-up inspection carried out in that same year resulted in the IVW's conclusion that Railion's SMS did not comply with the Railways Act and that the associated risk inventory and evaluation (RI&E) exhibited shortcomings. As a result, Railion received a provisional renewal of the safety certificate for the period of one year (instead of the maximum period of three years).

The IVW assessed the SMS again in 2007. On the basis of the findings from this assessment the IVW concluded that Railion's safety awareness and operations had improved significantly and that the SMS was exhibiting an appropriate performance. However, the IVW did observe ten shortcomings and made a further ten remarks. The IVW renewed the safety certificate for a period of two years, with an interim inspection in 2008.

The interim inspection carried out in 2008 revealed four shortcomings and resulted in two remarks. One of the shortcomings related to the incompleteness of the RI&E with respect to the transport of dangerous goods and the use of mobile communication equipment (GSM-R). Another shortcoming related to the absence of deadlines for improvements. Railion was instructed to rectify the shortcomings and address the remarks before 1 February 2009. The Inspectorate established in June 2009, on the basis of information provided by Railion about the measures the company had implemented, that three of the four shortcomings had been rectified and that one of the two remarks had been addressed. Railion then stated the measures the company would implement to ensure that the shortcoming was rectified and the remark addressed within the near future. On the basis of this information the IVW stated in mid June 2009 that it had set a new deadline of mid August 2009. At the beginning of 2009 the IVW established, on the basis of information supplied by Railion, that the remaining violations had been rectified and the remarks had been addressed<sup>63</sup>.

The Board observes that the IVW has carried out the assessment at system level and has not verified that all the relevant risks are addressed in the RI&E. As a result, the assessments - including the inspections carried out in 2008 and 2009 - have not revealed that Railion's RI&E relates solely to employee risks and does not give consideration to the risks posed to others.

63 There is one remaining subject of discussion between Railion and IVW, which relates to the information to be shown on the employees' company passes.

#### *Assessment of ProRail's SMS*

ProRail is required to possess an approved safety management system as from the beginning of 2008, a requirement laid down in the management concession. The IVW carried out an assessment of ProRail's SMS to verify compliance with this requirement at the beginning of 2008. The assessment was carried out on the basis of the Railways Act and the European Railway Safety Directive. The inspection examined five of the 32 processes, in particular the most safety-critical processes. None of the five processes that were examined related directly to derailments caused by wheel set defects. In essence, the IVW concluded that ProRail's SMS did not comply with the requirements as a result of an insufficient insight into the relevant processes and documents, the unclear status of documents, the inadequate quality of the relevant documents and the incompleteness of the summary of safety-critical positions. In the first instance the IVW stated that it was able to issue the permit for six months (in stead of three years) subject to the condition that ProRail rectified the shortcomings and addressed the remarks within this period. ProRail lodged a number of objections to the assessment and the intended decision. This was in part the reason for the IVW's decision to grant approval for a period of three years, although the Inspectorate announced that it would carry out an audit at the end of 2008 to verify that the requested improvements had been made. This audit was carried out in September 2008, and on the basis of its findings the Inspectorate issued a statement stating that the shortcomings had been rectified and the remarks addressed.

The Board observes that the IVW carried out the assessment at system level and limited the assessment to a selective sample of company processes. The Board is also surprised that the assessment did not address the fact that ProRail, as mentioned earlier, had not yet carried out the risk assessment or the ALARP assessment of the potential control measures.

#### *Assessment of NS Reizigers' SMS*

The IVW carried out an assessment of NS Reizigers' SMS in mid 2006. This assessment was carried out within the context of the renewal of NS Reizigers' safety certificate (on 1 December 2006). The assessment was comprised of the examination of the SMS document and interviews of a number of officers. The IVW carried out the assessment on the basis of the Railways Act (and the underlying decrees and regulations). On the basis of the findings from its assessment the IVW concluded at the end of 2006 that NS Reizigers' SMS complied, bar one shortcoming and six remarks, with the substance of the requirements. The shortcoming related to the failure to specify the document management. The IVW also concluded that the implementation of the SMS exhibited five shortcomings (in the sense that practice was at variance with the specifications in the SMS) and made a further six comments. The shortcomings included the 'failure to carry out a demonstrable assessment of all safety-critical processes in the RI&E' and 'the assessment of the implementation of the SMS as inadequate'. However, in the IVW's opinion the number of shortcomings and their severity did not give cause to the decision to issue the safety certificate for a period shorter than three years. For this reason the IVW renewed NS Reizigers' safety certificate for a three-year period on 1 December 2006, with the note that the shortcomings the Inspectorate had observed were to be rectified by no later than 1 May 2007. In the first months of 2007, NS Reizigers issued information to the IVW about the actions that had been taken and were being taken to rectify the shortcomings observed by the Inspectorate. This information included a statement that the company was carrying out a quantitative and qualitative inspection of all the available RI&Es and that it had drawn up an audit and inspection plan (2007-2009) to review the implementation of the SMS. On the basis of this information<sup>64</sup> the IVW issued a statement in June 2007 stating that all shortcomings had been rectified.

The Board observes that the assessment was carried out at system level and the IVW has not verified whether all the relevant safety risks have been worked out in sufficient detail in the RI&E. As a result, no account has been taken of the failure of NS Reizigers' SMS to work out some of the relevant risks (including the risk that NS Reizigers' trains could collide with a derailed train) insufficient detail.

The IVW's assessment of the Railion, ProRail and NS Reizigers safety management (systems) has unjustifiably disregarded the fact that the risk of derailments caused by rolling stock failures has not been worked out in (sufficient) detail in the safety management systems.

64 The IVW issued an announcement within this context stating that the Inspectorate would make an appointment within the near future to verify NS Reizigers' inspection of the available RI&Es.

## 6 CONCLUSIONS

### 6.1 SUB-CONCLUSIONS:

#### 6.1.1 Cause

The Amsterdam-Muiderpoort derailment was caused by a defective wheel set on one of the wagons. This related to an axle journal which broke off because the axle box had overheated. The axle box overheated because one of the bearings in the axle box seized. The Board was unable to reach a definitive conclusion on the cause of the seizure of the bearing, although this was probably due to a problem with the bearing. The Board is of the opinion that the most probable cause was the failure of the bearing cage.

The total damage caused by the Muiderpoort derailment amounted to about five million euros. In addition, rail traffic in the Randstad was severely disrupted. This increased the risk of accidents at other locations on the rail network. Moreover, in slightly different circumstances passenger trains could have collided with the derailed goods wagons, with a real risk of casualties.

The derailment of wagons from the same series that occurred at Boxtel in 2005 was also caused by an overheated axle box. However, in this instance the axle box overheated because the fastening bolts had become loose. This defect was not an issue in the Muiderpoort derailments.

The findings from the Safety Board's technical inspection give cause to a critical evaluation of the periodic maintenance of the wheel sets of the relevant series of wagons and a further investigation of the damage to bearings observed in other axle boxes. The Board is of the opinion that the responsibility for these investigations is borne by the keeper of the wagons Xpedys, the carrier (Railion) and the infrastructure manager (ProRail).

#### 6.1.2 Severity of the problem

On average, derailments of the nature of the Muiderpoort derailment occur almost once a year. This frequency has not decreased significantly during the past ten years. Derailments of this nature are accompanied by a real risk of escalation into a major accident with casualties. Moreover, derailments of this nature cause a major disruption of rail traffic that, in addition to indirect damage and inconvenience, can result in additional safety risks.

#### 6.1.3 Risk control

The development of defects in wheel sets can be reduced by periodic maintenance, although this cannot preclude all defects. For this reason defects of this nature need to be identified and rectified in time to prevent derailments. However, timely detection is not feasible for all defects. Moreover, derailments can occur due to other causes (such as rail defects, SPADS and driving at excessive speeds). For this reason derailments also need to be detected in time so that measures can be implemented to reduce the risk of the derailment escalating into a follow-on accident. This latter can be achieved, for example, by stopping the derailed train or other trains in good time. Within this context it should be noted that the driver of a goods train is often unable to notice that one or more wheel sets (or even entire wagons) have derailed.

The following methods and systems are feasible means of reducing the derailment risk by detecting defects and derailments: dynamic maintenance management (Gotcha), defect detection (in the form of HotBox detection or QuoVadis/real-time) and derailment detection (DDD). The effectiveness of these technical safety nets has been demonstrated: dynamic maintenance management (Gotcha) is used for passenger trains in the Netherlands and defect detection (in the form of HotBox detection) and derailment detection are used outside the Netherlands.

The Netherlands makes only limited use of these technical measures for the reduction of the derailment risk. However, ProRail is working on plans for an upgrade of the QuoVadis system and on a European scale consideration is being given to the mandatory installation of derailment detection on new wagons used to carry specific dangerous goods. ProRail, Railion and NS Reizigers are aware of the technical means available for the reduction of the derailment risk and also appreciate their

importance. The fact that they have yet to introduce these methods is not based on structural considerations. In essence, the companies have adopted the standpoint that 'they are not the problem owner', it falls outside their sphere of influence' and 'it is not mandatory'.

#### 6.1.4 Safety management

ProRail, Railion and NS Reizigers have not worked out the risk of derailments caused by wheel sets in (sufficient) detail in their safety management systems (SMSs). IVW has assessed these companies' SMSs. However, the Inspectorate has disregarded these shortcomings and nevertheless approved their safety management systems.

#### 6.1.5 Government direction of the rail companies

After earlier derailments (in 2005 and 2007) the Inspectorate for Transport, Public Works and Water Management urged ProRail and Railion to introduce the aforementioned technical safety nets but has not attached any consequences to the failure to introduce them.

In 2007 the Ministry of Transport, Public Works and Water Management instructed ProRail to carry out a study of the feasibility of the control of the risk of goods train derailments caused by overheating problems. This study was completed in 2009. ProRail then stated that it was of the opinion that consultations on the division of responsibilities need to be held between ProRail and the carriers, and that these consultations should be chaired by the Ministry of Transport, Public Works and Water Management. The Ministry has indicated that it is of the opinion that these discussions are unnecessary and that it expects ProRail to upgrade/expand the QuoVadis system as quickly as possible. ProRail prepared a development and implementation plan in the second half of 2009 (with phased introduction and completion in 2013).

The rail sector has a consultative platform in the form of the Rail Company Safety Consultative Body, OVS, which is under the management of the Ministry of Transport, Public Works and Water Management and is comprised of representatives from all rail companies and the IVW. However, the Board has observed that this consultative structure has not resulted in the speedy introduction of the available control measures.

## 6.2 FINAL CONCLUSIONS

The Netherlands makes only limited use of the measures available to control the derailment risk. As a result, the number of derailments is excessive: these relate primarily to derailments of goods trains, although these also pose a serious threat to passenger trains.

The failure to introduce the available technical safety nets with due speed is the consequence of the rail companies' too-limited opinion of their duties in addition to the government's failure to provide the necessary direction and enforcement.

- a) The Board is of the opinion that the potentially serious consequences of derailments gives cause to the need to make optimum use of the measures available to control this risk. The Board observes that this is not currently the case since the parties involved fail to make use of the aforementioned technical measures (dynamic maintenance management, defect detection and derailment detection) in spite of their proven effectiveness in reducing the risk of (goods) train derailments caused by defective wheel sets.  
The Board has taken cognisance of the planned upgrading of the QuoVadis system and the developments relating to an obligation to install derailment detection on new wagons used to carry specific dangerous goods. However, the Board is of the opinion that these developments have been initiated too late and that the progress is too slow. Within this context the Board wishes to point out that the frequency of this type of derailment has remained approximately constant for at least ten years. In addition, HotBox detection and dynamic maintenance management have been available for at least ten years and derailment detection for about five years. The Board also observes that it is unclear whether the intended modification of

the QuoVadis system will be sufficient to achieve adequate control of the derailment risk: it is possible that more and/or other measurement points will be required as compared to the current QuoVadis network (that is primarily intended to measure the weight of trains).

- b) In the Board's opinion the rail companies' failure to introduce the available technical measures with due speed and the arguments are indicative of an incorrect opinion of their personal responsibilities for the safety of rail traffic and of their duties/roles within the rail sector. The Board appreciates that the relevant control measures relate to different areas of duties (rail infrastructure - design of the wagons - maintenance of the wagons) and that the individual rail companies do not have direct or full control over all these areas of duty. However, the Board does expect each of the rail companies to make every possible effort to minimise rail traffic safety risks within their specific area of operations. The rail companies need to jointly ensure that all relevant safety risks are reduced to the maximum possible extent. It will then be important that each rail company requires the other rail companies to make maximum use of the specific opportunities available to them. Within this context the Board is supported by the Railways Act and the management concession based on that Act, which lay down a 'duty of care' and require the rail companies to maintain demonstrably adequate control of safety risks associated with rail traffic. This duty of care is not limited to the risks arising from the specific duties of a company that can be tackled without the involvement of other rail companies.
- c) Pursuant to the ALARP principles the rail companies need to maintain 'adequate control' of safety risks by demonstrating that they make use of all control measures which result in safety gains that justify the investments. To this end the rail companies' safety management (systems) need to provide for a thorough inventory and analysis of the safety risks and a structural, transparent assessment of the available control measures. Within this context the Board is once again supported by the legislation, regulations and government policy, since the Railways Act and the associated regulations require the rail companies to implement adequate safety management to assure adequate control of the safety risks, whilst the government (as laid down in the Second Railway Safety Framework Memorandum) makes use of the ALARP principal as the criterion for the 'adequate control' of safety risks. The Board observes that the safety management (systems) of Railion, ProRail and NS Reizigers do not meet the aforementioned conditions with respect to derailment risks.
- d) The Board observes that the IVW has approved the safety management systems of Railion, ProRail and NS Reizigers even though they have not worked out the control of derailment risks in sufficient detail (in the sense that it has not been demonstrated that the risks have been reduced to ALARP level). Consequently, in the Board's opinion the IVW has failed to make use of an important instrument for the improvement of rail safety.
- e) The Board is of the opinion that the Minister of Transport, Public Works and Water Management should have arranged for the necessary direction of the control of the derailment risk in the form of an adequate consultative and decision-making structure in the rail sector and the formulation of specific targets for risk reduction. The Board observes that the direction provided to the current consultative and decision-making structure in the rail sector, including the Rail Company Safety Consultations) that is managed by the Ministry of Transport, Public Works and Water Management has not resulted in a dynamic approach to the derailment problem.

The Board observes that the Ministry of Transport, Public Works and Water Management has not formulated specific targets laying down the level to which the derailment risk must be reduced.





## 7 RECOMMENDATIONS

The shortcomings and underlying problems result in the Board's submission of the following two recommendations:

1. *To the Minister of Transport, Public Works and Water Management:*
  - a) Call the rail companies to account, in accordance with the Railways Act, for their individual and shared responsibility for rail traffic safety. This can be achieved by effective supervision and stringent enforcement of their duty of care for safety. In addition, require the rail companies to demonstrate that they have reduced the safety risks to ALARP level.
  - b) Achieve adequate control of the goods-train derailment risk by:
    - arranging for the direction of the consultations and the decision-making on the implementation of control measures;
    - imposing specific targets for the reduction of the derailment risk.
2. *To Railion, ProRail and NS Reizigers:*
  - a) Extend the safety management to the risks to the relevant company's operations that are caused by other companies and/or require a joint approach.
  - b) Make sure that the available technical options for defect and derailment detection are used to reduce the goods train derailment risk to ALARP level.

The Board is also of the opinion that the findings from the investigation give cause to supplementary investigations by the relevant companies and, for this reason, issues the following two recommendations:

3. *To Xpedys:*

Evaluate the periodic maintenance of the axle boxes of the series of wagons involved in the Muiderpoort derailment, with due regard for the chipping damage encountered in one of the bearings of the derailed wagons.
4. *To Railion and ProRail:*

Carry out an investigation of the current-flow damage to the axle box bearings observed with the wagons involved in the Muiderpoort derailment and make sure that the necessary measures are implemented to prevent this form of damage.

Administrative authorities to whom a recommendation is addressed should make their standpoint on implementing the recommendation known to the relevant Minister within six months of the publication of the final report. Non-administrative authorities or persons to whom a recommendation is addressed should make their standpoint on implementing the recommendation known to the relevant Minister within one year of the publication of the final report. Copies of these responses should simultaneously be issued to the Chair of the Dutch Safety Board and the Minister of the Interior and Kingdom Relations.

**ANNEXES**

## **ANNEX 1: JUSTIFICATION FOR THE INVESTIGATION**

### **Investigation by the Dutch Safety Board**

The Dutch Safety Board carries out independent investigations into the (presumed) causes of incidents, identifies learning points from the investigation and, when possible, submits recommendations for safety improvements. The objective of this investigation is in line with the above: conduct an investigation into the Muiderpoort derailment to identify learning points for the prevention of accidents of this nature or the restriction of their consequences.

The reasons for the investigation of this accident were: the potential severity of derailments in general, the extent of the damage and the disruption of rail traffic caused by this accident as well as the possibility that the same problem had been an issue in an earlier derailment.

The Board formulated the following questions to be addressed by the investigation:

- a) What was the technical cause of the Muiderpoort derailment and was this the same cause as that of earlier derailments with wagons from this series?
- b) What were the (potential) consequences of the Muiderpoort derailment, how often do derailments of this nature occur and what are the potential risks associated with these derailments?
- c) To what extent do the findings from the investigation give cause to the modification of the periodic maintenance of the relevant series of wagons and/or the amendment of the relevant legislation and regulations?
- d) Which supplementary means are available for the control of the risk of goods train derailments due to wheel set defects and to what extent could these prevent derailments of the nature of the Muiderpoort derailment or limit the consequences?
- e) How have the parties involved made arrangements for the responsibility of controlling the derailment risk and how do they fulfil this responsibility?

### **Other investigations**

The carrier (Railion), the infrastructure manager (ProRail), the Railway Police and the IVW's Rail Supervision Division have carried out on-site investigations of the accident and the Dutch Safety Board has made use of their findings.

The Safety Board requested DeltaRail to carry out a further investigation, under the Safety Board's supervision, of the facts and technical cause of the Muiderpoort derailment and the IVW's Rail Supervision Division carried out a statistical review of the derailments that have occurred in the past ten years. The Board took account of the findings from both sub-investigations in arriving at its assessment.

Lloyd's Register Rail Europe BV and Significance provided support for this investigation.

### **Investigation method**

The investigation encompassed:

- an on-site investigation;
- a document study;
- a materials investigation;
- simulation calculations;
- interviews.

### **Interviews**

During the course of the investigation interviews were held with officers of the various parties involved, in this instance Railion, ProRail, the IVW and the Ministry of Transport, Public Works and Water Management. The objective of these interviews was to gain an insight into the cause of the accident and/or gain an insight into the manner in which the various parties fulfil their (personal) responsibility for the control of derailment risks.

## **Project team**

### *Investigation Manager:*

F.R. Smeding	Investigation Manager (until January 2009)
J.J.G. Bovens	Investigation Manager (from January 2009)

### *Core team:*

R.H.C. Rumping	Project Manager (until May 2009)
A. Sloetjes	Project Manager (from May 2009)
W. Walta	Investigator
T. van Prooijen	Investigator

### *Support:*

E.M. de Croon	Analyst
E.J. Willeboordse	Analyst
B.J. van de Griend	Internal Process Support
A.W. Noppe	Legal Advisor
P. Smets	Investigator/Reporter

## **Advisory Commission**

The project team was supported by an advisory commission comprised of three external experts and two members of the Board.

The members of this commission were as follows:

J.P. Visser	Member of the Board (Chair)
Annie Brouwer-Korf	Member of the Board
F.G. Bauduin	
J.F.M. Kitzen	
W.A. Vriesendorp	

## **Comments round**

A comments version of this report was submitted to the parties involved, in accordance with the Kingdom Act concerning the Safety Board. These parties were requested to check the report for errors and unclarities. The Dutch Safety board is obliged to state any divergent opinions in its report.

The comments version of this report was submitted to the following parties:

- Railion (the carrier using the derailed goods train, now DB Schenker Rail NV)
- ProRail (the infrastructure manager)
- NS Reizigers (carrier using passenger trains on adjacent tracks)
- The Minister of Transport, Public Works and Water Management (bears the system responsibility for rail safety)
- The Inspectorate for Transport, Public Works and Water Management (supervision/enforcement of rail safety)
- Xpedys (Belgian rail company, keeper of the derailed wagons)
- DVIS (Belgian Inspectorate, supervision and enforcement in Belgium)

All parties submitted comments, whereby the Minister of Transport, Public Works and Water Management and Inspectorate for Transport, Public Works and Water Management submitted joint comments.

The comments received from the parties are summarised below in the sequence in which the relevant issue is addressed in the report. Each comment is accompanied by an indication of the section of the report to which the comment relates, the party that submitted the comment and whether the comment was adopted: the comments that have been adopted are supplemented with an explanation of the manner in which they were incorporated in the report and the comments that are not adopted are supplemented with the Board's reason for its decision not to adopt the comment.

## COMMENTS THAT WERE ADOPTED

no	Section	company / comment / incorporation
1	1.1	<i>Railion: The derailment occurred at about quarter to five: 18 wagons were carrying chalk and 7 wagons were carrying quicklime.</i> <u>Incorporation:</u> This information has been incorporated.
2	2.1.1	<i>Ministry of Transport, Public Works and Water Management: A technical inspection encompasses more than was stated in the outline description (included in the draft report).</i> <u>Incorporation:</u> The relevant phrase has been amended.
3	2.1.2-c	<i>Xpedys: The report does not state the sense in and the extent to which the rail alignment at the location of the accident did not comply with the design regulations.</i> <u>Incorporation:</u> This has now been incorporated in the report.
4	2.1.3-b	<i>Railion: The number of totally destroyed wagons was '8' and the number of severely damaged wagons was '1'.</i> <u>Incorporation:</u> This information has been incorporated.
5	2.3.1	<i>Railion and Xpedys: The two derailments referred to in the draft report that occurred in Belgium in 2007 and 2008 involved wagons that did not belong to the series of one hundred wagons that Railion lets from Xpedys (and of which 25 were involved in the Muiderpoort derailment).</i> <u>Incorporation:</u> the two accidents concerned have been deleted from the summary.
6	2.3.3-b	<i>Railion: The investigation of the Venlo derailment was, in consultation with the IVW, carried out by Railion.</i> <u>Incorporation:</u> The text has been amended accordingly.
7	3.1.1	<i>Ministry of Transport, Public Works and Water Management: The management concession is applicable to all main rail lines.</i> <u>Incorporation:</u> The text has been amended accordingly.
8	4.2	<i>Xpedys: Xpedys is of the opinion that it would be wise to avoid misunderstandings by indicating that the term 'keeper' as used in the report is in line with the term 'keeper' used in international regulations (such as the COTIF Convention).</i> <u>Incorporation:</u> The text has been amended accordingly.
9	4.2	<i>Railion and Xpedys: Maintenance and inspection of the wagons: a distinction needs to be made between long-term maintenance (overhauls) and minor maintenance (replacement of wearing parts, interim lubrication, etc.)/technical inspections (before a journey).</i> <u>Incorporation:</u> To avoid misunderstandings 'long-term maintenance' has been replaced by 'periodic maintenance' in the definitive text.
10	4.2	<i>Ministry of Transport, Public Works and Water Management: The Railways Act does not refer to 'sound maintenance': however, the Act does specify that the vehicles must continue to comply with the prescribed technical specifications.</i> <u>Incorporation:</u> This explanation has been incorporated (in a footnote).
11	5.1.2	<i>Railion and Xpedys: The two derailments referred to in the draft report that occurred in Belgium in 2007 and 2008 involved wagons other than those involved in the Muiderpoort derailment.</i> <u>Incorporation:</u> the two accidents concerned have been deleted from the summary.
12	5.3.1	<i>Xpedys: The maintenance plan of the relevant series of wagons drawn up by NMBS stipulates that the axle boxes must be overhauled once every ten years or a after a maximum of 800,000 km.</i> <u>Incorporation:</u> The maximum number of kilometres for overhaul periods has been added.

no	Section	company / comment / incorporation
13	5.4.4	<p><i>ProRail</i>: The modification of the QuoVadis system into an effective safety net for derailments caused by wheel set defects requires not only the addition of a real-time warning system but also a network of a sufficient number of measurement points.</p> <p><u>Incorporation</u>: The text has been supplemented with the need to have measurement points installed throughout the network.</p>
14	5.4.5	<p><i>Railion</i>: The decision-making on the inclusion of the obligation to install derailment detection on specific wagons has been deferred until the revision round in 2013.</p> <p><u>Incorporation</u>: The information about the deferment of the decision-making has been added to the text.</p>
15	5.5.2-a	<p><i>Railion</i>: A number of goods carriers drew ProRail's attention to the need for QuoVadis data for dynamic maintenance management some time before the Muiderpoort derailment.</p> <p><u>Incorporation</u>: This is incorporated in the text.</p>
16	5.5.2-a	<p><i>ProRail</i>: ProRail, in response to the Board's observation that the rail companies did not feel themselves called, obliged or in a position to introduce defect and derailment detection, wishes to draw attention to the study that ProRail carried out on the request of the Ministry of Transport, Public Works and Water Management. ProRail also states that the project QuoVadis II has now begun, the objective of which is to replace the current system and expand the functionality to include the detection of wheel tyre anomalies: QuoVadis II will be tested for 3 months at the beginning of 2010 and then introduced. QuoVadis II provides for the ability of the carriers to obtain real-time access to the measurement data. Parallel to this work is being carried out on the development of the online signalling of measurement data, the precursor of a real-time warning instrument.</p> <p><u>Incorporation</u>: This information has been incorporated in the report.</p>
17	5.5.2-b	<p><i>Ministry of Transport, Public Works and Water Management</i>: Following recent incidents (Vleuten and Barendrecht) the Ministry of Transport, Public Works and Water Management implemented suitable measures to reduce the probability of future derailments (see the correspondence VenW/DGMO-2009-7386 of 14 August 2009 between the Ministry and ProRail relating to the HotBox detection project and the response of the Minister of Transport, Public Works and Water Management relating to the General Meeting of 8 October 2009 (House of Representatives, 2009-2010, 29 893, no. 94, page 20).</p> <p><u>Incorporation</u>: This information has been incorporated in the report.</p>
18	5.5.3	<p><i>ProRail</i>: It is correct that the SMS does not address defect or derailment detection: this is because the SMS incorporates solely the control measures that have already been implemented. It is correct that the level of the risks is lacking from the 2008 risk analysis: ProRail carried out this assessment in 2009. The ALARP substantiation of the high risks, including the derailment risk, which is scheduled for 2010 will indicate the extent of the need for supplementary control measures.</p> <p><u>Incorporation</u>: This information has been incorporated in the report.</p>
19	5.5.3	<p><i>ProRail</i>: The draft report states that 'other points' of the SMS are also not worked out in sufficient detail. However, the relevant points are not stated.</p> <p><u>Incorporation</u>: This phrase referred to the fact that the observed shortcomings (no account is taken of important potential control measures, no further assessment of the risks and no ALARP assessment of the potential control measures) are not only applicable to the derailment risks but also to other risks. However, since it is correct that the term 'other points' could be interpreted differently the relevant phrase has been deleted. The observation that 'the identified incompleteness is also applicable to other risks' has been retained.</p>

no	Section	company / comment / incorporation
20	5.5.3-c	<i>NS Reizigers: NS Reizigers' SMS includes a risk analysis of the general operations: this is enclosed in an annex to the SMS.</i> <u>Incorporation:</u> The text has been amended accordingly. However, this is accompanied by the statement that the Board is of the opinion that the risk of goods train derailments (to NS Reizigers' operations) has been worked out in insufficient detail.
21	5.5.4	<i>ProRail: A company target has been formulated for the reduction of the number of derailments irrespective of their cause, i.e. including derailments caused by wheel set defects.</i> <u>Incorporation:</u> This information has been incorporated in the report.
22	Appendix 3	<i>DVIS: The identification numbers of the relevant wagons are not given in the draft report.</i> <u>Incorporation:</u> The list of wagon numbers has been added (in Annex 3).

### COMMENTS NOT ADOPTED BY THE BOARD AND THE REASONS

no	section	company / comment / the Board's reason
23	1.1	<i>Railion: The disruption did not affect the entire Randstad conurbation, but solely Amsterdam.</i> <u>Board:</u> It is true that the actual obstruction was restricted to the rail block between Amsterdam Centraal and Amsterdam-Muiderpoort. However, this obstruction also had considerable consequences outside Amsterdam, in particular for passenger trains.
24	1.1	<i>Railion: A derailment of this nature occurred on one previous occasion in the past ten years and for this reason 'a certain degree of regularity' is not correct.</i> <u>Board:</u> Within this context 'derailments of this nature' not only refers to derailments of Railion trains with wagons from the relevant series: there were indeed only two derailments in the past ten years. However, serious derailments of goods trains caused by wheel set defects have occurred on an average of 'once every year' (see 5.2.3).
25	2.1.1	<i>Xpedys: The description of the facts would appear to be based (solely) on the train driver's statement. The same is applicable to the train's speed at the time of the derailment.</i> <u>Board:</u> The overall description of the facts is based on a number of sources, including the train documents (for the composition of the train), the Railway Police's official report (for the resting position of the wagons) and the investigation carried out by DeltaRail on-site that was requested by the Safety Board (for the location of the actual derailment and the escalation of the derailment). Only two points in the description make use of the train driver's statement, namely his description of the train's speed during the time in which it approached the location of the accident and his statement that he noticed the derailment only when the locomotive began to jolt severely during the escalation. It should be noted that the driver's statement of the speed of the train as it approached the location of the derailment has been verified using the records of the Train Number Tracking System (TNTS). The manner in which this was carried out (by dividing the distance travelled by the time required to do so) and the finding (between 48 and 58 km/hour) is described in Section 2.1.2-b.



no	section	company / comment / the Board's reason
26	2.1.2-c	<p><i>Xpedys: The IVW's draft report (version of 8 September 2009) states that according to ProRail the rail alignment complied with the regulations: it is not clear why the Board arrives at a different conclusion. In addition, the Safety Board's report does not state the degree of canting at the location of the derailment or the escalation of the derailment.</i></p> <p><b>Board:</b> It is correct that the IVW's draft report states that according to ProRail the rail alignment complied with the regulations. ProRail also stated this in its report of the Muiderpoort derailment. The Safety Board arranged for an investigation to verify whether this assertion was correct. The investigation - as indicated in the report - revealed that one aspect of the rail alignment did not comply with the regulations.</p> <p>The actual cant (40 mm for a curve radius of 3200 m) did comply with the regulations. The degrees of canting are not included in the report since the Board is of the opinion (as explained in the report) that the canting did not play a material role in the derailment.</p>
27	2.1.2-c	<p><i>Railion: It is incorrectly stated that the infrastructure did not contribute to the derailment, with a reference to Annex 3 under 2. The fact that according to the simulations a melted off axle journal inevitably results in a derailment does not as such imply that the infrastructure did not have an influence on the (location of) the derailment.</i></p> <p><i>Xpedys: The report lacks a (further) explanation of the conclusion that the rail alignment anomaly and train's speed did not contribute to the derailment.</i></p> <p><b>Board:</b> The Board's conclusion that the derailment was caused by an overheated axle box and that the infrastructure did not play a material role is based on simulation calculations. The calculations and their results are described in Annex 3 (under 2). In essence, the findings from the simulations reveal that the derailment of the relevant wheel set following the complete melting off of axle journal would also have occurred if the course of the track had been different (for example, a straight section of track without canting). The simulations also revealed that in the absence of the defect there was no tendency to derailment at the location of the derailment and the relevant speed of the train: the wheel unloading is less than 20% and the Y/Q is smaller than 0.4.</p> <p>For this reason the location of the derailment was not determined by the rail geometry and/or the train's speed, but by the time at which the overheated axle journal melted off. The relevant information is given in the report (Annex 3).</p>
28	2.1.3	<p><i>Xpedys: The report lacks a further specification/substantiation of the amounts of damage stated in the report.</i></p> <p><b>Board:</b> The report intentionally states only approximate amounts for the damage to the infrastructure and the rolling stock: these are 'indicative' amounts. The amounts are the amounts stated by ProRail and the IVW respectively. The report also states an approximate amount for the process damage. This is also an indicative amount: the basis of this estimate is explained in Annex 4.</p>
29	4.2	<p><i>Railion: Defect detection is more effective than derailment detection.</i></p> <p><b>Board:</b> Self-evidently, preference is given to the 'prevention' of derailments rather than the 'limitation of the consequences'. However, the Board also draws attention to the importance of the limitation of the consequences (derailment detection) because it is impossible to prevent all derailments.</p>

no	section	company / comment / the Board's reason
30	5.1.1 and Annex 3	<p><i>Xpedys: Xpedys is of the opinion that further investigation and better substantiation is required with respect to the seizure of the bearing and the failure of the bearing cage, as well as the cause of the current-flow damage and chipping. Xpedys requests the Safety Board to arrange for supplementary investigation and a further explanation. This should also extend to the findings from the overhaul of the axle boxes of the derailed wagons carried out after the derailment, which revealed that more than 80% of the bearings exhibited current-flow damage (pitting). In Xpedys' opinion this further investigation should also include a metallurgical investigation. In addition, Xpedys is also of the opinion that it is necessary to investigate the extent to which the current-flow damage could have been or was caused by a possible inadequate performance of the locomotives Railion used with these wagons.</i></p> <p><b>Board:</b> In essence, the Board concludes that the seizure of the bearing probably began with the failure of the bearing cage. This conclusion is, as is stated in the report, based on the fact that the nature of the damage to the bearing reveals that at least one cage lip must have been broken off at the time the bearing began to seize. Within this context it is important to note that the investigation revealed no indications of external causes (such as an assembly error, overloading or a lack of lubrication). The Board bases its conclusion that the seizure of the bearing was probably not caused by current-flow damage or chipping on the fact that an inspection of the dismantled bearing revealed no chipping of either the inner or outer ring of a degree that could explain the seizure.</p> <p>The Board is of the opinion, as it explicitly states in the report, that it is necessary to carry out a further investigation of (i) the feasibility of preventing bearing seizure by a modification of the maintenance regime and (ii) the cause of the current-flow damage. However, the Board is of the opinion that the responsibility for these investigations is borne by the companies involved.</p>
31	5.2.3	<p><i>Railion: Since the amount of freight carried by goods trains in the period reviewed by the report (1999-2008) has increased the number of goods train derailments per tonne kilometre has decreased rather than remained unchanged.</i></p> <p><b>Board:</b> The relevant section of text does not relate to the relative involvement of goods wagons in derailments but to the fact that this type of derailment (and the associated risk to rail traffic) has not been reduced in an absolute sense.</p>
32	5.3.1 and 6.1.1	<p><i>Xpedys: The Board's conclusion that the findings from the investigation give cause to an evaluation of the maintenance regime is not, in Xpedys' opinion, compatible with the observation that the investigation revealed no specific indications of errors or shortcomings in the periodic maintenance.</i></p> <p><b>Board:</b> It is correct that the investigation did not reveal any specific indications of errors or shortcomings in the periodic maintenance. The Board's opinion that a critical evaluation of the maintenance regime is, nevertheless, required is based on the following two reasons. Firstly, the derailment was caused by the seizure of an axle box bearing less than three years into the prescribed overhaul interval of ten years. Secondly, the bearings experts who were consulted for the inspection of one of the other twenty bearings indicated that this defect would probably have resulted in the failure of the bearing within the prescribed overhaul interval. In view of these two issues the Board is of the opinion that a critical review is required to assess whether the current maintenance regime (including the specified overhaul interval and the reuse of bearings on the basis of a visual inspection) is justifiable for these wagons. In the Board's view this evaluation should extend to a further investigation of issues such as the technical condition of the other bearings of the relevant series of wagons. Self-evidently, this further investigation should also include an examination of the current-flow damage revealed during the Safety Board's investigation and Xpedys' remarks with respect to this damage.</p>

no	section	company / comment / the Board's reason
33	5.3.1	<p><i>Xpedys: Xpedys misses further information about the minor maintenance Railion did or did not carry out on the relevant wagon(s).</i></p> <p><b>Board:</b> This issue is not addressed since the Safety Board did not investigate the minor maintenance Railion carried out on the relevant wagon(s) because the Board sees no reason to presume that the minor maintenance played a material role in the cause of the derailment.</p>
34	5.4.2	<p><i>Railion: The sub-conclusion incorrectly states that the QuoVadis-Gotcha system can, in analogy with HotBox detection, detect overheating axle boxes in time.</i></p> <p><b>Board:</b> The sub-conclusion does not - in contrast to the assertion in the comment - refer to the use of the QuoVadis/Gotcha system to detect an overheating axle box. To this end the system will indeed need (as is also indicated in the report) to be expanded into a real-time warning system. However, dynamic maintenance management can prevent an axle box from overheating (by eliminating the cause in time).</p>
35	5.4	<p><i>Railion: HotBox detection offers better protection from derailment caused by overheating than an upgraded/expanded QuoVadis system.</i></p> <p><b>Board:</b> HotBox detection will indeed usually detect an overheating axle box at an earlier stage than can be detected by a modified QuoVadis system.</p> <p>However, this is without detriment to the fact that consideration needs to be given to supplementing HotBox detection with the functionality of the QuoVadis system, which is why this system is included in the report.</p>
36	5.4.3	<p><i>Railion: Practical trials (in Berlin) have revealed that the reliability of derailment detection is currently far from adequate. This is also the standpoint of the international rail community. It is by no means certain that derailment detection could have prevented the Muiderpoort derailment. Installing derailment detection on all European goods wagons will be several orders of magnitude more expensive than installing HotBox detection or a comparable system on the Dutch rail infrastructure.</i></p> <p><b>Board:</b> Enquiries to the relevant manufacturer (Knorr) resulted in the Board receiving information that, in essence, indicates that the reliability of the equipment has since been demonstrated to be adequate. As indicated in the report, the RIDCE is giving consideration to the introduction of a mandatory requirement for the installation of derailment detection on specific types of wagons as from 2013. In the first instance the Muiderpoort derailment was restricted to one wheel set that was no longer rolling on the rails: the escalation occurred once the train had travelled a distance of a further 500 metres. Since the derailed wheel set was running on the sleepers over this distance it is probable that this would have activated the derailment detection on the relevant wagon. Since the train was traveling at a speed of no more than 48-58 km/hour it would probably have been possible to stop the train before it reached the escalation point.</p> <p>The Board decided not to review the specific advantages and disadvantages of the various systems or to compare their costs: the Board is of the opinion that this is an issue to be addressed by the parties.</p>

no	section	company / comment / the Board's reason
37	5.5.1	<p><i>NS Reizigers: The progress in improvements to rail safety is not optimum due to uncertainty about the rail companies' responsibilities. However, it is undesirable - and legally and operationally intolerable - to assign (part) of the responsibility for the control of the risk of goods train derailments to NS Reizigers. NS Reizigers holds itself and feels responsible for the control of risks within the company's direct sphere of influence. NS Reizigers welcomes an opportunity to contribute to joint efforts to improve rail safety. However, the statement that NS Reizigers is (jointly) responsible for the control of the risk of goods train derailments is overstepping the mark. Moreover, in NS Reizigers' opinion the necessary statutory basis is lacking. However, NS Reizigers does hold itself responsible for the notification of goods train derailments or other hazardous situations observed by the company's employees (to the traffic management centre).</i></p> <p><b>Board:</b> In essence, NS Reizigers' standpoint is that the rail companies are (and can be held) responsible solely for the for the control of the safety risks they cause, i.e. the safety risks that are completely within their sphere of influence. As indicated and explained in the report, the Board has a fundamentally different standpoint. This is because NS Reizigers' standpoint, that in a certain sense is in agreement with that of ProRail and Railion, results in the inadequate control of important safety risks. This relates to a number of the risks - such as derailments, but also the SPAD problem - that arise from the operations of one rail company whilst the control measures for those risks like partially or entirely within the direct sphere of influence of other rail companies. For this reason the Board expects the rail companies, where necessary, to make arrangements for and/or cooperate in the control of the risks confronting their operations that are caused by others and/or require a joint approach. In the Board's opinion the Railways Act also imposes this obligation on the rail companies, since the duty of care for the safety of rail traffic laid down in the Act is not limited to the risks arising from the specific duties/role of a given company and/or the risks that the company can control to an adequate extent without the involvement of other rail companies.</p> <p>On the contrary, the duty of care laid down in the Railways Act requires the rail companies to make optimum use of their specific control opportunities irrespective of whether they cause the risk. It is of great importance to the safety of rail traffic that the rail companies to call each other to account for their joint duty of care and, where relevant, set consequences for their own activities. The Board is of the opinion that the rail companies' adoption of an attitude of this nature is essential to the provision of adequate assurances for the safety of rail traffic.</p>
38	5.5.2-c	<p><i>Ministry of Transport, Public Works and Water Management: The current consultative structures in the rail sector have resulted in a joint approach to some issues, such as tackling the SPAD problem and setting up a Rail Centre of Expertise.</i></p> <p><i>NS Reizigers: The rail sector has several consultative bodies alongside the OVS (such as the VSD and SERV) and a number of steering and working groups (such as the SPAD steering group). The rail sector is also working on the formation of a Centre of Expertise for the management, control and coordination of a number of safety issues.</i></p> <p><b>Board:</b> The consultative bodies cited in the comment (the VSD and SERV) are active in specific sub-areas (the train driver's manual and competence, respectively). The Board perceives an analogy between the SPAD steering group and the reduction of the derailment risk problem: the joint approach was adopted only once, under the direction of the Ministry of Transport, Public Works and Water Management, the sector's consultative structure was supplemented with the SPAD steering group.</p> <p>The extent to which a comparable effect can be expected with the Rail Centre of Expertise that is currently being developed depends on the duties and powers assigned in that respect.</p>

no	section	company / comment / the Board's reason
39	5.5.3	<p><i><u>Railion</u>: The report unjustifiably devotes no attention to the safety management (system) of the keeper of the wagons and the relevant maintenance workshop.</i></p> <p><i><u>Board</u>: The Safety Board has not carried out an investigation of the safety management (system) of these companies since the investigation revealed no specific indications of errors/shortcomings in the periodic maintenance of these wagons. Moreover, (as explained in 5.3.2) there are already plans to make the (international) regulations governing the periodic maintenance of goods wagons (including the maintenance plans and the quality of the workshops) more stringent.</i></p>
40	5.5.3-c	<p><i><u>ProRail</u>: The observation that the risk of goods train derailments caused by rolling stock defects is not worked out in sufficient detail in ProRail's SMS is incorrect. This risk is recognised in the risk analysis and a description of the implemented control measures is included. Defect and derailment detection are not amongst the control measures that are described since these measures have not been implemented. The Board's observation relates more to the question as to whether the totality of the control measures is sufficient to achieve an acceptable residual risk. This is slightly different from an observation that the SMS is inadequate or does not comply with the statutory requirements. The requirements the European Safety Directive imposes on the SMS do not include any requirements governing specific control measures such as defect or derailment detection, the minimum control level or the residual risk. The Safety Directive does prescribe the elements to be included in the SMS, such as the possession of a risk analysis and an assessment of the risks. The IVW, in 2008, assessed that the SMS complies with these statutory requirements.</i></p> <p><i><u>Board</u>: In essence, ProRail's standpoint is that pursuant to the European Safety Directive it is sufficient to have a risk analysis together with an assessment of the risks and a description of the measures that have been implemented. The Board draws emphatic attention to the fact that the Railways Act and the management concession based on that Act also state that assurances must be in place for an analysis of the safety risks and the implementation of suitable measures to ensure that the risks are controlled to an adequate extent (whereby account needs to be taken of the state of the art). In essence, the difference between the two standpoints is that in ProRail's opinion it is sufficient to have an SMS document that contains the prescribed sections whilst the Board is of the opinion that the issue is that the relevant safety risks must have actually been reduced to ALARP level. The investigation revealed that this was not the case.</i></p> <p><i>At the end of the company's response ProRail draws attention to the fact that the IVW has assessed and approved ProRail's SMS. However, in the Board's opinion - as indicated in the report - this assessment/approval was incomplete and/or incorrect.</i></p>

no	section	company / comment / the Board's reason
41	5.5.3-c	<p><i>NS Reizigers: The Board's observation that the risk of collisions with derailed goods trains is not worked out in sufficient detail in NS Reizigers' SMS (as a result of which the SMS does not comply with the statutory requirements) is incorrect. The risk of collisions with other trains and objects is included in a risk analysis enclosed as an annex to the SMS. Consequently, with the presence of this analysis in combination with the courses and training given to the train drivers, NS Reizigers' SMS complies with the requirements stipulated in the Railways legislation, in particular with Article 3 of the Regeling Veiligheidsattest Hoofdspoorwegen ('Safety Certificate Main Railway Network'). A variety of measures implemented in the past to control risks have resulted in the achievement of a high safety level. Many of these issues have implicitly been included in the risk analysis and are now made explicit and/or described in the SMS: it is possible that the description of these risks and measures could be described in a more convenient and accessible form.</i></p> <p>Board: NS Reizigers' is of the opinion that the goods train derailment issue in the company's SMS does comply with the (statutory) requirements. This is based on the argument that the company has a risk analysis that includes the risk of collisions with other trains and object and that the train drivers follow courses and receive training. However, the Board is of the opinion that although it is true that the NS Reizigers SMS addresses this issue it is not worked out in sufficient detail. Moreover, the SMS does not include an adequate assessment or consideration of the potential control measures. NS Reizigers' draws attention to the statutory requirements laid down in Article 3 van de <i>Regeling Veiligheidsattest</i> ('Safety Certificate Main Rail Network Regulations') (which stipulates that rail carriers must have an RI&amp;E). Within this context the Board draws emphatic attention to the fact that Article 33 of the Railways Act is applicable in this situation. This Article stipulates that rail carriers must apply an adequate SMS to assure that the company implements suitable measures to maintain adequate control of the safety risks. The Board also notes that pursuant to the <i>Tweede Kadernota Spoorwegveiligheid</i> ('Second Railway Safety Framework Memorandum') 'adequate control' means the reduction of residual risks to the extent that is reasonable (ALARP level). The Board's investigation reveals that adequate control certainly has not been achieved in derailments such as the Muiderpoort derailment.</p>
42	5.5.5-b	<p><i>Railion: The conclusion that Railion's SMS does not comply with the statutory requirements cannot be derived solely from the limitation of the IVW assessment. A conclusion of this nature would be justifiable solely on the basis of the Safety Board's own findings with respect to Railion's SMS. However, these findings have not been found in the report.</i></p> <p>Board: The Board has not based its conclusion that the risk of goods train derailments caused by rolling stock defects is not worked out in sufficient detail in Railion's SMS on the fact that the IVW disregarded this issue in the Inspectorate's assessment of the Railion SMS. This conclusion is indeed based on the Safety Board's own investigation of Railion's SMS: these findings are summarised in Section 5.5.3-a.</p>

no	section	company / comment / the Board's reason
43	5.5.5-b	<p><i>ProRail: The process involved in ProRail's acquisition of the safety permit was not as described in the report but, namely, as follows: ProRail submitted an application in 2007 that was allowed. The assessment of the documents and the IVW's inspection resulted in four shortcomings and three comments. No violations were observed.</i></p> <p><i>ProRail immediately submitted a plan for improvement to the IVW and agreed to rectify the shortcomings and address the comments within six months. Subject to this condition the IVW decided to issue the safety permit immediately and for the longest possible period, namely three years. The IVW then carried out an inspection to verify that the improvements had been implemented and established that this was the case.</i></p> <p><b>Board:</b> The comment does not explicitly state the sense in which ProRail is of the opinion that the process took place other than described the Safety Board's report. It would appear that ProRail refers to the observation that the IVW initially came to the conclusion that ProRail's SMS did not comply with the requirements and that for this reason the IVW wished to issue the permit for six months (instead of for three years) subject to the condition that ProRail rectified the observed shortcomings and addressed the comments within that period. This observation is based on the correspondence conducted between ProRail and the IVW at the time. The description of the process is also based on this correspondence. Consequently, the Board sees no reason for the amendment of the relevant text.</p>
44	5.5.5-c and 6	<p><i>Railion: The draft report unjustifiably concludes that Railion's SMS does not comply with the social and statutory requirements and provides insufficient substantiation.</i></p> <p><b>Board:</b> The report explains the sense (in Section 5.5.3-a) in which the Board is of the opinion that Railion's SMS exhibits shortcomings. This relates to fundamental issues: the risk analysis extends solely to the risks confronting the company's employees and not to the risks confronting third parties (such as other trains and the passengers in those trains), important risks are disregarded and the control measures that are stated are restricted to 'supervision of competence'. In addition, the prescribed targets and plans are lacking. With these shortcomings Railion's SMS is in stark contrast with the requirements that, in the Board's opinion and pursuant to the Railways Act, are imposed on safety management (systems) (see 3.2 and 3.1.1 respectively).</p>
45	6.1.3	<p><i>Railion: Railion does not deny that it is a joint problem owner, but cannot compel an effective solution in isolation.</i></p> <p><b>Board:</b> The Board is aware that the introduction of HotBox detection and the upgrading of the QuoVadis system is not within Railion's operational area (or of the other carriers). However, the Board does expect the carriers to call ProRail to account for the fact that these measures have not been implemented. The Board is also of the opinion that Railion and the other rail carriers should make a company assessment of the use of dynamic maintenance management and derailment detection on the trains that they use on a more-or-less permanent basis. In the Board's opinion Railion has failed to give sufficient shape to both the company's responsibility and the rail companies' joint responsibility to demonstrably reduce the derailment risk to an adequate level.</p>

**ANNEX 2: EXPLANATION OF TECHNICAL TERMS**

The wagons involved in the Amsterdam-Muiderpoort derailment were comprised of a hopper mounted on two bogies. Each bogie has two wheel sets, each of which is comprised of two wheels mounted on an axle. The section of the shaft that projects beyond the wheel is called the axle journal. The axle journal is mounted in an axle box that, via springs, supports the bogie supporting the hopper. The axle box is fitted with two bearings that allow the axle to rotate in the axle box.



Figure 6: Wagon with two bogies (each of which has two wheel sets).



Figure 7: Wheel set with (in the foreground) an axle box.





*Figure 8: The second wheel set of the eleventh wagon. The left-hand axle journal has broken off/melted.*



*Figure 9: the overheated axle box found next to the track at the location of the derailment.*

The axle-box bearings are comprised of an inner ring and an outer ring that house two rows of (barrel-shaped) rollers. The rollers are held in place by a bearing cage. The projections from the cage that hold the rollers in place are called cage lips.

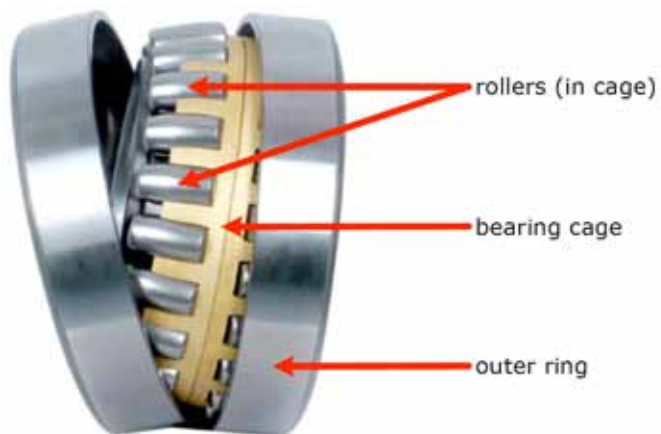


Figure 10: Example of a bearing. This outer ring has been opened to show the rollers and the bearing cage. The bearing shown in this photo (of the same as the bearing involved in the Muiderpoort derailment) is a double-row barrel bearing with a comb-shaped bearing cage.

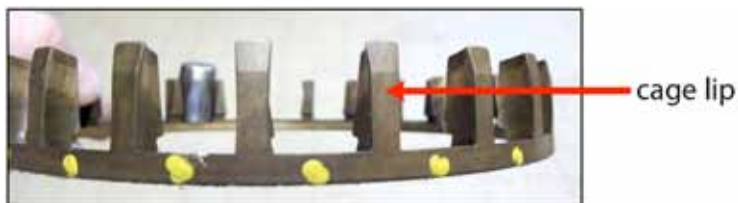


Figure 11: This photo shows a comb-shaped bearing cage as used in the bearings in question.

The breakage of a cage lip will result in friction between the rollers that are no longer held in place and can seize. If the wagon continues to move then the seized rollers begin to rub against the inner and/or outer ring. The resultant friction heats the axle box and axle journal (overheating) to an extent that the axle journal can break off or melt (as was the case in the Muiderpoort derailment).



### ANNEX 3: EXPLANATION OF THE FINDINGS FROM THE TECHNICAL INSPECTION

#### 1. Facts of the derailment

On the basis of the on-site inspection the Safety Board concludes that the actual derailment occurred at a short distance (51 metres) after the end of the platform of Amsterdam-Muiderpoort station and that the derailment was comprised of the front wheel set of the eleventh wagon running off the rails to the right. This conclusion is based on the following observations:

- a) Damage was seen on the right-hand rail of the relevant track (UP) 51 metres past the end of the platform that was indicative of a wheel flange climbing over the head of the rail. The length of these 'derailment marks' were about 15 metres.



Figure 12: This photo shows the derailment marks on the head of the right-hand rail.

- b) The sleepers immediately following the end of the derailment marks exhibited damage indicating that a wheel set had run alongside the rails.



Figure 13: This photo shows the damage the left-hand wheel of the derailed wheel set caused to the concrete sleepers. The overheated axle box and one of the four springs accompanying the axle box lie next to the rail.

The two wheels of the front wheel set were the only derailed wheels that exhibited severe damage of the flanges and running face of the form that can be expected when wheels run a considerable distance over concrete sleepers (see Figure 14).



Figure 14: These photos show the damage to the wheels of the front wheel set (of the front bogie of the eleventh wagon) caused by the wheel set running over the concrete sleepers.

- c) From its findings from the on-site inspection also concludes that:
- the train continued its journey with one derailed wheel set after the actual derailment (see a);
  - that the derailed wheel set damaged a set of points (421-B) about 500 metres further on;
  - that as a result the 'following' wheel sets did not go straight on (as the previous wheel sets had) but turned to the right;
  - that as a result the wagons 11 to 19 inclusive were derailed, whereby the coupling between the twelfth and thirteenth wagon broke and some of the derailed wagons (wagons 11, 12, 14 and 15) toppled over.

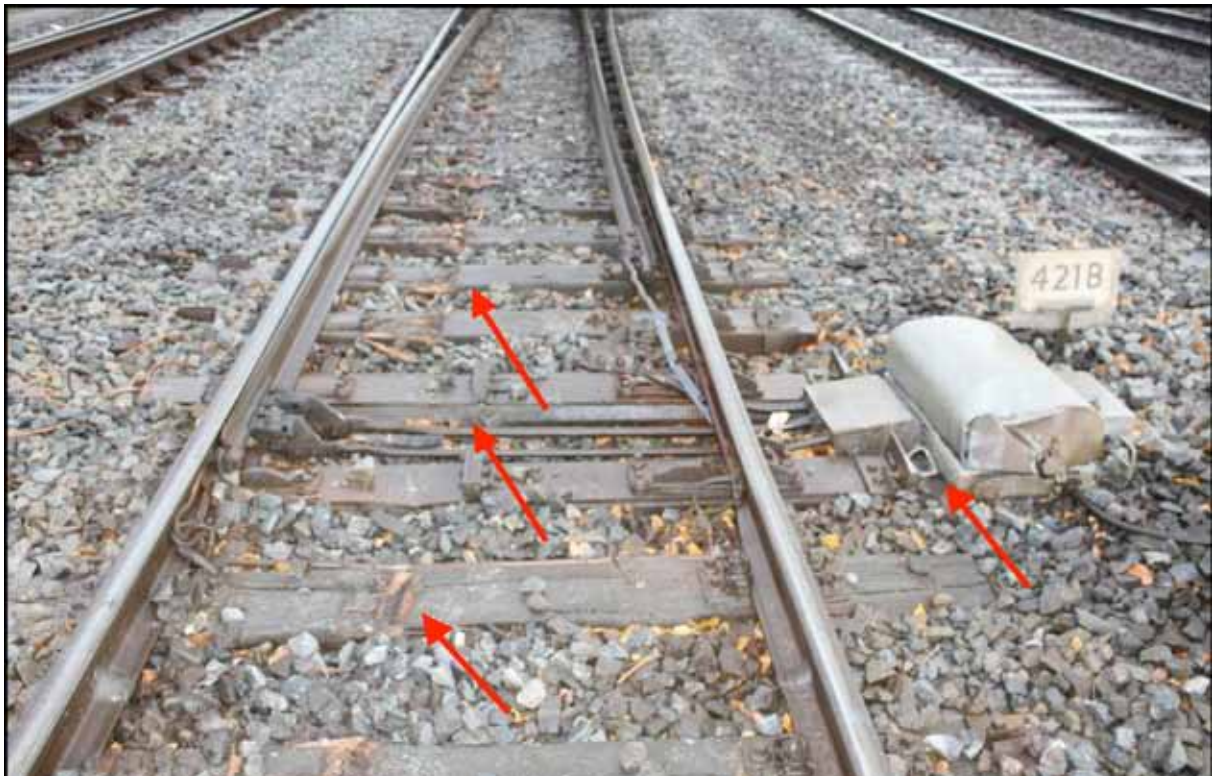


Figure 15: This photo shows the damage the derailed wheel set caused to the sleepers and the operating mechanism of the set of points

The above implies that the following the actual derailment the train travelled a distance of about 500 metres until the derailment escalated.



Figure 16: This photo shows some of the derailed wagons and a number of wheel sets that had broken off.

## 2. Cause of the derailment

On the basis of the situation observed at the location the Board concludes that the derailment was caused by the overheating of the left-hand axle box of the second wheel set of the eleventh wagon that in turn caused the relevant axle journal to break off. This conclusion is based on the following observations and arguments:

The left-hand axle box of the second wheel set was found next to the left-hand rail about 30 metres past the derailment marks (see 1-a). The axle box was still hot and the end of the relevant axle journal (that had broken off the wheel set) was enclosed in the axle box.

Simulation calculations carried out on the Safety Board's request reveal that in the relevant circumstances the breakage of the relevant axle journal does indeed result in the derailment of the front wheel set of the relevant bogie derailing to the right (in agreement with what actually happened).

The following observations can be made about the simulation calculations:

- The simulation calculations were used to investigate the effect the (gradual) breaking off of the axle journal concerned had on the running properties of the relevant bogie. The calculations were carried out by DeltaRail UK using the Vampire simulation program developed by the company. A detailed vehicle model was used for the relevant goods wagon: the overheating of the axle box and the 'gradual' breaking off of the axle journal were modelled by making the connection between the axle journal and bogie frame time-dependent (in the sense that the connection could be eliminated at any chosen time and during a period that could be set to a specific time). The model was used to carry out simulations for both a straight section of track and a curved section of track with an alignment that was the same as at the derailment point. The track alignment at the derailment point was configured using the relevant available measurement data<sup>65</sup>. The simulations were carried out with a train travelling at a speed of 60 km/hour.

65 The alignment of the relevant section of track was surveyed on 09-11-2008 (i.e. about two weeks before the derailment). The data was comprised of the X/Y/Z coordinates and the cant, at intervals of 10 metres.

- In essence, the results from the simulations were as follows:
  - Breaking the connection between the axle journal and the bogie frame resulted in the complete unloading of the rear left-hand wheel, a reduction of up to 17% of the load on the front right-hand wheel and an increase of up to 141.5% on the front left-hand wheel and rear right-hand wheel.
  - Neither the bogie as such nor the rear wheel set exhibited any misalignment during the 'breaking process'.
  - As soon as the connection between the axle journal and bogie frame falls away the rear left-hand wheel climbs the rail and the rear wheel set turns to the right, taking the bogie with it (and as a result the bogie becomes misaligned).
  - As a result of the aforementioned misalignment the front right-hand wheel climbed the rail and this resulted in the derailment of the front wheel set to the right (which is in agreement with what actually happened).
  - The aforementioned process takes place on both a straight section of track (without canting) and a curved section of track with canting, as was the situation at the derailment point.
  - Without the defective wheel mounting the wheels exhibit no tendency to derail at the section of the track where the derailment occurred, since the unloading of the wheel is restricted to less than 20% and the value of  $Y/Q$  remains below 0.4.

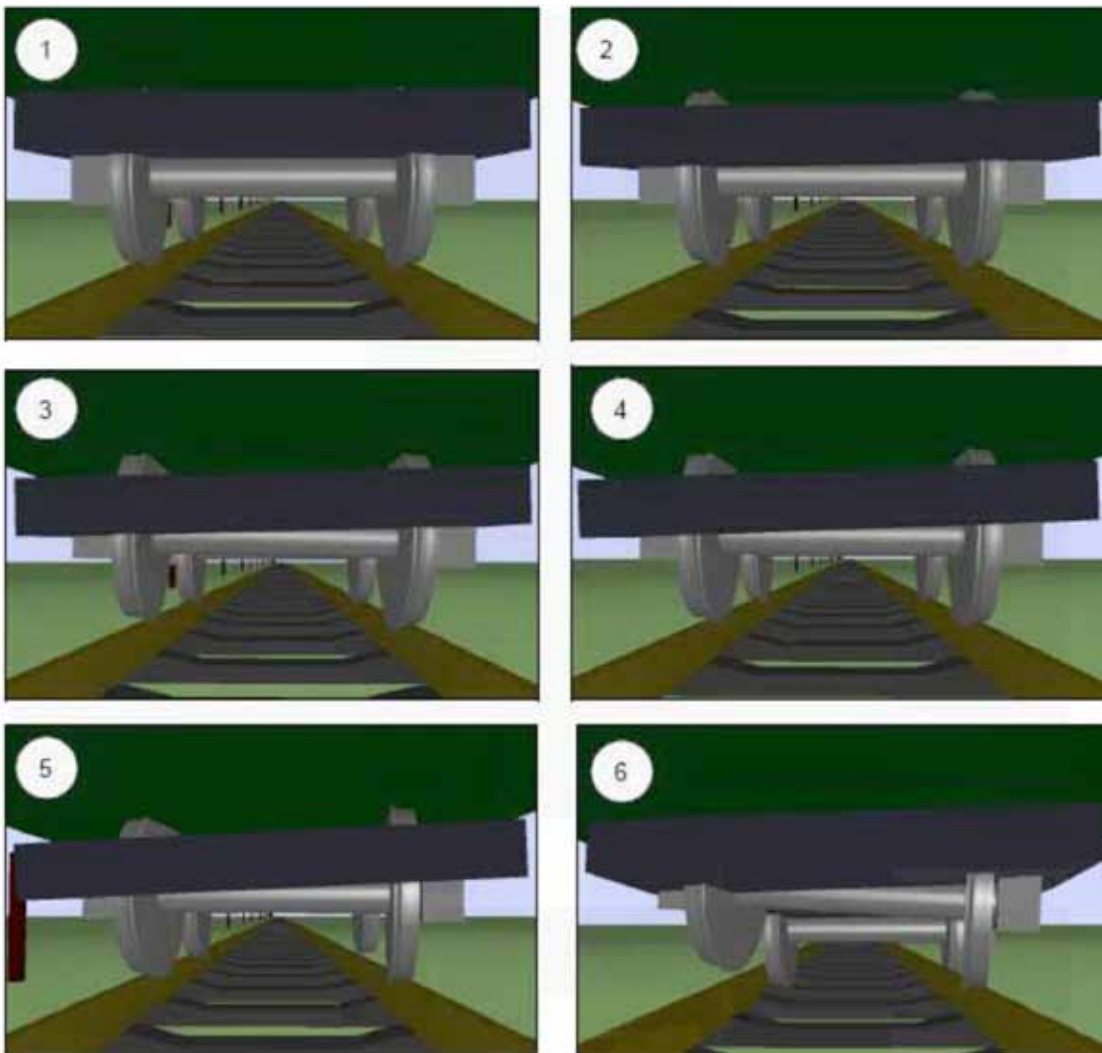


Figure 17: Simulated derailment process (seen in the direction of travel): 1 = initial situation, 2+3 = rear wheel set climbs left rail , 4+5 = front wheel set climbs right rail and 6 = derailment of front wheel set.

The simulations explained above reveal that both the derailment of the wheel set and the location at which the derailment occurred are determined by the time at which the axle journal melted completely off. The simulations also reveal that the rail alignment (both the radius of the curve and the canting) did not play a material role.

### 3. Cause of the axle box overheating

The Board arranged for a further technical investigation to determine the cause of the axle box overheating. In essence, the findings were as follows:

- a) The total weight of the relevant wagon was 85.1 tonnes, lower than the maximum permitted weight (90 tonnes). The upper sides of the axle boxes did not exhibit any traces of indentation of the nature that would be expected with substantial overloading. The wheel set did not exhibit any traces of grease extruded from the axle boxes.
- b) A visual inspection of the wheel set mounted in the overheated axle box did not reveal any flats on the running surface or other insufficient roundness of the wheels. The flange of the wheel did exhibit damage in the form of a rim that had worn at an angle, although this probably occurred after the derailment (when the bogie, after the derailment of the front axle, was misaligned with the rails during the approximately 500 metres that the wagon travelled before the train was stopped). Measurements of the wheel geometry did not reveal any anomalies that could be of relevance to the overheating.
- c) When the axle box was dismantled the bolts fastening the axle box housing were found to be sufficiently tight. The axle box cover was also of the correct type (for a 22.5 tonnes axle). The bolts fastening the pressure cap that locked the bearings in place were broken. The damage was caused by excessive force: the nature of the damage indicated that these bolts had not come loose. The bearings fitted to the axle box (FAG-502472) were of the prescribed make and type and were mounted correctly relative to the axle box housing.

A further technical inspection revealed the following (see also the drawing below):

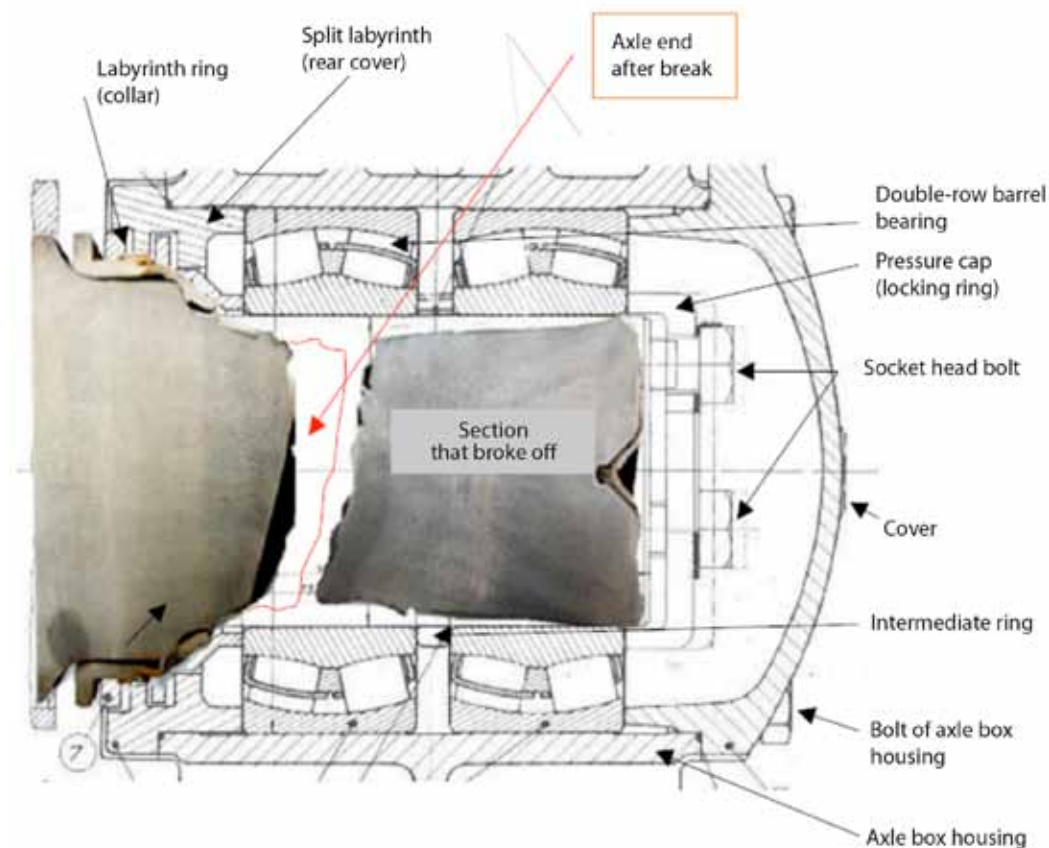


Figure 18: Cross-section of the axle journal and axle box housing. Two double-row barrel bearings are mounted in the axle box housing. The axle journal has broken at the point where it passes through the inner bearing.

The axle journal broke at the point where it passed through the inner bearing. The boring of the inner ring of the outer bearing exhibited clearly-visible erosion: this indicated that the axle journal had rotated in and eroded this bearing. Sections of the inner ring were completely worn away.



In the Board's opinion the above implies that the outer bearing seized (jammed) before the axle journal broke off. Consequently, the cause of the overheating must be sought in the seizure of the outer bearing.

The outer bearing was extremely severely damaged (see photos below).



Figure 19: The outer layer from the overheated axle box. the top left photo shows the outer side, the top right photo the inner side. The bottom left photo was taken once the outer ring had been cut through and partly removed. The bottom right photo shows the raceway of the outer ring after the ring had been cleaned.

An inspection of the raceways of the inner ring and the outer ring after the bearing had been opened did not reveal a degree of chipping that could have explained the seizure (see Figure 20, bottom right photo). It was also observed that flats had been worn on some of the rollers in the bearing before the rollers had become 'welded' to the inner ring (see Figure 20).



Figure 20: Three rollers from the outer layer: one roller had turned through 90 degrees and flats had worn on all three rollers.

This situation can be explained only by the relevant rollers becoming jammed relative to the outer ring while the inner ring was still rotating. Since one of the rollers had turned through 90 degrees (see Figure 20) at least one cage lip of the bearing cage must already have been broken off at the time the bearing began to seize.

The bearing cage, which was made of brass and was comb-shaped (see left photo in Figure 21), had largely melted. The cage lips had broken off from the remains of the bearing cage (see right photo in Figure 21).



Figure 21: Left: a comb-shaped brass bearing cage of the type used in the relevant bearings. Right: the remains of one of the two bearing cages from the outer bearing mounted in the overheated axle box (with the cage lips broken off).

- d) Since the axle box had overheated it was no longer possible to assess the lubrication conditions (the quantity, distribution and quality of the grease) in the relevant axle box. For this reason the lubrication condition of ten other axle boxes mounted on the relevant wagons was inspected. This revealed that:
- the quantity and distribution of the grease were correct;
  - the film of lubricant on the bearings' raceways was (visually) correct;
  - the consistency of the grease was in agreement with the prescribed specifications;
  - the grease did not contain any sand;
  - the grease did not contain abnormal concentrations of abrasive particles (iron/copper).

On the basis of the aforementioned nature of the damage the Board concludes that the course of the overheating of the axle box must have been as follows: the axle box began to overheat when the outer bearing seized. The bearing began to seize once some of the rollers jammed relative to the outer ring, at which point at least one of the cage lips had broken off. The inner ring then continued to rotate for some time relative to the (jammed) rollers. As a result the inner ring also jammed, which in turn resulted in the axle journal rotating in and eroding the inner ring. The axle journal then broke off (at the point where it passed through the inner bearing. Finally, the remaining section of the axle journal eroded the inner bearing and the axle box in an upward direction.

#### 4. Damage to the reference bearings

The technical inspection of the overheated axle box was supplemented with an inspection of ten other axle boxes (that were also mounted on the derailed wagons). This revealed that the (total of twenty) bearings in these axle boxes exhibited slight to moderate current-flow damage in the form of small crater-shaped pits in the raceways of the inner and outer ring and the rollers, on occasion in a series of pits (viewed in the direction of rotation).

In the longer term damage of this nature can result in chipping of the raceway and, in turn, the failure of the bearing.

In addition, one of the twenty bearings that were inspected exhibited chipping of the raceway of the outer ring at two locations. The distance between the two locations was equal to the centre-to-centre distance between the rollers. In the opinion of the bearing experts the Board consulted the form and the distance between the chipping indicated that this chipping was probably not caused by current-flow damage but by brinelling<sup>66</sup> or corrosion.

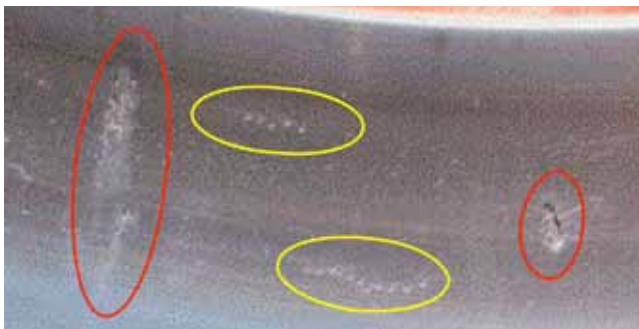


Figure 22: The adjacent photo shows the current-flow damage (circled in yellow) and chipping (circled in red) in the raceway of the outer ring of a bearing from one of the ten other axle boxes that were inspected.

The bearing experts that the Board consulted stated they expected that chipping of this magnitude would have resulted in the failure of the bearing within the remaining period of the overhaul interval (eight years).

#### 5. Detectability of the overheated axle box

On the basis of the available information the Safety Board is of the opinion that the overheating of the axle box could in any case have been detected when the train was still more than sixty kilometres and, possibly, still considerably further from the location of the derailment. This conclusion is based on the following information and arguments:

The goods train covered a distance of more than 230 kilometres from the Belgian/Dutch border at Maastricht to the location of the derailment. This, including a number of stops on the way, took more than five hours. The train passed five QuoVadis-Gotcha<sup>67</sup> stations on its journey that were located at Maastricht, Bunde, Geldrop, Esch and Tricht. The wheel loads were measured at these stations.

The first four measurement stations did not measure an anomalous distribution of the load over the wheels of any of the bogies. However, the fifth measurement station (at Tricht) did measure an anomalous distribution of the load over the wheels of one bogie: this was the front bogie of the eleventh wagon (the wagon with the overheating axle box). The anomaly related to a diagonal difference in the wheel loads: the load on the front left wheel and the rear right wheel was about 40% more than the nominal load<sup>68</sup> and the load on the rear left wheel and front right wheel was about 40% less than the nominal load.

66 Brinelling relates to small dents in the raceway of rolling bearings caused by exposure to vibration when the bearing is stationary.

67 A further explanation of the QuoVadis-Gotcha system is given in 5.4.2 and 5.4.4.

68 The total weight bearing on a bogie is normally divided approximately equally between the two axles and four wheels of the bogie, i.e. each axle bears about one quarter of the total weight of the wagon and each wheel about one eighth of the total weight of the wagon. The total weight of the wagon in question was more than 80 tonnes, so the nominal wheel load was about 10 tonnes.

The distance from the relevant measurement station (Tricht) to the location of the derailment (Amsterdam-Muiderpoort) was more than 60 kilometres and the train took about 53 minutes to cover this distance.

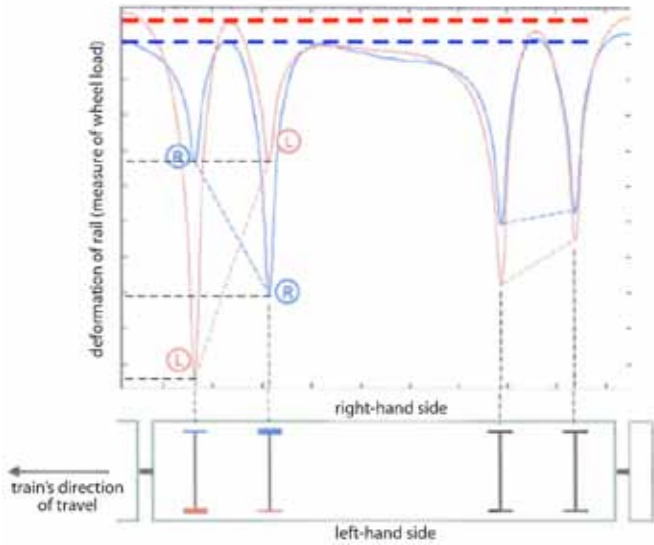


Figure 23: This figure shows the wheel loads of the eleventh wagon as recorded by the QuoVadis-Gotcha station at Tricht. The front bogie exhibits a diagonal difference in the wheel loads.

The anomalous distribution of the wheel loads at Tricht should be viewed in combination with the fact that by the time the train reached Amsterdam-Muiderpoort the left-hand axle box of the rear wheel set of the relevant bogie had overheated to an extent such that the axle journal had eroded its way through the axle box. For this reason the Board concludes that the difference in wheel loads measured at Tricht was due to the fact that at that location and at that time the axle box had eroded through the axle box to an extent such that the axle box had already 'sagged' by an appreciable distance. On the basis of the available information about the dimensions of the relevant parts and the spring stiffness of the primary suspension the wheel unloading measured at Tricht (approximately 40%) is equivalent to the axle box sagging - and the axle journal eroding into the axle box - by a distance of approximately 95 mm. This distance (95 mm) is about half of the total distance (approximately 200 mm) required for the axle journal to erode completely through the axle housing (before the axle journal broke free shortly before reaching the derailment point at Amsterdam-Muiderpoort).



Figure 24: This photo of (the inner side of) the overheated axle box shows that the axle journal erodes its way upwards through the axle box.

In the Board's opinion it is also possible to state that this degree of erosion (approximately 95 mm) of the axle journal through the axle box would have been accompanied by the generation of sufficient heat to raise the temperature of the axle box to a level that could also have been detected by a HotBox detection system at that location and at that time.

The distance between the last measurement station (Tricht) and the last measurement station but one (Esch) was more than thirty kilometres. Since the last measurement station but one did not measure any anomalous distribution of the load over the wheels it is possible to state that at that location and at that time (approximately 95 km before the derailment) the overheating process had not reached a stage at which the axle box had already sagged to a significant extent. However, in the Board's opinion this does not preclude the possibility that the axle box had already overheated to a degree that could have been detected with a HotBox detection system.

#### 6. List of identification numbers

Train number: 48642

Carrier: Railion

Position	Wagon number	Weight (tonnes)	Net (tonnes)
1	3180 0665 001-0	81.6	56.8
2	3180 0671 118-4	84.1	59.6
3	3180 0671 104-4	85.1	60.1
4	3180 0671 102-8	84.9	59.9
5	3180 0671 111-9	84.2	59.7
6	3180 0671 145-7	84.5	60.0
7	3180 0671 133-3	83.5	59.0
8	8188 6640 054-7	87.0	61.8
9	8188 6640 088-5	88.7	63.8
10	8188 6640 058-8	84.6	59.5
<b>11</b>	<b>8188 6640 082-8</b>	<b>85.1</b>	<b>60.8</b>
12	8188 6640 050-5	84.5	59.6
13	8188 6640 020-8	83.4	58.5
14	8188 6640 059-6	85.2	60.4
15	8188 6640 076-0	83.2	58.5
16	8188 6640 009-1	85.4	60.7
17	8188 6640 099-2	85.2	60.6
18	8188 6640 045-5	87.4	62.7
19	8188 6640 018-2	86.3	61.2
20	8188 6640 053-9	87.1	62.3
21	8188 6640 052-1	88.0	63.2
22	8188 6640 046-3	89.6	64.7
23	8188 6640 061-2	87.1	62.8
24	8188 6640 069-5	85.5	60.8
25	8188 6640 031-5	87.7	62.7

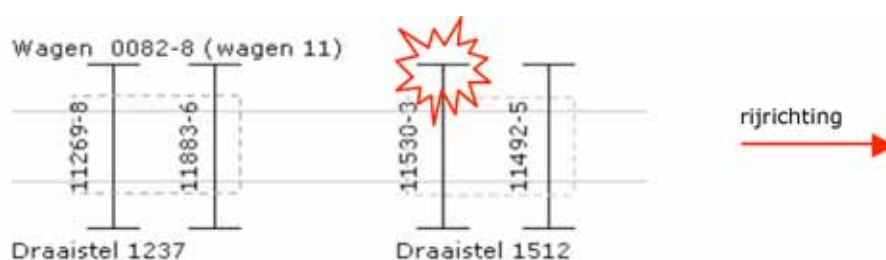


Diagram of wagon number 11 with bogie and wheel set numbers; the overheated axle box was on the left-hand side of wheel set 11530-3.

## ANNEX 4: EXPLANATION OF PROCESS DAMAGE

Until now it has not been customary to express process damage in terms of financial loss in the Netherlands. Pursuant to the customary practice a description of the magnitude and duration of the disruption of the rail traffic has sufficed. ProRail was asked to supply a description of the process damage incurred as a result of the last three derailments, expressed in a number of index numbers. The information is listed in the following table.

Goods train derailment	Amsterdam-Muiderpoort	Vleuten Terwijde	Venlo
Date	22 November 2008	23 March 2009	14 July 2009
Closure	7 days	7 days	5 days
Cancelled trains	74 goods trains 2700 passenger trains	96 goods trains 2600 passenger trains	76 goods trains 26 passenger trains
Of which diverted	30 goods trains 514 passenger trains	87 goods trains 300 passenger trains	41 goods trains 0 passenger trains
Emergency infrastructure	Until 2 February 2009 0.8 minute/train	Until 20 July 2009 0.6 minute/train	None
Delay minutes, passenger trains	20,800 minutes	7,250 minutes	0 minutes

*Process damage incurred as a result of recent goods train derailments<sup>69</sup>*

The Safety Board carried out a calculation for the Muiderpoort derailment to gain an impression of the magnitude of the process damage. The ERA supplied a calculation method that can be used to quantify the delay passenger and goods trains suffer as a result of a closed rail line. Significance, which has cooperated at a European level in the index numbers for the valuation of (travelling) time, gave an explanation of the method. The variables in the formula are the number of trains (with a distinction between goods and passenger trains) that suffer disruption due to the derailment, the average number of passengers in each passenger train and the (average) delay incurred by passenger and goods trains. These quantities can be multiplied to obtain the total lost time incurred by passenger trains and goods trains. The calculated time loss can be converted into financial loss by multiplying the time by the costs per time unit (minutes). The delay suffered by goods trains can be calculated using the tonnage per train. However, within this context it is customary to use the number of goods trains rather than tonnage in the Netherlands.

The values for the variables were requested from ProRail, NS and Railion. The ERA bases the costs per time unit on the 'HEATCO' figures, index numbers developed at a European level to calculate the benefits of infrastructural work. Travellers and goods carriers were requested to indicate what they would be prepared to pay for a one-minute time gain. A study was carried out to normalise this amount. The figures are now used by European countries in the decision-making on infrastructural works. The time gain expressed in financial terms relates to the benefits compared to the investments. In the Netherlands these index numbers are used and periodically updated by the Netherlands Bureau for Economic Policy Analysis, the Directorate-General for Public Works and Water Management and the Ministry of Housing, Spatial Planning and the Environment. The ERA now uses this method for the converse situation, a disruption of rail traffic that results in time loss<sup>70</sup>.

69 Data from ProRail (Memo of 22 July 2009).

70 A theoretical explanation is given by Jong (2008). The Dutch index numbers are available from the Directorate-General for Public Works and Water Management's website.

The Safety Board used these index numbers (the updated index numbers for the Netherlands) to calculate the process costs. The calculations were based on conservative assumptions: for example, no account was taken of the fact that travelling time loss is fundamentally more expensive than travelling time gain.

The calculations carried out using the method described above indicate that the total process costs of the Amsterdam-Muiderpoort derailment amount to about two million euros. This calculation does not take account of the process costs incurred by goods trains.

The calculation reveals that by far the most determinative factor is the number of passengers that suffered 'hindrance' from the disruption of train services. Goods trains make a relatively much smaller contribution to the costs, both because of the differences in scale in the numbers for passenger trains and goods trains and because goods trains that are cancelled simply do not travel. In contrast to travellers, who take a later train or make a detour, goods trains are not loaded (when the cancellation is known in advance). The Safety Board is unaware of an index number that can be used for this calculation.

## ANNEX 5: MEMORANDUM OF UNDERSTANDING

### Memorandum of Understanding (MoU)

Establishing the basic principles of a common system of certification of entities in charge of maintenance for freight wagons.

Brussels, 14 May 2009

#### 1. PREAMBLE

- (1) The entry into force of the new 1999 COTIF<sup>1</sup> Convention on 1st July 2006 has brought in new rules governing contracts for the use of vehicles. According to its CUV appendix<sup>2</sup>, wagon keepers are no longer obliged to register their wagons with a railway undertaking. The former RIV<sup>3</sup> Agreement between railway undertakings has ceased to apply and was partially replaced on the same date by a new private and voluntary agreement the General Contract of Use (GCU)<sup>4</sup> between railway undertakings and wagon keepers whereby the latter are in charge of the maintenance of their wagons. In order to reflect these changes and to make easier the implementation of Article 10 of Directive (EC) No 2004/49 (hereinafter referred to as "Railway Safety Directive") on safety certification of railway undertakings, the European Commission (hereinafter referred to as "the Commission") adopted on 13 December 2006 a proposal of modification of that Directive. This amendment was adopted on 16 December 2008 under Directive 2008/110/EC<sup>5</sup>. This MoU is based on that amendment.
- (2) Before a vehicle is placed in service, according to the rules for authorising new vehicles and those relating to existing vehicles, or used on the network, an Entity in Charge of its Maintenance (hereinafter referred to as "ECM") will be a mandatory requirement and is to be identified in the National Vehicle Register. A railway undertaking, an infrastructure manager or a keeper could be such an ECM.
- (3) In accordance with the revised Railway Safety Directive and for freight wagons only, the ECM shall be certified in accordance with a system to be developed by the European Railway Agency (hereinafter referred to as "the Agency") and to be adopted by the Commission. Where this ECM is a railway undertaking (RU) or an infrastructure manager (IM), this certification should be included in the procedure for safety certification or authorisation. The certificate delivered to such entity would ensure that all applicable maintenance requirements are met for any freight wagon of which it is in charge. This certificate should be valid in the whole Community and should be delivered by a body able to audit the maintenance management system set up by such entities. As freight wagons are frequently used in international traffic and as an ECM may want to use workshops established in more than one Member State, the certification body should be able to perform its controls in the whole Community.

<sup>1</sup> Convention concerning International Carriage by Rail (COTIF)

<sup>2</sup> Uniform Rules concerning Contracts of Use of Vehicles

<sup>3</sup> *Regolamento Internazionale Veicoli*

<sup>4</sup> The GCU website: <http://www.gcuoffice.org/spip.php?article15>

<sup>5</sup> Directive 2008/110/EC of the European Parliament and of the Council of 16 December 2008 amending Directive 2004/49/EC on safety on the Community's railways (Railway Safety Directive) (OJ L 345, 23.12.2008, p. 62)



- (4) The increasing opening of the railway traffic markets results in additional interfaces, in particular between the ECMs of freight wagons and the railways companies.
- (5) The stakeholders, as represented by ERFA<sup>6</sup>, CER<sup>7</sup>, UIC<sup>8</sup> and UIP<sup>9</sup> have repeatedly stated their substantial interest in a certification system for ECMs to be set up on a voluntary basis, with a view to the adoption of the certification system in accordance with Article 14a(5) of Directive 2004/49/EC. This possibility was discussed in the working group "role of the keeper" and considered to be a good solution for the transition period. This solution can be implemented by means of a Memorandum of understanding (MoU) between the appropriate authorities of the Member States of the European Union.
- (6) As railway traffic does not stop at the borders of the European Union, it would make sense, in anticipation of the intended revision of Appendix G (ATMF) of the COTIF 1999 and its adjustment to Community legislation, to extend such an agreement also to interested non EU Member States of OTIF<sup>10</sup>. This would accommodate the legitimate interest of the stakeholders in a use of freight wagons as generous as possible.

## 2. AGREEMENT:

The signatories conclude the following agreement:

### 2.1. Goal

#### 2.1.1. Recognition:

This MoU aims at setting up a provisional voluntary system of certification of ECMs in the case of freight wagons. It establishes the principle of mutual recognition of certificates granted to ECMs.

#### 2.1.2 Certification:

Any RU or IM, which is, as stated in its safety certificate, operating vehicles for which maintenance is carried out by an ECM certified according to this MoU, will be understood to satisfy all safety requirements concerning maintenance of those vehicles which may be imposed by any National Safety Authority (NSA) under a safety certificate or safety authorisation issued in compliance with Articles 10 or 11 of the Railway Safety Directive.

<sup>6</sup> European Rail Freight Association

<sup>7</sup> Community of European Railways Infrastructure Companies

<sup>8</sup> International Union of Railways

<sup>9</sup> International Union of Private Wagons

<sup>10</sup> Intergovernmental Organisation for International Carriage by Rail

This is without prejudice to the responsibility, under Article 4 of the Railway Safety Directive, of railway undertakings and infrastructure managers for the safe operation of trains.

Such certification will not prevent the hauling RU or IM to do any necessary safety visual, auditory checks and measurements before starting a train. These checks are the last and most important safety means to detect any "non safe" events which may have happened during the previous trip of the vehicle or where a train preparation check has detected a lack of maintenance.

#### 2.1.3 Common Understanding:

This MoU will support a common understanding of the role and tasks of the ECM and interfaces with other actors.

### 2.2. Role and tasks of the ECM

The ECM will ensure that vehicles are maintained in accordance with:

- a) the maintenance file of each vehicle;
- b) the requirements in force including maintenance rules and TSI provisions.

The ECM is responsible for following up the maintenance process and rules of a vehicle.

The tasks of the ECM and its interfaces with the actors are further developed in Annex B.

### 2.3. Certification of the ECM under this MoU

2.3.1. An ECM may be certified if it has implemented a system for maintenance which includes the requirements given by Annex B.

2.3.2. An ECM will be certified by a body fulfilling the requirements mentioned in Annex D.

2.3.3. The initial certification of the ECM and its ongoing inspection will comply with the criteria and procedures set out in Annex C. Use of the forms given in Annex E is recommended.

2.3.4. To obtain certification of its Maintenance System an ECM has to hold a civil liability insurance.

2.3.5. The cost of the certification and ongoing inspection procedure will be met by the ECMs.

#### **2.4. Validity of certificates of an ECM**

- 2.4.1. The ECM certification will be renewed at least every five years and it can be revoked by the issuing certification body, if the ECM does not fulfil the relevant requirements.
- 2.4.2. The ECM certificates granted under the provisions of this MoU will be valid throughout the Community.

#### **2.5. Requirements for the certification bodies**

- 2.5.1. The Certification Body (hereinafter referred to as “CB”) will fulfil the following minimum requirements, further detailed in Annex D:
- (a) The CB will be organisationally, functionally and in its decisions independent from railway undertakings, infrastructure managers, wagon keepers and ECMs and will not perform similar services.
  - (b) The CB and the deployed personnel will have the required professional competence in particular regarding the organisation of the maintenance of freight wagons and the appropriate maintenance systems.
  - (c) The CB will ensure that it makes its decisions impartially.
  - (d) The CB will hold civil liability insurance, unless a member state is liable under a national legal provision.
- 2.5.2. Member states will implement an appropriate recognition or accreditation process. Both the accreditation and recognition process will be based on criteria of independence, competence and impartiality, such as the relevant European standards.
- Competent authorities will publish an application form to be used by bodies which intend to act as CBs for ECMs or a list of detailed criteria to be recognised as competent to do so. The competent authorities have the right to undertake audits from time to time of the compliance with Annex B of the approval/recognition procedure.
- A CB being assessed under paragraph 2.3.2 has a declaration of its competence on the basis of the relevant European standards, this will be considered by the Member state when assessing the body.
- 2.5.3. The Agency will consider the need to establish a CB Coordination Group and if appropriate, the Commission will mandate the Agency to organise such a group. Each body acting as certification body for ECMs and, where appropriate, the competent authorities will keep a list of the ECMs certified by them. These lists will be kept up-to-date and notified to the Agency to be published.
- 2.5.4. Each Member State will notify the Agency of the list of CBs. That notification will be done one year after the signature of this MoU for the first time and then in all cases of changes. The CBs have to notify to the Agency the ECMs they have

certified and also those, whose certification have been refused. The Agency will publish and keep up-to-date a consolidated list of ECM certification bodies.

## **2.6. International cooperation**

2.6.1. Competent authorities of OTIF states which are not EU Member States will be able to sign this MoU. To this effect, the General Directorate for Energy and Transport of the Commission (DG TREN) will liaise with the OTIF Secretariat General in order to organise the signature by OTIF non EU Member States who would like to sign this MoU.

Due to differences between Community legislation and the COTIF 1999 convention, specific provisions applicable to non EU signatories are necessary and are detailed in Annex F.

## **2.7. Governance of this MoU**

2.7.1. This agreement will be signed by the competent authorities of the EU Member States. It will apply in each Member State from the date of signature by the representative of that Member State and, where appropriate, when the Member State has taken the national measures needed to apply the MoU. The Member States notify this date to DG TREN.

2.7.2. DG TREN will publish it and keep up-to-date the lists of signatories and the date of the application in the Member States (Annex A).

2.7.3. The Agency will organise an exchange of experience between NSAs, under Article 6(5) of its Regulation (EC) No 881/2004 (Agency Regulation) and Article 17(4) of the Railway Safety Directive with a view to a uniform application of this MoU.

2.7.4. This agreement will lose its validity as soon as a certification system for ECMs adopted under Community legislation enters into force.

**Done at Brussels, 14 May 2009**

**For Austria:**

Dipl. Ing. Michael Walter  
Railway and Interoperability Committee (RISC) Member  
Ministry of Transport



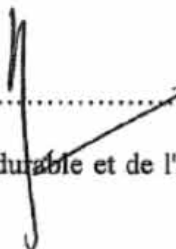
**For Belgium:**

Mr Pierre Forton  
Directeur général Transport Terrestre  
Service Public Fédéral Mobilité et Transports



**For France:**

Mr Denis Huneau  
Ingénieur général des ponts et chaussées  
Ministère de l'écologie, de l'énergie, du développement durable et de l'aménagement du territoire  
*(pour le Ministre, par délégation)*



**For Germany:**

Mr Michael Harting  
Deputy Director General of the Department "Railways"  
Federal Ministry of Transport, Building and Urban Affairs



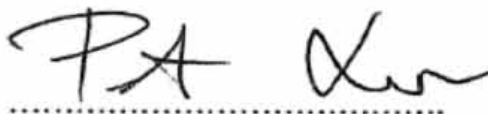
**For Greece:**

Mr. George Patris  
Transport Attaché  
Permanent Representation of Greece to the EU



**For Hungary:**

Mr. Péter Lányi  
Deputy General Director  
Ministry of Transport, Telecommunication and Energy



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**For Italy:**

Mr. Massimo Provinciali  
Direttore Generale  
Ministero delle Infrastrutture e dei Trasporti



.....

**For Luxemburg:**

M. François Jaeger  
Directeur Gestion Réseau  
*(pour le Gouvernement, par délégation)*



.....

**For The Netherlands:**

Drs. E. Griffioen  
Chief Inspector  
National Safety Authority



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**For Romania:**

Dr. Marin Stancu  
Deputy Director  
Ministry of Transport and Infrastructure  
Directorate for Infrastructure and Railway Transport



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**List of Annexes:**

- Annex A: List of EU Member States and OTIF non EU Member States applying this MoU
- Annex B: Requirements to the ECM for setting up its Maintenance System
- Annex C: Assessment Criteria and Procedures
- Annex C1 – Assessment Criteria
  - Annex C2 – Assessment Procedures
- Annex D: Accreditation and recognition of CB
- Annex E: Forms
- Annex E1 – Application form
  - Annex E2 – Certificate form
- Annex F: Specific provisions applicable to OTIF non EU signatories

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