BEA-TT

Land Transport Accident Investigation Bureau

Technical Investigation Report on the collision between a train and a load on a crossing train which occurred on 20 May 2009 in the tunnel of Livernantt in Charmant (16)

December 2010

Ressources, territoires, habitats et logement
Énergie et climat
Développement durable
Infrastructures, transports et mer
Prévention des risques

Présent pour l'avenir

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer

Ministère de l'Ecologie, de l'Energie,
du Développement durable et de la Mer
en charge des Technologies vertes et des Négociations sur le climat

www-developpement-durable.gouv.fr

General Council of the Environment and Sustainable Development

Land Transport Accident Investigation Bureau

Case N° BEATT-2009-005

Technical investigation report on the collision between a train and a load on a crossing train which occurred on 20 May 2009 in the tunnel of Livernantt in Charmant (16)

List of documentation

Commissioning organisation: Ministère de l'Ecologie, du Développement durable, des Transports et du Logement (MEDDTL) [The Ministry of Ecology, Sustainable Development, Transport and Housing]

Reporting organisation: The Land Transport Accident Investigation Bureau (BEA-TT)

Title of the document: Technical investigation report on the collision between a train and a load on a crossing train which occurred on 20 May 2009 in the tunnel of Livernant in Charmant (16)

ISRN N°: EQ-BEAT--10-15-FR

Proposition of key words: Freight transport, securing, training, regulations, inspection, forestry machine

Warning

The technical investigation which forms the subject of this report was carried out under Title III of Law No 2002-3 of 3 January 2002, and decree No°2004-85 dated 26 January 2004, relating in particular to the technical investigations conducted after a land transport accident or incident.

The sole object of this investigation was to prevent future accidents by determining the circumstances and causes of the event in question and preparing the appropriate safety recommendations. It does not aim to determine responsibility.

Consequently the use of this report for purposes other than prevention could lead to erroneous conclusions.

CONTENTS

GLOSSARY 8

SUMMARY 10

1 - IMMEDIATE OBSERVATIONS AND OPENING OF THE INVESTIGATION 11

1.1 - Circumstances of the accident 11

1.2 - Human and material assessment 11

1.3 - Opening the investigation 12

2 - BACKGROUND INFORMATION FOR THE ACCIDENT 14

2.1 - Line characteristics 14

2.2 - Trains directly involved in the accident 15

2.2.1 - ECR freight train 41249 15

2.2.2 - SNCF freight train 74424 15

2.2.3 - SNCF freight train 4194 15

2.2.4 - SNCF freight train 56724 15

2.3 - Transport carried out for the Maierhofer Company 15

2.3.1 - Object of the transport 15

2.3.2 - The TWA wagon loaded with the Skogsjan 487XL machine 16

3 - REPORT OF THE INVESTIGATIONS CARRIED OUT 17

3.1 - Statements made by the train drivers 17

3.1.1 - Driver of ECR freight train 41249 17

3.1.2 - Driver of SNCF freight train 74424 17

3.1.3 - Driver of SNCF freight train 4194 17

3.1.4 - Driver travelling "as a passenger" in the locomotive of freight train 4194 18

3.1.5 - Driver of SNCF freight train 56724 18

3.2 - Analysis of the graphical recording tapes and the ground-train radio conversations 19

3.2.1 - The graphical recording tapes from the trains 19

3.2.2 - The recordings from the ground-train radio 21

3.3 - The Skogsjan 487XL forestry machine 22

3.3.1 - General characteristics 22

3.3.2 - Device immobilising the turntable and its arm 25

3.3.3 - Compatibility with the clearance gauge on French railways 25

3.4 - Provisions applicable to the securing operations 27

3.4.1 - The loading instructions 27

3.4.2 - Provisions concerning straps 27
3.4.3 - Provisions set out for the Skogsjan machine in the technical documentation 28
3.5 - Findings concerning securing of the Skogsjan 487XL machine on the wagon 29
3.5.1 - Transport position of the Skogsjan 487XL machine 29
3.5.2 - Failure to lock the turntable concerning rotation 29
3.5.3 - Securing the felling head and the arm of the Skogsjan 487XL 30
3.5.4 - Anomalies noted after the accident, on the other loads prepared by Maierhofer 33
3.6 - Consistency and implementation of the procedure for sending sensitive elements 33
3.6.1 - The advice for loading provided on 13 May 2009 at Mosbach-Neckarelz 34
3.6.2 - Execution of the loading work on 15 May 2009 35
3.6.3 - Inspection and acceptance on 15 May 2009 35
3.7 - Technical visits during the journey 37
3.7.1 - Execution of the technical visit in Mannheim on 16 May 2009 37
3.7.2 - Execution of the transfer visit at Einsiedlerhof RBf on 19 May 2009 38
3.8 - Steps to be taken for trains running under hazardous conditions 39

4 - HOW THE ACCIDENT DEVELOPED AND THE EMERGENCY SERVICES COPED WITH IT 41
4.1 - Advice, loading and acceptance of the elements shipped 41
4.1.1 - The advice for loading 41
4.1.2 - Loading the wagons 41
4.1.3 - Acceptance of the loading 42
4.2 - Journey through Germany and visits en route 42
4.2.1 - Technical visit at Mannheim 42
4.2.2 - Technical transfer visit at Einsiedlerhof RBf 42
4.3 - Journey in France to the tunnel of Livernant 42
4.4 - The accident 43
4.5 - The emergency services 45
4.6 - The risks involved 45

5 - ANALYSIS OF THE CAUSES AND ASSOCIATED FACTORS, PREVENTATIVE MEASURES 47
5.1 - The process for sending sensitive elements 47
5.2 - The technical visit and the technical transfer visit 48
5.3 - The steps to be taken in the event of an impact or unusual noises when crossing a train 48

6 - CONCLUSIONS 50
6.1 - Causes of the accident 50

6.2 - Recommendations 50

ANNEXES 52

Annex 1: Decision to start an investigation 53

Annex 2: Journey made by the wagon carrying the Skogsjan forestry machine 54

Annex 3: Impacts on the locomotives of SNCF trains 74424 and 4194 55

Annex 4: Faulty securing and immobilisation of a forestry machine loaded by Maierhofer 57

Annex 5: TWA 800 type low-bed wagon and Skogsjan 487XL 59

Annex 6: Extract from the actual traffic graph 60

Annex 7: UIC data sheet 7.3 61

Annex 8: Summary of the findings for ECR train 41249 65

Annex 9: Summary of the findings for SNCF train 56724 70

Glossary

BAL: Block automatique lumineux assurant le cantonnement des trains (espacement)	**ACLB:** Automatic colour light block ensuring train signalling (headway)
BP URG : Bouton poussoir d'urgence en cabine de conduite agissant directement sur le frein	**BP URG**: Emergency pushbutton in the driver's cab acting directly on the brakes
COGC : Centre Opérationnel de Gestion de la Circulation de la SNCF	**COGC**: Centre Opérationnel de Gestion de la Circulation de la SNCF[SNCF Operational Traffic Management Centre]
CUU : Contrat uniforme d'utilisation des wagons, dispositions contractuelles définissant les droits et devoirs des entreprises ferroviaires lors de l'utilisation des wagons	**CUU**: Uniform Contract covering wagon use, contractual provisions setting out the rights and duties of railway undertakings during use of wagons
DBSR : Deutsche Bahn Schenker Rail Deutschland AG, entreprise ferroviaire allemande, filiale de la Deutsche Bahn	**DBSR**: Deutsche Bahn Schenker Rail Deutschland AG, German railway undertaking, a subsidiary of Deutsche Bahn
EBA : Eisenbahn Bundesamt, autorité de sécurité ferroviaire allemande	**EBA**: Eisenbahn Bundesamt, German railway safety authority
ECR : Euro Cargo Rail, entreprise ferroviaire française, filiale de la Deutsche Bahn	**ECR**: Euro Cargo Rail, French railway company, a subsidiary of Deutsche Bahn
EF: Entreprise ferroviaire	**RU**: Railway undertaking
EUB : Eisenbahn-Unfalluntersuchungsstelle des Bundes - Organisme allemand d'enquête sur les accidents ferroviaires	**EUB**: Eisenbahn-Unfalluntersuchungsstelle des Bundes – German Organisation conducting investigations into railway accidents
PIS: Plan d'intervention et de sécurité du Tunnel Ferroviaire du Livernant	**SIE**: Safety and intervention plan for the Railway Tunnel of Livernant
RFF : Réseau Ferré de France, gestionnaire du réseau ferré national	**RFF**: Réseau Ferré de France, Manager of the Infrastructure for the French National Railways
SAR : Signal d'alerte radio sol/train	**SAR**: Ground/train radio warning signal
SKOGSJAN 487XL : Engin forestier de fabrication suédoise	**SKOGSJAN 487XL**: Forestry machine made in Sweden
SNCF: Société Nationale des Chemins de fer Français, gestionnaire d'infrastructure délégué et entreprise ferroviaire française	**SNCF:** Société Nationale des Chemins de fer Français, delegated infrastructure management entity and French railway undertaking
TWA 800 : Wagon surbaissé de la société Transwaggon	**TWA 800**: Low-bed wagon owned by the Transwaggon Company
UIC: Union Internationale des Chemins de fer	**UIC:** International Union of Railways
VT: Visite technique	**VT:** Technical Visit

VTE : Visite technique d'échange entre entreprises ferroviaires	**VTE**: Technical transfer visit between railway undertakings

Summary

On Wednesday 20 May 2009, at 0:39 a.m., the mobile arm of a forestry machine loaded on Euro Cargo Rail ECR train 41249 violently struck the crossing SNCF train 56724 in the tunnel of Livernant in Charmant (16).

This accident caused slight injuries to the driver of train 56724, partial destruction of the locomotive and varying levels of damage to the wagons and the loads of the two trains, together with damage to the track and the railway equipment.

The immediate cause of the accident was uncontrolled rotation of the turntable and the mobile arm of the Skogsjan forestry machine, thus bringing it into the gauge of the adjacent track.

Two factors are at the origin of this accident:

- Poor execution of the work to secure the mobile parts of the machine by the shipper, who was not an experienced professional specialist, when loading the wagon in Germany;
- Faulty application by DBSR (the German railway undertaking that dealt with the transport) of the advisory and inspection procedure set out for this type of shipping.

Two factors may also have contributed to the absence of detection and alerts while the train was running under hazardous conditions:

- Failure to detect defects in immobilisation, chocking and securing during the technical visits in the course of the journey;
- The lack of clarity concerning the steps to be taken by the drivers if they notice sounds of impacts, which failed to enable the train running under hazardous conditions to be stopped before the accident.

This has led the BEA-TT to issue five recommendations concerning:

- The specific DBSR procedure for sending sensitive loads;
- Execution of the technical visits;
- The steps to be taken if train drivers notice the sounds of impacts.

1 - Immediate observations and opening of the investigation

1.1 - Circumstances of the accident

On Wednesday 20 May 2009, train 41249 operated by the Euro Cargo Rail railway undertaking was running towards south-west France on the Paris-Bordeaux main line, on the section from Angouleme to Coutras.

Figure 1: Geographical location of the accident

The train was crossing SNCF freight train 56724 in the tunnel of Livernant in the municipality of Charmant (16) when the arm of a forestry machine loaded on the third wagon of the train went through the driver's cab of the crossing train, reaching the engine compartment of the locomotive, and going through it, and through the left-hand side panel of locomotive BB 407220.

The driver of train 56724 sent a radio alert signal immediately from his locomotive – it was 0:39 a.m. He stopped his train, which came to a halt in the tunnel of Livernant, 150 metres from the end of the tunnel.

1.2 - Human and material assessment

The driver of train 56724 was the only person injured in the accident, with a broken wrist; he was immediately evacuated by the emergency rescue team to Camille Claudel hospital in Angoulême.

The material damage was very severe:

- On train 56724, locomotive BB 407220 was perforated from the front right-hand side of the driver's cab to about 1/3 of the length of the locomotive, with damage to the various elements of the engine and other items of equipment. As well as the locomotive, sixteen wagons were damaged to varying extents, and an axle of the second wagon was derailed.
- On train 41249, as well as the machines on the TWA 800 wagon containing the front two

forestry machines that were the most severely damaged, the loads on the next four wagons were also severely damaged, and about twenty other wagons were damaged to varying extents.

- The track infrastructures were seriously damaged; track 2 in the tunnel had to be re-laid over several hundred metres. The electrical installations providing lighting, warnings, and signalling, together with catenaries, required inspection and repairs.

Perforation of the front right-hand side of the driver's cab on train 56724

Figure 2: Locomotive 407220 after the accident

1.3 - Opening the investigation

In view of the circumstances of this accident and at the request of the Minister for transport, the Director of BEA-TT decided to undertake a technical investigation by applying the third title of the law dated 3 January 2002, and decree No°2004-85 of 26 January 2004, regarding, in particular, technical investigations after land transport accidents or incidents – See Annex 1.

The investigators went to the scene and examined the damaged machines; they met the Public Prosecutor at the Angoulême Tribunal de Grande Instance [Court of first instance], the investigators of the Brigade Départementale de Renseignements et d'investigations Judiciaires [Département Brigade for Judiciary Information and investigations] from Angoulême, and the local and regional managers from SNCF.

They obtained communication of the file covering the legal proceedings.

A meeting was organised on 3 July 2009 by the civil expert, with the parties considered and the BEA-TT.

The meeting enabled those concerned to obtain further details as to the circumstances of the accident and hear the various "players" and persons responsible for safety as regards loading, verification and routing of the train, together with the SNCF managers dealing with routing of the train hit and maintenance of the infrastructures.

The BEA-TT investigation gave rise to several investigations on the spot:

- On the two crossing trains to record the damage and measure the impact during the

collision, and also at Angoulême station for the locomotive of train 4194 and at Saint-Pierre-des-Corps for the locomotive of train 74424.

- In Saint-Pierre-des-Corps, Angoulême and Bayonne to meet the various SNCF drivers, and also in Paris for the ECR driver.

The investigators obtained help from the German organisation conducting investigations into railway accidents (EUB), concerning the loading operations and the visits made to the wagons, together with information on the operations carried out during the part of the journey made in Germany. Their investigations did not include analysis of the initial contractual documents concluded between the owner of the machines who loaded them (Maierhofer), the owner of the wagons (Transwaggon) and the transport company (DBSR).

They also contacted the ECO LOG Company (in Sweden) that provides after-sales services for the Skogsjan machine as such and that sent them the reference documents providing information concerning the normal conditions of immobilisation for the machine.

2 - Background information for the accident

2.1 - Line characteristics

The Angoulême to Coutras line is operated by SNCF, and it forms part of the Paris – Bordeaux main railway line.

The SNCF operational railway traffic control centre in Bordeaux directs and controls train traffic.

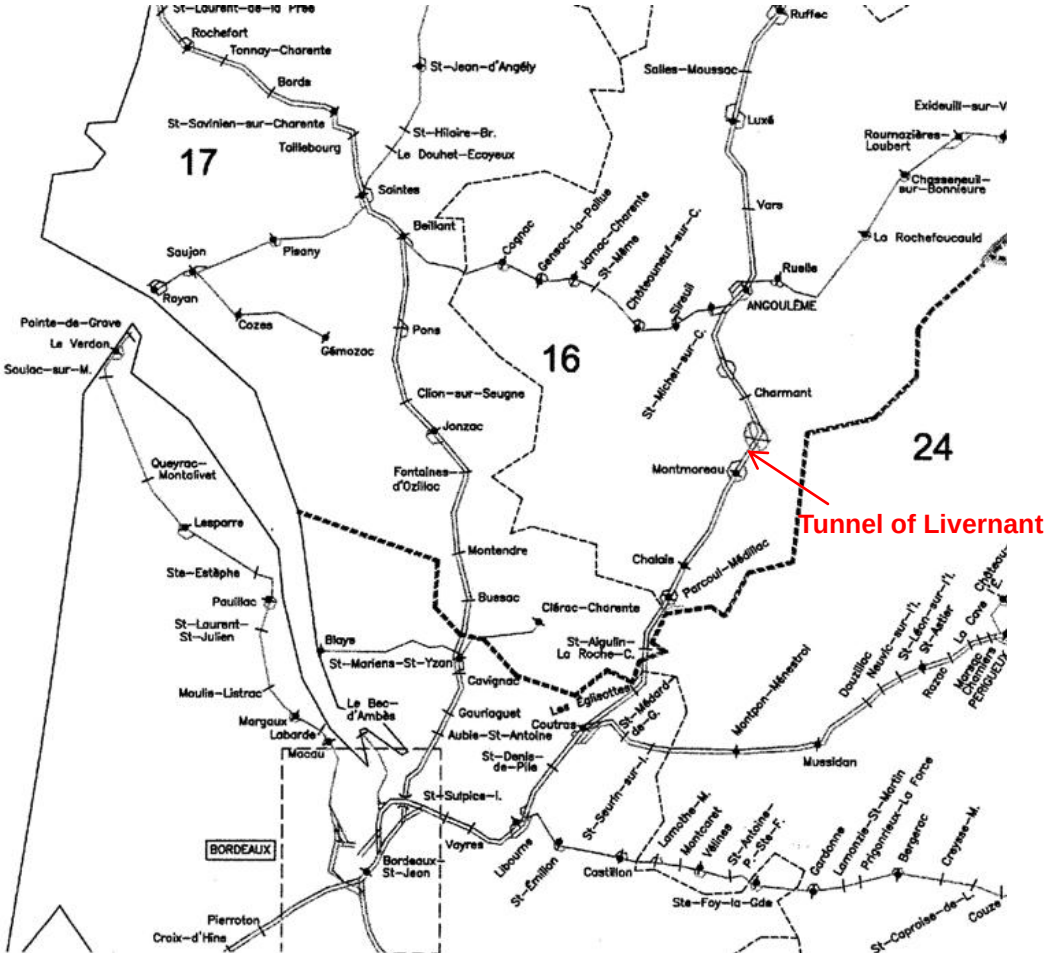


Figure 3: The tunnel of Livernant on the French network

Part of the line is located in the Charente *département*, as far as Parcoul-Médillac.

It is operated as a twin-track line and its train signalling (headway) system is of the BAL/ACLB block automatique lumineux [automatic colour light block] type.

It is fitted with radio sol-train* (RST) [ground to train radio] providing a radio link with the trains.

The electric traction power is provided via a 1 500 volt direct current supply.

The line is open to all types of railway passenger and freight transport.

The highest speed limit for the trains is 220 km/h.

2.2 - Trains directly involved in the accident

The trains shown below are classified in the chronological order of their involvement in the accident. Train 41249 was the only train running on the odd-numbered track (in the Paris-Bordeaux direction); the other trains were running on the even-numbered track (in the Bordeaux-Paris direction).

2.2.1 - ECR freight train 41249

ECR freight train 41249 was made up of 24 wagons, six of them loaded with forestry machines for clearing work in the Landes (40) forest. It had come from Forbach (in Germany) and its destination was Bayonne. The train was drawn by CLASS 66 JT42 locomotive 66038.

In the running direction, it was made up of two flatbed wagons with stakes, and six TWA 800 low-bed wagons, four of which had been loaded by the Maierhofer Company and two by the Mujot Company. The wagons behind them were covered and flat wagons for the most part.

The third wagon from the front was carrying the Skogsjan 487XL forestry machine.

2.2.2 - SNCF freight train 74424

SNCF freight train 74424 was the first train struck by the forestry machine fouling the gauge of the adjacent track. It had come from Bordeaux Hourcade and its destination was Saint-Pierre-des-Corps.

It was made up of 20 wagons and drawn by locomotive BB 407360. These wagons were carrying hazardous materials consisting of ammonium nitrate fertiliser.

2.2.3 - SNCF freight train 4194

SNCF freight train 4194 was the second train struck by the forestry machine fouling the gauge of the adjacent track. It had come from Bordeaux Hourcade and its destination was Angoulême.

It was made up of 10 covered SERNAM wagons and drawn by locomotive BB 22267.

2.2.4 - SNCF freight train 56724

SNCF freight train 56724 was the third and last train struck by the forestry machine fouling the gauge of the adjacent track. It had come from Bayonne and its destination was Tours.

It was made up of 40 wagons, including flat-bed wagons, a tank containing hazardous materials, empty motor vehicle transport wagons and tipping wagons. It was drawn by locomotive BB 407220.

2.3 - Transport carried out for the Maierhofer Company

2.3.1 - Object of the transport

The Maierhofer Company was sending eight forestry machines to clear the Landes (40) forest, following the damage caused by the "Klaus" storm the previous winter. It hired four low-bed wagons from the Transwaggon Company to carry its forestry

machines. The German DBSR railway undertaking, a subsidiary of Deutsche Bahn, provided the railway transport.

2.3.2 - The TWA wagon loaded with the Skogsjan 487XL machine

The TWA 800 wagon No°23 804334 221-7 is of the low-bed type. Its front part was loaded with the Skogsjan 487XL forestry machine at Mosbach-Neckarelz station in Germany (Baden-Württemberg) on 15 May 2009 – See Annex 5.

The rear part was occupied by another forestry machine of the Timberjack type.

3 - Report of the investigations carried out

3.1 - Statements made by the train drivers

The summaries given below were prepared by the technical investigators on the basis of the oral and written declarations of which they were aware. They only feature the elements that appeared to be relevant to understanding and analysing the events and expressing the recommendations. It may be that there are divergences between the various statements or with the conclusions put forward by others, or with the findings or declarations presented elsewhere.

3.1.1 - Driver of ECR freight train 41249

At Saint-Pierre-des-Corps, the driver of train 41249 carried out the approach sequence, and then coupled up. He carried out a connection test and looked at the train, because he was surprised to see the "backhoes" loaded on wagons. He did not note any visible anomalies affecting the train.

He drove the train as far as the tunnel of Livernant without him being informed of there being any problems about that.

ECR train 41249 was running normally at 74 km/h. It crossed SNCF train 56724 without noticing any particular problems, until 0:39 a.m. when the driver noticed a radio alert.

He then stopped the train near the PK 475 distance marker and asked the controller about the event; the controller told him that part of a load on that train had struck the train he had just crossed in the tunnel of Livernant. The driver then took the necessary safety measures.

3.1.2 - Driver of SNCF freight train 74424

(Train 74424 was the first train struck by the load on train 41249)

When crossing ECR train 41249 at Vars at the PK 441 distance marker, at 0:13 a.m., the driver was travelling with the left-hand side window open; he heard an impact at the level of the door on the right-hand side, but thought it was harmless.

He thought some ballast had been thrown up, in the light of the sound and its location, because as he saw it, an element in the gauge of his track "...would have hit the front...". When he spoke to the gendarmes, he mentioned hearing two sounds.

At Châtellerault, at about 1:50 a.m., he entered a siding to let other trains go through. When the train went over the entry points, he noticed that the right-hand side door of the locomotive opened on its own. He then realised that the locomotive had received impacts, but in the light of the damage found, he did not think the impact was a major one.

At Saint-Pierre-des-Corps, while changing the braking system, he noticed that the louvres of the locomotive were damaged, two handrails had been torn off, and the door had been hit by something.

3.1.3 - Driver of SNCF freight train 4194

(Train 4194 was the second train struck by the load on train 41249)

This train crossed ECR train 41249 at 0:34 a.m. near the PK 468 distance marker at Charmant. The driver was travelling toward Angoulême, accompanied by another driver travelling "as a passenger", who was dozing on the right-hand seat.

During the crossing, the driver travelling "as a passenger" woke up and told him about a sharp noise that had woken him up. At the time, the driver of train 4194 thought some ballast had fallen from hoppers on train 41249 and identified the sound as an impact – a muffled sound or slight impact depending on the declarations – so he disregarded the comment and continued on his way.

On arriving at Angoulême, the driver noticed the marks on the door and its upright, and also on the louvres of the locomotive.

It was then, taking into account the size of the impact noted, that he contacted the controller to ask him to stop the train he had crossed. From the conversations in progress on the ground-train radio, he realised that a train behind him had been hit.

He also stated that the right-hand headlight on the locomotive had gone out when the train left Bordeaux Hourcade, and that prevented him from seeing the right-hand side of the train clearly and noticing the impact that had occurred.

3.1.4 - Driver travelling "as a passenger" in the locomotive of freight train 4194

The driver travelling "as a passenger" was an employee who was travelling to go on duty at Angoulême. The regulations thus enabled him to travel in the locomotive of train 4194.

He stated that at the time of crossing the ECR train, he was woken up by a sharp noise. He mentioned it to his colleague and asked him whether he ought not to stop. The driver of train 4194, who was not convinced, said he thought some ballast had been thrown up.

3.1.5 - Driver of SNCF freight train 56724

(Train 56724 was the train involved in an accident caused by the load on train 41249)

When crossing ECR train 41249 in the tunnel of Livernant at 0:39 a.m. near the PK 473.500 distance marker, the driver was travelling towards Angoulême. It felt a sudden violent impact, without any warning signs.

Shortly after the impact, he realised that his wrist was broken and the locomotive was seriously damaged.

He nonetheless managed to bring the train to a stop by pressing the emergency pushbutton (BP URG), lower the pantograph, trigger the radio warning signal (SAR) and contact the COGC at Bordeaux to declare that half the driver's cab had been torn off by the last crossing train.

3.2 - Analysis of the graphical recording tapes and the ground-train radio conversations

3.2.1 - The graphical recording tapes from the trains

These graphical recording tapes installed in the locomotives show the speed, compliance with signals, the time elapsed and various safety elements.

The further notes to be found on these documents were written down after the accident by the traction supervisor who retrieved the tapes.

- a – ECR train 41249

This train was travelling at 74 km/h (circled in red) when the accident occurred with train 56724, below the speed limit for its category (100 km/h for an MA 100 at that spot).

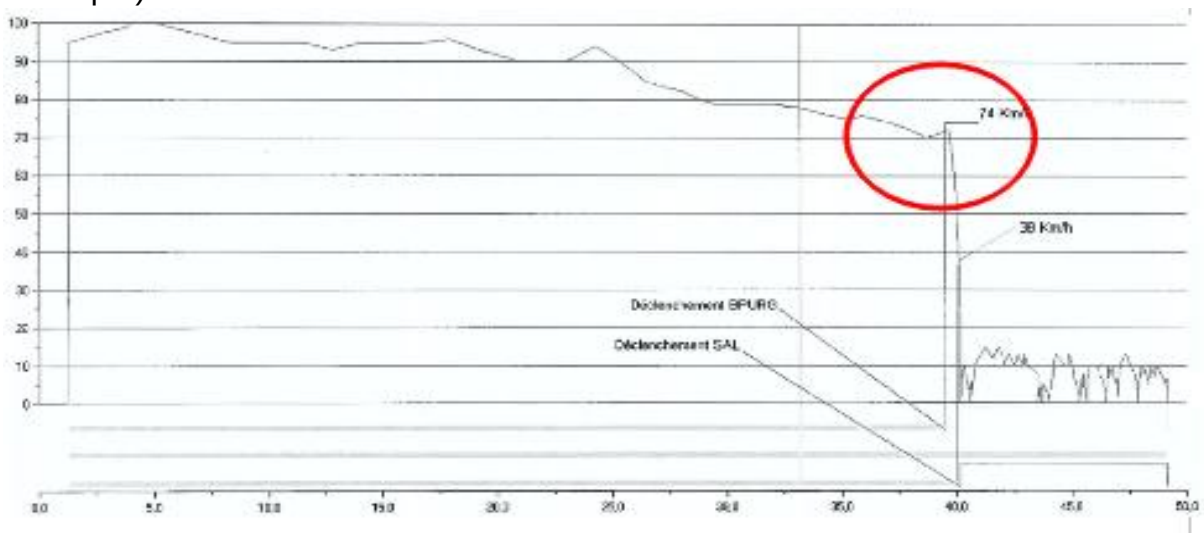
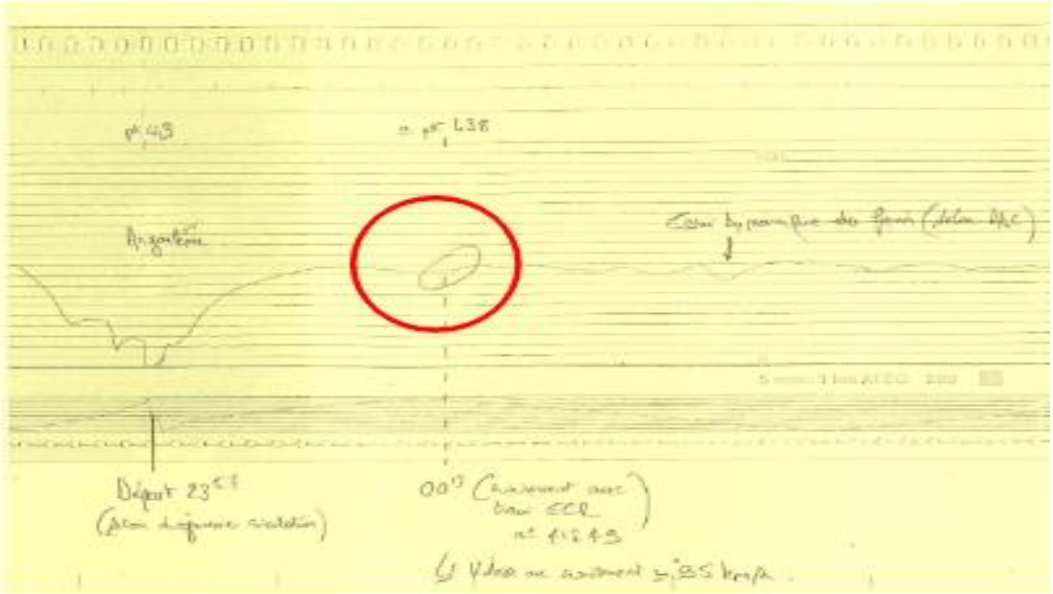


Figure 4: Extract from the graphical recording tape from train 41249

- b – SNCF train 74424

This train was travelling at 95 km/h (circled in red) when it was struck by the load on train 41249, below the speed limit for its category (100 km/h for an MA 100 at that spot).



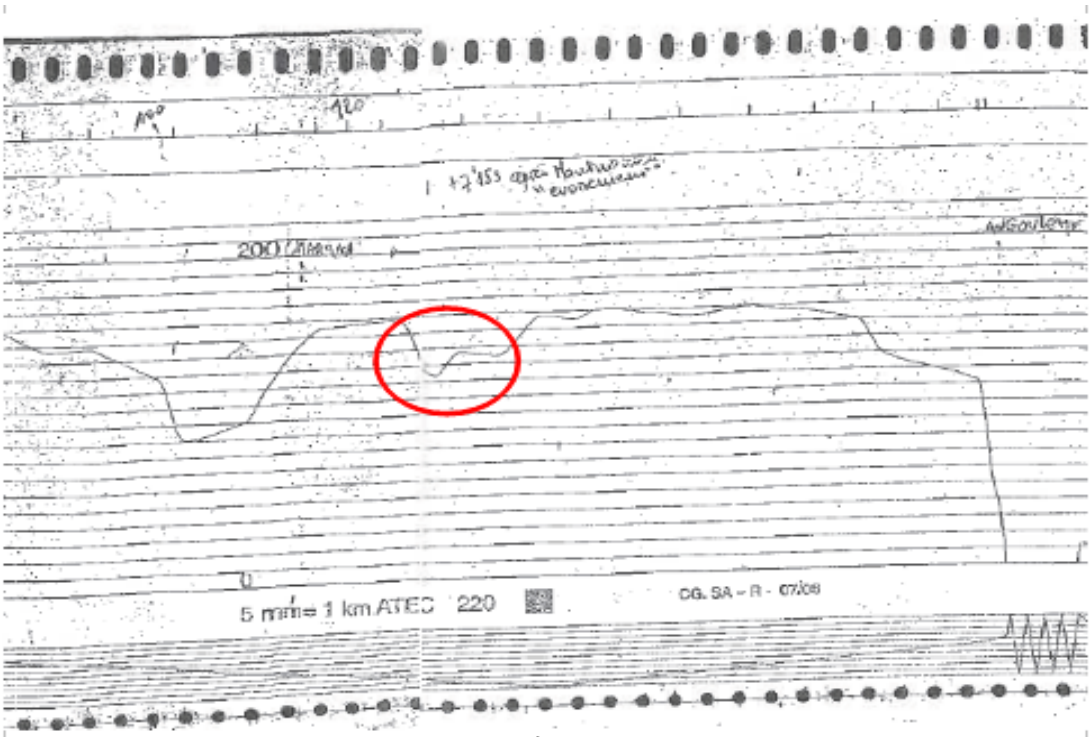
Chaque intervalle entre chaque trait correspond à 10 km/h. La lecture de la vitesse du train 74424 est donc entre le neuvième et dixième trait en partant du bas

Figure 5: Extract from the graphical recording tape from train 74424

Each interval between two lines corresponds to 10 km/h. The speed reading for train 74424 is thus between the ninth and tenth lines from the bottom.

- c –SNCF train 4194

This train was travelling at 157 km/h (circled in red) at the time of the impact with the load on train 41249, below the speed limit for its category (160 km/h for an MV 160 at that spot). The speed reduction to 123 km/h recorded corresponds to a TIV 140, which is announced and executed at that spot.



Chaque intervalle entre chaque trait correspond à 10 km/h. La lecture de la vitesse du train 4194 est donc entre le douzième et le treizième trait en partant du bas

Figure 6: Extract from the graphical recording tape from train 4194

Each interval between two lines corresponds to 10 km/h. The speed reading for train 74424 is thus between the ninth and tenth lines from the bottom.

- d – SNCF train 56724

This train was travelling at 92 km/h when it was struck by the load on train 41249, below the speed limit for its category (100 km/h for an MA 100 at that spot).

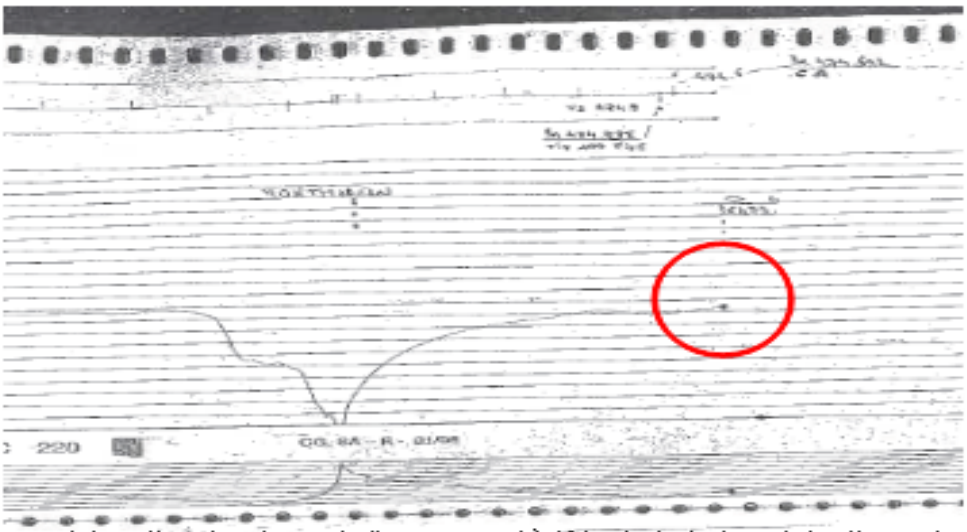


Figure 7: Extract from the graphical recording tape from train 56724

Each interval between two lines corresponds to 10 km/h. The speed reading for train 74424 is thus between the ninth and tenth lines from the bottom.

3.2.2 - The recordings from the ground-train radio

- ECR train 41249

The driver of train 41249 stated, at 0:39 a.m., that on receiving the radio alert he applied the instructions concerning an immediate stop by triggering the BP URG. The controller then asked him to stay on the spot and wait for further orders.

- SNCF train 74424

The driver of train 74424, while on a siding at Châtellerault, only spoke once to ask at what time he would be able to leave the sidings, at about 1:55 a.m. (i.e. more than 1 hour and 15 minutes after the accident).

- SNCF train 4194

The driver of train 4194, after it had entered the sidings at Angoulême, contacted the controller to tell him about the incident he had noted with the previous crossing train; it was about 0:45 a.m. (*6 minutes after the accident involving train 56724*).

He said that he had crossed a train on the Mouthiers gradient. He thought the train had been hit by a stone, but apparently the other train had something fouling the gauge that had damaged his machine (*locomotive)*.

- SNCF train 56724

The driver of train 56724 immediately informed the controller that his train had received a considerable impact from the train crossed, and that his train was stopped in the tunnel of Livernant. The impact with the train crossed had torn off half the driver's cab from the locomotive.

In the same recording, we can hear the controller contact all the other trains in the sector, including train 41249, to make sure they stopped, over and above the radio alert signal triggered by the driver of train 56724.

3.3 - The Skogsjan 487XL forestry machine

3.3.1 - General characteristics

The forestry machine weighs 13.5 tonnes, and it is 2 780 mm wide and about 6 950 mm long; it is fitted with an articulated working arm that is fixed on the operating turntable. It is equipped with a Skogsjan 601 II type felling head that weighs 950 kg.

Figure 8: Catalogue photo of the Skogsjan 487XL

Figure 9: Catalogue photos of the Skogsjan 487 and the felling head

The angle of rotation of the arm with the operating cab is ± 135° and the useful length of the telescopic arm is 2 X 2.5 metres, which provides a possibility of working over about 10 metres.

The diagram below shows the dimensions estimated on the basis of the technical documentation.

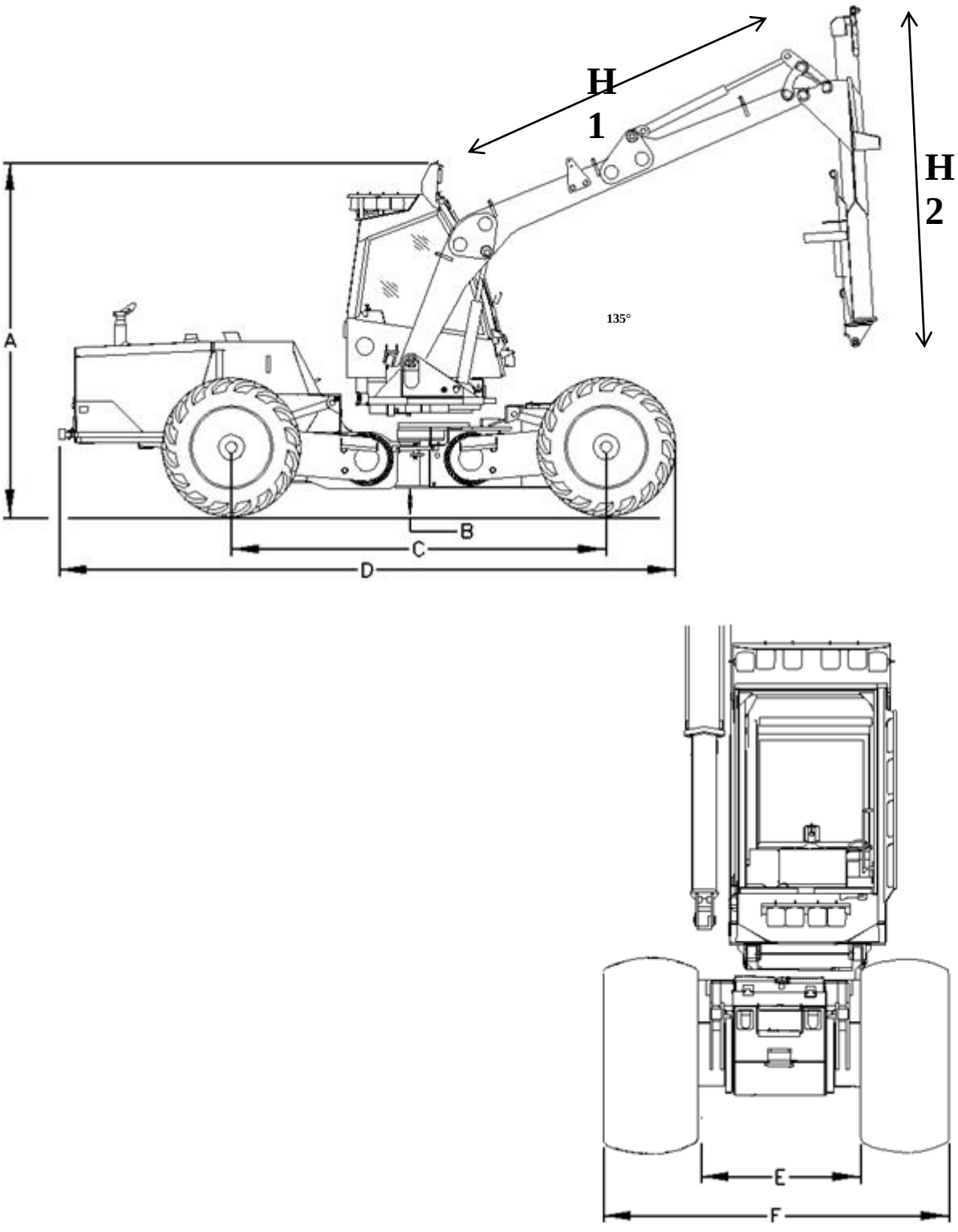
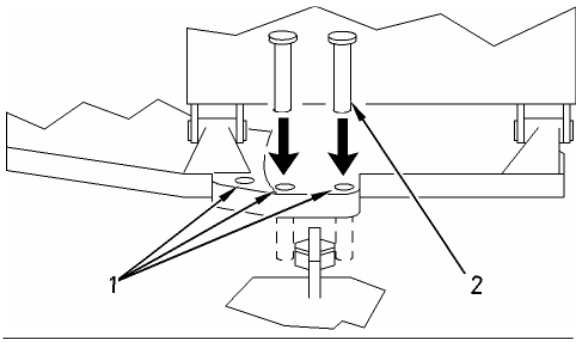


Figure 10: Diagram of the Skogsjan 487XL machine
the dimensions of the Skogsjan machine shown on this diagram are given for information purposes only

3.3.2 - Device immobilising the turntable and its arm

To enable transport of the forestry machine, the immobilisation device provided by the constructor of the machine must be installed before moving it.

The outline diagram below shows the fixed parts that receive the device to prevent the turntable from making any rotary movements.



Principle of the system immobilising the turntable and the arm with pins

Insert the two slewing blocking pins (2) in front of the cab to prevent it from turning. The three holes (1) are provided so that the cab can be fixed in two different positions.

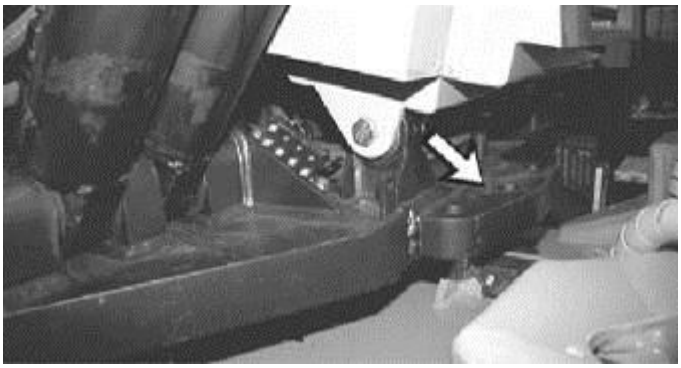


Figure 11: Example of the immobilising device

The photo in Figure 16 shows the device on the machine transported after the accident.

3.3.3 - Compatibility with the clearance gauge on French railways

The clearance gauge on French railways enables use of wagons within the dimensions shown below.

Figure 12 opposite**: International loading gauge**

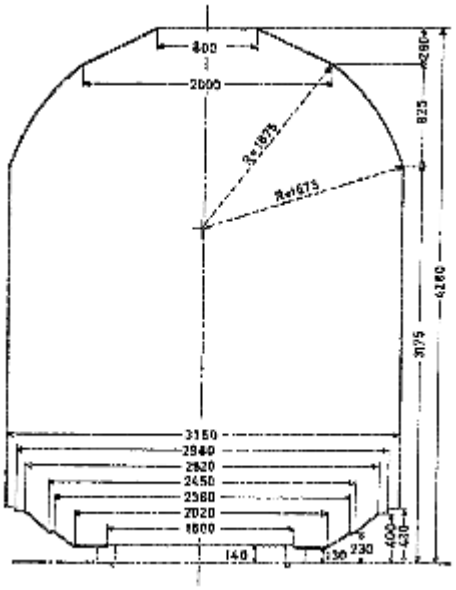


Figure 13 below:
- **Top**, the forestry machine in its classic rest position, incompatible with the gauge.
- **Centre**, the position given by the technical documentation in the shipper's possession and which would have involved a special consignment.
- **Bottom**, the solution adopted by the shipper.

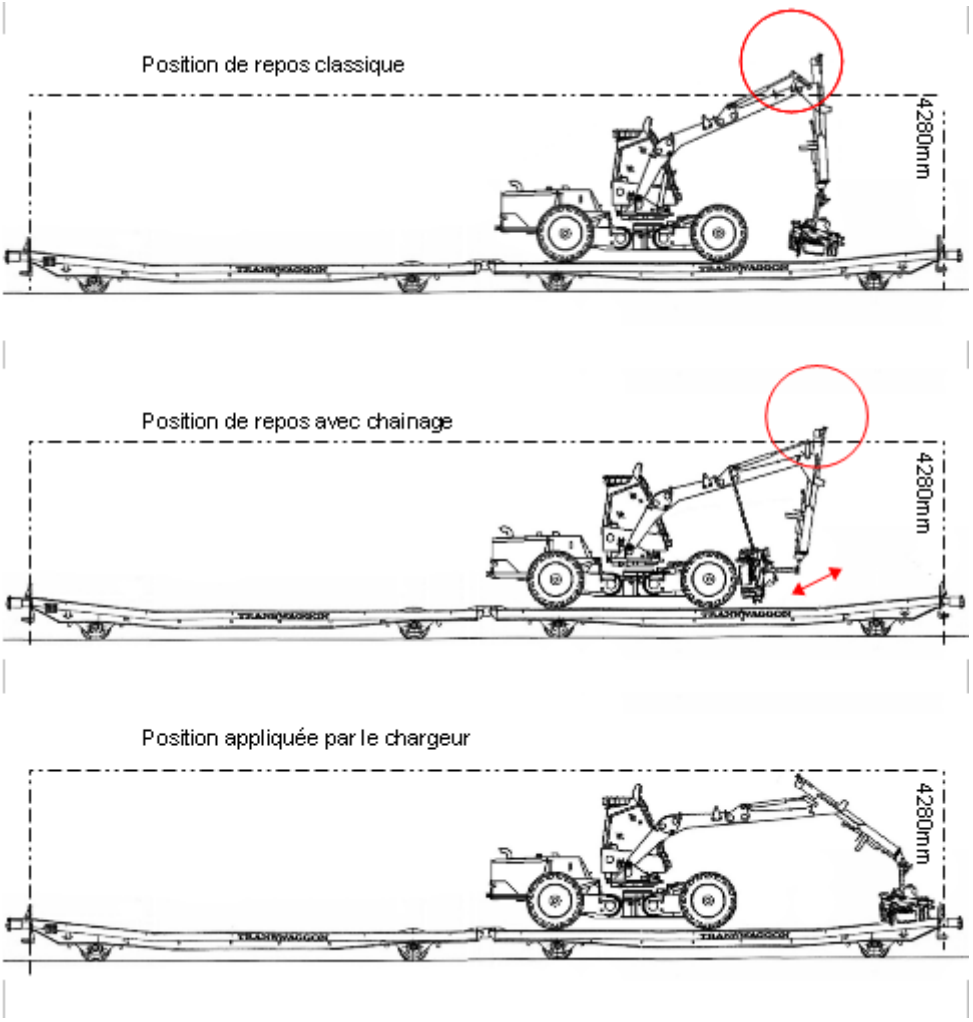


Figure 13: Machine loaded on the TWA800 wagon

The international gauge is shown as a dotted line

3.4 - Provisions applicable to the securing operations

3.4.1 - The loading instructions

The loading instructions drawn up by the International Union of Railways constitute the baseline applied by all the railway undertakings that are members of the organisation.

Data sheet 7.3 sets out the rules concerning wheeled vehicles - See the complete data sheet in Annex 7.

Concerning mobile parts of vehicles, the sheet states that "All sliding, oscillating or swivelling parts (such as crane jibs, lifting equipment, etc.[...]) are fixed mechanically or immobilised in such a way that their position cannot change during transport (breaking strength of the securing elements: min. 1 000 daN, and in the case of crane jibs: min. 4 000 daN)".

As we can see, if we assimilate the arm of a forestry machine to a crane jib, which is reasonable, the securing elements holding it in place must have a breaking strength of 4 000 daN.

3.4.2 - Provisions concerning straps

When straps are used to secure loads, the straps must comply with European standard EN 12195-2, show the necessary level of strength, and be installed in accordance with the UIC rules.

Under the standard, straps are identified by labels such as the one shown below.

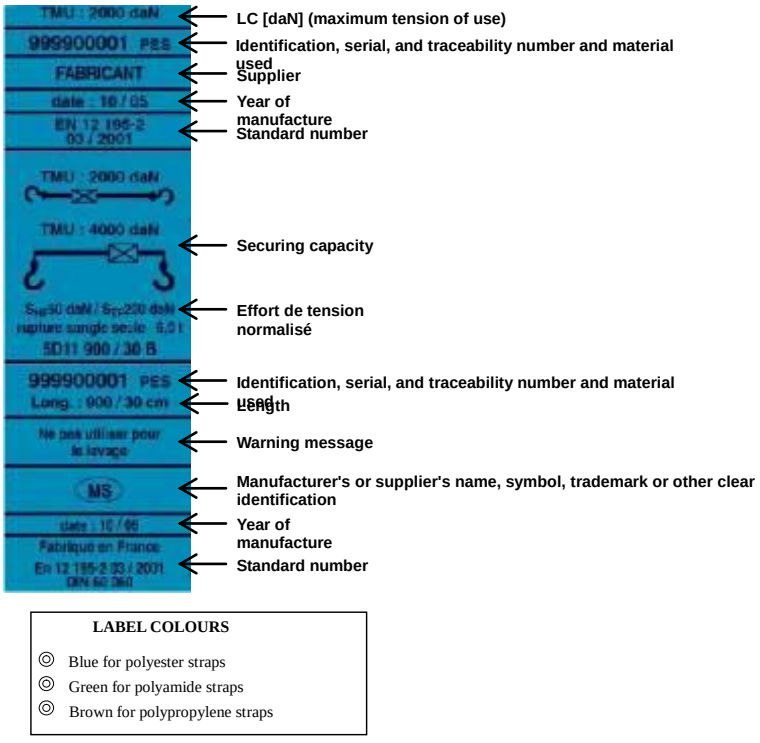


Figure 14: Strap label under standard EN 12195-2

In the instructions for use of strap securing systems, the following requirements are set out in detail:

- The securing straps must be selected and used in the light of the securing capacity required, the method of use and the type of load;
- The choice of the straps to be used is determined by the size, shape and weight of the load, the method of use, the type of transport and the type of load;
- The minimum securing system is made up of a pair of securing straps for friction securing and two pairs of securing straps for direct holding;
- The securing straps selected must be both strong enough and of suitable length for the method of use;
- The number of securing straps must comply with EN 12195-2;
- The securing devices must be in perfect condition: otherwise, the straps must be returned to the manufacturer (cuts, cracks, notches, etc.);
- Only straps legibly labelled and marked can be used;
- They must not be used if they are cut or knotted;
- Any strap overloads must not exceed 50 daN;
- Loads must never be secured at a slant;
- Loads must be secured so that their centre of gravity is as close as possible to the central line of the central longitudinal axis of the vehicle;
- Bed level anchoring points are to be avoided: it is necessary to secure loads in such a way that they cannot move, turn, roll, fall from the vehicle or topple the vehicle over (sudden braking).

3.4.3 - Provisions set out for the Skogsjan machine in the technical documentation

The owner was unable to forward to the investigators a full user manual for the Skogsjan 487XL machine.

The only rules set out in the technical documentation forwarded to the investigators were those for securing the felling head. The rules for immobilising the turntable were not included.

To secure the felling head during transport, the technical documentation forwarded by the shipper recommends fitting chains between the head and the arm.

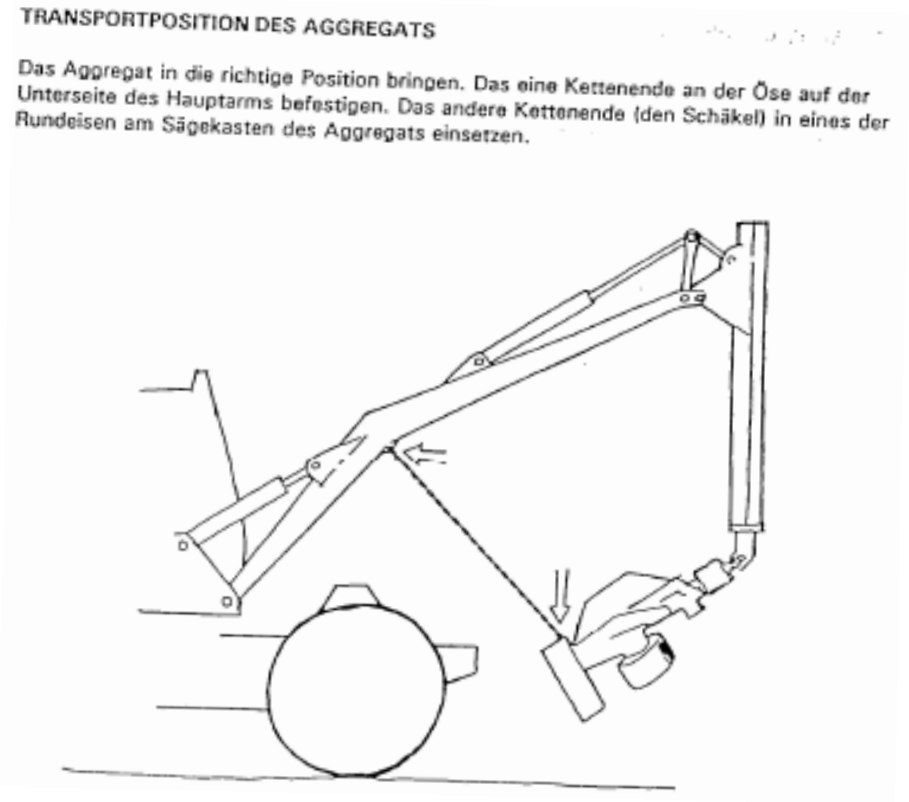


Figure 15: Extract from the technical documentation for the Skogsjan 487XL

3.5 - Findings concerning securing of the Skogsjan 487XL machine on the wagon

3.5.1 - Transport position of the Skogsjan 487XL machine

The Maierhofer Company personnel loaded the forestry machine on a TWA 800 low-bed wagon. It was the first time that the shipper had sent that type of machine on wagons. According to its declarations, the Skogsjan 487XL forestry machine was loaded without any problems. The loading sequence was carried out via an end-on loading platform.

Thus the Skogsjan 487XL machine was loaded with:

- The working arm not chained, and extended to comply with the railway clearance gauge (cf 3.3.3)
- The turntable and the arm at an angle of 10 to 15° towards the left, because the shipper wanted to install the felling head as close as possible to the centre of the wagon, on wood chocks.

The wheels were held in place with metal chocks supplied with the wagon.

3.5.2 - Failure to lock the turntable concerning rotation

The shipper failed to lock the turntable using the pins provided for the purpose.

Such locking may not have been possible in the diagonal position in which the arm of the machine was placed.

The photo below shows the turntable after the accident, without the pins that should have been inserted; no trace of the pins was found. The absence of the pins enabled turntable rotation movements, as it was not held in place by the limit stops.

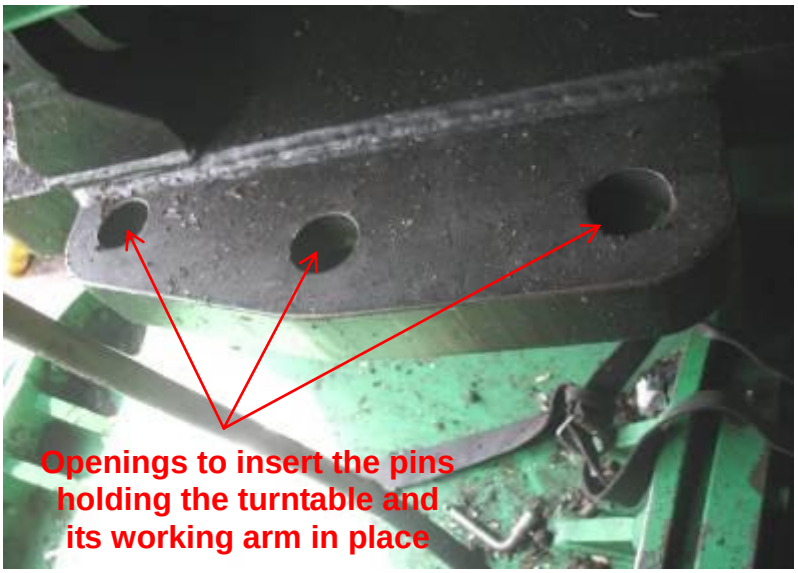


Figure 16: Openings used to immobilise the Skogsjan 487XL

3.5.3 - Securing the felling head and the arm of the Skogsjan 487XL

Securing the felling head

UIC data sheet 7.3 does not set out any particular rules for chocking or attaching a part such as the felling head.

The head should have been installed in compliance with the general instructions for chocking and attaching loads as set out in volume 1 of the UIC loading instructions.

The shipper chocked the felling head with narrow wood battens (100 X 100 mm) that were not fixed in place, and completed immobilisation of the felling head by attaching it indirectly with a strap hooked on the edge of the wagon.

This system did not comply with any rules, and it was bound to come loose during transport.

Photo Source Maierhofer

Figure1: Felling head not fixed to the bed of the wagon
In red, the possible transversal and longitudinal movements

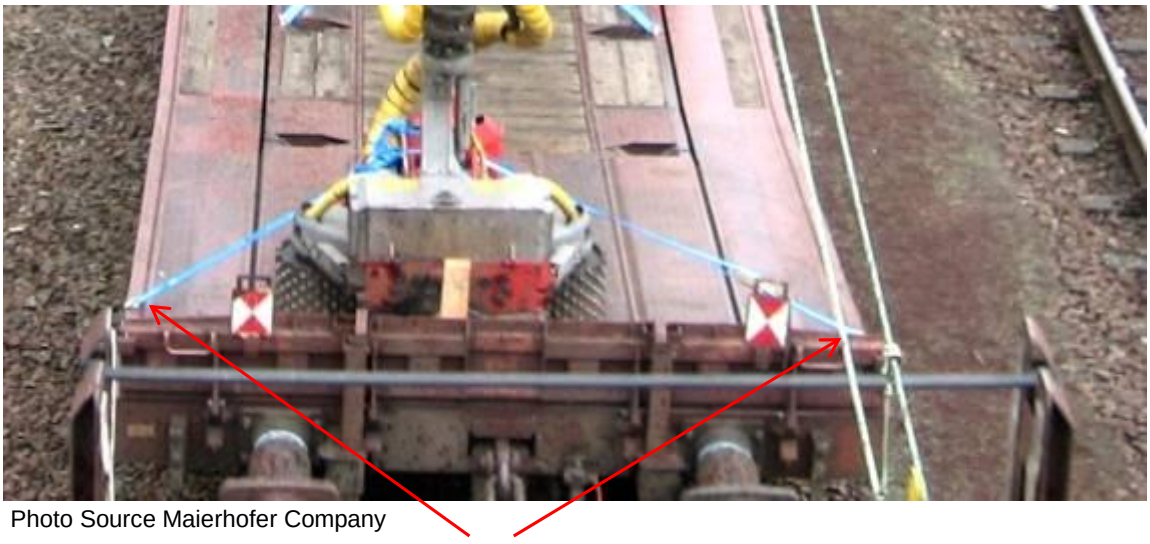


Photo Source Maierhofer Company

Figure 18 - Straps on edges of bed

In Figures 17 and 18 above, taken before the load left Mosbach-Neckarelz, after the loading and securing operations; we can note the positions of the hooks at the ends of the straps, fixed on the edges of the wagon.

Securing the arm of the machine

To complete immobilisation of the arm and the turntable concerning rotation, the shipper completed its securing procedure with a 2 500 daN strap halfway along the arm.

This solution does not comply with the instructions:

- Indirect attaching with a single strap does not enable satisfactory transversal immobilisation of the arm and the turntable
- The strap was not strong enough; sheet 7.3 sets out a minimum strength level of 4 000 daN.

Photo taken after loading of the Skogsjan at Mosbach-Neckarelz station

In red, the oscillating movements of the Skogsjan 487XL arm and turntable

Figure 19:

Skogsjan forestry machine loaded at an angle of 10 to 15° on the TWA 800 wagon without immobilisation of the turntable and with unsuitable securing (2 500 daN straps) and chocking

The type of strap shown in Figure 20 was found at various points on the wagon carrying the Skogsjan machine. Some of the straps were so worn and faded that it was no longer possible to make out their reference (cf. Annex 4).

Figure 20: 2 500 daN strap found on the load

3.5.4 - Anomalies noted after the accident, on the other loads prepared by Maierhofer

The investigation showed that on the other wagons prepared by the shipper:

- Straps of different origins were knotted together, some of them showing very different levels of strength (never exceeding 2 500 daN) and not suitable for joint use;
- In some cases, other hooks on straps holding the loads in place were installed directly on the edges of the wagon beds, without any retaining systems;
- Some of the knots were very close to the ratchet buckles, considerably reducing the strength of the straps;
- Some straps were used to replace the metal immobilisation device provided between the mobile parts, but with indeterminate strength levels (absent, illegible, etc.);
- Others had no legible labels, so they were probably very old.

During the various visits, we were also able to note – See Annex 4 – that certain other machines loaded on other wagons by the same Company were not fitted with their immobilising systems either.

3.6 - Consistency and implementation of the procedure for sending sensitive elements

To enhance the transport safety levels for certain items known as "sensitive" elements, such as these forestry machines, the German railway undertaking DBSR has implemented a specific procedure.

The "Wagensonderbehandlungen und deren Arbeitsinhalte 936.0101A02 Seite 9" [Handling and acceptance of sensitive elements for transport], states that this type of transport is called "sensitive", and sets out the steps to be taken.

The machines involved in the accident come under category 1 for transport of sensitive elements, which includes civil engineering and agricultural equipment.

The procedure covers the following three stages:

- Advice for loading;
- Execution of loading;
- Inspection and acceptance.

3.6.1 - The advice for loading provided on 13 May 2009 at Mosbach-Neckarelz

Prior to the loading operations, a loading adviser from DBSR has to meet the shipper and draw up an agreement with him, setting out the loading instructions to be applied and the particular aspects for making the load safe (chocking, securing, etc.).

The loading adviser went to see the shipper at Mosbach-Neckarelz on 13 May and drew up the following agreement in the shipper's presence.

We noted that the handwritten recommendations made in the document are very brief, even though the goods shipped show particular aspects calling for precautions on the part of a customer that had no experience of shipping goods by railway.

Moreover, we can point out that there is no space provided for the shipper's signature confirming that he has indeed been informed of the recommendations. We also noted that there is no mention of the possibility of asking the adviser to attend the loading sequence if necessary.

There is no indication as to whether the personnel entrusted with acceptance were given a copy of the document.

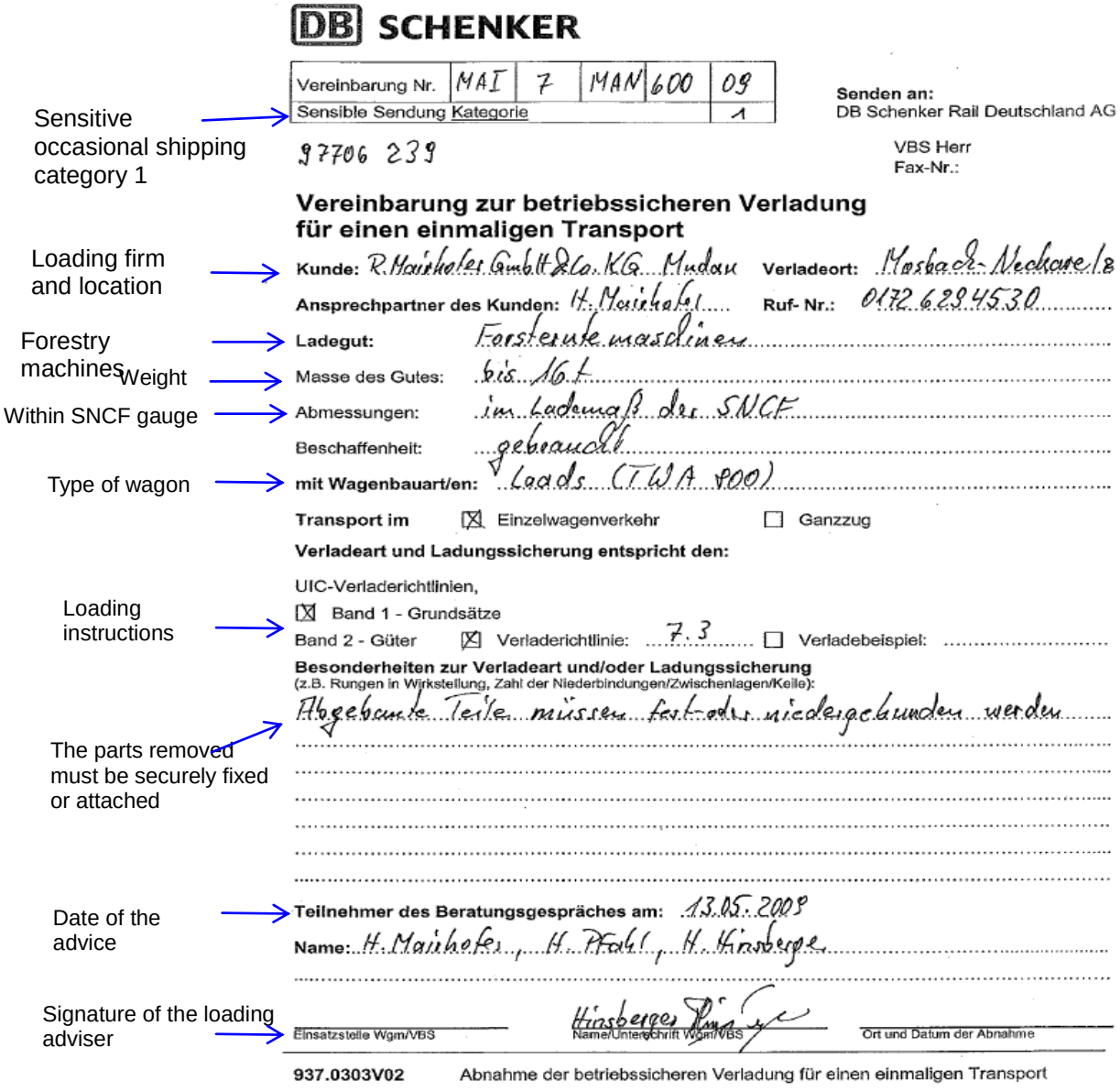


Figure 21: Agreement drawn up between DBSR and the shipper Maierhofer

3.6.2 - Execution of the loading work on 15 May 2009

The loading work was carried out in the morning of 15 May. The loading adviser was not present.

3.6.3 - Inspection and acceptance on 15 May 2009

Once the loading had been carried out, an acceptance visit was made by a specially qualified visitor, who carried out the usual visit operations, and also checked correct application of the instructions set out in the agreement. On completing the examination, the visitor made out the specific labelling that is placed on the wagon concerned or on the first and last wagons of the set.

The original form (reference 936.0301) concerning the equipment shipped was not found during the investigation on 3 July 2009.

Sensible Sendungen der Kat I abgenommen
Vordruck 936.0301V21

sensible Sendungen der Kat I abgenommen

Die Abnahme Sensibler Sendungen der Kategorie I, die direkt vom Kunden übernommen werden, sind durch Wgm mit besonderer Verwendungsfortbildung beidseitig am Wagen mit Vordruck „Sensible Sendungen der Kategorie I abgenommen" zu kennzeichnen.

Bei Sendungen mit gleicher Verladeweise in Ganzzügen oder Wagengruppen eines Empfängers genügt die Kennzeichnung des ersten und letzten Wagens.


DB SCHENKER

sensible Sendung(en) der Kategorie I abgenommen

Einzelsendung [1]
Wagennummer (vollständige Angaben)

Wagengruppe/Ganzzug [1]
Wagennummer (vollständige Angaben) erster Wagen
Wagennummer (vollständige Angaben) letzter Wagen

Bei Sendungen der Kat. I mit gleicher Verladeweise in Ganzzügen oder Wagengruppen eines Empfängers genügt die Kennzeichnung des ersten und letzten Wagens.

[1] nicht zutreffendes streichen

Laufweg von
Laufweg nach

Verladeart und Ladungssicherung entspricht

Verladerichtlinie
Nummer
Verladebeispiel/Vereinbarung

Besonderheiten

Name Wgm./VBS

Einsatzstelle Wgm / VBS
Datum,
Uhrzeit
Unterschrift

936-0301V21 sensible Sendung der Kategorie I abgenommen 01.2010

Figure 22: Model of the "sensitive elements" label

Furthermore, the visitor made out a report following the acceptance visit, in the form of a list of the wagons checked, mentioning any comments where applicable.

Indication 731 "geprüft" ["checked"] in the listing below shows that the visitor was aware of the fact that the goods came under "sensitive elements" shipping category 1 and the absence of indications in the "Schäden" ["Damage"] column » shows that he did not find any anomalies concerning the wagons or the loads.

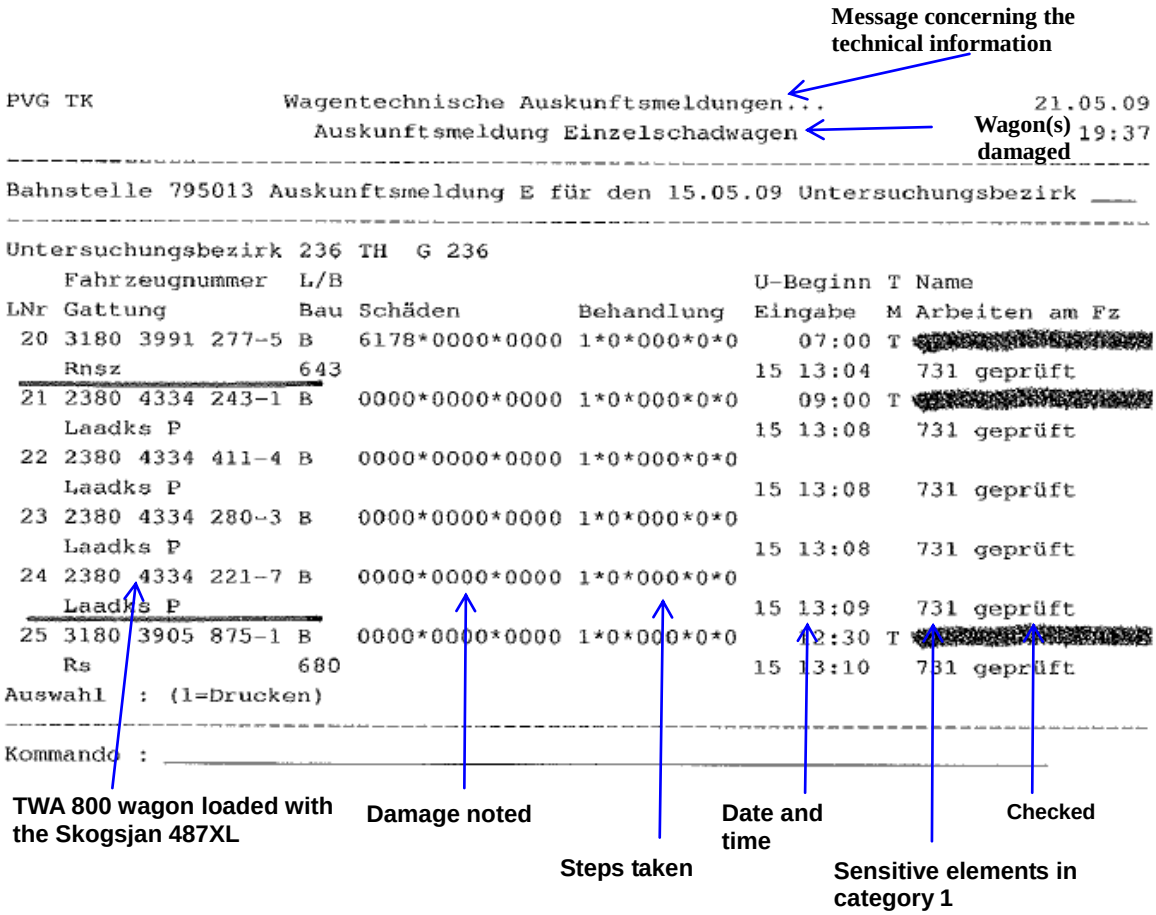
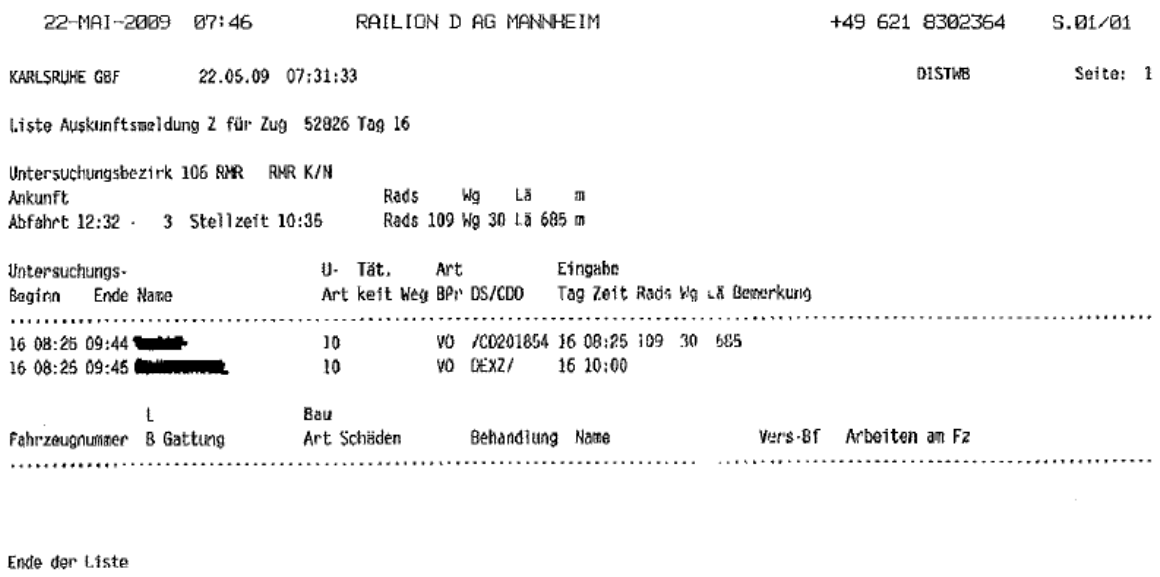


Figure 23: List of the wagons checked, including wagon No°24 2380 4334 221-7

3.7 - Technical visits during the journey

3.7.1 - Execution of the technical visit in Mannheim on 16 May 2009

Although checks were to be made for any anomalies concerning the loads and their securing, this technical visit did not give rise to any comments, as can be seen from the following computer printout.



22-MAI-2009 07:46 RAILION D AG MANNHEIM +49 621 8302364 S.01/01

KARLSRUHE GBF 22.05.09 07:31:33 DISTWB Seite: 1

Liste Auskunftsmeldung Z für Zug 52826 Tag 16

Untersuchungsbezirk 106 RMR RMR K/N
Ankunft Rads Wg Lä m
Abfahrt 12:32 - 3 Stellzeit 10:35 Rads 109 Wg 30 Lä 685 m

Untersuchungs-Beginn	Ende	Name	U-Art	Tät. keit	Art Weg	BPr	DS/CDO	Eingabe Tag	Zeit	Rads	Wg	Lä	Bemerkung
16	08:25	09:44 [redacted]		10		VO	/CD201854	16	08:25	109	30	685	
16	08:25	09:45 [redacted]		10		VO	DEXZ/	16	10:00				

Fahrzeugnummer	L B	Gattung	Bau Art	Schäden	Behandlung	Name	Vers-Bf	Arbeiten am Fz

Ende der Liste

Figure 24: Listing showing the report of the visit at Mannheim

3.7.2 - Execution of the transfer visit at Einsiedlerhof RBf on 19 May 2009

Data sheet UIC 471-2, which is applicable to all railway undertakings that are members of the International Union of Railways, provides for three possibilities during the transfer.

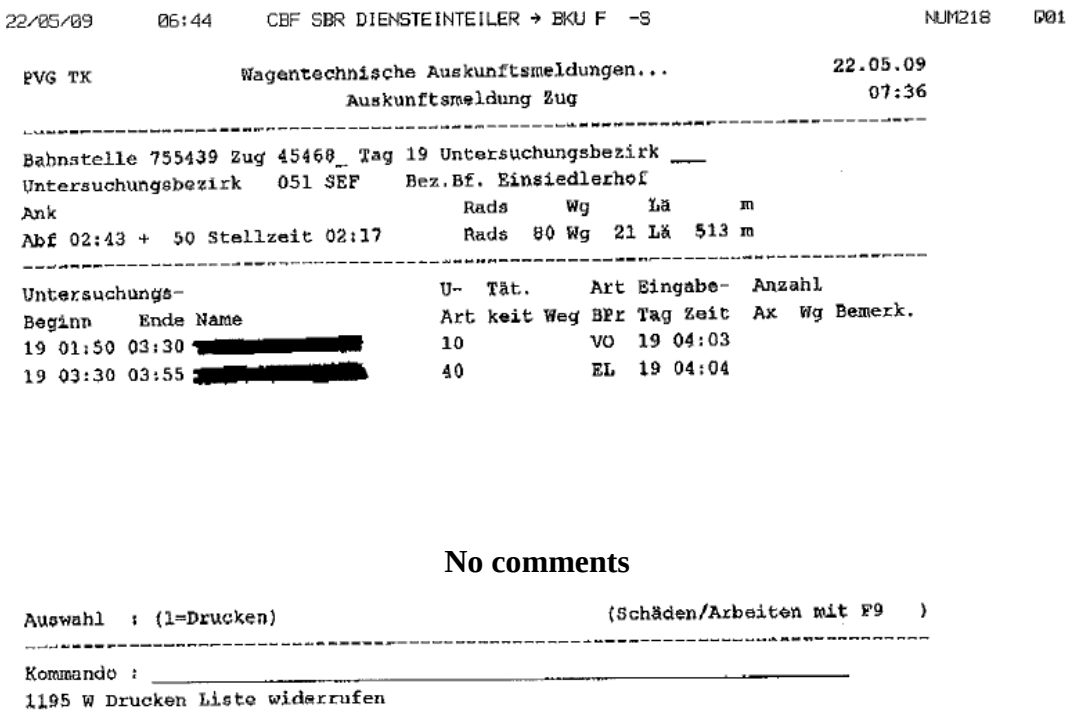
- A technical visit known as a transfer/acceptance visit, carried out at the place of transfer, and consisting of checking the operating safety of the wagons and their ability to travel without damage;
- A technical visit outside the place of transfer, carried out by the railway undertaking handing over the elements, which can be the visit before the train leaves;
- Particular monitoring including operations linked to traffic safety and maintenance operations. This concerns specific, clearly identified trains, travelling on clearly defined routed, or trains allocated to regular rotations.

If one of the latter two options is selected, a mutual trust agreement is concluded between the two railway undertakings in accordance with the modalities set out in the provisions of Annex 9 to the CUU.

A mutual trust agreement was signed between the two parties, DBSR and ECR. The agreement came into force on 1 March 2009. Under the agreement, the technical transfer visit took place at Einsiedlerhof RBf, whereas the train was actually handed over to ECR at Forbach.

During that visit, Appendix 1 to Annex 9 of the CUU states that any anomalies concerning the loads and their securing are to be searched for and reported.

However, no anomalies were reported by the visitors, as is shown in the following computer printout.



22/05/09 06:44 CBF SBR DIENSTEINTEILER → BKU F -S NUM218 G01

PVG TK Wagentechnische Auskunftsmeldungen... 22.05.09
Auskunftsmeldung Zug 07:36

Bahnstelle 755439 Zug 45468_ Tag 19 Untersuchungsbezirk ___
Untersuchungsbezirk 051 SEF Bez.Bf. Einsiedlerhof
Ank Rads Wg Lä m
Abf 02:43 + 50 Stellzeit 02:17 Rads 80 Wg 21 Lä 513 m

Untersuchungs- Beginn	Ende	Name	U- Art	Tät. keit	Art Weg	Eingabe- BPr	Tag	Zeit	Anzahl Ax	Wg	Bemerk.
19	01:50	03:30 [redacted]	10			VO	19	04:03			
19	03:30	03:55 [redacted]	40			EL	19	04:04			

No comments

Auswahl : (1=Drucken) (Schäden/Arbeiten mit F9)

Kommando : _____
1195 W Drucken Liste widerrufen

Figure 25: Listing of the transfer visit at Einsiedlerhof Rbf

3.8 - Steps to be taken for trains running under hazardous conditions

The drivers of trains 74424 and 4194, who heard unusual noises when crossing ECR train 41249, could have reacted to stop the train concerned if they had interpreted the sounds as revealing a risk for the train traffic.

In such cases, the SNCF driver's manual (TT 0057) provides for two possibilities:

- Data sheet 103 "Impacts, abnormal movements or presumption of danger on the track". This sheet requires the driver to stop the train, and then inspect the track and the train to look for any anomalies. The sheet does not bring the driver to take any useful steps in the present case.
- Data sheet 443 "Trains *[other than the driver's own train]* running under hazardous conditions". This sheet requires the driver to stop the train concerned, or arrange to have it stopped. In the case that we are examining, it presupposes that the driver establishes a link between the noise heard and a possible anomaly on the crossing train.

  This link is not easy to make and it relies on individual appreciation.

  The manuals have to present, in a format that is easier to assimilate and apply, the principles and rules set out in the higher-level regulations and repositories.

  In fact, data sheets 103 and 443 in manual TT 0057 simply transcribe Articles 511 and 501 of regulations EN 1514 (S2C) without providing any criteria that can be used by the drivers, under the circumstances met with by the drivers of trains 74424 and 4194.

It is to be noted that an acoustic test carried out under the same conditions (same locomotive, same route, at night with the window open) by the judiciary authorities from Angoulême, led to the finding that inside a locomotive of the same type as the one drawing train 74424, it would seem that the noise level noted that night would not have covered noises from outside, but would not have enabled them to be heard clearly either.

4 - How the accident developed and the emergency services coped with it

A railway map of the complete journey is to be found in Annex 2.

4.1 - Advice, loading and acceptance of the elements shipped

The Maierhofer Company planned to arrange for railway transport of the forestry machines to be sent to the Landes forest. The machines were loaded by its personnel at Mosbach-Neckarelz station. The personnel had had no training or experience in the field of railway loads.

DBSR railway undertaking provided the railway transport. Because of the type of goods involved, the transport was provided under the "sending sensitive elements" category 1 procedure.

4.1.1 - The advice for loading

On 13 May, a freight loading adviser from DBSR went to Mosbach-Neckarelz and met the personnel from the Maierhofer Company.

Following that meeting, he issued the loading safety agreement certifying that loading advice had been given to the personnel of the Maierhofer Company by that person, in particular as regards compliance with data sheet UIC 7.3 for sending sensitive elements in category 1, with some brief notes.

It was not possible to determine exactly what advice was given during the meeting.

4.1.2 - Loading the wagons

On 14 May, three TWA 800 type low-bed wagons – see Annex 5 – owned by the Transwaggon Company were loaded with forestry machines at Mosbach-Neckarelz (Germany) by personnel from the Maierhofer Company.

On 15 May, wagon 23 80 4334 221-7 of the same type and owned by the same company was also loaded, by the Maierhofer, Company at the same station, via an end-loading platform. That load consisted of two forestry machines placed back to back.

To comply with the railway clearance gauge, the arm of the forestry machine was not installed in its normal rest position, or in the transport layout with chains, but in an extended position. To be able to install the felling head at the centre of the wagon, the cab and the arm of the machine were not placed parallel to the chassis, but turned at an angle of 10° to 15° towards the left. This meant that the cab could not be locked in its position using the pins provided.

The Skogsjan 601 II felling head, weighing 950 kg, was placed on wood chocks that were not fixed and was attached indirectly using a 2 500 daN strap.

It was not possible to use the mechanical system provided to prevent the turntable from rotating, due to the offset, so the arm was held in place by attaching it indirectly (without a round turn) with a 2 500 daN strap placed towards the middle of the arm.

The documents forwarded during the investigations do not show that the loading advisor played an active part in the loading operations.

4.1.3 - Acceptance of the loading

That same day, 15 May, at the end of the loading sequence, the "Wagenmeister" ["wagon foreman"] from DBSR checked the load (acceptance) and marked the word "geprüft" ["checked"] on the visit listing (cf 3.6.3).

Although he was informed that the specific load consisted of "sensitive elements" and he was authorised to visit this type of goods shipped, he did not detect any anomalies.

4.2 - Journey through Germany and visits en route

On 15 May at 12:19 p.m., train 56031 took the goods from Mosbach-Neckarelz to Jagstfeld, where it arrived at 12:35 p.m., with the four loaded wagons, without any problems.

The wagons were then taken from Jagsfeld to Mannheim by train 52830, which left at 4:31 p.m. and arrived at 6:26 p.m.

Other elements were taken to Mannheim by train 51941 to form the complete train 52826 for Einsiedlerhof Rbf.

4.2.1 - Technical visit at Mannheim

On Saturday 16 May 2009, a technical visit and a brake test were carried out on the complete train at Mannheim, by the visitor from DBSR. The visit was made from 8:25 to 9:44 a.m., without giving rise to any comments, and train 52826 took all the goods from Mannheim to Einsiedlerhof Rbf, from 12:29 to 1:40 p.m.

4.2.2 - Technical transfer visit at Einsiedlerhof RBf

On Tuesday 19 May 2009, at Einsiedlerhof RBf station, the train underwent a technical transfer visit (between DBSR and ECR) and a brake test in accordance with the instructions set out in CUU Annex 9, by a visitor from DBSR, between 1:50 and 3:30 a.m., without any comments.

On the same day, between 3:33 and 4:58 a.m., train 45468 took the goods from Einsiedlerhof RBf to Forbach, via Saarbrücken.

At Forbach, the wagons were handed over to ECR within the framework of the mutual trust agreement, without further formalities.

4.3 - Journey in France to the tunnel of Livernant

On Tuesday 19 May, ECR train 41248 left Forbach at 7:12 a.m. (the train had an even number because it was travelling towards Paris) made up mainly of the four wagons loaded by the Maierhofer Company. It went onto a siding at Metz for a change of personnel, at Châlons-en-Champagne to refuel, and at Valenton for a change of personnel, before arriving at Saint-Pierre-des-Corps at 20:25 p.m. As it crossed the Paris region, it changed numbers and became ECR train 41249.

During the journey, no operating lookout stations entrusted with the task of monitoring the trains running reported any anomalies concerning ECR freight train 41248/9; the reports from the stations do not feature any comments on the subject.

At Saint-Pierre-des-Corps, the ECR driving personnel was switched over – change of personnel – and the locomotive was refuelled, without the driving personnel noticing any problems.

At 9:50 p.m., ECR train 41249 left for Bordeaux and Bayonne.

4.4 - The accident

Since the beginning of the route covered during the journey, the load had probably started to shift under the effects of the jolting, the chocks may have moved and the straps could have slackened.

At one time or another, the most likely hypothesis is that the wood chocks under the felling head, which were not fixed in place, came loose.

This slackened the straps, and the turntable and the arm swung back and forth with increasing movements as the train went over points, curves and counter-curves of the railway lines, until the straps broke or came free. The arm swung round and fouled the gauge of the other track.

Crossing train 74424

On Wednesday 20 May 2009, as ECR train 41249 continued on its route, it crossed several freight trains. At 0:13 a.m., when the train was at Vars, it crossed SNCF train 74424 – see the actual traffic chart in Annex 6.

The arm of the forestry machine swivelled round, hit the right-hand part of SNCF freight train 74424 and violently struck locomotive BB 407360 at a height of about 2.30 m from the ground (2.17 m from the rails). The blow, although a brief one, left a deep mark on the front right-hand door and its upright, about 40 cm long and 5 cm wide - See Annex 3.

The driver of train 74424 thought at the time that a ballast stone had been thrown up, and continued on his way. When he stopped at Châtellerault, at about 1:55 a.m., he noticed the damage to the right-hand side of the locomotive: traces of blows, handrails ripped off, and ventilation grille louvres torn away.

Crossing train 4194

At 0:34 a.m., near Charmant station, the ECR train crossed SNCF freight train 4194. The load hit that train at a height of about 2.30 m from the ground (2.17 m from the rails) and struck a blow on the right-hand side about 10 cm in diameter– see the actual traffic chart in Annex 6.

In spite of the comments made by the driver travelling "as a passenger", the driver of train 4194 also thought that a ballast stone had fallen from two ballast wagons. He disregarded his colleague's comments and continued on his way.

It was when he arrived at Angoulême, for a change of personnel, that he noticed the damage done to the locomotive: traces of blows, handrails and ventilation grille louvres torn off. He called the controller at 0:43 a.m., too late to avoid the accident.

Crossing train 56724

At 0:39 a.m., train 41249 crossed train 56724 in the tunnel of Livernant. At that time, train 56724 was travelling at 92 km/h and train 41249 at 74 km/h.

The front end of the arm on the Skogsjan 487XL forestry machine struck the locomotive of train 56724 and entered the driver's cab, on the right-hand side, at the level of the seat for the accompanying employee, and it came apart from the rest of the arm. In the shock, the felling head came away from the swivel arm and hit the forestry machine on its left-hand side.

Through good luck, the accident only caused one minor injury to the driver, whose wrist was broken.

In the accident caused by the impact, the forestry machine moved across the TWA 800 wagon, the right front wheel hit the SNCF train and was ripped off in the tunnel.

The pivoting movement continued through 180°, and the remains of the Skogsjan 487XL's arm hit the "Timberjack" forestry machine placed immediately behind it on the same wagon, damaging that machine's engine. The judiciary authorities found various parts from the Skogsjan 487XL in SNCF train 56724. Annexes 8 and 9, set out in the form of summary tables, give details of the findings for all the equipment after the accident.

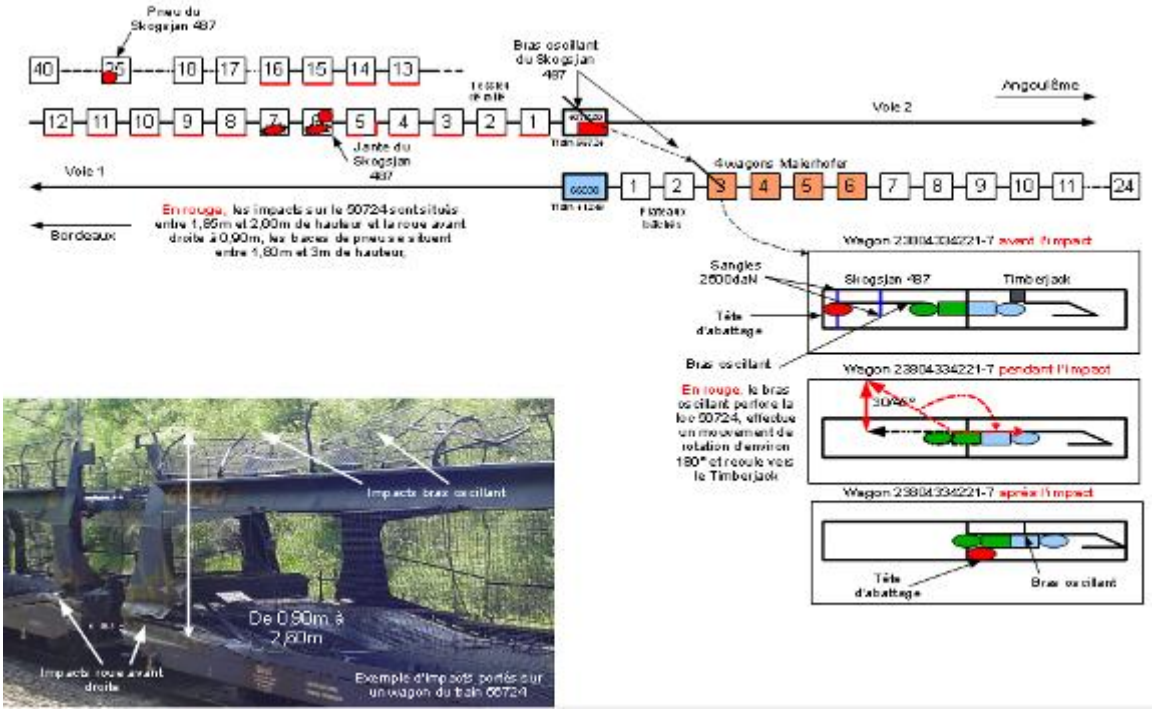


Figure 26: Diagram of the events

Rear end of the wagon – Front end of the wagon

Figure 27: Wagon carrying the Skogsjan 487 after the accident

In **red**, we show the swivelling movement of the turntable and arm of the Skogsjan 487XL through about 180°, with the backward movement of the machine towards the second part of the articulated wagon.

4.5 - The emergency services

The driver of SNCF train 56724 gave the alert by radio at 0:41 a.m. to the SNCF Regional Operational Centre in Bordeaux.

The emergency services were called in immediately by the Regional Operational Centre in Bordeaux. The rescue operations concerning the injured driver of train 56724 were executed immediately by the emergency services, and the driver was taken to Camille Claudel hospital in Angoulême.

On the other hand, the gendarmes were not told about the accident during the initial moments after it occurred. They were only informed via a radio newsflash, and that resulted in delays concerning the on-the-spot investigation.

The operations to clear the tracks were then carried out by the emergency services and the technical personnel from the SNCF infrastructure. The trains involved in the occurrence were moved to passing tracks at Mouthiers for SNCF train 56724 and at Charmant for ECR train 41249.

4.6 - The risks involved

The driver of train 56724 was the only person injured in the accident.

Nonetheless, five persons could have been in the front of a train struck, and hence, depending on the impact, they could have suffered major consequences:

- The driver of train 56724, of course;

- The drivers of trains 74424 and 4194, who could have been involved in the same type of accident, without any warning signs;
- The driver travelling "as a passenger", who changed trains at the last moment and travelled in the previous train, train 4194;
- The traction supervisor in charge of the driver of train 56724, who put off, shortly before the train left, the trip he was to have made with the driver that night.

It is also necessary to remember that the trains involved were freight trains, and not passenger trains. An impact as violent as that with a passenger train could have increased the number of victims considerably.

It should also be noted that the wagons in train 74424 all contained hazardous materials that could have made the accident worse.

5 - Analysis of the causes and associated factors, preventative measures

The direct, immediate cause of the accident is rotation of the turntable and fouling of the clearance gauge of the adjacent track by the arm of the Skogsjan forestry machine.

Three themes can be selected when looking for preventative measures:

- The process for sending sensitive elements, including advice, loading and acceptance of the elements shipped;
- The technical visit and the technical transfer visit;
- The steps to be taken in the event of an impact or unusual noises when crossing a train.

5.1 - The process for sending sensitive elements

The process drawn up by DBSR for sending sensitive elements in order to enhance safety levels when transporting certain types of goods showed failures at two levels.

On the one hand, the loading advice provided did not give the shipper enough information to make up for its lack of experience in the field of shipping goods by railway. The agreement drawn up by the loading adviser two days before loading only provides the shipper with very brief recommendations. In the light of the difficulties entailed by the operation, the adviser's active presence during the loading operations would have been very useful.

The agreement does not mention the possibility for the shipper of requesting the adviser's presence if necessary during the loading operations.

It is clear that during the loading work, the Maierhofer personnel were unaware of the basic rules governing loading, chocking and securing elements for railway travel. As well as the anomalies concerning the Skogsjan machine, other serious anomalies were found regarding the other machines shipped.

On the other hand, even though the acceptance examination was carried out by a specially authorised visitor who was well aware that the goods concerned were sensitive, it did not enable him to detect the anomalies referred to above.

Taking these facts into account, the BEA-TT has issued two recommendations to be implemented by DBSR. In conformity with the international practices put forward by the European railway agency, these recommendations are forwarded to DBSR via the French national railway safety authority (EPSF), which will pass it on to its German counterpart (EBA) for implementation by DBSR.

Recommendation R1 (to DBSR via the EPSF and the EBA):

Check the training and awareness enhancement for the personnel (loading advisers, trained visitors) concerned by the process for shipping sensitive elements, and schedule active participation by the advisers when the loading work is carried out by an inexperienced company.

Recommendation R2 (to DBSR via the EPSF and the EBA):
Complete the text of the "sending sensitive elements" agreement by adding:

- **The shipper's signature confirming that it is fully aware of the adviser's recommendations and its undertaking to comply with them;**
- **The mention that the shipper can request the adviser's presence during loading if necessary.**

5.2 - The technical visit and the technical transfer visit

The anomalies concerning the load and its securing were not detected during the two technical visits made in the course of the journey through Germany, and in which four visitors took part.

Even though these visits mainly concern the condition of the rolling stock, they must also enable detection of clearly visible anomalies affecting the loads.

In the case of the wagons dispatched by the Maierhofer Company, the chocking and securing anomalies were visible from the ground and could have been detected.

It is thus advisable to ensure that the visitors do in fact possess the necessary skills to make these visits.

Taking these facts into account, the BEA-TT has issued the following recommendation:

<u>Recommendation R3</u> (to DBSR via the EPSF and the EBA):
Check the initial and ongoing training of all the visitors regarding verification and inspection of loads during journeys, and especially those made on sensitive elements shipped.

5.3 - The steps to be taken in the event of an impact or unusual noises when crossing a train

Neither the manuals for the SNCF drivers nor the regulatory texts at higher levels lead drivers to immediately implement the provisions to stop or arrange for stopping of the crossing train if they notice an impact or hear an unusual noise when crossing a train.

It is true that under normal conditions, noises are frequently heard, some of them loud, while running or when crossing a train, without affecting safety in any way (aerodynamic effects, ballast thrown up, or blocks of ice in winter, etc.). A rule of a systematic nature could lead to multiplying unjustified stoppages without leading to any significant progress from a safety standpoint.

Nonetheless, it could be useful to deal differently with the case of crossing a freight train at night or under reduced visibility. In that case, the driver could systematically be led to presume that the crossing train is fouling the gauge and trigger the procedure concerning trains running under hazardous conditions.

It would also seem advisable to review regulatory text EN 1514 – S2C, covering running incidents, to set out in greater detail the provisions to be applied by all the railway undertakings.

Taking these facts into account, the BEA-TT has issued two recommendations:

Recommendation R4 (SNCF):
Examine the pertinence of modifying the application documents for drivers (TT 0057), to encourage them to presume gauge fouling by a crossing train if they notice an unusual noise of impact when crossing a freight train, at night or under reduced visibility.

Recommendation R5 (EPSF, DGITM):
Examine the modalities enabling adaptation of the regulatory text EN 1514-S2C or recommendations concerning the manuals for railway undertakings, to lead train drivers to presume gauge fouling by a crossing train if they notice an unusual noise of impact when crossing a freight train, at night or under reduced visibility.

6 - Conclusions

6.1 - Causes of the accident

The immediate cause of the accident is uncontrolled rotation of the turntable and the mobile arm of the Skogsjan forestry machine, thus fouling the clearance gauge of the adjacent track.

Two factors lie at the origin of the accident:

- Poor execution of the work to immobilise the moving parts of the machine by the shipper, which was not an experienced professional specialist, when loading the wagon in Germany;
- Faulty implementation by DBSR (the German railway undertaking that dealt with the transport) of the advisory and inspection procedure set out for this type of shipping.

Two factors may also have contributed to the lack of detection and alerts while the train was running under hazardous conditions:

- Failure to detect the faulty immobilisation, chocking and securing work during the technical visits en route;
- The lack of clarity concerning the steps to be taken by the drivers if they notice noises of impacts, which failed to stop the train running under hazardous conditions before the accident.

6.2 - Recommendations

This had led the BEA-TT to issue five recommendations. Three of them are to be implemented by German operators, so the forwarding procedure involves passing them on, as recommended by the European railway agency (ERA), via the French and German railway safety authorities (EPSF and EBA respectively).

<u>Recommendation R1</u> (to DBSR via the EPSF and the EBA):

Check the training and awareness enhancement for the personnel (loading advisers, trained visitors) concerned by the process for shipping sensitive elements, and schedule active participation by the advisers when the loading work is carried out by an inexperienced company

<u>Recommendation R2</u> (to DBSR via the EPSF and the EBA):

Complete the text of the "sending sensitive elements" agreement by adding:

- **The shipper's signature confirming that it is fully aware of the adviser's recommendations and its undertaking to comply with them;**
- **The mention that the shipper can request the adviser's presence during loading if necessary.**

Recommendation R3 (to DBSR via the EPSF and the EBA):
Check the initial and ongoing training of all the visitors regarding verification and inspection of loads during journeys, and especially those made on sensitive elements shipped.

Recommendation R4 (SNCF):
Examine the pertinence of modifying the application documents for drivers (TT 0057), to encourage them to presume gauge fouling by a crossing train if they notice an unusual noise of impact when crossing a freight train, at night or under reduced visibility.

Recommendation R5 (EPSF, DGITM):
Examine the modalities enabling adaptation of the regulatory text EN 1514-S2C or recommendations concerning the manuals for railway undertakings, to lead train drivers to presume gauge fouling by a crossing train if they notice an unusual noise of impact when crossing a freight train, at night or under reduced visibility.

ANNEXES

Annex 1: Decision to start an investigation

Annex 2: Journey made by the wagon carrying the Skogsjan forestry machine

Annex 3: Impacts on the locomotives of SNCF trains 74424 and 4194

Annex 4: Faulty securing and immobilisation of a forestry machine loaded by Maierhofer

Annex 5: TWA 800 type low-bed wagon and Skogsjan 487XL

Annex 6: Extract from the actual traffic graph

Annex 7: UIC data sheet 7.3

Annex 8: Summary of the findings for ECR train 41249

Annex 9: Summary of the findings for SNCF train 56724

Annex 1: Decision to start an investigation

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

MINISTERE DE L'ECOLOGIE, DE L'ENERGIE, DU DEVELOPPEMENT DURABLE
ET DE L'AMENAGEMENT DU TERRITOIRE

Bureau d'enquêtes sur les accidents
de transport terrestre

Le Directeur

La Défense, le 20 mai 2009

DECISION BEA-TT 2009-005

Le directeur du bureau d'enquêtes sur les accidents de transport terrestre ;

Vu la loi n° 2002-3 du 3 janvier 2002 modifiée relative à la sécurité des infrastructures et systèmes de transport et notamment son titre III sur les enquêtes techniques ;

Vu le décret n° 2004-85 du 26 janvier 2004 modifié relatif aux enquêtes techniques après accident ou incident de transport terrestre ;

Vu la décision du 5 mars 2009 portant délégation de signature au secrétaire général du BEA-TT

Vu les circonstances de la collision de deux trains de fret dans le tunnel de Livernan (Charente) survenue le 20 mai 2009.

DECIDE

Article 1 : Une enquête technique, effectuée dans le cadre du titre III de la loi n° 2002-3 du 3 janvier 2002 susvisée, est ouverte concernant la collision de deux trains de fret sur la ligne Angoulême-Coutras survenue le 20 mai 2009 dans le tunnel de Livernan situé sur la commune de Charmant (Charente).

pour le directeur empêché et par délégation
Le secrétaire général

René BARLET

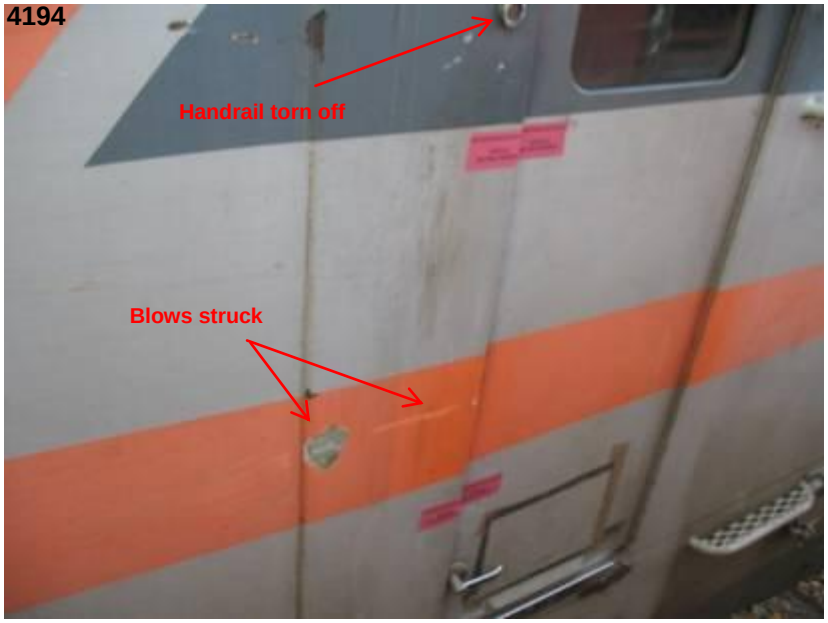
Tour Voltaire 92055 La Défense Cedex
Tél. : 01 40 81 23 27 – www.bea-tt.developpement-durable.gouv.fr

Annex 2: Journey made by the wagon carrying the Skogsjan forestry machine

Annex 3: Impacts on the locomotives of SNCF trains 74424 and 4194

BB 407360 of train 74424

BB 22267 of train 4194



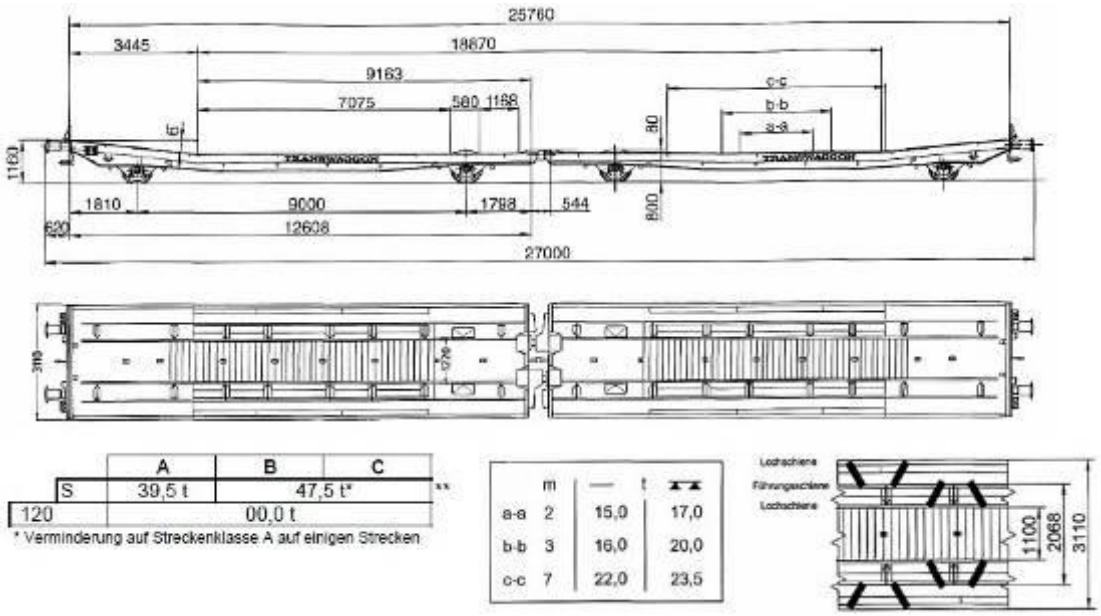
Annex 4: Faulty securing and immobilisation of a forestry machine loaded by Maierhofer

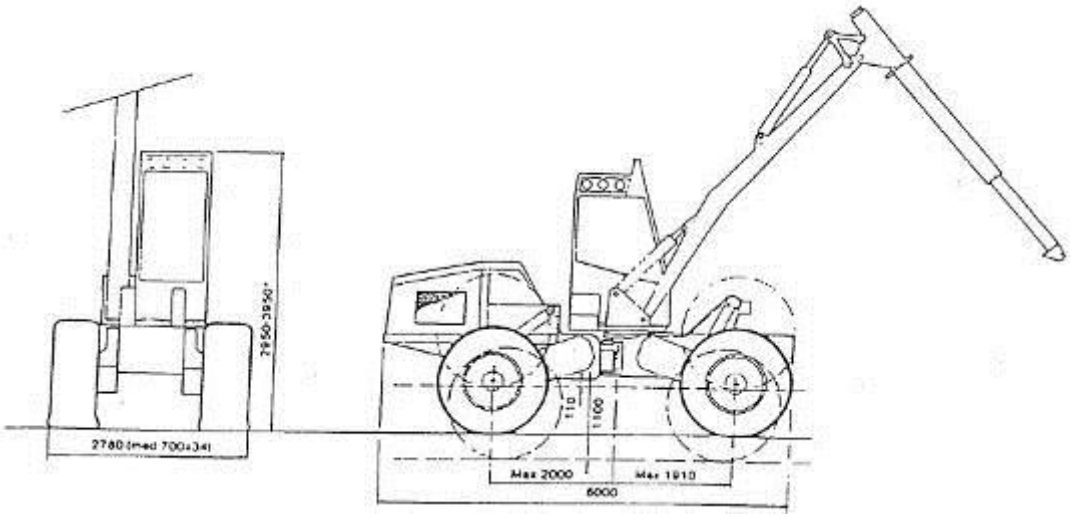
In red, example of an immobilisation bar correctly fitted on a machine loaded by Maierhofer

Well-worn strap found on the second wagon, which was only slightly damaged in the accident

Strap found on the first wagon with a faded validity label

Annex 5: TWA 800 type low-bed wagon and Skogsjan 487XL

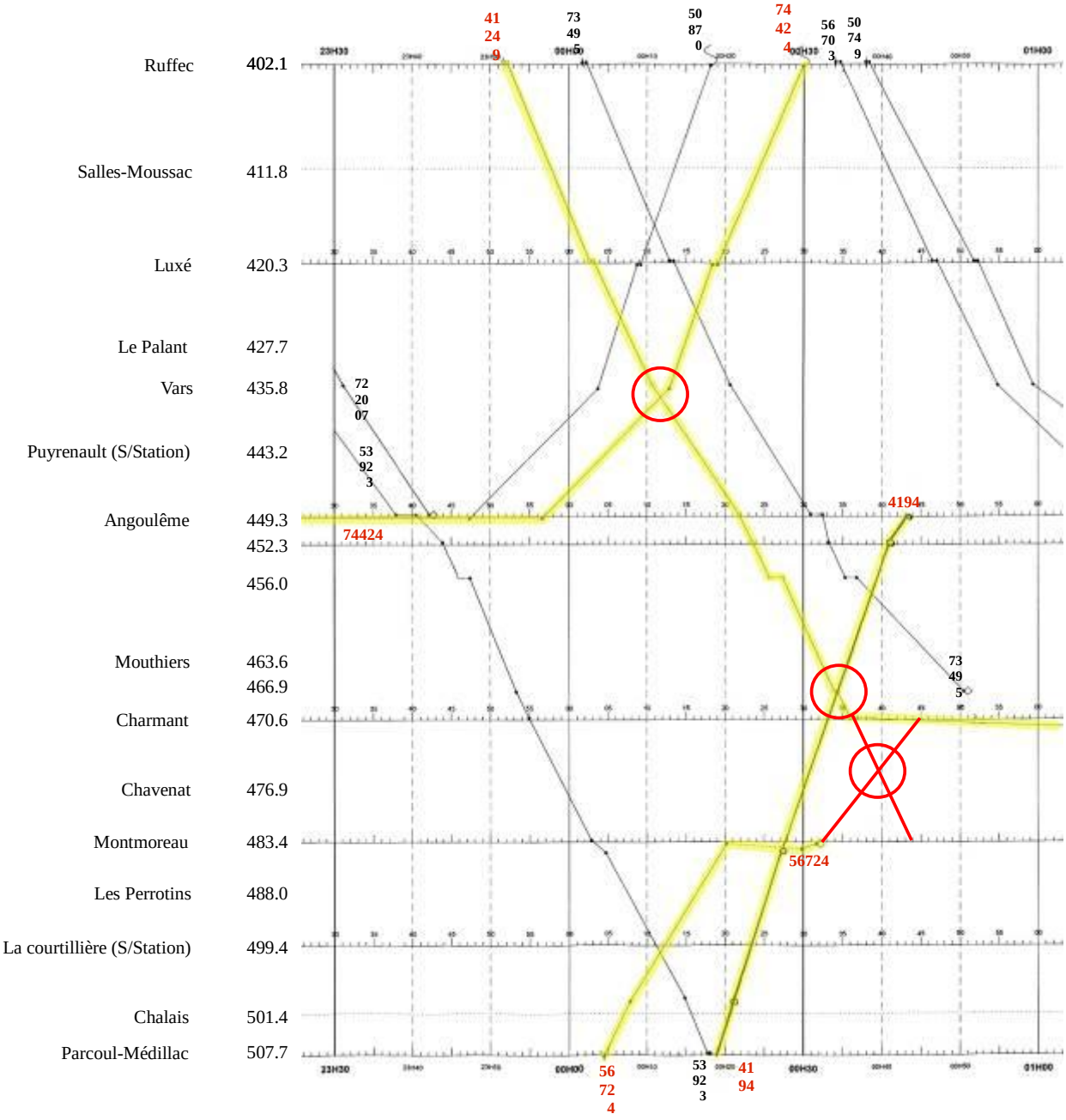




	TWA 800 wagon	**Skogsjan 487XL**
Weight	Laden weight S 39.5 tonnes	13.5 tonnes
Admissible weight between the marks CC	22 tonnes	13.5 tonnes
Width	Accepted 3,110 mm	2,780 mm
Length	Accepted 12,608 mm	6,950 mm

Annex 6: Extract from the actual traffic graph

The red circles show the crossings of trains 74424 and 4194 with train 41249. The crossing with train 56724 is shown with a red dotted line, as the trains had not yet gone past the next detection beacon at the time of the accident.



Annex 7: UIC data sheet 7.3

In German

In French

Véhicules sur roues

Wagons isolés et en groupes	Wagons en trains complets et transport combiné Wagons à amortisseurs à longue course

Marchandises

Véhicules sur pneumatiques
- bâches ou capotes de véhicules, fermées et fixées,
- antennes rentrées, démontées ou rabattues,
- moteurs protégés contre un démarrage intempestif,
- pneumatiques gonflés à la pression de service.

Wagons

Wagons plats, couplages de wagons plats et wagons à deux niveaux pour le transport d'automobiles (La....) équipés de cales avec un angle de 45°

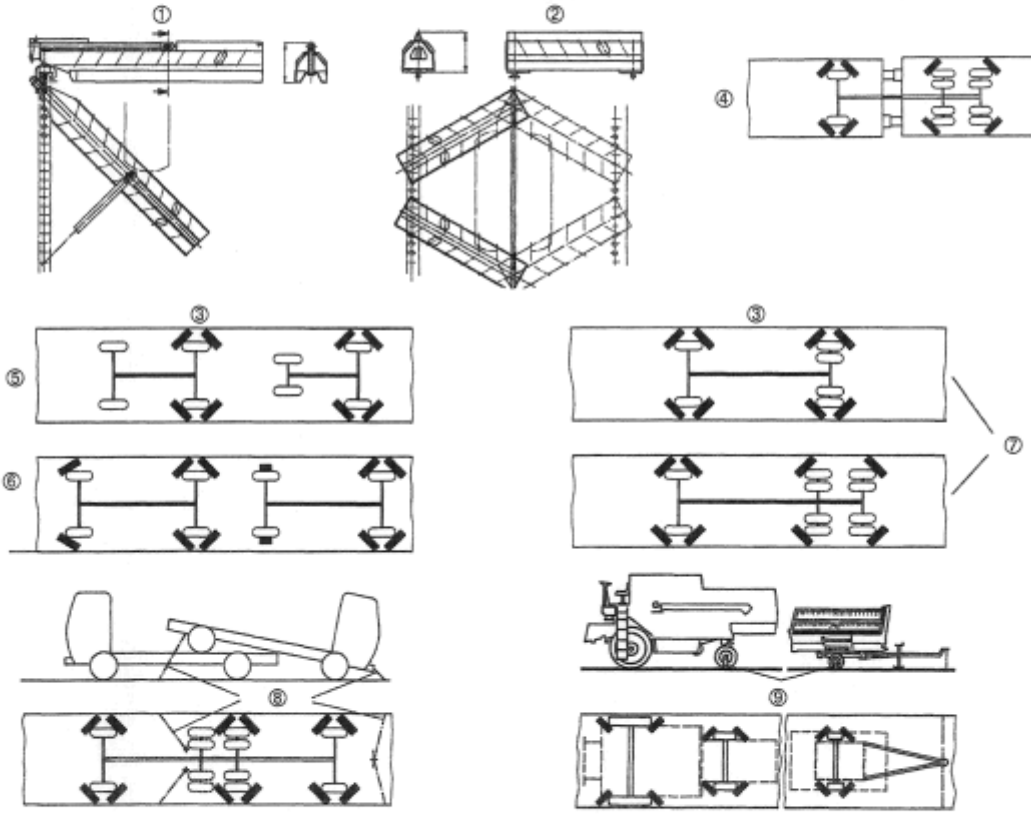
① - avec bras-support ou

② - escamotables

Mode de chargement

③ Placer le véhicule dans le sens longitudinal du wagon. Les cales sont disposées sur les roues avec un angle d'environ 45°
Les véhicules ont leur frein d'immobilisation serré et la vitesse inférieure enclenchée ou la boîte de vitesse bloquée

④ Le chargement à cheval sur wagons plats à couplage est admis



Arrimage

⑤ Pour les voitures et les véhicules d'empattement jusqu'à 3 000 mm maximum et de poids inférieur à 5,5 t, les cales sont placées uniquement sur les roues de l'essieu freiné

⑥ Sur les autres véhicules de poids inférieur à 5,5 t, l'essieu avant est aussi immobilisé au moyen de cales ou assuré latéralement par les glissières ou des cales

⑦ Pour les véhicules dont le poids est supérieur à 5,5 t, chaque roue de l'essieu avant est aussi assurée au moyen de deux cales

7.3

⑧ Des ligatures supplémentaires (dans chaque cas, 2 à l'avant et à l'arrière ; résistance à la rupture : 4000 daN) pour les véhicules
– dont le frein d'immobilisation n'est pas serré ou qui ne sont pas bloqués,
– chargés en chevauchement,
– dont la masse est supérieure à 20 t (5,5 t en cas d'arrimage fixé sur essieu),
– dont le diamètre de roue est supérieur à 1990 mm,

⑨ L'essieu arrière des moissonneuses-batteuses et celui des remorques à essieu unique sont en outre maintenus par arrimage indirect faiblement tendu (résistance à la rupture : 2000 daN).

Les pièces coulissantes, oscillantes ou pivotantes (par exemple flèches de grues, dispositifs de levage, contrepoids ou cabines de véhicules et engins) sont fixées mécaniquement ou immobilisées de façon à ce que leur position ne puisse se modifier pendant le transport (résistance des amarres à la rupture : min. 1000 daN, dans le cas de flèches de grues : min. 4000 daN).

Les timons de remorques non accouplées doivent recevoir un amarrage indirect (résistance à la rupture : 1000 daN).

Indications complémentaires

Les cales de roues doivent être disposées contre les pneus avec un angle d'environ 45°. Un jeu généré entre la cale et le pneu par la position des orifices sur le rail portecales est admis. Les véhicules à roues directrices braquées doivent être assurés de façon suffisante dans cet état.
Les cales de roues non utilisées doivent être fixées.
Répartition de la charge et gabarit de chargement : voir fiches 0.1 et 0.2

Annex 8: Summary of the findings for ECR train 41249

Sequence N°	Locomotive N° / wagon N°	Wagon type	Damage found on the railway equipment	Securing	Loading	Other objects
loco-motive	66038	-----	None			
1	31803525262-2	Flatbed with stakes				
2	31803525499-0	Flatbed with stakes				
3	23804334221-7	Low-bed wagon	None	Metal chocks and a few straps	Green Skogsjan 487 machine. The machine was no longer attached to the bed; only a fragment of blue strap was visible, stuck under the left front wheel. Iron chocks fixed on the bed could be seen, but the wheels of the machine were no longer in the locations provided. The machine had clearly moved backwards, hitting another forestry machine attached on the second half of the wagon. The forestry machine is articulated at the centre with half-axles enabling it to manoeuvre. **There was no system to block the articulation like that found on other forestry machine chassis (Red metal fixing arm).** The machine had also moved sideways and stood at an angle on the flatbed, partially articulated and with a closed angle on the right. The hub of the front right wheel was fouling the clearance gauge outside the wagon. The pins on the wheel hub crown were sheared and the rim was broken. The rim and tyre had disappeared. On the left, the left rear wheel was outside the flatbed and stood out from the wagon by 55 centimetres. The metal rim was deformed, and the tyre had burst; it showed many traces of rubbing and stone debris. The securing chock had left its housing and was also hanging off the edge of the wagon. The felling head was also found on the left between the front and rear wheels. The felling head was fouling the gauge by 50 centimetres and it also showed many traces of rubbing and stone debris. **The machine turntable had swivelled towards the back and the main arm had struck the engine unit of the second forestry machine. The jib was missing, together with the pins holding it on the main boom.** The wearing bushings at the level of the pins were partially torn out of their housings. The cab was partially destroyed, and the door had been torn off and was missing. On the bed, some securing chocks seemed to have left their original position. On the second half-wagon, the green forestry machine of the TIMBERJACK make was also damaged. It had been struck from behind by the first machine and damaged by the main boom of the SKOGSJAN felling machine at the level of the engine unit. In particular, the cowling was twisted and it was standing vertically. The remaining blue securing straps (made in 2009) were slack, and the others were missing. **That machine, which was also centrally articulated, was not fitted with a bar blocking the articulation.**	Behind the felling head and under the machine, there were two boxes used for emergency communication in the tunnel of Livernant, bearing the Figures BD 25 and BD 38. There was a lot of metal and electrical debris under both machines, together with hydraulic fluid.
4	23804334280-3	Low-bed wagon	None	Both machines were held in place by blue ratchet straps 5 cm wide, fixed on the front and rear axles of both machines. The rear tyres of both machines had been removed, and they had also been fixed with the same type of straps, at the front and rear ends of the wagon. **On machine N° 1** (front of the wagon), the 4 straps fixing the double front axle and the 4 straps fixing the rear axle were all taut and locked in place. **On machine N° 2** (rear of the wagon), as on the first machine, all the straps were taut	Two forestry felling machines of TIMBERJACK make, type 1270 D, attached back to back. Machine N° 1: the windscreen was broken and a chock was missing from the rear right wheel Machine N° 2: the engine cover was open, the rear window of the cab was broken and the air filter casing on the engine cover was broken.	Numerous pieces of iron, printed circuits, nut, pieces of Plexiglas, metal grille with electric wires, a step, and a wood chock.

Sequence N°	Locomotive N° / wagon N°	Wagon type	Damage found on the railway equipment	Securing	Loading	Other objects
				and locked in place. On both these machines, we noted the presence of the anti-slewing bar.		
5/1	23804334411-4	Low-bed wagon	None	1st strap: holding machine tyres, blue, **slack,** fixed on the tyres and the wagon. 2nd strap: holding the front axle of a machine to the bed of the wagon, blue, taut, fixed, but showing **traces of tearing.** 3rd strap: holding the tyres of the machine on the wagon, orange, taut, fixed. 4th strap: holding the front axle of the machine on the wagon, blue, taut and fixed. 5th strap: holding tyres to the machine, orange, taut and fixed. 6th strap: holding the rear axle of the machine to the wagon, blue, taut and fixed. 7th strap: holding the rear axle of the machine to the wagon, blue, taut and fixed. Anti-slewing bar present and in place.	Machine of JOHN DEERE make, serial N° CD6068GO38669, model 1110D	
5/2	23804334411-4	Low-bed wagon	None	**No anti-slewing bar on the articulated part of the machine.** All the straps were positioned symmetrically on each side of the machine. *Blue straps used to secure the wheels and the machine:* *Characteristics illegible; made in 2002* Two straps of this type were positioned crosswise on the 4 wheels. They were fixed, in place, taut, and showed no signs of damage. Four straps were used to secure the machine. All the straps were numbered from the front of the half-wagon towards the rear. **Strap N° 4 on the right-hand side of the wagon was slack, open and not fixed.** The straps on the left-hand side were correctly positioned, fixed and taut. No straps showed any signs of damage. ***Chocks*** *These were about 60 cm long, with a triangular cross-section, and they featured two fixing points. The inside point was formed by a T-shaped element sliding along in a rail (present on each side and along the full length of the half-wagon), and it was positioned by rotation. The second point was formed by inserting a protruding cylindrical element in holes (present on each side and along the full length of the half-wagon).* There were six chocks on each side of the half-wagon. Details on the right-hand side: **1st chock: blocking the front of wheel N° 01: it was not positioned correctly because it was not blocked against the tyre and could easily come free at the level of the protruding cylindrical element.** **2nd chock:** blocking the rear of wheel N° 01: it was positioned correctly and could not come free without human intervention. **3rd chock**: blocking the rear of the hub of wheel N° 02 (the wheel had been removed). **It was not positioned correctly because it was not blocked against the hub and could easily come free at the level of the protruding cylindrical element.** **4th chock**: blocking to the front of the hub of wheel N° 03 (the wheel had been removed). It was positioned correctly and could not come free without human intervention. **5th chock**: blocking the rear of wheel N° 04 of the machine: **it was not positioned correctly because it was not blocked against the tyre and could easily come free at the level of the protruding cylindrical element.** **6th chock**: blocking the rear of the wheels stored: it was positioned correctly and could not come free without human intervention. Details on the left-hand side: All the chocks on the left-hand side were positioned in the same locations and were all correctly fixed.	Forestry felling machine: Make: VELSAFE; Model: C1000; Serial N° 127; Year: 1998; articulated vehicle; type 8X8 (8 driving wheels) The machine was positioned on the front of the half-wagon with some of the wheels removed. It was made up of a loading part and a telescopic arm. Starting from the front of the vehicle, wheels 2 and 3 had been removed on each side. The four wheels removed were strapped on the rear of the half-wagon. These wheels were laid flat on their rims.	A piece of metal grille, multiple debris of hydraulic hoses, printed circuits and metal plates.
6	238004334243-1	Low-bed wagon	None	Right-hand side: 9 straps taut and fixed Left-hand side: 8 straps, one of them taut, **but none fixed**	Two forestry felling machines **Machine N° 01:** VALNET 860 (red) **Machine N° 02:** LOGSET (green)	**Presence** of grille, shards of glass, electrical wiring, pieces of iron and steel **Side window** of machine N° 02 broken **Tube** of machine N° 1 bent **Presence** of a broken tail light from the wagon in front of machine N° 2 **Chocks** of wheels in position

Sequence N°	Locomotive N° / wagon N°	Wagon type	Damage found on the railway equipment	Securing	Loading	Other objects
7/1	23804334297-7	Low-bed wagon	None	1st strap: holding the arm of the machine to the wagon, orange, taut, fixed. 2nd strap: holding the front axle of a machine to the bed of the wagon, orange, taut, fixed. 3th strap: holding the axle of the machine on the wagon, brown, taut, fixed. 4th strap: holding the articulation of the machine on the wagon, brown, taut and fixed. 5th strap: holding the trailer coupling of the machine to the wagon, orange, taut and fixed, **but with a tautening length cut off and separated from its fixing to the wagon.** Anti-slewing bar present and in place. Slight shifting of a tyre from the machine placed flat on the wagon.	Machine make JOHN DEERE, serial N° LOK-1163-1260-12,06-F070753, model 1270D	None
7/2	23804334297-7	Low-bed wagon	None	**Absence of anti-slewing bar on the articulated part of the machine.** All the straps were positioned symmetrically on each side of the machine. ***Red straps used to secure the machine:*** *Type 431; length 8 m; year 2009; code 2009 05 8459; strength 2.5T to 5 T.* Two straps of this type were positioned on the rear chassis of the machine and on each side of it; these straps were taut, in place, and fixed, and showed no signs of damage. The front of the machine was also secured by taut red straps, in place, fixed and showing no signs of damage. ***Blue straps used to secure the wheels:*** *Characteristics not legible; year 2002* Two straps of this type were positioned crosswise on the 4 wheels. They were fixed, in place, and taut, and showed no signs of damage. **Chocks** *Characteristics: These were about 60 cm long, with a triangular cross-section, and they featured two fixing points. The inside point was formed by a T-shaped element sliding along in a rail (present on each side and along the full length of the half-wagon), and it was positioned by rotation. The second point was formed by inserting a protruding cylindrical element in holes (present on each side and along the full length of the half-wagon).* There were seven chocks on each side of the half-wagon. Details on the right-hand side: **1st chock**: blocking the rear of wheel N° 01: it was positioned correctly and could not come free without human intervention. **2nd chock**: blocking the front of wheel N° 01: **it was not positioned correctly because it was not blocked against the tyre and could easily come free at the level of the protruding cylindrical element.** **3rd chock**: blocking to the front of the hub of wheel N° 02 (the wheel had been removed). **It was not positioned correctly because it was not blocked against the hub and could easily come free at the level of the protruding cylindrical element.** **4th chock**: blocking the rear of the hub of wheel N° 03 (the wheel had been removed). It was positioned correctly and could not come free without human intervention. **5th chock**: blocking the rear of wheel N° 04 of the machine: **it was not positioned correctly because it was not blocked against the tyre and could easily come free at the level of the protruding cylindrical element.** **6th chock**: blocking the front of wheel N° 04 of the machine: **it was not positioned correctly because it was not blocked against the tyre and could easily come free at the level of the protruding cylindrical element.** **7th chock**: blocking the front of all the wheels removed from the machine and placed at the rear of wagon N° 01 of the machine: **it was not positioned correctly because it was not blocked against the tyre and could easily come free at the level of the protruding cylindrical element.** Details on left-hand side: All the chocks on the left-hand side were positioned in the same locations and were all correctly fixed.	**Forestry felling machine**: Make: TIMBERJACK Model: 1110C, Serial N° 17DC0881; Year: 2001; Unladen weight: 13.1 Tonnes; articulated vehicle; type 8X8 (8 driving wheels) The machine was positioned on the front of the half-wagon with some of the wheels removed. It was made up of a loading part and a telescopic arm. Starting from the front of the vehicle, wheels 2 and 3 had been removed on each side. The four wheels removed were strapped on the rear of the half-wagon. These wheels were laid flat on their rims.	A ripped-off hydraulic hose was found on the machine.
8	23804334235-7	Low-bed wagon	None	**Right-hand side** 1st strap: **Worn,** fixed, **stretched** 2nd strap: Fixed, taut 3rd strap: **Worn,** fixed, taut 4th strap: **not fixed**, taut 5th strap: fixed, taut 6th strap: **non fixed,** taut **Left-hand side**	Two felling machines	Presence of electrical wires on the bed of the wagon. **No locking system on either of the two machines.** Wheel chocks in position.

Sequence N°	Locomotive N° / wagon N°	Wagon type	Damage found on the railway equipment	Securing	Loading	Other objects
				1st strap: fixed, taut 2nd strap: fixed, **not taut** 3rd strap: fixed, **not taut** 4th strap: fixed, **not taut**		
9	24744359235-4	Covered wagon	Closed wagon/none			
10	318027800133-7	Covered wagon	**Closed wagon** 2 horizontal dents: - 7.25 m X 1.45 m height X 3.55 m Length - 12.55 m X 1.45 m height X 9.45 m length	Closed wagon/none		
11/1	21804309094-1	Low-bed wagon	**Bent side uprights** 1st bend: vertical from the corner of the wagon over 25 cm at 1.30 m from the ground 2nd bend: vertical at 2.10 m from the corner of the wagon over 25 cm at 1.30 m from the ground 3rd bend: vertical at 8.90 m from the corner of the wagon over 25 cm at 1.30 m from the ground	Closed wagon/none		
11/2	21804309094-1		**Horizontal scratches** height between 2.60 m and 2.40 m on a lumber retaining stake, located 2.10 m from the front of the wagon (second stake from the front) **Mark** of black rubber on the 3rd lumber retaining stake, at a height of 2.92 m, and located 3.85 m from the front of the wagon.	Empty wagon/ None		On the bed, 3 m from the front of the wagon, a piece of rubber was found, coming from the tread of an agricultural machine tyre with a diameter of 20 cm.
12/1	21804309027-1	Low-bed wagon	**Bend** in a panel located on the right-hand side of the wagon, at the front, at a height of between 1.30 m and 1.55 m **From** the front right-hand corner, the first 5 side posts set 1.70 m apart were all bent backwards at their bases, placed at a height of 1.20 m above the sleepers.	Empty wagon/ None		Presence of a piece of iron about 1m long
12/2	21804309027-1		**Bent side uprights.** 1st bend: vertical 2.10 m from the corner of the wagon over 20 cm at 1.30 m from the ground 2nd bend: vertical 7.25 m from the corner of the wagon over 20 cm at 1,30 m from the ground 3rd bend: vertical 8.95 m from the corner of the wagon over 20 cm at 1.30 m from the ground 4th bend: vertical 10.65 m from the corner of the wagon over 20 cm at 1.30 m from the ground	Empty wagon/ None		
13/1	21804309051-1	Low-bed wagon	A lumber retaining stake located 3.83 m from the front was bent back at its base placed at a height of 1.30 m from the sleepers, and the threaded fasteners had been pulled out. (Distance between the uprights: 1.45 m)	Empty wagon/ None		
13/2	21804309051-1					

Sequence N°	Locomotive N° / wagon N°	Wagon type	Damage found on the railway equipment	Securing	Loading	Other objects
14	24744359626-4	Covered wagon	**Horizontal scratch** (start of marks/height/length/end of marks): - 22.2 m X 2.20 m X 22.2 m X 2.20 **7 Horizontal cuts**(start of marks/height/length/end of marks): - 7.75 m X 2.20 m X 3 cm X 2.20 m - 5.80 m X 2.20 m X 24 cm X 2.20 m - 4.65 m X 2.20 m X 16 cm X 2.20 m - 3.45 m X 2.20 m X 16 cm X 2.20 m - 2.25 m X 2.20 m X 16 cm X 2.20 m - frontwag X 2.20 m X 22 cm X 2.20 m	Empty wagon / None		
15	21802458268-2	Closed wagon	Closed wagon / None			
16	21802459295-6	Closed wagon	Closed wagon / None			
17	31802777020-1	Closed wagon	Closed wagon / None			
18	34742782030-8	Closed wagon	1st scratch: horizontal and vertical 30 cm from the corner of the wagon over a length of 45 cm and at 1.65 m from the ground 2nd scratch: horizontal 3.55 m from the corner of the wagon over 1.85 m and at 1.65 m from the ground	Closed wagon / None		
19	34742782057-1	Closed wagon	- Right-hand side, a horizontal scratch 10 cm long at a height of 1.60 m from the sleepers. It started at 21.80 m and ended at the rear of the wagon at 21.90 m. **- Vertical mark** 21 cm long at the upper right-hand corner of the wagon. It started at 1.49 m from the sleepers and ended at 1.70 m. - Fine horizontal **scratches** at a height of between 1.20 m and 1.30 m over the full length of the wagon.	Closed wagon / None		
20	33802742173-8	Closed wagon	Closed wagon / None			
21	33802782594-6	Closed wagon	Closed wagon / None			

Annex 9: Summary of the findings for SNCF train 56724

Sequence N°	locomotive N°/ wagon N°	Wagon type	Damage found on the railway equipment	Securing	Loading	Other objects
locomotive	**BB407220**	**----**	A steel cable went through the front right-hand part of the locomotive, attached to a tackle element installed on the right-hand side of the locomotive.	None		Numerous mechanical and electrical parts were strewn over the floor of the locomotive. The jib found certainly comes from the forestry machine.
1	**23874180474-0**	**Car carrier**	- Lower part of grille torn off - Rubbing marks from 3.30 m from the front corner at **a height of 2.60 m** over the full length	None		None
2	**43874273069-2**	**Car carrier**	- Lower part of grille torn off over the full length, upper part partially torn off - Rubbing marks from the front corner from **a height of 1 m to 2.50 m** - Impact marks at 13.20 m at a height of 1.90 m - Rubbing marks at 21.50 m over 3.90 m and at a height of 1.45 m			
3	**23874270849-4**	**Car carrier**	- Upper part of grille damaged over the full length - Upright dented at 11.70 m at a height of 1.80 m - Upright cut at the corner over **2.70 m at a height of 1.35 m** - Upright cut at 23.10 m at a height of 1.70 m			- Piece of steel plating from the locomotive - Piece of the door from the Skogsjan 487
4	**43874272898-5**	**Car carrier**	- Upper part of grille damaged over the full length - Vertical bend at the upper corner at a height of 1.40 m, 0.60 m in length and finishing at **a height of 2.50 m** - Scratch on the upright at 11.80 m at a height of 1.85 m over a length of 13.50m and finishing at a height of 1.70 m.			- Bent wheel rim from the Skogsjan 487
5	**33877816083-2**	**Tanker**	- Horizontal bend on ladder at 8.50m from the upper corner and at **a height of 1.30 m** - Handle holder plate bent to a horizontal position at 9.60 m from the upper corner at **a height of 0.90 m** - Horizontal tyre mark at 0.50 m from the upper corner, over 1 m and at a height of 3 m	None		None
6	**11873997315-4**	**Truck carrier**	- Vertical bend on side upright at 14.85 m from the upper corner at **a height of 1.90 m**			Presence of a hydraulic hose
7	**11873942365-5**	**Truck carrier**	- Bends on the first side uprights at 1.70 m, 5.95 m, 8.05 m and 10.65 m from the upper corner at **a height of 1.95 m**	None	I-beams	None
8	**1876737554-2**	**Tipping wagons**	- Horizontal tyre rubbing mark over the full length at a height of 3 m - Upper ramp cut at **a height of 2.60 m**	None		None
9	**31876737179-8**		- Horizontal tyre rubbing mark over the full length at a height of 3 m - Upper ramp cut at **a height of 2.15 m**			
10	**31876736768-9**		- Horizontal tyre rubbing mark over the full length at a height of 3 m - Upper ramp cut at **a height of 2.10 m**			Presence of fragments of hydraulic hoses
11	**31876734209-6**		- Horizontal tyre rubbing mark over the full length at a height of 3 m			None
12	**31876736929-7**		- Horizontal tyre rubbing mark over the full length at a height of 2.10 m - Upper ramp cut			
13	**31876734599-0**		- Horizontal tyre rubbing mark over the full length at a height of 1.80 m - Upper ramp bent			
14	**31876736966-9**		- Horizontal tyre rubbing mark over the full length at a height of 1.90 m - Upper ramp bent at **a height of 2.15 m**			
15	**31876736140-1**		- Horizontal tyre rubbing mark over the full length at **a height of 2.80 m**			
16	**31876737502-1**		- Horizontal tyre rubbing mark over a length of 12 m and at a height of 2.55 m - Upper ramp bent at **a height of 2.55 m** - Horizontal dent at 1.30 m			
17	**31876736523-8**		None			

18	**31876737923-9**			
19	**31876735287-1**			
20	**31876736879-4**			
21	**31876736248-2**			
22	**31876736378-9**			
23	**31876734903-1**			
24	**31876734414-2**			
25	**31876737249-9**		None	Forestry machine tyre 1/25/B
26	**31876734280-7**		None	
27	**31876737331-5**			
28	**31876766500-6**			
29	**31876734287-2**			
30	**31876737109-4**			
31	**31876737736-9**			
32	**31876735355-6**			
33	**31876734234-4**	**Tipping wagons**		
34	**31876736775-4**			
35	**31876737254-8**			
36	**31876735259-0**			
37	**31876734549-5**			
38	**31876734537-2**			
39	**31876737165-7**			
40	**31876734434-0**			

Bureau d'Enquêtes sur les Accidents de Transport Terrestre (BEA-TT) (Land transport investigation body)

Tour Voltaire – 92055 LA DEFENSE CEDEX
Tel: +33 (0) 1 40 765921 – Fax : + 33(0)1 40 81 21 50

cgpc.beatt@developpement-durable.gouv.fr
www.bea-tt.developpement-durable.gouv.fr