Investigation Body for Railway Accidents and Incidents

Summary
Safety Investigation Report
Derailment of a Lineas freight train
Aubange - 19 May 2017

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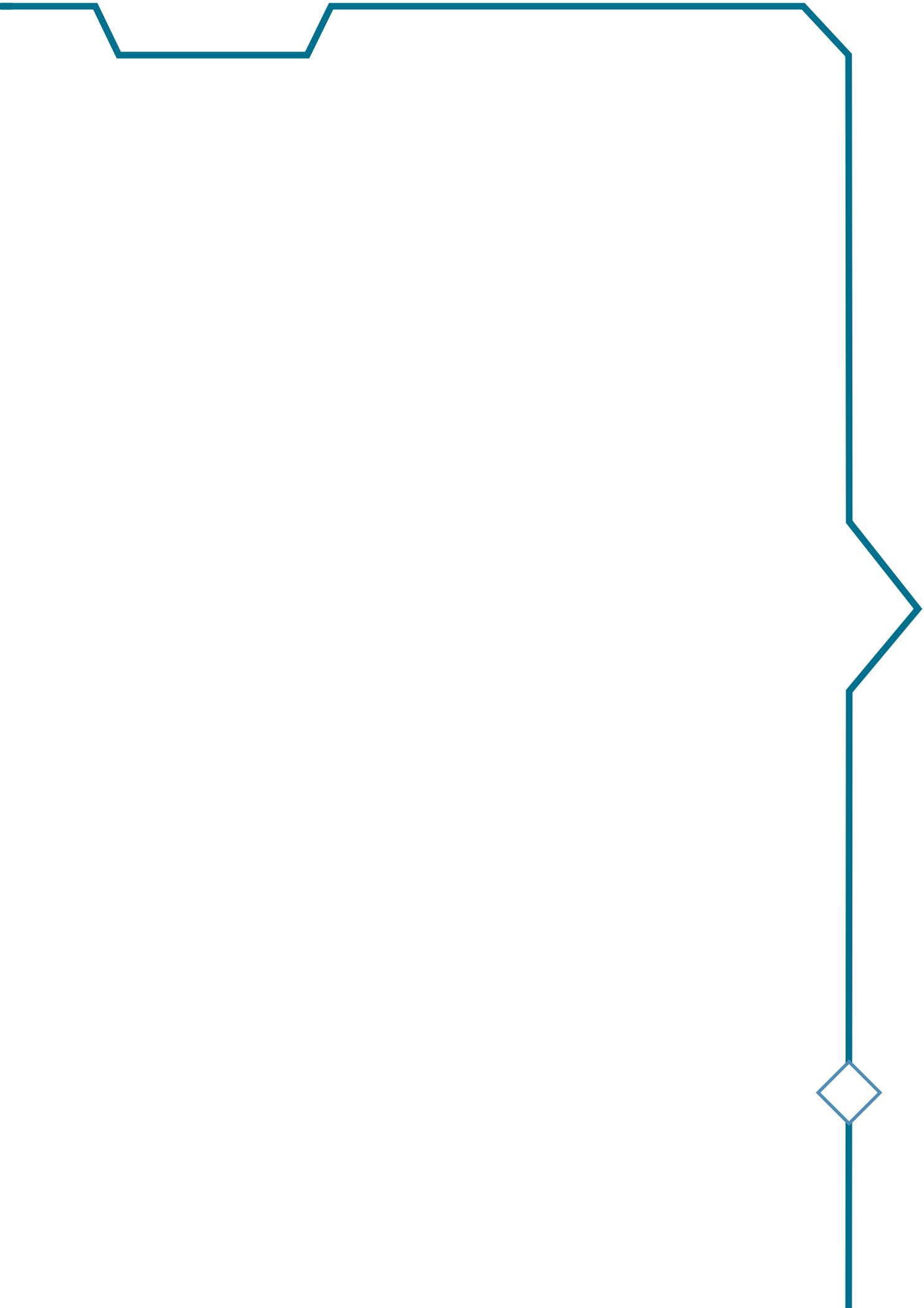
July 2018

REPORT VERSION TABLE

Version number	Subject of revision	Date
1.0	First version	19/07/2018

Any use of this restricted report with a different aim than of accident prevention - for example in order to attribute liability - individual or collective blaim in particular - would be a complete distortion of the aims of this report, the methods used to assemble it, the selection of facts collected, the nature of questions posed and the ideas organising it, to which the notion of liability is unknown. The conclusions which could be deduced from this would therefore be abusive in the literal sense of the term.
In case of contradiction between certain words and terms, it is necessary to refer to the French version.



1. SUMMARY

The facts

On the 19th of May, 2017, shortly before 3 a.m., freight train 40378 owned by Lineas, a railway undertaking, departs from Virton and travels along line 165. It includes a type-13 electric locomotive and 25 wagons.

Having covered approximately 6 km, shortly before the unmanned stopping point of Halanzy, the right wheel of the 3-3' axle (centre bogie on an articulated wagon) of the 24th wagon breaks and a fragment of the wheel is detached from the wheel, followed by a 2nd fragment.
There is nothing in the driver's cabin of the train to inform him that a wheel is broken, and the train continues on its journey.
The centre bogie of the 24th wagon derails, thereby "crabbing" the wagon and causing damage to the infrastructure and various railway signalling elements.

The derailment of the 24th wagon (n°3368 4952 072-9) is the result of the broken right wheel of the 3-3' axle of the wagon (see illustration below).

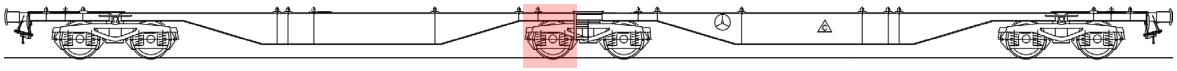


Illustration of a Sggmrs-type wagon, showing the 3-3' axle.

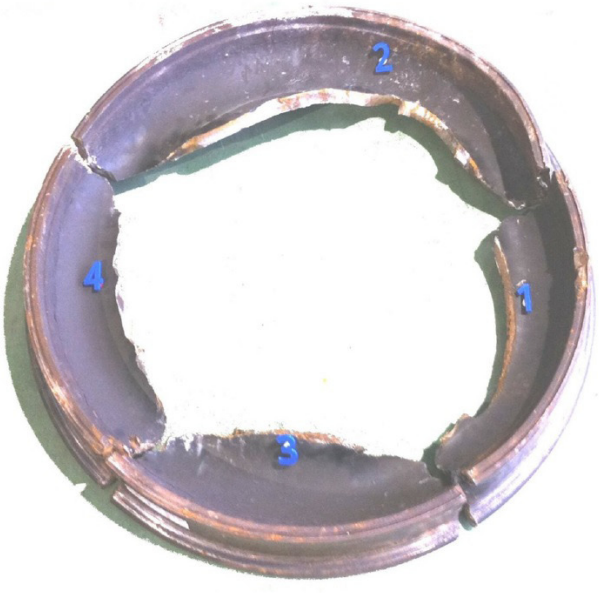
Block 23 of Bertrix observes various infrastructure and signalling disruptions in the Halanzy-Aubange section following the passage of train 40378: abnormal occupancies and vacancies of the track circuit detecting the presence of trains in those sections, loss of control of several switches and alarms on level crossings.
The staff of block 23 contact the train driver to ask whether there have been any issues with his train: he reports that he has not noticed any particular issue, and continues his journey.
Convinced that the problem comes from the train, the block staff contact the driver again to ask him to stop his train and to carry out an inspection. The driver stops the train at the level of kilometre marker 141200. The call is interrupted by an alarm triggered by Traffic Control through GSM-R, halting all traffic.
The inspection of the train by the driver reveals that the two last wagons of the train have derailed. The initial inspections of the rolling stock, of the tracks and of the area surrounding the tracks reveal that one of the wheels of the penultimate wagon broke some 17 kilometres from the train's stopping point, causing the derailment of the wagon.

Analysis of the broken wheel and of the axles of the bogie

The broken wheel fragments, along with the implicated axle and the second axle of the bogie, were analysed in a laboratory to determine what caused the wheel to break.
This analysis reveals that following a braking incident, excessively-energetic braking or the application of aggressive brake blocks, such as some LL-type composite blocks, the wheel tread could have developed thermal cracking or tearing-type defects, and generated significant heating of the wheel rims.
Damages to the paint observed at the connection between the plate and the rim of broken wheel fragments confirm these observations.
During operations, these fatigue-induced defects spread in a radial direction under the effect of thermal stress.

Based on the laboratory analysis, the report concludes that:

- the observed phenomena confirm the significant increase of the rim's temperature during the wagon's operations;
- the issue affecting the broken wheel is not so much a problem of the wheel's profile (height of the flange or equivalent conicity value) as it is a problem relating to its resistance to thermal stress and to the stress cycles imposed on the wheel;
- the heating affected all the wheels of the bogie and was due to overly-intense braking and/or the use of an unsuitable wheel/pad couple.

Fragment n°	Borne Kilométrique (BK)	
1	127.800	
2	127.000	
3	124.000	
4	124.000	

Who is the keeper of the wagon?

The wagon was built in 2003 by the company LOSTR for the wagon keeper "Ahaus Alstätter Eisenbahn Cargo AG" (known by its acronym AAE).
The wagon is registered with the NVR (National Vehicle Register) by the German National Safety Authority (Eisenbahn-Bundesamt).
According to the CUV[1] appendix of the COTIF[2] 1999, the keeper is no longer required to register his wagons with a railway undertaking.

The use of wagons by railway undertakings (RUs) as a means of transport requires the implementation of contractual provisions defining the rights and duties of each party.

To limit the proliferation of bilateral agreements between all the users/owners of wagons and all the railway undertakings, all the industry stakeholders held meetings in 2002/2003 to define the General Contract of Use for Wagons (or GCU) .
These stakeholders are:

- historical railway undertakings (through the UIC);
- new stakeholders (through the ERFA[3]);
- wagon keepers (through the UIP).

For the purpose of increasing the efficacy and competitiveness of the rail freight industry, wagon keepers and RUs that have entered into the GCU (General Contract of Use for Wagons) agree to apply the provisions of this contract.
The GCU is a multilateral contract based on the international COTIF 1999 agreement and its CUV appendix. It lists the mutual rights and duties of wagon keepers (Ks) and railway undertakings (RUs) when using wagons as a means of transport in Europe and beyond.
In 2015, the VTG group took over the activities of the AAE company: VTG became the new owner of the wagons formerly owned by AAE, and therefore of wagon 33 68 4952 072-9.
A single entity has the responsibility for maintenance operations and managing the maintenance schedule.
The VTG company is certified as an Entity in Charge of Maintenance (ECM).

The VTG company is both the keeper and the ECM of wagon 33 68 4952 072-9.

LINEAS is a European Railway Freight Undertaking operating Open Access trains in Belgium, Luxembourg, The Netherlands, France and Germany. It has its own wagons but it is also a RU that "uses" wagons belonging to various keepers, including VTG wagons.

1 *CUV = Uniform Rules concerning Contracts of Use of Vehicles in International Rail Traffic.*
2 *COTIF = Convention concerning International Carriage by Rail.*
3 *ERFA = European Rail Freight Association. The ERFA was created in 2002 in Brussels by emerging rail freight operators (private and independent European companies), for the purpose of supporting the European vision of a liberalised railway sector.*

During maintenance operations on wagon 33 68 4952 073-9 conducted in November 2015, the cast iron blocks were replaced by composite blocks of the LL type by VTG.

Why use LL-type composite blocks?

Noise has long been a specific point of concern in the railway industry. There has been increasing awareness of the impact of railway-related noise on public health, which has led to:

- pressure by local residents in areas close to railway lines, governments and health organisations for improved noise mitigation:
- extra costs for the insulation of areas surrounding the tracks (noise nuisance mitigation);
- requests for availability/capacity limits;
- resistance to network extensions.

New noise management strategies and technologies have emerged within the industry. One of these resides in softening the rail/wheel contact ("smooth wheels on smooth rails" principle). For decades, the brake blocks of freight wagons have been made of cast iron: their influence on the steel of the wheels generates little damage, but these blocks undergo significant wear and cause changes to the wheel tread to which they are applied.

Studies have been conducted with different materials, including composite materials. These blocks feature a mixture of metal powder and other additives. The purpose of this research was to build brake blocks that feature improved performance and that polish the wheel during braking. Combined with smooth rails, this technology reduced the rolling noise by about 10 dB, which lowers the perceived noise by half.

Two technical solutions were developed: K-type or LL-type[4] composite blocks.

Certification of LL-type blocks

An UIC working group provides the technical expertise to certify one or several LL-type brake blocks. A new version of UIC Leaflet 541-4 was issued and lists all the additional tests.
The UIC recommends:

- that the process whereby new braking unit types are certified be extended for the coming three years;
- that for each braking unit and wagon-type combination, sliding tests be conducted to confirm braking performance;
- that the equivalent conicity of the wheels be monitored during operations;
- that all the test data relating to safety, efficiency and performance be given to the UIC.

In December 2010, the UIC launched its "EuropeTrain" project, for the purpose of assessing the long-term behaviour of various LL-type brake pad configurations and to speed up the certification process of LL-type blocks.

4 *LL = Low friction Low noise.*

The measurement operations of the "EuropeTrain" project were completed in September 2012: more than 200,000 kilometres were covered by 16 trains with 5 different routes featuring highly different climatic, topographic and operational conditions.
Static and dynamic measurements were completed to determine the stability of certain wagons. LL-type blocks were certifieds[5] in the course of 2013.

The conclusions, along with the measures and provisions stemming from the "EuropeTrain" tests, feature in various documents, including:

- Document V-BKS (LL), valid as of 01/08/2013, directive governing the use of LL composite brake blocks, which defines the equipment (part 1), the operations, the monitoring and the maintenance (part 2) of wagons fitted with LL-type composite blocks, certified according to UIC Leaflet 541-4.
- UIC Leaflet 518 "Testing and approval of railway vehicles from the point of view of their dynamic behaviour - Safety - Track Fatigue - Ride Quality".

Document V-BKS (LL) provides the conditions that the rolling equipment must meet for grey cast iron pads to be replaced by LL blocks. It also lists the monitoring and operating measures for rolling stock.

Process for the modification of freight wagons

The modification of freight wagons is subject to the modalities described in Directive 2008/57/EC (Art.20). The Member State must therefore decide, with respect to the TSI, whether the importance of the work requires a re-commissioning. Re-commissioning is in any event required each time the safety level is affected by the work under consideration.
For the purpose of modifying the wagon's brake blocks, the VTG company used as basis document V-BKS (LL), valid as of 01/08/2013[6].
The document V-BKS (LL) defines the scope of application of wagons taken into account for the replacement of cast iron blocks with LL blocks.
The document describes all the conditions the wagon must meet for such a replacement to be made. It was concluded that the wagon 33 68 4952 072-9 met all the requirements of V-BKS (LL).
In 2015, using for certain aspects the conditions listed in document "V-BKS (LL)" and for another aspect the results stemming from the "EuropeTrain" project, the VTG ECM replaced the grey cast iron blocks with LL-type composite blocks.

5 *"interoperable" braking units are described in list G, appended to the Wagon TSI (see http://www.era.europa.eu/Document-Register/Pages/CR-WAG-TSI.aspx)*

6 *The Directive for the use of LL composite brake blocks (UIC), which defines the equipment (part 1), the operations, the monitoring and the maintenance (part 2) of wagons fitted with LL-type composite blocks, according to sheet UIC 541-4, and certified according to sheet UIC 540-00.*

Monitoring of the wheels and axles of the wagons

According to the UIC Leaflet 510-2, in terms of the wheels, the following measures must be implemented:

- the monitoring of the wheels during operations is performed as per the provisions of the GCU;
- all the axles of wagons fitted with LL composite blocks undergo a special inspection when the wagon is brought to the workshop. The assessment of the state and treatment of the wheels is conducted according to the GCU or UIC Leaflet 510-2 and in compliance with the procedure described in the Manufacturing Directive of K composite blocks:
  - presence of visible features that indicate thermal overloading (for example clear and well-defined burning of the paint below the rim, rims with a bluish colour, metal inclusions),
  - strong or inhomogeneous wear, damage to the wheel tread and thermal cracking.

According to the provisions of the GCU, "technical transfer inspections" of the train are conducted before each train departure. Wagon 33 68 4952 072 9 was therefore inspected on several occasions between March 2017 (date at which the wagon was brought to the ECM workshop) and the 19th of May, 2017 (date of the accident).
The wheel's design does not facilitate its inspection: the following photo shows the visible portion of the wheel of a wagon of the same type as wagon 33 68 4952 072 9.

After the installation of LL blocks in November 2015, wagon 33 68 4952 072 9 had been brought to the workshop on several occasions for preventive maintenance operations, in particular in October 2016 and in March 2017.
In December 2016, the brake blocks of wagon 33 68 4952 072-9 were replaced.
We have no information to indicate the presence of visible signs of thermal overloading, of damage to the wheel tread or of thermal cracking.

Both the various technical transfer inspections and the maintenance operations conducted in March 2017 on wagon 33 68 4952 072 9 failed to reveal any anomalies affecting the wheels of the wagon.

Monitoring of the wheel profiles

It has been observed that the use of LL blocks increases speed of equivalent conicity growth compared with grey cast iron blocks (linear evolution, even with a high mileage).
This requires the frequency of re-profiling operations to be doubled, i.e. every 100,000 km (although this figure depends on the operating conditions).
The UIC recommends an inspection every 50,000 km, and re-profiling operations every 150,000 to 200,000 kilometres.

However, document "V-BKS (LL)" does specify that, based on their specific experience and a corresponding assessment of risks, the ECMs are free to adapt the profile monitoring requirements of the wagon wheels on which LL blocks have been installed.

Based on the experience gained during the tests, the VTG company scheduled a first inspection once wagon 3368 4952 072-9 had travelled 200,000 km after the re-profiling of the wheels of the wagon.

The tests and the experience gained had allowed VTG to determine that neither the height of the flange, nor the equivalent conicity were in excess of critical values during the use of LL-type brake blocks, even with a mileage of more than 200,000 km.

According to the data available for this wagon, at the time of the accident, the wagon had travelled approximately 193,000 km since the last re-profiling of its wheels in October 2015.

Measures taken

The VTG company has taken various measures that were forwarded to the workshops through several notices:

- 14/06/2017: Notice for the identification of the concerned wagons (wheel types, brake types, wagon markings);
- 10/08/2017: Visual inspection of the wheels to identify possible damage and signs of excessive heating;
- 14/09/2017: Adapting the brakes on certain wagon series;
- 21/09/2017: Adapting the brakes on certain (other) wagon series.

The VTG company also conducted an analysis in September 2017: its purpose was to verify whether the components of the pneumatic system of the brakes of wagons of the same type as wagon 33 68 4952 072 9 had to undergo adaptations.

With the support of the ERA, the Joint Network Secretariat (JNS) established a working group in June 2017.

The mission of the working group was to come up, as soon as possible, with an action plan relating to the mitigation measures with a short-term impact, the underlying causes of the broken wheels, and any option or efficient solution to maintain the interoperability and safety of the European railway network.

For its mission, the working group sought various types of experts. According to the solicitation document, expert candidates had to specify their field of expertise, i.e.: specialisation in the design, manufacturing and maintenance of freight wagon wheels and rolling elements and experience in the use of composite brake blocks in freight operations.
Following similar cases (see 3.7), the group of experts established by the JNS ("Broken Wheels" Task Force) implemented several short-term emergency measures:

- Introduction of additional measurements during operations, maintenance of the wagons and maintenance of the axles mounted on the vehicles;
- Gathering of information on observed cases for the purpose of conducting cross-analyses and determining possible causes.

The purpose of the cross-analyses is to determine long-term measures.

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http://www.mobilit.belgium.be