REPUBLIC OF SERBIA
CENTER FOR INVESTIGATION OF ACCIDENTS IN TRANSPORT
SECTOR FOR INVESTIGATION OF ACCIDENTS IN RAILWAY TRAFFIC
Nemanjina 11, 11000 Belgrade

No. ŽS - 01/19

No. 340-00-3/2019-02-1-110

Date: 10.03.2025.

FINAL REPORT ON ACCIDENT INVESTIGATION

Accident type:	Derailment
Train No:	52770
Location:	Municipality of Knjaževac, open railway line between Svrljig and Knjaževac stations
Date:	14.02.2019.
Time:	01:45

This Report presents the results of investigation of an accident, derailment of the train No. 52770, which occurred on 14.02.2019. at 01:45 on the regional railway line Crveni Krst - Zaječar - Prahovo Pristanište.

The Working Group for investigation of this accident was formed by the Director of the Center for Investigation of Accidents in Transport of RS, by Decision No. 340-00-3/2019-02-1-3 of 20.02.2019.

In accordance with the Article 33 of the Law on Investigation of Accidents in Air, Railway and Waterborne Traffic ("Official Gazette of RS" No. 66/15 and 83/18) and the Article 23 of the Directive 2004/49/EC of the European Parliament and of the Council of EU (Railway Safety Directive), the Center for Investigation of Accidents in Transport (hereinafter referred to as: CINS) drafted and published this Final Report.

In this report, all values are expressed as part of the International System of Units (SI).

The meaning of abbreviations used in the text is explained in the Glossary.

CINS has been established in accordance with the Law on Investigation of Accidents in Air, Railway and Waterborne Traffic ("Official Gazette of RS" No. 66/15). The founder is the RS and the holder of founding rights is the Government of the RS.

Sector for Investigations of Accidents in Railway Traffic carries out tasks within the competence of the CINS in relation to rail traffic with the aim of possible improvement of safety on the railway by issuing safety recommendations. The investigative procedure in the field of railway traffic is conducted on the basis of the provisions of the Law on Investigation of Accidents in Air, Railway and Waterborne Traffic ("Official Gazette of RS" No. 66/15 and 83/18).

CINS conducts investigations following the serious accidents on the railway system with a view to possible improvement of railway safety and the prevention of new accidents caused by the same or similar causes. Serious accident in railway traffic means any train collision or derailment of trains, resulting in the death of at least one person or serious injuries to five or more persons or extensive damage to rolling stock, the infrastructure or the environment, and any other similar accident with an obvious impact on railway safety regulation or the management of safety.

In addition to serious accidents, CINS may also investigate other accidents and incidents that could lead to a serious accident, including the technical failure of structural subsystems or interoperability constituents.

CINS has the discretion to decide whether to open an investigation of other accidents and incidents.

CINS is independent in its work and performs independent accident investigations. The aim of an investigation is to identify the causes and the possibility of improving safety on the railways and to prevent accidents by issuing safety recommendations.

Professional activities related to safety investigations are independent of judicial inquiry or any other parallel investigations which objective is to determine responsibility or the degree of guilt.

Glossary:

CINS	Center for Investigation of Accidents in Transport
IŽS	Infrastructure Railways of Serbia
ZJŽ	Community of the Yugoslav Railways
JŽ	Yugoslav Railways
ŽS	Railways of Serbia
RS	Republic of Serbia
MGSI	Ministry of Construction, Transport and Infrastructure
MUP	Ministry of Interior
a.d.	Joint stock company
OC	Organizational unit
SS	Signalling-safety
TT	Telephone-telegraph
ZOP	For track maintenance
TMD	Heavy motor vehicle
DMV	Diesel motor train
DMK	Diesel motor wagon
DTŠ	Continuous welded rail
RID	The Regulation concerning the International Carriage of Dangerous Goods by Rail *(Règlement concernant le transport international ferroviaire des marchandises dangereuses)*
d.o.o.	Ltd.
ECM	Entity in Charge of Maintenance
FŽV	Railway Vehicle Factory

C O N T E N T :

1. Summary

1.1. Short description of the accident

On 14.02. 2019, at 1:45 AM, at km 55+252 on the regional railway line Crveni Krst - Zaječar - Prahovo Pristanište, between the stations Svrljig and Knjaževac, a derailment of the train No. 52770 occurred (operated by the railway undertaking "NCL Neo Cargo Logistic"d.o.o.). A total of five wagons of series Z carrying dehydrated ammonia (RID 268/1005, NHM code 2814.10) derailed from the train composition. Viewed from locomotive 661-318, the following wagons derailed: the third Zags wagon, No. 33 87 7814 136-0, with two axles of the first bogie, the fourth Zags wagon, No. 33 80 7818 085-2, with all axles, the fifth Zags wagon, No 33 80 7818 094-4, with all axles, the sixth Zags wagon, No. 33 87 7813 564-4, with all axles and the seventh Zags wagon, No. 33 87 7816 547-6, with one axle of the second bogie. All derailed wagons remained standing on their wheels within the track area.

There were no fatalities or injuries in this accident.

No leakage of the cargo (ammonia) occurred. Material damage was inflicted on the railway infrastructure and vehicles.

1.2. Accident causes determined by investigation

The direct and immediate cause of the accident was the spreading of the rails under load and the inner wheel falling into the track in a curve. The wheel fall occurred due to the unsatisfactory condition of the track in the section where the accident took place. In the narrowest area of the derailment, there was a lack of or loose fastening and connecting equipment, decayed and cracked sleepers in sequence, combined with deviations in track geometry: rail spreading (deviation +40 mm), cant (deviation - 42 mm) and twist (deviation 36 mm), which is above the limit for urgent intervention - that is, the error of type "C".

Track maintenance on the observed section was not conducted in accordance with the Regulations on Technical Conditions and Maintenance of the Railway Track Superstructure ("Official Gazette of RS" No. 39/16 and 74/16), considering the years since the last track repairs, as well as the insufficient number of personnel, machinery, and tools (see sections 3.3.6 and 4.2.6).

The Instruction on Unified Criteria for Track Condition Control on the Railway Network JŽ (Instruction 339) from 2001/2004 introduced "speed reduction" as an alternative measure for cases of "unsatisfactory" track condition (track geometry defects exceeding operational limits, classified as "Type C"). This measure did not exist in earlier versions of the Instruction (e.g., the 1989 version). Furthermore, a paragraph from the 1989 version of Instruction 339 was removed, which stipulated that measures should be taken to prevent the exceedance of operational limits before they are reached.

The current Regulation on the Maintenance of the Super and Sub Structure of Railway Tracks (see section 3.3.7) also lists the following measures for reducing the risk of derailment to an acceptable level in cases of "Type C" defects or reaching the limits for urgent intervention (Immediate Action Limit - IAL): closing the track, restoring track geometry, or reducing speed. This formulation was adopted from the EN 13848-5 standard. However, these measures should not be understood as alternatives; rather, the appropriate measure must be applied in each specific case.

The consequences of track widening and twist beyond operational limits (classified as “Type C” defects or “IAL” - Immediate Action Limit) cannot be mitigated by reducing speed. On the contrary, traveling at low speeds on twisted tracks in sharp curves with superelevation creates precisely the conditions under which derailment most easily occurs through the leading wheel climbing the rail (see EN 14363, section 6.1).

Neither the current Regulation on the Maintenance of the Supper and Sub Structure of Railway Tracks nor Instruction 339 explicitly and clearly define operational limits for the condition of sleepers and fastening equipment, at which immediate corrective measures must be taken or the track must be closed to traffic due to safety risks. (For example, there is no specification of the maximum number of consecutive sleepers with non-functional fastening equipment that would require immediate intervention or closure of the track. In EN 14363, several safety criteria use a travelled distance of 2 meters as a reference for derailment risk, which could serve as a solid basis for introducing such a criterion).

The consequences of non-functional fastening equipment in curves with superelevation cannot be mitigated by reducing speed. On the contrary, traveling through a curve with superelevation at a low speed below the equilibrium speed (corresponding to the superelevation) creates an excess of superelevation. As a result, the vehicle tilts towards the inner side of the curve, increasing the vertical forces on the inner wheels and decreasing them on the outer wheels. In combination with track twist, two wheels on one diagonal of the bogie experience additional vertical loading, while the two on the opposite diagonal are unloaded. Guiding forces in the curve on the leading axle of conventional bogies (see section 4.2.1, figure 4.2.1.6.), when fastening equipment is non-functional, can sufficiently spread or twist the rails. In such a situation, due to increased vertical loading, the inner wheel of the leading axle most easily falls into the track. This is precisely what happened in this accident, as well as in several other accidents investigated by CINS.

The consequences of vertical deviations (stability) and transverse deviations in track geometry beyond the “Type C” (or “IAL”) limit can, however, be mitigated by reducing speed.

1.3. Main recommendations and information on the subjects to which the Report is submitted

Aiming to improve safety on the railway line and to prevent occurrence of the new accidents, CINS has issued the following safety recommendations:

To the Directorate for Railways the following recommendations are issued: SR_01/25, SR_02/25, SR_03/25, SR_04/25 and SR_05/25

SR_01/25 The Directorate for Railways should, as soon as possible, amend the current Regulation on the Maintenance of the Super and Structure of Railway Tracks ("Official Gazette of RS" No. 39/2023) to define the limit states of track elements requiring immediate rectification or track closure until the unacceptable condition is resolved. Additionally, the regulation should stipulate that in cases of "Type C" defects or those exceeding the "IAL" (Immediate Action Limit) for track widening and twist, speed reduction cannot be considered a measure to mitigate the risk of derailment. Instead, only urgent intervention or track closure should be undertaken (see section 4.3.3).

SR_02/25 The Directorate for Railways, in accordance with Article 37 of the Law on Railway Traffic Safety ("Official Gazette of RS" No. 41/18), should amend and supplement the Regulation on Technical Conditions and Maintenance of the Railway Telecommunications Network ("Official Gazette of RS" No. 68/21). In Section II: Technical Conditions for the Railway Telecommunications Network, the regulation should define the minimum technical requirements for equipping railway lines with telecommunication devices to ensure reliable communication between traffic control personnel and train drivers. These requirements should be based on factors such as train speed, track categorization, volume of railway traffic, and similar considerations (see sections 2.2.4 and 3.4.3).

SR_03/25 "IŽS"a.d, should amend and supplement the Instruction on Unified Criteria for Track Condition Control on the Railway Network (Instruction 339, "Official Gazette of the ZJŽ" No. 2/2001 and 4/2004). The amendments should stipulate that in cases of "Type C" defects or those exceeding the "IAL" (Immediate Action Limit), for track widening and twist, speed reduction cannot be considered a measure to mitigate the risk of derailment. Instead, only urgent intervention or track closure should be implemented (see sections 3.3.5 and 4.3.3).

SR_04/25 "IŽS"a.d, should review the adequacy of the current provisions in the Regulation on the Organization and Systematization of Work Positions of the Joint Stock Company for the Management of Public Railway Infrastructure "Infrastruktura Železnice Srbije" Belgrade. It should also assess the possibility of ensuring an appropriate number of personnel in construction activities, both on the section of the railway where the accident occurred and across the entire network, with the aim of ensuring the safe operation of railway traffic. In line with the appropriate number of personnel, the company should plan the procurement of the necessary machinery and tools, all in the interest of maintaining the safety of railway traffic (see sections 3.4.2 and 4.2.9).

SR_05/25 "IŽS"a.d, when approving special shipments/consignments that exceed the allowed axle load or allowed weight per meter of track on a transport route or section of the transport route, it is mandatory to conduct an analysis of the track's load-bearing capacity and assess the condition of the supper and substructure of the track (see section 5.2).

To the Ministry of Construction, Traffic and Infrastructure the recommendations SR_06/25 and SR _07/25 are issued:

SR_06/25 The Ministry of Construction, Transport, and Infrastructure, Sector for Railways and Intermodal Transport, considering that Article 49 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023) stipulates that the infrastructure register is maintained by the European Union Agency for Railways, and that this has not been formally enabled for infrastructure managers in the Republic of Serbia in practice, should resolve this issue to ensure the application of the provisions of Article 49 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023). If this issue is not resolved, or the provisions of Article 49 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023) cannot be applied, the Ministry should amend and supplement the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023), or restore the provisions of Article 34 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 41/2018), as well as the Law on the Interoperability of the Railway System ("Official Gazette of RS" Nos. 41/2018 and 16/2022 – Authentic Interpretation), in order to ensure the maintenance of the infrastructure register by the Directorate for Railways (see sections 3.3.3, 3.3.4, and 5.1).

SR_07/25 The Ministry of Construction, Transport, and Infrastructure, Sector for Inspection Supervision, Railway Traffic Inspection Department, should, in accordance with Article 50 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023), to carry out an inspection supervision at "IŽS"a.d. and take measures within its authority regarding the obtaining of permits for renovated and upgraded tracks in accordance with Article 36 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023), starting from the adoption of the first version of the law in 2018 (see sections 3.3.3, 3.3.4, and 5.1).

2. Direct accident facts

2.1. Basic accident data

2.1.1. Date, time and location of the accident

An accident occurred on 14.02.2019. at 01:45 in the area of the municipality Knjaževac, on the regional railway line Crveni Krst - Zaječar - Prahovo Pristanište, on the open track section between the unoccupied station Palilula and unoccupied station Podvis, which is located on a concrete bridge over the Svrljiški Timok River, between tunnel No. 21 and tunnel No. 22. The area where the accident occurred is not inhabited.

The appearance of the accident site, captured from the satellite, is shown in Fig. No. 2.1.1.1.

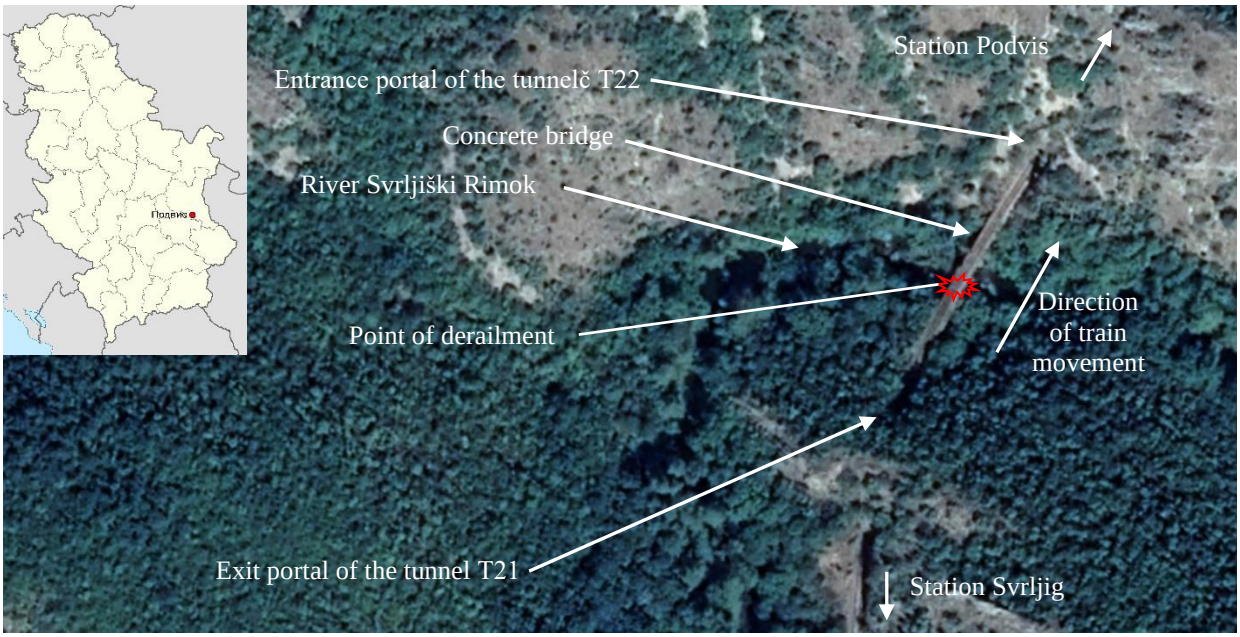


Figure 2.1.1.1: Satellite image of the accident site area (*Google maps*)

2.1.2. Description of the accident and the accident site and the work of emergency rescue services

On the regional railway line Crveni Krst - Zaječar - Prahovo Pristanište, between the stations Svrljig and Knjaževac, upon driving in direction from the station Svrljig to the station Knjaževac, on the open track, on a concrete bridge over the Svrljiški Timok River, between tunnel No. 21 and tunnel No. 22, at km 55+252, a train No. 52770 derailed.

From train composition, the following wagons derailed: the third Zags wagon, No. 33 87 7814 136-0, with two axles of the first bogie, the fourth Zags wagon, No. 33 80 7818 085-2, with all axles, the fifth Zags wagon, No. 33 80 7818 094-4, with all axles, the sixth Zags wagon, No. 33 87 7813 564-4, with all axles and the seventh Zags wagon, No. 33 87 7816 547-6, with one axle of the second bogie.

The appearance of the accident site (concrete bridge between the tunnel No. 21 and tunnel No.22) is shown in Fig. No. 2.1.2.1.

Figure 2.1.2.1: Appearance of the derailment of the train No. 52770 site

After the derailment, the train travelled another 83 m before coming to a stop.

The derailed wagons were found on the tracks, on their wheels. There was no tilting or overturning of the wagons, and there was no cargo leakage.

All the wagon- tank in the composition of train No. 52770 were loaded with dehydrated ammonia (RID 268/1005, NHM code 2814.10).

Considering that the train carried a substance that, in the event of uncontrolled release from the tanks, could endanger human health and pose a potential threat to the environment, members of the MUP RS, the Emergency Situations Sector, the Emergency Situations Department in Zaječar, and the local Fire and Rescue Unit in Knjaževac were called to the scene.

There were no fatalities nor injuries in this accident, and there was no threat to human health or harmful impact on the environment (no cargo leakage occurred). However, there was material damage to the railway infrastructure and railway vehicles.

As a result of this accident, railway traffic between the stations of Svrljig and Knjaževac was disrupted.

By telegram No. 89 dated 14.02. 2019, from the Executive Director for Railway Infrastructure Management, a section of the regional railway line between the stations Crveni Krst and Zaječar was closed to train traffic.

The remediation of the consequences of this accident (lifting the derailed wagon-tanks and removing them from the scene) was managed by engaging the professional services and resources

of “IŽS”a.d., with the presence of members of the MUP RS, the Emergency Situations Sector, the Emergency Situations Department in Zaječar, and the local Fire and Rescue Unit in Knjaževac.

2.1.3. Decision to investigate, team composition and managing the investigation

CINS was notified immediately after the occurrence of the accident. The Main Investigator for Railway Traffic was first informed about the accident on 14.02.2019, at 2:22 A.M. via telephone by the Assistant Director of the Operations Sector of “IŽS”a.d. Based on the information received and the facts established by the CINS investigative team during the on-site inspection, CINS initiated an investigation into the accident in accordance with the Law on the Investigation of Accidents in Air, Railway, and Waterborne Traffic (“Official Gazette of RS” Nos. 66/15 and 83/18).

The composition of the Working Group for Accident Investigation was determined by Decision No. 340-00-3/2019-02-1-3 dated 20.02.2019, issued by the Director of CINS, based on Articles 6 and 32 of the Law on the Investigation of Accidents in Air, Railway, and Waterborne Traffic (“Official Gazette of RS” Nos. 66/15 and 83/18).

2.2. Accident background

2.2.1. Involved railway staff, contractors, other persons and witnesses

The train staff involved in the accident included the train driver and the train driver assistant of train No. 52770, employees of the railway operator “NCL Neo Cargo Logistic”d.o.o.

The infrastructure manager's staff from “IŽS”a.d. was not involved in the accident, nor were contractors, other individuals, or witnesses.

2.2.2. The trains involved in this accident and their composition

The accident involved train No. 52770, which was operating on the route Crveni Krst - Prahovo. The train consisted of a locomotive belonging to the railway undertaking “NCL Neo Cargo Logistic”d.o.o., series 661-318, and 14 (fourteen) wagon- tank of series Z (13 marked as Zags and 1 marked as Zagkk). All the wagon-tanks in train No. 52770 were loaded with dehydrated ammonia (RID 268/1005, NHM code 2814.10). According to information provided by the railway undertaking “NCL Neo Cargo Logistic”d.o.o. (Appendix 12 of correspondence No. IV-318/19 dated 15.04. 2019), the net weight of the entire shipment of dehydrated ammonia was 509,280 kg.

A total of 5 (five) wagon-tanks of series Z derailed from the train.

Table 2.2.2.1 provides a detailed overview of the wagons included in train No. 52770.

Table 2.2.2.1: A detailed overview of the wagons included in train No. 52770 (viewed from locomotive 661-318)

Serial wagon No.	The letter marking of wagons	Unique wagon No.	ownership	note
1	*Zags*	3387 7813 563-6	*ATIR-RAIL*	
2	*Zags*	3387 7813 566-9	*ATIR- RAIL*	
3	*Zags*	3387 7814 136-0	*ERMEWA*	The wagon derailed with two axles of the first bogie
4	*Zags*	3380 7818 085-2	*ATIR- RAIL*	The wagon derailed with all the axles
5	*Zags*	3380 7818 094-4	*ATIR- RAIL*	The wagon derailed with all the axles
6	*Zags*	3387 7813 564-4	*ATIR- RAIL*	The wagon derailed with all the axles
7	*Zags*	3387 7816 547-6	*ERMEWA*	The wagon derailed with one axle of the second bogie
8	*Zags*	3387 7813 586-7	*ATIR- RAIL*	
9	*Zagkk*	3380 7918 799-7	*ERMEWA*	
10	*Zags*	3380 7814 611-9	*ATIR- RAIL*	
11	*Zags*	3784 7813 021-4	*GATX*	
12	*Zags*	3784 7813 032-1	*GATX*	
13	*Zags*	3380 7818 093-6	*ATIR- RAIL*	
14	*Zags*	3784 7813 006-5	*GATX*	

The appearance of the Z-series wagon-tanks that derailed in the accident is shown in Figure 2.2.2.1.

Figure 2.2.2.1: The appearance of the wagon-tanks *Z* series that derailed in the accident

The Z-series wagons involved in the accident are four-axle specialized enclosed wagon-tanks designed for the transportation of ammonia. They are equipped with appropriate systems for filling and discharging the cargo, ensuring safe handling of the hazardous material.

2.2.3. Infrastructure and safety-signalling system

The Crveni Krst - Zaječar - Prahovo Port regional railway line is a single-track, non-electrified line, predominantly characterized by a mountainous terrain.

According to data obtained from "IŽS"a.d. (Appendix 3 of correspondence No. 1/2019-1123 dated April 16, 2019, and correspondence No. 20/2020-90 dated January 15, 2020), a section of the regional line between km 3+455 and km 68+910 was built in 1912, and the section between km 68+910 and km 185+079 was constructed in 1914. The last major overhaul of the section between km 40+018 (Svrljig station) and km 68+365 (Knjaževac station) took place from 1957 to 1961.

On the section of the regional railway between km 3+455 and km 111+733, the maximum allowable axle load is 180 kN/axle, the minimum curve radius is R=240 m, and the maximum gradient is 12.84‰.

On the section of the mentioned line, between the stations Matejevac and Knjaževac, track types 45 and 49 have been installed, and the wooden sleepers are from the production years 1957 to 1985.

The section of the regional railway between Svrljig (km 40+018) and Knjaževac (km 68+365) was designed for speeds up to 60 km/h (from km 45+916 to km 61+105), 65 km/h (from km 40+018 to km 45+916, and from km 61+105 to km 68+099), and 90 km/h (from km 68+099 to km 68+365).

The maximum speed, according to the train Timetable Booklet 7.1 (which was in effect at the time of the accident), for the section between Svrljig and Knjaževac is 40 km/h for passenger trains (DMV) and 30 km/h for all other trains.

Between the stations Svrljig and Knjaževac, there are two official positions (the Palilula junction and the Podvis station) that are unoccupied and considered open track for train operations.

According to the Timetable Booklet 7.1 (in effect at the time of the accident), the maximum speed over switches at the official positions Svrljig, Palilula, Podvis, and Knjaževac is 20 km/h.

On the railway section between the stations Svrljig (km 40+018) and Knjaževac (km 68+365), three restricted speed runs were introduced: from km 41+300 to km 41+400 (first introduced on December 11, 2016, due to deformation of the track bed), from km 54+669 to km 54+700 (first introduced on March 25, 2014, due to the poor condition of the slope at the exit of Tunnel T-19),, from km 63+000 to km 63+100 (first introduced on January 29, 2019, due to a large amount of debris and mud at the level crossing). On the railway section between the stations Svrljig and Knjaževac, there are no other speed restrictions.

Traffic on this section is regulated within station distance by obtaining permission for train movement, train advisories, and dispatch acknowledgments (orally and via phonograms).

There is no functioning signalling and safety (SS) system between the stations Svrljig and Knjaževac, nor are there devices for control, management, or signalling.

The railway designation follows the Regulation on the Categorization of Railways ("Official Gazette of the RS" Nos. 115/2013 and 57/2017), which was in effect at the time of the accident.

2.2.4. Means of communication

On the section of the regional railway Crveni Krst - Zaječar - Prahovo Pristanište, between the stations Crveni Krst and Vražogrnac, communication between the staff managing traffic is conducted via the radio network for traffic management Crveni Krst - Zaječar - Vražogrnac. Radio stations are located with the train dispatchers at the following railway stations: Crveni Krst, Matejevac, Svrljig, Knjaževac, Zaječar, Vražogrnac, the level crossing keeper at Stražara 42, and the operational department in Zaječar. Conversations on this line are recorded on a phonographic recording device located in the telecommunications (TT) section in Niš, making this form of communication evidence-based. At the time of the accident, the radio network for traffic management was functional and operational in all stations.

On the section of the regional railway line between the stations Crveni Krst and Vražogrnac, there is no means of communication between the staff managing traffic and the train staff provided by the telecommunications service of "IŽS"a.d. For this purpose, only mobile operator lines are available. In this context, at the site of the train derailment accident involving train No. 52770, there was no mobile operator signal coverage. Consequently, the driver of the derailed train was forced to walk along the railway line for 4 to 5 kilometres to reach an area with mobile signal coverage and inform the relevant parties about the accident.

2.2.5. Works conducted at or near the accident site

Near the accident site there were no works done.

2.2.6. Activation of emergency on the railway plan and sequence of events

The infrastructure manager "IŽS"a.d. immediately notified the CINS, i.e., the Main Investigator in Railway Traffic, following the occurrence of the accident. The railway undertaking "NCL Neo Cargo Logistic"d.o.o. did not notify the CINS or the Main Investigator in Railway Traffic about the accident, which is contrary to Article 30 of the Law on Investigation of Accidents in Air, Railway, and Waterborne Traffic ("Official Gazette of RS" Nos. 66/15 and 83/18) and Article 94 of the Law on Railway Traffic Safety ("Official Gazette of RS" No. 41/2018). The infrastructure manager "IŽS"a.d. and the railway undertaking "NCL Neo Cargo Logistic"d.o.o. formed a joint investigation committee that conducted the accident investigation in accordance with applicable regulations. Upon completion of the investigation, an Investigation Report U-60/19 was compiled.

Immediately after the accident, the section of the regional railway Crveni Krst - Zaječar - Prahovo Pristanište between the stations Svrljig and Knjaževac was closed to train traffic.

The lifting and removal of the derailed wagons were carried out with the assistance of the emergency train from "IŽS"a.d., EmergencyTrain Operations Center, Emergency Train Niš. The lifting of all derailed wagons was completed on 16.02.2019, at 19:20.

The work on repairing and restoring the track to operational condition (repairing 50 meters of damaged track and machine adjustment of the track using a ballast regulator and tamper over a length of 400 m) was carried out from 14.02. to 22.02. 2019.

2.2.7. Activation of the Emergency Plan for Public Rescue Services, Police, and Medical Services, and the Sequence of Events

Due to this accident, members of the MUP RS, Sector for Emergency Situations, Department for Emergency Situations in Zaječar, and the local Fire and Rescue Unit in Knjaževac were engaged.

According to the letter from the MUP RS, Sector for Emergency Situations, 09 No.: 217-688/19 dated 2.4.2019, the following information was provided: On 14.02.2019, at 02:38, a notification was received from the duty officer at the police station in Knjaževac, stating that a derailment of an ammonia wagon-tank occurred on the Niš - Zaječar railway, at the sixth kilometres from the settlement of Podvis toward Niš. At 05:13, the commander of the local Fire and Rescue Unit in Knjaževac and a "Lada Niva" vehicle were dispatched to the site. Due to the inaccessibility of the terrain, the commander of the local Fire and Rescue Unit in Knjaževac reached the site from the Svrljig railway station with the employees of "Železnice Srbije" using an auxiliary vehicle (TMD). Upon arrival at the site at 07:00, the commander determined that there was no overturning or damage to the ammonia tanker and that there was no ammonia leakage. The commander then returned to the unit at 09:40.

During the process of returning the derailed ammonia wagon-tanks to the track, two interventions were carried out by the duty team (two firefighters and a "Lada Niva" vehicle) from the local Fire and Rescue Unit in Knjaževac. These interventions took place on 15.02.2019, from 12:01 to 19:38, and on 16.02.2019, from 05:01 to 21:40. The teams from the local Fire and Rescue Unit in Knjaževac arrived at the site and left the site with employees of "Železnice Srbije" using an auxiliary vehicle (TMD) from the Svrljig railway station. The interventions were completed successfully. During the process of returning the derailed ammonia wagon-tanks to the track, there was no ammonia leakage.

2.3. Fatally injured, injured and material damage

2.3.1. Passenger, third parties and the railway staff including the contractors

In this accident, there were no fatally injured nor injured.

2.3.2. Goods, luggage and other assets

There was no loss or damage to the cargo (dehydrated ammonia) in the accident.

2.3.3. Railway vehicles, infrastructure and the environment

In the accident, railway vehicles and infrastructure were damaged. No material damage was caused to third-party property.

The structure of the material damage is as follows:

Damage to railway vehicles (wagons in the train composition):	1 323 005.50	RSD
Total cost of lifting the derailed wagons:	691 652.11	RSD
Damage to the track and railway facilities:	1 039 278.00	RSD
Total direct material damage:	**3 053 935.61**	**RSD**

The damage is stated in the official currency of RS (Dinar - RSD).

According to the official average exchange rate of the National Bank of Serbia on 14.02.2019, which was 1 EUR (Euro) = 118.1687 RSD (Dinar), the total material damage caused by the accident amounts to 25,843.86 Euros (EUR).

The material damage in this report is presented based on invoices, estimates, or documents confirming the stated damage amounts provided by "IŽS"a.d. and "Elixir Zorka"d.o.o. Šabac.

CINS has not received data from the railway undertaking "NCL Neo Cargo Logistic"d.o.o. regarding the amount of damage caused to the railway vehicles.

2.3.4. External conditions - weather conditions and geographical characteristics

The location of the accident is in the municipality of Knjaževac, in an uninhabited area of the Svrljig Gorge. The terrain configuration near the accident site is mountainous.

The geographical coordinates of the accident site are: 43º 30' 43.6" N and 22º 9' 30.8" E.

At the time of the accident, the weather was clear, with no precipitation. The air temperature was approximately 7°C.

The section of the railway where the train derailment occurred is located on a bridge between two tunnels. The site of the derailment is in a right curve, on the transitional curve behind a pure circular curve, with a slope of 10.19‰ (gradient, viewed in the direction of train movement, i.e., in the direction of increasing stationing).

When the accident investigation was carried out on 14.02.2019, by the CINS investigative team, it was daylight. The weather was mostly cloudy, with no precipitation, fog, or wind. Visibility was good. The air temperature was approximately 12°C. Given the terrain configuration and the location of the accident, the investigation by the CINS team was conducted under difficult conditions.

3. Minutes on investigation and examination

The data, facts, and evidence related to the cause of the accident were collected and determined based on:

- The investigation conducted by the CINS investigative team;
- The inspection of the wagons carried out at the FŽV "Želvoz"d.o.o. workshop in Smederevo;
- Materials provided by the infrastructure manager "IŽS"a.d.;
- Materials provided by the railway undertaking "NCL Neo Cargo Logistic"d.o.o.;
- Materials provided by the owner of the wagon "GATX Rail Europe";
- Materials provided by the owner of the wagon "Ermewa SA" and
- Materials provided by the owner of the wagon "ATIR RAIL".

The accident on-site inspection and investigation were conducted by the joint investigation committee of the infrastructure manager "IŽS"a.d. and the railway undertaking "NCL Neo Cargo *Logistic*"*d.o.o.*

3.1. Summary of testimonies

The records of the hearing of the train driver and train driver assistant, who were in possession of locomotive 661-318 of train No. 52770 at the time of the accident, were obtained from "IŽS"a.d. and "NCL Neo Cargo Logistic"d.o.o. Additionally, the Report of the train worker regarding irregularities on the track (S-67), issued by the train driver of locomotive 661-318 of train No. 52770, was also obtained.

No statements were obtained from the staff regulating traffic on that section of the regional railway line (train dispatchers at Svrljig and Knjaževac stations), nor were they questioned, as this staff did not participate in the accident. Reports from the train dispatchers regarding irregularities during their work (S-23) at Svrljig and Knjaževac stations were obtained.

3.1.1. Railway staff

The train driver stated that during the full brake test at the Crveni Krst station, with the wagon inspector and the conductor from the NCL undertaking, there were no issues. During the ride between Crveni Krst station and the site of the derailment, there were no problems. When the derailment occurred, he had been following the prescribed speed limit. Since departing from Crveni Krst station, he had continuously monitored the train's speed on the speedometer and the pressure in the main air system. He noticed (around the site of the derailment) that the speed of the train was decreasing and immediately initiated the braking process. He initiated the braking process due to the suspicion that some wagons in the train had derailed, which he confirmed after stopping the train and inspecting it. Upon inspecting the train, he confirmed that there was no leakage of fluids (ammonia), nor did he detect any unpleasant odours. At the site of the derailment, there was no mobile network signal, so he walked towards Podvis, and after four to five kilometres of walking, he received a signal and notified the authorities about the derailment. This occurred at approximately 01:45. The train driver assistant remained with the train, as he could not send him to walk four to five kilometres due to a previous leg injury. During the train's journey, there were no irregularities, shaking, or jolting of the cargo.

The assistant train driver stated that during the full brake test at the station Crveni Krst, there were no issues, and he participated as the train conductor, and the mere brake test was carried out by the wagon examiner and the train driver. Up until the derailment, there were no problems, but the train driver initiated the braking process due to a decrease in speed at one point. After stopping, they noticed that the third wagon from the locomotive and another four wagons behind it had derailed. There was no leakage of the transported goods (ammonia) or unpleasant odours.

3.1.2. Other witnesses

There were no other witnesses to this accident.

3.2. Safety management system

3.2.1. Organizational frame and manner of executing and issuing orders

In accordance with the applicable Safety Management System Rulebook, "IŽS"a.d. notified the CINS about the accident.

According to the valid Safety Management System of the limited liability company for railway freight transport "NCL Neo Cargo Logistic"d.o.o. Belgrade, "NCL Neo Cargo Logistic"d.o.o. did not notify CINS about the accident.

In point 6.17.1, subpoint a), item 7 of the Safety Management System of the limited liability company for railway freight transport "NCL Neo Cargo Logistic"d.o.o. Belgrade, it is stipulated that, due to the leading role of the infrastructure manager in the case of emergency events on public railway infrastructure, the immediate notification of relevant state authorities about such events and their reporting is usually carried out by the infrastructure manager, while "NCL Neo Cargo Logistic"d.o.o. only verifies whether all relevant state authorities have been notified, and if not, coordinates further notification procedures with the infrastructure manager.

The Safety Management System of the limited liability company for railway freight transport "NCL Neo Cargo Logistic"d.o.o. Belgrade (point 6.17.1, subpoint a), item 7) stipulates that only in the case of accidents and incidents on industrial tracks, "NCL Neo Cargo Logistic"d.o.o. is responsible for the direct notification and reporting of accidents and incidents to the Center for Investigation of Accidents in Transport.

This procedure outlined in the Safety Management System of the limited liability company for railway freight transport "NCL Neo Cargo Logistic"d.o.o. Belgrade is not in accordance with the Law on Railway Safety ("Official Gazette of RS" No. 41/2018), which in Article 94, paragraph 7 stipulates that: "The infrastructure manager, railway undertakings, and the Directorate, if they have knowledge, must immediately notify the Center and the national railway traffic inspector about an accident or incident in railway traffic." Furthermore, the Law on Railway Safety ("Official Gazette of RS" No. 41/2018) does not define the term "emergency event," but only terms such as serious accident, accident, and incident. Additionally, this procedure outlined in the Safety Management System of "NCL Neo Cargo Logistic"d.o.o. Belgrade is not in accordance with Article 30 of the Accident Investigation in the Law on Air, Railway and Waterborne Transport ("Official Gazette of RS" No. 66/15 and 83/18).

The infrastructure manager "IŽS"d.o.o. and the railway undertaking "NCL Neo Cargo Logistic"d.o.o., in accordance with the Law on Railway Safety ("Official Gazette of RS" No.

41/2018), formed a joint investigation committee, which conducted an investigation into the accident. After completing the investigation, the Investigation Report U-060/19 was prepared.

3.2.2. Requirements that railway staff must fulfil and how they are applied

The railway undertaking “NCL Neo Cargo Logistic”d.o.o., through its Safety Management System, has defined (under section 6.1.1) procedures for identifying risks that arise directly from work activities, job descriptions, workplace load, and (under section 6.6) procedures ensuring that staff entrusted with responsibilities within the organization possess the authorization, professional competence, and necessary resources to fulfil their tasks.

Regarding the serious accident involving the train driver and the train driver assistant employed by “NCL Neo Cargo Logistic”d.o.o., all activities related to professional training, competence, and work time planning were carried out in compliance with applicable regulations.

3.2.3. Procedures for internal audits and their checks and results

“NCL Neo Cargo Logistic”d.o.o., as a railway undertaking, has established a Safety Management System (SMS) within the limited liability company for freight railway transport “NCL Neo Cargo Logistic”d.o.o. Belgrade. The general purpose of the Safety Management System is to ensure that “NCL Neo Cargo Logistic”d.o.o. achieves its business objectives in a safe manner. The primary purpose of the Safety Management System is to ensure the safe management of the activities of “NCL Neo Cargo Logistic”d.o.o.

In accordance with Article 53 of the Law on Railway Traffic Safety (“Official Gazette of RS” No. 41/2018) and the Rulebook on the Maintenance of Railway Vehicles (“Official Gazette of RS” No. 101/2015, 24/16, and 36/17), the Entity in Charge of Maintenance (ECM) ensures that railway vehicles are maintained in compliance with regulations and the vehicle maintenance file. The ECM is responsible for controlling risks related to the condition of the vehicles and for overseeing the maintenance services performed. For railway vehicles used under lease agreements, the ECM function is performed by the vehicle owner. “NCL Neo Cargo Logistic”d.o.o. performs the ECM function for the traction vehicles it owns.

Regarding the accident in question, the regular and extraordinary maintenance of railway vehicles by the ECM was carried out in accordance with applicable regulations.

“IŽS”a.d., as the infrastructure manager, has established a Safety Management System Rulebook. The Safety Management System encompasses the organization and all procedures and processes established within “IŽS”a.d. to ensure the safe operation of railway traffic.

Risk control related to the maintenance of railway infrastructure (infrastructure subsystems, energy, control, management, and track signalling) and the railway vehicles used for maintenance by “IŽS”a.d. is based on implementing defined regular and extraordinary maintenance activities and their monitoring and control. Regular and extraordinary maintenance includes continuous supervision, inspections, examinations, adjustments, and repairs.

The requirements, standards, and procedures for maintenance at “IŽS”a.d. are determined based on legal regulations, the company's general and specific acts, manufacturer instructions, and standards.

Regarding the accident in question, regular and extraordinary track maintenance was not carried out in accordance with applicable regulations.

3.3. Relevant international and national regulations

3.3.1. Law on Railway (*"Official Gazette RS" No. 41/2018*)

Note: The Law on Railway ("Official Gazette of RS" No. 41/2018) was in effect at the time of the accident. The Law on Amendments to the Law on Railway ("Official Gazette of RS" No. 62/2023 of July 27, 2023) came into force on the eighth day following its publication in the "Official Gazette of RS" except for the provisions of Articles 39 and 40 of this law, which apply one year after the Law's effective date, and the provisions of Article 38 of this Law, which apply from the date of Serbia's accession to the European Union or the date of full implementation.

II Railway infrastructure

...

1. Railway infrastructure management

...

Obligations of the infrastructure manager

Article 10 (excerpt)

The infrastructure manager is obligated to ensure the safe and unhindered organization, regulation, and management of railway traffic, unobstructed access to and use of public railway infrastructure, as well as access to service facilities entrusted to it for management and the services it provides in those facilities to all interested applicants for infrastructure capacity allocation. This must be done under equal, non-discriminatory, and transparent conditions, as well as ensuring the continuous, uninterrupted, and high-quality maintenance and protection of railway infrastructure.

...

III Calculation of Access Charges and Allocation of Railway Infrastructure Capacity

...

7. Railway Infrastructure Management

Article 55

Public railway infrastructure must be maintained in a condition that ensures safe and unobstructed railway traffic, as well as high-quality and orderly transport, in accordance with regulations governing railway traffic safety, technical regulations, and standards. The maintenance of public railway infrastructure includes regular maintenance and extraordinary maintenance. The maintenance technological system comprises all elements of the public railway infrastructure. Maintenance interventions are conducted on individual elements to restore them to a state that preserves the railway's technological function and prevents bottlenecks on the railway. The infrastructure manager must issue a specific act to approve the introduction of any speed restricted runs or permanent speed limits below the designed parameters of the railway. This act must include an explanation of the reasons for the reduced speed and railway capacity, prescribe technical measures for their resolution, and specify a planned deadline for lifting the speed restriction. This document must be submitted to the Republic Railway Traffic Inspector.

Article 56

Works under regular maintenance include: maintenance and replacement of superstructure railway track elements (switches, tracks, and track connections) with the same or other types that maintain railway parameters at the designed level, works on the railway's substructure (drainage and slope stabilization), removal of trees, shrubs, and brush from the railway belt, replacement and renewal of culverts and bridges up to 10 meters in length with the same or other materials, provided their openings remain unchanged, replacement and supplementation of elements of signalling, safety, and telecommunications devices and installations, replacement and supplementation of elements of fixed installations for electric traction and other facilities for the transformation and transmission of electricity for train traction, adaptation and repair of railway station buildings and other facilities at railway stations that serve railway traffic, provided their construction and external appearance remain unchanged, snow and ice removal from tracks, installations, and surfaces at station platforms, stops, etc.

Article 57

Extraordinary maintenance works include major repairs carried out to address the consequences of extraordinary events (accidents, floods, earthquakes, etc.) on the elements of the existing railway infrastructure, with the aim of restoring safe traffic and achieving the designed parameters.

3.3.2. Law on Railway Traffic Safety (“Official Gazette RS” No. 41/2018)

III Safety management in railway system

Ensuring safety in the railway system

Article 5

The Ministry responsible for transport affairs (hereinafter: the Ministry), the Directorate, the Center for Investigation of Accidents (hereinafter: the Center), the infrastructure manager (hereinafter: the manager), and the railway undertaking, each in accordance with their respective duties, ensure the following: 1) The safety of railway traffic within the railway system is maintained and, where feasible, continuously improved, with priority given to preventing accidents, 2) Safety regulations are applied transparently and without discrimination, 3) The development of a unified railway system is accelerated. The manager and the railway undertaking are responsible for the safe operation of the railway system and the control of risks associated with it. They ensure this by implementing necessary risk control measures, cooperating with each other, applying national safety regulations and standards, and establishing safety management systems in accordance with this Law.

...

Supervision over the safety management systems

Article 15

The Directorate oversees the safety management systems of the infrastructure manager and the railway undertaking following the issuance of the safety certificate for railway infrastructure management and the safety certificate for transport.

The oversight mentioned in paragraph 1 of this article verifies whether the manager and the railway undertaking are implementing their safety management systems and, if necessary, orders the implementation of appropriate measures.

The decision ordering the implementation of appropriate measures under paragraph 2 of this article is final in the administrative procedure, and a dispute against it may be initiated before the Administrative Court.

On-site inspections, as referred to in paragraph 1 of this article, are carried out by authorized personnel of the Directorate at least once a year.

...

V Infrastructure subsystem

...

Subsystem infrastructure maintenance

Article 28 (excerpt)

The infrastructure manager is obligated to maintain the super and sub structures of railway tracks in a condition that ensures safe and orderly railway traffic.

...

3.3.3. Law on Railway System Interoperability ("Official Gazette RS" No. 41/2018)

Note: The Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 41/2018) was in effect at the time of the accident. With the entry into force of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023 of July 27, 2023), this law ceased to be valid.

Meaning of Certain Terms

Article 2

...

14) Subsystem renewal is a major replacement of a subsystem or part of a subsystem that does not change its basic characteristics;

...

29) Subsystem improvement is a significant modification of a subsystem or part of a subsystem that enhances its basic characteristics;

...

4. Permit for the Use of Subsystems Not Compliant with TSIs

...

Renewal or Improvement of a Structural Subsystem

Article 30 (excerpt)

In the case of renewing or improving a structural subsystem, the contractor or manufacturer submits documentation to the Directorate containing a project description. The Directorate then

decides, taking into account the implementation plan for the TSIs in the Republic of Serbia, whether the scope of the work requires a new permit for the use of the structural subsystem or a new permit for the use of vehicles.

...

3. Infrastructure Register

Article 34

The Infrastructure Register (hereinafter: RINF) contains the main characteristics of each subsystem or part of a subsystem (e.g., basic parameters) and their connection to the characteristics specified in the relevant TSIs.

The Directorate shall prescribe the specifications and data format for RINF, the architecture of the information system supporting RINF, the use of RINF, and the deadlines for submitting data.

The infrastructure manager is responsible for submitting data to the Directorate for RINF and for their accuracy.

The Directorate shall provide the RINF database to the European Union Agency for Railways.

3.3.4. Law on Railway System Interoperability ("Official Gazette RS" No. *62/2023*)

Meaning of Certain Terms

Article 2 (excerpt)

Certain terms used in this law have the following meanings:

...

21) Subsystem renewal is a major replacement of a subsystem or part of a subsystem that does not change its basic characteristics;

...

48) Subsystem improvement is a significant modification of a subsystem or part of a subsystem that enhances its basic characteristics and requires an amendment to the technical documentation attached to the verification declaration;

...

Renewal or Improvement of a Structural Subsystem

Article 36 (excerpt)

In the case of renewing or improving a structural subsystem, the contractor or manufacturer submits documentation to the Directorate containing a project description. The Directorate shall inform the contractor or manufacturer within one month whether the documentation is complete or if additional information is required, providing a reasonable deadline for submission.

The Directorate decides, taking into account the TSIs implementation plan for the Republic of Serbia, whether the scope of the work requires a new permit for the use of the structural subsystem or a new permit for the use of vehicles.

...

Infrastructure register

Article 49

The infrastructure manager submits data on subsystems of infrastructure, energy, control, management, and signalling (track section) to the Agency for the Infrastructure Register and is responsible for the accuracy, completeness, consistency, and updating of these data, as well as for their timely submission.

The Directorate provides the infrastructure manager with guidelines for the submission of data referred to in paragraph 1 of this article.

VI. Inspection Supervision

Article 50 (excerpt)

Inspection supervision over the implementation of this law and the subordinate regulations adopted under this law is carried out by the ministry responsible for traffic affairs, through the national railway traffic inspector (hereinafter: inspector).

...

The provisions of the law regulating inspection supervision shall apply to the inspection supervision process, unless otherwise provided by this law.

3.3.5. Instruction on Unique criteria for controlling the condition of the railway line on the railway network JŽ. Instruction 339 ("Official Gazette ZJŽ" No. 2/2001 and 4/2004 and "Official Gazette ŽS" No. 14/22 and 19/22)

Note: By decision No. 4/2015-51-17 dated December 29, 2015, issued by "IŽS"a.d., regarding the adoption of regulations issued by ZJŽ as its internal acts in accordance with Article 152 of the Law on Railway Safety and Interoperability ("Official Gazette of RS" Nos. 104/13, 66/15 - other law, 92/15, and 113/17 - other law) and Article 128 of the Law on Railway Traffic Safety ("Official Gazette of RS" No. 41/2018), this Instruction has been adopted and continues to be in effect at "IŽS"a.d.

Point 2, subpoint 6 (excerpt):

"... The record should include the following basic elements: what is being inspected and with what, the date of track recording and the stationing of the recorded track or section, **a diskette with a graphical and analytical presentation of the technical condition of the measured track or part of the track**, ..."

. . . . . .

Important note: The emphasized part of the text was replaced by the following text from the 2001 edition of Instruction 339 in the amendments made in 2004:

"The record should include the following basic elements: what is being inspected and with what, the date of track recording and the stationing of the recorded track or section**, the registered locations that directly endanger railway traffic safety, ..."**

In point 7 of the current edition of Instruction 339, the text under item 5 from Article 7 of the 1989 edition of the Instruction (which is no longer in effect) is missing.

Article 7, item 5, of Instruction 339 from 1989:

"Registered defects that directly endanger traffic safety must be rectified on the same day after the passage of the track inspection coaches. If this is not possible, appropriate safety measures must be implemented."

. . . . . .

Point 9, subpoint 3 (excerpt) of the current Instruction 339 from 2001/2004:

- "B - defects requiring planned works for their rectification"
- "C - defects exceeding operational limits **that require urgent rectification or speed reduction"**

. . . . . .

Important Note: The emphasized part of the text in Instruction 339 from 1989 stated:

"And which must be immediately rectified as they endanger traffic safety."

. . . . . .

Point 9 (excerpt) of the current Instruction 339 from 2001/2004:

"The track condition is assessed based on the total length of defects in groups 'B' and 'C' over a length of one kilometre."

The condition of one kilometre of track is:

- "Satisfactory, up to 250 m of defects in group B and up to 25 m of defects in group C, i.e., ≤250/25 (B/C)."
- "Unsatisfactory, more than 250 m of defects in group B and more than 25 m of defects in group C, i.e., >250/25 (B/C)".

. . . . . .

Important Note: Additionally, the last paragraph from Point 9 of Instruction 339 was deleted in the 2001 amendments. In the 1989 edition of Instruction 339, Article 9, the last paragraph (excerpt) stated:

"Immediately after the track inspection run, work is undertaken on all kilometres where the length of defects exceeds 200/20, with a report required to determine how this situation occurred. After identifying the reasons for the defects and their locations, a plan for improving the condition of the observed kilometre is immediately developed...."

. . . . . .

Point 17 (excerpt) from the current Instruction 339 from 2001/2004, with amendments as of 25.02.2022:

...

"- IAL - Immediate Action Limit

Refers to values exceeding operational limits that require urgent rectification or speed reduction."

3.3.6. Rulebook on technical conditions and railway line superstructure maintenance (*"Official Gazette RS" No. 39/16 and74/16*)

Note: The Rulebook on Technical Conditions and Maintenance of the Superstructure of Railway Line ("Official Gazette of RS" Nos. 39/16 and 74/16) was in effect at the time of the accident. On the date of entry into force of the Rulebook on Maintenance of the Superstructure and Substructure of Railway Line ("Official Gazette of RS" No. 39/2023), Articles 66-112 of this Rulebook ceased to be valid. Furthermore, on the date of entry into force of the Rulebook on Technical Conditions of the Infrastructure Subsystem ("Official Gazette of RS" No. 39/2023), Articles 1-65 of this Rulebook ceased to be valid.

Rails

Types of Rails and Their Installation

Article 4 (excerpt)

In the tracks of the Republic of Serbia, rails of type 49E1 and 60E1 are installed in accordance with SRPS EN 13674-1.

...

On regional and local railways, rails of type 49E1 with the minimum steel quality of R200 may also be installed.

...

Article 77 (excerpt)

The size of the expansion gap at rail joints and the depth and width of the groove for the passage of rail vehicle wheels are measured at least twice a year, preferably in April and October, and more frequently if necessary.

...

Expansion devices in the track on railways and bridges must have all sleeper s in proper condition, with joint and fastening hardware present in full quantity and properly tightened. The minimum and maximum gap for the expansion devices is determined by the track alignment design.

The rails installed in the track are inspected and checked with measuring instruments and measuring vehicles for crack testing in the rails.

Regular inspections with measuring vehicles on mainline railways are conducted once every two years, on regional railways once every three years, and on local railways as needed.

...

Inspections are carried out using the measuring instruments or equipment provided by the contractor.

Checks and controls on shorter sections, if necessary, can be performed with manual devices and measurement equipment.

Before the wear of rails in curves reaches the limit values, the rails should be swapped (rails from the inner track should be moved to the outer and vice versa).

Rails removed from the mainline can be reused in regional and local railways after regeneration, provided they have the required load capacity and are not worn beyond the allowed limits.

...

Article 81, Paragraphs 1 and 2:

The technical condition of all types of track equipment and components as a whole must be such that it ensures a firm connection between the rails, the rail and the sleeper, and prevents loosening of the equipment and connections.

Damaged, worn-out, or missing track elements should be replaced or supplemented, loosened equipment should be tightened, and individual components should be lubricated as needed.

3.3.7. Rulebook on railway line super and sub structure maintenance (“Official Gazette RS” No. 39/2023)

Article 5 (excerpt)

…

1) IAL - Immediate Action Limit - refers to the value of a parameter that, if exceeded, requires measures to be taken to reduce the risk of derailment to an acceptable level. This can be achieved by closing the track, repairing the track geometry, or reducing the speed.

Article (excerpt)

...

3) Type C defects - defects that exceed operational limits and require measures to be taken to reduce the risk of derailment to an acceptable level. This can be achieved by closing the track, repairing the track geometry, or reducing the speed.”

3.4. Functioning of Railway Vehicles and Technical Installations

3.4.1. Control, command and signalling

On the section of the regional railway line Crveni Krst - Zaječar - Prahovo Pristanište, between the stations Svrljig and Knjaževac, traffic is regulated at the station distance, by requesting permission for train traffic, notifying, and reporting (verbally, via sound recordings).

Between the stations Matejevac and Svrljig, there is no functioning SS system, nor are there devices for control, command, and signalling.

3.4.2. Infrastructure

The location of the accident (km 55+252) is on a concrete bridge at km 55+254 (the center of the bridge), with a length of L=30 m, between Tunnel No. 21 (entrance portal at km 55+163.90, exit portal at km 55+204.15, L=40.25 m) and Tunnel No. 22 (entrance portal at km 55+301.56, exit portal at km 55+480.94, L=179.38 m), at the end of the curve, on the section of the transition curve (right curve R=250 m, D=171.80 m, start of the transition curve at km 55+110.72; start of the circular curve at km 55+150.72; end of the circular curve at km 55+242.72 and end of the transition curve at km 55+282.52). The track gradient at the location of the derailment is 10.19‰ (from km 55+200 to km 55+512, a fall of 10.19‰, viewed in the direction of train travel, or in the direction of increasing stationing).

Figure 3.4.2.1. shows the accident site sketch.

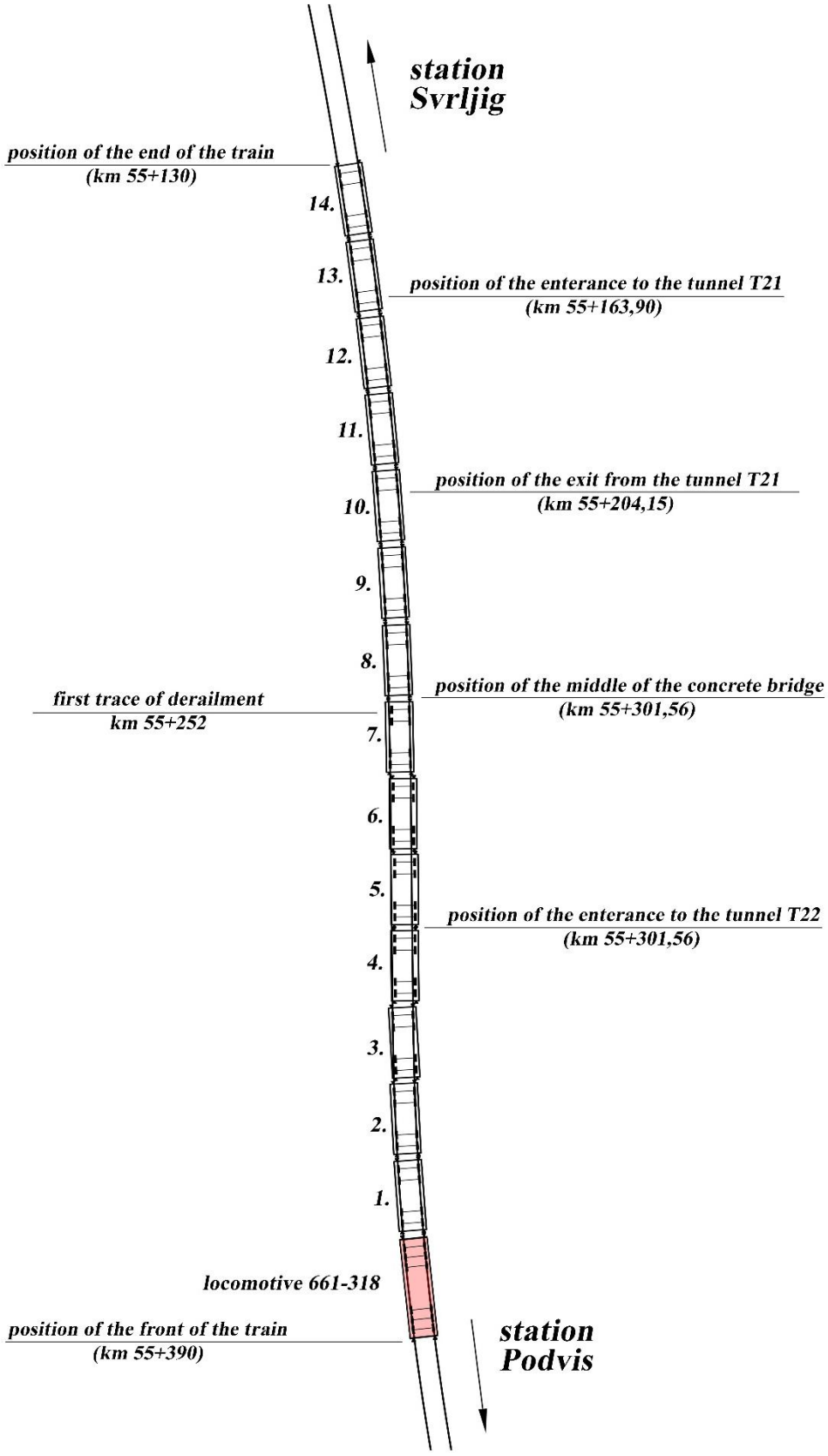


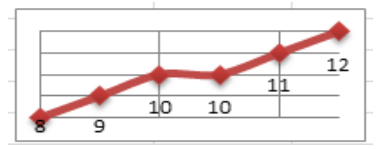
Figure 3.4.2.1: The accident site sketch

According to the provided data on track inspections conducted prior to the accident, carried out by the track maintenance department of "IŽS"a.d., OC ZOP Zaječar, the factual condition is stated in the following text.

The wear of the rails in the outer and inner curves is within operational values. The measured rail wear on February 14, 2019, at the location of the derailment was 13 mm laterally and 0 mm vertically in the outer curve of the bend.

The inspection of rail wear from 2013 to 2018 is shown in Table 3.4.2.1.

Table 3.4.2.1: Wear of the rails measured in the period from 2013 to 2018.

Stationing (km position)	Radius of curvature (m)	Element of curvature	Rail type	External arch		Rail type	Internal arch		Remark
				lateral	vertical		lateral	vertical	
1	2	3	4	5	6	7	8	9	10
55+110.72	250	KPK	45	9	3	45	0	3	06.02.2013.
55+196		SK		8	3		0	3	
55+282.52		KPK		9	3		0	3	
		sk		9	3		0	3	05.11.2013.
		sk		10	3		0	3	02.03.2015.
		sk		10	3		0	3	08.09.2015.
		sk		11	1		1	4	17.07.2017.
		sk		12	2		0	4	26.07.2018.

At the location of the derailment of train No. 52770, rails of type 45, with lengths ranging from 30.0 m to 45.0 m (ZENICA VIII-61-M-45), were installed, connected to supported (classic) track assemblies using standard rail fastening equipment.

The rail fastening equipment is of type "K".

The track bed consists of ballast.

Train No. 52770 derailed at km 55+252 on a reinforced concrete bridge with a span of 30.0 m. At the location of the derailment, the track is in a 10.19‰ gradient, in a right curve with a radius of R=250 m, and with superelevation of h=90 mm.

The track geometry is very poor, manifesting in disrupted levels both longitudinally and transversely. The rail twist is above the allowed limit, which jeopardizes the safety of traffic.

Due to the poor condition of the super and sub track components, the maximum allowed speed on the section of the track from km 45+916 to km 61+105 is Vmax=40 km/h for passenger trains and Vmax=30 km/h for freight trains, whereas the designed speed for this section of the track is V_{mah}=60 km/h.

An inspection of the inventory of decayed wooden sleepers on the section of track from the station Matejevac (km 3+455) to the station Knjazevac (km 95+000) revealed that out of 133,788 wooden sleepers installed from 1957 to 1985, 62,790 (46.94%) were decayed, with decayed sleepers in nests ranging from 8 to 20, and at some places, for every 143 installed wooden sleepers per 100 meters, 90 to 120 were decayed.

During the onsite investigation conducted by the joint investigation committee of "IŽS"a.d. and "NCL Neo Cargo Logistic"d.o.o. on February 14, 2019, measurements were taken of the track width in the zone where the first signs of derailment were observed.

The measurements were carried out using a track gauge, brand Robel, owned by "IŽS"a.d. The measured values are shown in Table 3.4.2.2, and a graphical representation of the measured values is shown in Chart 3.4.2.1.

The sleepers marked with the prefix "-" are those located before the derailment site, when viewed in the direction of train travel. The distance between adjacent sleepers is 0.70 m.

Table 3.4.2.2: Track gauge immediately after the accident, measured by the joint investigation committee of "IŽS"a.d. and "NCL Neo Cargo Logistic"d.o.o.

		Track gauge		Elevation in KK		
		1435		**90**		
km position	Place of measuring	*mm*		*mm*		
55+252.00	**0**					**First trace of derailment**
55+251.30	**-1**	**1475**	**40**	**71**	-0.4	
55+247.30	**-2**	**1475**	**40**	77	-3	Transition curve
55+243.30	**-3**	**1472**	**37**	80	-10	55+242.72 ÷ 55+282.72
55+239.30	**-4**	**1462**	27	82	-8	
55+235.30	**-5**	**1466**	31	80	-10	
55+231.30	**-6**	**1475**	**40**	80	-10	
55+227.30	**-7**	**1471**	**36**	80	-10	
55+223.30	**-8**	**1469**	34	80	-10	
55+219.30	**-9**	**1470**	**35**	86	-4	
55+215.30	**-10**	**1464**	29	81	-9	
55+211.30	**-11**	**1465**	30	90	0	
55+207.30	**-12**	**1463**	28	87	-3	According to Instruction 339 For IV category of the railway
55+203.30	**-13**	**1461**	26	88	-2	
55+199.30	**-14**	**1465**	30	97	7	
55+195.30	**-15**	**1464**	29	87	-3	gauge
55+191.30	**-16**	**1462**	27	91	1	+35
55+187.30	**-17**	**1458**	23	83	-7	1435 mm
55+183.30	**-18**	**1460**	25	85	-5	-10
55+179.30	**-19**	**1453**	18	81	-9	
55+175.30	**-20**	**1457**	22	82	-8	cant
55+171.30	**-21**	**1462**	27	84	-6	+15
55+167.30	**-22**	**1459**	24	83	-7	h mm
55+163.30	**-23**	**1463**	28	78	-12	-15
55+159.30	**-24**	**1464**	29	86	-4	
55+155.30	**-25**	**1464**	29	83	-7	

Graph 3.4.2.1: Track gauge immediately after the accident, measured by the joint investigation committee of "IŽS"a.d. and "NCL Neo Cargo Logistic"d.o.o.

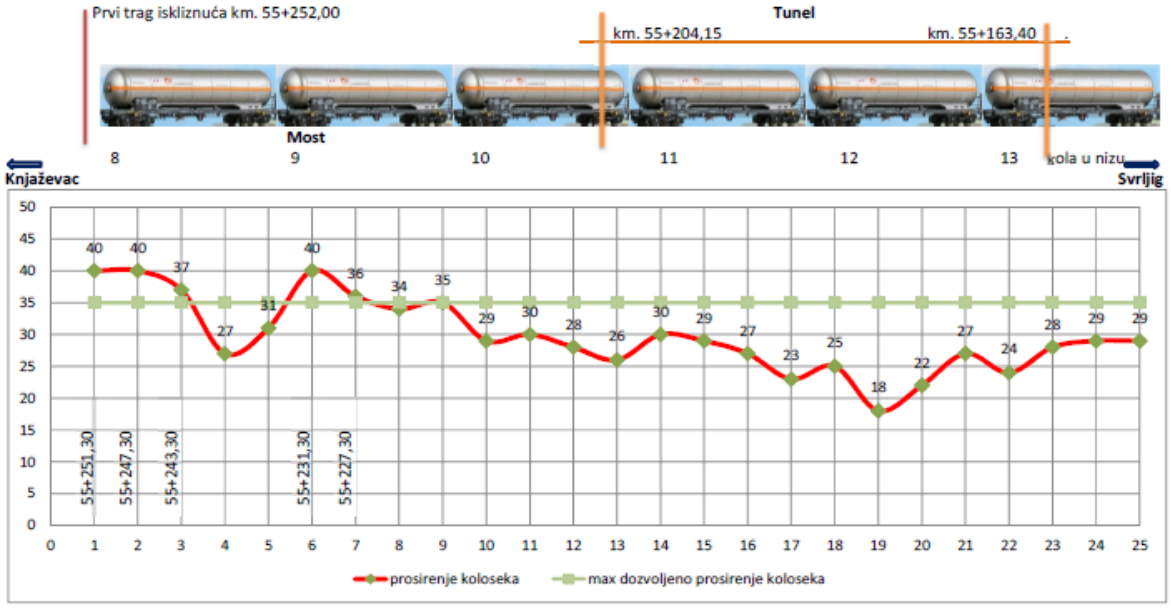
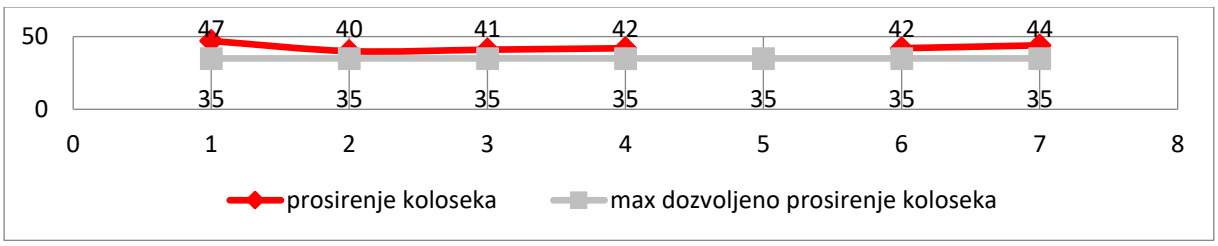


Table 3.4.2.3: Track gauge immediately after the accident, measured by CINS

		Track gauge		Cant in KK		
		1435		**90**		
km position	sleeper	*mm*		*mm*		
55+252.00	**0**	**1482**	**47**	**71**	1	**First trace of derailment**
55+251.30	**-1**	**1475**	**40**	**71**	-0.4	
55+250.60	**-2**	**1476**	**41**	Not measured		Transition curve
55+249.90	**-3**	**1477**	**42**	Not measured		55+242.72 - 55+282.72
55+249.20	**-4**	Not measured		Not measured		
55+248.50	**-5**	**1477**	**42**	**74**	-4	
55+247.80	**-6**	**1479**	**44**	**76**	-3.4	

Graph 3.4.2.2: Track gauge immediately after the accident, measured by CINS



The regional railway line from Crveni Krst to Zaječar to Prahovo Pristanište, from km 3+455 to km 95+000, is maintained by the track section of OC ZOP Zaječar, with the following staff members:

- Section Chief, 1 staff member
- Assistant Section Chief, 1 staff member
- Track Workers, 2 staff members
- Track Keepers, 2 staff members

In total, there are 6 staff members.

The track section from Matejevac to Knjazevac is equipped with small track machinery and two small motorized rail vehicles.

OC ZOP Zaječar is responsible for a total of 254 km of track, which includes 71 tunnels with a total length of 21,559.41 m, 95 bridges with a total length of 4,831 m, 702 culverts, 243 switches, and 163 level crossings. OC ZOP Zaječar has a total of 13 track workers and 7 track keepers. In addition to the Matejevac section, OC ZOP Zaječar also oversees the following track sections: Zaječar - Negotin (2 track workers and 2 track keepers), Vlaole - Bor (6 track workers and 3 track keepers) and a section for embankment maintenance (2 track workers).

3.4.3. Communication tools

At the time of the accident, the communication equipment between the personnel regulating the traffic was functional and in good working order. No malfunctions or faults were recorded on the communication equipment.

Considering that there is no communication system between the traffic regulation personnel and the train crew, which is provided by the TT service of “IŽS”a.d. on this section of the regional railway, communication between the locomotive crew and the traffic personnel is only possible through mobile operator lines. At the location of the accident, there is no mobile network signal coverage, so the driver of train No. 52770 was forced to walk along the track between 4 and 5 km to reach an area with mobile phone signal coverage and inform the relevant parties about the accident. The lack of reliable communication equipment could have severe consequences in the event of a hazardous materials spill (or similar dangerous incidents).

3.4.4. Railway vehicles

At the time of the accident, train No. 52770 was traveling from the Svrljig station towards the Knjazevac station (from the beginning to the end of the track, in the direction of increasing station numbering).

During the journey, a total of five (5) wagons of series Z derailed. From the train composition, starting from locomotive 661-318, the third, fourth, fifth, sixth, and seventh wagons derailed.

At the scene, upon the arrival of the investigative team from CINS, a portion of train 52770, from the second to the fourteenth wagon, was found, while locomotive 661-318 and the first wagon (wagon No. 3387 7813 563-6) were not found at the scene. The part of the train found at the scene was not separated.

All derailed wagons were found on the tracks in the derailed section, resting on their wheels. There was no tilting or overturning of the derailed wagons. Additionally, there was no leakage of cargo from the tank wagons.

A review of the derailed wagons, starting from the locomotive, is provided in Table 3.4.4.1.

Table 3.4.4.1: Overview of the derailed wagons at the train No. 52770 (viewed from loc. 661-318)

Serial No.	Letter marking of the wagon	Unique wagon No.	owner	note
3	*Zags*	3387 7814 136-0	*ERMEWA*	The wagon derailed with two axles of the first bogie
4	*Zags*	3380 7818 085-2	*ATIR- RAIL*	The wagon derailed with all axles.
5	*Zags*	3380 7818 094-4	*ATIR- RAIL*	The wagon derailed with all axles.
6	*Zags*	3387 7813 564-4	*ATIR- RAIL*	The wagon derailed with all axles.
7	*Zags*	3387 7816 547-6	*ERMEWA*	The wagon derailed with one axle of the second bogie

Appearance of the derailed wagons is shown in Figs 3.4.4.1, 3.4.4.2 and 3.4.4.3.

Figure 3.4.4.1: Appearance of the parts of derailed wagons

Figure 3.4.4.2: Appearance of the parts of derailed wagons

Figure 3.4.4.3: Appearance of the parts of derailed wagons

For the speedometer devices manufactured by Hasler, installed on locomotive 661-318, an Attestation No. 221/2018 dated September 21, 2018, was provided. This attestation confirms that the speed recording device type 9, serial No. 14317, and the display speedometer device serial No. 14799, were found to be accurate according to the tests and adjustments conducted in accordance with Instruction 230.

The data processing from the speedometer tape removed from the registering speedometer device on locomotive 661-318 of train No. 52770 was carried out at “Srbija Voz”a.d, Section for Train Traction Niš. Based on this, Form EV-85, Appendix 1: Data from the speedometer tape No. 33/2019-161 dated February 18, 2019, was issued.

The data processing from the speedometer tape removed from the registering speedometer device on locomotive 661-318 of train No. 52770 (Data from speedometer tape No. 33/2019-161 dated February 18, 2019) revealed that during the journey from the station Crveni Krst to km 55+400 (the stopping point after the derailment), the train was traveling at speeds between 12 and 27 km/h. However, there were a few exceptions: Around km 10+768, after a gradual speed reduction (from km 10+500 to km 10+600 at 20 km/h), the train slowed to 2 km/h, with slight slipping, around km 29+627, after a gradual speed reduction (from km 29+000 to km 29+600 at 20 km/h), the train stopped, accompanied by noticeable slipping, around km 32+560, after a speed restriction (for DMVs only, from km 30+700 to km 32+410 at 30 km/h), the train stopped, around km 41+360, after a gradual speed reduction (from km 41+300 to km 41+400 at 10 km/h), the speed decreased to 1 km/h. After passing km 55+065 at a speed of 15 km/h, the train accelerated and reached a speed of 22 km/h at km 55+253. Shortly after, the speed dropped, and around km 55+348, there was a speed jerk, with a sudden increase from 11 km/h to 16 km/h, followed by a sudden stop of the train around km 55+400. It was not possible to determine the exact time of these events because the speedometer clock was not operational for the entire route (the driver did not set the speedometer clock before departure).

Based on the data from the speedometer tape of locomotive 661-318, it was concluded that there was no violation of the speed limit (30 km/h) on this section of the railway, as prescribed by the timetable booklet 7.1 and the operational schedule material (light driving).

3.5. Traffic regulation and management

3.5.1. Actions taken by the staff responsible for regulating and controlling traffic and signalling

The train traffic for train No. 52770 on the Svrljig - Knjazevac route was conducted within station intervals. Prior to dispatching train No. 52770, permission was duly requested and granted in accordance with applicable regulations, and there were no irregularities in this regard.

The train staff, through accompanying documentation, received orders and notifications about the train's operation on this section of the track.

3.5.2. Voice messages exchange regarding the accident

Immediately before and during the occurrence of the accident, there was no communication between the train driver and the staff regulating traffic.

Communication between the traffic control staff and the train driver was established after the accident in order to notify about the accident. The train driver of train No- 52770, using a mobile phone operator line, informed the dispatchers at the Svrljig and Knjazevac stations, and subsequently the Transport Organizer at the railway carrier “NCL Neo Cargo Logistic”d.o.o.

3.5.3. Measures undertaken to protect and secure the accident site

After the accident, the section of the regional railway track from Crveni Krst - Zaječar - Prahovo Port between the Svrljig and Knjazevac stations was closed for traffic.

Given the fact that train No. 52770 stopped on a section of track that, in the direction of travel, had a gradient between 10.24‰ and 10.19‰ (from km 55+030 to km 55+200 with a gradient of 10.24‰, and from km 55+200 to km 55+512 with a gradient of 10.19‰), viewed in direction of travel, that is, the growing stationing, and that five wagons derailed (the 3rd, 4th, 5th, 6th, and 7th wagon, viewed from the locomotive) without breaking up the train (no rupture of the main air hose), no special measures were taken to secure the train against running.

Considering that the train was carrying materials that, if released uncontrollably from the wagon-tanks, could pose a health risk to people and potentially be dangerous to the environment, the MUP RS was notified about the accident.

No additional measures were taken to secure the accident site.

3.6. Interface between people, machines and organization

3.6.1. Involved staff working hours

From the railway undertaking “NCL Neo Cargo Logistic”d.o.o., data was provided for the railway staff (the locomotive driver and assistant driver), which indicates that the train driver and assistant train driver operating locomotive 661-318 did not exceed the maximum working hours prescribed by law.

3.6.2. Health and personal circumstances influencing the accident, including the presence of physical or psychological stress

For the railway staff, data has been provided confirming that the train driver on duty for train No. 52770 is professionally qualified and medically fit to perform their duties. The locomotive driver holds a License to Operate a Traction Vehicle, No. RS 71 2017 0583, issued by the Railway Directorate on 1.1.2017, with a validity period until 18.9.2022. No information was provided regarding whether the train driver possesses an Additional Authorization for operating specific types of traction vehicles on particular infrastructures.

For the train driver assistant on duty for train No. 52770, data has been provided confirming that he was medically fit to perform their duties. The train driver assistant holds a Certificate of Completion of the Professional Examination for the Position of Train Driver (Certificate No. 40-16/2018 dated 3.2.2019, issued by "NCL Neo Cargo Logistic"d.o.o.).

A joint investigative committee, composed of representatives from "IŽS"a.d. and "NCL Neo Cargo Logistic"d.o.o., conducted alcohol testing on the locomotive driver and assistant locomotive driver of train No. 52770 on 14.02.2019, at Knjaževac station. The testing was performed using an ethyl-meter manufactured by Dräger Safety Lubeck, Germany, serial No. ARXA-0180. The alcohol test revealed no presence of alcohol in either the train driver or the train driver assistant.

3.6.3. Method of design of the equipment affecting the interface between user and the machine

A section of the regional railway line Crveni Krst – Zaječar – Prahovo Pristanište, between the stations Svrljig (km 40+018) and Knjaževac (km 68+365), was originally designed for speeds of up to 60 km/h (from km 45+916 to km 61+105), 65 km/h (from km 40+018 to km 45+916 and from km 61+105 to km 68+099), and 90 km/h (from km 68+099 to km 68+365), with maximum axle loads of 18 t/axle (180 kN/axle).

Due to the condition of the railway line, the designed speeds have been reduced to 40 km/h for DMUs (Diesel Multiple Units) and 30 km/h for all other trains.

According to the designed condition, traffic on this railway is regulated by station spacing.

The locomotive is operated by a train driver and an assistant using controls located in the driver's cab, which were designed during the locomotive's manufacturing. All defects previously noted in the systems and devices for controlling locomotive 661-318 have been resolved, and no remarks or deficiencies have been registered.

No remarks or deficiencies have been registered regarding the designed technical and operational characteristics of the Z-series freight wagons.

3.7. Previous accidents of the similar character

Based on data obtained from "IŽS"a.d., for the period from January 1, 2009, to February 14, 2019, a total of 19 (nineteen) accidents involving train derailments occurred on the regional railway Crveni Krst – Zaječar – Prahovo Pristanište. An overview of the accidents is provided in Table 3.7.1.

Table 3.7.1: An overview of the accidents for the period from January 1, 2009, to February 14, 2019

Ordinal No.	Date	Time	Short description	Cause
1	July 24, 2010	13:10	Between Rogljevo and Negotin stations at km 157+550, train No. 52730 with six Eas cars derailed.	External force - track deformation due to high daytime temperatures
2	March 22, 2014	18:15	At the entrance to Prahovo station, on the area of the switch No. 3, train No. 53729 with three Za wagons derailed.	Poor track condition
3	October 19, 2015	22:15	At the exit from Zaječar station, on switch No. 5 at km 111+132, train No. 45721 with one wagon derailed, causing train separation.	Poor track condition
4	January 18, 2016	05:50	At the exit from Prahovo Pristanište station, on switch No. 3, train No. 53737 ("Srbija Kargo"a.d.) with three wagons derailed.	Violation of speed limit by the train driver
5	June 30, 2017	23:00	Between Matejevac and Svrljig stations at km 25+900, train No. 53734 (loc.661-118 and 14 Za wagons loaded with ammonia RID 268/1005, OM 4189/17) with one wagon derailed	External force - track deformation due to high daytime temperatures
6	August 12, 2017	13:35	Between Matejevac and Svrljig stations at km 24+741, train No. 53731 derailed with non-working loc.661-138 with one axle	External force - track deformation due to high daytime temperatures
7	November 20, 2017	10:55	At Negotin station, km 174+337, on the area of the switch No. 6, train No. 53728 ("Srbija Kargo"a.d.) with six wagons derailed	Overloading beyond the wagon's permissible capacity
8	January 15, 2018	14:43	In Negotin station, at switch No. 2, at km 173+733, train No. 63729 ("Srbija Kargo"a.d.) with its last wagon derailed.	Switch malfunction due to improper positioning by the switch operator
9	January 29, 2018	14:55	In Negotin station, at switch No. 7, at km 174+370, train No. 63729 ("Srbija Kargo"a.d.) with five Za wagons derailed. The wagons were loaded with sulfuric acid (RID 80/1830, OM 560/18).	Technical malfunction on wagon No. 33 72 7867 899-6 which cause blocking the first axle of the first bogie
10	May 9, 2018	15:25	In Podvis station at km 60+766, train No. 52730 with two Za wagons derailed.	External force - track deformation due to high daytime temperatures
11	May 25, 2018	13:10	Between Matejevac and Svrljig stations at km 25+800, train No. 52792 with one Za wagon with booth bogies derailed	External force - track deformation due to high daytime temperatures
12	September 2, 2018	02:15	Between Rogljevo and Negotin stations at km 166+800, train No. 52731 with four Za wagons derailed	Track deformation in direction and level due to unstable embankment

Ordinal No.	Date	Time	Short description	Cause
13	September 2, 2018	20:15	Between Rogljevo and Negotin stations at km 166+500, train No. 52731 with one Za wagon derailed	Poor track condition
14	September 25, 2018	22:00	At Podvis station at km 60+590, train No. 52770 (“NCL Neo Cargo Logistic”d.o.o.) with one Za wagon loaded with ammonia derailed	Correlation of multiple factors contributing to derailment at the given moment: small curve radius (R = 280 m), increased spacing between the bolts of the bogies, parasitic movement of liquid inside the tank during the train's stopping and starting, and the track condition, which is within tolerance but not of consistent quality.
15	December 12, 2018	15:50	Between Rogljevo and Negotin stations at km 167+180, train No. 52770 (“NCL Neo Cargo Logistic“d.o.o.) with one Za wagon loaded with ammonia (RID 268/1005) derailed	Improper train composition (the derailed wagons did not have a loading spiral spring installed on No.7 of the derailed bogie due to prior deformation of the inner spiral spring). When entering a left curve in the direction of movement, most of the liquid inside was directed toward the mentioned bogie, which ultimately resulted in lifting of the right side of the wheels and the derailment. The technical malfunction of the mentioned wagons clearly indicates that they were not inspected by workers with the required and adequate qualifications. Additionally, improper coupling was observed on some wagons, caused by incorrect positioning of the spindle in the middle position and several threads loosened from the coupling nut. The force and type of braking were also found to be improper – in a half-engaged position, including the derailed wagons
16	December 27, 2018	01:15	Between Rogljevo and Negotin stations at km 167+270, train No. 52770 (NCL Neo Cargo Logistic) with one Za car loaded with ammonia derailed.	Non-compliance with restricted speed instructions by the train driver from km 167+150 to km 167+800 with 10 km/h by General order No. I/30 Zaječar station
17	December 28, 2018	12:50	Between Matejevac and Svrljig stations at km 25+850, train No. 73700 (working machine “ИЖС”а.д.) derailed	Malicious act by third parties (theft of track accessories holding the rail in place, at the length of 4 m)
18	January 19, 2019	22:55	Between Matejevac and Svrljig stations at km 26+650, train No. 52770 (“NCL Neo Cargo Logistic”d.o.o.) with three Za wagons loaded with ammonia (RID 268/1005) derailed	Improper train composition, (technical malfunction on the wagon - non-functionality of the center bowl of the first boogie in the direction of the movement, metal-on-metal friction; failure to perform the role of the side slider of the same boogie and looseness of the clutch between the eighth and ninth wagon)

Ordinal No.	Date	Time	Short description	Cause
19	February 10, 2019	00:35	Between Matejevac and Svrljig stations at km 29+565, train No. 52792 (“Srbija Kargo”a.d.) with five Za wagons loaded with phosphoric acid derailed	Improper train composition, (technical failure of the traction-buffer equipment)

In all the reported accidents, there were no fatalities or injuries.

3.8. Course of the investigative procedure

The following text provides a brief overview of the investigation process.

Immediately after the accident occurred, CINS (Center for Investigation of Accidents in Transport) reached out to the relevant parties, including the railway undertaking “NCL Neo Cargo Logistic”d.o.o., which was involved in the accident, to direct the involved wagons to a workshop in accordance with Article 6, item 5, and Article 11 of the Rulebook on the Maintenance of Railway Vehicles (“Official Gazette of RS” Nos. 101/15, 24/16, and 36/17), which was in force at the time of the accident.

CINS issued a letter, reference No. 340-00-3/2019-02-1-11, dated March 22, 2019, to the railway undertaking “NCL Neo Cargo Logistic”d.o.o., requesting the submission of data in accordance with Article 31 of the Law on Investigation of Accidents in Air, Railway, and Waterborne Transport (“Official Gazette of RS” Nos. 66/15 and 83/18). However, “NCL Neo Cargo Logistic”d.o.o. did not submit a report on the inspection of all derailed wagons conducted after the accident as required by Article 11 of the Rulebook on the Maintenance of Railway Vehicles. This was due to the fact that the wagons were not sent to a workshop in accordance with the provisions of the aforementioned Rulebook (as noted in the first paragraph of this text), meaning the undertaking did not act in compliance with this subordinate regulation.

Given that the railway operator “NCL Neo Cargo Logistic”d.o.o. refused to comply with legal and regulatory requirements, CINS addressed the Ministry of Construction, Transport, and Infrastructure (MGSI) with a letter, reference No. 340-00-3/2019-02-1-15, dated April 30, 2019. The letter highlighted the operator's refusal to act in accordance with legal and regulatory provisions regarding the handling of derailed wagons following the accident, specifically their refusal to send the wagons involved in the accident to a workshop. Additionally, CINS sent another letter, reference No. 340-00-3/2019-02-1-33, dated July 22, 2019, to MGSI, requesting that measures within MGSI's jurisdiction, or those of the Railway Safety Inspection, be taken in accordance with the Law on Railway Traffic Safety (“Official Gazette of RS” No. 41/18).

Although CINS sent several requests to MGSI (Ministry of Construction, Transport, and Infrastructure) for action within its jurisdiction, including letters Nos. 340-00-3/2019-02-1-39 on August 28, 2019, 340-00-3/2019-02-1-42 on December 9, 2019, and 340-00-3/2019-02-1-45 on January 17, 2020, as well as letter 340-00-3/2019-02-1-47 on February 6, 2020, addressed to the MGSI Sector for Inspection Supervision, Railway Inspection Group, the Chief Rail Accident Investigator was only informed by email on February 26, 2020, by the acting inspector (from MGSI's Railway Inspection Group) that an inspection procedure had been initiated ex officio after a risk assessment. Although the Main Investigator for Rail Traffic emailed the acting inspector on February 28, 2020, requesting the inspection report, imposed measures, and coordination to keep

CINS informed and enable further action, CINS subsequently sent additional letters Nos. 340-00-3/2019-02-1-54 on September 3, 2020, and 340-00-3/2019-02-1-55 on October 20, 2020, to the MGSI Inspection Supervision Sector, Railway Inspection Group, again requesting action within MGSI's jurisdiction. The MGSI Inspection Supervision Sector, Railway Traffic Inspection Department, finally sent letter No. 340-06-399/2020-18 on October 20, 2020, informing CINS that Decision No. 340-06-082/2020-18 had been issued on October 16, 2020, to the railway undertaking "NCL Neo Cargo Logistic"d.o.o., with imposed measures. Since there was no further information from the inspection authorities or "NCL Neo Cargo Logistic"d.o.o., CINS sent another letter, No. 340-00-3/2019-02-1-60, on December 10, 2020, to the MGSI Inspection Supervision Sector, Railway Traffic Inspection Department, requesting action within its jurisdiction, coordination, and information exchange to enable CINS to monitor activities relevant to the investigation process. On December 15, 2020, MGSI's Inspection Supervision Sector, Railway Traffic Inspection Department, responded with letter No. 340-06-399/2020-18/1. In the letter, the acting railway traffic inspector informed CINS that the railway undertaking "NCL Neo Cargo Logistic"d.o.o. had filed an appeal against Decision No. 340-06-082/2020-18 of October 16, 2020. The appeal was being processed by the second-instance body, and a final decision had not yet been reached. Following this, CINS sent letter No. 340-00-3/2019-02-1-65 on January 11, 2021, to the MGSI, Sector for Inspection Supervision, Railway Traffic Inspection Department, requesting action within MGSI's jurisdiction. In response, MGSI sent letter No. 340-06-399/2020-18/2 on January 14, 2021, informing CINS that MGSI, as a second-instance body, had issued a second-instance decision No. 340-01-00541/2020-04 on January 4, 2021, rejecting the appeal of the company "NCL Neo Cargo Logistic"d.o.o. as unfounded. The second-instance decision was final in the administrative procedure. Since there was no further information from the inspection authorities or "NCL Neo Cargo Logistic"d.o.o., CINS sent letter No. 340-00-3/2019-02-1-67 on January 27, 2021, and letter No. 340-00-3/2019-02-1-69 on April 6, 2021, to the MGSI, Sector for Inspection Supervision, Railway Traffic Inspection Department, again requesting action within its jurisdiction. In response, MGSI sent letter No. 340-06-399/2020-18-3 on April 7, 2021, informing CINS that "NCL Neo Cargo Logistic"d.o.o. had filed a lawsuit with the Administrative Court in Belgrade on February 5, 2021, challenging the second-instance decision and requesting its annulment. Additionally, the acting inspector had submitted a request to the Misdemeanour Court in Niš to initiate misdemeanour proceedings against "NCL Neo Cargo Logistic"d.o.o. in accordance with Article 123 of the Railway Safety Act. As there were no further updates, CINS sent letter No. 340-00-3/2019-02-1-72 on December 7, 2021, to the MGSI, Sector for Inspection Supervision, Railway Traffic Inspection Department, requesting further action within MGSI's jurisdiction. On January 10, 2022, MGSI responded with letter No. 340-06-399/2020-18-4, stating that there were no new developments regarding the lawsuit filed by "NCL Neo Cargo Logistic"d.o.o. The Misdemeanour Court in Niš had issued a decision to suspend the proceedings against "NCL Neo Cargo Logistic"d.o.o. due to the statute of limitations for initiating the misdemeanour procedure. Given the lack of new information, CINS sent additional letters Nos. 340-00-3/2019-02-1-75 on July 27, 2022, and 340-00-3/2019-02-1-78 on February 22, 2023, to the MGSI, Sector for Inspection Supervision, Railway Traffic Inspection Department, requesting further action. In response, MGSI sent letters Nos. 340-06-399/2020-18-5 on July 29, 2022, and February 23, 2023, informing CINS that there were still no new developments regarding the lawsuit filed by "NCL Neo Cargo Logistic"d.o.o. with the Administrative Court in Belgrade to annul the second-instance decision, meaning the case before the Administrative Court was still pending.

CINS regularly informed the owners of the wagons and the persons responsible for maintenance (ECM) about the progress of the investigation.

The company for the production of mineral fertilizers, Elixir Zorka – Mineralna đubriva d.o.o. Šabac, as the second involved party (wagons renter and goods owner) or an interested party, addressed CINS with letter No. 231027-0002 dated October 27, 2023, with the aim of resolving the issue. The correspondence states that a bankruptcy proceeding has been initiated against the company "NCL Neo Cargo Logistic"d.o.o. based on the Decision of Case No. 8 St 205/2022 dated November 9, 2022, of the Commercial Court in Belgrade. Due to this, it is clear that "NCL Neo Cargo Logistic"d.o.o. cannot fulfil the order contained in the Decision No. 340-06-082/2020-18 dated October 16, 2020, from the Ministry of Construction, Transport and Infrastructure, Sector for Inspection Supervision, Railway Inspection Department. The legal proceeding conducted before the Administrative Court in Belgrade has been discontinued. Additionally, the company "NCL Neo Cargo Logistic"d.o.o. has had its License for Transport in Railway Traffic revoked by the Decision No. 340-742/2022 dated June 27, 2022, of the Directorate for Railways. In light of these developments, the company for the production of mineral fertilizers, Elixir Zorka – Mineralna đubriva d.o.o. Šabac, has proposed to take over all the obligations of "NCL Neo Cargo Logistic"d.o.o. and has received the consent of the owners of the vehicles and persons responsible for maintenance (ECM) to conduct the inspection and testing of the vehicles at an authorized certified workshop.

Considering the proposal from the company Elixir Zorka – Mineral Fertilizers d.o.o. Šabac, CINS sent letters No. 340-00-3/2019-02-1-82 dated November 1, 2023, and No. 340-00-3/2019-02-1-85 dated January 10, 2024, to the Ministry of Construction, Transport and Infrastructure (MGSI) to inform them about the proposal from Elixir Zorka – Mineral Fertilizers d.o.o. Šabac. In response, MGSI sent letter No. 340-01-00541/2020-04/2 dated March 13, 2024, confirming that MGSI considers the proposal from Elixir Zorka – Mineral Fertilizers d.o.o. Šabac, submitted in letter No. 231027-0002 dated October 27, 2023, to be acceptable. CINS immediately informed Elixir Zorka – Mineral Fertilizers d.o.o. Šabac about this via letter No. 340-00-3/2019-02-1-90 dated March 25, 2024. Following this, further actions were taken to implement the measures required by the Decision No. 340-06-082/2020-18 dated October 16, 2020, from MGSI, Sector for Railway Traffic Inspection, Section for Railway Inspection Affairs. The inspection of the involved vehicles was carried out in June 2024 (on June 12, 13, and 14, 2024) at FŽV "Želvoz"d.o.o., Smederevo. This allowed for the continuation of the railway traffic investigation conducted by CINS.

4. Analysis and conclusions

4.1. Final review of the course of events and making conclusion on the event based on the facts determined during investigation and examination

According to the documentation provided by "IŽS"a.d., train No. 52770 passed through the Svrljig station on February 13, 2019, at 23:40 (recorded in the traffic log of the Svrljig station). The train was pulled by locomotive 661-318 and consisted of 14 (fourteen) tanks, series Z, loaded with dehydrated ammonia.

The accident occurred on February 14, 2019, at 01:45, at km 55+252 on the regional railway line Crveni Krst - Zaječar - Prahovo Port, during the train's journey between Svrljig and Knjaževac stations. On a concrete bridge between tunnels No. 21 and 22, at the end of a right-hand curve (looking in the direction of travel), with a radius of 250 m, 5 (five) tanks of series Z derailed. After derailing, the train continued for another 83 m before coming to a stop. All the derailed wagons remained on the tracks on their wheels. There was no tilting or overturning of the derailed cars. There was no leakage of the cargo (dehydrated ammonia). The track was damaged over a distance of 50 m. Following the accident, based on the MGSI Decision No. 340-06-62/2019-18 from February 14, 2019, the telegram from "IŽS"a.d. No. 82 from February 14, 2019, announced the closure of a section of the regional railway line No. Crveni Krst - Zaječar - Prahovo Port, between the stations Crveni Krst and Zaječar, for traffic.

4.2. Discussion - analysis of facts determined during the investigation with the aim of drawing conclusions about the accident causes

4.2.1. Overview of the derailed wagons and track condition on the site

On February 14, 2019, representatives of the CINS went to the site of the accident. The general condition of the railway vehicles at the scene of the accident is described in section 3.4.4.

The analysis also uses data and documentation obtained from other participants in the investigation, as well as documentation and photographs taken during subsequent inspections of the derailed vehicles.

The train was traveling in the direction of increasing stationing. In the analysis, the orientation "left" or "right" is used, as well as the sequence of axles of the individual wagons, relative to the direction of travel. In the photographs, the direction of movement before the accident is shown by a white arrow. Red arrows on the images mark the details relevant for the analysis. The sequence of the sleepers is marked by yellow numbers, starting from the location of the first observed trace of the wheel leaving the sleeper, which is marked as No. 0 ("zero" sleeper). Sleepers before the zero point are numbered in order as -1, -2, -3…, while rails after the zero point, in the direction of train movement, are numbered 1, 2, 3… The sequence of cars in the train composition is marked with red numbers on the images.

A detailed inspection of the track in the area of the accident was carried out to find the first traces of the derailment. In Figure 4.2.1.1, the location at km 55+252 is shown, where the first trace of wheel slippage across the head of the inner rail, in the direction of entry into the track, was observed at rail "0". This trace is shown in greater detail in the enlarged portion of Figure 4.2.1.1.

A detailed inspection of the track in the accident zone was carried out to find the first traces of derailment. In Figure 4.2.1.1, the location at km 55+252 is shown, where the first trace of wheel

slippage across the head of the inner rail, in the direction of entry into the track, was observed at rail “0”. This trace is shown in greater detail in the enlarged portion of Figure 4.2.1.1.

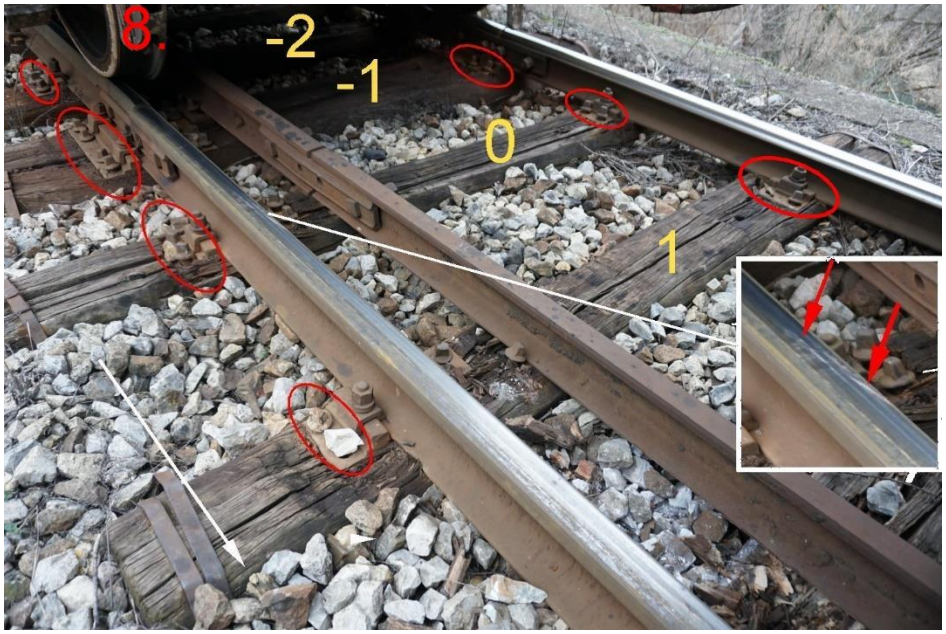


Figure 4.2.1.1: The first trace of wheel entry into the track and the condition of the sleepers and fastening equipment

a)

b)

Figure 4.2.1.2: First traces of damages from the entered wheel on the inner rail

Figure 4.2.1.2 a) shows the trace on the bolt where the wheel, upon entering the track, detached the nut from the fastening equipment of sleeper 1. Figure 4.2.1.2 b) shows the fastening equipment on the inner side of the inner rail, which was broken and torn out of sleeper 2 by the impact of the derailed wheel. Similar traces can be found on the fastening hardware of the following sleepers.

The illustration of the condition of the sleepers and fastening equipment in the derailment zone can be seen in Figures 4.2.1.1, 4.2.1.3, and 4.2.1.4. The sleepers have cracked and are rotting in the area of the fastening hardware, both in front and behind sleeper 0. Some fastening hardware is missing, and the screw bolts (tirphons) along the series of sleepers in the derailment zone are loose.

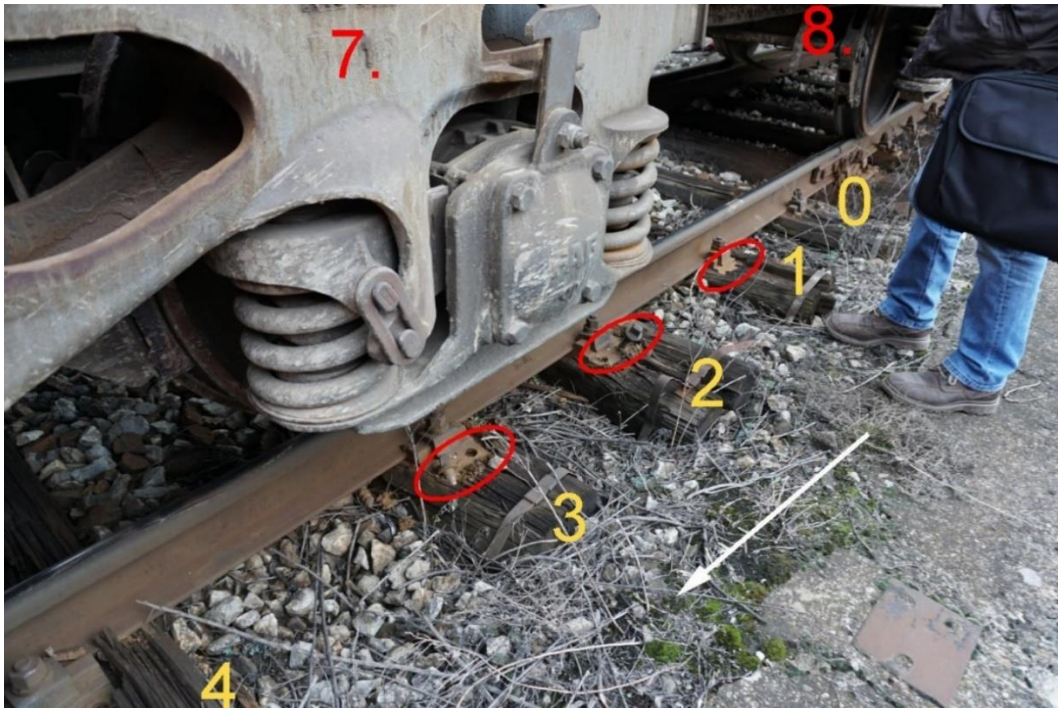


Figure 4.2.1.3: Derailment zone from the outside curvature side

On the outer rail, between the zero and third sleeper, there are no signs of the wheel climbing onto the rail. In Figure 4.2.1.3, the first traces of the wheel flange movement on the rail can be seen, starting from sleeper 3, approximately 2.1 meters after the inner wheel entered the track.

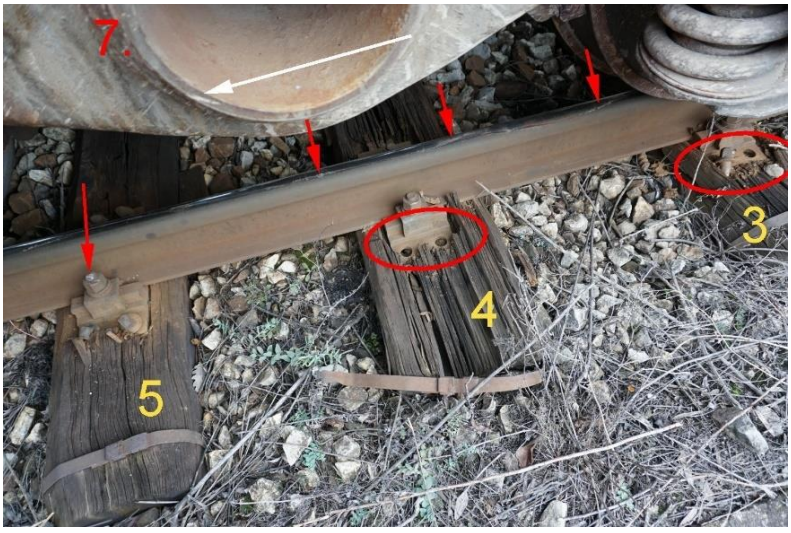


Figure 4.2.1.4: Signs of the wheel climbing onto the rail and derailment on the outer side

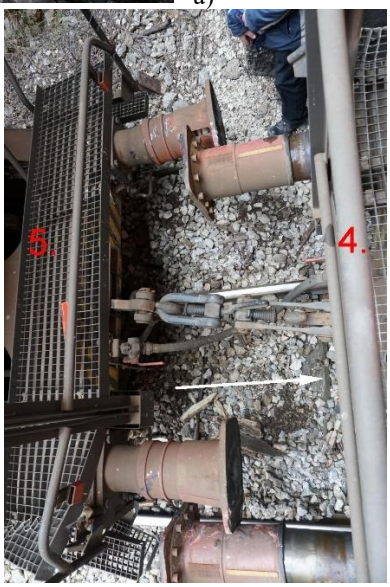
On the bolt of the fastening equipment, on the outer side of sleeper 5, the first damage from the sliding of the outer wheel is visible.

Following this, in the direction of travel, starting from sleeper 11 (approximately 7.7 meters behind the "zero" sleeper), both rails are separated from the sleepers with broken fastening equipment. The track is destroyed over a length of approximately 45 meters (see images from 3.4.4.1 to 3.4.4.3).

Figure 4.2.1.5 shows the condition of the buffers on the derailed wagons. The deformation of the front right buffer of the seventh wagon (Figure 4.2.1.5.a) indicates that this car hit the sixth car with great force. The relationship of the buffers between the sixth and fifth wagons (Figure 4.2.1.5.b) shows that the sixth wagon overtook the fifth during the accident. Similarly, Figure 4.2.1.5.c shows that the fifth wagon overtook the fourth wagon. Figure 4.2.1.5.d shows that the front left buffer of the fourth wagon was pushed under the buffer of the third wagon.

a)

b)



v)

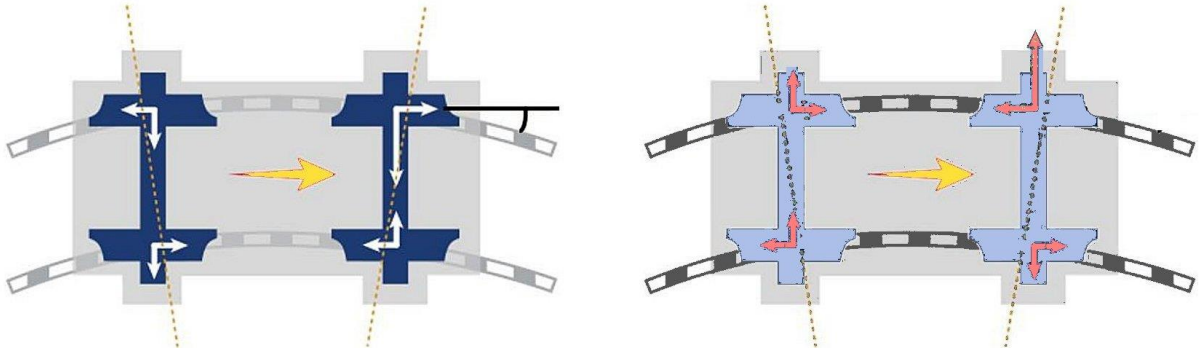
g)

Figure 4.2.1.5.: Relationship of the buffers of the derailed wagons

The third wagon in the composition is the first in the direction of travel with derailed axles. In this case, the first and second axles derailed, while the third and fourth axles remained on the tracks with all their wheels.

In the case of classic bogies, such as those on the derailed wagons (type Y25), Figure 4.2.1.6.a) schematically shows the forces in the horizontal plane acting on the wheels of the bogie. The forces opposite to those shown are acting on the track as reactions (Figure 4.2.1.6.b)). It can be observed that the transverse reactions from the leading axle on the rails are acting in the direction of rail displacement. This is not the case with the second axle.

On the rear bogie of the wagon, due to the opposite direction of the torque between the chassis and the bogie, the transverse guiding force on the leading axle is smaller. Therefore, the most unfavourable conditions for derailment occur on the first axle of the front bogie.



a) b)

Figure 4.2.1.6: Longitudinal and transverse forces in a curve between the wheelsets of the bogie and the rails

Given the details provided:

- The mutual position of the buffers of the derailed wagons — the fourth, fifth, sixth, and seventh wagons were chasing the third wagon during the derailment.
- The wheels of the rear bogie remained on the track — despite the derailment of the first two axles, the track had not yet been damaged enough to cause the other axles to derail.
- In the curve, the forces acting on the first axle of the wagon had the greatest impact in the direction of track expansion.

It can be concluded that the first axle of the third wagon likely initially derailed into the track. Subsequently, due to the transverse forces of the spread track, the left wheel of this axle climbed and derailed on the outer side of the left rail. After this, as the track became increasingly damaged, the remaining four wagons derailed until the train came to a stop.

4.2.2. Train braking

During the on-site inspection, it was determined that on the fourth wagon, No. 33 80 7818 085-2, and on the ninth wagon, No. 33 80 7918 799-7, there has been put a list was due to faulty brakes. The brakes on these wagons were turned off. All other wagons were found to have brake gear set to the “P” position and braking force gear set to the “freight” position.

In the freight list for train No. 42010 from 09.02.2019, which travelled from the state border through the Dimitrovgrad station to the Crveni Krst station and then continued from Crveni Krst

towards Prahovo as train No. 52770, which was submitted by the undertaking "NCL Neo Cargo Logistics"d.o.o. the total gross weight of the hauled composition was 991 tons, and the total braking weight of all engaged brakes was 712 tons, giving a braking weight percentage (λ) of 72%. This percentage is higher than the minimum required by the Train Operation Booklet 7.1, which was in effect at the time of the accident, and which for train No. 52770 was 58%.

After the accident, a control weighing of thirteen wagons from the composition was performed at the Niš marshalling station by "IŽS"a.d. The control weighing of the fourteenth wagon was conducted in Prahovo at the receiver Elixir Group d.o.o. The deviations in the control weighing data compared to the freight list were within the scale accuracy limits and did not indicate any irregularities in the loading of the wagons.

No irregularities or indications were found that would suggest that braking or loading of the train had any impact on the occurrence or consequences of the accident.

4.2.3. Traction-buffer devices

At the scene, no deficiencies were found regarding the condition of the traction and buffer devices that would be relevant to the accident.

The derailment occurred in a sharp curve with a radius of 250 m. Any potential deviation in the elastic characteristics of traction and buffer devices between the first derailed wagon and the wagon in front of it, in terms of generating excessive longitudinal forces due to the compression of the inner buffer and the tightening of the coupler in the curve, could have contributed to the accident by significantly increasing the guiding forces in the curve. Therefore, the CINs instructed that, at a later stage, the characteristics (force-deflection diagram) be recorded in the workshop for:

- The buffer at housing No. 7 of the first derailed wagon 33 87 7814 136-0 and the traction device on that side of the wagon,
- The buffer at housing No. 1 of the wagon No. 33 87 7813 566-9, which was positioned in front of the first derailed wagon, and the traction device on that side of the wagon.

4.2.4. Bogies

At the scene, no defects were identified on the bogies that could have clearly contributed to the accident and its consequences.

Considering that the accident occurred in a sharp curve, CINS ordered the disassembly of both bogies of wagon No. 33 87 7814 136-0 in the workshop and an inspection of the condition of the bogie bowls and lateral slides. The purpose of the inspection is to verify their proper condition and to detect any signs of wear that could significantly increase the rotational resistance between the wagon body and the bogie, thereby substantially affecting the increase in guiding forces in the curve.

It was also ordered that the workshop perform control measurements of the key dimensions of the wheel profile and axle assemblies, as well as identify any other defects that might have been crucial to the occurrence of the accident and its consequences.

4.2.5. Documentation review on derailed wagons maintenance

For all derailed wagons listed in Table 4.2.5.1, the documentation provided by the car owners at CINS's request was reviewed. According to the submitted documentation:

- All derailed wagons had authorization for use.
- All wagons were maintained within the prescribed intervals.
- At the time of the accident, all wagons were within the specified maintenance intervals.
- Since the last overhaul, there had been no extraordinary repairs on the wagons.
- No maintenance deviations were identified that could have influenced the accident under investigation.

Table 4.2.5.1: Data on periodic maintenance of derailed wagons

Unique wagon No.	Owner	Last revision documentation (month/year)	Next revision of the wagons (month/year)	Next revision of the wagon tank	Extraordinary repairs since the last revision
33 87 7814 136-0	*ERMEWA*	3/15	3/19	3/19	No
33 80 7818 085-2	*ATIR- RAIL*	10/17	10/21	10/21	No
33 80 7818 094-4	*ATIR- RAIL*	12/17	12/21	12/21	No
33 87 7813 564-4	*ATIR- RAIL*	10/17	10/21	10/21	No
33 87 7816 547-6	*ERMEWA*	6/15	12/22	12/20	No

Based on the stated, the wagons were maintained in accordance with the applicable regulations.

4.2.6. Wagon check in the workshop

When the conditions for continuing the investigation were met (the course of the investigation is described in section 3.8), five years and four months after the accident, an inspection of the derailed wagons was conducted at FŽV "Želvoz"d.o.o, Smederevo.

On June 12, 2024, the following measurements and inspections were carried out:

1. For wagon No. 33 87 7814 136-0:

- Measurement of the key dimensions of wheels and axle assemblies,
- Lifting and inspection of bogie bowls and side bearers,
- Recording the characteristics of the coupling device on the side of bearing Nos. 7-8, and
- Recording the buffer characteristics at housing No. 7.

2. For wagon No. 33 80 7818 085-2:

- Measurement of the key dimensions of wheels and axle assemblies, and
- Lifting and inspection of bogie bowls and side bearers.

On June 13, 2024, the following measurements and inspections were conducted:

1. For wagon No. 33 87 7813 566-9:

- Recording the buffer characteristics at bearing No. 1,
- Recording the characteristics of the coupling device at bearings No. 1-2,

- Lifting and inspection of bogie bowls and side bearers, and
- Measurement of the key dimensions of wheels and axle assemblies.

2. For wagon No. 33 87 7813 564-4:

- Measurement of the key dimensions of wheels and axle assemblies.

3. For wagon No. 33 80 7818 094-4:

- Measurement of the key dimensions of wheels and axle assemblies.

On June 14, 2024, the following measurements and inspections were conducted:

1. For wagon No. 33 84 7813 021-4:

- Measurement of the key dimensions of wheels and axle assemblies.

2. For wagon No. 33 87 7816 547-6:

- Measurement of the key dimensions of wheels and axle assemblies.

All characteristic measurements of the wheels and axle assemblies were within the allowed limits.

Upon inspection of the center bowls and side bearers, it was found that on the bogie at housings 7 and 8 of wagon No.33 87 7814 136-0, there were cracked and partially broken sections at the upper and lower ends of the bogie bowl insert. No signs of friction between metal parts were observed on either the upper or lower bogie bowls (see images 4.2.6.1 and 4.2.6.2.), which means that the insert was still functional and could not have influenced the accident. At the time of the accident, the car was within the last month before its next scheduled overhaul.

Figure 4.2.6.1: The condition of the lower center bowl on wagon No. 33 87 7814 136-0 at housings 7 and 8

Figure 4.2.6.2: The condition of the upper center bowl and side bearers on wagon No. 33 87 7814 136-0 at housing 7 and 8

The other inspected center bowls and their inserts showed no defects that could have influenced the accident.

Figure 4.2.6.3: Lower side bearers of the wagon No. 33 87 7814 136-0 at housing 7

All inspected inserts of the lower side bearers were found to be within the permissible wear limits (example shown in image 4.2.6.3.). There were no signs of wear or defects on the upper or lower side bearers that could have had an impact on the accident or its consequences.

At the request of CINS, static force-deflection diagrams were recorded for the buffers at housings 7 of the first derailed wagon No. 33 87 7814 136-0 and at housing 1 of the wagon No. 33 87 7813 566-9, which was in front of it. These two buffers were in contact at the point of the derailment, functioning as buffers on the inner side of the curve. The recorded characteristics are shown in image 4.2.6.4. (Note: The “ideal” characteristic provided by the software does not correspond to the tested type of buffer and does not affect the measurement record).

The recorded characteristics of the coupling devices at the interface ends of wagon Nos. 33 87 7814 136-0 and 33 87 7813 566-9 are shown in image 4.2.6.5. (Note: The “ideal” characteristic

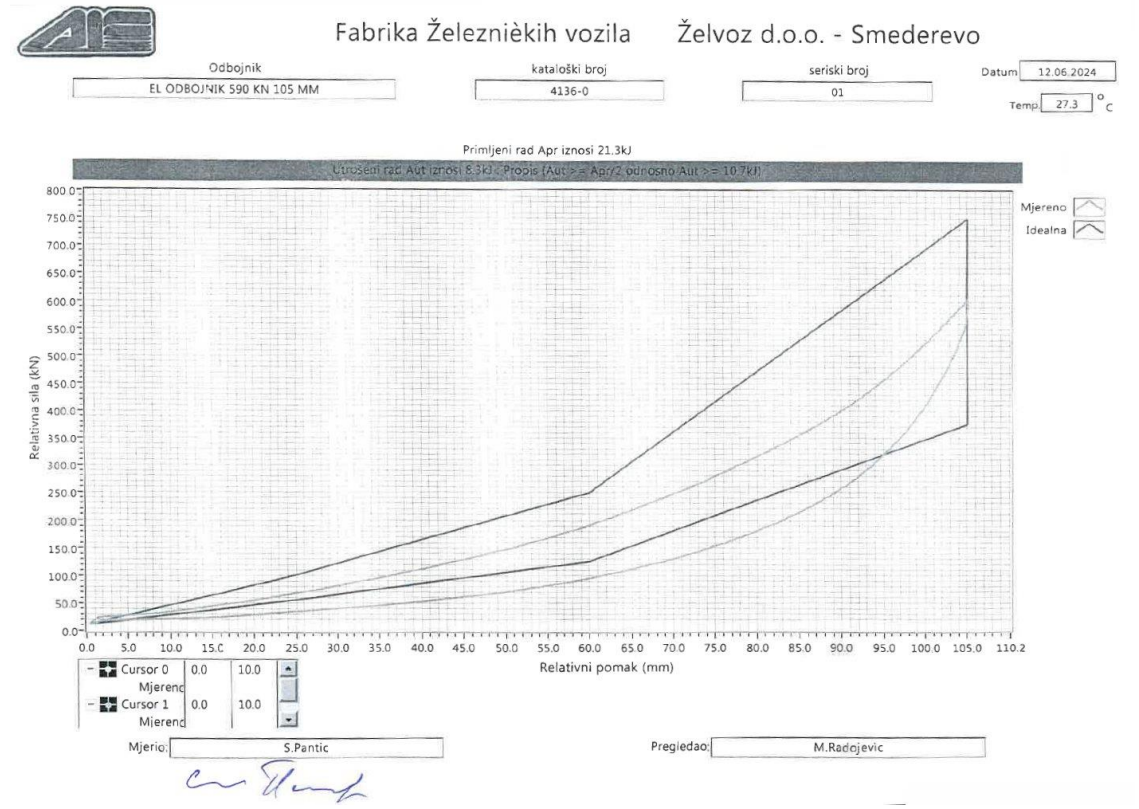
provided by the software does not correspond to the tested type of buffer and does not affect the measurement record).

For the curve position where the accident occurred, it is significant that the forces in the static compression cycle fall within the prescribed limits for deflections up to 60 mm according to EN 15551 for buffers and during the extension cycle according to EN 15566 for the coupling device. Table 4.2.6.1. provides an overview of the prescribed and measured characteristics.

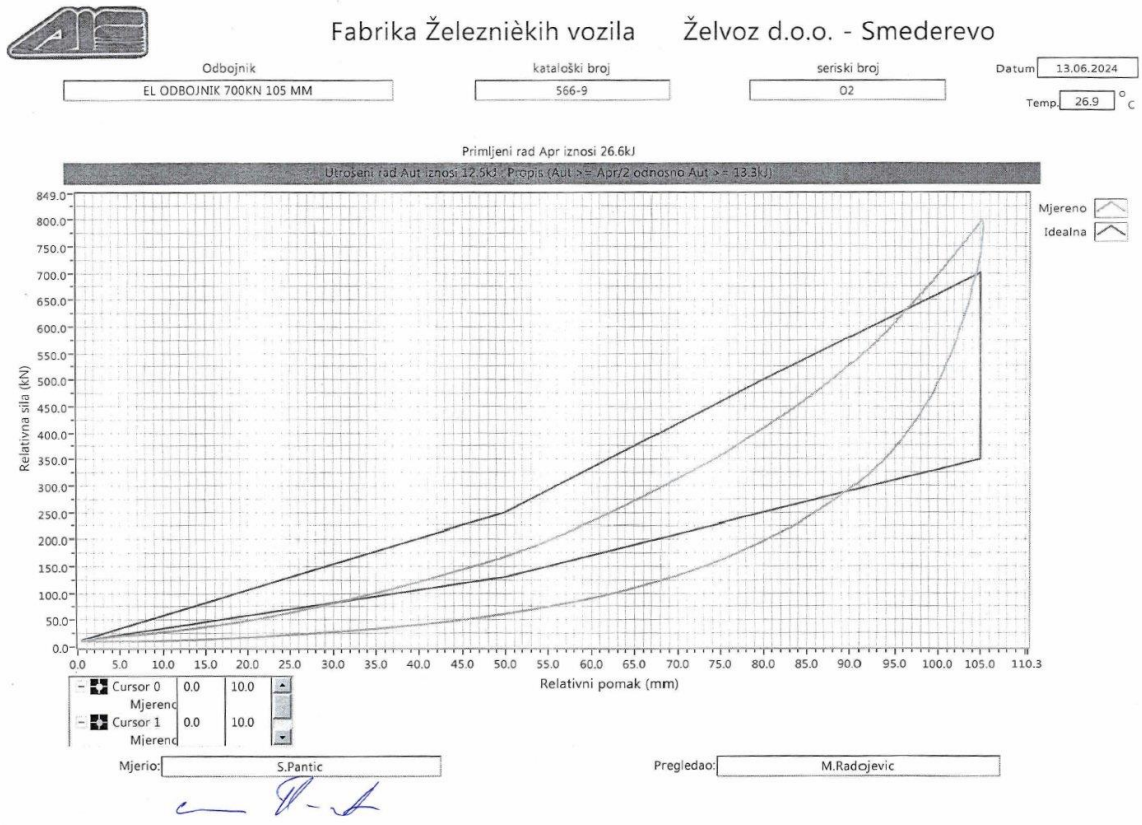
It can be concluded that the measured characteristics were within the prescribed limits. No irregularities were observed that could have been the cause or could have worsened the consequences of the accident.

Table 4.2.6.1: Overview of the calculated and prescribed characteristics

Buffer stroke 105 *mm* *EN 15551*		Measured-Buffer at the housing 7	Measured-Buffer at the housing 1	Traction device *EN 15566*		Measured Wagon No. 33 87 7814 136-0	Measured Wagon No. 33 87 7813 566-9
stroke (*mm*)	force (*kN*)	force (*kN*)	Force (*kN*)	stroke (*mm*)	force (*kN*)	force (*kN*)	force (*kN*)
start	10-50	12	12	start	min. 10	30	30
25	30-130	70	67	50-60	min. 400	950	930
60	100-400	195	170				

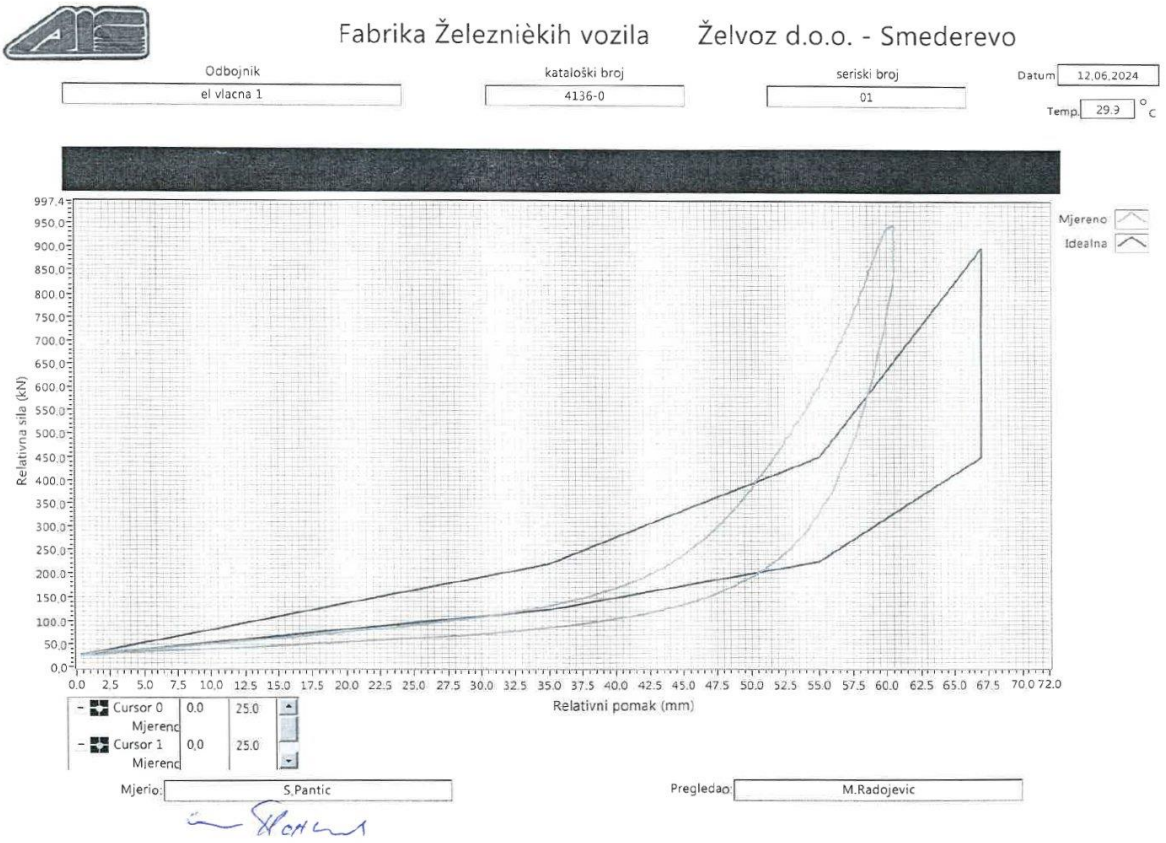


a)



b)

Figure 4.2.6.4: Force-deflection diagram at the contact with the derailed wagon No. 33 87 7814 136-0 and wagon in front, No. 33 87 7813 566-9



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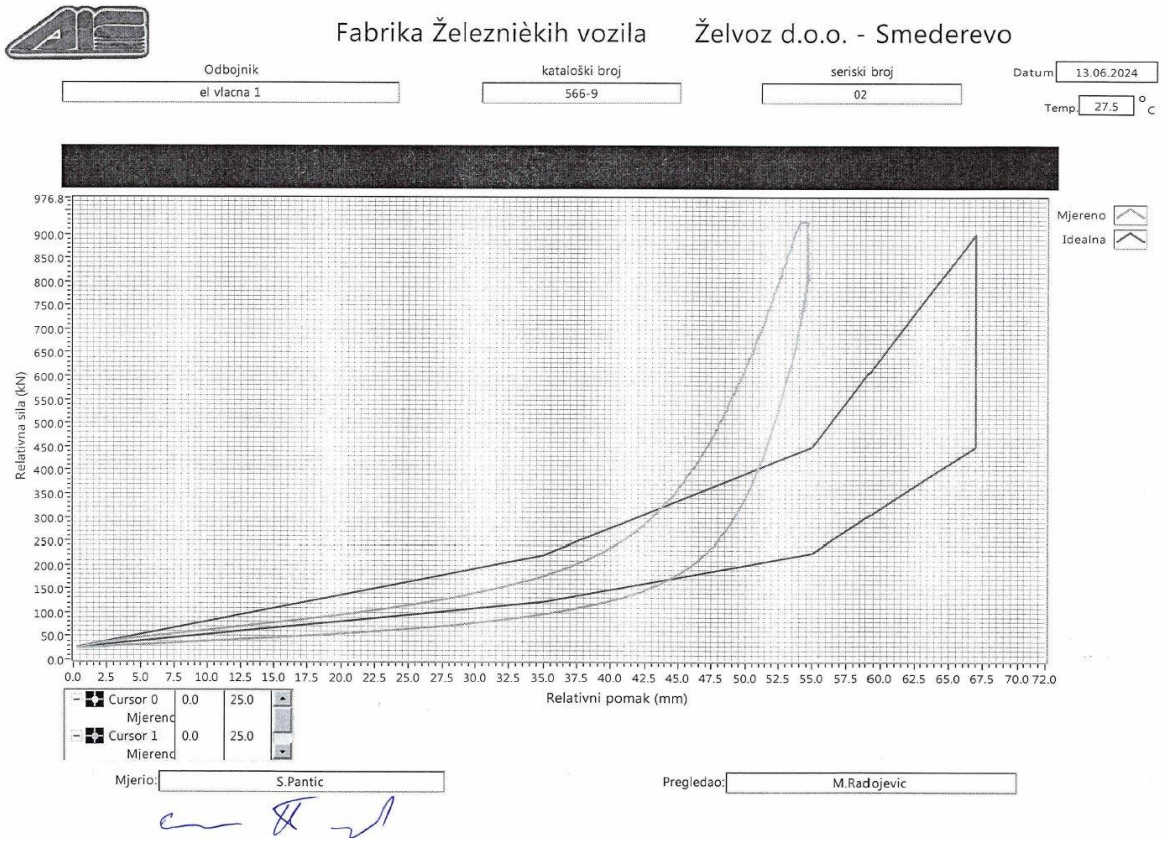


b)

Figure 4.2.6.5: Force-deflection diagram of the traction vehicles of the derailed wagon No. 33 87 7814 136-0 and the wagon in front, No. 33 87 7813 566-9

4.2.7. Speedometer record analysis

The locomotive 661-318 is equipped with an older type of speedometer, the "Hasler" type 9, which mechanically records data on a tape. A copy of the tape and the analysis of the records (Form EV 85, Appendix 1, No. 33/2019-161) were provided by the carrier "NCL Neo Cargo Logistic"d.o.o. The report stated that the time on the tape could not be determined because the train operator had not wound the clock. The absence of a time record on the tape does not affect the speed recording, which is independent of the clock.

According to the report, train No. 52770 was traveling at a speed of up to 22 km/h immediately before the accident (approximately at km 55+253), after which the speed dropped to 11 km/h (approximately at km 55+348), followed by a jerk at 16 km/h, and then the train abruptly stopped approximately at km 55+400.

It should be noted that the distance travelled on the tape is recorded such that 5 mm on the tape corresponds to 1 km of travelled distance. Considering the thickness of the recording line, it can be assumed that determining the distance with a measurement uncertainty smaller than 20 m is not feasible.

Independent of the tape records, the position of the first derailed axle of wagon No. 33 87 7814 136-0 can be determined from the photographs taken at the scene, in relation to the first track of the derailment. This distance is approximately 83 m.

The analysis of the speedometer tape data revealed no findings that could have had an impact on the occurrence of the accident or its consequences.

4.2.8. Track condition reports

The regional railway line from Crveni Krst to Zaječar to Prahovo Port was constructed in 1912 from km 3+455 to km 68+910 and in 1914 from km 68+910 to km 185+079 as a single-track, non-electrified line. The class of the track is O-I (other first-class tracks), and it belongs to category B2 (180.0 kN per axle and 64.0 kN per meter). According to the data from the OC ZOP Zaječar, the railway line was renovated in the following years:

1961: from km 12+079 to km 29+888 and from km 68+910 to km 81+906;
1962: from km 32+410 to km 67+534 and from km 81+906 to km 96+073;
1963: from km 84+984 to km 96+073 and from km 103+046 to km 110+929;
1964: from km 68+910 to km 84+984 and from km 96+073 to km 103+046.
In 1966, the railway line was renovated from km 110+929 to km 118+834;
In 1969, it was renovated from km 3+455 to km 12+079;
In 1982/83, renovations were carried out from km 17+480 to km 32+000.

The last track renovation took place in 1985, from km 12+100 to km 17+800, using new and refurbished materials.

The designed speeds for the sections of the railway line are as follows:
From km 3+455 to km 45+916: v = 65 km/h
From km 45+916 to km 61+105: v = 60 km/h
From km 61+105 to km 68+099: v = 65 km/h
From km 68+099 to km 86+935: v = 90 km/h
From km 86+935 to km 96+720: v = 65 km/h
From km 96+720 to km 97+177: v = 60 km/h

From km 97+177 to km 97+539: v = 85 km/h
From km 97+539 to km 98+659: v = 70 km/h
From km 98+659 to km 106+240: v = 85 km/h
From km 106+240 to km 108+126: v = 70 km/h
From km 108+126 to km 112+195: v = 75 km/h

The actual maximum speeds on the regional railway line: from km 3+455 to km 68+099 is *v*=40 km/h for passenger and *v*=30 km/h for freight traffic; from km 68+099 to km 112+195 is *v*=50 km/h for both passenger and freight traffic.

The minimum curve radius is R_{min}=240 m, and the maximum longitudinal gradient is 12.84 ‰.

The track is constructed with classic supported rail assemblies. The rail lengths are between 30 and 45 m, with rail types S45 (as shown in image 4.2.8.1.) and S49. In some station tracks, non-standard rails of type 8a are installed. At locations where the rail breaks and needs welding, floating assemblies are used (as shown in image 4.2.8.3.). In curves, to equalize the rail type across both tracks, the increased lateral and vertical wear of the rail head requires the replacement of rails over a total length of 18399 m.

On the section of the railway line from Matejevac to Knjazevac (from km 3+455 to km 95+000), out of 133,788 wooden sleepers installed between 1957 and 1985, 62,790 are rotten, accounting for 46.94% (poor rail-tie connection, as shown in image 4.2.8.4.). On the same section, track fittings of type “K” (rail fasteners with Tiffoni-type spikes, as shown in image 4.2.8.2.) have been installed, while on station tracks, the track fittings are non-standard, generally corroded, unlubricated, and not properly tightened.

The ballast is of limestone origin, and in some sections of the railway, due to the lack of embankments, it has eroded down slopes. There are areas of the track, particularly near level crossings, where the ballast is heavily muddied (over 50%, as shown in image 4.2.8.6.). In service areas, all tracks are overgrown with grass.

Due to the high percentage of rotten sleepers, occasionally poor connections between sleepers and rails, unsupported and floating rail assemblies, and muddied ballast, the track geometry is unsatisfactory.

The track is mainly maintained manually because machine work is hindered by the large number of rotten sleepers (“pockets” of rotten sleepers, as shown in image 4.2.8.5.) and the muddy ballast.

The line has 71 tunnels, with a total length of 21,559.41 meters, 95 bridges totalling 4,831 meters, 702 culverts, 243 switches, and 163 level crossings.

Figure 4.2.8.1: Appearance of the rail “*S45” ZENICA* VIII-61

Figure 4.2.8.2: The depiction of rail fastening with tirphones

Figure 4.2.8.3: The appearance of a floating assembly

Figure 4.2.8.4: Appearance of the rail-sleeper connection

Figure 4.2.8.5: Appearance of the pockets of rotten sleepers

Figure 4.2.8.6: Appearance of the ballast

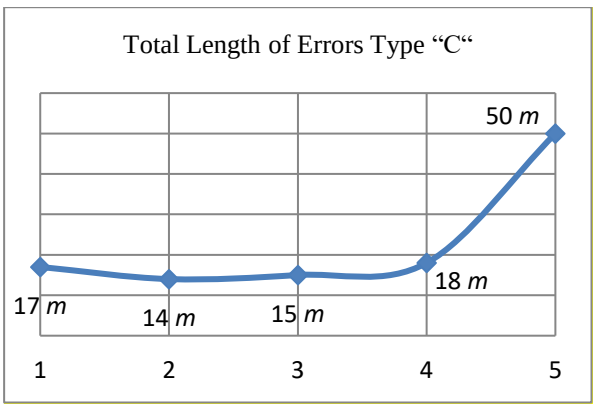
4.2.9. Track inspection coach record

From the delivered numerical record of track condition measurements conducted by the track inspection coach on the section Crveni Krst – Zaječar from km 3+455 to km 111+733, it can be concluded:

a) In the derailment zone of train No. 52770 (km 55+252), within the summary report section from km 55+000 to km 56+000, the number of "C" type defects increased by 50% as of May 15, 2018, compared to the measurements from May 17, 2017, while the length of the defects increased by 194%.

Table 4.2.9.1: Length and number of type "C" defects during time from km 55+000 to km 56+000

	Section of the route Crveni Krst - Zaječar from km 55+000 to km 56+000				
		Errors Type "B"		Error Type *"C"*	
Serial No.	Measurement Date	Length [*m*]	No.	Length [*m*]	number
1	20.11.2014.	**229**	**84**	**17**	**6**
2	06.10.2015.	**250**	**97**	**14**	**6**
3	15.11.2016.	**266**	**90**	**15**	**7**
4	17.05.2017.	**260**	**96**	**18**	**8**
5	15.05.2018.	**256**	**83**	**50**	**12**



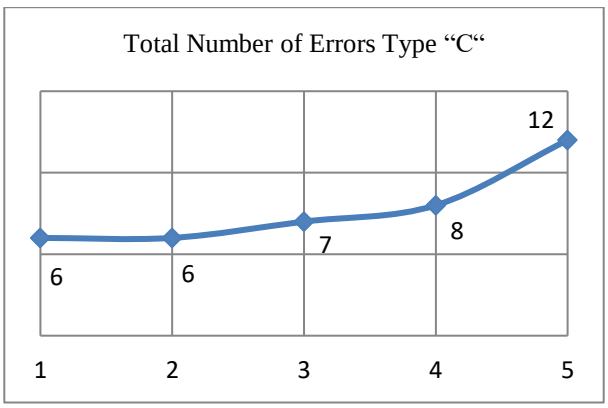


Figure 4.2.9.1: Overview of the length and number of type "C" defects during time from *km 55*+000 to *km 56*+000

```
<<<SUMMARY>>>  KM  55.000   TO   56.000  =  947M

====CLASS: 4   =====A=====  =====B=====  =====C=====
PARAMETER      LEN(M) #DEF  LEN(M) #DEF  LEN(M) #DEF
STABILNOST-L     235    62     57    18      3     1
STABILNOST-D     249    71     50    14      0     0
SMER-LEVO          8     2      0     0      0     0
SMER-DESNO        14     3      0     0      0     0
PROSIRENJE       430    30     53     8     17     2
SUZENJE           62    13     18     6      0     0
NADVISENJE       277    51    141    28     38     6
NADV. > 150mm      0     0      0     0      0     0
VITO. 3.5m       147    51     26     9      9     3
TOTAL            772   283    256    83     50    12
================================================
```

Figure 4.2.9.2: Part of analytical record of track inspection coach from 15.05.2018.

b) On the railway section from km 3+455 to km 111+733, within the summary report, the number of "B" type defects increased by 45% as of May 15, 2018, compared to the measurements from April 9, 2014, while the length of the defects increased by 37%. At the same time, the number of "C" type defects increased by 121%, and the length of the defects increased by 135%, compared to the measurements from April 9, 2014.

Table 4.2.9.2: Length and number of type "C" defects during time from km 3+455 to km 111+733

Section of the route Crveni Krst - Zaječar from km 3+455 to km 111+733					
Serial No. of the measu-rement	Measurement Date/ Section	Error Type *"B"*		Error Type *"C"*	
		Length [*m*]	number	Length [*m*]	number
1	09.04.2014.				
	Crveni Krst - Podvis	10302	3582	795	248
	Podvis -Zaječar	7487	2391	316	109
	Total:	**17789**	**5973**	**1111**	**357**
2	20.11.2014.				
	Crveni Krst - Podvis	9795	3572	666	229
	Podvis -Zaječar	8702	2591	424	139
	Total:	**18497**	**6163**	**1090**	**368**
3	06.10.2015.				
	Crveni Krst - Podvis	11456	4387	837	338
	Podvis -Zaječar	9143	2787	450	172
	Total:	**20599**	**7174**	**1287**	**510**
4	15.11.2016.				
	Crveni Krst - Podvis	2333	834	258	92
		10845	4029	742	295
	Podvis -Zaječar	9981	3033	486	172
	Total:	**23159**	**7896**	**1486**	**559**
5	17.05.2017.				
	Crveni Krst - Podvis	12125	4616	872	329
	Podvis -Zaječar	9743	3125	431	176
	Total:	**21868**	**7741**	**1303**	**505**

Section of the route Crveni Krst - Zaječar from km 3+455 to km 111+733					
Serial No. of the measu-rement	Measurement Date/ Section	Error Type *"B"*		Error Type *"C"*	
		Length [*m*]	number	Length [*m*]	number
6	15.05.2018.				
	Crveni Krst - Podvis	13644	4919	1658	522
	Podvis -Zaječar	10780	3598	958	268
	Total:	**24424**	**8517**	**2616**	**790**

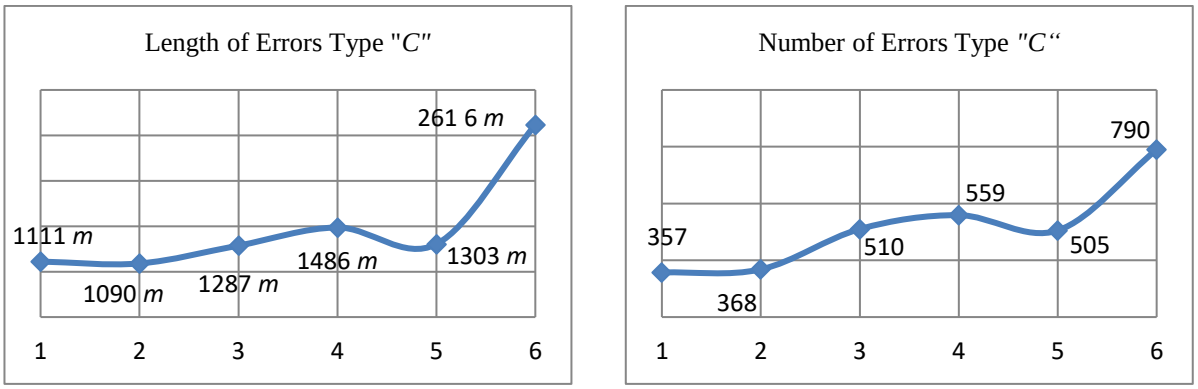


Figure 4.2.9.3: Overview of the length and number of type "C" defects during time from km *3*+455 to *km 111*+733

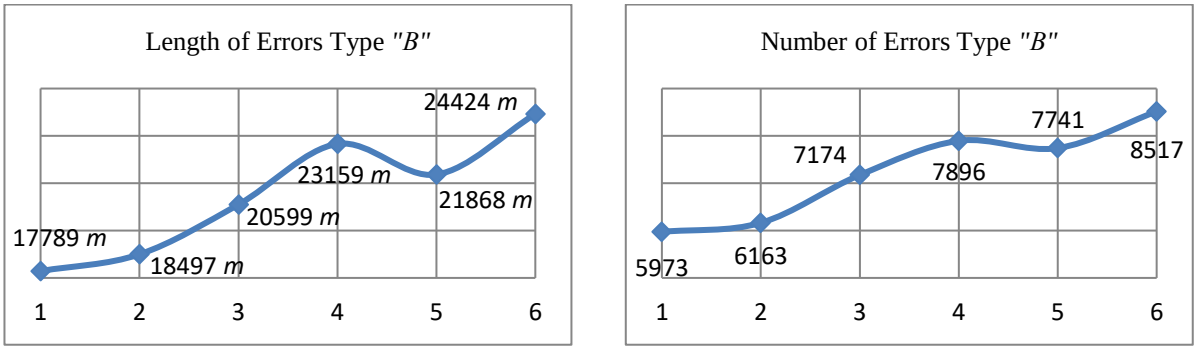


Figure 4.2.9.4: Overview of the length and number of type "B" defects during time from *km 3*+455 to *km 111*+733

Based on the Instruction on Unique Criteria for Railway Track Condition Monitoring on the JŽ network, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004), which was valid at the time of the accident, and according to the measurement records from May 15, 2018, the track in the derailment zone (km 55+252) was not in satisfactory condition.

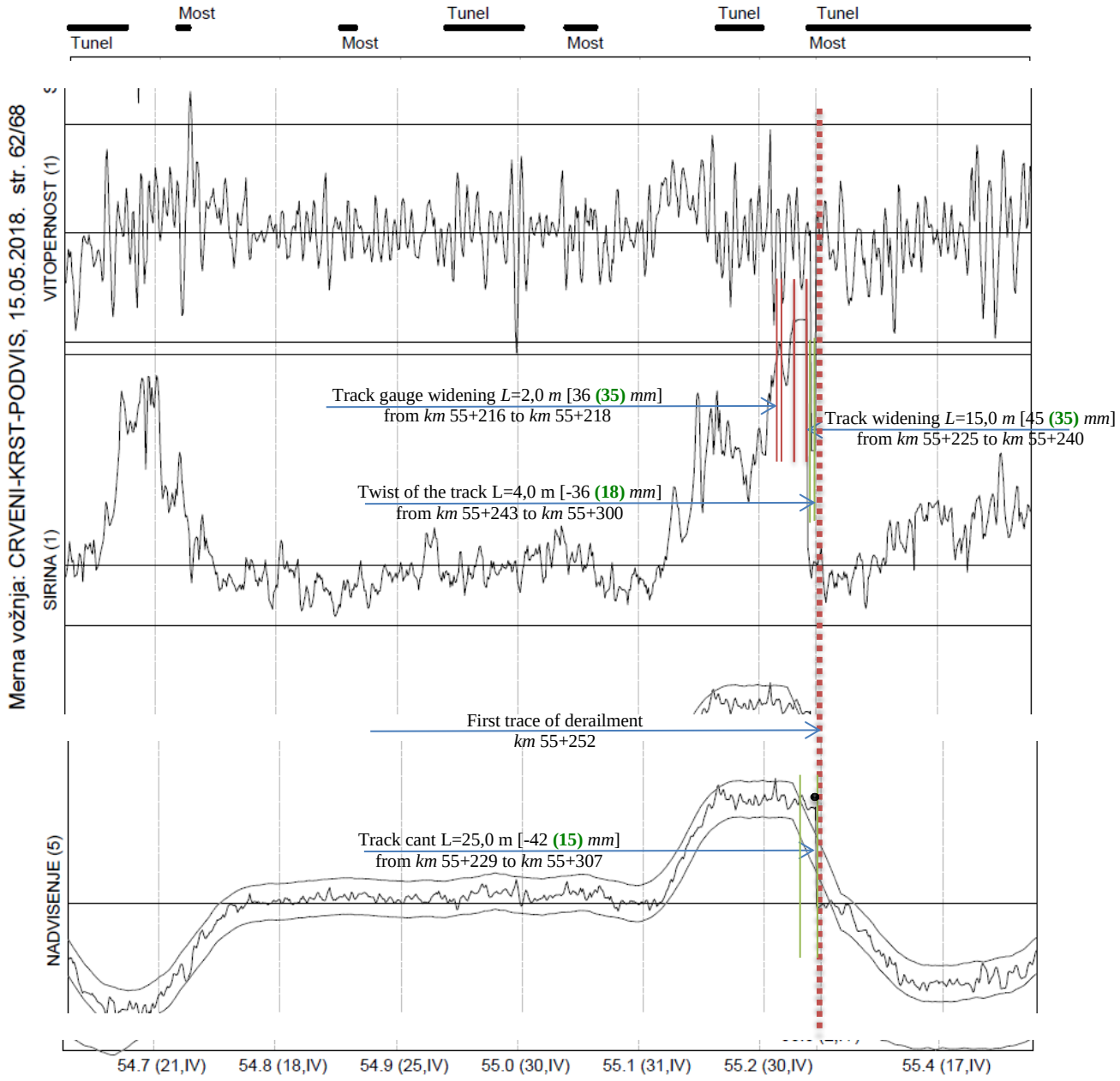
It is unacceptable for the track condition, defined in Section 9 of Instruction 339 (see Section 3.3.5) as "unsatisfactory," as well as defects exceeding operational limits that endanger traffic safety, to be tolerated or "addressed" merely by reducing the permitted speed.

Figure 4.2.9.5 illustrates an excerpt of the graphical and numerical record from the track inspection coach in the critical track zone as of May 15, 2018. It shows that, in the area immediately preceding the derailment site, the track gauge was widened by 40 mm (exceeding the operational limit of 35 mm). At the derailment site, the super-elevation abruptly decreases,

resulting in a warp twice as large as the operational limit. These sudden changes, even assuming they were not correctly recorded due to the impact of the measurement train, indicate a severe deviation in track geometry in the derailment zone, which required immediate and thorough inspection and correction.

In correspondence No. 20/2018-3.3 dated May 23, 2018, from the Section OC ZOP Zaječar addressed to the Head of the Matejevac Track Section, following an analysis of the May 15, 2018, measurement run, it was instructed that the Head of the Track Section, together with the track supervisor, personally analyse the identified defects related to warp and stability through on-site measurements and immediately rectify the observed deficiencies. Parameters such as gauge widening, narrowing, super-elevation, and track alignment were to be urgently addressed based on priorities in coordination with OC ZOP Zaječar.

In the Appendix to the Letter No. 20/2019-3.3-247, dated April 1, 2019, titled “Data Delivery on Train Derailment No. 52770 (km 55+252)”, the section on measurement runs does not indicate that the defects identified during the track inspection coach survey of the Crveni Krst – Zaječar section in the derailment zone were rectified. Considering that nine months had elapsed between the measurement run and the accident, it can be assumed that the track parameters at the time of the accident were worse than during the measurement run.



Tunel START	54939	END 55002	LEN 63			
Most START	55039	END 55063	LEN 24			
KM 55.126	KRIVINA					
NADVISENJE	55.161	55.163	2	17MM08 162	15MM 4 5 C R	
Derail Rear 55.164						
KM 55.174	TANGENT					
Vertical Pressure Off 55.174						
Vertical Pressure Off 55.176						
Tunel START	55165	END 55202	LEN 37			
PROSIRENJE	***55.216***	***55.218***	***2***	***36MM 68***	***216***	***35MM 4 5 T***
Derail Center 55.230						
PROSIRENJE	***55.225***	***55.240***	***15***	***40MM77 229***	***35MM 4 5 T***	
Most START	55241	END 55297	LEN 56			
KM 55.297 LOCATION CHANGE: OLD LOCATION> KM 55.243						
VITO. 3.5m	***55.243***	***55.300***	***4***	***-36MM00***	***243***	***18MM 4 5 T***
NADVISENJE 55.229		***55.307***	***25***	***-42MM51***	***297***	***15MM 4 5 T***

Figure 4.2.9.5: Graphic and numeric excerpt from track inspection coach record from 15.05.2018.

Table 4.2.9.3: Analysis and operational plan of rectifying the defects from *km 55*+000 to *km 56*+000

ANALIZA								
GREŠAKA NAĐENIH MERNIM KOLIMA **EM 80L DANA 15.05.2018.**								
U PRUŽNOJ DEONICI **MATEJEVAC**								
Re. br.	TIP GREŠKE	KM položaj		Veličina greške	Uzrok	Datum otklanjanja	Mere u koloseku	
							Pre rada	Posle rada
466	NADVISENJE	55,161	55,163	17MM08				
467	PROSIRENJE	55,216	55,218	36MM68				
468	PROSIRENJE	55,225	55,240	40MM77				
469	VITO. 3.5m	55,243	55,300	-36MM00				
470	NADVISENJE	55,229	55,307	-42MM51				
471	STABILNOST-L	55,502	55,505	23MM62				
472	NADVISENJE	55,534	55,536	-17MM82				
473	VITO. 3.5m	55,590	55,593	-25MM96				
474	NADVISENJE	55,591	55,594	-16MM82				
475	NADVISENJE	55,648	55,652	-18MM96				
476	NADVISENJE	55,659	55,661	18MM57				
477	VITO. 3.5m	55,663	55,665	-22MM65				

OPERATIVNI PLAN								
otklanjanja grešaka po nalazu mernih kola **EM-80L od 15.05.2018.** - **DEONICA MATEJEVAC-KNJAŽEVAC**								
vrste greške : VITOPERNOST								
R. br.	TIP GREŠKE	Opis radova	KM položaj - mesto rada		VELIČINA GREŠKE	Rok završetka radova	Radovi izvršeni	Radovi evidentirani
145	VITO. 3.5m		55,243	55,300	-36MM00	30-06-18		
146	VITO. 3.5m		55,590	55,593	-25MM96	30-06-18		
147	VITO. 3.5m		55,663	55,665	-22MM65	30-06-18		

Analysing the measurement reports from May 15, 2018, the OC ZOP Zaječar, through Letter No. 20/2018-3.3-286 dated June 1, 2018, requested instructions from the Civil Works Sector to address the recorded defects. The letter stated that a comparison of the numerical reports from the measurement runs conducted in May 2017 and May 2018 on railway line No. 216 from Crveni Krst to Prahovo Pristanište revealed an increase in the total number of "C" group defects requiring urgent rectification. Parameters such as track stability, gauge widening, super-elevation, and warp had increased, while the number of gauges narrowing defects had decreased. The worst condition on the railway from Crveni Krst – Zaječar – Prahovo Pristanište is between Crveni Krst station (km 3+455) and Tabakovačka reka stop (km 138+764), which, according to the track condition monitoring criteria, falls under Category IV (speed less than 60 km/h) and Category III (speed equal to 60 km/h). The increase in warp defects, gauge narrowing, gauge widening, and deformations on this section of the Crveni Krst – Zaječar – Prahovo Pristanište railway occurred due to:

- Due to the large number of decayed sleepers and the inability to regulate the track on this section of the railway with the current workforce and available machinery,
- Due to the contamination of the ballast prism,
- Due to the increase in freight traffic on the section between Prahovo Pristanište port and Niš station.

On the Crveni Krst – Knjaževac railway section, the current speed limits are 30 km/h for freight traffic and 40 km/h for passenger traffic. Further speed reduction would jeopardize passenger traffic operations due to engine and gearbox overheating caused by low speeds in DMK Series 710 trains. Additionally, there is the issue of improper super-elevation in curves for such low speeds.

It was also noted that planning more substantial works in OC ZOP Zaječar is challenging (254 km of open track, complex terrain, including 71 tunnels (total length: 21559.41 m), 95 bridges (total length: 4831 m), 702 culverts, 243 switches, and 163 level crossings) with only 13 track workers and 7 track patrollers, distributed as follows:

- Matejevac - Knjaževac section: 2 track workers and 2 track keepers,
- Zaječar - Negotin section: 3 track workers and 2 track keepers,
- Vlaole - Bor section: 6 track workers and 3 track keepers,
- Section for slope maintenance: 2 track workers.

Hazardous materials such as phosphoric acid, nitric acid, sulfuric acid, and ammonia are transported in this region.

Based on the issues outlined above, the correspondence emphasized the urgent need for: Machine-assisted track regulation, ballast supply (125 Fad cars, equivalent to 3,750 m³), additional track workers from other OC ZOP section and hiring new track workers.

Otherwise, OC ZOP Zaječar will not be able to independently eliminate the defects identified by the EM-80 track inspection coach on May 15, 16, and 17, 2018, within the required timeframe.

Table 4.2.9.4: Overview of the Crveni Krst – Zaječar railway condition over time from km 3+455 to km 111+733

Section of the route Crveni Krst - Zaječar from *km* 3+455 to *km* 111+733					
Serial No.	Measurement Date/ Section	Condition			
		Very good	Good	satisfactory	unsatisfactory
1	09.04.2014.				
	Crveni Krst - Podvis	0	1000	39884	14741
	Podvis - Zaječar	0	4004	39002	7925
	Total:	**0**	**5004**	**78886**	**22666**
2	20.11.2014.				
	Crveni Krst - Podvis	0	1000	45946	9100
	Podvis - Zaječar	1000	0	40857	8792
	Total:	**1000**	**1000**	**86803**	**17892**
3	06.10.2015.				
	Crveni Krst - Podvis	0	0	49096	8422
	Podvis - Zaječar	0	3000	36944	11013
	Total:	**0**	**3000**	**86040**	**19435**
4	15.11.2016.				
	Crveni Krst - Podvis	0	0	5052	4171
		0	0	30352	17203
	Podvis - Zaječar	0	2000	34816	14143
	Total:	**0**	**2000**	**70220**	**35517**
5	17.05.2017.				
	Crveni Krst - Podvis	0	4616	32093	22469
	Podvis - Zaječar	0	1000	35961	14007
	Total:	**0**	**5616**	**68054**	**36476**

Section of the route Crveni Krst - Zaječar from *km* 3+455 to *km* 111+733					
Serial No.	Measurement Date/ Section	Condition			
		Very good	Good	satisfactory	unsatisfactory
6	15.05.2018.				
	Crveni Krst - Podvis	0	0	21059	33075
	Podvis - Zaječar	0	0	31412	16328
	Total:	**0**	**0**	**52471**	**49403**

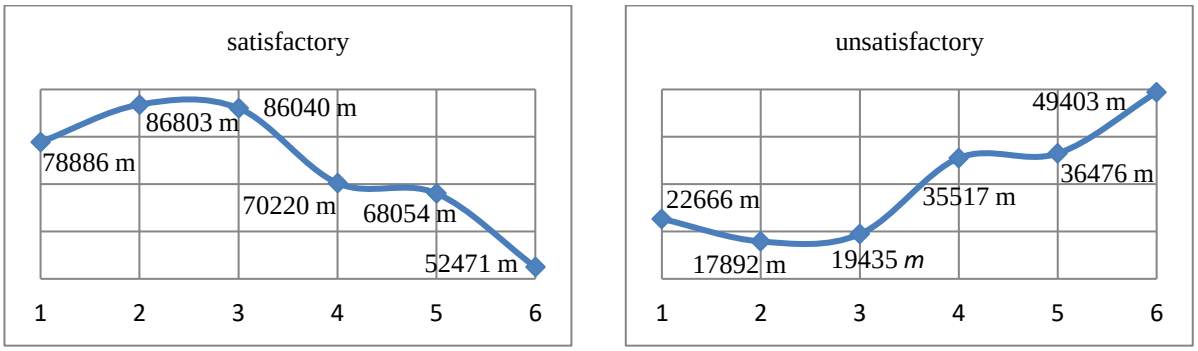


Figure 4.2.9.6: The condition of the Crveni Krst – Zaječar railway (from km 3+455 to km 111+733) over time

On the railway section from km 3+455 to km 111+733, the total length of track in satisfactory condition as of May 15, 2018, decreased by 34% compared to the measurements from April 9, 2014. Meanwhile, the length of track in unsatisfactory condition as of 15.05.2018, increased by 101% compared to the same measurements from 09.04. 2014.

It is unacceptable to disregard legal obligations concerning "C" type defects (as stated in point 3.3.1), relying on deficiencies in the valid Guidelines for Unified Criteria for Track Condition Control on the Rail Network of JŽ, Instruction 339 ("Official Gazette ZJŽ", Nos. 2/2001 and 4/2004) (see point 3.3.5.), which allows reducing speed as a risk mitigation measure for derailment.

4.2.10. Condition of sleepers and fastening equipment

The derailment of a wheel into the track can occur due to the movement of the wheels on the axle (loosening of the pressed assembly) in the direction of reducing the internal distance between the wheels, or due to the widening of the rails.

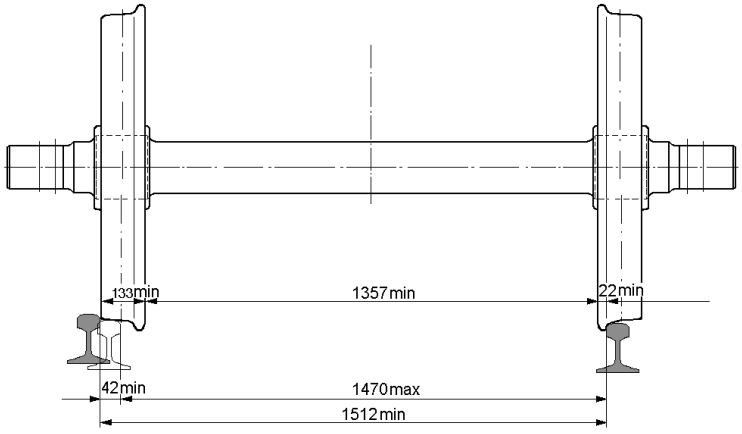


Figure 4.2.10.1: Conditions for slipping of the wheel into the track

Figure 4.2.10.2: Overview of wheel slipping into the track

In the image 4.2.10.1, the required ratio between the track gauge dimensions and the wheelset dimensions is illustrated to show the conditions under which a wheel might derail due to the rail gauge spreading. This is based on the prescribed limits for wheelset dimensions (SRPS EN 15313) and track gauge width (SRPS EN 13848-5). It is observed that the rails must spread by at least 42 mm beyond the allowable limit of 1435+35 mm for a derailment to occur. Inspection of the measurement records reveals that at several locations, the track gauge has exceeded the operational limit of +35 mm. At such locations, wheel derailment may occur even with less additional rail spreading.

The condition of the sleepers and fastening devices in the vicinity of the derailment shows significant defects, including loose or missing fasteners, shifted fastening plates, and rotten or cracked sleepers. Considering the track was originally constructed in 1912 and last refurbished in 1962 (between km 49+022 and km 67+534) with new and used materials, the sleepers are now over 60 years old.

The condition of the sleepers and fastening devices in the derailment zone is illustrated in images 4.2.10.3, 4.2.10.4, 4.2.10.5, and 4.2.10.6.

Figure 4.2.10.3: Local decay beneath the rail support and longitudinal cracks in the sleeper.

Figure 4.2.10.4: Rail-sleeper connection with an underlying fastening plate and tirphones

Figure 4.2.10.5: Rail-floating joint connection

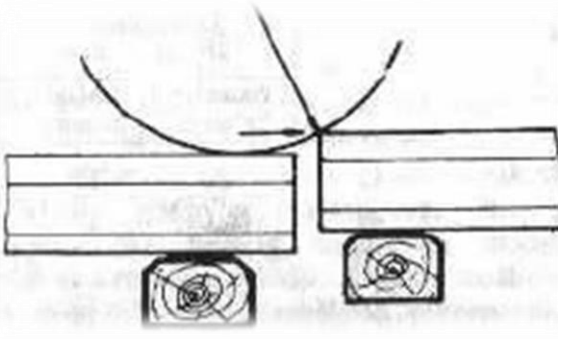


Figure 4.2.10.6: Influence of the wheel on the rail joint

The current condition of the track is non-compliant with the requirements specified in the Rulebook on Technical Conditions and Maintenance of the Superstructure of Railway Tracks (No: 340-201-2/2016) as stated in the Official Gazette of RS, Nos. 39/16 and 74/16 (see point 3.3.6). The regulation was in effect at the time of the accident. Due to the action of horizontal longitudinal forces, particularly during braking or acceleration of the train, and temperature fluctuations, along with reduced friction between the fastening components and the rail and between the rail foot and its base, the rail experiences longitudinal displacement (often referred to as "rail travel"). The connection of the rail assembly in several locations is made with a reduced number of connecting bolts (illustrated in Figure 4.2.10.5). All of this leads to uneven displacement of the rail assembly, as shown in Figure 4.2.10.6. This is contrary to Articles 4 and 77 of the same Rulebook, which set forth standards for proper track alignment and maintenance.

4.2.11. Inspection supervision

In order to investigate all relevant facts regarding the condition of the regional railway line Crveni Krst - Zaječar - Prahovo Port, CINS sent a letter No. 340-00-3/2019-02-1-7 on 08.03.2019. to the Ministry of Construction, Transport, and Infrastructure, specifically to the Inspectorate Sector, Railway Inspection Group, on March 8, 2019, in accordance with the Law on Investigation of Accidents in Air, Rail, and Water Transport ("Official Gazette of RS" Nos. 66/15 and 83/18). CINS requested information regarding the following:

- The number of inspection checks (regular, extraordinary, control, and supplementary inspections) carried out on the Crveni Krst - Zaječar - Prahovo Port railway line between January 1, 2009, and February 14, 2019.

- For each inspection, CINS requested the Inspection Report and any Decision on imposed measures, if applicable.

However, CINS did not receive any response to this inquiry.

4.2.12. Analysis of the Performance of the Rescue Service

Given that the train was carrying a substance that could potentially harm human health and the environment in case of uncontrolled release from the wagon- tanks, MUP RS, the Emergency Situations Sector, and the Firefighting and Rescue Department in Knjaževac were dispatched to the scene upon request.

Due to terrain inaccessibility, the local Firefighting and Rescue unit, accompanied by Serbian Railways employees, arrived at the scene using a special, auxiliary vehicle (TMD) from Svrljig railway station. Upon arrival, it was confirmed that there was no derailment or damage to the wagon tank, and ammonia leakage was not detected. The intervention was successfully completed.

During the return of the derailed wagon tank to the track, the Knjaževac Firefighting and Rescue unit conducted two separate interventions on February 15, 2019, from 12:01 to 19:38, and on February 16, 2019, from 05:01 to 21:40. In both cases, they were assisted by employees of Serbian Railways with the same auxiliary vehicle. The interventions were completed successfully, and no ammonia leakage occurred during the return operation.

4.3. Conclusions on the accident causes

4.3.1. Direct and indirect accident causes

The direct and immediate cause of the accident was the spreading of the rails under load and the inner wheel falling into the track in a curve. The wheel fall occurred due to the unsatisfactory condition of the track in the section where the accident took place. In the narrowest area of the derailment, there was a lack of or loose fastening and connecting equipment, decayed and cracked sleepers in sequence, combined with deviations in track geometry: rail spreading (deviation +40 mm), cant (deviation - 42 mm) and twist (deviation 36 mm), which is above the limit for urgent intervention - that is, the error of type “C”.

4.3.2. Basic causes deriving from skills, procedures and maintenance

Track maintenance on the observed section was not conducted in accordance with the Regulations on Technical Conditions and Maintenance of the Railway Track Superstructure (“Official Gazette of RS” No. 39/16 and 74/16), considering the years since the last track repairs, as well as the insufficient number of personnel, machinery, and tools (see sections 3.3.6 and 4.2.6).

4.3.3. Main causes deriving from legal condition and safety management system application

The Instruction on Unified Criteria for Track Condition Control on the Railway Network JŽ (Instruction 339) from 2001/2004 introduced “speed reduction” as an alternative measure for cases of “unsatisfactory” track condition (track geometry defects exceeding operational limits, classified as “Type C”). This measure did not exist in earlier versions of the Instruction (e.g., the 1989 version). Furthermore, a paragraph from the 1989 version of Instruction 339 was removed, which stipulated that measures should be taken to prevent the exceedance of operational limits before they are reached.

The current Regulation on the Maintenance of the Super and Sub Structure of Railway Tracks (see section 3.3.7) also lists the following measures for reducing the risk of derailment to an acceptable level in cases of “Type C” defects or reaching the limits for urgent intervention (Immediate Action Limit - IAL): closing the track, restoring track geometry, or reducing speed. This formulation was adopted from the EN 13848-5 standard. However, these measures should not be understood as alternatives; rather, the appropriate measure must be applied in each specific case.

The consequences of track widening and twist beyond operational limits (classified as “Type C” defects or “IAL” - Immediate Action Limit) cannot be mitigated by reducing speed. On the contrary, traveling at low speeds on twisted tracks in sharp curves with superelevation creates precisely the conditions under which derailment most easily occurs through the leading wheel climbing the rail (see EN 14363, section 6.1).

Neither the current Regulation on the Maintenance of the Supper and Sub Structure of Railway Tracks nor Instruction 339 explicitly and clearly define operational limits for the condition of sleepers and fastening equipment, at which immediate corrective measures must be taken or the track must be closed to traffic due to safety risks. (For example, there is no specification of the maximum number of consecutive sleepers with non-functional fastening equipment that would

require immediate intervention or closure of the track. In EN 14363, several safety criteria use a travelled distance of 2 meters as a reference for derailment risk, which could serve as a solid basis for introducing such a criterion).

The consequences of non-functional fastening equipment in curves with superelevation cannot be mitigated by reducing speed. On the contrary, traveling through a curve with superelevation at a low speed below the equilibrium speed (corresponding to the superelevation) creates an excess of superelevation. As a result, the vehicle tilts towards the inner side of the curve, increasing the vertical forces on the inner wheels and decreasing them on the outer wheels. In combination with track twist, two wheels on one diagonal of the bogie experience additional vertical loading, while the two on the opposite diagonal are unloaded. Guiding forces in the curve on the leading axle of conventional bogies (see section 4.2.1, figure 4.2.1.6.), when fastening equipment is non-functional, can sufficiently spread or twist the rails. In such a situation, due to increased vertical loading, the inner wheel of the leading axle most easily falls into the track. This is precisely what happened in this accident, as well as in several other accidents investigated by CINS.

The consequences of vertical deviations (stability) and transverse deviations in track geometry beyond the “Type C” (or “IAL”) limit can, however, be mitigated by reducing speed.

4.3.4. Additional remarks on shortcomings and flaws determined during the investigation, but with no relevance to the accident causes conclusions

N/A.

5. Measures taken

Following the accident, the ZOP Section of Zaječar assessed the damage and developed a plan for the track repairs. Work began on February 14, 2019, including the demolition of the damaged track, removal of the old materials, and installation of a new track with 50 meters of rail, wooden sleepers, and both new and reused track fittings. During the repairs, 76 wooden sleepers, 100 meters of rail, 300 kg of track fittings, and 25 m³ of ballast were replaced. The repairs were completed on February 22, 2019, and the track was restored for use.

Following the accident, the regional section of the Crveni Krst - Zaječar - Prahovo Station railway between Crveni Krst and Zaječar was closed for traffic due to frequent accidents and incidents, as stated in the telegram from the Executive Director for Railway Infrastructure Management (February 14, 2019), based on Decision of MGSI No. 340-06-62/2019-18 from February 14, 2019.

According to data from "IŽS"a.d.(Letter of Section for Construction Affairs, No. 340-06-62/2019-18 from15.01.2020. as an attachment of the electronic mail sent on 17.01.2020.) after the closure of the regional line Crveni Krst – Zaječar – Prahovo Pristanište, ŽS's expert services focused on enhancing the maintenance of the super track elements between the Matejevac and Zaječar stations.

5.1. Railway line reconstruction

At the request of CINS, by "IŽS"a.d., the Center for Safety Management Systems, Letter No. 366/2024-109 dated July 3, 2024. Among other things, the document submitted: Works performed in the period from February 2019 to December 20, 2021, railway No. 216 (now No. 219) Crveni Krst - Prahovo pristanište, Increased maintenance of the elements of the superstructure on the section Matejevac - Zaječar km 12+084 to km 110+929.

The document states that part of the works was carried out by "IŽS"a.d. starting from 25.02.2019. From 11.04.2019., "ZGOP"d.o.o. is included in the works under the contract. Novi Sad and Traffic Institute "CIP"d.o.o. Belgrade, which according to the contract have 650 calendar days to complete the section "A" Matejevac - Svrljig (km 12+084.50 - km 40+321.35) L=28237 m and the section "B" Svrljig - Knjaževac (km 40 +321.35 – km 68+911.85) L=28590 m.

According to the document provided, the following has been executed:

- demolition and laying of new track for a total of 60132 meters (main and siding tracks);
- ballasting of 59541 m of track;
- track regulation for 63327 m;
- completion of the ballast prism for regulated tracks;
- dismantling of track fields in stations including Matejevac, Gramada, Svrljig, Palilula, Podvis, and Knjaževac, track fittings and rail sorting;
- ballast replenishment of 74211 m^3;
- installation of 43 new level crossings;
- total of 1657 rail welds;

- mechanical rail adjustments;
- installation of 17133 lateral restraint caps;
- installation 2368 longitudinal restraint devices;
- replacement of switch components at 24 switches and mechanical adjustment of switches;
- installation of track-marks throughout the line.

According to the document provided, the renovation works on the Crveni Krst – Prahovo Pristanište railway, carried out by "IŽS"a.d., were financed by the Ministry of Construction, Transport and Infrastructure (MGSI) and the Republic of Serbia.

According to Law on Railway System Interoperability ("Official Gazette RS" No. 41/2018) (see section 3.3.3. и 3.3.4.) These works, categorized under regular maintenance rather than a full reconstruction of the railway, did not require a new structural subsystem use permit or vehicle use permit as specified by the Law on Interoperability of the Railway System. The IŽS considered the activities as part of regular maintenance and therefore did not seek approval from the Railway Directorate, which would typically be required for subsystem renovation works. The Sector for Construction Affairs of "IŽS"a.d. confirmed this stance in a letter dated July 18, 2024.

"IŽS"a.d. provided a telegram No. 89, dated February 14, 2019, which outlines instructions for utilizing the auxiliary route Crveni Krst - Stalać - Lapovo - Velika Plana - Mala Kršna - Požarevac - Majdanpek - Bor Teretna - Rasputnica 2 - Prahovo Pristanište due to the closure of the section Crveni Krst - Zaječar. The telegram also notes that two sections of this auxiliary route were reinforced in the upper track system, allowing for higher axle loads. These improvements are considered as an enhancement of the structural subsystem (see point 3.3.3).

At the request of CINS, by the Directorate for Railways, by e-mail from 27.08.2024. submitted the answer that, from the adoption of the Law on Interoperability ("Official Gazette of RS" No. 41/2018) until 27.08.2024. the Directorate had 18 (eighteen) requests for issuing permits for the use of structural subsystems. All requests refer to new railways (Belgrade - Novi Sad, Subotica - Horgoš - Roszke (HU) and Novi Sad - Subotica - Kelebija (HU)). It was also stated in the answer that since the existing railways that are being renewed or upgraded do not have an old license, in accordance with the Law, in case of their renewal or improvement, it is necessary to submit to the Directorate a request and all the necessary documentation for the issuance of a new license for the use of structural subsystems.

Based on the aforementioned details, it is deemed unacceptable for sections of old railways undergoing renovation or upgrades to not submit requests to the Directorate for Railways, as required by Article 30 of the Railway Interoperability Law (see section 3.3.3.), valid at the time of occurrence of the accident, and Article 36 of the current Law on Railway Interoperability ("Official Gazette of RS" No. 62/2023, see section 3.3.4.). Such sections should not be used further without the issuance of a permit in accordance with the applicable Law.

According to Article 49 of the Law on Railway Interoperability Law ("Official Gazette of RS" No. 62/2023), referring to the Infrastructure Register (RINF), Paragraph 1 states that the infrastructure manager is required to provide data about the infrastructure subsystem to the European Union Agency for Railways (ERA) for the Infrastructure Register (RINF). On the website of the European Railway Agency, in the section related to the Register of Infrastructure (RINF - Register of Infrastructure - https://data-interop.era.europa.eu/search), the list of countries for which the Register of Infrastructure is maintained it can clearly be seen that the Republic of

Serbia does not exist (it is not a member of the European Union - EU network). Based on the above, it can be concluded that for the Republic of Serbia a Register of Infrastructure is not maintained. The provisions of Article 49 of the Law on Railway Interoperability are aligned with Regulation (EU) 2019/777, but since Serbia is not an EU member, these provisions are not applicable for the Republic of Serbia. According to the Law on Railway Interoperability ("Official Gazette of RS" No. 41/2018) and according to the Article 34 of the Law on Railway Interoperability ("Official Gazette of RS" No. 41/2018 and 16/2022 - Authentic Interpretation), in the Article 34, Paragraph 1, 2 and 3), it was stipulated that the Directorate for Railways (as the national safety body) should maintain the infrastructure register, and infrastructure managers were required to provide data for it to the Directorate, which completely adequate bearing in mind the status of the Republic of Serbia, which is not a member of EU. Considering the aforementioned, it can be concluded that for the infrastructure managers an Infrastructure Register is not currently maintained in Serbia, which is unacceptable and creates a legal gap and allows for unlawful practices without oversight, for the entire previous period and the following period, that is, the next year, since it is unknown when Serbia will become a member of EU, that is, when it will be allowed that the Register is maintained by the European Union Agency for Railways. Bearing in mind the aforesaid, to remedy this situation and to ensure that the Register is maintained for the Republic of Serbia, it would be advisable as the only logical solution for Serbia to reinstate the provisions from Article 34 of Law on Railway Interoperability ("Official Gazette of RS" No. 41/2018) into Article 49 of the current law, allowing the Directorate for Railways to maintain the infrastructure register, since it is a national body for safety, until Serbia becomes an EU member and the European Agency for Railways can take over this responsibility.

5.2. Special telegrams with load above the designed category

The document submitted by "IŽS"a.d. includes a Record from the Commission for Technical Inspection of infrastructure installations on the regional railway line 219 (Niš) - Crveni Krst - Zaječar - Prahovo Port, section from Matejevac (inclusive) to Zaječar (exclusive), from km 12+084 to km 110+425, No. 15/2021-912 dated July 23, 2021, as well as a corresponding telegram No. 91 dated August 13, 2021. These documents provide detailed information regarding the technical inspection and the condition of the railway infrastructure on the mentioned section, stating:

" …

3)The document states that the section of the railway from Crveni Krst to Zaječar remains classified as category A2 (180 kN, 64 kN/m). However, this part of the railway is also allowed to accommodate trains with axle loads up to the C3 category (200 kN, 72 kN/m).

In a Letter dated July 18, 2024 (No. 20/2024-1091), "IŽS"a.d., Section for Construction Affairs, specified that, according to the applicable Rulebook on the technical conditions and maintenance of railway track superstructure (at the time of the accident), the railway allows the operation of trains with axle loads up to the C3 category based solely on the type of rails and sleepers used.

However, it is highlighted that approval based only on the type of rails and sleepers poses a risk, as it could lead to serious damage to the infrastructure. It is deemed unacceptable to authorize train operations with loads exceeding the design category of the track based solely on the type of installed rails and sleepers, without a full assessment of the track's bearing capacity and the complete evaluation of the upper and lower super and sub structures (including bridges, culverts, etc.).

6. Safety recommendations

Aiming to improve safety on the railway line and to prevent occurrence of the new accidents, CINS has issued the following safety recommendations:

To the Directorate for Railways the following recommendations are issued: SR_01/25, SR_02/25, SR_03/25, SR_04/25 and SR_05/25

SR_01/25 The Directorate for Railways should, as soon as possible, amend the current Regulation on the Maintenance of the Super and Structure of Railway Tracks ("Official Gazette of RS" No. 39/2023) to define the limit states of track elements requiring immediate rectification or track closure until the unacceptable condition is resolved. Additionally, the regulation should stipulate that in cases of "Type C" defects or those exceeding the "IAL" (Immediate Action Limit) for track widening and twist, speed reduction cannot be considered a measure to mitigate the risk of derailment. Instead, only urgent intervention or track closure should be undertaken (see section 4.3.3).

SR_02/25 The Directorate for Railways, in accordance with Article 37 of the Law on Railway Traffic Safety ("Official Gazette of RS" No. 41/18), should amend and supplement the Regulation on Technical Conditions and Maintenance of the Railway Telecommunications Network ("Official Gazette of RS" No. 68/21). In Section II: Technical Conditions for the Railway Telecommunications Network, the regulation should define the minimum technical requirements for equipping railway lines with telecommunication devices to ensure reliable communication between traffic control personnel and train drivers. These requirements should be based on factors such as train speed, track categorization, volume of railway traffic, and similar considerations (see sections 2.2.4 and 3.4.3).

SR_03/25 "IŽS"a.d, should amend and supplement the Instruction on Unified Criteria for Track Condition Control on the Railway Network (Instruction 339, "Official Gazette of the ZJŽ" No. 2/2001 and 4/2004). The amendments should stipulate that in cases of "Type C" defects or those exceeding the "IAL" (Immediate Action Limit), for track widening and twist, speed reduction cannot be considered a measure to mitigate the risk of derailment. Instead, only urgent intervention or track closure should be implemented (see sections 3.3.5 and 4.3.3).

SR_04/25 "IŽS"a.d, should review the adequacy of the current provisions in the Regulation on the Organization and Systematization of Work Positions of the Joint Stock Company for the Management of Public Railway Infrastructure "Infrastruktura Železnice Srbije" Belgrade. It should also assess the possibility of ensuring an appropriate number of personnel in construction activities, both on the section of the railway where the accident occurred and across the entire network, with the aim of ensuring the safe operation of railway traffic. In line with the appropriate number of personnel, the company should plan the procurement of the necessary machinery and tools, all in the interest of maintaining the safety of railway traffic (see sections 3.4.2 and 4.2.9).

SR_05/25 "IŽS"a.d, when approving special shipments/consignments that exceed the allowed axle load or allowed weight per meter of track on a transport route or section of the transport route, it is mandatory to conduct an analysis of the track's load-bearing capacity and assess the condition of the supper and substructure of the track (see section 5.2).

To the Ministry of Construction, Traffic and Infrastructure the recommendations SR_06/25 and SR _07/25 are issued:

SR_06/25 The Ministry of Construction, Transport, and Infrastructure, Sector for Railways and Intermodal Transport, considering that Article 49 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023) stipulates that the infrastructure register is maintained by the European Union Agency for Railways, and that this has not been formally enabled for infrastructure managers in the Republic of Serbia in practice, should resolve this issue to ensure the application of the provisions of Article 49 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023). If this issue is not resolved, or the provisions of Article 49 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023) cannot be applied, the Ministry should amend and supplement the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023), or restore the provisions of Article 34 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 41/2018), as well as the Law on the Interoperability of the Railway System ("Official Gazette of RS" Nos. 41/2018 and 16/2022 – Authentic Interpretation), in order to ensure the maintenance of the infrastructure register by the Directorate for Railways (see sections 3.3.3, 3.3.4, and 5.1).

SR_07/25 The Ministry of Construction, Transport, and Infrastructure, Sector for Inspection Supervision, Railway Traffic Inspection Department, should, in accordance with Article 50 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023), to carry out an inspection supervision at "IŽS"a.d. and take measures within its authority regarding the obtaining of permits for renovated and upgraded tracks in accordance with Article 36 of the Law on the Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023), starting from the adoption of the first version of the law in 2018 (see sections 3.3.3, 3.3.4, and 5.1).