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

No.: ŽS - 01/22

No.: 340-00-2/2022-02-1-120

Date: 12.10.2023.

FINAL REPORT ON SERIOUS ACCIDENT INVESTIGATION

Serious accident type:	Train derailment
Train No.:	45010
Place:	City of Pirot, outskirts of the village of Sopot, open track between the Staničenje crossing point and the Pirot station
Date:	25.12.2022.
Time:	16:45

This Report presents the results of investigation of a serious accident, derailment of a train No. 45010, which occurred on 25.12.2022. at 16:45, at km 67+244 of the main arterial line No. 106: Niš- Dimitrovgrad -state border- (Dragoman), between the crossing point Staničenje and the station Pirot.

The Working Group for investigation of this serious accident was formed by the Director of the Center for Investigation of Accidents in Transport of RS, by Decision No. 340-00-2/2022-02-1-10 of 30.12.2022.

Pursuant to 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 Republic of Serbia and the holder of founding rights is the Government of the Republic of Serbia.

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
RS	Republic of Serbia
MUP	Ministry of the Interior
JP	Public Enterprise
IŽS	Infrastructure Railways of Serbia
a.d.	Joint Stock Company
d.o.o.	Ltd. Company
ŽS	Railways of Serbia
JŽ	Yugoslav Railways
ZJŽ	Community of the Yugoslav Railways
ZOP	For track maintenance
ZOVS	For rolling stock maintenance
TT	Telephone-telegraph
SS	Safety- signaling
DTŠ	Continuous welded rail
TMD	Heavy motor vehicle
ECM	Entity in Charge of Maintenance
GCU/VPI/OUK	General Contract of Use for Wagons
RID	The Regulation concerning the International Carriage of Dangerous Goods
PU	Police Department
OJ	Organizational Unit
UKC	University Clinical Centre
SRJ	Federal Republic of Yugoslavia
OJT	Basic Public Prosecutor
MGSI	Ministry of Construction, Transport and Infrastructure
GIŠ	Upper rail edge

C O N T E N T :

1. Summary

1.1. Short description of the serious accident

On 25.12.2022. at 16:45, at km 67+244 of the main arterial line No. 106: Niš- Dimitrovgrad -state border- (Dragoman), between the crossing point Staničenje and the station Pirot, there occurred a derailment of the train No. 45010 (railway undertaking "Srbija Kargo"a.d.) A total of six wagons of the series Z loaded with ammonia (RID 268/1005, OM 4869) have derailed from the train composition. Viewed from the locomotive 661-249, the following have derailed: 9th wagon of the series Zags No. 33 87 7813 563-6 with the right wheels of both axles of the second bogie (remained on its wheels in the track zone), 10th wagon of the series Zags No. 33 87 7813 580-0 with all the axles (turned on its side to the left, viewed in the direction of the train movement), 11th wagon of the series Zags No. 33 87 7813 586-7 with all the axles (turned on its side to the left, viewed in the direction of the train movement), 12th wagon of the Zagkks series No. 33 80 7922 029-3 with all the axles (turned on its side to the left, viewed in the direction of the train movement), 13th wagon of the series Zags No. 33 80 7818 081-1 with all the axles (turned on its side to the left, viewed in the direction of the train movement) and 14th wagon of the series Zags No. 33 80 7818 089-4 with the right wheels of both axles of the first bogie (remained on its wheels in the track zone). In this serious accident, there were injured and fatally injured. There occurred ammonia leakage from the 13th wagon No. 33 80 7818 081-1. Material damage was caused to the infrastructure, railway vehicles and goods.

1.2. The causes of the serious accident determined by investigation

The direct and immediate cause of the serious accident was the spreading of the rails under the load's action and the entry of the inner wheel into the track in the curve. The entry occurred due to the absence or looseness of fastening equipment on multiple consecutive sleepers, decayed or cracked sleepers, in combination with the track's geometric parameters beyond the emergency intervention limit – specifically, type "C" errors (cross level, twist, and track gauge). Due to a significant excess of cross level, the vertical load on the inner (left, in the direction of movement) wheels was increased. At the same time, the change in twist between the two values above the current intervention limit further induced oscillations around the longitudinal axis, causing even higher amplitude load on the inner wheels. Combined with the lateral guiding force in the curve, the very poor condition of the fastening equipment and sleepers led to the spreading of the rail heads and the entry of the inner wheel into the track.

Maintenance of the railway track on the observed section was not conducted in accordance with the Rulebook on the Technical Conditions and Maintenance of the Superstructure of Railway Tracks ("Official Gazette of RS" No. 39/16 and 74/16), considering the years since the last track repairs and the insufficient number of workers, machinery, and tools (see points 3.3.5. and 4.2.6.).

The Instruction on Unique Criteria for Track Condition Control on the Railways of the Republic of Serbia, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004), introduced an alternative measure of "speed reduction" for the case of "unsatisfactory" track condition (errors in track geometry beyond the operational limits "C"), which did not exist in earlier editions of Instruction 339 (from 1989). Additionally, a paragraph from the previous 1989 edition of Instruction 339, which envisaged taking measures before reaching the operational limits to prevent

their exceeding, has been removed. The amendments and supplements to the Instruction on Unique Criteria for Track Condition Control on the Railways of the Republic of Serbia, Instruction 339 ("Official Gazette of ŽS" No. 14/22) only include specific provisions related to the track inspection coach Sever 1435 (see point 3.3.4.).

The Rulebook on Maintenance of Super and Substructure of the Railway Tracks ("Official Gazette of RS", No. 39/23, dated 12.5.2023.) also provides for the case of values appearing in the parameters of the relative geometry of the track that exceed the limit for emergency (urgent) intervention, as an alternative measure, "speed reduction" (see point 3.3.7.).

The Rulebook on Technical Conditions and Maintenance of the Superstructure of the Railway Track, No.: 340-201-2/2016 ("Official Gazette of RS", No. 39/16 and 74/16), which was in force at the time of the occurrence of a serious accident, as well as Instruction 339 ("Official Gazette of ZJŽ", No. 2/2001, 4/2004, and "Official Gazette of ŽS", No. 14/22), and the Rulebook on Maintenance of Super and Substructure of the Railway Tracks ("Official Gazette of RS", No. 39/23 of May 12th, 2023), do not explicitly and clearly establish operational limits for the condition of sleepers and fastening equipment, where immediate corrective measures must be taken or the track must be closed for traffic due to safety risks.

At the section of the railway between Pirot station and the Staničenje crossing point, at the time of the serious accident, no reduced or restricted speeds or restricted speed runs were implemented. However, considering the fact that the projected speed on this section of the track was 85 km/h, while the maximum allowed speed, according to the valid Timetable Booklet 9.4, is 30 km/h, it is evident that the projected speed was significantly reduced in the previous period. Based on the above, it can be stated that on the mentioned section, due to the poor condition of the track over an extended period, in accordance with The Instruction on Unique Criteria for Track Condition Control on the Railways of the Republic of Serbia, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004), the applied measure of "speed reduction" (by telegrams from "IŽS"a.d. in 2011) was applied, which, starting from the Timetable 2017/2018, was categorized as the maximum allowed speed. Please note that the measure of "speed reduction" in cases of exceeding certain track parameters (e.g., track widening), above the operational limits, is not adequate, that is, this measure cannot be used to reduce the risk of derailment, as stipulated in Instruction 339, but it is necessary to urgently remediate the tracks in order to return the parameters of the track geometry to the permitted limits.

Even though with the Safety Management System Rulebook, "IŽS"a.d. did not perform a safety risk assessment and did not take appropriate measures based on multi-year reports that indicated that the condition of the section where the serious accident occurred was not in accordance with the Rulebook on the Technical Conditions and Maintenance of the Superstructure of Railway Tracks No.:340-201-2/2016 ("Official Gazette of RS" No. 39/16 and 74/16).

1.3. Main recommendations and information on subjects to which this Report is being 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 SR_01/23, SR_02/23, SR_03/23, SR_04/23, SR_05/23, SR_06/23 and SR 07/23 are issued:

SR_01/23 The Directorate for Railways is to supervise the safety certificate for managing railway infrastructure of "IŽS"a.d. due to the failure to take urgent measures to rectify type "C" errors identified by measurements with track inspection coaches according to Instruction 339, prolonged poor track condition and inadequate maintenance of the track. It is required to take measures within its jurisdiction in accordance with the Article 15 of the Law on Railway Traffic Safety ("Official Gazette of RS", No. 41/2018) (see points 4.2.6, 4.2.7, and 4.3.2.).

SR_02/23 The Directorate for Railways is to amend and supply The Rulebook on Maintenance of Super and Substructure of the Railway Tracks ("Official Gazette of RS", No. 39/23, dated 12.5.2023.) by removing, in Article 5, paragraph 2, point 1), the speed reduction as a measure to decrease the risk of train derailment in the case of values appearing in the parameters of the relative track geometry that exceed the limit for emergency intervention (see points 3.3.7 and 4.3.3.).

SR_03/23 The Directorate for Railways is to amend and supply the Article 4, subitem 5) Annex 3 of the Rulebook on Brakes and Braking of Trains and Vehicles ("Official Gazette of RS", No. 68, dated 7.7.2021.) in accordance with the relevant requirements of IRS 40421 (see points 3.3.8, 3.3.9, 4.2.3, and 4.3.4.).

SR_04/23 "IŽS"a.d. is required to conduct a review of the reasons for the occurrence of a large number of type "C" errors detected during the measurements with track inspection coaches, according to The Instruction on Unique Criteria for Track Condition Control on the Railways of the Republic of Serbia, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004, Official Gazette of ŽS, No. 14/22), over an extended period. Based on the assessment of safety risks that have arisen as a result, they should take effective measures to rectify safety deficiencies, in accordance with the requirements of Article 5 of the Law on Railway Traffic Safety ("Official Gazette of RS" No. 41/2018), and its Safety Management System Manual (see points 4.2.7 and 4.3.1.).

SR_05/23 "IŽS"a.d. is required to amend and supply The Instruction on Unique Criteria for Track Condition Control on the Railways of the Republic of Serbia, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004, Official Gazette of ŽS, No. 14/22), which is, by Decision "IŽS"a.d. No. 4/2015-51-17 of 29.12.2015. still in application in "IŽS"a.d., in accordance with provisions of the Instruction 339 from 1989, stated in point 3.3.4. (see points 3.3.4. and 4.3.3.)

SR_06/23 **"**IŽS"a.d. is required to, considering the inadequate maintenance and condition of the track, sleepers, and fastening equipment, conduct a risk assessment for train traffic on the main arterial line No.106: Niš - Dimitrovgrad - state border - (Dragoman) and take measures to reduce the risks to an acceptable level. Based on this, they should conduct a professional assessment of the minimum necessary resources (materials, machinery, workforce) for track maintenance (see points 4.2.1, 4.2.6, 4.2.7, 4.2.9, 4.3.1, and 4.3.2.).

SR_07/23 "IŽS"a.d. to consider in its Rulebook on organization and systematization of tasks within the Joint Stock Company for the Management of Public Railway Infrastructure "IŽS"a.d. and to examine the possibility of predicting an appropriate number of staff in the construction sector, both for the section of the track where the accident occurred and for the entire network, in order to ensure the safe operation of railway traffic. In accordance with the appropriate number of staff, they should plan the procurement of necessary machinery and tools, all with the aim of ensuring safe railway traffic (see points 4.2.6, 4.3.1, and 4.3.2.).

To the Ministry of Construction, Transport and Infrastructure the recommendations SR_08/23 and SR_09/23 are issued:

SR_08/23 The Ministry of Construction, Transport, and Infrastructure, Inspection Supervision Sector, Department for Railway Traffic Inspection, is to conduct an extraordinary inspection of the state of railway infrastructure on the main arterial line No.106: Niš - Dimitrovgrad - state border - (Dragoman), from Niš station to Pirot station, in accordance with Article 55 of the Law on Railways ("Official Gazette the RS", No. *41/2018 and 62/2023*), and take measures within its jurisdiction (see points 4.2.6, 4.2.7, 4.2.9, 4.2.10, 4.3.1, and 4.3.2.).

SR_09/23 The Ministry of Construction, Transport, and Infrastructure, Railways and Intermodal Transport Sector, is to consider the possibility of amending Article 51 of the Law on Railway Traffic Safety ("Official Gazette of RS" No. 41/2018), equipment and traction vehicles, to stipulate that the locomotive must also have adequate equipment for the protection of the respiratory organs - protective equipment (see points 3.6.2 and 4.3.4.).

To Autorité française de sécurité ferroviaire the recommendation SR_10/23 is issued:

SR_10/23 Atir-Rail SA, is to, when receiving a vehicle from a regular repair, perform additional monitoring of the condition of the valves for filling and emptying the cistern, considering that on some cisterns, only a few months after the regular repair, leaks appear on the valves (see point 4.2.5.2.).

2. Direct facts about the serious accident

2.1. Basic serious accident data

2.1.1. Date, time and location of the serious accident

On 25.12.2022. at 16:45, in the area of the city of Pirot, on the main arterial line No. 106: Niš-Dimitrovgrad -state border- (Dragoman), between the crossing point Staničenje and the station Pirot, on the open section of the track in the direct vicinity of the of IA class state road, marking 259 and the IIA class state road, marking 221, there occurred the serious accident.

The location of the occurrence of the mentioned serious accident is approximately 290 m away from the IA class state road, marking A4 (highway Niš - Pirot - Dimitrovgrad - state border with Bulgaria (border crossing Gradina)), and the IIA class state road, marking 259 (Niš (Malča interchange) - Bela Palanka - Pirot - Dimitrovgrad - state border with Bulgaria (border crossing Gradina)) (the location of the wagon-tanks' overturning is approximately 220 m away). It is also approximately 50 m away from the IIA class state road, marking 221 (Knjaževac - Kalna - Temska - Pirot - Visočka Ržana - Mojinci - Dimitrovgrad) (the location of the wagon-tanks' overturning is approximately 70 m away). In the vicinity of the IIA class state road, marking 221, there is a hamlet of the village of Sopot (area of the local community Sopot), and the nearest residential building is approximately 70 m away from the location of the serious accident (from the location of the wagon tanks 'overturning, it is approximately 130 m away). Furthermore, on the other side of the IIA class state road, marking 221, near the location of the serious accident, there is the river Nišava, which is approximately 60 m away from the accident site (from the location of the wagon-tanks' overturning, the river is approximately 40 m away).

The appearance of the area of the serious accident site taken from a satellite is shown in Figure 2.1.1.1.

Figure 2.1.1.1: The satellite image of the area of the serious accident site (Google maps)

The marking for the railway line was taken according to the Regulation on the categorization of railways belonging to the public railway infrastructure ("Official Gazette of RS" No. 92/2020, 6/2021, 33/2022 and 63/2023), and the markings for the roads according to the Regulation on the categorization of state roads ("Official Gazette of RS" No. 105/2013, 119/2013 and 93/2015).

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

On the main arterial line No. 106: Niš- Dimitrovgrad -state border- (Dragoman), between the crossing point Staničenje and the station Pirot, on the open section of the track at km 67 +244, there occurred a derailment of the train No. 45010, with six wagons of the series Z.

Viewed from the locomotive 661-249, the following have derailed: 9th wagon of the series Zags No. 33 87 7813 563-6 with the right wheels of both axles of the second bogie (remained on its wheels in the track zone), 10th wagon of the series Zags No. 33 87 7813 580-0 with all the axles (turned on its side to the left, rotated with the rear end approximately 15° to the left side relative to the longitudinal axis of the railway tracks, viewed in the direction of the train movement), 11th wagon of the series Zags No. 33 87 7813 586-7 with all the axles (turned on its side to the left, parallel to the track, viewed in the direction of the train movement), 12th wagon of the Zagkks series No. 33 80 7922 029-3 with all the axles (turned on its side to the left, rotated with the rear end approximately 15° to the left side relative to the longitudinal axis of the railway tracks, viewed in the direction of the train movement), 13th wagon of the series Zags No. 33 80 7818 081-1 with all the axles (turned on its side to the left, rotated with the front end approximately 15° to the left side relative to the longitudinal axis of the railway tracks, viewed in the direction of the train movement) and 14th wagon of the series Zags No. 33 80 7818 089-4 with the right wheels of both axles of the first bogie (remained on its wheels in the track zone).

After derailment, the train No. 45010 travelled approximately 132m more, after which it stopped (the exact distance could not be determined due to the track damages and the railway vehicles, but also due to the conditions during which this on-site investigation was carried out, namely, a high concentration of ammonia in the atmosphere).

The appearance of the serious accident site (the point of overturning of the wagon-tanks) is shown in Figure 2.1.2.1. and 2.1.2.2.

Figure 2.1.2.1: The appearance of the serious accident site (source: MUP, Sector for Emergency Situations)

Figure 2.1.2.2: The appearance of the point of overturning of the wagon-tanks
(source: MUP, Sector for Emergency Situations)

In Figure 2.1.2.3. a schematic view of the mutual position of the wagon-tanks in the train, after the serious accident, is shown.

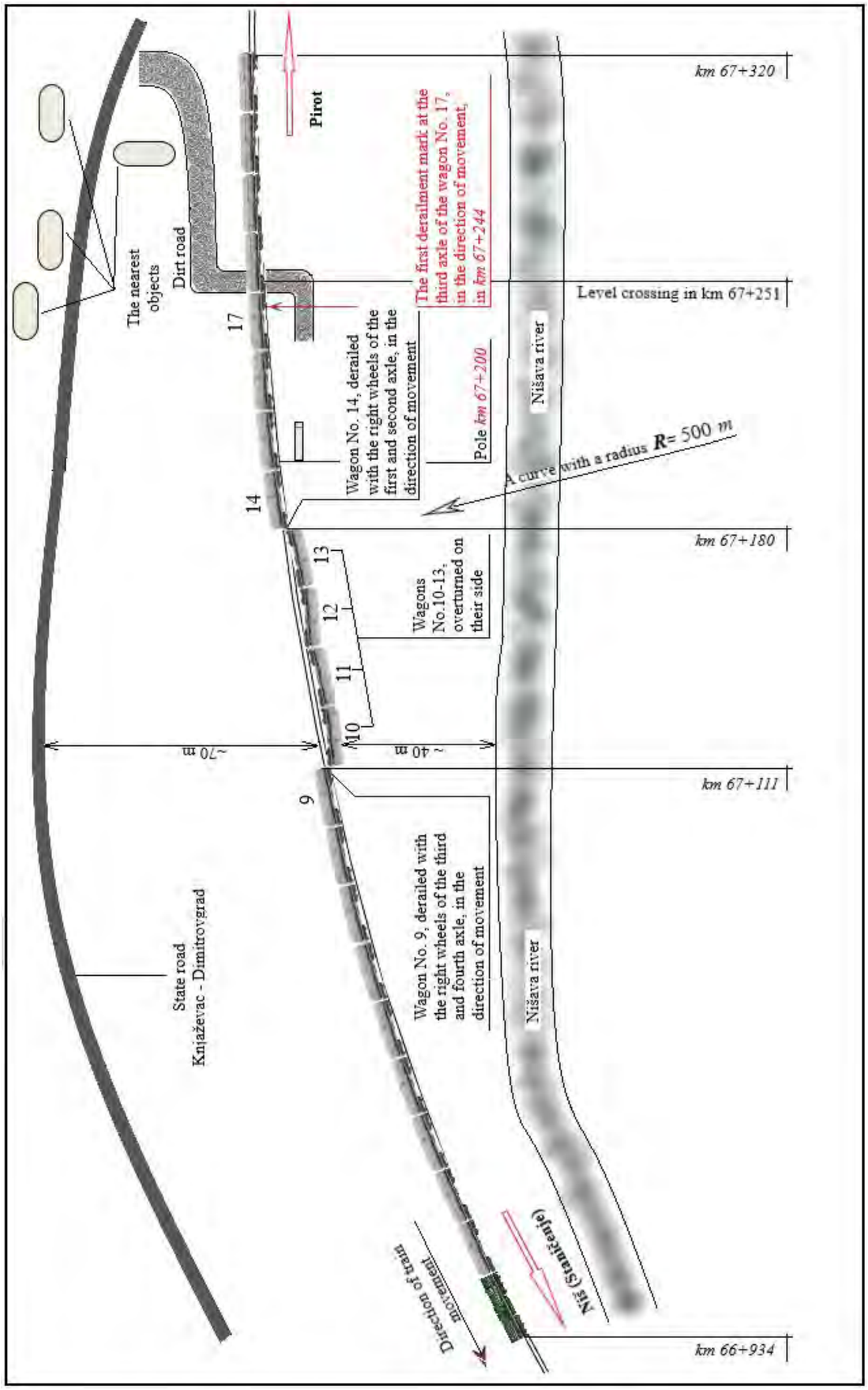


Figure 2.1.2.3: The scheme of the serious accident site (CINS)

Due to the occurrence of an ammonia release (leakage) (classified under RID: gas, toxic, corrosive), upon the call, the following units responded to the scene: members of the MUP RS, the PU in Pirot, members of the MUP RS, Sector for Emergency Situations, Department for Emergency Situations in Pirot, and members of the Emergency Medical Service of the Pirot Health Center.

The consequences of this serious accident were remedied by engaging the expert services and resources of "IŽS"a.d., "Srbija Kargo"a.d, "National Company Railway Infrastructure" of the Republic of Bulgaria, auto-cranes from Bulgaria, Elixir Zorka Mineral Fertilizers d.o.o. Šabac, HIP-Azotara d.o.o. Pančevo, Patenting d.o.o. Belgrade, as well as construction and forestry services by "Pixi", with assistance from firefighters and rescue services.

Due to this serious accident, railway traffic between the Pirot station and the Staničenje crossing point was interrupted. The interruption lasted from 25.12.2022. at 16:45, until 14.01.2023. at 19:00, when the mentioned section of the railway track was reopened for train traffic. According to telegram No. 2 of 14.01.2023, from the Pirot station, the section between the Staničenje crossing point and the Pirot station was opened for train traffic with the introduction of restricted speed running with a speed limit of Vmax=20 km/h, from km 67+042 to km 67+890. Additionally, the maximum train weight was limited to 1200 t, and the transportation of ammonia wagon tanks loaded with ammonia on the main arterial line No. 106: Niš - Dimitrovgrad - state border - (Dragoman) was prohibited, until the replacement and strengthening of the superstructure on certain sections of the track was completed.

2.1.3. Decision to investigate, investigative team composition and conducting the investigation

CINS has been informed immediately upon the occurrence of the serious accident. Main Investigator for Railway Traffic received the first notification of the serious accident occurred on 25.12.2022. at 18:04 via telephone by the Main Wagon Dispatcher of "Srbija Kargo"a.d. and then via telephone at 18:07 by the Main Designer of the Central Operational Department "IŽS"a.d. Based on the information received and the facts that the investigative team of CINS determined by on-site investigation of the serious accident on 26.12.2022, CINS has launched the investigation of the serious accident in question in accordance with the Law on Investigation of Accidents in Air, Railway and Waterborne Traffic ("Official Gazette of RS" No. 66/15 and 83/18).

Composition of the Working group for investigation of the serious accident is determined by Decision No. 340-00-2/2022-02-1-10 of 30.12.2022. of the Director of CINS based on the Articles 6 and 32 of the Law on Investigation of Accidents in Air, Railway and Waterborne Traffic ("Official Gazette of RS" No. 66/15 and 83/18).

2.2. Serious accident background

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

In the serious accident in question, of the train No. 45010, the train driver and the train driver assistant, employed at "Srbija Kargo"a.d. were involved.

The workers of the infrastructure manager "IŽS"a.d. did not participate in the serious accident, nor did the contractors, other individuals, or witnesses.

2.2.2. The trains that participated in the serious accident and their composition

In the serious accident, the train No. 45010 was involved. The train operated on the route Dimitrovgrad - Šabac. The train consisted of a locomotive of the series 661-249, owned by the railway undertaking "Srbija Kargo"a.d., and 21 (twenty-one) Z series wagon-tanks, with a total length of 359 meters (84 axles) and a total gross weight of 1615 tons. The train No. 45010 consisted of 20 ammonia-loaded wagon tanks (RID 268/1005, OM 4869) and one empty wagon tank (RID 80/1830). According to the data provided by the railway undertaking "Srbija Kargo"a.d. (Shipment note attached to letter No. 1/2023-444 from 09.02.2023), the net mass of the entire ammonia shipment was 895,700 kg.

The table 2.2.2.1. shows an overview of the wagons that were part of the train composition of the train No. 45010.

Table 2.2.2.1: An overview of the wagons in the train No. 45010 (viewed from the loc. 661-249)

Serial wagon No	Letter marking of wagon series	Individual wagon No.	Owner	Holder	*ECM*
1	Zags	33 80 7814 621-8	ATIR-Rail	ATIR-Rail	ATIR-Rail
2	Zags	33 80 7814 624-2	ATIR-Rail	ATIR-Rail	ATIR-Rail
3	Zags	33 80 7814 616-8	ATIR-Rail	ATIR-Rail	ATIR-Rail
4	Zags	33 80 7814 619-2	ATIR-Rail	ATIR-Rail	ATIR-Rail
5	Zags	33 80 7918 856-5	VTG	VTG	VTG
6	Zags	33 80 7814 622-6	ATIR-Rail	ATIR-Rail	ATIR-Rail
7	Zags	33 87 7813 561-0	ATIR-Rail	ATIR-Rail	ATIR-Rail
8	Zags	33 80 7818 092-8	ATIR-Rail	ATIR-Rail	ATIR-Rail
9	Zags	33 87 7813 563-6	ATIR-Rail	ATIR-Rail	ATIR-Rail
10	Zags	33 87 7813 580-0	ATIR-Rail	ATIR-Rail	ATIR-Rail
11	Zags	33 87 7813 586-7	ATIR-Rail	ATIR-Rail	ATIR-Rail
12	Zagkks	33 80 7922 029-3	VTG	VTG	VTG
13	Zags	33 80 7818 081-1	ATIR-Rail	ATIR-Rail	ATIR-Rail
14	Zags	33 80 7818 089-4	ATIR-Rail	ATIR-Rail	ATIR-Rail
15	Zags	33 80 7818 093-6	ATIR-Rail	ATIR-Rail	ATIR-Rail
16	Zags	33 80 7818 077-9	ATIR-Rail	ATIR-Rail	ATIR-Rail
17	Zags	33 80 7814 612-7	ATIR-Rail	ATIR-Rail	ATIR-Rail
18	Zags	37 80 7819 976-7	ATIR-Rail	ATIR-Rail	ATIR-Rail
19	Zags	37 80 7819 874-4	ATIR-Rail	ATIR-Rail	ATIR-Rail
20	Zags	37 80 7819 887-6	ATIR-Rail	ATIR-Rail	ATIR-Rail
21	Zacs-z	33 72 7867 832-7	-	-	-

Note: Table 2.2.2.1. presents data for the wagons from the composition of train No. 45010 based on extracts from the European Virtual Vehicle Register (VVR). Data for wagon No. 33 72 7867 832-7 is not provided because the wagon is not registered in the National Vehicle Register of the Republic of Serbia (NVR). According to the information provided by Elixir Zorka Mineral Fertilizers d.o.o. Šabac, based on the Sales Agreement for technical sulfuric acid concluded between Serbia Zijin Copper d.o.o. Bor (as the seller) and Elixir Group d.o.o. Šabac (as the buyer) on December 20, 2019, with a validity period until December 31, 2029 (registered Nos. 10327 and 334/1), Serbia Zijin Copper d.o.o. Bor, as the owner of the sulfuric acid wagon tanks, leased them to Elixir Group d.o.o. Šabac during the Sales Agreement period.

A total of 6 (six) Z series wagon-tanks derailed from the train composition.

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

Figure 2.2.2.1: Appearance of Z-series derailed wagons

The Z-series wagons involved in the serious accident are four-axle special closed wagons for the transport of ammonia with appropriate loading and unloading systems.

2.2.3. Infrastructure and SS system

The main arterial line No. 106: Niš- Dimitrovgrad -state border- (Dragoman), between the crossing point Staničenje and the station Pirot, is one-track, unelectrified line. The designed axle load is 225 kN, and the axle load per meter of track is 72 kN/m. The ballast is made of crushed limestone. The track grid is constructed using E-49 type rails, with K-type track accessories and non-standard accessories (dž 71 plates), along with wooden sleepers. The track is welded in DTŠ.

On the section of the line in question, the designed speed is according to the following:

- from *km* 63+800 to *km* 64+613, 40 *km/h*;
- from *km* 64+613 to *km* 65+635, 85 *km/h*;
- from *km* 65+635 to *km* 66+989, 60 *km/h*;
- from *km* 66+989 to *km* 72+900, 85 *km/h*.

On the specific section of the railway, the minimum curve radius is R=300 m, and the maximum gradient is +8‰ (from km 72+170 to km 72+500, uphill with a 8‰ slope, considering the increasing stationing direction).

The Niš - Dimitrovgrad railway line was put into operation on August 1st, 1888.

Between the Staničenje crossing point and the Pirot station, the track was repaired in 1985, during which E49 type rails were installed and welded in DTŠ, the wooden sleepers were also installed at intervals of 60 cm.

According to Timetable Booklet 9.4 (which was valid at the time of the serious accident), the maximum permitted speed on the section of the railway between the Staničenje crossing point and the Pirot station is 30 km/h. According to the same timetable, there were no restricted speeds on the specific distance between the stations.

From 01.01.2018, until the occurrence of the serious accident, there were no imposed restricted speed runs on the section of the railway between the Staničenje crossing point (km 63+800) and the Pirot station (km 72+900).

The Staničenje crossing point is an official position situated at km 63+800 of the main arterial line No. 106, and the Pirot station is an official position located at km 72+900 of the main arterial line No. 106. In terms of train traffic control, these are official positions that manage the traffic of opposing and consecutive trains (crossing, overtaking, and following trains).

On the distance between the stations Staničenje and Pirot, there are no installed SS devices. Train traffic between the Staničenje crossing point and the Pirot station is regulated through telecommunication lines using voice communication (permissions, advisories, pre-advisories, and check-outs) and signaling by an electric signal bell. The train traffic control between these mentioned official locations is carried out by the train dispatchers at the Pirot station and the Staničenje crossing point.

The track designation is taken according to the Regulation on the categorization of railway lines which belong to the railway public infrastructure ("Official Gazette of RS" No. 92/2020, 6/2021, 33/2022 and 63/2023).

The description of the railway and facilities is based on the data obtained from "IŽS"a.d. (correspondence from the Traffic Affairs Sector No. 15/2023-106 of 01.02.2023, Construction Affairs Sector No. 20/2023-197 of 03.02.2023, and Electrotechnical Affairs Sector No. 21/2023-120 of 30.01.2023, submitted in the attachment of "IŽS"a.d. correspondence No. 1/2023-176 of 06.02.2023) and the Directorate for Railways (correspondence I-01 No. 340-336-2/2023 of 04.04.2023).

2.2.4. Means of communication

The means of communication between the crossing point Staničenje and the station Pirot consists of inductive and track semi-automatic telephones (PPA). Communication between the traffic control staff is established through the omnibus line (OV) or cable connection, which stretches over wooden TT poles. The communication line includes the train dispatchers at Staničenje and Pirot station, as well as the officer at the level crossing.

The telephone connections between the train dispatchers at Pirot station and the Staničenje crossing point are established by using phones connected to the business line 40630, the track automatic line 20630, and the electric signal bell line. The telephone connection used for train traffic regulation (business line 40630) is recorded by register phones (VC MDX PUPIN ATIS) at Dimitrovgrad station. All stations from Niš to Dimitrovgrad are connected to the business line.

On the main arterial line 106: Niš - Dimitrovgrad - state border - (Dragoman), between the Staničenje crossing point and the Pirot station, there is no radio-dispatcher communication.

Communication between the traffic control staff (train dispatcher) at Pirot and Staničenje official positions, with the train staff, is carried out using general orders and aspects of signals from traction and station staff. In each station, the train dispatcher has an official mobile phone, and in some cases, train drivers also communicate via mobile phones.

The description of the communication means is provided based on the data received from "IŽS"a.d. (correspondence from the Traffic Department, reference No. 15/2023-106, of 01.02.2023., and the Electrotechnical Department, reference No. 21/2023-120, of 30.01.2023, delivered as attachments to the "IŽS"a.d. letter, reference No. 1/2023-176, of 06.02.2023).

2.2.5. Works executed at or near the serious accident site

In the vicinity of the serious accident site no works were executed.

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

The railway undertaking "Srbija Kargo"a.d. has, immediately after the occurrence of the accident, informed CINS, that is, the Main Investigator in Railway Traffic, and then the infrastructure manager "IŽS"a.d. did the same. The infrastructure manager "IŽS"a.d. and the railway undertaking "Srbija Kargo"a.d., have formed a joint investigative committee, that conducted investigation into the serious accident in question, in accordance with the applicable regulations. Until the Final Draft Report is concluded by the CINS, the Report made by the joint investigative committee of the infrastructure manager and the railway undertaking, has not been submitted.

According to the information provided as an attachment to the letter from "Srbija Kargo"a.d, reference No. 1/2023-444, of 09.02.2023, after stopping the train, exiting the locomotive 661-249, and observing the ammonia leak, the train driver, along with the assistant train driver, left the accident site. Immediately after evacuating to a safe location, the train driver informed the train dispatcher (on his official mobile phone) at Pirot station about the accident via a mobile phone call through the mobile phone network operator.

According to the information provided as an attachment to the letter, reference No. 15/2023-106, of 01.02.2023, from the Traffic Department of "IŽS"a.d. the duty train dispatcher at Pirot station received the first notification of the accident at 17:00 from the train driver of train No. 45010. The train driver informed him about the accident, specifically the derailment of ammonia tank wagons between the Pirot station and Staničenje crossing point. The train dispatcher at Pirot station immediately notified the Pirot station Chief, the Operations Department in Niš, MUP, firefighters, and emergency services.

According to the information received from "IŽS"a.d. (correspondence from the Traffic Department, reference No. 15/2023-106, of 01.02.2023), immediately after the occurrence of the serious accident in question, the part of the main arterial line 106: Niš - Dimitrovgrad - state border - (Dragoman), between the Staničenje crossing point and the station Pirot, was closed for train traffic. Due to the prohibition of access to the accident site by the Public Prosecutor in Pirot and the Emergency Situations Sector in Pirot (access was restricted within a radius of 5 km towards Pirot and 20 km towards Niš), the Operational Commission for Accident and Incident Investigation Niš, as well as the employees of the ZOP Section in Niš and the OJ for Emergency Train Operations in Niš, were allowed access to the accident site only on 26.12.2022. The process of repairing the consequences of the serious accident started on 30.12. 2022, at 10:00 AM.

From 30.12. 2022, at 10:00, until 14.01.2023, at 19:00, with the involvement of equipment and staff from emergency trains, as well as employees from the ZOP Section in Niš, the derailed and overturned wagons were lifted and returned to the tracks as follows: wagon No. 33 87 7813 563-6 on 01.01.2023; wagons No. 33 80 7818 081-1 and 33 80 7818 089-4 on 07.01.2023; wagon No. 33 87 7813 580-0 on 12.01.2023; wagon No. 33 87 7813 586-7 on 13.01.2023, and wagon No. 33 80 7922 029-3 on 14.01.2023. After removing the derailed wagons to the Staničenje crossing point (9th wagon in order) and Pirot station (10th, 11th, 12th, and 14th wagons in order), and after loading and removing the wagons to Sukovo station (13th wagon in order, where ammonia was released, and before removal, it was transferred to an auto-tank of the company Patenting d.o.o. Belgrade, by HIP - Azotara Pančevo), members of the Civil Works Sector, ZOP Section in Niš, took measures to organize the repair of damage on the section of the railway between Staničenje crossing point and Pirot station. The lifting of the derailed wagons was carried out by engaging the emergency train of "IŽS"a.d., the Center for Emergency Train Operations, the OJ for Emergency Train Operations in Niš, as well as the emergency train and auto-crane from the Republic of Bulgaria (the emergency train and auto-crane from the Republic of Bulgaria arrived on 06.01.2023).

The works on the rehabilitation and restoration of the railway track were completed on 14.01.2023, at 19:00, when the section between the Staničenje crossing point and Pirot station was reopened for train traffic with a speed restriction for restricted speed runs from km 67+042 to km 67+890 with Vmax=20km/h. Additionally, on the main arterial line No. 106: Niš - Dimitrovgrad - state border - (Dragoman), the maximum train weight is limited to 1200 t, and the transport of ammonia wagons-tank is prohibited until the replacement and strengthening of the superstructure on certain sections of the track are completed.

2.2.7. Activation of the emergency plan of public rescue services, police and medical services and the sequence of events

Due to this serious accident, members of the MUP RS, PU in Pirot, members of MUP RS, Emergency Situations Sector, as well as the employees of the Health Center Pirot, Emergency Medical Service were involved. Also, after learning about the occurrence of a serious accident, special measures were taken by the Ministry of Environmental Protection, the Environmental Protection Agency, and the City Administration of the city of Pirot.

2.2.7.1. Activities of MUP RS, PU Pirot

By a letter from the MUP RS, PU Pirot, No. 320/23 dated 07.04.2023, and a letter from the MUP RS, PU Pirot, Traffic Police Department, No. 220-3-12/23 dated 05.04.2023 (delivered in attachment to the letter from MUP RS, Police Directorate, PU Pirot, No. 321/23 dated 07.04.2023), it was reported that on 25.12.2022, at 17:10, the duty service of the PU in Pirot received a telephone report from an unknown person that there was a traffic obstruction due to thick smoke covering the mentioned section of the road on IA class state road, marking A4, near the "Pirot West" interchange. The information was immediately relayed by phone to the duty service of the Traffic Police Department, the Criminal Police Department, the Emergency Situations Department, the Emergency Medical Service in Pirot, and the competent OJT in Pirot.

On the same day, around 17:30, upon receiving information that there was an accident situation involving hazardous substances near the IA class state road, marking A4, at the "Sopot interchange" (on the territory of the city of Pirot), on the international railway line between Niš

and Dimitrovgrad, resulting from a derailment and overturning of part of the train composition with the release of hazardous material (ammonia), the PU in Pirot conducted a blockade in the immediate and wider area of the accident situation, traffic on roads near the serious accident was stopped, and all police officers were deployed to redirect traffic, prevent, and mitigate the consequences of the accident situation.

Units of the Emergency Situations Sector and the Emergency Medical Service in Pirot were dispatched to the scene of the serious accident to take necessary measures within their jurisdiction, warn the local population, and evacuate them. The police officers on the ground and the workers from the Emergency Situations Sector were engaged in this operation.

After assessing that the available resources were not sufficient to protect and rescue the affected population, immediate coordination and cooperation were established with the other organizational units of the MUP (PU in Niš and Leskovac), as well as with units from other local self-governments. Furthermore, timely and comprehensive information was provided to the Emergency Situations Headquarters in Pirot about the serious accident and the measures being taken to inform the public.

The engagement of general police officers from the PU Pirot in this accident situation lasted from 25.12.2022, until 12.02.2023, when the last wagon-tank was dispatched to Smederevo. On average, eight general police officers participated daily, with a total of 400 engagements during that period.

During the period from 30.12.2022. to 12.02.2023. measures were taken by general police officers from the Pirot PU to secure wagon-tanks and relocate them to specific locations within the territory of the city of Pirot, as well as transport them to locations in Dimitrovgrad, Smederevo, and Šabac.

Traffic police officers implemented roadblocks (stopping of the traffic) on roadways near the serious accident. Traffic patrols were organized on the ground to redirect the traffic, prevent and mitigate the consequences of traffic accidents, and actively coordinate with other organizational units of the Pirot PU, police officers from Leskovac and Niš PU, as well as other services (Emergency Medical Service, Road Managers, Emergency Situations Sector, and the Emergency Situations Headquarters).

On that occasion, a total of 19 traffic police officers were engaged, equipped with protective gear, to inspect the accident site and check the remaining passenger and freight vehicles on state road IA class, marking A4, and state road IIA class, marking 259, and state road IIA class, marking 221, in order to find individuals inside and provide necessary first aid. Additionally, injured individuals were visited at the General Hospital in Pirot. From 25.12. 2022, at 17:15, when traffic was interrupted, until 28.12. 2022, at 15:00, when traffic was normalized on state road IA class, marking A4, and state road IIA class, marking 259, police officers from the PU Pirot, Traffic Police Department redirected traffic to alternative routes and escorted columns of freight vehicles on state road IIB class, marking 428, on the route between Pirot - Ponor - Bela Palanka, and vice versa, forming what is referred to as the “convoy of freight vehicles”. During this period, the Pirot PU received assistance from the Leskovac PU and the Niš PU, ensuring the passage of over 2,500 groups of freight vehicles.

During the period from 07.01. to 10.01.2023, while raising overturned and damaged 13th ammonia wagon-tank for later ammonia transfer, traffic police officers from the Traffic Police Department of the Pirot PU were on standby at critical points. In the event of a situation escalation, they were ready to immediately halt traffic on state road IA class, marking A4, and state road IIA

class, marking 259. Around this serious accident, from 25.12.2022, to 14.01.2023, an average of 20 traffic police officers were engaged daily, performing various tasks and assignments.

On 25.12.2022, between 17:00 and 17:30, due to the release of ammonia in the form of a white non-transparent cloud spreading in all directions, resulting in zero visibility in the wider and closer surroundings (drivers could not see the road nor the vehicles in front of them), two traffic accidents have occurred on the state road IA class, marking A4, at a distance of approximately 500m. In the first traffic accident (multiple-vehicle collision), 7 (seven) vehicles were involved, with three individuals suffering minor injuries and one person sustaining severe injuries. In the second traffic incident (vehicle collision with a protective metal fence), there were no reported injuries.

During the inspection of the state road IIA class, marking 259, near the Sopot interchange, traffic police officers noticed three abandoned vehicles with visible damages to their front parts, which were damaged on 25.12.2022, around 17:30.

During the inspection of the state road IIA class, marking 221, in Pirot, on Knjazevačka Street, on the widening of the roadside, traffic police officers noticed one abandoned passenger vehicle.

On 26.12.2022, at 09:10, at the location known as “Sopotski Han” in the territory of the city of Pirot, in the immediate vicinity of the railway track and the locomotive of freight train No. 45010, a male body was found. Upon the investigation of the scene, it was determined that the deceased was a Turkish citizen and the driver of the freight road vehicle. It is most likely that while approaching the bridge over the Nišava River, he encountered an ammonia cloud and, due to zero visibility, fell from a height of about 20 meters after exiting the cabin of the freight road vehicle, resulting in his immediate death.

2.2.7.2. Activities of MUP RS, Emergency situations sector

By a letter from the MUP RS, Sector for Emergency Situations 09, No.: 217-479/2023, dated 31.03.2023, data were provided stating that on 25.12.2022, at 17:12, the Command-Operative Center of the Fire and Rescue Battalion in Pirot received a report from the Traffic Police Department, PU Pirot, that thick smoke without flames was visible on the state road IA class, marking A4, near the village of Staničenje, city of Pirot. Members of the Fire and Rescue Unit were dispatched to the scene.

On the road near the location “Sopotska Petlja”, a large concentration of gas was observed in the form of a cloud, rapidly spreading in all directions. Additionally, on the state road IIA class, marking 259, and on the state road IA class, marking A4, around ten traffic accidents (vehicles veering off the road and collisions involving multiple vehicles) were noticed.

Members of the fire and rescue units were deployed on the roadways in the areas of “Muntina Padina”, “Žukovo”, “Presečica”, “Sopotski Han”, and “Sopotska Petlja” (sections of the highway IA class, marked as A4, and state roads IIA class, marked as 221, and 259). They conducted evacuations and rescues of individuals injured in traffic accidents, as well as evacuations of employees at the toll ramp Pirot West and families residing near the mentioned roadways. Through the coordinated efforts of the fire and rescue unit members, a total of 56 individuals were evacuated and rescued and handed over to the Emergency Medical Service teams for further care.

Firefighters-rescuers conducted the detection of hazardous substance at the scene of the occurrence. The detection devices possessed by the fire and rescue units are designed to measure the current concentration of dangerous substances in the atmosphere, in order to determine the level of protection and the appropriate response within the work zone. Additionally, members of

the fire and rescue units performed duty and provided assistance to the investigative team of the PU Pirot, the Traffic Accident Investigation Team, and other relevant services. This assistance included ensuring an adequate number of respiratory protective equipment for the personnel working at the location of the emergency event.

During the period from 25.12. to 29.12.2022, on the mentioned emergency event, members of the fire and rescue units from Pirot, Niš, Belgrade, Pančevo, Kragujevac, Leskovac, and Zaječar were engaged, totaling 172 firefighters and rescuers and 34 vehicles. Additionally, four members of the Fire and Rescue Administration were involved with two vehicles and one unmanned aerial craft. During their involvement in the emergency event, evacuation, and rescue of individuals directly affected by the serious accident, five members of the fire and rescue units requested medical assistance and were provided care at the General Hospital in Pirot.

2.2.7.3. Activities of Pirot Health Care, Emergency Medical Service

By a letter from the Pirot Health Center, Emergency Medical Service, No. 02-219, dated 02.02.2023, data were provided stating that on 25.12.2022, at 17:19, the Emergency Medical Service in Pirot received the first call regarding the release of ammonia from overturned wagon tanks. One team consisting of three members (a doctor, a medical technician, and a driver) was dispatched to the scene of the serious accident. After receiving new information about the serious accident and in coordination with the firefighters, the team was redirected to the toll ramp Pirot West, which was at a safe distance from the site of the serious accident. There, the firefighters transported the injured individuals to receive medical assistance.

After receiving new calls and information that were considered an alert for the Emergency Medical Service to engage additional teams, another available team from the shift was dispatched to the scene, and additional medical staff and drivers were called in. They promptly responded and reported for duty.

Regarding the serious accident, a total of 21 (twenty-one) employes from the Emergency Medical Service in Pirot participated with 6 (six) ambulances, consisting of 4 (four) doctors, 4 (four) medical technicians, and 4 (four) drivers who were always on-site at the scene. During the period from 25.12.2022, at 17:30, to 26.12.2022, at 12:40, four teams from the Emergency Medical Service took care of a total of 27 patients who complained of respiratory distress. These patients were provided oxygen therapy and transported to the Triage and Emergency Care Department of the General Hospital in Pirot for further treatment. In addition to these activities, two ambulance drivers from the Emergency Medical Service transported two patients from the General Hospital in Pirot to the UKC Niš. Furthermore, one ambulance driver, who was passing the highway shortly after the serious accident while transporting a patient unrelated to the accident, also picked up three adults and one child who complained of respiratory distress and took them to the UKC Niš. On 26.12.2022, at 10:15, following a report from the firefighters, the emergency medical services team found an unconscious person in the area of the village of Sopot. The person was not conscious, not breathing, had no heartbeat, showed signs of rigor mortis, and had postmortem spots on the body.

2.2.7.4. Activities of the Ministry for Environmental Protection

By a letter No. 353-03-327/23-07, dated 02.02.2023 of the Ministry of Environmental Protection, Sector for Supervision and Preventive Actions in the Environment, data was provided

that the Ministry was informed about the serious accident by the MUP RS, Sector for Emergency Situations. Following this notification, the authorized laboratory of the Institute of Mining and Metallurgy in Bor was engaged to conduct examinations of ammonia concentrations in water and air at the affected location. As attachments to the letter from the Ministry of Environmental Protection, Sector for Supervision and Preventive Actions in the Environment, the following reports were provided Examination Report No. 11/23, dated 04.01.2023, on water samples taken from the Nišava River near Pirot after the ammonia release from the wagon tank, taken on 26, 27, 28, and 30.12.2022. and Examination Report No. 220-23, dated 13.01.2023, on the ambient air quality in the accident situation near the village of Sopot, Pirot, during the period from 30.12 2022, to 03.01.2023, as provided by the Institute of Mining and Metallurgy in Bor. The reports indicate that during the first two days of monitoring, based on the concentration of ammonium ions, the water of the Nišava River at the accident site was classified as Class IV surface water, indicating a weak ecological status. On the third day of monitoring, the concentration of ammonium ions decreased; however, the water at the accident site still fell under Class IV surface water. On the fourth day of monitoring, the concentration of ammonium ions visibly decreased, and the water of the Nišava River was classified as Class III surface water, indicating a moderate ecological status. In the same report, it was noted that the water sampled downstream from the accident site on 27.12.2022, did not contain increased concentrations of ammonium ions, indicating that the pollution caused by ammonia did not reach downstream into the Nišava River. Regarding the Report on the examination of ambient air quality, there is no data mentioned about the concentration of ammonia.

As an attachment to the letter from the Ministry of Environmental Protection, Sector for Supervision and Preventive Actions in the Environment, an Official Note from the Republic Inspector for Fisheries, No. 914-480-324-49/2022-17, dated 28.12.2022, was delivered. In the note, it was stated that on 28.12.2022, an extraordinary field inspection was conducted on the Nišava River based on a submitted report. Following the received report, the Republic Inspector for Fisheries, along with the chief of the fishery monitoring service, the director, and representatives of the company “Association Veternica-Vlasina” from Leskovac, performed an extraordinary field inspection at several locations downstream from the derailment of the railway wagon tanks, up to the bridge over the Nišava River in Bela Palanka. During the inspection, it was found that there were no changes in the sensory properties of the water nor any dead fish observed at the controlled locations.

2.2.7.5. Activities of the Environmental Protection Agency

By a letter No. 353-01-00001/2/2023-02, dated 31.01.2023, the Environmental Protection Agency provided data indicating that, in accordance with Article 106 (accidental pollution monitoring) of the Law on Waters (“Official Gazette of RS” No. 30/10, 93/12, 101/16, and 95/18), the Environmental Protection Agency conducted continuous emergency water sampling of the Nišava River from 26.12.2022, to 09.01.2023, upon the order of the water inspection. Furthermore, on 26.12.2022, a mobile automatic air quality monitoring station was installed within the premises of the “Tigar Tyres” factory. The measurements began on the same day at 21:00 and were carried out until 13.01.2023, at 11:00. The average daily concentrations of ammonia measured during this period ranged from 3 to 9 $\mu g/m^3$, which is below the permissible limit of 100 $\mu g/m^3$.

2.2.7.6. Activities of the City Administration of the city of Pirot

By letter number 8-4/2023, dated 13.02.2023, from the City Administration of Pirot, along with other attachments, the Decision on declaring a state of emergency for a part of the territory of the City of Pirot II no. 8-8/2022, dated 25.12.2022 (for the area of the Urban Settlement of Pirot and the villages of Crnoklište, Crvenčevo, Staničenje, and Sopot), the Decision on the termination of the state of emergency for a part of the territory of the City of Pirot II no. 8-1/2023, dated 16.01.2023 (for the area of the Urban Settlement of Pirot and the villages of Crnoklište, Crvenčevo, Staničenje, and Sopot), and the Report from the Institute of Public Health Pirot No. 374, dated 03.02.2023, on the concentrations of ammonia in the water from the moment of introducing the state of emergency until its termination were delivered. Regarding the introduced state of emergency, an expert operational team was formed, consisting of representatives from the Pirot PU, Department for Emergency Situations, "Srbija Kargo"a.d, "HIP-Azotara"d.o.o. Pančevo, "Elixir Zorka - Mineral Fertilizers"d.o.o. Šabac, the company Tekon, and "IŽS"a.d., which continuously monitored and coordinated the work of all services involved in monitoring the situation and mitigating the consequences of the serious accident. From 26.12.2022, to 16.01.2023, the Institute of Public Health Pirot performed daily sampling and analysis of drinking water from rural water supply systems, capped wells, and surface waters of the Nišava River in the area where the accident occurred. Sampling and analysis of water were carried out in the morning and evening - twice a day, except on 07.01. and 08.01.2023, when the Institute of Public Health Niš performed the same measurements. The following chemical parameters were examined: pH, ammonia, nitrates, and nitrites. The Report on the concentrations of ammonia in the water during the state of emergency in the area of the city of Pirot from 25.12.2022, to 16.01.2023, from the Institute of Public Health Pirot, No. 374, dated 03.02.2023, states that all tested waters were hygienically safe concerning the examined parameters, in compliance with the applicable Regulation on the Hygienic Safety of Drinking Water ("Official Gazette of SRJ", No. 42/98 and 44/99, and "Official Gazette of RS", No. 28/19), except for one water sample from a well in the village of Sopot, for which it was determined that the cause of non-compliance was inadequate maintenance rather than a serious accident on the railway. As for the samples from the Nišava River, taken at two locations, twice a day, from 26.12.2022, to 16.01.2023, near the village of Staničenje and near Bela Palanka, the water was of Class V only on 26.12.2022, while in all other cases, it was classified as Class II and III.

2.2.7.7. Danger Area – Prohibited Access Area

The figure 2.2.7.7.1 shows danger areas or restricted access areas established on 25.12.2022, by the members of the MUP RS, Sector for Emergency Situations (the provided data are attached to the letter from "IŽS"a.d., Sector for Traffic Affairs, reference No. 15/2023-106 dated 01.02.2023). These areas were designated in response to the decision made by the mayor of the city of Pirot on 25.12.2022, and were determined based on the wind direction in the zone of the serious accident that occurred on 25.12.2022.

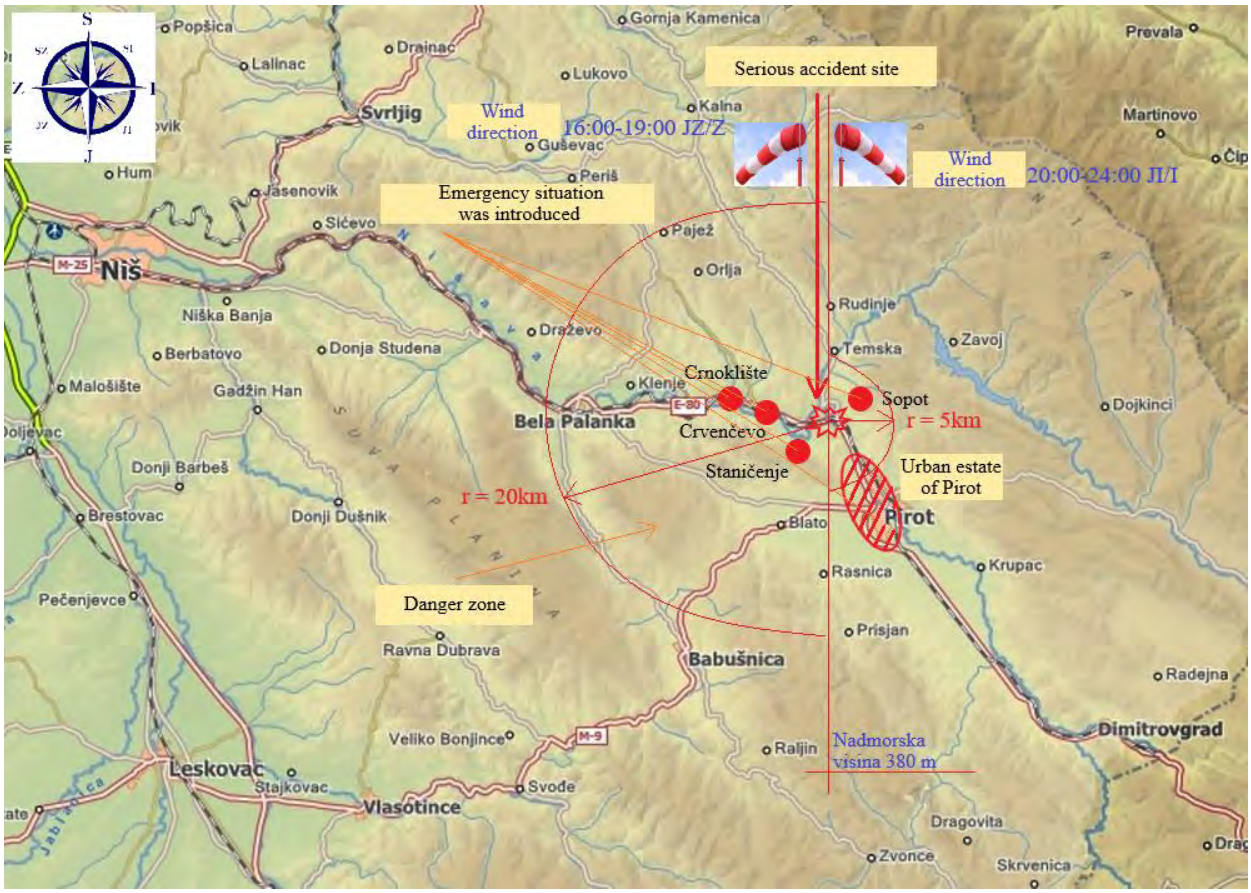


Figure 2.2.7.7.1: Review of the danger area, the areas where the emergency situation has been introduced and the direction of wind, for 25.12.2022.

2.3. Fatally injured, injured and material damage

2.3.1. Passengers, third parties and the railway workers including contractors

In the serious accident, 2 (two) third parties were fatally injured as follows: one person (a citizen of the Republic of Serbia) passed away after being admitted to the General Hospital in Pirot with symptoms of poisoning due to exposure to ammonia vapors, and the other person (a citizen of the Republic of Turkey) was found dead on 26.12.2022, in the vicinity of the accident site, below the bridge on the state road IA class, A4 marking, in the area of the village of Sopot, by the Pirot Emergency Medical Service, following a report from the firefighters at the scene. The total number of third parties with symptoms of poisoning due to exposure to ammonia vapors, who required medical assistance, is 62 (sixty-two) (out of which one person died within 24 hours after admission to the hospital, the aforementioned citizen of the Republic of Serbia). Out of this number, 51 (fifty-one) individuals were treated at the General Hospital in Pirot (41 (forty-one) were treated on an outpatient basis, and 10 (ten) individuals were hospitalized (eight individuals at the General Hospital in Pirot, and two individuals were transferred to the UKC Niš)), while 13 (thirteen) individuals were treated at the UKC Niš (11 (eleven) individuals were directly admitted to the UKC Niš, and 2 (two) individuals were transported from the General Hospital in Pirot).

Out of the 62 (sixty-two) individuals who required medical assistance, 9 (nine) individuals were hospitalized for more than 24 hours (5 (five) individuals at the General Hospital in Pirot and 4 (four) individuals at the UKC Niš), while 1 (one) person passed away.

Table 2.3.1.1: Review of fatally injured and injured (with symptoms of poisoning) persons

	Passengers	Railway workers	Third parties	Total
Fatally injured	-	-	2	2
Seriously injured	-	-	9	9
Slightly injured	-	-	52	52

In the letter of the MUP RS, PU Pirot, No. 220-3-12/23 April 5.4. 2023, it is stated that as a result of "zero" visibility on the state road IA class, mark A4, near the location of Sopot, Pirot city, on the section of the road between Bela Palanka interchange and Pirot interchange, 3 (three) persons were slightly injured and 1 (one) person was seriously injured in a traffic accident. It is not known whether these individuals are included in the total number of 62 treated individuals at the General Hospital in Pirot and the Clinical Center of Niš, whose letters clearly stated that all treated individuals had symptoms of ammonia poisoning due to exposure to ammonia fumes (no other types of injuries are mentioned anywhere).

According to the data provided by the OJT in Pirot (autopsy records attached to the letter with reference Ktn No. 218/22 dated 27.04.2023), the first person (citizen of the Republic of Serbia) passed away shortly after being admitted to the General Hospital in Pirot, directly due to ammonia poisoning, while the second person (citizen of the Republic of Turkey) was found near the scene of the serious accident and possibly passed away due to inhalation of ammonia.

Data on the fatally injured and injured individuals were provided by the General Hospital in Pirot (letter No. 02-215/2 dated 02.02.2023), the Health Center in Pirot (letter No. 02-219 dated 02.02.2023), the UKC Niš (letter No. 2793/2 dated 03.02.2023), the City Administration of Pirot (attached to the letter No. 8-4/2023 dated 13.02.2023), and the Forensic Medicine Department in Pirot (letter Ktn No. 218/22 dated 27.04.2023).

2.3.2. Goods, luggage and other assets

In this serious accident, due to the release from the damaged wagon-tank No. 33 80 7818 081-1 (thirteenth wagon, viewed from the locomotive), there was a loss of part of the cargo (ammonia).

Based on the information provided by "Elixir Group"d.o.o. Šabac via email on 22.06.2023, the weight of the lost cargo amounts to 34.66 t, with a value of 52,650.00 euros.

According to the official middle exchange rate of the National Bank of Serbia on 25.12.2022, which was 1 EUR (Euro) = 117.2892 RSD (Serbian Dinars), the total material damage to the cargo (ammonia) caused by the aforementioned serious accident amounts to 6,175,276.38 dinars (RSD).

2.3.3. Railway vehicles, infrastructure and the environment

In the serious accident, railway vehicles and infrastructure were damaged. The extent of the material damage caused to the property of third parties is not known.

The structure of the incurred material damage is given as follows:

Damage to railway vehicles (wagons within the composition):	1,622,962.33	RSD
Costs of lifting the derailed wagons:	6,795,444.06	RSD
Damage to the track (super and substructure):	1,134,963.00	RSD
Costs of machinery for the repair of the track damage:	952,104.00	RSD
Labor costs for the repair of the railway track damage:	3,457,349.00	RSD
Total direct material damage:	**13,962,822.39**	RSD

The damage is expressed in the official currency of the Republic of Serbia (Dinar - RSD).

According to the official middle exchange rate of the National Bank of Serbia on 25.12.2022, which was 1 EUR (Euro) = 117.2892 RSD (Serbian Dinars), the total material damage caused to the infrastructure and railway vehicles in the serious accident amounts to 119,046.10 euros (EUR).

The material damage in this report is presented based on invoices, assessments, and documents confirming the mentioned amounts of damage, provided by "IŽS"a.d, "Srbija Kargo"a.d, and MGSI, and which were available until the moment of concluding this report.

In order to determine the material damage caused to the environment, CINS addressed the Cabinet of the Ministry of Environmental Protection (letter No. 340-00-2/2022-02-1-17 dated January 17.01.2023, and urgent letter No. 340-00-2/2022-02-1-57 dated 14.03.2023), the Environmental Protection Agency (letter No. 340-00-2/2022-02-1-19 dated 17.01.2023), and the Cabinet of the Mayor of Pirot (letter No. 340-00-2/2022-02-1-21 dated 17.01.2023), with a request for providing data on the damage caused to the environment. In response to the request from CINS, the Environmental Protection Agency stated in a response (letter No. 353-01-00001/2/2023-02 dated 31.01.2023) that the Agency is not competent to determine the environmental damage. The responses from the City Administration of Pirot (letter No. 8-4/2023 dated 13.02.2023), the Ministry of Environmental Protection, Sector for Supervision and Preventive Action (letter No. 353-03-327/23-07 dated February 2, 2023), and the Ministry of Environmental Protection, Cabinet of the Minister (official letter dated 22.03.2023) also did not provide data on the damage caused to the environment. Based on the information provided, it can be concluded that the material damage caused to the environment has not been determined.

2.3.4. External conditions- weather conditions and geographic features

The site of the serious accident is located within the territory of the city of Pirot, in the area of the village of Sopot. The terrain configuration near the site of the serious accident is hilly and mountainous, at an approximate cross level of 380 m above sea level.

The geographical coordinates of the site of the serious accident are: 43° 12' 48.1" N and 22° 33' 08.2" E.

The area where the serious accident occurred is inhabited (several residential buildings belonging to the territory of the village of Sopot are located near the site of the serious accident).

The location where the overturned tanks were situated is approximately 130 m away from the nearest residential buildings in the territory of the village of Sopot and approximately 220 m away from the state road IA class, marked A4.

The section of the railway track where the serious accident occurred is situated on an embankment, within a right curve with a radius of 500 m and a gradient of 0‰ (horizontal).

By the letter from the Republic Hydro-Meteorological Institute, number: 925-1-13/2023 dated January 20, 2023, the following data was provided for December 25, 2022, in the area between Pirot and Staničenje maximum air temperature was 12.0°C, minimum air temperature was -1.9°C and minimum air temperature at 5 cm above the ground was 2.6°C. Throughout the day, there were no precipitation events, and no meteorological phenomena were observed. The soil remained moist during the entire day. The meteorological visibility was between 15 to 20 km during most of the day, and at 16, 17, 18, 19, 20, 21, 22, 23, and 24 hours, it was 20 km. (Meteorological visibility is the transparency of the atmosphere, expressed as the greatest distance at which objects of a known size can be recognized by a standard observer.) A moderate wind was blowing with maximum gusts ranging from 5.5 to 7.9 m/s. A total of 0.7 mm of precipitation was recorded. The following meteorological phenomena were observed: weak dew from 19:10 to 21:10 and weak to moderate hoarfrost from 21:10 to 24:00.

Here is the summary of the weather data for the mentioned hours:

16:00: Air temperature 9.3°C, air pressure 971.5 hPa, wind speed 2.0 m/s from the southwest.

17:00: Air temperature 7.7°C, air pressure 972.0 hPa, wind speed 2.4 m/s from the west.

18:00: Air temperature 5.1°C, air pressure 972.0 hPa, wind speed 0.9 m/s from the west.

19:00: Air temperature 3.1°C, air pressure 972.7 hPa, wind speed 0.8 m/s from the west.

20:00: Air temperature 2.9°C, air pressure 972.7 hPa, wind speed 1.7 m/s from the east.

21:00: Air temperature 1.9°C, air pressure 972.7 hPa, wind speed 1.6 m/s from the east.

22:00: Air temperature 0.9°C, air pressure 973.0 hPa, wind speed 1.4 m/s from the east/southeast.

23:00: Air temperature 0.3°C, air pressure 973.0 hPa, wind speed 1.5 m/s from the east/southeast.

24:00: Air temperature 0.4°C, air pressure 973.0 hPa, wind speed 2.6 m/s from the east/southeast.

The data was issued based on measurements and observations at the Meteorological Station in Dimitrovgrad, which is climatologically representative for the requested area.

Based on the provided data, it can be concluded that the observed fog or “white smoke” reported by road traffic participants at the site of the serious accident and during the time of the accident is not of atmospheric origin (visibility from 16:00 to 24:00 was 20 km). Instead, it is the result of the release of ammonia from the overturned and damaged thirteenth wagon-tank No. 33 80 7818 081-1, part of the train composition of the train No. 45010.

The investigative team of CINS conducted an on-site investigation of the serious accident on 26.12.2022, with the approval of the MUR RS, Sector for Emergency Situations. The inspection was carried out after 10:00, when conditions allowed for the visit to the accident site. Due to the

presence of ammonia in the air at concentrations hazardous to human life and health, the on-site investigation was conducted under the supervision and assistance of members from the MUP RS, Sector for Emergency Situations with using respiratory protective equipment, which was provided by the members of the Sector for Emergency Situations. During the on-site investigation of this serious accident on 26.12.2022, by the investigative team of CINS, it was daytime. The weather was sunny, with occasional weak-intensity winds. Visibility was good, and the soil was moist. The air temperature was 10°C.

3. Minutes on investigation and examination

Data, facts and evidence regarding the occurrence of the serious accident in question were collected and determined on the basis of:

- On-site investigation by the investigative team of CINS;
- The inspection of the car was conducted at certified workshops (“Inter-mehanika”d.o.o. in Skorenovac, Smederevo, and “Srbija Kargo”a.d, Sector ZOVS, Section ZOVS, Belgrade, OJ for ROS and freight vehicles in the Belgrade Marshalling Yard station)
- Materials submitted by infrastructure manager “IŽS”a.d.;
- Materials submitted by railway undertaking “Srbija Kargo”a.d.
- Material submitted by “Elixir Group”d.o.o. Šabac;
- Material submitted by “ATIR-RAIL SA”,
- Material submitted by”VTG Rail Europe” GmbH and
- Material submitted by OJT in Pirot.

For the serious accident in question, the on-site investigation was conducted by the joint investigative committee of the infrastructure manager “IŽS”a.d. and the railway undertaking “Srbija Kargo”a.d.

Members of MUP RS, PU in Pirot and employees of OJT in Pirot also conducted on-site investigation of this occurrence.

3.1. Summary of testimonies

On 29.03.2023, the working group of CINS conducted hearings with the train driver and the assistant train driver who were on duty with train No. 45010 at the time of the serious accident. Both of them were employed by the railway undertaking “Srbija Kargo” a.d.

From “Srbija Kargo”a.d., Transcripts of the hearings of the employees who were on duty on train No. 45010 (the train driver and the assistant train driver) were obtained.

From “ИЖС”a.d., Transcripts of the hearings of the employees who were on duty at the Staničenje crossing point and at the Pirot station (train dispatchers), as well as the Train Dispatcher's Report on irregularities during operation (SP-9) No. 41 from 25.12.2022, issued by the train dispatcher of the Pirot station, who was on duty at the time of the serious accident, were obtained. Also, the first statement of the train driver was submitted by Letter No. 1/2023-1619 of 31.08.2023. from “IŽS”a.d.

The statement of the train driver taken immediately after the occurrence of the serious accident, as well as the transcripts of hearings from the infrastructure manager “IŽS”a.d. and the

railway undertaking “Srbija Kargo”a.d., match in all essential facts with the testimonies given during the hearings conducted on 29.3.2023, in the premises of CINS.

The summary of testimonies from the train driver and the assistant train driver, who were on duty with train No. 45010, was provided based on the hearings conducted by the working group of CINS.

3.1.1. Railway workers

The train driver stated that he had no objections when taking over the wagon-tanks at the Dimitrovgrad station, and the train's journey from the starting station proceeded normally. There were no unusual jerks during the train's movement with the wagons-tank until the site of the serious accident, where there were multiple consecutive jerks. He assumed that something was wrong with the train and applied emergency braking. They weren’t sounds, just more consecutive jerks. He mentioned that he first initiated the braking and only after that, decoupling occurred, as he would have seen a drop in pressure on the pressure gauge otherwise. He emphasized that the speed on the section of the track where the serious accident occurred was low, at 30 km/h, while just before the serious accident, the train was moving at a slightly higher speed of around 20 km/h. After stopping the train, he got out of the locomotive to check if some wagons had derailed, but upon seeing a cloud of vapor, he immediately reacted, called his colleague (assistant train driver), and they evacuated themselves (using a third-party vehicle) to the Staničenje crossing point. He mentioned that a female person (medical worker) provided them with first aid and drove them to Staničenje. Later, they decided that they didn't need further medical assistance, so they didn't seek it. In the morning hours of 26.12.2022, they resumed evacuation and arrived in Niš, where, upon request of the supervisor, they underwent a medical examination confirming that everything was fine. The stress was felt later when he arrived home and realized the gravity of the situation, he had been in.

The train driver assistant stated that he had no objections during the takeover of the wagon-tanks at the Dimitrovgrad station, and that the train drive from the initial Dimitrovgrad station proceeded regularly. There were no unusual jerks during the starting or during the train drive with the wagon-tanks, until the point of a serious accident, where he felt a jerk in the sense of rocking back and forth, when, at that point, the train driver assistant initiated emergency braking. There was a lot of noise in the locomotive, so he didn't hear any sounds. Bearing in mind that, after opening the windows on the locomotive, he felt a burning sensation in his throat, an unpleasant odor, and saw a white cloud, upon the train driver’s call, they both safely evacuated the train. Initial first aid was provided by a female individual (medical worker) who then transported them by car to Staničenje. Later, they decided that they did not require medical assistance, so they didn't seek it. In the morning hours of 26.12. 2022, they resumed the evacuation and arrived in Niš, where at the request of the supervisor, a medical examination was conducted, which confirmed that everything was in order. It was determined that he experienced mild stress and agitation. He mentioned that the protective equipment he usually receives includes protective clothing and footwear, and that he doesn't have any additional protective gear.

3.1.2. Other witnesses

CINS has no knowledge of witnesses to this serious accident.

3.2. Safety management system

3.2.1. Organizational frame and manner of issuing and executing orders

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

In accordance with the applicable Safety Management System Manual of "Srbija Kargo"a.d. informed CINS about the occurred accident.

The Infrastructure Manager "IŽS"a.d. and the railway undertaking "Srbija Kargo"a.d. in accordance with the Law on Railway Traffic Safety ("Official Gazette of RS" No. 41/2018), formed a joint investigative committee that conducted an investigation of the mentioned accident. Until the Draft of the Final investigation report is concluded by CINS, the Investigation Report drafted by the joint investigative committee of the infrastructure manager and the railway undertaking has not been submitted.

3.2.2. Requirements that must be fulfilled by the railway staff and the manner they are applied

"Srbija Kargo"a.d. has ensured competency management through the Safety Management System Manual (SMS), meaning that processes are in place to train and ensure competency for all employees directly involved in railway operations, as well as planning of workload.

Regarding the serious accident in question, involving the train driver and the train driver assistant employed by "Srbija Kargo"a.d. all activities related to professional training, competency, and work schedule planning have been conducted in accordance with applicable regulations.

"IŽS"a.d. has ensured competency management through the Safety Management System Procedure (SMS), which means processes are in place to train and ensure competency for all employees directly involved in railway operations, as well as planning of workload.

3.2.3. Procedures for internal audit and checks and their results

"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. for the purpose of ensuring safe railway operations.

Risk control related to the maintenance of railway infrastructure (infrastructure subsystems, energy, control, management, and signaling - track section) and railway vehicles maintained by "IŽS"a.d. is based on implementing defined activities of regular and extraordinary maintenance, and their monitoring and control. Regular and extraordinary maintenance includes continuous supervision, inspections, reviews, repairs, and corrections.

Requirements, standards, and procedures for maintenance at "IŽS"a.d. are determined based on legal regulations, general and specific company documents, manufacturer's instructions, and standards.

Regarding the mentioned serious accident, regular and extraordinary maintenance of the track was not conducted in accordance with the applicable regulations.

Although it is stipulated in the Safety Management System Procedure of "IŽS"a.d. that a safety risk assessment should be carried out and appropriate measures should be taken based on multi-year reports, "IŽS"a.d. did not perform a safety risk assessment and did not take appropriate measures based on multi-year reports that indicated that the condition of the section where the serious accident occurred was not in line with the Regulation on Technical Conditions and Maintenance of the railway track superstructure, No.: 340-201-2/2016 ("Official Gazette of RS" No. 39/16 and 74/16).

3.3. Relevant international and national regulations

3.3.1. Law on Railways ("Official Gazette of RS" No. 41/2018)

Note: The Law on Railways ("Official Gazette of RS" No. 41/2018) was in force at the time of the serious accident. The Law on Amendments to the Law on Railways ("Official Gazette of RS" No. 62/2023 of 27.07.2023) entered into force on the eighth day from the day of its publication in the "Official Gazette of the RS", except for the provisions of Article 39 and 40 of this Law, which are applied after one year from the date of entry into force of this Law and the provisions of Article 38 of this Law, which are applied from the day of accession of the Republic of Serbia to the European Union, i.e. from the day of full implementation.

II Railway infrastructure

...

1. Management of the public railway infrastructure

...

Obligations of the railway infrastructure manager

Article 10 (excerpt)

The infrastructure manager is obligated to ensure the safe and uninterrupted organization, regulation, and management of railway traffic, as well as unobstructed access and utilization of public railway infrastructure and access to service facilities entrusted to its management. It must provide services within these facilities to all interested applicants for the allocation of infrastructure capacity under equal, non-discriminatory, and transparent conditions. Additionally, the infrastructure manager is responsible for the continuous, uninterrupted, and high-quality maintenance and protection of the railway infrastructure.

...

III Calculation of access prices and allocation of railway infrastructure capacity

...

7. Public railway infrastructure maintenance

Article 55

Public railway infrastructure must be maintained in a condition that ensures safe and uninterrupted railway traffic, as well as quality and orderly transportation, in accordance with regulations governing railway safety and technical regulations and standards. Maintenance of public railway infrastructure includes regular maintenance and extraordinary maintenance. The technological unit for maintenance comprises all elements of the public railway infrastructure. Maintenance intervenes on specific elements, ensuring that they are in a state that maintains the technological function of the track and prevents bottlenecks on the rail line. The infrastructure manager, through a special document, approves the introduction of any restricted speed runs or permanent speed reductions in relation to the designed track parameters, providing reasons for the reduction of traffic speed and track capacity with prescribing technical measures for their improvement, as well as setting a planned deadline for the removal of the speed restrictions/ restricted speed runs which submit to the Republic railway inspector.

Article 56

The works related to regular maintenance particularly include: Maintenance and replacement of super structure elements of the railway track (switches, tracks and track connections) with the same or different types that maintain the track parameters at the designed level; works on the substructure of the railway track (drainage and slope arrangement); clearing the trees, shrubs, and vegetation from the track area, replacement and renovation of culverts and bridges up to 10 m in length, without altering their span; replacement and supplementation of signaling- safety devices, telecommunication devices and installations; replacement and supplementation of stable installations for electric traction, as well as other installations for transforming and transmitting electric energy for train traction; adaptation and repair of railway service official position buildings and other facilities at railway service official positions, without altering their construction and external appearance; snow and ice removal from tracks, installations and surfaces on station platforms, stops, etc.

Article 57

Extraordinary maintenance works are major repairs carried out to address the consequences of extraordinary/exceptional events (accidents, floods, earthquakes, etc.) on existing railway infrastructure elements, with the goal to restore safe traffic conditions and achieve the designed parameters.

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

III Safety management in railway traffic

Ensuring safety in railway traffic

Article 5

The Ministry responsible for traffic affairs (hereinafter referred to as: the Ministry), the Directorate, the Center for Investigation of Accidents in Transport (hereinafter referred to as; the Center), the infrastructure manager (hereinafter referred to as: the manager), and the railway undertaking, each in accordance with their respective responsibilities, ensure the following: 1) the preservation of safety within the railway system and, wherever feasible, the continuous

improvement of railway safety, with a priority on accident prevention; 2) transparent and non-discriminatory application of safety regulations; 3) acceleration of the development of a unified railway system. The infrastructure manager and railway undertaking are responsible for the safe operation of the railway system and the control of associated risks, achieved by implementing necessary risk control measures, fostering mutual collaboration, adhering to national safety regulations and standards, and establishing safety management systems in accordance with this Law.

…

Supervision over safety management systems

Article 15

The Directorate supervises the safety management systems of the infrastructure manager and railway undertaking, after issuing safety certificates for the management of railway infrastructure and safety certificates for transportation.

Through the supervision outlined in paragraph 1 of this Article, it is verified whether the infrastructure manager and railway undertaking are implementing their safety management systems, and, if necessary, appropriate measures are ordered to be taken.

The decision to implement appropriate measures as stipulated in Paragraph 2 of this Article is finally determined through an administrative procedure, and a dispute regarding it can be brought before the Administrative Court.

On-site supervision, as referred to in paragraph 1 of this Article, is conducted by authorized persons of the Directorate, at least once a year.

...

V Subsystem infrastructure

...

Subsystem infrastructure maintenance

Article 28 (excerpt)

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

...

Traction vehicles devices and equipment

Article 51

The locomotive must possess:

1) control device;

2) braking device;

3) traction device;

4) alertness device;

5) auto-stop device, on tracks equipped with a track part of auto-stop device, except in the case of:

(1) train traffic on a bypass track.

(2) extension of the train's movement until the first possible locomotive replacement in the event of a failure of the auto-stop device during operation.

(3) delivering the locomotive to the depot or maintenance workshop, etc.;

6) registering speedometer (tachograph);

7) device for lighting and providing head signals;

8) device for emitting audible signals;

9) device for radio communication with the dispatch center when operating on tracks equipped with radio dispatch communication;

10) device for wiping the front glass;

11) external mirrors - rearview mirrors or cameras;

12) fire extinguishing equipment for initial fire extinguishing;

13) first aid kit;

14) manual chocks for preventing self-movement.

3.3.3. Law on Railway System Interoperability ("Official Gazette of RS", No. 41/2018 and 16/2022 – Authentic Interpretation)

Note: The Law on Interoperability of the Railway System ("Official Gazette of RS", No. 41/2018 and No. 16/2022 - Authentic Interpretation) was in force at the time of the occurrence of the serious accident. With the entry into force of the Law on Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023 of 27.7. 2023), this Law ceased to be valid.

III License for use

...

2. License for vehicle type

Article 22 (excerpt):

All types of vehicles that are registered in the Republic of Serbia, regardless of the manufacturer, must be approved.

The vehicle type approval is issued by the Directorate in the prescribed form and in the format of a decision.

...

Vehicles that correspond to an approved type must obtain individual licenses for use, which are issued based on a conducted procedure that verifies conformity with the approved type and declarations of compliance with the vehicle type.

...

3.3.4. Instruction on Unique Criteria for track condition control on the railway network of JŽ, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004, "Official Gazette of ŽS" No. 14/22)

Note: Decision "IŽS"a.d. No. 4/2015-51-17 dated 29.12.2015, regarding the adoption of regulations issued by the ZJŽ as their internal documents, this Instruction has been adopted and continues to be applicable at "IŽS"a.d.

Point 2. (excerpt)

...

6. The record must include the following essential elements: what is being examined and with what, the date of recording the track and stationing of the recorded track section, **a diskette with a graphical and analytical representation of the technical condition of the measured track or track section.**

Important note:

1. The highlighted part of the text in point 2, under 6, was replaced by the amendments from 2004, replacing the text from the earlier edition of Instruction 339 (2001), which read:

The record must contain the following basic elements: what is being examined and with what, the date of recording the track and stationing of the recorded track section, **registered locations directly endangering the safety of railway traffic.**

1. In point 7 of the current edition of Instruction 339, the text under article 7 under 5 is missing from the earlier edition of Instruction 339 (1989), which read:

Registered errors directly endangering traffic safety must be rectified on the same day after the passage of the track inspection coach. If this is not possible, appropriate safety measures should be taken.

Point 9, subpoint 3, excerpt from the current Instruction 339 of 2001/2004/2022 reads:

"B - errors that require planning work for their removal"

"C - errors that are above operational limits **and require urgent removal or speed reduction**"

Important note:

The highlighted portion of the text in point 9, under 3, was replaced by the text from the earlier edition of Instruction 339 (1989), which read:

"and which must be immediately removed as they endanger traffic safety"

Point 9 (excerpt) from the current Instruction 339 of 2001/2004/2022:

The condition of the track is evaluated based on the total length of errors in groups “B” and “C” over a distance of one kilometer.

The condition of one kilometer of track is as follows:

- Satisfactory, up to 250 m of errors in group B and up to 25 m of errors in group C, or ≤250/25 (B/C).
- Unsatisfactory, over 250 m of errors in group B and over 25 m of errors in group C, or >250/25 (B/C).

Important note: In the Instruction 339, with amendments from the year 2001, the last paragraph from point 9 was removed which was, in the earlier edition of Instruction 339 (1989), read as follows:

Immediately after the track inspection drive, works are undertaken on all kilometers where the length of errors exceeds 200/20, while it must be recorded in the log how this situation occurred. After determining the reasons for the appearance of errors and their location, the immediate preparation of a plan to improve the condition of the observed kilometer is initiated.

3.3.5. Rulebook on Technical Conditions and Maintenance of the Railway Line Superstructure No.: 340-201-2/2016 (“Official Gazette of RS” No. 39/16 and 74/16)

Note: With the entry into force of the Rulebook on Technical Conditions for the Infrastructure Subsystem (“Official Gazette of RS” No. 39/23 dated 12.05.2023) and the Rulebook on Maintenance of the Railway Track Super and Sub structure (“Official Gazette of RS” No. 39/23 dated 12.05.2023), this Rulebook ceases to be valid.

II TECHNICAL CONDITIONS FOR SUPERSTRUCTURE

...

3. Sleepers

Type and use of sleepers

Article 8

Sleepers made of prestressed concrete and wooden sleepers are installed on the tracks.

Concrete sleepers must be in accordance with SRPS EN 13230 (from 1-5), and wooden sleepers in accordance with SRPS EN 13145.

Wooden sleepers (hardwood and beech) can be installed everywhere, primarily in tunnels, on isolated rail sections, at level crossings, on curves with a radius less than 250 m, on platform tracks, at switch connections up to 150 m in length, if those tracks have wooden sleepers, as well as in sections of the track where the ballast is in motion.

Softwood sleepers (pine, chestnut, fir) can only be installed on tracks in straight sections, on lightly loaded tracks.

All wooden sleepers must be labelled with a hammer for the reception of raw sleepers, protected from splitting, impregnated, marked with a year of impregnation using a numeration that simultaneously indicates the year of their installation. If the sleepers are installed later, the year of installation is marked with a separate numeration.

Wooden sleepers cannot be completely drilled in places where tyrphons or nails are placed.

Used wooden sleepers are installed during individual sleeper replacements.

III Method and deadlines for maintenance of the superstructure

Types of superstructure maintenance

Article 66.

Superstructure maintenance can be:
1) regular;
2) extraordinary.

Regular maintenance includes:
1) current maintenance;
2) medium repairs;
3) main repairs;
4) inspections and controls.

Extraordinary maintenance includes:
1) unforeseen works;
2) reconstructions.

1. Regular maintenance

Ongoing Maintenance

Article 67 (excerpt)

During ongoing maintenance, minor defects in the superstructure that occur between intermediate and major overhauls are eliminated and the task is to slow down the wear and deterioration of the track material and to preserve the gauge, height, and alignment of the track within the prescribed tolerances.

...

Intermediate Overhauls

Article 68 (excerpt)

Intermediate overhaul works on the superstructure are carried out periodically through individual replacement and supplementation of track materials with adjusting the track in terms of gauge, height, and alignment, so that all elements and the track as a whole are brought to proper condition.

...

Major Overhauls

Article 69 (excerpt)

Major overhaul works are performed when the wear and deformation of the track material cannot be rectified by intermediate overhaul works.

…

Inspection and control of the superstructure

Article 75

Inspection, Control, and Correctness of the Superstructure as a Whole, Individual Element Groups, or Individual Elements are carried put using track inspection coaches and other rail vehicles, measuring instruments, tools, riding on a traction vehicle, and visually - on foot, whereby the technical parameters of the track, track arrangement, and the state of the installed Superstructure material are checked.

Staff responsible for inspecting and controlling the superstructure must have the necessary technical documentation for their section, including curves with all elements, intermediate straight lines, transition ramps, straight sections before and after switches, cross level of the outer rail in curves, track gradient, level breaks, expansion dimensions, temperature data for the DTŠ, complete basic data for installed switches, etc.

Regular examinations of the geometric state of the track are carried out using track inspection coaches according to separately established plans:

1) on mainline tracks with speeds ≥ 120 km/h, four times a year, with no less than two and a half, nor more than three and a half months between individual inspections;

2) on mainline tracks with speeds up to 120 km/h, as well as on regional tracks, at least twice a year (spring and autumn), with no less than four months between individual measurements;

3) on local tracks in public transportation, at least once a year (either in spring or autumn).

During regular inspections, the condition of the track is also assessed.

Inspections are not conducted at temperatures below -5°C or above +40°C, and if these temperatures occur during the inspection, they are interrupted until permissible temperatures return.

In addition to regular inspections, as needed, working checks of the track's condition can be carried out before and after extensive work is performed on specific sections of the track.

Manual measurements of individual elements of the superstructure and geometric relationships are performed during local track condition checks, as well as for measurements of turnouts, crossings, other station, workshop, platform, and industrial tracks.

Measurements as described in item 7 of this article are carried out for each track and segment at least twice a year, and for industrial tracks, at least once a year.

Inspection, control and track measurement

Article 80 (excerpt)

…

The examination of the correctness of installed wooden sleepers is carried out through systematic inspection, with particular attention given to visible damage to the sleepers and the condition of the spikes, especially if the spikes are wooden. Cracks and damages observed on concrete sleepers are protected against water penetration and damage to reinforcement. In case of significant damages, sleepers are replaced.

Article 81 (excerpt)

The technical condition of all types of track accessories and fittings as a whole must be such as to provide a firm connection between rails, rail to sleeper connections, and prevent loosening of fittings and connections.

Damaged, worn-out, or missing elements of track fittings should be replaced or supplemented, loosened fittings should be tightened, and individual elements may need to be lubricated as necessary.

...

3.3.6. Rulebook on technical conditions of the Infrastructure Subsystem ("Official Gazette of RS", No. 39/23 from 12.05.2023)

Note: Rulebook on Technical Conditions of the Infrastructure Subsystem ("Official Gazette of RS" No. 39/23) is applicable as of May 20th, 2023.

III. TECHNICAL CONDITIONS FOR SUPERSTRUCTURE CONSTRUCTION ELEMENTS

Sleepers

Article 48 (excerpt)

On all tracks, prestressed concrete sleepers or wooden sleepers are used.

Exceptionally, installation of synthetic material sleepers is possible. On mainline tracks, for open line tracks, mainline crossovers, and passing tracks in stations, except for secondary station tracks, concrete or treated wooden sleepers of length 2.60 m are installed.

Treated wooden sleepers of length 2.60 m and concrete sleepers of length 2.50 m can be installed on regional tracks, local tracks, industrial tracks, and secondary station tracks.

...

Wooden sleepers

Article 49

The type of wood, origin, quality conditions, manufacture conditions, shapes, dimensions, tolerances, as well as protection and durability of wooden sleepers for tracks and switches are defined by the standard SRPS EN 13145.

Hardwood sleepers (oak and beech) are installed on all sections of the track, and are mandatory on sections with an unstable substructure.

Softwood sleepers (pine, chestnut, fir) are only installed in the direction of the track, on lightly loaded tracks, industrial tracks, etc.

Wooden sleepers are labelled with a hammer for the reception of raw sleepers, they need to be protected from splitting and impregnated, and the year of impregnation is marked with a numeration.

Wooden sleepers cannot be completely drilled in places where tyrphons or nails are placed.

Used and regenerated wooden sleepers can be installed only during individual sleeper replacements, except on mainline tracks and main running tracks.

At the ends of DTŠ, only sharp-edged wooden sleepers of Class I are installed.

Wooden sleepers are installed 30 m in front of and behind bridges.

Bridge wooden sleepers are sharp-edged, rectangular or square in shape, made of oak wood.

The dimensions of bridge wooden sleepers are determined by the project.

At level crossings on wooden sleepers, 30 wooden sleepers are installed in the track, both before and after the level crossing.

3.3.7. Rulebook on Railway Lines Super and Sub Structure Maintenance ("Official Gazette of RS" No. 39/23 from 12.05.2023)

Note: Rulebook on Railway Lines Super and Sub Structure Maintenance ("Official Gazette of RS" No. 39/23) is applicable as of May 20th, 2023.

II. INSPECTION OF THE INFRASTRUCTURE SUBSYSTEM CONDITION

Inspection of the infrastructure subsystem condition

Article 3

Inspection of the condition of elements, element groups, or the infrastructure subsystem as a whole is carried out through:

1) visual inspections;
2) manual measuring instruments;
3) track inspection coaches or trolleys.

Condition inspections of the infrastructure subsystem can be:

1) regular (including periodic);
2) extraordinary (including supplementary and special inspections);
3) working (during the acceptance of construction works).

The condition of the superstructure of railway tracks is checked through visual inspections, manual measurements, measuring instruments, track inspection coaches, or by riding on a traction vehicle.

Apart from the mentioned inspections, for artificial facilities of the substructure, bridges, and tunnels, continuous monitoring is conducted based on an operational plan prepared for each individual structure.

This Rulebook prescribes deadlines for conducting inspections and measurements and depending on the condition of the superstructure and substructure elements, inspections and measurements may be carried out more frequently.

Measurement of Track Geometry on Mainline and Regional Tracks

Article 5

For new, upgraded, and rehabilitated mainline and regional tracks, relative track geometry measurements are carried out based on parameters defined by standard SRPS EN 13848-1, using measurement systems and track inspection coaches defined by standard SRPS EN 13848 (parts 2 to 4).

The limit values for parameters of relative track geometry, as defined by standard SRPS EN 13848-5, are:

1) emergency Intervention Limit (hereinafter referred to as GHI) - pertains to the parameter value that, if exceeded, requires taking measures to reduce the risk of derailment to an acceptable level, what can be achieved through track closure, track geometry rectification, or speed reduction;

2) intervention Limit (hereinafter referred to as GI) - refers to the parameter value that, if exceeded, requires extraordinary maintenance to ensure that the indicator value does not reach the GHI before the next measurement;

3) warning Limit (hereinafter referred to as GU) - pertains to the parameter value that, if exceeded, requires an analysis of the track geometry condition and inclusion in regular maintenance if necessary.

Tolerances for GHI parameters are defined by standard SRPS EN 13848-5, while tolerances for GI and GU parameters are defined within the safety management system of the infrastructure manager.

The determination of track geometry quality is defined by standard SRPS EN 13848-6.

Track Inspection runs

Article 7

Track Inspection runs can be:

1) regular;

2) extraordinary;

3) working (during acceptance of works).

Regular track inspection runs are conducted within the following timeframes:

1) on tracks with a maximum permitted speed ≥ 160 km/h, at least every two months;

2) on mainline tracks with a maximum permitted speed ≥ 120 km/h, four times a year, with intervals between measurements not less than two and a half months, nor more than three and a half months;

3) on mainline tracks with a maximum permitted speed < 120 km/h and on all regional tracks, at least twice a year (spring and autumn), with intervals between measurements not less than four, nor more than eight months;

4) on other tracks, at least once a year (spring or autumn), with the longest permitted interval of 15 months between two consecutive measurements.

Track Inspection runs re not conducted at temperatures lower than -5°C or higher than +40°C, and if these temperatures occur during measurements, the measurements are suspended until permissible temperatures return.

The documentation of a completed measuring run consists of a report accompanied by textual and graphical documentation.

The Record includes the following information:

1) attendance list for the track inspection run;

2) information about the track inspection coach;

3) date and duration of the track inspection run;

4) data about the measured track section;

5) isolated points or sections that jeopardize traffic safety.

Inspection of Track Condition

Article 15 (excerpt)

When assessing track stability, out of the total amount of examined sleepers, the number of loose sleepers must not exceed 10%, with the condition that the distance between individual loose sleepers is at least 5 m.

On tracks where traffic is conducted at speeds greater than 80 km/h, loose sleepers must not be present at rail joints, within 10 m before and after artificial structures, and at turnouts where the track crosses over.

The examination of the integrity of installed wooden sleepers is performed through systematic inspection, with special attention given to visible damages of sleepers and the condition of fastenings, especially if they are wooden.

3.3.8. Rulebook on Train and Vehicle Brakes and Braking, ("Official Gazette of RS", No. 68 of 07.07.2021.)

Appendix 3. Train Composition and Brake Type Selection for Freight and Passenger Trains

...

4. Inclusion of wagons and Brake Type Selection for Passenger and Freight Trains

...

5) Wagons of the SS mode (with automatic continuous brake force adjustment) for speeds up to 120 km/h, the P braking mode is functional on all vehicles and without exception on the last vehicle.

In the case of a towed mass greater than 800 t and less than or equal to 1,200 t, the active locomotive at the front of the train brakes in mode G.

In the case of a towed mass from 1,200 t to 1,600 t, in addition to the locomotive at the front of the train, the first five towed vehicles in the train brake in mode G. This braking mode is also known as "long locomotive" (marked as LL).

If the G braking mode is not possible for a particular vehicle, the brake of that vehicle is deactivated.

In the case of a towed mass exceeding 1,600 t, all vehicles in the train brake in mode G.

3.3.9. IRS 40421 Rules for the consist band braking of the international freight trains, ed. 11

Note: IRS 40421 replaces UIC Leaflet 421

3.3 Trains braked in P Mode

The maximum train speed must not exceed 120 km/h.

The P braking mode should generally be activated on all vehicles, without exception, on the last vehicle.

In the case of a towed mass greater than 800 t and less than or equal to 1,200 t, the active locomotive at the front of the train brakes in the G mode.

For a trailed mass between 1,200 t and 1,600 t, in addition to the locomotive at the front of the train, the first five trailing vehicles also brake in the G mode. This braking mode is known as the "long locomotive" (marked as LL).

If the G braking mode is not possible or not allowed for any of the first five vehicles, the braking system of that vehicle is disabled. And if the braking system of any of the first five vehicles does not function, it is considered to be in the LL mode.

...

In the case of a trailed mass exceeding 1,600 t, all vehicles in the train brake in the G mode.

3.3.10. Rulebook on Official and Protective Clothing and Footwear of Employees in the Joint Stock Company for Railway Cargo Transport "Srbija Kargo", Belgrade ("Official Gazette of ŽS" No. 56/2019)

I. GENERAL PROVISONS

Article 2 (excerpt)

Right to Official and Protective Clothing and Footwear

Employees who are assigned to perform tasks in accordance with Annex 3, which is printed alongside this Rulebook and constitutes an integral part of it, have the right to protective clothing and footwear.

Appendix 3. TABULAR REVIEW OF PERSONAL PROTECTIVE EQUIPMENT AND GEAR

-SECTOR FOR TRAIN TRACTION

Work positions: Train driver

Name of the gear and equipment	Standard label	Duration
protective boots	EN ISO 20347	2 years
protective clog style shoes	EN ISO 20347	1 year
protective work coat/gown	SRPS EN 340 EN 13402 SRPS EN 420	2 years
protective leather gloves	SRPS Z.B1.021 SRPS EN 420	1 year
signaling devices		
whistle		no deadline

3.3.11. Law on Railway ("Official Gazette of RS" No. 41/2018 and 62/2023)

II Railway Infrastructure

...

1. Public Railway Infrastructure Management

...

The obligations of the railway infrastructure manager

Article 10

The infrastructure manager is obligated to ensure the safe and smooth organization, regulation, and management of railway traffic, unobstructed access and use of public railway infrastructure, access to service facilities entrusted to their management, and the services they provide in these facilities to all interested railway infrastructure capacity applicants under equal, non-discriminatory, and transparent conditions. Additionally, they are responsible for the permanent and continuous maintenance and protection of the railway infrastructure in accordance with regulations.

...

IIIA Construction, Reconstruction, Renovation, and Maintenance of Public Railway Infrastructure

...

2. Maintenance of Public Railway Infrastructure

Article 55.

Public railway infrastructure must be maintained in a condition that ensures safe and smooth railway traffic, as well as quality and orderly transportation, in accordance with regulations governing railway safety and technical regulations and standards.

Maintenance of public railway infrastructure includes regular maintenance and extraordinary maintenance.

The technological entity for maintenance comprises all elements of public railway infrastructure. Maintenance intervenes in individual elements, bringing them to a condition that does not reduce the technological function of the track and prevents bottlenecks on the track.

The infrastructure manager approves, by a special act, the introduction of any temporary restricted speed running or permanent speed reduction in relation to the designed parameters of the track, with an explanation of the reasons for reducing traffic speed and capacity. Technical measures for their elimination are also prescribed, along with a planned deadline for the removal of temporary restricted speed running, which is submited to the national railway traffic inspector.

Article 56.

Works on regular maintenance include, in particular: maintenance and replacement of super structure elements of the railway track (switches, tracks, and track connections), with the same or other types that maintain the parameters of the railway track at the designed level; works on the sub structure of the railway track (drainage and slope maintenance); removal of trees, shrubs, and vegetation from the track area, replacement and renovation of culverts and bridges with the same materials, if their openings are not changed; replacement and supplementation of SS and telecommunication devices and facilities; replacement and supplementation of stable electric traction facilities, as well as other facilities for the transformation and transmission of electrical energy for train traction; adaptation and repair of railway station official position buildings and other facilities at railway service locations that are in railway traffic operation, without changing their construction and external appearance; snow and ice removal from tracks, facilities, and surfaces on station platforms, stops, and others.

Article 57.

Extraordinary maintenance works are major repairs, remediation, and other works performed to eliminate the consequences of extraordinary events (accidents, floods, earthquakes, etc.) and to rectify critical or poor conditions of existing railway infrastructure elements with the aim of restoring safe traffic and achieving the designed parameters, in accordance with the regulation governing the maintenance of super structure elements of railway tracks, or the maintenance of sub structure elements of railway tracks.

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

III. License for use

...

2. License for use Mobile Subsystems

...

Vehicle Type License

Article 26 (excerpt)

All types of vehicles from any manufacturer for which the Directorate issues a license for use must be approved.

The vehicle type license is issued by the Directorate on the form prescribed by the regulation from paragraph 12 of this article, as well as in the form of a decision.

...

For vehicles that correspond to an approved type, individual licences for use must be issued based on a procedure verifying compliance with the approved type and a declaration of conformity with the approved type of vehicle.

...

The Directorate specifies the manner and conditions for issuing vehicle type licences, the content of the application for a vehicle type license, the content and form of the declaration of conformity with the vehicle type, and the content and form of the vehicle type license.

...

3.4. Functioning of vehicles and technical installations

3.4.1. Control, command and signaling

Traffic on the section of the main arterial line No. 106: Niš - Dimitrovgrad - state border - (Dragoman), between the crossing point Staničenje and the Pirot station, is controlled within station distance by obtaining permission for train traffic, giving notices and cancellations (verbally, through recorded announcements).

On the open track between the crossing point Staničenje and the Pirot station, there is no operational signaling-safety system, nor are there devices for control, management, and signaling.

3.4.2. Infrastructure

At the site of the train derailment of train No. 45010, it has been determined that type 49E1 rails (ZENICA 85 and 86 UIC 49) have been installed, which are connected by rail joints. According to the Letter from the Section ZOP Niš, reference No. 20/2023-1.20-112/1 dated 26.01.2023, it is stated that a section of the Staničenje - Pirot track has welded in DTŠ. In the Letter No. 20/2022-1.20.4-100 dated 31.07.2022, regarding the railway section Bela Palanka - Dimitrovgrad, it is mentioned that a weld in DTŠ has never been formed on the aforementioned section.

The appearance of the rails is shown in Figure 3.4.2.1.

Figure 3.4.2.1: Appearance of the rails type "*49E1*" *ZENICA 85 and 86 UIC 49* (source: "IŽS"a.d.)

In the broader area of the serious accident site, several non-aligned floating rail joints have been observed. The appearance of these rail joints is shown in Figure 3.4.2.2.

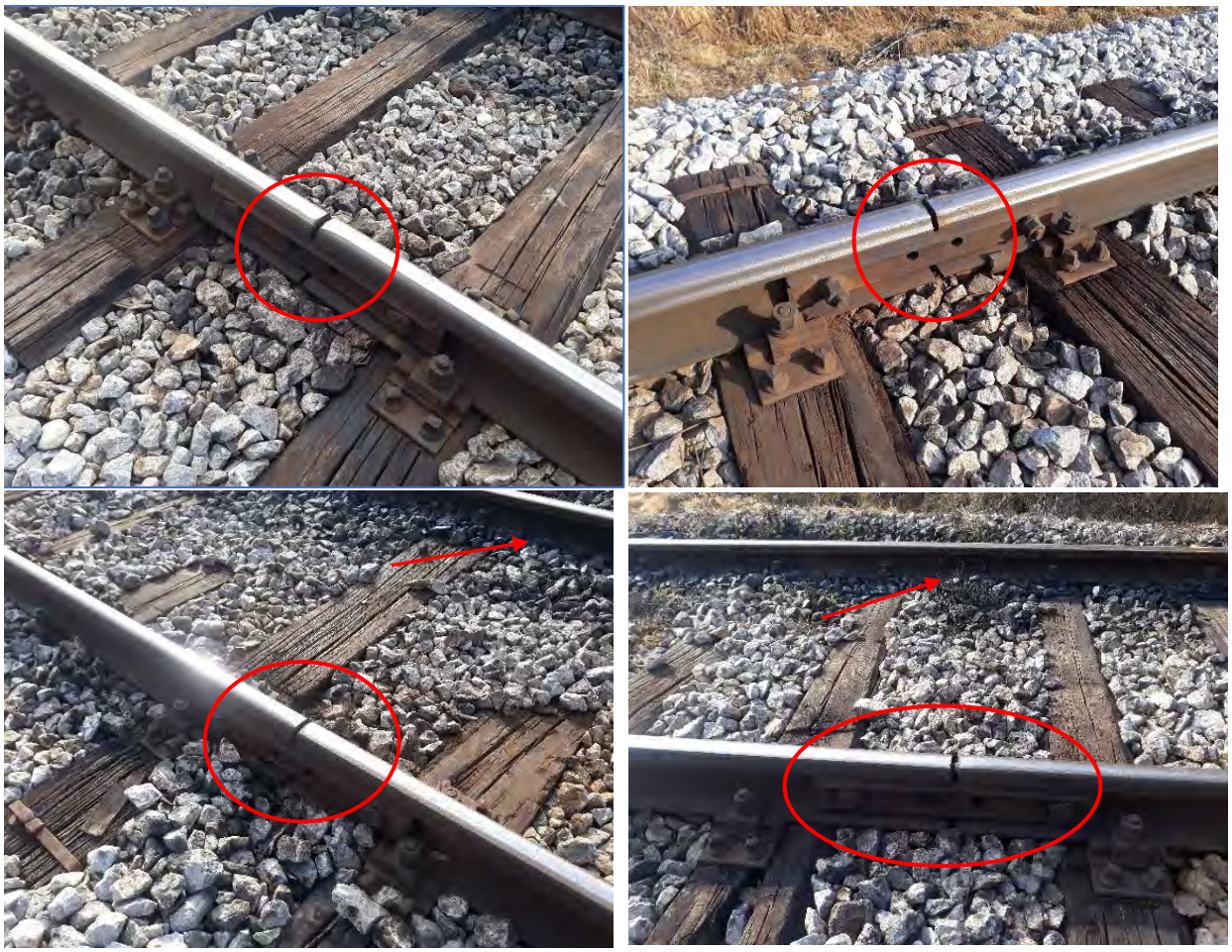


Figure 3.4.2.2: Appearance of rail joints (source: "IŽS"a.d.)

Between the Staničenje crossing point and the Pirot station, from km 63+800 to km 72+900, wooden sleepers have been installed at a distance of 60 cm with fastening equipment of type “K”. The appearance of the sleepers and the fastening equipment is shown in Figure 3.4.2.3.

Figure 3.4.2.3: Appearance of track fastening equipment (source: “IŽS”a.d.)

The track grid is covered with crushed limestone. The appearance of the track grid is shown in Figure 3.4.2.4.

Figure 3.4.2.4: The track grid made of crushed limestone (source: “IŽS”a.d.)

The designed axle load is 225 kN, and the axle load per linear meter is 72 kN/m.

In the wider area of the serious accident occurrence site, it was observed that anti-rail travel devices (for longitudinal movement) have been installed on the track (Figure 3.4.2.2).

At the site of the train derailment of train No. 45010, the track is horizontal, in a curve with a radius of R=500 m, and on an embankment.

Starting from the timetable of 2017/2018, the maximum permitted speed on the section Staničenje - Pirot is 30 km/h, which was also valid in the timetable of 2022/2023. Within this maximum permitted speed, there are no introduced restricted speeds, nor were there any introduced slow-moving sections between 01.01.2018. and 25.12.2022.

During the on-site investigation conducted by representatives of CINS, on 26.12.2022, measurements of the track gauge were taken in the area where the first signs of the derailment were observed, as follows:

- at km 67+260 (in the zone of the second bogie of the 18th wagon, observed in the direction of train movement), a measurement of 1473 mm was recorded, which deviates from the prescribed gauge width by 38 mm;
- at km 67+245 (in the zone of the second bogie of the 17th wagon, observed in the direction of train movement), a measurement over 1485 mm was recorded (the instrument's indicator measured up to 1485 mm and exceeded the marked values), deviating from the prescribed gauge width by over 50 mm;
- at km 67+235 (in the zone of the first bogie of the 17th wagon, observed in the direction of train movement), a measurement over 1485 mm was recorded (the instrument's indicator measured up to 1485 mm and exceeded the marked values), deviating from the prescribed gauge width by over 50 mm.

The measurements were conducted using a track gauge instrument of the brand Geismar, property of “IŽS”a.d., with certificate No. 63156/369-22 and calibration date of 05.07.2022.

According to data obtained from “IŽS”a.d., (Letter from the Civil Engineering Department, reference No. 20/2023-197 dated 03.02.2023), a joint track measurement was conducted on 28. and 29.12.2022. The measurements were taken 100 m ahead of the locomotive and 100 m behind the last wagon in the train (in this case, the 18th wagon, as wagons Nos. 19, 20, and 21 were detached and moved to the Pirot station). The values of track parameters measured by the joint commission on 28. 12. and 29.12.2022. are presented in Table 3.4.2.1.

Table 3.4.2.1: Track gauge measured by the joint committee (Section ZOP NIš)

Serial measurement No.	The place of measurement (*km* position)	Deviation from the prescribed gauge (*mm*)	Cross level (*mm*)
Start of the measurement from the train head to the crossing point Staničenje (from *km* 66+934 to km 66+844)			
1.	66+934	+14	+20
2.	66+924	+15	+32
3.	66+914	+13	+45
4.	66+904	+10	+46
5.	66+894	+12	+46
6.	66+884	+12	+47
7.	66+874	+15	+47
8.	66+864	+16	+48
9.	66+854	+16	+48
10.	66+844	+15	+48
Start of the measurement from the eighteenth wagon to the station Pirot (from *km* 67+260 to *km* 67+350)			
11.	67+260	+30	+141
12.	67+270	+31	+130
13.	67+280	+29	+122
14.	67+290	+15	+108
15.	67+300	+5	+100
16.	67+310	+5	+100
17.	67+320	+16	+110
18.	67+330	+21	+121
19.	67+340	+21	+20
20.	67+350	+22	+122

3.4.3. Communication tools

At the time of occurrence of the serious accident, in the area of the crossing point Staničenje, the station Pirot and at the section between the crossing point Staničenje and the station Pirot, the communication tools were correct and functional. No disturbances or malfunctions were recorded on the means of communication.

3.4.4. Railway vehicles

At the time of the serious accident occurrence, train No. 45010 was moving in the direction from the Pirot station towards the Staničenje crossing point (from the end to the beginning of the track, in the direction of decreasing stationing).

During the operation of train No. 45010, a total of 6 (six) wagon-tanks derailed, including five Zags series wagon-tanks and one Zagkks series wagon-tank. Derailed wagons were the ninth, tenth, eleventh, twelfth, thirteenth, and fourteenth wagons when viewed from the locomotive 661-249.

On the scene, the locomotive 661-249 and all wagon-tanks from the train No. 45010 were found.

An overview of the derailed wagons, when viewed from the locomotive 661-249, is provided in Table 3.4.4.1.

Table 3.4.4.1: Overview of the derailed wagons

wagon		**description:**
series:	**No.:**	
Zags	33 87 7813 563-6	9th wagon derailed with the right wheels of both axles of the second bogie, in the direction of train movement, remained in the track zone on its wheels
Zags	33 87 7813 580-0	10th wagon derailed with all the axles turned on its side to the left, viewed in the direction of the train movement, from the wagon-tank there was no release of the cargo-ammonia
Zags	33 87 7813 586-7	11th wagon derailed with all the axles (turned on its side to the left, viewed in the direction of the train movement, from the wagon-tank there was no release of the cargo-ammonia
Zagkks	33 80 7922 029-3	12th wagon derailed with all the axles (turned on its side to the left, viewed in the direction of the train movement), from the wagon-tank there was no release of the cargo- ammonia
Zags	33 80 7818 081-1	13th wagon derailed with all the axles (turned on its side to the left, viewed in the direction of the train movement), from the wagon-tank, at a damaged inspection hole, there was a release of cargo (ammonia).
Zags	33 80 7818 089-4	14th wagon derailed with two axles of the first bogie, viewed in the direction of the train movement, in the track zone, on their wheels

The derailed wagons in the serious accident are specialized four-axle wagon-tanks designed for the transportation of liquid anhydrous ammonia, equipped with appropriate loading and unloading systems.

Except for the last empty wagons in the train, intended for transporting sulfuric acid, all the other wagons are labeled according to the RID regulations with the code P26 BH, which corresponds to the transportation of anhydrous ammonia, identified with UN No. 1005.

The appearance of the derailed wagons is shown in Figures 3.4.4.1. and 3.4.4.2.

Figure 3.4.4.1: Appearance of the derailed wagons

Figure 3.4.4.2: Appearance of the derailed ninth (up) and fourteenth wagon (down) (source: "IŽS"a.d.)

According to the information provided by “Srbija Kargo”a.d., as attachments to the letter number 1/2023-144 dated 09.02.2023, all the wagons that were part of the train No. 45010 (except for the last wagon No. 33 72 7867 832-7) have permits for use and are registered in the European Virtual Vehicle Register (VVR). No information has been provided for the wagon No. 33 72 7867 832-7 (the last wagon in the train), indicating that it possesses a permit for use and is registered in the national vehicle register of the Republic of Serbia (NVR). As per the information supplied by “Elixir Zorka Mineral Fertilizers”d.o.o. Šabac (Letter No. 230203-0005 dated 03.02.2023, along with attachments), based on the Sales Agreement for technical sulfuric acid concluded between “Serbia Zijin Copper” d.o.o. Bor (as the seller) and “Elixir Group” d.o.o. Šabac (as the buyer) on 20.12.2019, with a validity period until 31.12.2029 (factory Nos. 10327 and 334/1), “Serbia Zijin Copper”d.o.o. Bor has leased the wagon-tank for transporting sulfuric acid, wagon No. 33 72 7867 832-7, to “Elixir Group”d.o.o. Šabac during the duration of the Agreement.

The locomotive of the series 661-249 is a six-axle diesel-electric locomotive designed for operating on standard gauge tracks with a width of 1435 mm, intended for traction all types of passenger and freight trains on all track categories. The locomotive's body is divided by the driver cab into a shorter and a longer section.

At the time of the serious accident, the locomotive 661-249 was used for traction of the train No. 45010 and was positioned with the shorter section of the locomotive's body at the front.

On locomotive 661-249 a device for measuring and registering speed of manufacturer Hasler: registering speedometer type RT9, fabric No. B.B. (which does not allow for unambiguous device identification) and indicating speedometer device type A16i, fabric No. *L08.110* were installed. According to the Notice of Completed Replacement and Verification of Speedometer Device Operation, No. 29/22-02-1309 dated 26.12.2022, issued by the Section for Railway Vehicles and Special Equipment in Niš (document provided as an attachment to the letter number 1/2023-144 dated 09.02.2023, from “Srbija Kargo”a.d.), the mentioned speedometer devices were installed on locomotive 661-249 on 23.12.2022 (replacement of previously installed speedometer devices due to malfunction) and the next verification of the operation of these speedometer devices is scheduled for 24.11.2023. Measurement records on the operation verification of the registering speedometer Hasler type RT9, factory No. B.B., dated 24.11.2022, and the measurement record on the verification of the indicating speedometer Hasler type A16i, factory No. L08.110, dated 24.11.2022, were provided by “Srbija Kargo”a.d. (as attachments to the letter number 1/2023-144 dated 09.02.2023). These documents confirm that the mentioned speedometer devices are in proper working condition and can be installed in the locomotive.

After the occurrence of the serious accident, the speedometer tape was removed from the speedometer device of locomotive 661-249 of train No. 45010, which was carried out and the tape was seized by the police officers of the PU Pirot (including all related documents), based on the order of the Deputy Public Prosecutor from the OJT Pirot.

In a letter from the OJT Pirot, reference Ktn No. 218/22 dated 13.03.2023 (delivered by the Deputy Public Prosecutor, attached to the email dated 13.03.2023), CINS was informed that an on-site inspection of the movable object will be conducted on 17.03.2023, at the premises of the PU Pirot. This inspection is aimed at reading the records from the speedometer tape of train No. 45010 (locomotive No. 661-249), and representatives from CINS may be present during this procedure.

The on-site inspection of the movable object was carried out on 17.03.2023, starting at 13:00 in Pirot, within the premises of the PU. The inspection was attended by representatives from CINS, police officers from the PU Pirot, and representatives of all relevant parties (infrastructure manager, railway undertaking, owner of the railway wagons, and NN person against whom proceedings are being conducted). During the final phase of the inspection (toward its conclusion), the Deputy Public Prosecutor from the OJT Pirot joined the inspection. Throughout the inspection, data processing from the speedometer tape, which was removed from the speedometer device of locomotive 661-249, was conducted by representatives (experts) from the Section for Train Traction in Niš, independent railway undertaking "Srbija Voz"a.d. (a railway undertaking without any conflict of interest regarding the serious accident). After processing the data from the speedometer tape, experts from "Srbija Voz"a.d. prepared the form Data from Speedometer Tape with reference number 37/2023-229 dated 17.03.2023 (Form EV-85 Appendix I), which was seized by the present police officers. During the inspection, representatives of CINS were allowed to examine the extracted speedometer tape from locomotive 661-249 and the completed Data from Speedometer Tape form (Form EV-85 Appendix I). Other present representatives were not granted access to these materials.

By examining the Data from Speedometer Tape form with reference No. 37/2023-229 dated March 17, 2023 (Form EV-85 Appendix I) and the speedometer tape, it was determined that the train's speed on the route between stations Dimitrovgrad and Pirot ranged from 20 km/h to 48 km/h, except for the section between km 74+290 and km 74+191 (restricted speed of 30 km/h) where the speed was up to 12 km/h. Between station Pirot and the location of the serious accident, the train's speed ranged from 20 km/h to 29 km/h. At a speed of 22 km/h, the speed started to decrease abruptly, and after covering approximately 180 m, the train came to a stop. The duration of the journey from the departure of station Dimitrovgrad to the stop after the serious accident was 67 minutes. In the mentioned Form EV-85 Appendix I, notes were entered indicating that it was not possible to read the hours from the speedometer tape, that no data regarding the procedure on extraordinary events (Instruction 230) 16/98-574 were recorded and that the speedometer tape was read according to the available data.

3.5. Traffic regulation and management

3.5.1. Actions taken by the staff that manages traffic regulation, control and signaling

The train traffic of train No. 45010 between the station Pirot and the crossing point Staničenje was conducted at the station distance. According to the review of the traffic logs of the Pirot station and the crossing point Staničenje, permission for train No. 45010 was granted at 16:26 to operate between the Pirot station and the crossing point Staničenje, and it passed the Pirot station at 16:36, using the third track.

The accompanying documents issued for train No. 45010 at the initial Dimitrovgrad station were taken by the staff of the PU Pirot upon the order of the Deputy Prosecutor of OJT in Piriot. CINS has, through correspondence No. 340-00-2/20212-02-1-43 dated 22.02.2023, and an electronic mail sent on 10.05.2023, contacted the OJT in Pirot with a request for the delivery of the withheld accompanying documents for train No. 45010. Up to the completion of this Report, the withheld accompanying documents for the train have not been delivered.

3.5.2. Exchange of voice messages in relation to the serious accident

Immediately before and during the occurrence of the serious accident, there was no communication between the train staff of train No. 45010 and the staff that regulates the traffic. The last communication between the train driver and the staff that regulates the traffic was established at the Dimitrovgrad station. Based on a copy from the General Orders book of the Dimitrovgrad station (provided by "IŽS"a.d. via email dated 14.06.2023), it can be concluded that the train driver was handed General Order I No. 30 (S-20) dated 25.12.2022, by the train dispatcher at the Dimitrovgrad station. This Order included instructions for restricted speed runs, but no instructions for restricted speed runs were indicated for the section of the track between the Piriot station and the Staničenje crossing point.

Communication between the staff that regulates the traffic and the train driver was again reached after the occurrence of the serious accident, with the aim of informing about the serious accident occurred, so that the train driver of the train No. 45010, via the mobile phone operator, has informed the train dispatcher of the station Pirot.

3.5.3. Measures taken to protect and secure the place of the serious accident

After the occurrence of the serious accident, a section of the main arterial line No. 106: Niš-Dimitrovgrad -state border- (Dragoman), between the crossing point Staničenje and the station Pirot, was closed for traffic.

Due to the release of cargo - ammonia resulting from the serious accident, a life-threatening situation arose that required urgent evacuation of the train staff (train driver and train driver assistant) of train No. 45010. Therefore, no specific measures were taken to secure the train from moving on its own. Taking into consideration that the train came to a stop on a horizontal section of the track, that it was braked by an automatic air brake, and that the locomotive remained operational (not uncoupled and the engine not turned off), it was not necessary to undertake special measures to prevent the train from moving on its own.

Considering that train No. 45010 contained substance that, in the event of uncontrolled release from wagon-tanks, could threaten human health and potentially pose a danger to the environment, and that a release of this substance into the atmosphere had occurred, the regional organizational unit of the MUP RS was informed about the serious accident.

Members of the MUP RS secured the site of the serious accident by restricting access to the wider area of the accident site. Traffic on the highway and local road near the accident site was stopped, and the evacuation of people from surrounding houses (parts of the settlement of Sopot) was ordered and carried out.

3.6. Interface between the people, machines and organization

3.6.1. Working hours of the staff involved

With document No. 2022-33 dated 19.01.2023 (provided as an attachment to the letter No. 1/2023-144 dated 09.02.2023, from "Srbija Kargo"a.d.), it has been reported that the train driver of train No. 45010 had finished his previous work assignment on 24.12.2022, at 00:10, while the assistant train driver had finished his previous work assignment on 22.12.2022, at 16:10. Before

the occurrence of the serious accident, both the train driver and the assistant train driver had used the legally stipulated rest period.

Both of them began their work assignments on 25.12.2022, at 08:00. Up until the occurrence of the serious accident, their work assignments were in accordance with the Law.

3.6.2. Health-related and personal circumstances that have effects on the serious accident, including the presence of physical or mental stress

Data has been provided for the railway workers, indicating that the train driver and assistant train driver who were on duty for train No. 45010 were professionally qualified and medically fit for performing their duties. The train driver of train No. 45010 holds a Traction Vehicle Driving License No. RS 71 2017 0782 issued by the Directorate for Railways on 09.12.2016, valid until 09.12.2026, along with an Additional Certificate for driving specific types of traction rolling stock on certain infrastructures, No. 00033155, issued by "Srbija Kargo"a.d. on 09.12.2016, valid until 09.12.2026. The assistant train driver of train No. 45010 possesses a Traction Vehicle Driving License No. RS 71 2019 0523 issued by the Directorate for Railways on 01.06.2019, valid until 01.06.2029, and an Additional Certificate for driving specific types of traction rolling stock on certain infrastructures, No. 00044896, issued by "Srbija Kargo"a.d. on 01.06.2019, valid until 01.06.2029.

The joint investigative committee composed of representatives from "IŽS"a.d. and "Srbija Kargo"a.d. did not conduct alcohol testing on the train driver and assistant train driver of train No. 45010.

Immediately after the occurrence of the serious accident, given their exposure to ammonia vapors, the train driver and assistant train driver were provided with initial medical assistance by a medical worker in the official premises of the Staničenje crossing point (where they were evacuated to after the accident by a third-party vehicle driven by a medical worker). Subsequently, they were directed to undergo an emergency medical examination. Considering the consequences of the serious accident in terms of ammonia vapor release, the train driver and assistant train driver were able to evacuate to a safe location (the official premises of the Staničenje crossing point) under positive circumstances (arrival of a vehicle driven by third-party – a medical worker, which stopped and offered assistance). It should be noted that without these positive circumstances, such as the arrival of the vehicle, it's questionable whether the train driver and assistant train driver could have evacuated to a safe location without health consequences, considering the speed and direction of the ammonia vapor spread in the air.

3.6.3. Design of the equipment that has an influence on the interface between the user and the machine

According to the data provided in the attachment to the letter from "IŽS"a.d. No. 1/2023-176 dated 06.02.2023, a section of the main arterial line No. 106: Niš - Dimitrovgrad - state border - (Dragoman), between the Staničenje crossing point (km 63+800) and the Pirot station (km 72+900), is designed for speeds ranging from 40 km/h to 85 km/h, with maximum axle loads up to 225 kN and longitudinal axle load per meter up to 72 kN/m (as indicated in section 2.2.3).

According to the timetable booklet 9.4 (valid at the time of the serious accident), the maximum allowed speed on the section of track between the Staničenje crossing point and the Pirot station was 30 km/h.

In accordance with the designed conditions, the traffic on the specific railway line is regulated at a station distance.

The locomotive's operation is carried out by the train driver and assistant train driver using commands from the driver cab, which are designed during the locomotive's manufacturing process. No objections or deficiencies have been registered on the control systems and devices of locomotive 661-249.

Regarding the designed technical and operational characteristics of the Z-series wagons that were part of the train, no objections or deficiencies that could impact the interface between the user and the machinery have been registered.

3.7. The issue of modernization and reconstruction of the main arterial line No. 106: Niš - Dimitrovgrad - state border - (Dragoman)

Through the letter from “IZS”a.d., Development Sector, No. 26/2023-61 dated 24.01.2023, along with corresponding attachments (provided as an attachment to the letter from “IZS”a.d., No. 1/2023-176 dated 06.02.2023), data has been provided about the activities related to the modernization and reconstruction of the main arterial line number 106: Niš - Dimitrovgrad - state border - (Dragoman), as outlined in the following text.

During the period from 2003 to 2005, within the framework of the “Rehabilitation of Railway 1” project, the first phase of the modernization of the Niš - Dimitrovgrad railway line was realized. This included the reconstruction of the track from km 97+000 to km 104+000 and the reconstruction of the station complex of Dimitrovgrad station. During this phase, both the track and the Dimitrovgrad station were reconstructed, equipped with overhead contact lines, electronic signaling, and optical cable.

The rehabilitation and reconstruction of 6 (six) tunnels and 19 (nineteen) bridges have been carried out on the section of the Ćele Kula - Staničenje railway line. The purpose of these works was to ensure the necessary load-bearing capacity and provide clearance for the electrification of the track, as well as to facilitate the operation of combined transportation in accordance with international standards. This project was financed through a loan from the European Investment Bank No. 1.

Back on 14.04.2006, the former state-owned enterprise JP “Železnice Srbije” initiated an environmental impact assessment procedure by obtaining a Decision on determining the scope and content of the Environmental Impact Assessment Study (EIAS). However, the study did not receive the necessary approval due to objections raised by the holders of public authorizations at the local level. These objections stemmed from the adopted changes to the General Plan of Niš in 2007, which included the relocation of the railway track from the city of Niš.

Subsequently, on 01.10.2008, JP “Železnice Srbije” prepared Project Task No. 102/08-3370 for the development of the Conceptual Design for the civil reconstruction of the sections of the railway between Niš - Ćele Kula and Staničenje - Dimitrovgrad.

Given that approval of the Environmental Impact Assessment Study (EIAS) is a necessary condition for obtaining permits, an extension of the deadline for submitting the revised EIAS for the railway section from Prosek to Staničenje was initiated in 2010. due to the urgency of reconstructing the existing track.

Funding from the EU - IPA (Instrument for Pre-accession Assistance) was used to create the General and Conceptual Design for the construction of a new railway bypass around Niš, including a Justification Study and an Environmental Impact Assessment Study. After construction, this bypass will be part of the main arterial line from Niš to Dimitrovgrad, allowing train traffic at speeds of up to 160 km/h.

A Protocol was signed between the Government of the Republic of Serbia and the Government of the Czech Republic on 04.05.2010, and a Framework Agreement was signed between "Železnice Srbije"a.d. and the "Inekon Enixus Consortium" on 16.11.2010, for the realization of the project "Reconstruction and Modernization of the Railway Line Niš - Dimitrovgrad." The offer from the Main Contractor, "Inekon Enixus Consortium", for the implementation of the first phase of the project was acceptable to the then "Železnice Srbije"a.d. in 2014. However, due to the incomplete financial structure for project implementation, the contract was not finalized.

After changes in the legal regulations, "IŽS"a.d. concluded the following contracts with the Transport Institute CIP for the preparation of technical documentation for the modernization and reconstruction of the main arterial line Niš - Dimitrovgrad:

- Contract for the provision of updating and adapting technical documentation for the needs of the implementation of the Project for the reconstruction of civil infrastructure on the section Sićevo - Staničenje - Dimitrovgrad, railway line Niš - Dimitrovgrad, for Part 1: Updating the cost-benefit analysis ("cost-benefit" analysis) for the Project for the reconstruction of civil infrastructure on the section Sićevo - Staničenje - Dimitrovgrad, railway line Niš - Dimitrovgrad and preparation of the Conceptual solution (No. 1/2016-4304 dated 21.10.2016);
- Contract for the provision of updating and adapting technical documentation for the needs of the implementation of the Project for the reconstruction of civil infrastructure on the section Sićevo - Staničenje - Dimitrovgrad, railway line Niš - Dimitrovgrad, for Part 2: Adaptation of the Main Project for the reconstruction of civil infrastructure on the section Sićevo - Staničenje, railway line Niš - Dimitrovgrad with the preparation of the Main Volume (No. 1/2016-4305 dated 21.10.2016);
- Contract for the provision of updating and adapting technical documentation for the needs of the implementation of the Project for the reconstruction of civil infrastructure on the section Sićevo - Staničenje - Dimitrovgrad, railway line Niš - Dimitrovgrad, for Part 3: Adaptation of the Conceptual Project for the reconstruction of civil infrastructure on the section Staničenje - Dimitrovgrad, (No. 1/2016-4303 dated 21.10.2016).

The Ministry of Construction, Transport, and Infrastructure (MGSI) issued Location Conditions for the reconstruction and modernization of the railway line Niš - Dimitrovgrad, section Sićevo - Dimitrovgrad, from km 16+634 (entrance to Sićevo station) to km 96+700 (entrance to Dimitrovgrad station) under No. 350-02-00305/2017-14 dated 13.11.2017.

As part of the Location Conditions, there were conditions set by Local Authorities, including Water Conditions No. 325-05-00347/2017-07 dated 27.09.2017 issued by the Ministry of Agriculture, Forestry, and Water Management, Republic Directorate for Water. A problem arose as it was not feasible to comply with these water conditions. Implementing these conditions into the technical solutions of the project could lead to changes in the gradient of the track's profile. Addressing the water drainage issue to the recipient would require, in some cases, extensive hydrotechnical research, alteration of urban planning documents, and often necessitate property expropriation to solve this problem, leading to a significant increase in investment costs and additional time.

After the amendment of the Water Law in 2018, which defined that water conditions are not required for the reconstruction of railways, culverts, and bridges on them, new Location Conditions were obtained in 2019. In line with the new Location Conditions, consent for the Environmental Impact Assessment Study of the project for the reconstruction and modernization of the arterial line Niš - Dimitrovgrad, section Sićevo - Dimitrovgrad, was obtained in August 2020.

During 2020, "IŽS"a.d. obtained Resolution No. 05-340-4254/2020 dated 04.06.2020 from the Government of the Republic of Serbia. This resolution transferred investment rights for the implementation of the mentioned project to them and declared the project for the reconstruction and modernization of the Niš - Dimitrovgrad railway line as a project of special significance for the Republic of Serbia.

A condition for obtaining the Decision for the approval of construction works, or the construction permit for electrification, is that property-legal relationships are resolved on all parcels. In line with this condition, according to the Government of the Republic of Serbia Resolution No. 05-465-1616/2021-1 dated 04.03.2021, a public interest for expropriation, or administrative transfer of properties and land, was established in the territories of the municipalities of Bela Palanka and Dimitrovgrad, as well as in the territories of the cities of Niš and Pirot.

Currently, activities are ongoing to obtain a positive report from the Commission for the Review of the Technical Documentation of the Project for the construction permit for electrification of the Niš-Dimitrovgrad arterial line, section Prosek-Dimitrovgrad.

The tender for the selection of a consultant and supervision for the reconstruction and modernization project of the Niš-Dimitrovgrad arterial line and the construction of the bypass railway around Niš has been completed. A consortium consisting of DB Engineering & Consulting GmbH (Leader), Egis d.o.o. Beograd - Start Engineering jsc, Projekt biro UTIBER d.o.o, MC Transport Design and Simulation d.o.o, CERTIFIER SA, has been selected, and a contract was signed with them under contract No- 1/2021-1550/99 dated 01.07.2022.

After the tender procedure, on 22.07.2022, a Decision was made to sign a contract with the construction contractor Trace Group Hold PLC, Consorzio Armatori Ferroviari S.C.p.A, and Start Engineering JSC for the construction works on the super and sub track structure, electrification of the railway, as well as preparatory works for the installation of signaling and telecommunication equipment (ducts, trenches, foundations of poles) on the section from Sićevo to Dimitrovgrad. The contract was signed on 12.10.2022.

3.8. Previous accidents of similar character

Based on the information provided by "IŽS"a.d. (included in the attachment to the letter number 1/2023-176 dated 06.02.2023), for the period from 01.01.2012, to 25.12.2022, on the main arterial line 106: Niš - Dimitrovgrad - state border - (Dragoman), between the stations Niš and Dimitrovgrad, there have been 24 (twenty-four) accidents, train derailments. An overview of the occurred accidents is presented in table number 3.8.1.

Table 3.8.1: Overview of the accidents occurred in the period between 01.01.2012 and 25.12.2022

Serial No.	Date	Time	Short description	Cause
1	05.03.2012.	10:40	At km 54+365, between the crossing point Čiflik and Staničenje, train No. 35903 (TMD No.25-014) derailed with its first axle	The impact of multiple factors, each of which individually could not have caused the derailment - a combination of several circumstances
2	21.05.2013.	16:00	At km 47+690, between the station Bela Palanka and the Čiflik crossing point, train number 45002 derailed with locomotive number 661-119	Poor condition of the track
3	25.08.2013.	15:00	At km 82+950, between the stations Pirot and Sukovo, train No. 40770 derailed with three wagons from the train composition	Track deformation due to high daily temperatures
4	29.08.2013.	12:45	At km 25+982, between the Dolac crossing point and the Ostrovica station, train number 35904 (TMD No. 25-014, which was pulling a construction machine called "Robel" No. 24-243, with one axle raised on a "Walter" trolley due to a malfunction in the axle assembly) derailed with the construction machine (the raised axle on the "Walter" trolley derailed)	The influence and superimposition of multiple technical factors that affect the interaction between the rail and the wheel when transporting vehicles using "Walter" trolleys, with all measures within the boundaries of allowable tolerances
5	27.10.2013.	23:20	At km 22+807, at Ostrovica station, at switch No. 3, train number 44721 with two wagons of the Gbs and Hbis series derailed	Track gauge widening due to not tidy technical condition of the track
6	22.12.2014.	17:45	At km 14+860, between the stations of Niška Banja and Ostrovica, the derailment of train number 45005 with one empty wagon of the Za series (wagon for the transport of ammonia - OM 1005)	Poor condition of the track
7	10.06.2015.	16:00	At km 91+800, between Sukovo and Dimitrovgrad stations, derailment of train number 46878 with 7 wagons of the Eaos series (loaded with pyrite, owned by BDŽ)	The influence and superimposition of several technical factors affecting the rail-to-wheel relationship, each of which alone could not have caused the skid
8	08.01.2016.	00:10	At km 53+078, at the Čiflik crossing point, the derailment of train number 46871 (undertaking "Srbija Kargo"a.d.) with one wagon of the Sh series loaded with metals	Poor condition of the track
9	06.08.2017.	15:04	At km 67+784, between the official points Staničenje and Pirot, train number 48005 (undertaking "Srbija Kargo"a.d.) with one wagon of the series Za, loaded with hydrogen peroxide derailed (RID 58-2015, OM 4976/17)	Track deformation due to high daily temperatures
10	11.08.2017.	13:55	At km 68+172, between the Staničenje crossing point and the Pirot station, the derailment of train number 52967 (undertaking "Srbija Kargo"a.d.) with one wagon of the Eas series loaded with lead ore	Track deformation due to high daily temperatures
11	19.09.2017.	03:35	At km 5+650, at the Ćele Kula station, between switches number 5 and 7, train number 47042 (undertaking "Srbija Kargo"a.d.) with one wagon of the Eas series derailed	Multiple intertwined negative factors

Serial No.	Date	Time	Short description	Cause
12	13.08.2018.	15:45	In km 27+400, between Ostrovica station and Dolac crossing point, train number 52954 (undertaking “Kombinovani prevoz” d.o.o.) with locomotive 667-100 derailed	A combination of several factors: when encountering the provisional, while the speed reduction process was still ongoing, the locomotive was pushed by the cargo
13	26.08.2018.	11:40	At km 27+400, between Ostrovica station and Dolac crossing point, train number 52954 (undertaking “Kombinovani prevoz” d.o.o.) with pusher 667-100 derailed	Multi factors
14	10.09.2018.	19:38	In km 27+416, between Ostrovica station and Dolac crossing point, train number 52959 (undertaking “Kombinovani prevoz” d.o.o.) with locomotive 667-100 derailed	Multi factors
15	23.11.2018.	17:00	At km 22+287, in the Ostrovica station, at switch number 1, train number 45022 (undertaking “Srbija Kargo”a.d.) derailed with two wagons of the Zacs series loaded with sulfuric acid (UN 1830)	Poor condition of the track
16	02.08.2019.	08:30	At km 56+950, between the crossing points Čiflik and Stanicenje, train number 52953 (undertaking “Kombinovani prevoz”d.o.o.) derailed with locomotive 667-001	Multiple significant damages to the left wheel rim of the locomotive led to the derailment of the second axle of the locomotive. The undertaking (operator) has issued its opinion
17	21.01.2020.	05:55	At km 27+400, between the Ostrovica station and the Dolac crossing point, train number 53988 (undertaking “Kombinovani prevoz”d.o.o.) derailed with locomotive 667-100	The consequence of unstable driving upon approaching the provisional measures during the process of reducing speed and locomotive pushing by the cargo
18	23.06.2021.	11:15	At km 61+634, between the Čiflik and Stanicenje crossing points, train number 40776 (undertaking “Srbija Kargo”a.d.) derailed with one freight wagon from the Sgs series	Deformed track geometry
19	22.09.2021.	21:50	At km 22+867, in the Ostrovica station, at switch number 3, train number 46830 (undertaking “Srbija Kargo”a.d.) derailed with one freight wagon from the Ea series	Infrastructure managers opinion: technical malfunction of skid wheels. Undertaking's opinion: bad condition of track and switch no. 3
20	26.11.202.1	20:13	At km 22+195, in the Ostrovica station, train number 45003 (undertaking “Srbija Kargo”a.d.) derailed with one wagon from the Eas series, loaded with ore	Infrastructure manager’s opinion: a combination of several unfavorable circumstances, none of which individually would lead to a slippage. Undertaking's opinion: poor condition of the track
21	12.12.2021.	05:15	At km 63+407, at the Staničenje crossing point, between switches No.1 and 2, train number 51983 derailed (undertaking Kombinovani prevoz d.o.o.). with two wagons of the Eas series	Infrastructure manager's opinion: in the conditions of a defective sandblasting system, driving backwards in order to reach the position for starting the train caused the train to slip and break. The opinion of the undertaking: the rotting of the sleepers on the switch

Serial. No.	Date	Time	Short description	Cause
22	22.02.2022.	05:25	In km 50+485, between Bela Palanka station and Čiflik crossing point, train number 46678 (undertaking "Srbija Kargo" a.d.) with 6 cars of the Smp series, loaded with copper anodes, derailed	Poor condition of the track (contaminated ballast, rotting of the sleepers) due to which there was movement and deformation of the fastening track accessories and expansion of the track gauge
23	13.09.2022.	09:08	At km 73+211, in Pirot station, between switches number 9 and 10, train number 40833 (undertaking "Transagent operator" d.o.o.) with one wagon of the La series, loaded with containers, derailed	Infrastructure manager's opinion: improper loading and securing of cargo caused unstable movement of the cart. The opinion of the undertaking: technical malfunction of the switch
24	22.11.2022.	00:07	At km 44+783, at Bela Palanka station, on switch number 1, train number 48052 (undertaking "Transagent operator"d.o.o.) with one wagon of the Eas series loaded with iron ore concentrate derailed	Infrastructure manager's opinion: excessive car loading. The opinion of the undertaking: excessive loading of vehicles and poor condition of the infrastructure

In the mentioned accidents, there were no fatalities or injuries.

Besides the accidents and train derailments presented in table No. 3.8.1, for the period from 01.01.2012. to 25.12.2022, according to the data obtained from "IŽS"a.d., there have been three additional accidents involving train derailments during maneuvering (on 15.08.2016. at 17:20 in Dimitrovgrad station, on 27.01.2021. at 11:30 in Pirot station, and on 17.06.2022. at 00:10 in Dimitrovgrad station) and one train derailment on the part of the main railway line No.106 between Dimitrovgrad station and the state border (on 21.10.2020. at 01:40 at km 101+560, train derailment No. 45005 by a Bulgarian undertaking, with locomotive No. 91530400534-0).

3.9. Previous accidents investigated by CINS

According to the Law on Investigation of Accidents in Air, Railway, and Waterborne Transport ("Official Gazette of RS" No. 66/15 and 83/18), CINS conducts investigations after serious accidents in the railway system with the aim of possible safety improvement on the railways and prevention of new accidents caused by the same or similar causes.

Although CINS is obligated to conduct investigations after serious accidents in the railway system, for the purpose of improving railway safety and preventing the occurrence of new accidents caused by the same or similar causes, CINS has also conducted investigations of accidents related to train derailments, including:

1. On 16.08.2017. at 15:30 on the main line: Belgrade Marshalling Yard "A" - Junction "B" - Junction "K" - Resnik, between Junction "B" and Junction "K", there was a train derailment of train No. 62946 (ŽS - 02/17, Final Investigation Report No. 33, No. 340-8059/2017-16 dated 05.01.2018).

2. On 03.11.2017. at 15:25 at km 33+150 of the local railway line Markovac - Resavica, between the stations Svilajnac and Despotovac, there was a train derailment and separation of train No. 56990 (ŽS - 06/17, Final Investigation Report No. 33, No. 340-00-10982/2017-16 dated 14.08.2018).
3. On 23.12.2017. at 13:15 at km 122+250 of the regional railway line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia), in the area of the station Novi Bečej, there was a train derailment of train No. 53527 (ŽS - 07/17, Final Investigation Report No. 33, No. 340-00-13136/2017-19 dated 26.11.2018) and
4. On 28.11.2020. at 19:27 between km 123+600 and km 123+670 of the main railway line 102: Belgrade Center - Junction "G" - Rakovica - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), between the stations Bagrdan and Jagodina, on the left track of the double-track railway line, there occurred a train derailment of train No. 45022 (ŽS - 03/20, Final Investigation Report No. 340-00-2/2020-02-1-53 dated 17.11.2021).

In order to enhance safety in the railway system and prevent the occurrence of new accidents caused by similar or the same causes, CINS has issued the following safety recommendations among others:

1. To the Directorate for Railways, concerning "IŽS"a.d. Safety Recommendations SR_03/17, SR_05/17, SR_24/18, SR_25/18, SR_28/18, SR_29/18, SR_13/21, and SR_14/21 (Note: SR_03/17, SR_24/18, and SR_28/18 are identical);
2. To the MGSI, Sector for Inspection Supervision, Department for Inspection Activities in Railway Traffic: Safety Recommendations SR_07/17, SR_26/18, SR_31/18, and SR_22/21 were issued.

No one of the mentioned safety recommendations have been implemented except for SR_22/21, which has been partially implemented.

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

On 25.12.2022, train No. 45010, consisting of twenty wagon-tanks of series Za loaded with 895.7 t of liquid ammonia (RID 268/1005, OM 4869) and one empty wagon-tank of series Za intended for transporting sulfuric acid (RID 80/1830), pulled by locomotive No. 661-249, departed from Dimitrovgrad station and passed through Pirot station, heading towards the Staničenje crossing point. According to data recorded on the speedometer tape removed from the registering speedometer device of locomotive 661-249, the train was moving at the speed prescribed by the current Timetable Booklet 9.4, from the departure of Dimitrovgrad station to the location of the serious accident.

At 16:45, between Pirot station and the Staničenje crossing point, near the settlement of Sopot, on a section of track that was in a horizontal and curved position (left curve, viewed in the direction of train movement), the train driver, according to his own statement, felt several consecutive jerks of the pulling vehicle (train). He assumed that something was wrong with the train and initiated emergency braking, after which the train came to a stop with its front (locomotive) at km 66+934.

A total of six wagons derailed, of which four overturned. The train decoupled between the eighth and ninth wagons. Ammonia was released into the atmosphere from the relief valve of the thirteenth wagon with No. 33 80 7818 081-1 (viewed from the locomotive).

There was a loss of a portion of the cargo (ammonia). According to data provided by “Elixir Group”d.o.o. Šabac via email dated 22.06.2023, the mass of the lost cargo amounts to 34.66 t.

The track was damaged over a length of approximately 134 m, of which around 69 m of the superstructure was completely destroyed.

Thanks to the quick reaction of the train driver and assistant train driver, who immediately informed the relevant dispatchers about the release of ammonia into the atmosphere shortly after the occurrence of the serious accident, emergency services were notified in the shortest possible time.

4.2. Discussion - analysis of the facts established during the investigation and examination with the aim of drawing conclusions regarding the causes of the serious accident and the effect of the rescue services

4.2.1. Inspection of the derailed wagons on the site and of the infrastructure condition

On 26.12.2022, representatives of the CINS went to the site of the serious accident. Due to the leakage of ammonia from the thirteenth wagon-tank with No. 33 80 7818 081-1, the inspection was conducted under difficult conditions with the assistance of members of MUP, Sector for Emergency Situations. The analysis also includes 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 position of the derailed wagons in the train after the serious accident is shown in images 2.1.2.3. and 4.2.1.1.

Figure 4.2.1.1: Overview of the derailed wagons (source: MUP, Sector for Emergency Situations)

The train was moving in the direction of decreasing stationing. In the analysis (from point 4.2.1. to point 4.2.5.), the orientation “left” or “right” is used, as well as the order of axles of individual wagons, in relation to the direction of train movement. The direction of movement before the serious accident is indicated by a white arrow in the images. The sequential numbers on the images indicate the order of cars in the train. Relevant details for analysis are marked with red arrows in the images.

After the serious accident, the locomotive and the first two wagons were located at the beginning of the right curve with a radius of 400 m (at the start of the transitional curve). The third, fourth, and fifth wagons were located on a straight track. The sixth, seventh, eighth, and ninth wagons were positioned at the end of the left curve with a radius of 500 m, specifically on the transitional curve. The rest of the train was in a circular curve (left curve with a radius of 500 m).

The locomotive No. 661-249 and the first eight wagons were located on the track. The front bogie of the ninth wagon No. 33 87 7813 563-6 was standing on the track. The rear bogie had both left wheels (when viewed in the direction of movement) on a rail that was transversely deformed towards the inside of the curve (image 4.2.1.2.). Due to this deformation, the two right wheels of the rear bogie pedestal became trapped in the track. Based on the shape of the deformed couplings and the coupling guides between the ninth and tenth wagons No. 33 87 7813 580-0, as well as their relative position, it can be concluded that the track deformation occurred due to the pulling of the rear end of the ninth wagon by the tenth wagon during their overturning.

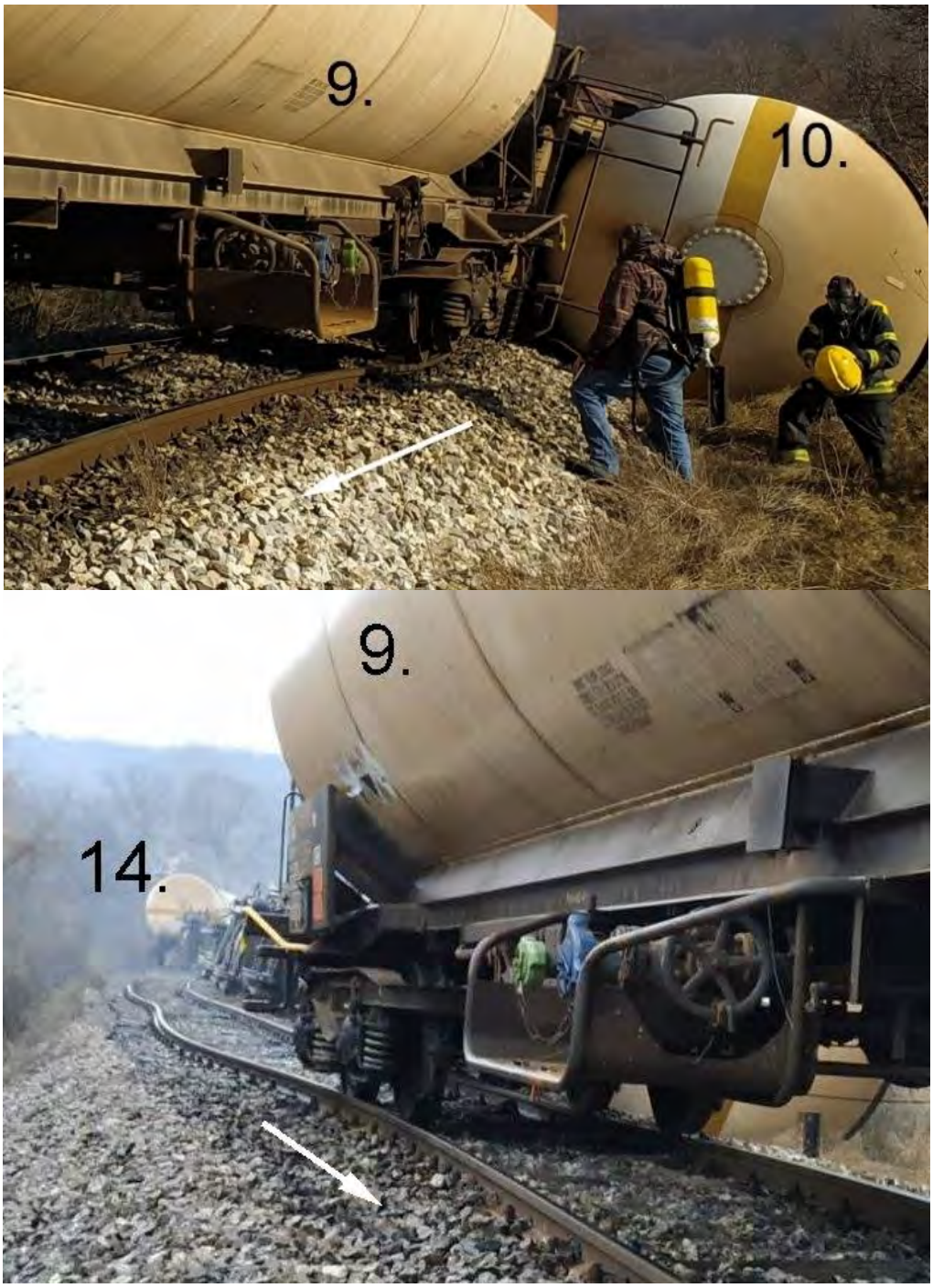


Figure 4.2.1.2: Position of the ninth wagon rear bogie

The tenth wagon No. 33 87 7813 580-0, eleventh wagon No. 33 87 7813 586-7, twelfth wagon No. 33 80 7922 029-3, and thirteenth wagon No. 33 80 7818 081-1 overturned on their left side, towards the inside of the curve (image 4.2.1.3). Traces of movement of the derailed wheels can be seen on the track extending up to the front axle of the tenth wagon (indicated on the image by vertical red arrows).

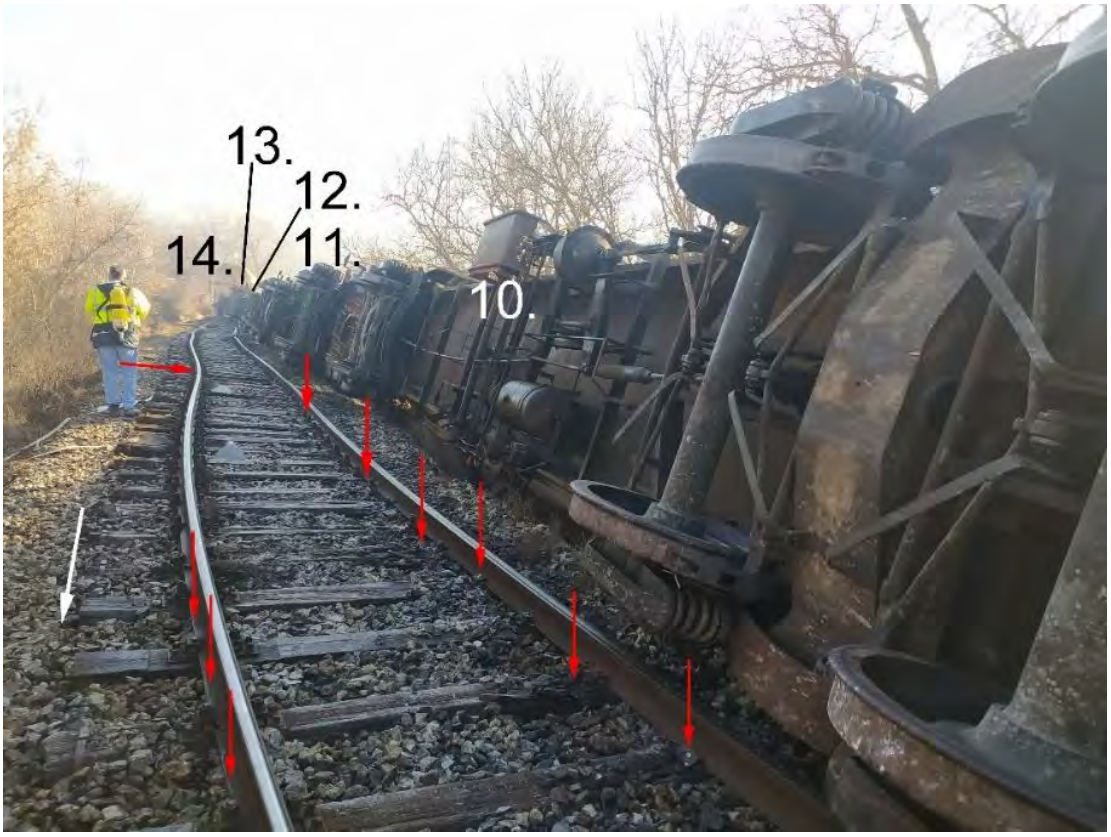


Figure 4.2.1.3: Appearance of the derailed wagon from tenth to thirteen

This indicates that the overturning of the tenth wagon occurred before the train stopped.

In the zone of the rear bogie of the tenth wagon, the track is transversely deformed towards the inside of the curve. Based on this, as well as on the basis of the deformations of the traction devices and the guides of the traction devices between the tenth and eleventh wheels (Figure 4.2.1.4.), it can be concluded that the eleventh wheels pulled the tenth wheels to the side during the overturning, caused the deformation of the track, and then the overturning of ten wagons.

Figure 4.2.1.4: Joint position of the overturned tenth and eleventh wagon

The red arrow in Figure 4.2.1.4. indicates the deformation of the lower guide of the eleventh wagon's hook, most likely caused during their overturning and pulling to the side of the tenth wagon. The tightened coupler in the overturned position is another indication that the eleventh wagon overturned due to friction against the ground, acting as supplementary brakes before the tenth wagon overturned and came to a stop.

In Figure 4.2.1.4., it is observed that the brake couplings are disconnected, which indicates a strong tightening in the connecting hoses during the relative rotation of the tenth and eleventh wagon during overturning.

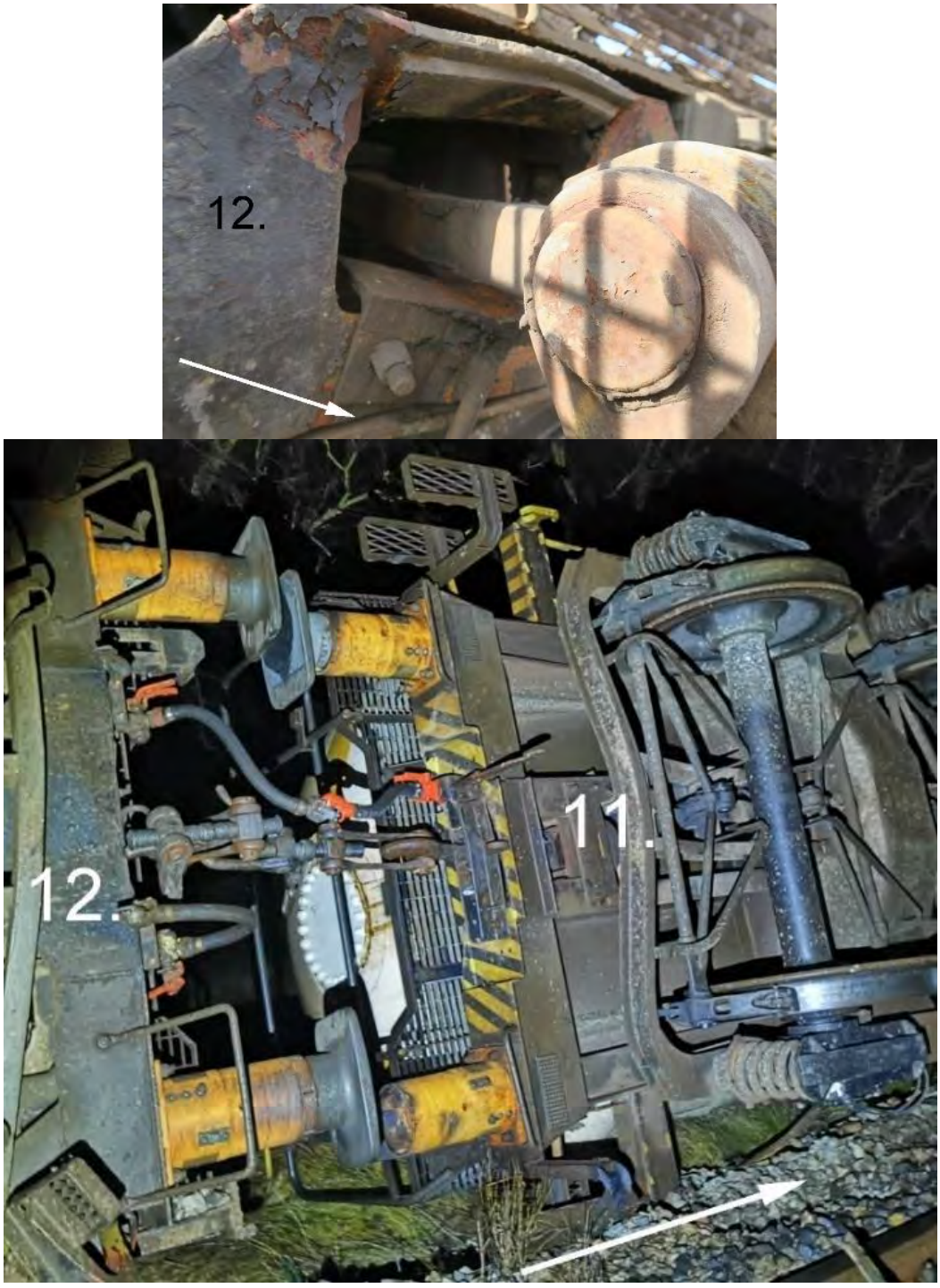


Figure 4.2.1.5: Draw devices of the eleventh and twelfth wagon

At the front part of the twelfth wagon, both the lower and upper guides are bent (fig. 4.2.1.5). For the eleventh wagon, there is only a small deformation in the lower guide on which the hook rested in the found position. The buffer shroud on the rear left buffer of the eleventh wagon fell off, which suggests that this buffer was, probably at the beginning of the overturning, in contact with the corresponding buffer of the twelfth wagon, enduring loads that caused the inner boundaries to collapse. Subsequently, under the action of the preloading force of the spring, buffer

shroud with the buffer plate was ejected. These deformations of the traction and buffing devices and their guides between the eleventh and twelfth wagons do not provide a clear indication of which of these wagons overturned first.

Based on the fact that the coupler was found in a tightened state, there is a probability that the twelfth wagon overturned before the eleventh wagon, and they were additionally braked by friction against the substrate, causing the coupler to tighten towards the eleventh wagon before their definitive fall to the side.

Figure 4.2.1.6. shows deformed hooks and their guides between the twelfth and thirteenth wagon. The neck of the twelfth wagon hook is strongly bent downwards and to the right relative to the direction of movement. The left (in relation to the direction of movement) boundary of the thirteenth car's hook is detached, and the neck of the hook is slightly deformed on that side. These deformations indicate that the twelfth wagon strongly pulled the thirteenth wagon to the side during overturning, after which the thirteenth wagon also overturned.

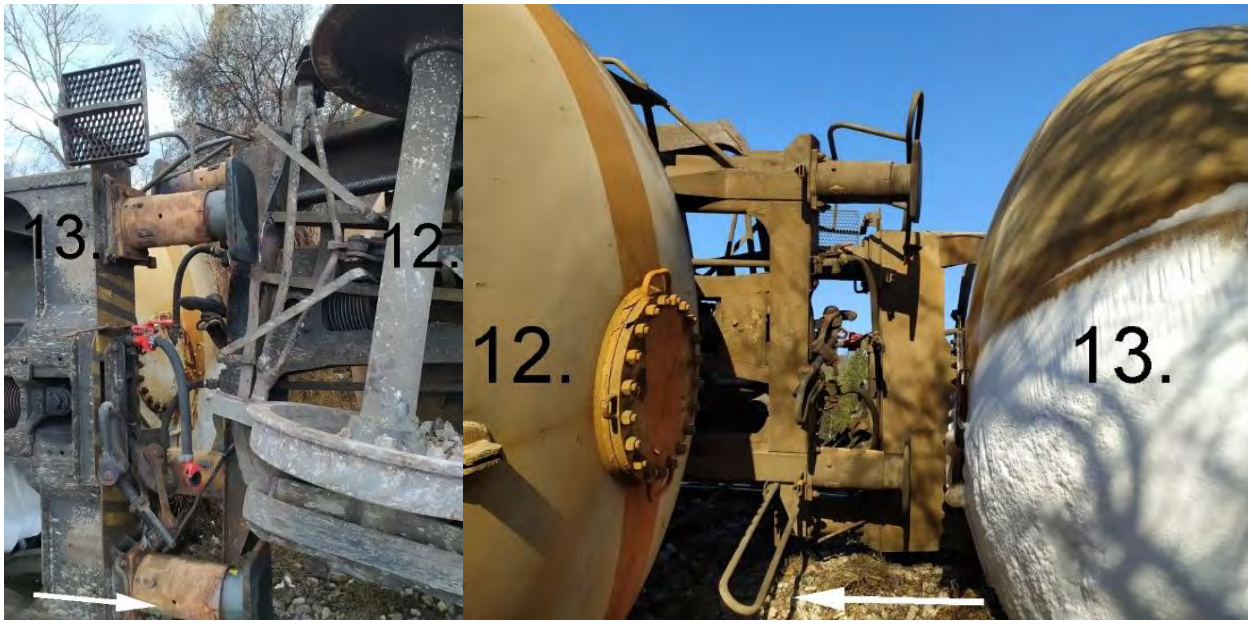
Figure 4.2.1.6: Deformed hooks and guides between the twelfth and thirteenth wagon

Figure 4.2.1.7. shows the transverse deformation of the rails (indicated by the red arrow) in the area of the front bogie of the thirteenth wagon, which indicates a strong pulling of that end of the wagon to the side before their overturning.

Figure 4.2.1.7: Track deformation in the zone of the front thirteen wagon bogie

Figure 4.2.1.8. shows the relationship between the overturned twelfth and thirteenth wagon. From the position after a serious accident, it can be concluded that the thirteenth wagon caught up with the twelfth wagon during the overturning, which allowed the uncoupling of the traction devices. The found position is consistent with the conclusion that the twelfth cars overturned first, due to friction against the substrate and had supplementary braking. Furthermore, the position of the twelfth wagon, whose buffers are further from the track axis than the buffers of the thirteenth wagon, confirms the sequence of overturning.

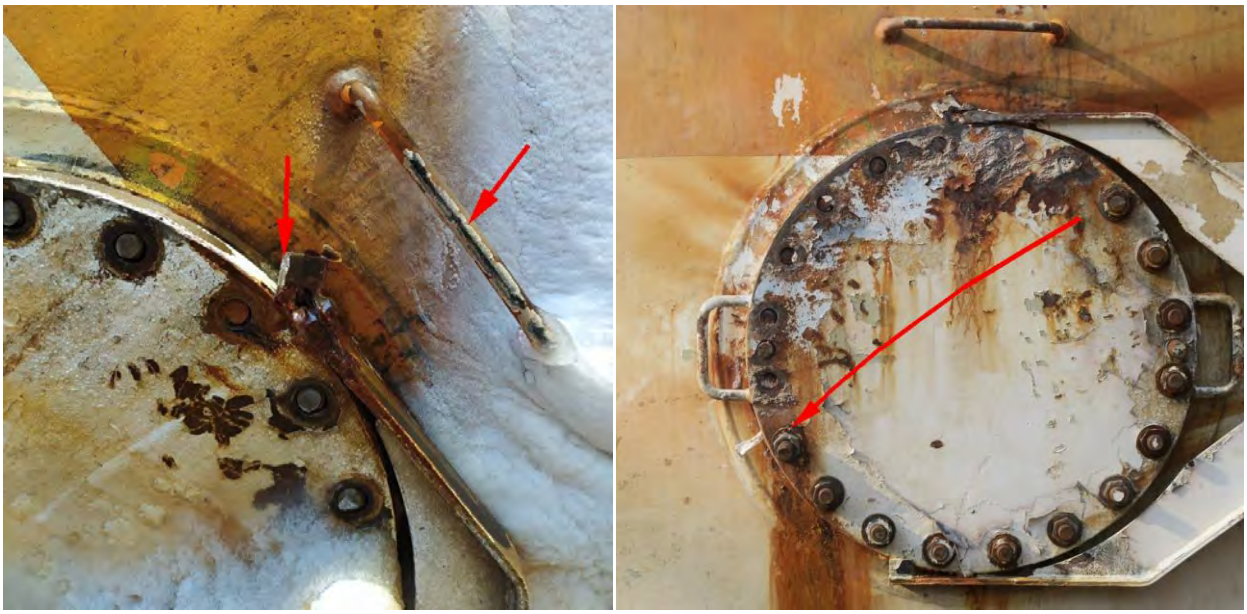
The brake couplings also disconnected during the overturning, due to the strong tightening in the connecting hoses.



a) *b)*

Figure 4.2.1.8: Condition found between the twelfth and thirteenth wagon

There has been a leak of ammonia under the inspection hole cover of the thirteenth wagon. In image 4.2.1.9. a), taken at the scene, the cover is shown with detached screws, as well as traces of scratched paint on the handle above the inspection hole and on the cover holder. Eight out of twenty screws have been detached, and the contact marks can still be seen on one screw in front and one screw behind the group of detached ones. In image 4.2.1.9. b), which was taken during a subsequent inspection of the wagon at the "Inter-mehanika"d.o.o. Skorenovac workshop in Smederevo on 08.02.2023, it can be observed that all the detached screws in the cover openings have been shifted in the direction indicated by the arrow. This suggests that they were detached by sliding in the same direction.



a) b)

Figure 4.2.1.9: Damages on the inspection hole cover of the thirteenth wagon

In Fig.4.2.1.10. the rear right buffer of the twelfth wagon is shown after lifting the wagon for inspection on 19.01.2023. The buffer is tilted upwards with deformation of the attachment plane on the chest beam (see image 4.2.1.10. a)). On the lower and right side of the buffer plate, there are surface traces of damage (see image 4.2.1.10. b)).

a) b)

Figure 4.2.1.10: Bent buffer and traces on the buffer plate of the twelfth wagon

All the previous facts indicate that the twelfth wagon overturned first. During this, the with great force, they pulled the thirteenth wagon via tow hooks, after which the thirteenth wagon also overturned. During the overturning, the thirteenth wagon caught up with the already overturned twelfth wagon. During this, as the thirteenth wagon was overturning, the handle above the inspection hole and the nut of the inspection hole cover screw came into contact with the buffer plate of the rear right buffer of the twelfth wagon. As a result, eight screws of the inspection hole cover were severed. This led to the release of ammonia from the thirteenth wagon-tank.

The investigative team from the competent OJT in Pirot found two nuts with detached parts of screws and four washers on the twelfth wagon (Forensic examination report of the scene, No. KT308-13/2023 dated 12.01.2023, delivered by the Deputy Prosecutor of the OJT in Pirot via email on 31.03.2023). The location of the discovery indicates that the relative speed of the thirteenth wagon in relation to the twelfth wagon at the moment of screw detachment was in the direction of the train's movement. In other words, the twelfth wagon, due to friction with the ground after overturning, was either stopped or had a significantly lower speed than the thirteenth wagon. The buffer spring which broke the screws, partially compressed due to this, which partially contributed to the subsequent relative rejection of the thirteenth wagon from the twelfth wagon. After the serious accident, the buffer plane was approximately 15 cm away from the plane of the inspection hole cover (Figure 4.2.1.8. b)).

On one side of nut 1 (Figure 4.2.1.11. a)), a gray area is visible, which differs from the rusty appearance of the other sides. Traces of paint, which could come from an impact with the buffer plate shown in Figure 4.2.1.10. b)), are also observed. Nut 2 (Figure 4.2.1.11. b)) is deformed from the received lateral impact.

a) b)

Figure 4.2.1.11: The appearance of the found severed screws

It should be noted that there are technical solutions for the inspection hole cover that would most likely reduce or eliminate the risk of screws being severed by the buffer in such accidents. Figure 4.2.1.12. a) shows a solution with a protruding cover. The protruding shape of the cover would likely significantly reduce the number of severed screws and consequently reduce the intensity of ammonia leakage into the environment.

An even better solution is shown in Figure 4.2.1.12. b), with a recessed inspection hole, which would probably avoid screw severing and gas leakage in such accidents. Additionally, the recessed inspection hole is positioned in the center of the beam, which reduces the likelihood of contact with neighboring buffers in accidents similar to this one.

a) b)

Figure 4.2.1.12: Appearance of structural variations of the inspection hole cover

Figure 4.2.1.13. shows the observed condition of the thirteenth wagon No. 33 80 7818 081-1 and the fourteenth wagon No.33 80 7818 089-4. On the thirteenth wagon, the left limit hook was torn off (in the direction of movement), and on the fourteenth wagon, the right hook was torn off, which is a result of the fourteenth wagon being pulled to the left side during the overturning of the thirteenth wagon. Due to the pulling force, the left rail beneath the front pivot stand of the fourteenth wagon was deformed. Both left points of the front pivot stand of the fourteenth wagon remained on the deformed rail, while the two right points fell into the rail track. The coupler yoke of the thirteenth wagon was twisted from its coupler pivot due to the forces during the overturning.

The buffer sleeve on the front right buffer of the fourteenth wagon fell off.

Figure 4.2.1.13: The condition found between the thirteenth and the fourteenth wagon

The wheels of the fourteenth wagon rear bogie, as well as the wheels of all wagons up to the end of the train, remained on the railway track.

Upon inspecting the railway track in the direction towards the end of the train, between the third and fourth axle of the rear bogie of the seventeenth wagon No. 33 80 7814 612-7, on the left rail in the direction of movement (inner rail in the curve with R=500 m), at km 67+244, the first trace of the wheels falling into the railway track was found (Figure 4.2.1.14.). First, you can observe the trace of the wheel's edge cutting into the rail edge (arrow 1). There is also a chip at the point of impact (arrow 2). On the screw head (arrow 3), there is the first trace of deformation due to the point's impact. Behind that, on the inner surface of the left rail, there is a metallic trace from the friction of the fallen wheel (arrow 4), and there are deformations visible on a series of screw heads from the impact of the fallen wheel.

On the outer, right rail in the direction of movement, there are no signs of derailment.

Figure 4.2.1.14: Trace of the first fall of the wheel into the track

Figure 4.2.1.15. shows the observed position of the inner point of the third axle of the seventeenth wagon No. 33 80 7814 612-7, which is the closest to the point of impact. Under the weight of the wagon, in a stationary state, the wheel rests on the rail with a width of approximately 15 mm. At the scene, under the weight of the train in front of the third axle of the seventeenth wagon, the width of the railway track was measured using the "Geismar" measuring instrument owned by "IŽS"a.d. The width of the railway track was beyond the measurement range of the instrument (1475 mm), and it was estimated to be approximately 1490 mm. Towards the front part of the seventeenth wagon, the width was even greater, meaning further outside the scale of the measuring instrument. Nevertheless, the rear part of the fourteenth, fifteenth, sixteenth, and seventeenth wagons crossed the widened railway track and remained with their wheels on both rails.

Figure 4.2.1.15: Position on the rail of the third axle of the seventeenth wagon`s left wheel

Figure 4.2.1.16. shows the sleeper where the first deformation on the top of the screw caused by the wheel's impact was found, marked as the zero sleeper. Sleepers in front of the impact site are marked with negative numbers, while sleepers after the impact site are marked with positive numbers (see Figure 4.2.1.19.).

Figure 4.2.1.16: Point of the falling of the wheel into the track (zero sleeper)

By examining the railway track further in the direction of the train's movement, a continuous trace of scraping on the inner side of the left rail, deformations on the tops of the fastening screws along the inner side of the left rail, and minor traces on the tie along the inside of the left rail can be observed over a length of 41 m. There are no traces of derailment or damage to the fastening equipment along the right rail on this path.

Based on this, it can be assumed that only one wheel, most likely from the front axle, fell onto the railway track, and therefore, the bogie had support along the other diagonal all the way to km 67+203. At that location, there are traces of derailment on the outer side of the right rail, and the trace of scraping from the fallen point on the left rail ceases (Figure 4.2.1.17.).

Figure 4.2.1.17: Trace of derailment on the right rail

Over the next twenty meters, the railway track is severely damaged with torn-up sleepers, leading to the point where four wagon-tanks were overturned (Figure 4.2.1.18.). It was not possible to determine how many axles in total derailed before the wagon-tanks overturned. However, it is confirmed that the traces of derailment extend all the way to the first axle of the tenth wagon (Figure 4.2.1.3.), so there is a probability that this axle was the first to derail.

Figure 4.2.1.18: Severely damaged track in the fourteenth wagon area

Figures from 4.2.1.19. to 4.2.1.21. show examples of the condition of the fastening equipment in the area of the first wheel derailing. Given that the expansion of the railway track required for the wheels derailing occurred during approximately one rotation of the wheel, the available images of the fastening equipment cover approximately 3 m before the point of derailing. A similar condition of the fastening equipment exists in the broader area around that location. On all sleepers, there is evidence of cracking, with some sleepers showing direct alignment with the tyrphons. Multiple tyrphons are missing, and the remaining ones are partially pulled out or loose. The ballast is soiled and partially muddy.

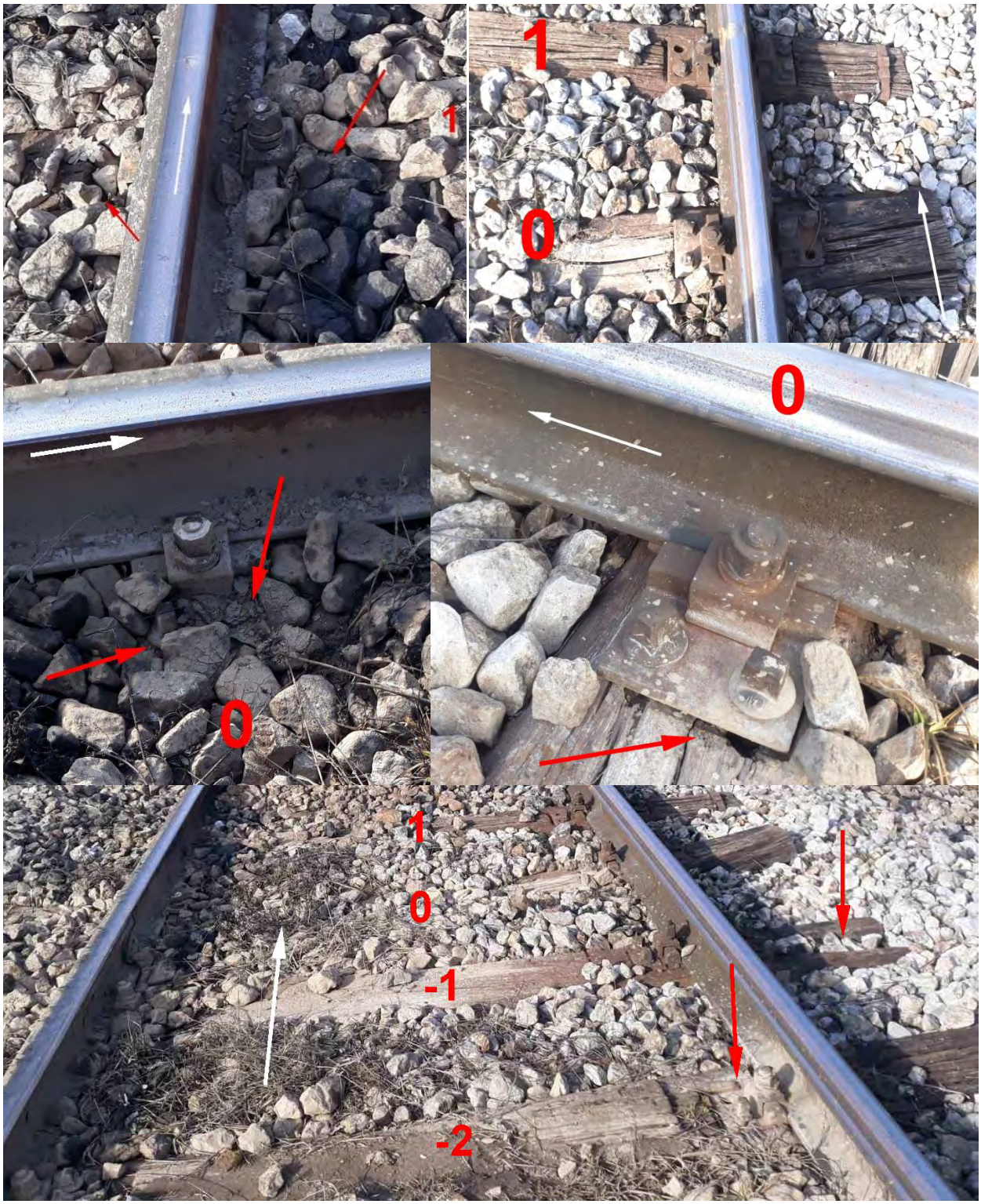


Figure 4.2.1.19: Condition of the fastening equipment in the area of the first wheel derailment

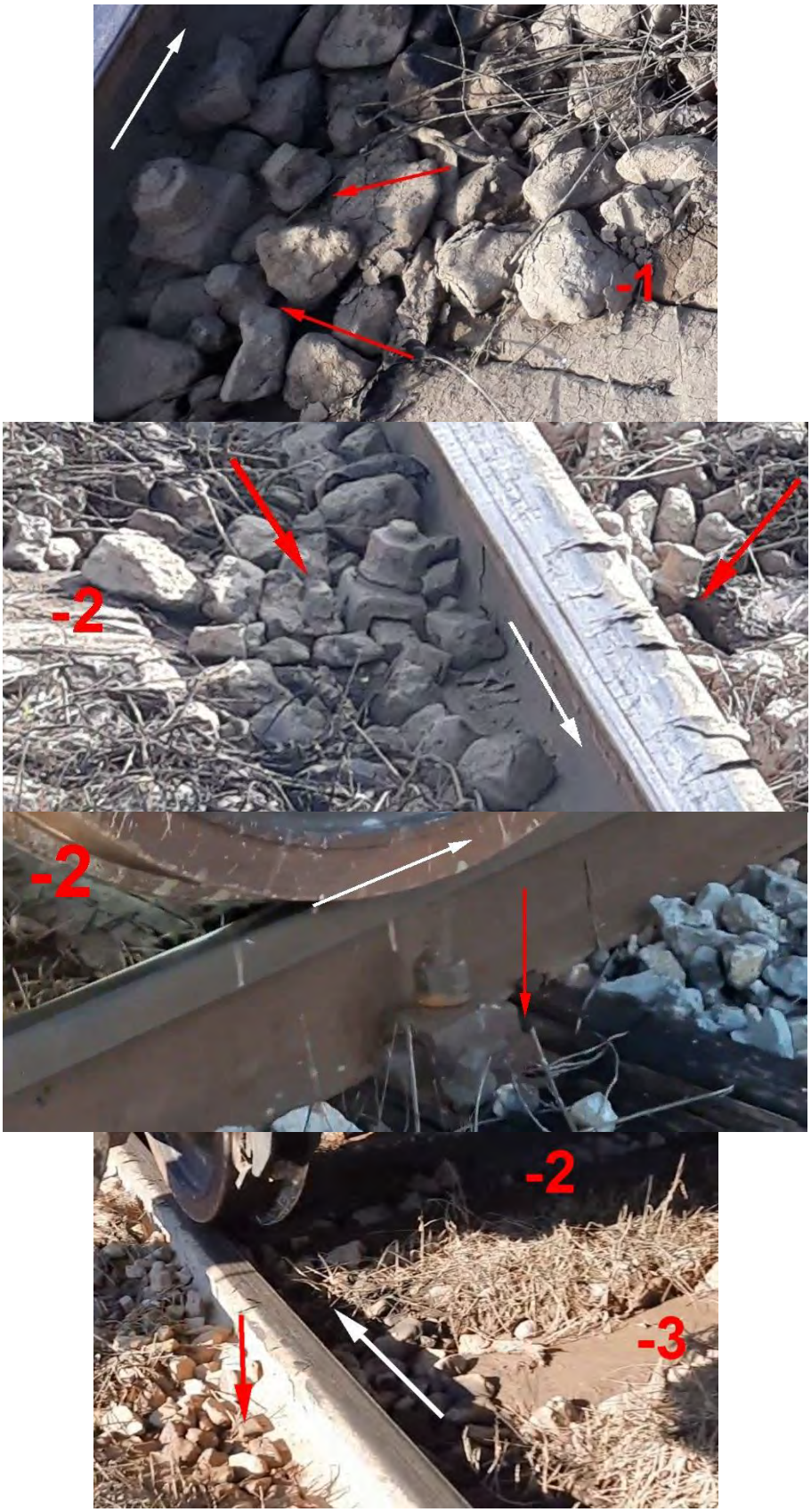


Figure 4.2.1.20: Condition of the fastening equipment in the zone of the first wheel derailment

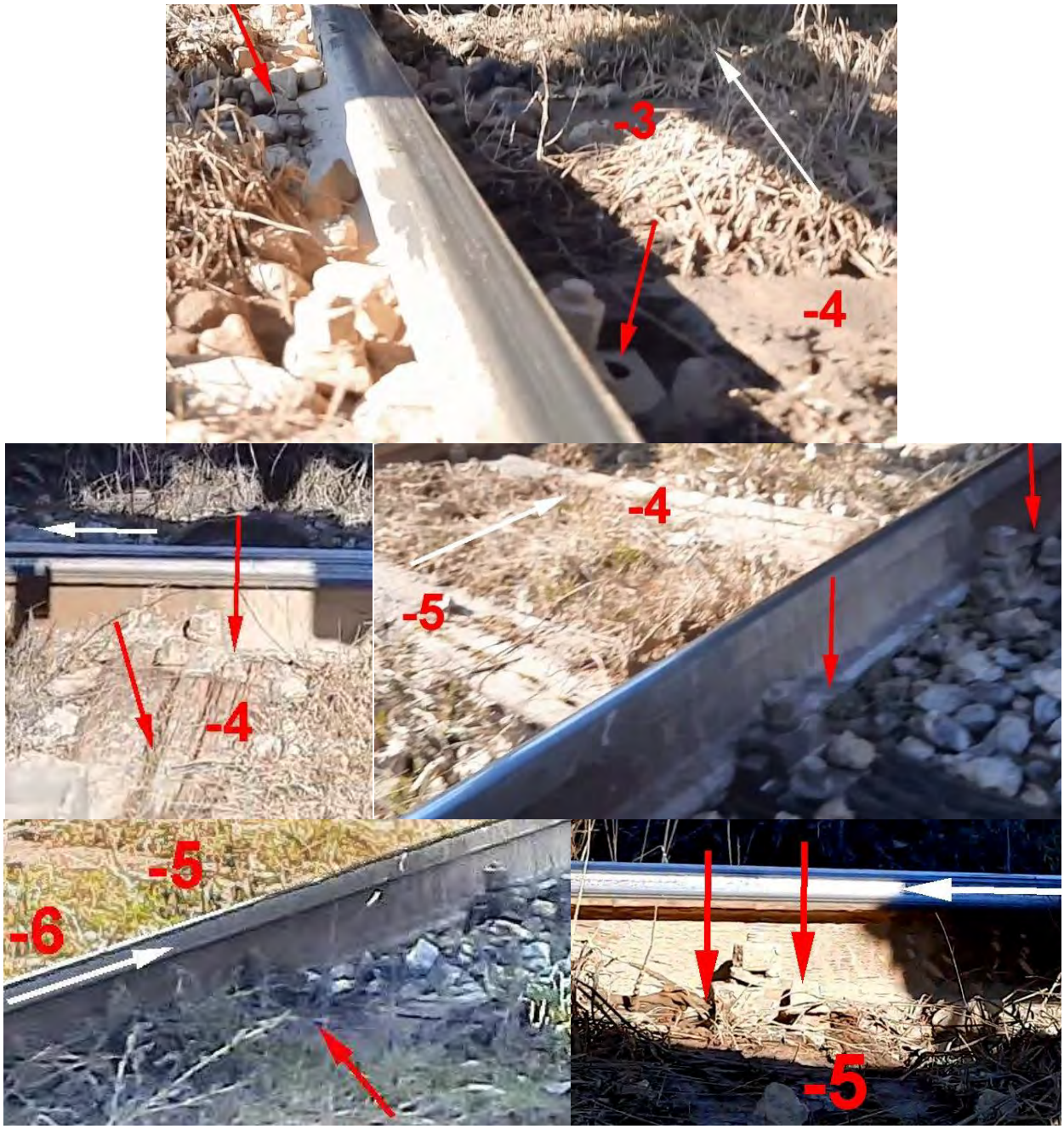


Figure 4.2.1.21: Condition of the fastening equipment in the zone of the first wheel derailment

From the measurements of the railway track geometry conducted on 20.10.2022, using the track inspection coach “Sever 1435” (approximately two months before the serious accident), details have been extracted and are presented in Figure 4.2.1.22. According to the reports provided by “IŽS”a.d., it can be seen that the parameters of the railway track in the zone of the serious accident exceeded the operational limits (Type “C” errors - the boundary of emergency intervention) and were not rectified before the occurrence of the serious accident. Therefore, the condition shown in Figure 4.2.1.22. is relevant for analysis. It is important to note that, since the Type “C” errors were not rectified, the parameters of the railway track at the time of the serious accident could only have been even more unfavorable.

In Figure 4.2.1.22., red lines indicate the points of the first derailment of the left wheel into the railway track and the first derailment of the right wheel across the rail. It can be observed that at the point of the left wheel's derailing into the railway track, there is a cross level of approximately 140 mm, which is significantly above the allowed limit for the designed speed of 85 km/h and even more unfavorable for the actual speed at the moment of derailment, which was approximately 22 km/h. Seven meters before the point of derailing, at km 67+251, in the level crossing zone, the cross level reaches a maximum value of 178 mm. The twist, measured over a length of 3 m, fluctuates around this point between two values above the emergency intervention boundary, one positive and the other negative. In the zone of the wheel's derailing, the track gauge begins to increase, and two meters after, at km 67+242, the gauge exceeds 1470 mm, which is the boundary for emergency intervention. At km 67+234, the track gauge was measured at 1482 mm using the track inspection coach.

It should be noted that during the measurements with the track inspection coach, the load on the railway track was significantly lower than in the case of derailed wagon-tank, which had an axle load of approximately 20 t.

The data provided indicate that due to the large excess of cross level, the vertical load on the inner (left in the direction of movement) wheels was increased. At the same time, the change in twist between two values above the current intervention boundary further triggered oscillations around the longitudinal axis, resulting in even greater amplitude load on the inner wheels. In combination with the lateral guiding force in the curve, the very poor condition of the fastening equipment and sleepers led to the spreading of the rail heads and the derailment of the inner point into the railway track. This has occurred on the axle where at a given moment a critical combination of a number of the mentioned parameters simultaneously happened, some of which have a random oscillatory character.

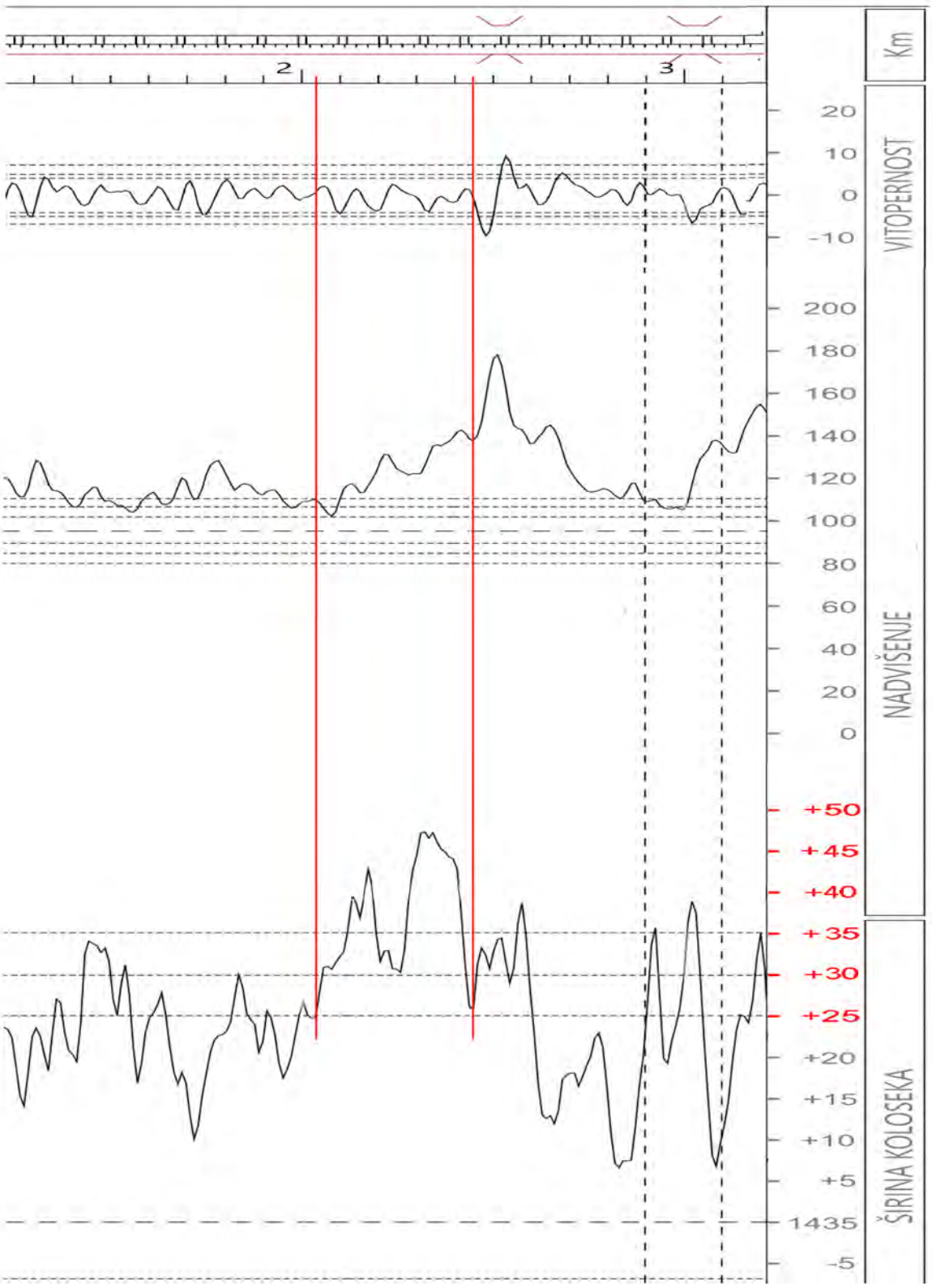


Figure 4.2.1.22: The geometric condition of the railway track in the zone of the wheel's derailment

4.2.2. Inspection of overhaul documentation and inspection of wagons in workshops

"Srbija Kargo"a.d. has, by Letter No. 1/2023-444 of 09.02.2023, e-mail on 06.03.2023 and e-mail on 14.03.2023 provided overhaul documentation obtained from the owners for the six derailed wagons (from the ninth to the fourteenth wagon in the train). Upon reviewing the documentation, it was determined that all wagons had been maintained within the prescribed deadlines and according to the required standards (RID, *GCU/VPI/OUK*). The twelfth wagon No. 33 80 7922 029-3 underwent a revision in September 2019. The ninth wagon No. 33 87 7813 563-6 underwent a revision in May 2022, and all other wagons underwent a revision in September 2022, approximately three to seven months before the serious accident. According to the provided data, from the time of the revision until the occurrence of the serious accident, only the twelfth wagon No. 33 80 7922 029-3 had its broken spring (*GCU/VPI/OUK* code 4.8.2) replaced. No extraordinary repairs were carried out on the other wagons.

Upon the request of the OJT Pirot, an inspection of all derailed wagons was conducted in the certified workshop "Inter-mehanika" d.o.o. Skorenovac in Smederevo, on 18.01., 06.02., 08.02., 10.02., 14.02.2023. The inspection included checking the geometric measurements of the axle assemblies, testing the brakes in place, and visually inspecting the wheelsets, side bearers, and damage to the swivel bogie pedestals.

The checking of the braking system in place could not be performed on the thirteenth wagon No. 33 80 7818 081-1 because the main air duct was damaged in the serious accident. No irregularities affecting the serious accident were found in the operation of the braking system on the other wagons.

During the inspection of the axle assembly dimensions of all derailed wagons, the height of the wheel tread was found to be slightly lower than nominal at 5 wheels. Since the wheels rolled on the track and fastening bolts during the serious accident, these variations are most likely a consequence of the serious accident. These minimal reductions in wheel tread height do not have significance. Other geometric dimensions are within operational limits.

During the inspection of the condition of the wheelset of all derailed wagon, as well as the side bearers and the swivel bogie bearing assemblies, no signs of damage or abrasive wear were found. Representatives from the competent prosecutor's office removed and retained the inserts of the wheelsets of the twelfth wagon No. 33 80 7922 029-3. These inserts did not exhibit any faults that would have required replacement according to applicable maintenance standards.

Another inspection of the derailed wagons was carried out at the request of the CINS and the joint investigative committee of "Srbija Kargo"a.d. and "IŽS"a.d. in "Srbija Kargo"a.d. workshop, Sector ZOVS, Section ZOVS Belgrade, OJ for ROS and freight wagons at the Belgrade Marshalling Yard Station. This inspection took place on 22.03. and 23.03.2023. It included checking the geometric measurements of the axle assemblies, visual inspection of the wheelsets, side bearers, and swivel bearing assemblies, as well as assessing any damage to the wagons.

During the inspection of the geometric measurements of all derailed wagons, no deviations were observed that would have had an impact on the serious accident.

In the examination of the condition of the wheelsets inserts and side bearers of the derailed wagons, no signs were noticed that would indicate any facts relevant to the circumstances of the serious accident.

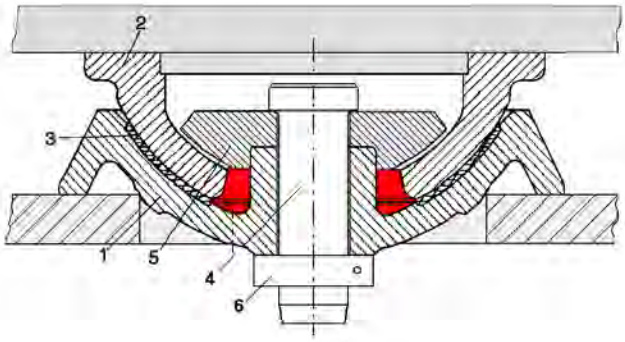
The President of the Joint Investigative Committee of the infrastructure manager and undertaking (representative of "IŽS"a.d.) subsequently, via email dated 29.03.2023, submitted a complaint regarding the signed Record of Inspection of the derailed wagons at the "Srbija Kargo"a.d. workshop. In the complaint, it was stated that during the inspection of the tenth wagon No. 33 87 7813 580-0, significant amounts of material composed of a mixture of soil, metal shavings, crushed stone, and similar substances were found inside the lower center bowl, on the opposite side of the inspection hole. This bogie was the rear bogie of the tenth wagon involved in the serious accident.

Figure 4.2.2.1. shows the center bowl with foreign material from the tenth wagon (which was provided with the complaint from the representative of "IŽS"a.d.).

Figure 4.2.2.1: Center bowl with the foreign material of the tenth wagon

Figure 4.2.2.1. does not show the initial condition before the removal of the deposits. Judging by everything, the dirt was packed in the gap between the upper and lower center bowl, as illustrated in red on Fig.4.2.2.2. It is unclear how such a quantity of material could have entered the center bowl through the small gap between the brackets and the opening in the lower center bowl.

Although there is red soil present in the wider area of the serious accident, similar to the one in Figure 4.2.2.1, photographs from the scene of the serious accident show that the overturning of the tenth wagon occurred on the ballast without visible traces of excavated red soil. Therefore, it is unlikely that the soil entered the center bowl during the serious accident. On the other hand, the probability of this happening during normal operation is even lower, especially since similar occurrences were not observed in the other center bowl The third possibility is that soil entered the center bowl during the unfastening of the bogies in some workshop, which is also unlikely since the previous revision was performed only three months before the serious accident (on 26.9.2022) in Smederevo, and according to the provided data, there was no extraordinary maintenance from that time until the serious accident.



1 – lower rotating cup
2 - upper rotating cup
3 - insert
4 - bolt
5 – counter bearing for lifting
6 - fuse

Figure 4.2.2.2: Cross-section through the center bowl assembly

No traces indicating the occurrence of abrasive friction were observed on the center bowl insert.

The presence of soil in the center bowl, regardless of other factors, could have increased friction within the center bowl and the swivel torque of the bogie. In Figure 4.2.2.3, firstly the effect of the swivel torque on the lateral force on the leading wheels of the front and rear bogie is shown. The direction of the swivel torque on the rear bogie (as was the case with the tenth wagon in the serious accident) is such that it reduces the guiding force and, consequently, the rail spread, while on the front bogie, it increases it.

In this sense, the increased swivel torque on the rear bogie does not have a significant impact on the specific case of the non-guiding (inner in relation to the curve) wheel entering the rail.

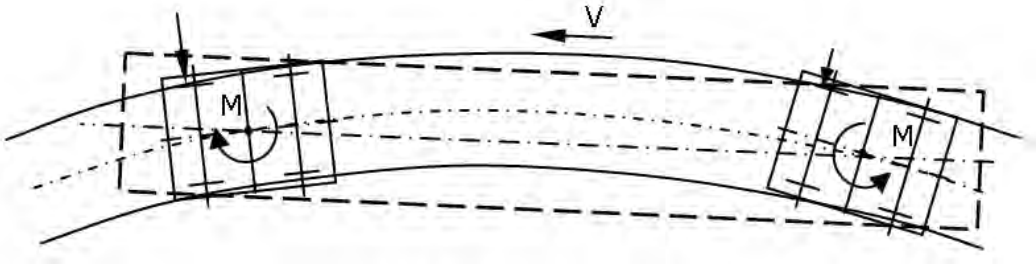


Figure 4.2.2.3: The action of the swivel torque on the guiding force of the front and rear bogie

4.2.3. Braking and loading of the train

The train No. 45010 had a total mass of 1615 t according to the provided cargo information. All wagons, except the last 21st wagon, were loaded to an axle load of 20 t. Out of which, two tanks are filled to 98% and 99% of the permitted capacity. Eighteen tanks are filled between 80.5% and 82.5% of the permitted capacity for anhydrous ammonia. The control weighing of the derailed wagons after the serious accident showed that there were no irregularities in loading (overloading the wagon-tanks). The mentioned wagon tank filling levels did not have an impact on the occurrence of a serious accident.

According to the data from the conductor's report, the percentage of the train's braking mass for train No. 45010 was 74%. Based on the diagram from the SRPS EN 16834 standard, for

individual wagons with gray cast iron brake shoes and a braking mass percentage of 74%, the stopping distance during emergency braking for 40 km/h is 78 m, 139 m from 50 km/h, and 196 m from 60 km/h.

Due to the minimum deceleration rate (at least 250 m/s), for a train composition that, according to the conductor's report, has a length of 359 m, the mentioned stopping distances must be further increased by approximately half of the deceleration time, in non braking state, which is approximately 359 m/2/250 m/s = 0.72 s. For the given speeds, this results in stopping distances for a composition of length 359 m of: 208 m for 60 km/h, 145 m for 50 km/h, and 86 m for 40 km/h.

The standard does not provide data for lower speeds. From the provided information, it is clear that at a speed of 22 km/h, which the train No. 45010 was traveling at just before the serious accident according to the speedometer tape, the stopping distance during emergency braking was significantly shorter than 86 m, as specified in the standard for 40 km/h.

The reported stopping distance of 180 m from the speedometer tape reading is not precise enough and, in any case, includes a portion of the traveled distance after the derailment, which itself caused deceleration (jerks felt by the train driver), as well as a portion of the stopping distance after the initiation of emergency braking, which was far less than 180 m.

All the wagons in the train were found with the brake shoes in the P position.

This is not in accordance with IRS 40421, which replaced UIC 421 Leaflet (see point 3.3.9. of this report), according to which the entire train should have been braked in the G mode. The cited provisions were the basis for point 4, sub-item 5) of Annex 3 of the Regulations on Brakes and Braking of Trains and Vehicles (see point 3.3.8. of this report). In the mentioned Regulations, the provisions for trains braked in the P mode are incorrectly linked to cars of the SS mode, which is just one of several sub-modes of the P mode.

The cited provisions from IRS 40421 are defined to reduce longitudinal reactions during braking, which occur due to the increasing delay in the onset of braking along the train (the effect of the final braking speed). Longitudinal reactions during braking primarily depend on the mass of the train and are not related to the speed at which the train is braking. These reactions can be overly pronounced and lead to negative consequences, especially for heavy freight trains (coupler breakage, flat spots on wheels in the train section, etc.).

The Directorate for Railways formalized this error with its “Explanation of the provisions of the Regulations on Brakes and Braking of Trains and Vehicles related to the braking of freight trains in the G mode” dated 07.02.2022. (published on the website of the Directorate for Railways), with the following explanation:

“As the material of the 2021/2022 Timetable does not envisage freight trains with speeds greater than 90 km/h, the provisions of point 4, sub-item 5) of Annex 3 of the Regulations are not applicable. Instead, all freight trains provided for in the 2021/2022 Timetable brake in the P mode, with the percentages as determined by the material of the timetable.”

This condition of the brakes was not the cause of the serious accident, as braking was applied after the jerks caused by the movement of derailed wagons over the ballast, rails, and fasteners, which the train driver felt.

There are no indications on the basis of which it could be assessed whether and to what extent potential jerks due to subsequently applied braking contributed to the consequences of the serious accident.

4.2.4. Analysis of the speedometer tape

The locomotive 661-249 has an old-type speedometer device that mechanically records data on tape. During the on-site inspection of the moveable object conducted on 17.03.2023, starting at 13:00 in Pirot, in the premises of the PU Pirot and at the request of the Deputy Prosecutor of the OJT Pirot, an inspection of the speedometer tape removed from the locomotive 661-249 and the completed form Data from the speedometer tape (Form EV-85 Annex I), which were revealed by the experts of "Srbija Voz"a.d. was carried out by CINS (see section 3.4.4). The origin of the tape was not identified in the report (empty fields: train No., traction vehicle, date, etc.). The report states that the train was moving at a speed of 20-29 km/h shortly before the serious accident, and at the moment of initiating braking, the speed was 22 km/h. According to the report, from the moment of braking, the train traveled approximately 180 m. This data cannot be considered accurate enough given the limited precision of the recording. In addition, that part of the distance does not only refer to rapid braking from 22 km/h, as explained in point 4.2.3.

The fact that there is no time record on the tape does not affect the recording of speeds, which is done independently of the clock.

The speed at the moment of the serious accident has no impact on the fact that a wheel of one axle set felt into the track. If the track was maintained in accordance with the Laws and bylaws, there would be no possibility for a wheel to felt into the track at any speed between 0 km/h and the designed speed for the observed curve (85 km/h), regardless of braking or the loading condition of the wagon tanks.

4.2.5. Other remarks

4.2.5.1. Damage to the Wooden Roadway Structure at the Level Crossing at km 67+251

Representatives of "IŽS"a.d. identified damage to the wooden roadway structure at the level crossing located at km 67+251, approximately 6 m ahead of the first point where the wheel enter in the track (see figure 4.2.5.1.1. a)). On the image, a red line is drawn to indicate the approximate level of the GIŠ. It can be observed that the damage occurred in the zone between 30 and 50 mm above the GIŠ.

In addition to the level crossing, metal shavings or debris were found (see figure 4.2.5.1.1. b)), most likely originating from the damage.

a) b)

Figure 4.2.5.1.1: Hollowed part of the wooden roadway structure at the level crossing

During the on-site inspection and later examinations, no parts that could be so low were found on any of the vehicles in the train. In the picture 4.2.5.1.2. a), taken at the scene, you can see that on the wagon-tanks, the lowest parts of the pedestal housings have their lower surfaces, at approximately 200 mm above the GIŠ, at medium wheel wear. In picture 4.2.5.1.2. b), also taken at the scene, you can see the rear rail cleaner of locomotive 661-249 and the low parts of the wagon-tanks. The rail cleaner, when the wheel are most worn and the springs are at their maximum deflection, can be as low as 80 mm above the GIŠ, but it is normally higher than that.

a) b)

Figure 4.2.5.1.2: Position of the lower parts of the vehicle

Based on the available facts, it is unlikely that the damage to the wooden road crossing structure originates from train No. 45010, nor can this damage be linked to the occurrence of the serious accident.

4.2.5.2. Leakage of ammonia at the wagon tank's valves

During the inspection following the serious accident on the scene on 29.12.2022, and at the Staničenje crossing point on 30.12.2022, and 02.01.2023, on the seventh wagon No. 33 87 7813 561-0, the staff of "Srbija Kargo"a.d. observed intermittent leakage of ammonia at the central valve of the gas phase, as shown in Figure 4.2.5.2.1. The leakage occurred on the cover beneath the main valve and was remedied by tightening the flange bolts. Since the leakage occurred behind the flange of the central valve, it indicates that neither the central valve had proper sealing. The wagon had undergone maintenance five months before the serious accident.

On the eighth wagon No. 33 80 7818 092-8, at the Staničenje crossing point on 31.12.2022, minor leakage was also observed at the flange between the side valve and the side cover, as indicated in Figure 4.2.5.2.2. This also indicates that both the central and side valves were partially leaking. The wagons had undergone maintenance three months before the serious accident.

The aforementioned leakages did not have an impact on the occurrence of the serious accident.

According to the provisions of the RID regulations (point 1.4.3.3 and 1.4.3.7), the Filler and the Unloader must establish a procedure to verify the proper functioning of the tank closure devices on the wagon-tank and ensure the sealing of the closure devices before and after loading.

Figure 4.2.5.2.1: The point of ammonia leakage on the seventh wagon-tank No. 33 87 7813 561-0

Figure 4.2.5.2.2: The point of ammonia leakage on the eighth wagon-tank No. 33 80 7818 092-8

4.2.6. Analysis of the number of executors, mechanization, and track conditions

The railway section Bela Palanka maintains a single-track railway No. 106: Niš - Dimitrovgrad - state border - (Dragoman), from switch No. 1 in Dolac station at km 31+405 to the border with Bulgaria at km 103+930, which totals 72.52 km of open track. It also maintains eight stations with their associated station tracks and switches. Other station tracks have a length of 22.57 km, with 72 simple switches and one double switch. The total length of the track maintained by the Railway Section is 95.09 km.

Out of the total of fourteen employees in the Railway Section Dimitrovgrad - Bela Palanka, there are eleven immediate executors (1 track maintenance supervisor, 1 blacksmith - mechanical locksmith, 4 operators of light track machinery, 1 track worker, 2 TMD drivers, and 2 track guards - patrollers). Excluding 1 track maintenance supervisor, 2 TMD drivers, and 2 track guards - patrollers from the immediate performers, six performers remain for carrying out the work.

According to the norms of I - IV of current maintenance of the superstructure for normal track, per relevant kilometer (Traffic Institute CIP Study: Methodology for calculating the costs of regular and investment maintenance of the upper track structure for speeds up to 160 km/h, Belgrade, April 1997), for renovated tracks with an age greater than 20 years (Normative III), the required number of workers per relevant kilometer is 0.526, which amounts to 50 workers for the total of 95.09 km of track maintained by the Railway Section Dimitrovgrad - Bela Palanka.

The mentioned study indicates an insufficient number of immediate executors in the Railway Section Dimitrovgrad - Bela Palanka for maintaining the upper track structure of railway tracks to ensure safe and orderly railway traffic. Consequently, the number of immediate executors is inadequate for maintaining the lower track structure of railway tracks as well.

The Railway Section Dimitrovgrad - Bela Palanka has the following machinery and tools: 1 TMD, 3 rail drilling machines, 1 rail cutting machine, 1 Walter axle trolley, 2 Walter trolleys, 1 turnout equipment bending machine, 2 tyrphons-tamping machines, 1 rail drilling machine, 1 manual vibratory compactor, and 1 rail profile measuring device. The mentioned machinery and tools are sufficient for maintaining the track with the existing number of executors, but they are not enough for the necessary number of performers to ensure safe and orderly railway traffic. This fact suggests the need to allocate the necessary number of executors, machinery, and tools to guarantee safe and orderly railway traffic.

According to the information provided in the letter from the Head of the ZOP Section in Niš, No. 20/2023-1.20-112/1 dated 26.01.2023 (attached to the letter from "IŽS"a.d. No. 1/2023-176 dated 06.02.2023), the main railway line number 106: Niš - Dimitrovgrad - state border - (Dragoman) has been categorized as follows: Category D3, maximum axle load of 225 kN and 72 kN/m, from km 0+246 to km 97+395 and Category D4, maximum axle load of 225 kN and 80 kN/m, from km 97+395 to km 103+929. The railway is single-track and unelectrified from km 0+246 to km 97+395. From km 97+395 to km 103+929.52, it is electrified (in operation since 10.12.2005). The track grid consists mainly of E-49 type rails and, to a lesser extent, E-45 type rails (crossover and manipulative tracks, part of the open track), while the passing track at the Dimitrovgrad station and the open track from Dimitrovgrad to the state border use UIC-60 type rails with elastic track accessories (SKL-14). The rest of the track has "K" accessories and non-standard accessories (dz 71 plates). The track grid includes wooden and concrete IM-2 sleepers within the ballast prism of limestone gravel. In the Reports of the Chief of the Railway Section Dimitrovgrad - Bela Palanka for the period from 2020 to 2022, it is noted that there is an extremely high level of decay in the wooden sleepers and that 6,431 sleepers out of a total of 13,692 installed (46.9%, in some areas even 75%) need replacement. The particularly **poor condition of sleepers is highlighted from km 66+300 to km 67+500** and from km 68+500 to km 71+800, as more than 50% of sleepers in these sections are no longer effective and could lead to derailments. From 2020 until the occurrence of the serious accident, no work had been done to replace the decayed sleepers on the mentioned section. The condition of the wooden sleepers in the area of the serious accident is shown in Figure 4.2.6.1.

Figure 4.2.6.1: Appearance of the wooden sleepers in the serious accident zone (source: "IŽS"a.d.)

The last overhaul of the railway section between the Staničenje crossing point (km 63+800) and the Pirot station (km 72+900) was carried out in 1985. As part of the planned maintenance during the period from 2003 to 2005, there was a replacement of bridge structures, including the construction of four new reinforced concrete bridges and four new steel bridge structures. Additionally, 11 steel grid bridges were reconstructed to accommodate the future electrification of the railway line. All six tunnels along this section, totaling a length of 860.80 m, were also reconstructed to fit the profile needed for future electrification. In the report from the Chief of the Infrastructure Maintenance Section in Niš, No. 20/2021-1.20-776 and dated 07.05.2021 (attached to the letter from "IZS"a.d. No. 1/2023-176 and dated 06.02.2023), it is noted that in recent years, only essential maintenance work has been carried out. The justification for this is that a major overhaul is planned, and there is no point in investing in something that will undergo renovation.

On the main railway line No. 106: Niš - Dimitrovgrad - state border - (Dragoman), between the Staničenje crossing point (km 63+800) and the Pirot station (km 72+900), the projected speeds are as follows: 40 km/h from km 63+800 to km 64+613, 85 km/h from km 64+613 to km 65+635, 60 km/h from km 65+635 to km 66+989, and 85 km/h from km 66+989 to km 72+900. Analyzing the period from 2018, starting from the 2017/2018 Timetable, the maximum allowed speed on the Staničenje – Pirot railway section is 30 km/h, which still applies. Within this maximum allowed speed, there are no restricted speeds or introduced restricted speed runs for period from 01.01.2018 to 25.12.2022.

Considering the previously mentioned text and the years since the last track maintenance, it can be concluded that the track maintenance of the superstructure has not been conducted in accordance with Area III maintenance methods and deadlines for superstructure maintenance, as specified in articles 66, 67, 68, and 69 of the Rulebook on Technical Conditions and Maintenance of Railway Tracks Superstructure ("Official Gazette of RS" No. 39/16 and 74/16). In light of this fact, the consequence of delayed maintenance has resulted in the condition of the tracks as described in the previous text.

According to the information provided in the letter from the Sector for Construction Works, numbered 20/2023-197 and 03.02.2023 (attached to the letter from "IZS"a.d., No. 1/2023-176 and dated 06.02.2023), for the period from 01.01.2018., until the occurrence of the serious accident, the construction works on the superstructure was conducted as detailed in the following text.

1. The machine and manual adjustment of the railway tracks were carried out as follows:

During the year 2018, no construction works on the tracks was performed.

During the year 2019, manual adjustments were made from km 63+800 to km 72+800 on nine segments, **excluding the segment from km 67+200 to km 67+300**, covering a total length of 4,880 m.

During the year 2020, manual adjustments were made from km 63+800 to km 71+007 on four segments, **excluding the segment from km 67+200 to km 67+300**, covering a total length of 530 m. Additionally, machine adjustments were carried out from km 67+700 to km 68+250, covering a length of 550 m.

During the year 2021, manual adjustments were made from km 66+400 to km 72+100 on four segments, **including the last 30 meters of the segment** from km 67+200 to km 67+300, covering a total length of 1,260 m. Additionally, machine adjustments were carried out from km 67+500 to km 68+500, covering a length of 1,000 m.

During the year 2022, machine adjustments were performed from km 71+800 to km 72+200, covering a length of 400 m.

2. The works related to manually lifting the depressions on wooden sleepers and tamping were carried out as follows:

During the year 2018, these works were conducted from km 63+800 to km 72+900 on eleven segments, **including the entire segment from km 67+200 to km 67+300,** covering a total length of 2,830 m.

During the year 2019, no relevant works were carried out.

During the year 2020, there were no works related to this.

During the year 2021, works were conducted from km 63+800 to km 72+400 on three segments, **excluding the segment from km 67+200 to km 67+300**, covering a total length of 1,000 m.

3. Works related to replacing and tamping the fallen sleepers and fallen assemblies were carried out as follows:

During the year 2018, there were no works related to this.

During the year 2019, there were no works related to this.

During the year 2020, there were no works related to this.

During the year 2021, there were no works related to this.

During the year 2022, work was carried out on nine segments from km 63+800 to km 72+533, including the segment from km **67+200 to km 67+300**, covering a total length of 8533 m.

4. Repairs to replace rails, reposition displaced rails, and rehabilitate rail fractures were carried out as follows:

During the year 2018, no specific work was performed.

During the year 2019, no specific work was performed.

During the year 2020, no specific work was performed.

During the year 2021, work was carried out from km 72+400 to km 72+500 and at km 71+223.

During the year 2022, no specific work was performed.

5. The works of replacing wooden sleepers with used ones, re-laying tracks, and adjusting track alignment and levels at the installation site were carried out as follows:

During the year 2018, no specific work was performed.

During the year 2019, the work was done from **km 67+290 to km 67+315 (4 pieces)** and at km 70+850 (6 pieces), including the completion of the segment from km 67+200 to km 67+300.

During the year 2020, no specific work was performed.

During the year 2021, the work was done at km 71+900 (6 pieces) and from km 72+775 to km 72+785 (6 pieces).

During the year 2022, the work was done from km 70+780 to km 70+820 (12 pieces).

6. The works of supplementing and tensioning the track equipment were carried out as follows:

During the year 2018, no specific work was performed.

During the year 2019, no specific work was performed.

During the year 2020, the work was done from km 66+500 to km 66+700 (100 pieces), at km 66+700 to km 66+900 (139 pieces), and at km 71+007 (at a level crossing).

During the year 2021, work was done only at km 71+900 (6 pieces).

During the year 2022, the work was done from km 70+780 to km 70+820 (12 pieces).

It should be noted that the aforementioned works also included addressing defects identified through measurements, and during the specified period on the Dimitrovgrad - Bela Palanka railway section, there were insufficient personnel, technical resources, and material conditions to promptly rectify "C" type defects that required urgent intervention due to safety concerns. The set deadlines, which demanded immediate action or completion within a month, were not achievable, as can be observed from several reports issued by the Chief of the railway section Dimitrovgrad - Bela Palanka. The fact that defects identified as of 09.05.2018, were not rectified until March 2019. (for almost five months, until September 2018, the errors were removed from km 63+400 until km 72+200). Additionally, the absence of any other measures during this time, is against the Instructions on unique criteria for controlling the condition of railways on the JŽ network, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004, "Official Gazette of ZJŽ" No. 14/22). Thus, in the Reports of the Head of the Dimitrovgrad - Bela Palanka railway section from 2018, 2019, 2020, after receiving instructions from the ZOP Niš Section to eliminate errors, concluded that, considering on the number of workers, the errors cannot be eliminated in prescribed dedlines. The example provided, where it would require 5500 working hours (equivalent to six months of work for five railway workers) just to eliminate errors identified by track inspection coach measurements on 16.01.2020.

According to the regular inspections conducted from the traction vehicle on railway line No. 106: Niš - Dimitrovgrad - state border - (Dragoman) between 01.01.2018, and the occurrence of a serious accident, the following findings were made by the expert team of the Section ZOP in Niš, or the relevant section responsible for Dimitrovgrad - Bela Palanka:

- During the year 2019, between km 67+250 and km 67+268, it was determined that there was a need to replace a rail segment with a length of 18 m in the outer curve of the track, which was worn down by over 23 mm. Additionally, 11 wooden sleepers with broken tyrphons needed replacement. **Instead of replacing the rail, it was rotated from km 67+240 to km 67+280,** as evidenced in the Daily Report for 19.03. and 20.03.2019.
- During the year 2020, no irregularities were noted.

Note: CINS did not receive the reports on track inspections from the traction vehicle for the years 2018, 2021. and 2022, nor did it receive information that the inspections in question were carried out.

Visual inspections of railway line No. 106: Niš - Dimitrovgrad - state border - (Dragoman), covering the period from 01.01.2018, to the occurrence of a serious accident, between the Staničenje railway crossing (km 63+800) and the Pirot station (km 72+900), including the accident zone (from km 66+700 to km 67+700), conducted by the expert team of the Section for Maintenance of Railway Lines (Section ZOP) in Niš, or the relevant section responsible for Dimitrovgrad - Bela Palanka, revealed the following:

- In 2018, a track deformation was observed at **km 68+080**, leading to a reduced speed limit of 10 km/h.

- In 2019, there was an exceptionally **high level of decay** in wooden sleepers between km **63+800 and km 72+400**, requiring the replacement of 6431 sleepers out of a total of 13692 installed.

- In 2020, there was an **exceptionally high level of decay** in wooden sleepers between **km 63+800 and km 72+400,** requiring the replacement of 6431 sleepers out of a total of 13692 installed. Additionally, between km 70+000 and km 72+400, 2200 sleepers needed replacement, which translates to replacing between 89 and 119 sleepers per hundred meters of track.

- In 2021, there was an exceptionally **high level of decay in wooden sleepers between km 63+800 and km 72+400**, requiring the replacement of 6431 sleepers out of a total of 13692 installed (**46.9%, and up to 75% in some sections**). It was noted in the report from the Chief of the Dimitrovgrad - Bela Palanka railway line, number 20/2021-1.20.4-225 dated December 22, 2021, that the solution is a massive replacement of wooden sleepers in the track (6431 pieces). It was also highlighted that **this condition is in violation of regulations and in direct contradiction with the Technical Conditions for the Superstructure.** Poor track conditions were noted from km 72+100 to km 72+300, with mud in the track and a poor track bed.\

- In 2022, there was **an exceptionally high level of decay in wooden sleepers between km 63+800 and km 72+400**, requiring the replacement of 6431 sleepers out of a total of 13692 installed (**46.9%, and up to 75% in some sections). Particularly poor sleeper conditions were noted from km 66+300 to km 67+500 and from km 68+500 to km 71+800**, **with less than 50% of sleepers remaining, which could lead to train derailments**. The report from the Chief of the Dimitrovgrad - Bela Palanka railway line, number 20/2022-1.20.4-8 dated 22.01.2022, also emphasized the need for a massive replacement of wooden sleepers in the track (6431 pieces). It was mentioned that improper dilatations are present in rail joints due to the installation of rails of different lengths in the past, without forming the DTŠ. Additionally, most rail joints are not aligned properly, resulting in significant dynamic impacts. It was also noted that elements of the lower structure, culverts, channels, and slope cuts, are overgrown with weeds and large vegetation and require cleaning of torrential streams at km 67+303 and km 69+021, where sediment has almost reached the lower edge of the structure.

The Chief of the Section ZOP in Niš, in his report on the condition of railway line No. 106: Niš - Dimitrovgrad - state border - (Dragoman), addressed to the Director of the Civil Engineering Department (Report No. 20/2021-1.20-776 dated 07.05.2021), highlighted several irregularities on the subject track. Among these irregularities, they emphasized **the significant decay of wooden sleepers on the section between Staničenje and Pirot, from km 63+800 to km 72+400, with some parts exhibiting decay rates of up to 75%.** They pointed out the urgent need for replacement, specifically 6431 sleepers. Furthermore, the report mentioned that in recent years, geometric measurements of the track with track inspection coach, have become irregular. There is no designated speed for the entire stretch, and the elements of curves have been maintained according to designed speeds. This has resulted in improper curve elements and excessive cross level, causing different forces on train movement and load distribution in curves. This, in turn,

leads to increased wear on rails and damage to fastening equipment. The report also noted that only essential maintenance work has been carried out in recent years, with the justification that a major overhaul is planned, making it unnecessary to invest in something that will be overhauled. At the end of the report, he also states that, if this situation continues and if the existing situation is not repaired as soon as possible, they will not be responsible for the safety of traffic because they are unable to and do not have the required amount of materials.

The Chief of the Dimitrovgrad - Bela Palanka Railway Section, in their latest report No. 20/2022-1.20.4-145 dated 01.12.2022, addressed to the Chief of the Section ZOP in Niš, before the occurrence of the serious accident, noted that in the recent period, there had been an increase in accidents involving train derailments on the Niš - Dimitrovgrad railway line. These accidents were primarily attributed to weak points on the track. They also made a request for the delivery of instructions for further work on maintaining the Niš - Dimitrovgrad railway line (the section from km 31+405 to km 103+929). The reason for this request was that the section was not able to bring the track into normal operational condition through timely maintenance. Given that the Niš - Dimitrovgrad railway line is of strategic importance for the Republic of Serbia, they couldn't close the most critical sections for traffic. In the subsequent text, they requested the formation of a working group to make the final decision on whether the railway line is capable of supporting traffic.

By the professional services of the Sector for Civil Engineering Works, from 01.01.2018, until the occurrence of the serious accident between the Staničenje junction and the Pirot station, there were no inspections for the control of the integrity of the track's upper and lower structure, both as a whole and for individual groups of elements or specific elements (where technical parameters of the track, track alignment, and the condition of installed materials are checked). By the professional services of the Sector for Civil Engineering Works , technical inspections of the track were only carried out on the Niš - Ostrovica section on 14.01, 15.01, and 16.01.2020, as documented in the Inspection Record of the Niš - Ostrovica Railway dated 16.01.2020, with the reference number 20/2020-1.20-104 (attached to the letter from the Sector for Civil Engineering Works dated 03.02.2023, with reference number 20/2023-197).

According to the information provided in the letter from the Internal Control Center with reference number 14/2023-31 dated 03.02.2023 (attached to the letter from “IZS”a.d. with reference number 1/2023-176 dated 06.02.2023), it can be observed that inspections of the railway were conducted between the Staničenje crossing point (km 63+800) and the Pirot station (km 72+900) from 01.01.2018, until the occurrence of the serious accident. These inspections were carried out based on the provisions of Articles 22. and 36. of the Regulation on the Organization and Implementation of Internal Control and Supervision Activities in the Joint Stock Company for Railway Infrastructure Management “IŽS”a.d. (“Official Gazette of ZJŽ” Nos. 13/17, 50/19, and 20/20). The inspections took place on the following dates: 09.05.2018, 16.04.2019, 19.05.2020, 20.04.2021, and 12.04.2022. Based on the Inspection Reports, decisions were made to impose measures to rectify the identified irregularities. In compliance with the decisions on imposed measures from the Internal Control Center, the Section for Railway Maintenance and Infrastructure in Niš carried out the prescribed measures within the specified deadlines, as confirmed by the inspector from the Internal Control Center during partial inspections. However, the overall condition of the railway did not improve until the next detailed inspection. In other words, although the identified irregularities were addressed, they reappeared over time.

According to the displayed track condition and the scope and type of works performed in the period from 01.01.2018. years until the occurrence of a serious accident, the data contained in the

letter from the Department of Civil Engineering with reference number 20/2023-197 dated 3.2.2023 (attached to the letter from "IZS"a.d. with reference number 1/2023-176 dated 06.02.2023), between the Staničenje crossing point (km 63+800) and the Pirot station (km 72+900), the following conclusions can be drawn:

- The railway section has been in operation for approximately 40 years since its last major overhaul, which is unacceptable, as it exceeds the operational lifespan of the installed materials (significant decay of wooden sleepers on certain sections, more than 50%, visible falled of "dž71" plates, poor condition of track fasteners, insufficient lubrication, inadequate tightening, absence or non-functional tyrphons in some areas, etc.). This is in violation of articles 80 and 81 of the Rulebook on Technical Conditions and Maintenance of the Superstructure of Railway Tracks ("Official Gazette of RS" No. 39/16 and 74/16).
- The condition of the railway tracks is very poor, with significant disturbances in cross level and track gauge, resulting in deformation in both the transverse and longitudinal directions.
- The railway track has not been adequately maintained in a timely manner.

4.2.7. Track inspection coach measurement

Based on the information from the letter of Section ZOP Niš No. 20/2023-1.20-49/1 dated 17.01.2023 (attached to the letter from "IŽS"a.d. No. 1/2023-176 dated 06.02.2023), it can be noted that during 2018, 2019, 2020, and 2022, measurements of the track condition were carried out on railway line number 106: Niš - Dimitrovgrad - state border - (Dragoman) using track inspection coach EM-80L and track inspection coach Sever 1435 (in 2022). In the period from 2018. to 2022, track condition measurements were conducted through geometric surveying of the track using track inspection coach, a total of five times, which is not in accordance with the prescribed number of track geometry condition controls, as specified in Article 75, paragraph 3, of the Rulebook on Technical Conditions and Maintenance of the Superstructure of Railway Tracks, No. 340-201-2/2016 ("Official Gazette of RS" No. 39/16 and 74/16), as well as point 3, paragraph 1, of the Instructions on Unified Criteria for Track Condition Control on the JŽ Network, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004 and "Official Gazette of ŽS" No. 14/22). According to these regulations for a main railway line, track condition control is performed twice a year, which, for the observed period of five years, should amount to 10 measurements. Additionally, according to the information from the letter of Section for Track Maintenance and Monitoring Niš No. 20/2020-1.20-1524/2 dated 04.01.2021, and No. 20/2022-1.20-590 dated 05.04.2022, as well as the letter from the Section for Civil Engineering Works No. 20/2022-858 dated April 11th, 2022 (attached to the letter from "IŽS"a.d. No. 1/2023-176 dated 06.02.2023), track condition measurements were not carried out during 2021. due to the malfunction of the track inspection coach and the dispatch of track inspection coach EM-80L for major repairs, a lack of workforce, and the uncalibrated manual measuring devices in the Section ZOP Niš.

Regarding the track condition measurements in the train derailment zone No. 45010 for the year 2018. and 2019, "IŽS"a.d. did not provide extracts from numerical and graphical records but instead provided only an analytical presentation in Excel format with saved data. This is shown for the observed track section from km 66+700 to km 67+700 in tables 4.2.7.1. and 4.2.7.2.

Table 4.2.7.1: Excerpt from the analytic representation of the recorded data measured with track inspection coach from 09.05.2018.

Serial No.	*km* position		Error type	Error size (*mm*)	Deadline for removal
	From *km*	To *km*			
225	66+715	66+719	CROSS LEVEL	-21	11.06.2018.
226	67+260	67+262	STABILITY-D	24	11.06.2018.
227	67+265	67+268	STABILITY *-D*	-32	11.06.2018.
228	67+267	67+269	CROSS LEVEL > *150 mm*	155	Immediately
229	67+265	67+269	TWIST *3,5 m*	36	Immediately
230	67+266	67+270	CROSS LEVEL	32	11.06.2018.
231	67+271	67+273	TWIST *3,5 m*	-29	Immediately
232	67+312	67+314	STABILITY *-D*	21	11.06.2018.
233	67+320	67+322	TWIST *3,5 m*	20	Immediately
234	67+506	67+509	CROSS LEVEL	20	11.06.2018.
235	67+653	67+655	TWIST *3,5 m*	-19	Immediately

Table 4.2.7.2: Excerpt from the analytic representation of the recorded data measured with track inspection coach from 24.04.2019.

Serial No.	*km* position		Error			Deadline for removal
	From *km*	To *km*	Error type	Size	Border	
1	2	3	4	5	5	6
152	66+719	66+723	CROSS LEVEL	-21 *mm*	15 *mm*	25.05.2019.
153	67+269	67+272	TWIST *3.5 m*	27 *mm*	18 *mm*	Immediately
154	67+270	67+273	CROSS LEVEL> *150 mm*	157 *mm*	15 *mm*	Immediately
155	67+270	67+274	CROSS LEVEL	25 *mm*	15 *mm*	25.05.2019.
156	67+275	67+277	TWIST *3.5 m*	-20 *mm*	18 *mm*	Immediately
157	67+323	67+334	TRACK EXTENSION	40 *mm*	35 *mm*	Immediately
158	67+336	67+908	TWIST *3.5 m*	-36 *mm*	18 *mm*	Immediately

Regarding the measurement of the track condition in the train derailment zone No. 45010 for the 2020. and 2022, "IŽS"a.d. did not provide numerical records but instead provided a graphical record and an analytical presentation in Excel format with recorded data. This is shown for the observed **section of the track from km 66+700 to km 67+700** in Tables 4.2.7.3, 4.2.7.4, and in Figures 4.2.7.1. and 4.2.7.2.

Table 4.2.7.3: Excerpt from the analytic representation of the recorded data measured with track inspection coach from 16.01.2020.

Serial No.	*km* position		Error type	Size	Deadline for removal
	From *km*	To *km*			
92	66+720	6+725	CROSS LEVEL	-21 *mm*	20.02.2020.
93	66+957	66+959	TWIST *3.5 m*	18 *mm*	Immediately
94	67+271	67+274	TWIST *3.5 m*	31 *mm*	Immediately
95	67+271	67+276	CROSS LEVEL	30 *mm*	20.02.2020.
96	67+271	67+276	CROSS LEVEL *> 150 mm*	163 *mm*	Immediately
97	67+276	67+279	TWIST *3.5 m*	-26 *mm*	Immediately
98	67+326	67+328	TWIST *3.5 m*	22 *mm*	Immediately
99	67+511	67+514	CROSS LEVEL	17 *mm*	20.02.2020.

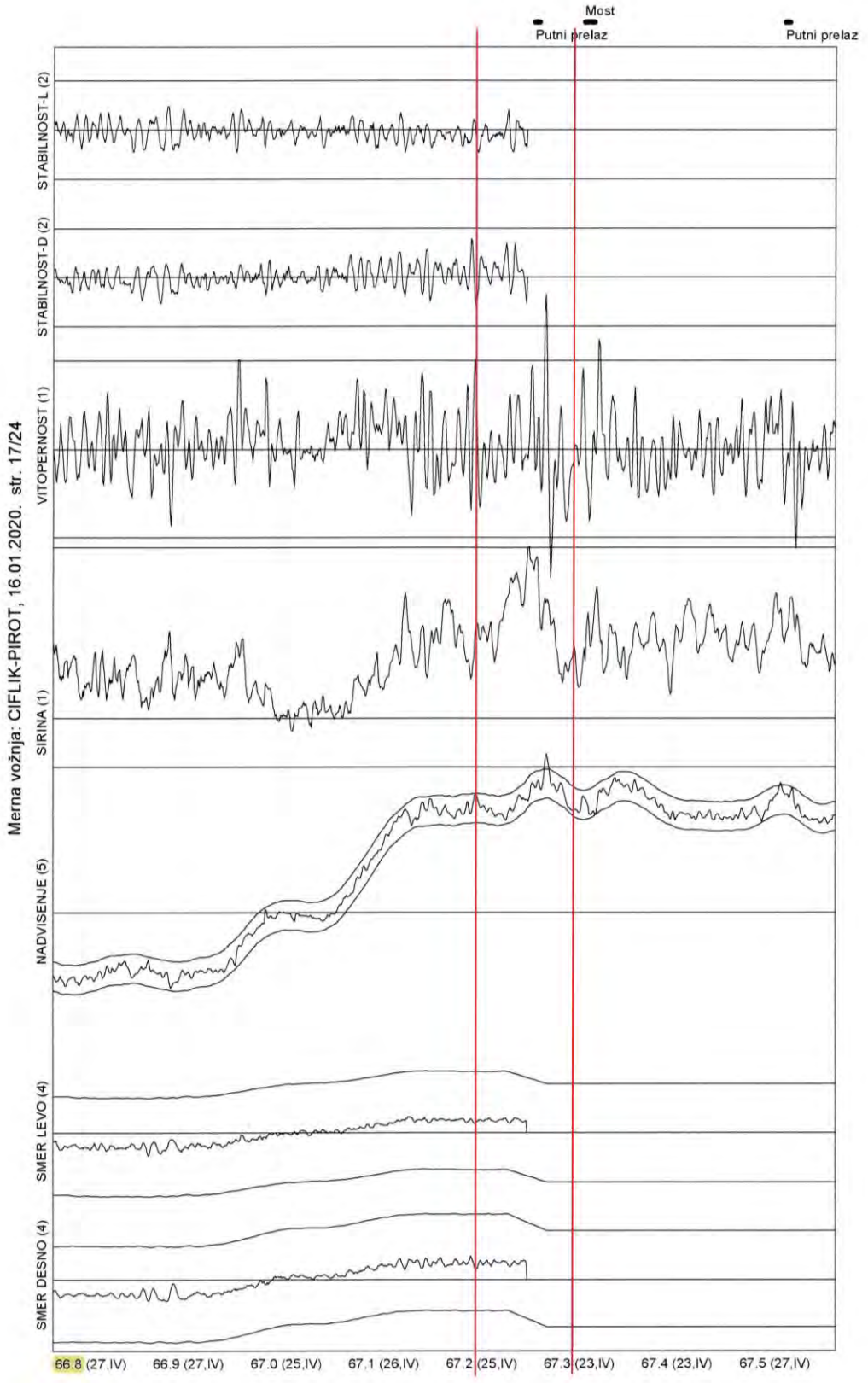


Figure 4.2.7.1: Track inspection coach graphic representation excerpt from 16.01.2020.

Table 4.2.7.4: Display of analytic representation excerpt of the recorded data with track inspection coach from 20.10.2022.

Serial No.	Parameters	Coordinate start	Coordinate end	Tolerance-*min*	Tolerance-*max*	Length (*m*)	Error type	Speed	Rail type	Deadline for removal
9233	CROSS LEVEL middle	66+702	66+698	-15,00	-20,53	4,60	***GHI***	*30*	*49E1*	*18.11.2022.*
9234	CROSS LEVEL	66+710	66+677	-15,00	-42,23	33,30	***GHI***	*30*	*49E1*	*18.11.2022.*
9317	CROSS LEVEL	66+729	66+729	-15,00	-15,26	0,70	***GHI***	*30*	*49E1*	*18.11.2022.*
9318	CROSS LEVEL	66+799	66+734	-15,00	-31,74	65,60	***GHI***	*30*	*49E1*	*18.11.2022.*
9322	CROSS LEVEL	66+810	66+807	-15,00	-17,80	2,90	***GHI***	*30*	*49E1*	*18.11.2022.*
9324	CROSS LEVEL	66+834	66+823	-15,00	-24,28	11,40	***GHI***	*30*	*49E1*	*18.11.2022.*
9347	CROSS LEVEL	66+891	66+849	-15,00	-31,63	42,10	***GHI***	*30*	*49E1*	*18.11.2022.*
9349	CROSS LEVEL	66+903	66+901	-15,00	-15,76	1,40	***GHI***	*30*	*49E1*	*18.11.2022.*
9351	CROSS LEVEL	66+910	66+907	-15,00	-16,70	3,70	***GHI***	*30*	*49E1*	*18.11.2022.*
9352	CROSS LEVEL	66+915	66+912	-15,00	-16,13	3,00	***GHI***	*30*	*49E1*	*18.11.2022.*
9405	CROSS LEVEL	66+923	66+918	-15,00	-17,49	4,30	***GHI***	*30*	*49E1*	*18.11.2022.*
9406	CROSS LEVEL	66+932	66+930	-15,00	-17,17	1,70	***GHI***	*30*	*49E1*	*18.11.2022.*
9435	CROSS LEVEL	66+963	66+962	15,00	15,89	1,00	***GHI***	*30*	*49E1*	*18.11.2022.*
9438	CROSS LEVEL	67+105	67+103	15,00	15,71	2,20	***GHI***	*30*	*49E1*	*18.11.2022.*
9480	CROSS LEVEL middle	67+131	67+130	15,00	17,25	1,70	***GHI***	*30*	*49E1*	*18.11.2022.*
9482	CROSS LEVEL	67+138	67+120	15,00	33,29	18,00	***GHI***	*30*	*49E1*	*18.11.2022.*
9485	CROSS LEVEL	67+148	67+143	15,00	20,83	5,00	***GHI***	*30*	*49E1*	*18.11.2022.*
9486	CROSS LEVEL	67+162	67+158	15,00	18,16	3,90	***GHI***	*30*	*49E1*	*18.11.2022.*
9496	CROSS LEVEL	67+171	67+166	15,00	25,02	5,10	***GHI***	*30*	*49E1*	*18.11.2022.*

Serial No.	Parameters	Coordinate start	Coordinate end	Tolerance-*min*	Tolerance-*max*	Length (*m*)	Error type	Speed	Rail type	Deadline for removal
9498	CROSS LEVEL	67+194	67+172	15,00	33,16	21,80	*GHI*	*30*	*49E1*	*18.11.2022.*
9509	TRACK GAUGE WIDENING	67+219	67+212	35,00	43,03	7,40	*GHI*	*30*	*49E1*	*Immediate*
9510	TRACK GAUGE WIDENING	67+242	67+227	35,00	47,62	14,80	*GHI*	*30*	*49E1*	*Immediate*
9529	TWIST	67+249	67+247	-7,00	-9,72	2,70	*GHI*	*30*	*49E1*	*Immediate*
9532	CROSS LEVEL middle	67+253	67+248	15,00	35,59	5,60	*GHI*	*30*	*49E1*	*18.11.2022.*
9549	TWIST	67+254	67+252	7,00	9,23	2,30	*GHI*	*30*	*49E1*	*Immediate*
9550	CROSS LEVEL *max*	67+254	67+247	150,00	178,24	7,00	*GHI*	*30*	*49E1*	*Immediate*
9557	TRACK GAUGE WIDENING	67+258	67+256	35,00	38,74	2,20	*GHI*	*30*	*49E1*	*Immediate*
9560	CROSS LEVEL	67+289	67+210	15,00	83,24	78,90	*GHI*	*30*	*49E1*	*18.11.2022.*
9585	TRACK GAUGE WIDENING	67+292	67+291	35,00	36,11	0,80	*GHI*	*30*	*49E1*	*Immediate*
9586	D1 DIRECTION D	67+297	67+295	-22,00	-22,64	2,40	*GHI*	*30*	*49E1*	*18.11.2022.*
9595	CROSS LEVEL middle	67+300	67+298	-15,00	-16,91	2,10	*GHI*	*30*	*49E1*	*18.11.2022.*
9596	TRACK GAUGE WIDENING	67+303	67+300	35,00	38,97	2,70	*GHI*	*30*	*49E1*	*Immediate*
9607	TRACK GAUGE WIDENING	67+320	67+320	35,00	35,03	0,10	*GHI*	*30*	*49E1*	*Immediate*
9608	CROSS LEVEL *max*	67+321	67+318	150,00	154,52	3,90	*GHI*	*30*	*49E1*	*Immediate*
9615	CROSS LEVEL *max*	67+342	67+339	150,00	154,90	3,00	*GHI*	*30*	*49E1*	*Immediate*
9616	CROSS LEVEL	67+375	67+301	15,00	59,90	73,60	*GHI*	*30*	*49E1*	*18.11.2022.*
9626	CROSS LEVEL	67+380	67+378	15,00	16,21	1,30	*GHI*	*30*	*49E1*	*18.11.2022.*
9628	CROSS LEVEL	67+390	67+385	15,00	16,42	4,10	*GHI*	*30*	*49E1*	*18.11.2022.*
9641	TRACK GAUGE WIDENING	67+395	67+393	35,00	36,48	1,80	*GHI*	*30*	*49E1*	*Immediate*
9642	CROSS LEVEL	67+408	67+406	15,00	16,38	1,90	*GHI*	*30*	*49E1*	*18.11.2022.*

Serial No.	Parameters	Coordinate start	Coordinate end	Tolerance-*min*	Tolerance-*max*	Length)	Error type	Speed	Rail type	Deadline for removal
9651	CROSS LEVEL	67+451	67+448	15,00	19,52	2,80	***GHI***	*30*	*49E1*	*18.11.2022.*
9652	CROSS LEVEL	67+465	67+459	15,00	20,28	5,40	***GHI***	*30*	*49E1*	*18.11.2022.*
9661	ПРОШИРЕЊЕ	67+485	67+483	35,00	37,92	2,20	***GHI***	*30*	*49E1*	*Immediate*
9662	CROSS LEVEL middle	67+490	67+488	15,00	18,47	2,10	***GHI***	*30*	*49E1*	*18.11.2022.*
9678	ПРОШИРЕЊЕ	67+502	67+499	35,00	44,38	3,90	***GHI***	*30*	*49E1*	*Immediate*
9680	CROSS LEVEL	67+509	67+475	15,00	45,53	33,70	***GHI***	*30*	*49E1*	*18.11.2022.*
9709	CROSS LEVEL	67+564	67+554	15,00	21,47	10,30	***GHI***	*30*	*49E1*	*18.11.2022.*
9710	CROSS LEVEL	67+567	67+566	15,00	15,27	1,00	***GHI***	*30*	*49E1*	*18.11.2022.*
9727	CROSS LEVEL	67+633	67+617	15,00	24,68	15,10	***GHI***	*30*	*49E1*	*18.11.2022.*
9728	CROSS LEVEL	67+655	67+648	15,00	18,45	6,50	***GHI***	*30*	*49E1*	*18.11.2022.*
9739	CROSS LEVEL	67+692	67+681	15,00	20,35	10,30	***GHI***	*30*	*49E1*	*18.11.2022.*

* *GHI* – Limit of urgent intervention

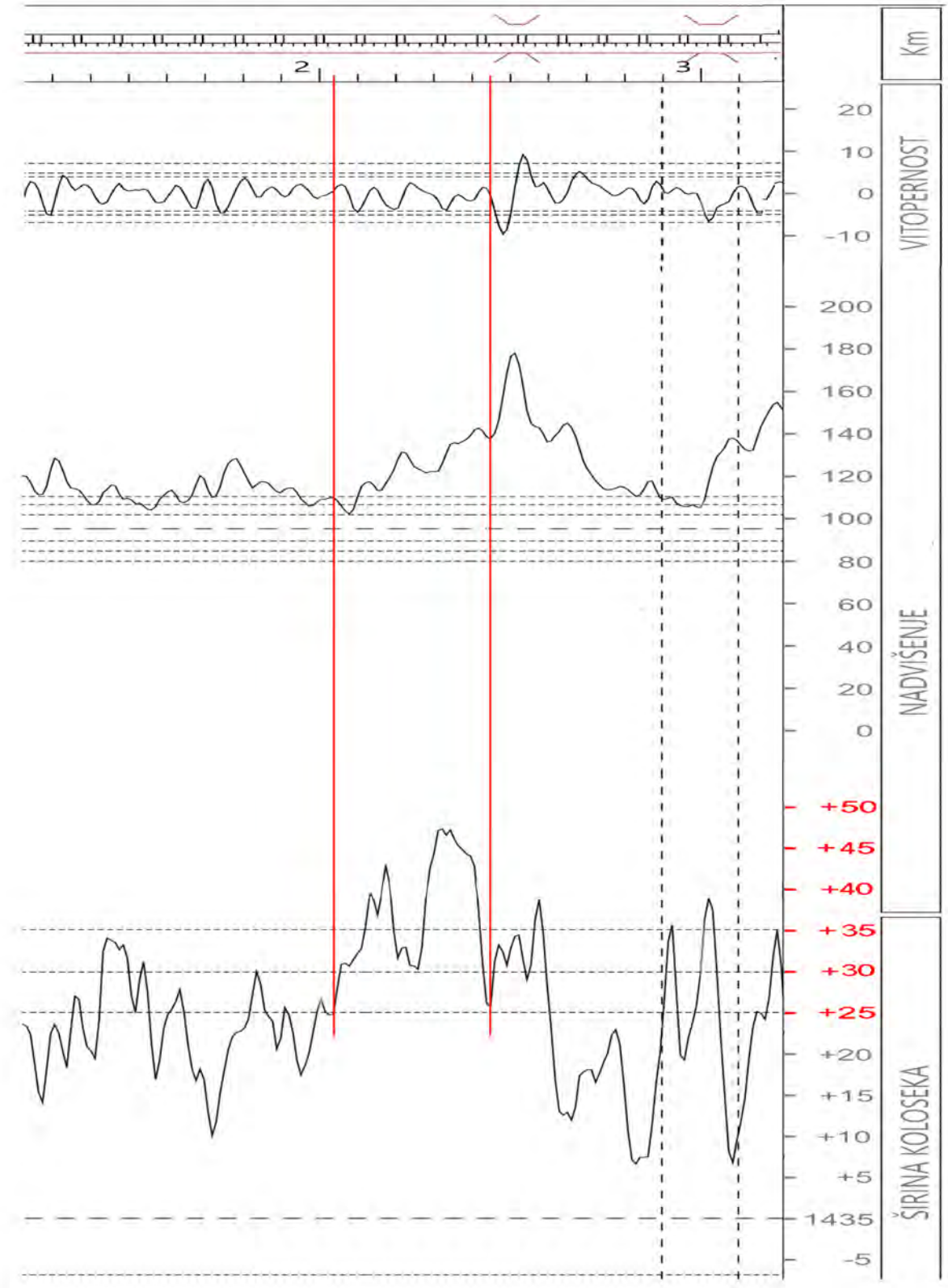


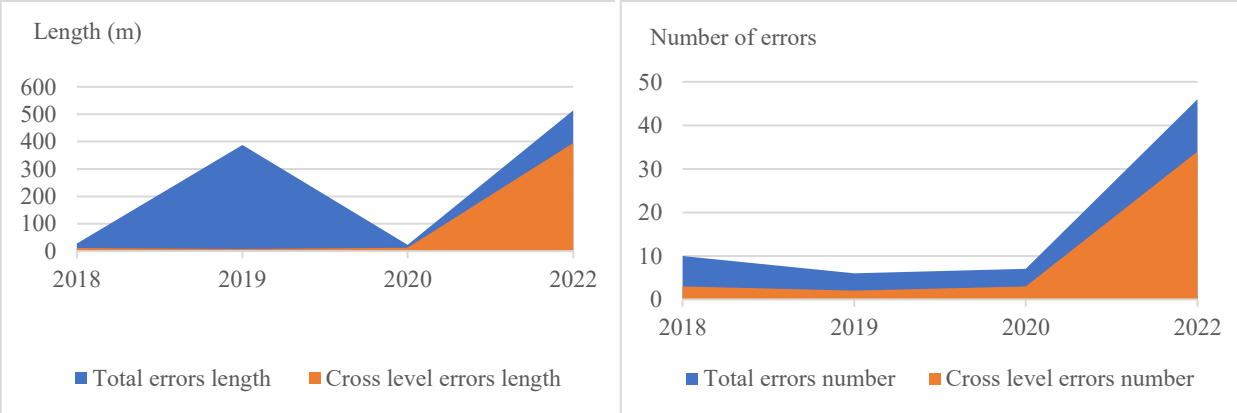
Figure 4.2.7.2: Excerpt from the graphical record of measuring devices from 20.10.2022.

Based on the provided analytical representations and graphical records from measurements of the track condition with track inspection coach EM-80L and track inspection coach Sever 1435, the lengths and numbers of errors of type "C" in the zone of train derailment No. 45010 (from km 66+700 to km 67+700) are displayed in Table 4.2.7.5.

Table 4.2.7.5: Lengths and number of errors of type "C" from km 66+700 to km 67+700 determined by track inspection runs

Track inspection Serial No.	Track inspection date	Errors type "C"	
		Total errors length/ errors length at cross level [m]	Total errors length/ errors length at cross level
1	09.05.2018.	28/11	10/3
2	24.04.2019.	388/8	6/2
3	16.01.2020.	23/13	7/3
4	20.10.2022.	514/395	46/34

The participation of "C" type errors in relation to the total number of "C" type errors in the zone of train derailment No. 45010 (from km 66+700 to km 67+700) is shown on Graph 4.2.7.1.



Graph 4.2.7.1: Overview of the length and number of "C" type errors from km 66+700 to km 67+700

Based on the provided analytical presentation and graphic records from the last measurement of the track condition No. 106: Niš - Dimitrovgrad - state border - (Dragoman) with track inspection coach Sever 1435, on 20.10.2022 (approximately 2 months before the serious accident occurred), it can be concluded that in the zone of train No.45010 derailment, from km 66+700 to km 67+700, according to defined parameters in the Instructions on Uniform Criteria for the Inspection of Track Condition on the JŽ Railways Network, Instruction 339 ("Official Gazette of ZJŽ", No. 2/2001, 4/2004, and "Official Gazette of ŽS", No. 14/22), the condition of the observed kilometer of the track was unsatisfactory. **The length of "C" type errors exceeded 20 times the maximum prescribed length of "C" type errors**, which is 25 m for a satisfactory condition. Furthermore, out of the total number of "C" type errors, **more than 76% were errors related to excess rail cross level,** where on some parts of the track, the values of outer rail cross level in curves exceeded 150 mm, resulting from the poor condition of both the super and sub track

structures. It is notable that there was a drastic increase in the length **(more than 6 times)** and the number **(more than 11 times)** of errors related to rail cross level excess in the period between the two measurements with track inspection coach EM-80L and Sever 1435, i.e., from 16.01.2020, to 20.10.2022. During this period, which lasted almost three years, there was no inspection of the track geometry.

If we compare the values measured on 20.10.2022, after the track condition measurement with track inspection coach Sever 1435, which were provided in the letter from the Construction Department Sector No. 20/2023-197 dated 03.02.2023 (attached to the letter from "IŽS"a.d. No. 1/2023-176 dated 06.02.2023), and the values measured after the serious accident (see section 3.4.2), a tendency of track widening can be observed. This also indicates the poor condition of the sleepers, which were installed approximately 40 years ago (installed in 1985).

The untimely and incomplete removal of "C" type errors requiring urgent intervention over time contributed to the continuous increase in the number of "C" type errors. Even the measure of reducing speed to 30 km/h (period from 01.01.2018, to the occurrence of the serious accident, analyzed by CINS, see sections 2.2.3. and 3.4.2.) couldn't prevent the train derailment (see section 3.8.).

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

4.2.8. Rail Wear

Based on the records of rail wear measurements between the Staničenje crossing point (km 63+800) and the Pirot station (km 72+900), provided in the letter from the Sector for Construction Works with reference No. 20/2023-1.20-112/1 dated 26.01.2023 (attached to the letter from "IŽS"a.d. with reference No. 1/2023-176 dated 06.02.2023), rail wear measurements were regularly conducted in 2018, 2019, 2020, 2021, and 2022. Based on the evidence provided, it can be concluded that the measured values were within the permissible tolerances, in accordance with Article 77. of the Rulebook on Technical Conditions and Maintenance of the Superstructure of Railway Tracks, No.: 340-201-2/2016 ("Official Gazette of RS" Nos. 39/16 and 74/16).

According to the information provided in the letter from the Internal Control Center with reference No. 14/2023-31 dated 03.02.2023 (attached to the letter from "IŽS"a.d. with reference No. 1/2023-176 dated 06.02.2023), it can be noted that during all five inspections conducted between 01.01.2018, and 25.12.2022, on the section of the Niš - Dimitrovgrad railway by the Acting Inspector, improper rail wear was observed.

Based on the above, it can be concluded that the Inspector's findings from the Internal Control Center are contrary to the findings of the Sector for Construction Works, and both organizational units are part of "IŽS"a.d.

4.2.9. Sleepers and fastening equipment condition

The derailing of a wheel from the track can occur due to the shifting of the wheels on its axis (loosening of the pressed assembly) in the direction of reducing the inner distance between the wheels or due to the spreading of the rails.

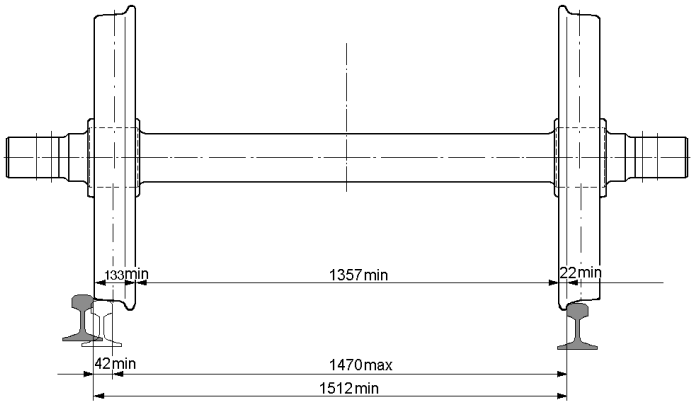


Figure 4.2.9.1: Conditions for wheel derailment

Figure 4.2.9.1 illustrates the necessary relationship between the dimensions of the track and the wheelset to cause a wheel to derail from the track when the relevant dimensions are within the allowed limits. It can be observed that the rails need to spread apart by at least 42 mm beyond the permitted limit of 1435+35 mm, due to loose or missing track fasteners or rotteness of sleepers. Considering that the measurements from the track inspection coaches (point 4.2.7.) show that in several places, the track expansion exceeds the operational limit of +35 mm, it is possible for a wheel to derail in such locations even with a smaller additional rail spacing.

Upon inspecting the condition of the sleepers and fastening equipment, it was found that in the broader area around the wheel derailment site, the track was in a faulty condition due to loose or missing fastening equipment, shifted fastening plates, or rotten and cracked sleepers. It should be noted that the railway was put into operation on 01.08.1888, with the last repair carried out in 1985. On-site inspection revealed that some rails were over 40 years old, and some sleepers were over 50 years old in the wider area of the wheel derailment site.

The condition of the sleepers and fastening equipment in the wheel derailment zone is illustrated in Figure: 4.2.9.2, 4.2.9.3, 4.2.9.4. and 4.2.9.5.

Figure 4.2.9.2: Overview of the track

Figure 4.2.9.3: Overview of the sleepers

Figure 4.2.9.4: Overview of the rail- sleeper link with a supporting plate

Figure 4.2.9.5: Overview of the rail- sleeper link with a supporting plate

The appearance of railway joints in the broader area of the wheel derailment is illustrated in images 4.2.9.6. and 4.2.9.7.

Figure 4.2.9.6: The appearance of railway joints in the broader area of the serious accident (floating unbalanced joints)

Figure 4.2.9.7: The appearance of railway joints in the broader area of the serious accident (floating unbalanced joints)

The displayed condition is not in accordance with the requirements of the Rulebook on Technical Conditions and Maintenance of the Superstructure of Railway Tracks No. 340-201-2/2016 ("Official Gazette of RS" No. 39/16 and 74/16) that was valid at the time of the occurrence of the serious accident.

4.2.10. Inspection supervision

By the letter of MGSI, Sector for Inspection Supervision No. 340-06-19/2023-18 dated 08.02. 2023. (with attached appendices), it was provided that inspectors of the Section for Inspection Affairs of Railway Traffic conducted a total of four inspection supervisions regarding the condition of railway infrastructure on the main railway line No.106: Niš - Dimitrovgrad - state border - (Dragoman) in the period from 01.01.2012, until the occurrence of the serious accident. The subject of inspection supervision and the corresponding Inspection Records were as follows:

1. Inspection Record No. 340-06-362/19-18 dated 26.8.2019, from km 30+290 to km 30+960 (section of stopping point Ravan Do),
2. Inspection Record No. 340-06-574/19-18 dated 20.12.2019, from km 11+589 to km 12+700 (section Niška Banja - Sićevo),
3. Inspection Record No. 340-06-205/20-18 dated 04.06.2020, from km 13+000 to km 14+000 and from km 13+100 to km 13+450 (section Niška Banja - Sićevo) and

4. Inspection Record No. 340-06-222/20-18 dated 11.06.2020, from km 22+900 to km 23+300 and from km 30+950 to km 31+950 (section Ostrovica - Dolac).

Based on the information provided, it can be observed that between 2012. and the occurrence of the serious accident, the section of the railway between the Staničenje railway crossing and the Pirot station was not subject to inspection supervision by the Section for Inspection Affairs of Railway Traffic.

After the serious accident, the Section for Inspection Affairs of Railway Traffic conducted two inspection supervisions, one over the subject "IŽS"a.d. and the other over the subject "Srbija Kargo"a.d. A Report on Inspection Supervision No. 340-06-398/22-18 dated 23.01.2023, was issued by the acting inspector following the extraordinary office and field inspection supervision carried out over the subject "IŽS"a.d. The subject of this inspection supervision was the implementation of measures to eliminate immediate danger to life and health of people and the fulfillment of obligations by the manager of public railway infrastructure in accordance with Article 10, 55, and 57. of the Law on Railways ("Official Gazette of RS" No.41/18) and Article 94. of the Law on Railway Safety ("Official Gazette of RS" No.41/18) after the serious accident. The Report states that, as of the date of the report's preparation, the supervised subject has been found to be complying correctly with Article 94. of the Law on Railway Safety, while other actions related to inspection supervision are ongoing (the supervised subject provides materials on actions related to the obligation of maintaining the railway in accordance with Article 10, 55, and 57. of the Law on Railways ("Official Gazette of RS" No.41/18), upon the inspection's request). The mentioned Report does not contain any imposed measures.

By electronic mail, you have received information from MGSI, Sector for Inspection Supervision, Department for Inspection Affairs of Hazardous Cargo Transport, stating that between 2017. and 25.12.2022 (before a serious accident occurred), a total of four extraordinary events involving hazardous cargo in railway transport were reported on the Crveni krst – Niš - Dimitrovgrad - state border rail section. These reports were made in accordance with the obligation of the undertaking to report extraordinary events involving hazardous cargo as per point 1.8.5 of the RID regulations. In one case, an inspection was carried out, resulting in Inspection Report No. 342-09-00753/2019-18 dated 23.08.2019. In the other cases, where incidents involved leakage and valve issues, as well as derailment with one axle, which were resolved on-site by adjusting the valve and re-railing the wagon without any overturning or damage, there was no reason for further inspection.

Following a serious accident, Inspector from the Department for Inspection Affairs of Hazardous Cargo Transport conducted extraordinary field and office inspections of the entities "Srbija Kargo"a.d., "IŽS"a.d., and "Elixir Zorka - Mineral Fertilizers" a.d. Šabac. The extraordinary inspection was conducted due to the necessity of taking urgent measures to prevent or eliminate immediate danger of category I to human life or environmental pollution with consequences that require long and expensive mitigation, category II danger of causing severe bodily harm to individuals or significant environmental pollution, and category III danger of causing minor bodily harm to individuals or negligible environmental pollution. During the course of the extraordinary inspection, Inspection Report No. 342-09-01555/2022-18 was prepared on 26.12.2022, and six amendments to the inspection report followed (No. 342-09-01555/2022-18/1 dated 31.01.2023, No. 342-09-01555/2022-18/2 dated 01.01.2023, No. 342-09-01555/2022-18/3 dated January 4, 2023, No. 342-09-01555/2022-18/4 dated 13.01.2023, No. 342-09-01555/2022-18/5 dated 31.01.2023, and No. 342-09-01555/2022-18/6 dated 10.02.2023). Inspection measures were imposed on all supervised entities as stated in the Inspection Report No. 342-09-01555/2022-18 dated 26.12.2022, and its subsequent amendments.

By the letter of Ministry of Environmental Protection, Sector for Environmental Monitoring and Prevention, No. 353-03-327/23-07, dated 02.02.2023 (with accompanying attachments) we provide information regarding the response to a report submitted on 27.12.2022, via email, which highlighted the observed fish mortality in the Nišava River downstream of Pirot. This incident occurred after the accidental derailment of railway wagon-tanks from the tracks. A state inspector for fisheries conducted an extraordinary field inspection on the Nišava River downstream from the location of the serious accident. This inspection was documented in Official Note No. 914-480-324-49/2022-07 dated 28.12.2022. The extraordinary inspection took place on 28.12.2022, from 10:00 AM to 1:00 PM, in the presence of representatives from the company "Association Vetrnica – Vlasina" from Leskovac, which is the user of the fishing area "Južna Morava 1", including the fishing waters of the Nišava River. The complainant did not attend the inspection (after being informed of the time and place by the responsible inspector via phone, the complainant expressed their unwillingness to participate in the inspection). The inspection covered several locations downstream from the derailment site of the railway wagon-tanks, extending to the bridge over the Nišava River in Bela Palanka. During the field inspection, it was noted that there were no changes in the organoleptic properties of the water or evidence of dead fish at the inspected locations. Therefore, it was concluded that there were no grounds for taking administrative or legal measures concerning the subject of the inspection.

4.2.11. Analysis of the Performance of the Rescue Service

Given that there was material (ammonia) on the train that could pose a threat to human health and potentially be hazardous to the environment, and that there was an uncontrolled release of hazardous material (ammonia) from the wagon-tanks, leading to an immediate threat to human health, personnel from the MUP RS, Directorate of Police, PU Pirot, personnel from the MUP RS, Sector for Emergency Situations, and the Pirot Health Center, Emergency Medical Service, were called to the scene. Furthermore, upon learning of the occurrence of a serious accident, the Ministry of Environmental Protection, Environmental Protection Agency, and the City Administration of Pirot also took special measures.

From 25.12. to 29.12.2022, a total of 172 firefighters and rescuers with 34 vehicles from MUP RS, Sector for Emergency Situations, Firefighting and Rescue Unit from Pirot, Niš, Belgrade, Pnačevo, Kragujevac, Leskovac and Zaječar, equipped with appropriate protective gear, along with four members of the Fire and Rescue Administration with two vehicles and one unmanned aerial vehicle, were deployed to the field. Firefighters and rescuers conducted the detection of hazardous materials' presence at the event site to determine the level of protection and the response mode within the work zone. Through the coordination of the work of firefighters and rescue units, 56 individuals were evacuated and rescued, who were then handed over to Emergency Medical Service teams for further care. During the engagement in the evacuation and rescue of individuals immediately at risk after the occurrence of the serious accident, five members of the Firefighting and Rescue Unit requested medical assistance and were subsequently cared for at the General Hospital in Pirot. Additionally, members of the firefighting and rescue units carried out duty shifts and provided assistance to the investigation team of the PU Pirot, the employees of Pirot, and other relevant services. This assistance included ensuring an adequate number of respiratory protection devices for personnel conducting operations at the scene of the serious accident.

Upon informing of the serious accident, a total of 21 emergency medical service personnel were deployed to the scene, along with six ambulance vehicles. Among them, 12 individuals (four doctors, four medical technicians, and four drivers) were continuously present at the scene. From

25.12.2022, at 17:30 until 26.12.022, at 00:40, emergency medical service teams provided care to a total of 27 patients who complained of respiratory distress. These patients received oxygen therapy and were transported to the triage and emergency care department of the Pirot General Hospital. In addition to these activities, two ambulance drivers from the emergency medical service transported two patients from the Pirot General Hospital to the UKC Niš. One of the drivers, who was passing by the accident site on the highway with an ambulance vehicle carrying a patient whose health condition was unrelated to this serious accident, also transported three adults and one child who complained of respiratory distress to the UKC Niš.

Upon informing of the serious accident, the PU Pirot implemented a blockade of both the immediate and wider accident area. Traffic on the nearby roads was halted, and all police officers were mobilized to redirect traffic, prevent further incidents, and reduce the consequences of the accident. Units from the Sector for Emergency Situations and the Emergency Medical Service in Pirot were also dispatched to the scene to carry out their respective duties and assist in warning and evacuating the local population. After assessing that the available resources were insufficient to protect and rescue the endangered population, coordination and cooperation were immediately established with other organizational units of the MUP RS (PU in Niš and Leskovac) and with units from other local self-governments. Timely and comprehensive information was also provided to the Emergency Situations Headquarters in Pirot regarding the serious accident and the measures being taken, for the purpose of informing the public. The involvement of police officers from the PU Pirot, who were responsible for general law enforcement, lasted from 25.12.2022, until 12.02.2023, when the last wagon-tank was dispatched to the workshop in Smederevo. On average, eight police officers from the Pirot PU were involved daily, totaling 400 engagements during this period. From 30.12. 2022, to 12.02.2023, traffic police officers from the PU Pirot were also engaged in the operation. On average, 20 traffic police officers participated daily, totaling 420 shifts during this period. The engagement of traffic police officers primarily focused on securing the accident site, redirecting traffic, and providing assistance to other work teams.

Following the occurrence of the serious accident, the Mayor of the City of Pirot issued a decision on 25.12.2022, to declare a state of emergency in a part of the territory of the City of Pirot. A specialized operational team was formed, consisting of representatives from the PU Pirot, the Department for Emergency Situations, “Srbija Kargo”a.d., “HIP- Azotara”d.o.o. Pančevo, “Elixir Zorka – Fertilizers”d.o.o. Šabac, the company Tekon, and “IŽS”a.d. The specialized operational team remained active until the state of emergency was lifted on 16.01.2023.

The response and performance of the rescue services were appropriate to the situation and contributed to controlling harmful impacts and preventing potential wider consequences for people and the environment.

4.3. Conclusions on the serious accident causes

4.3.1. Direct and immediate cause of the serious accident

The direct and immediate cause of the serious accident was the spreading of the rails under the load's action and the entry of the inner wheel into the track in the curve. The entry occurred due to the absence or looseness of fastening equipment on multiple consecutive sleepers, decayed or cracked sleepers, in combination with the track's geometric parameters beyond the emergency intervention limit – specifically, type “C” errors (cross level, twist, and track gauge). Due to a significant excess of cross level, the vertical load on the inner (left, in the direction of movement) wheels was increased. At the same time, the change in twist between the two values above the

current intervention limit further induced oscillations around the longitudinal axis, causing even higher amplitude load on the inner wheels. Combined with the lateral guiding force in the curve, the very poor condition of the fastening equipment and sleepers led to the spreading of the rail heads and the entry of the inner wheel into the track.

4.3.2. Basic causes deriving from skills, procedures and maintenance

Maintenance of the railway track on the observed section was not conducted in accordance with the Rulebook on the Technical Conditions and Maintenance of the Superstructure of Railway Tracks ("Official Gazette of RS" No. 39/16 and 74/16), considering the years since the last track repairs and the insufficient number of workers, machinery, and tools (see points 3.3.5. and 4.2.6.).

4.3.3. Main serious accident causes deriving from legal framework conditions and safety management system application

The Instruction on Unique Criteria for Track Condition Control on the Railways of the Republic of Serbia, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004), introduced an alternative measure of "speed reduction" for the case of "unsatisfactory" track condition (errors in track geometry beyond the operational limits "C"), which did not exist in earlier editions of Instruction 339 (from 1989). Additionally, a paragraph from the previous 1989 edition of Instruction 339, which envisaged taking measures before reaching the operational limits to prevent their exceeding, has been removed. The amendments and supplements to the Instruction on Unique Criteria for Track Condition Control on the Railways of the Republic of Serbia, Instruction 339 ("Official Gazette of ŽS" No. 14/22) only include specific provisions related to the track inspection coach Sever 1435 (see point 3.3.4.).

The Rulebook on Maintenance of Super and Substructure of the Railway Tracks ("Official Gazette of RS", No. 39/23, dated 12.05.2023) also provides for the case of values appearing in the parameters of the relative geometry of the track that exceed the limit for emergency (urgent) intervention, as an alternative measure, "speed reduction" (see point 3.3.7.).

The Rulebook on Technical Conditions and Maintenance of the Superstructure of the Railway Track, No.: 340-201-2/2016 ("Official Gazette of RS", No. 39/16 and 74/16), which was in force at the time of the occurrence of a serious accident, as well as Instruction 339 ("Official Gazette of ZJŽ", No. 2/2001, 4/2004, and "Official Gazette of RS", No. 14/22), and the Rulebook on Maintenance of Super and Substructure of the Railway Tracks ("Official Gazette of RS", No. 39/23 of 12.05.2023), do not explicitly and clearly establish operational limits for the condition of sleepers and fastening equipment, where immediate corrective measures must be taken or the track must be closed for traffic due to safety risks.

At the section of the railway between Pirot station and the Staničenje crossing point, at the time of the serious accident, no reduced or restricted speeds or restricted speed runs were implemented. However, considering the fact that the projected speed on this section of the track was 85 km/h, while the maximum allowed speed, according to the valid Timetable Booklet 9.4, is 30 km/h, it is evident that the projected speed was significantly reduced in the previous period. Based on the above, it can be stated that on the mentioned section, due to the poor condition of the track over an extended period, in accordance with The Instruction on Unique Criteria for Track Condition Control on the Railways of the Republic of Serbia, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004), the applied measure of "speed reduction" (by telegrams from

"IŽS"a.d. in 2011) was applied, which, starting from the Timetable 2017/2018, was categorized as the maximum allowed speed. Please note that the measure of "speed reduction" in cases of exceeding certain track parameters (e.g., track widening), above the operational limits, is not adequate, that is, this measure cannot be used to reduce the risk of derailment, as stipulated in Instruction 339, but it is necessary to urgently remediate the tracks in order to return the parameters of the track geometry to the permitted limits.

Even though with the Safety Management System Rulebook, "IŽS"a.d. did not perform a safety risk assessment and did not take appropriate measures based on multi-year reports that indicated that the condition of the section where the serious accident occurred was not in accordance with the Rulebook on the Technical Conditions and Maintenance of the Superstructure of Railway Tracks No. 340-201-2/2016 ("Official Gazette of RS" No. 39/16 and 74/16).

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

Incorrect application of the rules regarding train braking according to the Rulebook on Brakes and Braking of Trains and Railway Vehicles ("Official Gazette of RS," No. 68, dated 07.07.2021) can, in certain circumstances, lead to harmful events, accidents, or increased accident consequences. Therefore, it is necessary to align the text in the Rulebook on Brakes and Braking of Trains and Railway Vehicles with the provisions of IRS 40421 (see section 4.2.3).

Via electronic mail from 13.06.2023, "Srbija Kargo"a.d. data were submitted indicating that, according to the Rulebook on Official and Protective Clothing and Footwear for Employees in the Joint Stock Company for Railway Freight Transport "Srbija Kargo"a.d. Belgrade ("Official Gazette of ŽS" No. 56/2019), employees performing duties as train drivers and assistant train drivers in "Srbija Kargo"a.d. are provided with the following protective equipment: protective high boots, protective low shoes, a protective work coat, and protective leather gloves. Additionally, it was reported that, in accordance with Article 51. of the Law on Railway Traffic Safety ("Official Gazette of RS" No. 41/2018), traction vehicles equipped with equipment that can be used after accidents, if necessary, possess fire extinguishing equipment and first aid kits.

Based on the information provided, it can be concluded that in this serious accident, the train driver and assistant train driver did not have respiratory protection equipment (adequate masks), nor did they have such equipment on the locomotive, which they could have used in this case, considering the consequences of the serious accident (release of ammonia into the atmosphere).

Considering that it is common for trains to transport hazardous materials that are dangerous to human life and health (dangerous goods), there is a risk that, due to the release of such materials into the atmosphere, the lives and health of the train crew may be endangered, as was the case in this serious accident.

5. Measures taken

The remediation of the consequences resulting from this serious accident was carried out by engaging the expertise services and resources of "IŽS"a.d., "Srbija Kargo"a.d., "National Company Railway Infrastructure" of the Republic of Bulgaria, auto-cranes from Bulgaria, Elixir Zorka Mineral Fertilizers d.o.o. Šabac, HIP-Azotara d.o.o. Pančevo, Patenting d.o.o. Belgrade, as well as construction and forestry operations company "Pixi", with the assistance of members of the fire and rescue brigade.

According to the information provided by "IŽS"a.d. (enclosed in the Sector for Traffic Affairs Letter No. 15/2021-21 dated 11.01.2021), the works for the remediation and rehabilitation of the railway line for traffic were completed on 14.01.2023, at 19:00 when the section of the railway line between the Staničenje crossing point and the Pirot station was reopened for train traffic with introduced restricted speed running from km 67+042 to km 67+890, with Vmax=20km/h. Additionally, on the main arterial line No. 106: Niš - Dimitrovgrad - state border - (Dragoman), the maximum train weight was restricted to 1200 t, and also the transport of wagon-tanks carrying ammonia was prohibited until replacement and strengthening of the superstructure on certain sections of the track is completed.

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 SR_01/23, SR_02/23, SR_03/23, SR_04/23, SR_05/23, SR_06/23 and SR 07/23 are issued:

SR_01/23 The Directorate for Railways is to supervise the safety certificate for managing railway infrastructure of "IŽS"a.d. due to the failure to take urgent measures to rectify type "C" errors identified by measurements with track inspection coaches according to Instruction 339, prolonged poor track condition and inadequate maintenance of the track. It is required to take measures within its jurisdiction in accordance with the Article 15 of the Law on Railway Traffic Safety ("Official Gazette of RS", No. 41/2018) (see points 4.2.6, 4.2.7, and 4.3.2.).

SR_02/23 The Directorate for Railways is to amend and supply The Rulebook on Maintenance of Super and Substructure of the Railway Tracks ("Official Gazette of RS", No. 39/23, dated 12.5.2023.) by removing, in Article 5, paragraph 2, point 1), the speed reduction as a measure to decrease the risk of train derailment in the case of values appearing in the parameters of the relative track geometry that exceed the limit for emergency intervention (see points 3.3.7 and 4.3.3.).

SR_03/23 The Directorate for Railways is to amend and supply the Article 4, subitem 5) Annex 3 of the Rulebook on Brakes and Braking of Trains and Vehicles ("Official Gazette of RS", No. 68, dated 7.7.2021.) in accordance with the relevant requirements of IRS 40421 (see points 3.3.8, 3.3.9, 4.2.3, and 4.3.4.).

SR_04/23 "IŽS" a.d. is required to conduct a review of the reasons for the occurrence of a large number of type "C" errors detected during the measurements with track inspection coaches, according to The Instruction on Unique Criteria for Track Condition Control on the Railways of the Republic of Serbia, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004, Official Gazette of ŽS, No. 14/22), over an extended period. Based on the assessment of safety risks that have arisen as a result, they should take effective measures to rectify safety deficiencies, in accordance with the requirements of Article 5 of the Law on Railway Traffic Safety ("Official Gazette of RS" No. 41/2018), and its Safety Management System Manual (see points 4.2.7 and 4.3.1.).

SR_05/23 "IŽS"a.d. is required to amend and supply The Instruction on Unique Criteria for Track Condition Control on the Railways of the Republic of Serbia, Instruction 339 ("Official Gazette of ZJŽ" No. 2/2001 and 4/2004, Official Gazette of ŽS, No. 14/22), which is, by Decision "IŽS"a.d. No. 4/2015-51-17 of 29.12.2015. still in application in "IŽS"a.d., in accordance with provisions of the Instruction 339 from 1989, stated in point 3.3.4. (see points 3.3.4. and 4.3.3.)

SR_06/23 **"**IŽS"a.d. is required to, considering the inadequate maintenance and condition of the track, sleepers, and fastening equipment, conduct a risk assessment for train traffic on the main arterial line No.106: Niš - Dimitrovgrad - state border - (Dragoman) and take measures to reduce the risks to an acceptable level. Based on this, they should conduct a professional assessment of the minimum necessary resources (materials, machinery, workforce) for track maintenance (see points 4.2.1, 4.2.6, 4.2.7, 4.2.9, 4.3.1, and 4.3.2.).

SR_07/23 "IŽS"a.d. to consider in its Rulebook on organization and systematization of tasks within the Joint Stock Company for the Management of Public Railway Infrastructure "IŽS"a.d. and to examine the possibility of predicting an appropriate number of staff in the construction sector, both for the section of the track where the accident occurred and for the entire network, in order to ensure the safe operation of railway traffic. In accordance with the appropriate number of staff, they should plan the procurement of necessary machinery and tools, all with the aim of ensuring safe railway traffic (see points 4.2.6, 4.3.1, and 4.3.2.).

To the Ministry of Construction, Transport and Infrastructure the recommendations SR_08/23 and SR_09/23 are issued:

SR_08/23 The Ministry of Construction, Transport, and Infrastructure, Inspection Supervision Sector, Department for Railway Traffic Inspection, is to conduct an extraordinary inspection of the state of railway infrastructure on the main arterial line No.106: Niš - Dimitrovgrad - state border - (Dragoman), from Niš station to Pirot station, in accordance with Article 55 of the Law on Railways ("Official Gazette RS" No. 41/2018 and 62/2023), and take measures within its jurisdiction (see points 4.2.6, 4.2.7, 4.2.9, 4.2.10, 4.3.1, and 4.3.2.).

SR_09/23 The Ministry of Construction, Transport, and Infrastructure, Railways and Intermodal Transport Sector, is to consider the possibility of amending Article 51 of the Law on Railway Traffic Safety ("Official Gazette of RS" No. 41/2018), equipment and traction vehicles, to stipulate that the locomotive must also have adequate equipment for the protection of the respiratory organs - protective equipment (see points 3.6.2 and 4.3.4.).

To Autorité française de sécurité ferroviaire the recommendation SR_10/23 is issued:

SR_10/23 Atir-Rail SA, is to, when receiving a vehicle from a regular repair, perform additional monitoring of the condition of the valves for filling and emptying the cistern, considering that on some cisterns, only a few months after the regular repair, leaks appear on the valves (see point 4.2.5.2.).