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

No: ŽS - 07/17
33 No: 340-00-13136/2017-19
Date: 26.11.2018

FINAL REPORT ON ACCIDENT INVESTIGATION

Type of accident:	Derailment of train
Train No:	53527
Place:	Novi Bečej, the area of the station Novi Bečej, between the entrance signal and the first entrance switch
Date:	23.12.2017
Time:	13:15

This report presents the results of investigation of accident, derailment of the train No. 53527, which occurred 23.12.2017 at 13:15 on the regional line Pančevo Main Station - Zrenjanin - Kikinda - state border - (Jimbolia), in the area of the station Novi Bečej.

Director of the Center for Investigation of Accidents in Transport of the Republic of Serbia established the Working Group for the investigation of this accident by the Decision 33 No. 02-02-13137/2017 of 28.12.2017.

In accordance with the Article 33 of the Law on Investigation of Air, Rail and Water Traffic Accidents (*"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 (Directive on Railway Safety), Center for Investigation of Accidents in Transport drafted and published this Final Report.

In this report, all sizes and measurements are expressed in accordance with 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 Air, Rail and Water Traffic Accidents (*"Official Gazette of RS" No. 66/15 and 83/18*). The founder is the Republic of Serbia and the holder of founding rights is the Government of the Republic of Serbia.

Department for investigations of railway traffic accidents and international cooperation carries out tasks within the competence of the Centre for investigation of accidents in traffic in relation to rail traffic with the aim of possible improvement of safety on the railways by issuing safety recommendations. The investigation procedure in the field of railway traffic is conducted on the basis of the provisions of the Law on Investigation of Air, Rail and Water Traffic Accidents (*"Official Gazette of RS" No. 66/15 and 83/18*).

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

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

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

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

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

Glossary:

CINS	Center for Investigation of Accidents in Transport
IŽS	Serbian Railways Infrastructure
ZJŽ	Community of Yugoslav Railways
JŽ	Yugoslav Railways
RS	Republic of Serbia
a.d.	Joint Stock Company
d.o.o.	Ltd.
OJ	Organizational Unit
OC	Organizational Entity
MSK	Methanol and Acetic Acid Complex
TKP	Technical wagon jobs
ZOP	For track maintenance
TVB	Tatravagonka Bratstvo
MIP-RŠV	Enterprise for repair of rail vehicles
DMV	Diesel power train
TMD	Heavy power track car

C O N T E N T :

1. Summary

1.1. Short description of the accident

On 23.12.2017 at 13:15 at km 122+250 of the regional line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia), in the area of the station Novi Bečej, derailment of train No. 53527 occurred with total of 8 (eight) wagons of series Za loaded with acetic acid (RID 83/2789, OM 8194). From 8 (eight) derailed wagons, 4 (four) of them turned on its side, and at 3 (three) of them leakage of acetic acid occurred. From the train composition, viewed from the driving locomotive 661-243, derailed the second wagon of the series Za No. 33 72 7937 501-4 with the first wheel of the first bogie and 2 wheels of the second bogie, third wagon of series Za No. 33 72 7993 510-6 turned on the side and the acid leaked from it, fourth wagon of series Za No. 33 72 7993 519-7 turned on the side and the acid leaked from it, fifth wagon of series Za No. 33 72 7993 520-5 turned on the side, sixth wagon of series Za No. 33 72 7993 516-3 derailed with all the axles and remained to stand on their wheels on the bank aslope relative to the axis of the track, seventh wagon of series Za No. 33 72 7977 585-8 derailed with all the axles and remained to stand in the zone of the track on their wheels, eight wagon of series Za No. 33 72 7977 519-7 turned on the side and from it acid leaked and ninth wagon of series Za No. 33 72 7937 503-0 derailed with first bogie and remained to stand in the zone of the track on their wheels.

1.2. The causes of the accident determined by the investigation

Direct case of the accident is unsatisfactory condition of the track on the section where the accident occurred. The direct cause is the missing and loose fastening and connecting accessories, rotted and cracked series of sleepers, combined with the track gauge widening (41 mm), cross level (- 27 mm) and twist (36 mm) of the track in the zone of derailment, which is over the maximum exploitation limit.

The basic cause is the fact that the track maintenance on the observed section is below the technically accepted minimum.

The main cause is the long-standing practice of using the railway track with trains with an overload, i.e. with loads that exceed the designed load of track in daily use, combined with the maintenance of the track below the technical minimum.

By Instruction on unique criteria for control of the condition of tracks on the network JŽ, Instruction 339 (*"Official Gazette of ZJŽ" No.2/2001 and 4/2004*) it was introduced that in the case of "unsatisfactory" status of track (errors in the geometry of the track above the limits of exploitation "C") as an alternative measure of "speed reduction", which in previous editions of Instruction 339 (in 1989) did not exist. Also, the passage has been deleted from the previous issue of Instruction 339 of 1989 which stipulated that prior to reaching the limits of exploitation take measures to prevent their overdraft. Applicable Rulebook on technical conditions and maintenance of the superstructure of railways No. 340-201-2/2016 (*"Official Gazette of RS" No.39/16 and 74/16*) as well as Instruction 339 do not define explicitly and clearly exploitation boundaries for state of sleepers and fastening systems in which, due to security risks immediate corrective measures must be taken or closing the railway transport.

Covers on some of wagon-tanks probably were not sufficiently tightened or seals or sealing surfaces were not in good condition, that could contribute to leakage of hazardous cargo from the wagon-tank and potential threats to the environment.

"MSK"a.d. Kikinda in its guidelines does not prescribe the procedure for closing the opening for filling on the tanks, but the procedure is the only part of the program for the training of workers.

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

Aiming to achieve the possible improvement of railway safety and to prevent occurrence of new accidents, CINS issued the following safety recommendations:

To the Railway Directorate:

SR_27/18 Railway Directorate that in short deadline defines in the applicable Rulebook on technical conditions and maintenance of the superstructure of the railway tracks (*"Official Gazette of RS" No.39/16 and 74/16*) the boundary conditions of elements of superstructure of the track, which require urgent elimination or closing the track for traffic until removal of unsatisfactory state.

"IŽS"a.d:

SR_28/18 "IŽS"a.d. to conduct amendments to the Instruction on unique criteria for control of the condition of railway tracks on the network JŽ, Instruction 339 (*"Official Gazette of RS", No.2/2001 and 4/2004*), which is by the decision of the "IŽS"a.d. No. 4/2015-51-17 from 29.12.2015 is still applicable in "IŽS"a.d., pursuant to the provisions of Instruction 339 of 1989 which are listed in clause 3.3.5. For future track inspection coaches the parameters are recommended in accordance with standards: *SRPS EN 13848-1, SRPS EN 13848-2, SRPS EN 13848-6*.

SR_29/18 "IŽS"a.d. that, due to inadequate maintenance and condition of the track, sleepers and fastening systems, conducts an assessment of risk of train traffic on the regional railway line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia) and take measures to reduce risk to an acceptable level. Based on this, to conduct a technical assessment of the minimum required resources (material, machinery, work force) for track maintenance.

SR_30/18 "IŽS"a.d. to review the procedures and criteria for the approval of the traffic of trains with an overload and that this process is confined to the extreme and rare individual occasions, and not as a daily practice.

Ministry of Construction, Transport and Infrastructure:

SR_31/18 Ministry of Construction, Transport and Infrastructure, Sector for Inspection, Group for Railway Inspection to carry out extraordinary check of railway infrastructure on the regional line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia) and take measures within their jurisdiction.

"MSK"a.d. Kikinda:

SR_32/18 "MSK"a.d. Kikinda to additionally pay attention to the procedure of closing the openings for filling the wagon-tanks for acetic acid and to conduct additional training of the staff.

SR_33/18 "MSK"a.d. Kikinda to define the procedure for closing the opening for filling the wagon-tanks by bringing the instruction and therein to prescribe the moment of tightening of bolts on the covers of openings for filling.

2. Direct facts about the accident

2.1. Basic accident data

2.1.1. Date,time and place of the accident

The accident occurred on 23.12.2017 at 13:15 in the area of muncipiality Novi Bečej, in the settlement Novo Selo, on the regional line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia), in the area of the station Novi Bečej, on the section between the entrance signal and first entrance switch of the switch block 2 from the direction of the station Banatsko Miloševo. The area where the accident occurred is populated.

The review of the accident site is given in Fig 2.1.1.1.

Fig 2.1.1.1: The area of the accident site (source: *Google maps*)

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

On the regional line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia), during the drive in the direction from the station Banatsko Miloševo to the station Novi Bečej, in the area of the station Novi Bečej, between the entrance signal and first entrance switch of the switch block 2, derailment of train No. 53527 occurred. From the train composition, in total 8 (eight) wagons of series Za loaded with acetic acid derailed.

From eight derailed wagons, three of them remained on their wheels in the zone of the track, one of them remained on their wheels on the bank aslope to the axis of the track, four of them turned on their sides and in three of them leakage of acetic acid occurred. Viewed from driving locomotive, second, third, fourth, fifth, sixth, seventh, eighth and ninth wagon derailed.

From the total of 24 (twenty four) wagons that were part of the composition of train No. 53527, 23 (twenty three) were of the series Za at which 14 (fourteen) were loaded with acetic acid, 9 (nine) were empty and one was empty of the series Ea.

Due to the resulting leakage of acetic acid, on the site of the accident after the call came out representatives of the police and fire brigade. Because in this accident there were no dead and injured, there was no need for the engagement of the emergency services. Remediation of consequences caused by this accident was carried out by engaging professional services and resources "IŽS"a.d, "Srbija Kargo"a.d. and "MSK"a.d. Kikinda with the assistance of the fire department.

Because of the accident, there was an interruption of rail traffic between stations Banatsko Milosevo and Novi Bečej. The closure lasted until 29.12.2017 at 14:30 when the track was opened for traffic of trains with the speed according to the Timetable Booklet 5.1.

2.1.3. Decision to launch the investigation, composition of the investigation team and conducting of the investigation

The first notice of the accident occurred main investigator for rail traffic received on 23.12.2017 at 14:08 by telephone by the Assistant Director of Sector for Operations "IŽS"a.d. Based on the received first information and facts that the investigative team established on the accident site, CINS has launched an investigation of the respective accident pursuant to the Law on the investigation of accidents in air, railway and water transport *("Official Gazette of RS" No. 66/15 and 83/18*).

Composition of the Working Group for investigation of respective accident is determined by the Decision 33 No. 02-02-13137/2017 of 28.12.2017 of the Director of CINS, according to the Articles 6 and 32 of the Law on investigation of accidents in air, rail and water transport ("*Official Gazette of RS"" No. 66/15 and 83/18*).

2.2. Accident background

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

Train driver and assistant train driver of locomotive 661-243 were involved in the accident, employed by the Railway Undertaking "Srbija Kargo"a.d, Kargo Section Pančevo, OJ for traction Zrenjanin.

The other staff was not involved in the respective accident as well as contractors, other persons and witnesses.

2.2.2. Trains involved in the accident and their composition

In the respective accident the train No. 53527 was involved. The given train operated on the relation Kikinda - Banatsko Milosevo - Zrenjanin. The train composition consisted of driving locomotive of series 661-243, the property of "Srbija Kargo"a.d, 14 (fourteen) wagons of series Za loaded with acetic acid (RID 83/2789, OM 8194), 9 (nine) empty wagons of series Za and one empty wagon of series Ea.

Fig. 2.2.2.1: The view of the wagon of series Za that was involved in the respective accident

According to the data delivered by "MSK"a.d. Kikinda, the wagons of series Za that were involved in the respective accident are four-axle special closed wagons intended for transport of concentrated (glacial) acetic acid, anhydride of acetic acid, as well as other concentrations from the class 8 according to RID. The design of the wagon is satisfactory according to all regulations UIC, RIV and RID.

Filling of the wagon-tank is done on the lid of the opening for filling manually.

Discharge of the wagon is carried out via the dispensing device, consisting of the central floor valve, the catchment pipes and the two independent side ball valves.

2.2.3. Infrastructure and safety signaling system

Regional line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia) is a one-track, unelectrified. The section between the stations Zrenjanin and Kikinda is constructed in 1883. In the period between 1961 and 1964, on the section between stations Zrenjanin and Kumane, partial overhaul of track with the second hand material has been carried out. Between 1987 and 1988, on the section between the stations Banatsko Milosevo and Kikinda, the capital overhaul of track with new material and tracks in continuous welded rail with designed speed of 80 km/h has been carried out.

On this track, maximum permitted loads are:

- 180 kN / axle and 64 kN /m on the section between the stations Zrenjanin and Kumane,
- 160 kN / axle and 48 kN /m on the section between the stations Kumane and Banatsko Milosevo,
- 200 kN / axle and 72 kN /m on the section between the stations Banatsko Milosevo and Kikinda.

Maximum speed at this track for passenger/cargo trains, according to the Timetable Booklet 5.1., which was applicable at the time of the respective accident, is:

- 40 km/h / 30 km/h on the section between the stations Zrenjanin and Elemir
- 30 km/h / 30 km/h on the section between the station Elemir and km 102+000,
- 40 km/h / 30 km/h on the section between km 102+000 and station Kumane,
- 30 km/h / 30 km/h on the section between the stations Kumane and Banatsko Miloševo,
- 80 km/h / 60 km/h on the section between the stations Banatsko Miloševo and Kikinda.

On all official points between the stations Zrenjanin and Kikinda, the maximum speed on the running track and station tracks and over all the switches is 20 km/h.

On this section between stations Zrenjanin and Kikinda in 2017 two restricted runnings have been introduced (over the bridge at km 120+117 with 10 km/h and over the bridge at km 140+821 with 50 km/h) because of the great percent of the rotted wooden and bridge sleepers.

The maximum slope on the track is 6,0‰ and is located between the stations Banatsko Miloševo and Kikinda.

On the part of the abovementioned section between the stations Novi Bečej and Banatsko Miloševo, the track was built in 1882 with the rail type „I“ of length l=9 m, and in 1931 the rails of type „C“ of length l=12 m have been installed. In different time intervals and from different reasons, the rails were individually changed. Installed sleepers are common wooden, of dimensions 16x26x260 cm and 16x26x260 cm. The sleepers in different time intervals and from different reasons have been partly changed with the new or the second-hand ones.

The traffic on the abovementioned section is regulated in station departments, by seeking allowance for the traffic of trains, notifying and checking out (orally, via phonograms).

2.2.4. Communication tools

On the section between the stations Novi Bečej and Banatsko Miloševo, communication between personnel in charge of traffic regulation is performed via local radio. Communication on this radio network is recorded on the register device RC 3, approved by Instruction No. 20/11-620 from 21.06.2011, reg. No. 76, that was installed in the TT section Zrenjanin. This type of communication is considered as evidence-based communication.

In the area of the station Novi Bečej, communication between the dispatcher and switcher at securing the drive route is performed in person, by direct oral communication and written, with entry in the notebook S-46.

2.2.5. Works at or near the accident site

Near the site of the accident there were no works performed.

2.2.6. Activation of the emergency plan for railways and the sequence of events

Infrastructure Manager “IŽS”a.d informed CINS, i.e., the Main investigator for railway traffic. The Railway Infrastructure Manager “IŽS”a.d. and Railway Undertaking “Srbija Kargo”a.d, established a joint investigation committee that conducted an investigation of the

accident in accordance with applicable regulations. Upon completion of the investigation, the Investigation Report U-584/17 was drafted.

In connection with the leaking of content (acetic acid) from the overturned rail wagon-tanks, estimated by the representatives of the Ministry of Environmental Protection, who, after the occurrence of the respective accident came to the site, there was no danger to the health and lives of the local population.

Management of "MSK"a.d. Kikinda immediately after the occurrence of the accident got in touch with the city administration of Novi Bečej, organized the Crisis Headquarters, and held necessary meetings and agreements for the planned activities on the refunctioning of the track, raising and setting up all the wagons on the rails, that is, removal and remediation of accident consequences. Also, guidelines for giving necessary information to the media to inform and alert the public have been determined.

Lifting of derailed wagons and their removal from the accident site was carried out by two breakdown trains owned by "IŽS"a.d, which consisted of cranes in their composition.

The first breakdown train, owned by the Section for TKP Kraljevo, was dispatched across the stations Pančevo Main Station and Zrenjanin, arrived at the station Novi Bečej 24.12.2017 at 09:35.

The second breakdown train, owned by the Section for TKP Beograd, was dispatched across the stations Novi Sad and Subotica, arrived at the station Banatsko Miloševo at 19:35.

In order to ensure the conditions for work on the lift and removal of derailed wagons from the site and work on the remediation of the track, the contents of the tank-wagons were transfused into road vehicles-tanks. Transfusing of content is carried out parallelly with the work on the lifting of the derailed wagons and draw them out from the site and works on remediation of track with continuous involvement of employees in "MSK"a.d. Kikinda.

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

Police Station Novi Bečej was informed of the respective accident on 23.12.2017 at 13:20, by the phone by an unknown citizen. The accident site was guarded by the police officers of the police station Novi Bečej in the period from 23.12.2017 at 13:25 to 28.12.2017 at 06:00. In order to secure the site, a total of 19 (nineteen) police officers was engaged.

Upon received call from a natural person, members of the fire-rescue department of Novi Bečej, in cooperation with the Fire and Rescue Battalion from Zrenjanin, for technical intervention of an accident involving hazardous substances, came to the site. The intervention was attended by 16 (sixteen) firefighters with 15 (fifteen) vehicles. In the period from 23.12.2017 at 13:25 to 28.12.2017 at 03:05 continuous duty time was carried out (24 hours).

In this accident, there was no need to hire medical services.

2.3. Dead, injured and material damage

2.3.1. Passengers, third parties and railway staff, including contractors

In this accident there were no injured or dead persons.

2.3.2. Goods, luggage and other assets

In this accident due to leakage from the turned over wagon-tanks, there occurred loosing of the part of the cargo (acetic acid). The leakage occurred from the three wagon-tanks and according to the following:

From the wagon No. 33 72 7993 510-6	leaked	1.76 t	In total of	853.60	EUR
From the wagon No. 33 72 7993 519-7	leaked	2.16 t	In total of	1 047.60	EUR
From the wagon No. 33 72 7977 519-7	leaked	0.67 t	In total of	324.95	EUR
	In total leaked	**4.59 t**	In total of	**2 226.15**	**EUR**

Material damage made upon losing the cargo is shown on the basis of the documentatation that "MSK"a.d. Kikinda has delivered. The damage is stated in EUR.

According to the official middle exchange rate of the National Bank of Serbia on 22.12.2017, which is 1 EUR (Euro) = 119.0224 RSD (Dinars), the total material damage caused in the respective accident amounts to 264 962.91 RSD (Dinars).

2.3.3. Railway vehicles, infrastructure and environment

In the respective accident the railway vehicles and infrastructure is damaged. On the property of the third persons there is no material damage.

The structure of the material damage is given as follows:

The cost of six wagons for transport to the repair workshop and works on two less damaged wagons:	236 760.00	RSD
The cost of fare of wagons:	166 631.36	RSD
Lost earnings due to non-use of wagons until enabling them:	6 087 995.76	RSD
Hiring the workers of MSK:	1 060 727.63	RSD
Hiring the road vehicles-tanks:	273 751.52	RSD
The cost of spent chemicals on the accident site:	8 807.66	RSD
Engaging device for heating catchment branch of wagon-tanks:	30 260.25	RSD
Costs of shunting with loco-tractor on an industrial track MSK:	47 722.03	RSD
The cost of cleaning container wagon-tanks before sending them to the corrective repair:	1 092 244.76	RSD
Indiirect and other costs of MSK:	255 898.16	RSD
Labor costs of breakdown trains (lifting of derailed wagons):	6 956 784.30	RSD
On the track and track facilities (materials and labour):	3 659 313.40	RSD
Total material damage:	**19 876 896.83**	RSD

Damage is stated 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 22.12.2017, which is 1 EUR (Euro) = 119.0224 RSD (Dinars), the total material damage caused in the respective accident amounts to 167 001.31Euro (EUR).

The material damage in this report is stated based on documents submitted by invoices, estimates, i.e. documents that confirm the stated damage amounts, delivered by "IŽS"a.d. (direct material damage), "Srbija Kargo"a.d. (direct material damage) and "MSK"a.d. Kikinda (direct and indirect material damage, data that were available to be delivered upon closure of this Report). The total material damage at "MSK"a.d. Kikinda can be exactly determined upon finishing all the necessary activities for determining of the damage, and it will be greater than the data submitted until now.

2.3.4. External conditions - weather conditions and geographic characteristics

The site of respective accident is located in the area of the mucipiality Novi Bečej. The landscape in the vicinity of the occurrence of the accident is primarily flat with no high vegetation and low vegetation. The area is populated at both sides of the track. The facilities are located at a distance between 50 and 70 m.

The geographic coordinates of the place of accident are: 45º 36' 33,6" *N* and 20º 9' 10,4" *E*.

At the time of the accident, the weather was clear and sunny. The air temperature was 12°C.

During the on site investigation by the investigative team of CINS, it was night, there were no precipitations, the temperature was 5°C and there was a mild wind of changeable direction.

3. Minutes on the investigation and interviews

Data, facts and evidence regarding the respective accident were collected and determined on the basis of:

- investigation which was carried out on-site by investigative team CINS,
- a subsequent visit to the accident site and review of derailed wagon that performed the investigative team of CINS in the presence of "IŽS"a.d, "Srbija Kargo"a.d. and "MSK"a.d. Kikinda,
- materials supplied by Infrastructure Manager "IŽS"a.d,
- materials supplied by Undertaking "Srbija Kargo"a.d. and
- materials submitted by the owner of the wagon "MSK"a.d. Kikinda.

Police and judicial - investigative authorities did not conduct an investigation on the site.

3.1. Summary of testimonies

From "Srbija Kargo"a.d. the minutes of the hearing of train driver and assistant train driver of locomotive 661-243 were submitted.

From "IŽS"a.d the minutes of the hearing of dispatcher and switchman were submitted who at the time of occurrence of the accident were at the service of the station Novi Bečej.

3.1.1. Railway staff

The train driver stated: “on the section of Banatsko Miloševo - Novi Bečej, before the derailment, I had a minor standing at km 127+344 crossing “Sokolac”, and to secure the same, and by order I. After the continued drive shortly before the event I did not notice anything unusual. When exiting the curve, before the level crossing, I announced the assistant that the input signal shows the aspect of a signal “Free”, which my assistant confirmed. On the level crossing I stopped the train traction. In the curve mild twitch was felt and I immediately introduced fast braking. Before it full braking was achieved. The train stopped abruptly. When I saw that the wagon-tanks were turned over and that there is a leakage on them, I called the dispatcher and told her to call the fire department and the police service. About this event I announced mechanical dispatcher and requested permission to detach the locomotive and remove it to a safe distance (which was approved)”.

The train driver assistant stated: “because I was informed by the train driver that the input signal of station Novi Bečej is in the position “Free”, I said loud and clear this information and I acted in accordance with the duties. Immediately after leaving the train’s No. 53527 locomotive of the curve, I felt a slight twitch. At this point, the train driver introduced fast braking. When I “threw” a view of the train I saw the overturned wagon-tanks. By order of train driver, I have perused uncoupling of the locomotive from the rest of the train in order to prevent ignition and explosion”.

Train dispatcher stated, “after the passage of the train No. 2523 at 12:26, and after receiving the train No. 53527 at 13:03 I ordered securing of drive route to the train 53527 which is by switchman secured at 13:06. At 13:15 I heard a deafening noise and I called by mobile phone the train driver who informed me that there was a “falling out” of the wagon-tank. Then I was informed about the leakage from the tank, so I called the fire department Novi Bečej, which I did. In addition to the fire department, I called service of MUP Novi Bečej, and then I called the Department of Operations Zrenjanin. Upon the notification I went out to the site around 13:30 and convinced myself personally on the extent of the accident”.

Switchman stated: “on the abovementioned day after receiving the order by the dispatcher I exercised securing the drive route for train 53527 through the third track. Please note that the third track is a running track of railway station Novi Bečej. After securing the drive route I went on the block 2 to handle the input signal. The input signal I set to “Free” and waited for the train 53527 to enter, and then I heard a terrible noise and a crash. I did not see myself the event because of the distance and the curve. Since I went to meet the train, I saw immediately after the arrival the turned over wagon-tanks that are leaking, a locomotive driver informed me that he informed the dispatcher. Upon returning to the station, I personally informed about the event the train dispatcher”.

3.1.2. Other witnesses

There were no witnesses of this accident.

3.2. Safety management system

3.2.1. Organizational frame and manner of issuing and executing orders

In accordance with the Rulebook of Safety Management System, "IŽS"a.d. of the resulting accident has informed the stakeholders.

Railway Infrastructure Manager "IŽS"a.d. and Railway Undertaking "Srbija Kargo"a.d, in accordance with Law on railway safety and interoperability (*"Official Gazette of RS" No. 104/13, 66/15-other law and 92/15*), formed a joint investigative committee that carried out an investigation of the respective accident. Upon completion of the investigation, a Report on the investigation of U-584/17 has been made.

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

"Srbija Kargo"a.d. through Safety Management System manual (SMS) has provided competence management, i.e. processes that all employees who are directly involved in the performance of rail transport are trained and competent for planning the workload.

In connection with the respective accident, involving the train driver and assistant train driver, employed at "Srbija Kargo"a.d, all activities related to professional training, competence and planning office hours are conducted in accordance with applicable regulations.

"IŽS"a.d. through the Rulebook of the Safety Management System (SMS) provide competence management, i.e. processes that all employees who are directly involved in the performance of rail transport are trained and competent for planning of workload.

Regarding the respective accident, at dispatcher on duty and switchman of the station Novi Bečej, employed at "IŽS"a.d, all activities related to professional training, competence and planning office hours are conducted in accordance with applicable regulations.

3.2.3. Procedures for internal audits and controls and their results

"IŽS"a.d. as Infrastructure Manager has established Rulebook of Safety Management System. Safety Management System includes the organization and all the procedures and processes that have been established in "IŽS"a.d. for safe regulation of railway traffic.

Risk control related to the maintenance of the railway infrastructure (infrastructure subsystems, energy, control, management and signaling-track section) and railway vehicles for that "IŽS"a.d. uses for maintenance is based on the implementation of the defined activities of regular and corrective maintenance and their monitoring and control. Regular and corrective maintenance involves constant supervision, control, inspections, repairs and adjustments.

Requirements, standards and procedures to maintain at the "IŽS"a.d. are determined on the basis of legal regulations, general and individual acts of society, the manufacturer's instructions and standards.

Regarding the respective accident, regular and corrective maintenance of the track was not done according to valid regulations.

3.3. Relevant international and national regulations

3.3.1. Law on Railway (*"Official Gazette of RS" No. 45/2013 and 91/2015*) repealed on 08.06.2018

Important note: at the time of occurrence of the respective accident, the Law was applicable.

Article 14, Paragraph 1:

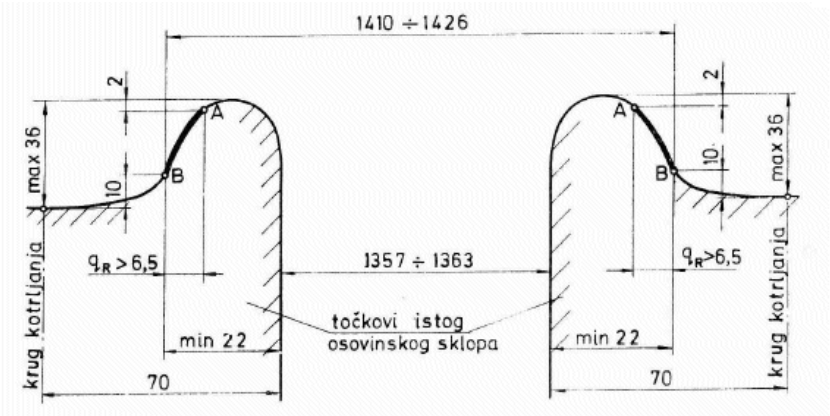
Infrastructure Manager is obliged to secure permanent, uninteruptted and quality maintenance and protection of railway infrastructure, uninterrupted use of infrastructure facilities and other means of work for railway traffic, as well as organisation and regulation of safe and uninterrupted traffic.

3.3.2. 250 Instruction for operation and maintenance of bogies type Y 25 and Y 27 adopted by the Yugoslav railways (*"Official Gazette of ZJŽ" No. 2/87*)

Note: According to "Procedure of maintenance of railway freight wagons and infrastructure of MSK" No. MSK-SP-2200-0006 of 27.02.2017, the check of freight wagons owned by "MSK"a.d. Kikinda performs "IŽS"a.d. Sector of TKP. Decision "IŽS"a.d. No.4/2015-51-17 from 29.12.2015 of the incorporation of regulations issued by ZJŽ as their internal acts in accordance with Article 152 of the Law on railway safety and interoperability, the Instruction has been downloaded and is still in the implementation of the "IŽS"a.d.

Part II Instruction, Point 1.1.1. Wheel set (excerpt):

- Fig space: the wheels of the same axle assembly and size ranges must correspond to the measures according to Figure:



Tockovi istog osovinskog sklopa = wheels of the same wheelset,
Krug kotrljanja = rotation circle

- width of the wheel rims should be between 133 mm (at the wagon BR 130 mm until 31.12.1982) and 140 mm including width change, caused by plastic deformation and material flow;
- the wheels must not show traces of movement on the axle.

3.3.3. Instruction on unique criteria for control of the condition of tracks on the network JŽ, Instruction 339 (*"Official Gazette of ZJŽ" No.2/ 2001 and 4/2004*)

Note: By decision of "IŽS"a.d. No. 4/2015-51-17 from 29.12.2015 on incorporation of regulations issued by ZJŽ as their internal acts in accordance with the Article 152 of Law on Railway Safety and Interoperability, this Instruction is incorporated and is still applicable in "IŽS"a.d.

In point 7 of the applicable edition of Instruction 339 from Article 7 is missing the text under the 5th from the edition of Instruction from 1989 (which repealed).

Article 7 under 5 of Instruction 339 from 1989:

"Registered errors which directly threaten traffic safety, must be removed the same day after the passage of track inspection coach. If this is not possible, appropriate security measures should be taken".

. . . . . .

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

- "B - errors due to which work for their elimination should be planned"
- "C - errors that are above the limits of exploitation **and require immediate elimination or speed reduction"**

. . . . . .

Important note: Emphasized part of the text, in Instruction 339 from 1989 stated:

" and that must be eliminated immediately because they threaten the safety of traffic".

. . . . . .

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

"The condition of track is estimated on the basis of the total length of errors in the groups "B"and "C" at one kilometer".

Condition of 1 km of the track is:

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

. . . . . .

Important note: In addition in Instruction 339 with amendments in 2001, the last paragraph was deleted from Point 9, which is in edition of the Instruction 339 of 1989 in Article 9 the last paragraph (excerpt) read:

"**Immediately after the track inspection coach the works are undertaken at all the miles where the errors length greater than 200/20 occur, while it must be determined in the**

Minutes how it came to this situation. After determining the reasons of errors appearance and their location, immediately developing a plan to improve the situation of the observed mile is started.... "

. . . . . .

3.3.4. Rulebook on tecnical conditions and maintenance of the superstructure of the railway tracks No.: 340-201-2/2016 (*"Official Gazette of RS" No. 39/16 and 74/16*)

Article 81, paragraph 1 and 2:

The technical condition of all kinds of track supplies and accessories as a whole must be such as to ensure a firm connection between the rails, rails with a sleeper and prevent loosening fittings and connections.

Damaged, worn out or missing elements of track accessories should be replaced or supplemented, tighten loose fittings, and if necessary, lubricate some of the elements.

3.3.5. Rulebook on the transport of special consignments (*"Official Gazette RS" No. 6/17*)

Transport of special consignments with an overload of allowed mass of railway vehicles

Article 22:

For special consignments that on the track, that is, on the section on the transportation track exceed the allowed mass of railway vehicles by the axle or the running metre for more than 2% of their own mass of the vehicle (tare), and that, according to the evaluation of the Infrastructure Manager is possible to transport, depending on the technical condition of the railway track and railway facilities, special conditions for transport of special consignment are determined:

1) reduced speed of the transport;
2) according to the need, separation of the vehicle with a special consignment from the rest of the heavy vehicles in a train with the convenient number of buffer wagons (loaded or empty), which mass by the running metre for each vehicle is not greater than 6.4 t/m for the tracks of categories from B2 to E5, that is, 3.5 t/m for the tracks of categories from A1 to B1;
3) according to the need, inspection of the railway track and the railway facilities after the carried out transportation.

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

Article 10, Paragraph 1:

Infrastructure Manager is required to ensure the safe and smooth organization, regulation and management of rail traffic, unrestricted access to and use of public railway infrastructure and access to service facilities that are entrusted to his management and the services it provides in these facilities to all interested applicants for the allocation of infrastructure capacities, under equitable, non-discriminatory and transparent conditions, as well as permanent, continuous and quality maintenance and protection of the railway infrastructure.

3.4. Functioning of railway vehicles and technical installations

3.4.1. Control, command and signalling

On the part of regional line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia), between the stations Bantsko Miloševo and Novi Bečej the traffic is regulated in the station department. On the forementioned distance between stations, except the entrance signal of the stations Banatsko Miloševo and Novi Bečej, there are no other signals. The entrance signal of the station Novi Bečej is imaged. The signal is in function.

3.4.2. Infrastructure

According to the delivered data of the railway inspections carried out in the period before the formation of the respective accident, executed by the activities of the ZOP "IŽS"a.d, Section for ZOP Zrenjanin, the factual state, as stated below, is determined.

Wornness out of rails in the outer and the inner arches is within the exploitation value.

From km 122+004,10 to km 126+452.30 in 1931 non-standard rails type "S" (RESICZA 1909 M.A; DIOSCZOR 1910 B.A; DIOSCZOR 1914 M.A.) were installed, connected with floating compositions with nonstandard fittings.

Tightening railway accessories is nonstandard.

Rail grid is in a ballast made of crushed stone, very ablated and grassy.

The geometry of the track is very bad and is manifested with disturbed level line in the longitudinal and transverse direction. Twist is above the limit, which jeopardizes the road safety.

Due to the poor condition of the elements of the super and the substructure, the maximum speed of the track between the station Kumane (km 112+469.00) to the station Banatsko Miloševo (km 141+291.00) is V_{max}=30 km/h, and designed speed on this section of the railway track is V_{max}= 80 km/h.

At the site of derailment, the railway track is on the embankment of a height of about 1.50 m, in the horizontal direction, in the left curve of radius R=500 m, with cross level h=40 mm.

After examining the Book of inventory of rotten sleepers in the track section in Banatsko Miloševo, from km 122+000.00 to km 123+000.00, of 1418 built-in wooden sleepers 412 or 29.05% were rotted, of which 18 places with rotten sleepers is in "a nest" of 3 (series of 3 consecutive sleepers), and the 5 places with the rotten sleepers in the "nest" of the 4 sleepers (a set of 4 consecutive sleepers).

During 2015, 2016 and 2017, a single shift of rotting wooden sleepers was carried out by installation of new and used, as can be seen from the daily reports of chiefs of railway works for section of the railway track between stations Novi Bečej and Banatsko Miloševo.

On the part of the regional line between stations Novi Bečej and Banatsko Miloševo, from 01.01.2015 until the occurrence of the respective accident, by employees of the Section ZOP Zrenjanin, and OJ of railway section Banatsko Miloševo, the following works on maintaining the upper and lower structure of the track were carried out:

- manually regulate the track in the direction in the gravel,
- manually regulating the tracks in a curve in the crushed stone,

- lifting sided depressions in the direction in the gravel,
- singular shift of sleepers in crushed stone and gravel with installation of new and used sleepers,
- singular shift of rails type "C", length l=12 m after the rupture of the track,
- works on eliminating the vegetation (contraction of shrubs, mowing of grass and weeds and chemical destruction of the growing season).

The stated works were carried out by employees at OJ of the track section Banatsko Miloševo (seven employees) with occasional help of the employees of OJ for track section Kikinda, which can be seen by reviewing the daily reports for the stated works.

For part of the regional railway line from km 113+127 to km 150+383 Section responsible for maintenance is Section for ZOP Zrenjanin, and OJ of railway section Banatsko Milosevo. Before the formation of the respective accident, OJ of railway section Banatsko Miloševo had seven employees who worked directly on the maintenance of the railway and four railway operators of light railway machinery mechanization and three railroad workers. In the responsibility of OJ of railway section Banatsko Miloševo was a total of 52.673 km of track.

From the light railway machinery and tools, OJ of railway section Banatsko Miloševo has:

- motor drilling machine for sleepers- 2 pieces,
- motor drilling machine for rail - 2 pieces,
- motor machines for cutting of rails with plate - 1 piece,
- motor machines for cutting of rails with the saw - 1 piece,
- motor machine for wrapping of screws - 3 pieces,
- tool for manual packing of sleepers - 2 pieces,
- motor rail vehicle - 3 pieces (defect),
- pitchforks - 15 pieces,
- hatches - 20 pieces,
- metal shovels - 15 pieces.

On the basis of systematization of workforce, OJ for track section Banatsko Miloševo has the distributed lineman for two track sections, and:

- section from km 112+701 to km 127+344 and
- section from km 127+344 to km 141+651.

Linemen patrol on foot their section based on the chart of section tours. Due to insufficient number of linemen, both linemen patrol their section pursuant to the monthly number of classes (20 to 23 times each month). During the tour of the railway, the linemen in the period from 01.01.2015 to occurrence of the respective accident, did not find irregularities in the track, which is contrary to the aforementioned condition of the track.

On the territory of railways maintained by Section for ZOP Zrenjanin in the period from 01.01.2015 until the occurrence of the respective accident, measurement with track inspection coaches is performed only once a year. Given that the letters from the Department for Construction Affairs of faults at track inspection coach EM 80L obtained sometimes later, Section for ZOP Zrenjanin was not able to make a measurement of the gauge of the track and cross level manually due to weather conditions, priority tasks and labor shortages.

On 25.11.2015 the commission has carried out technical inspection of the part of the regional railway line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia) from km 16+825 to

km 141+576 for the purpose of prescribing the conditions for traffic regulation with prescribed and overdue load, on which the Minutes were made whose analysis is performed in point 4.2.4.

3.4.3. Means of communication

At the time of occurrence of the respective accident, the means of communication were operating and functional. On the means of communiciation no faults or interferences have been recorded.

3.4.4. Railway vehicles

At the time of occurrence of the respective accident, the train No. 53527 was moving in the direction from the station Banatsko Miloševo to the station Novi Bečej (from the end towards the beginning of the track, in the direction of decreasing mileage).

During the train drive, there occurred a derailment of 8 (eight) wagons of series of Za. From the composition of the train, as viewed from the driving locomotive 661-243, derailed the second, third, fourth, fifth, sixth, seventh, eighth and ninth wagon.

On the site, taken aback were 4 (four) on their wheels and 4 (four) overturned wagons. Of 3 (three) of the wagon-tanks, on the openings for pouring load, leakage of acetic acid was noticed.

Review of derailed wagon, viewed from the driving locomotives, is given in Table 3.4.4.1.

Table 3.4.4.1: Review of the derailed wagon

wagon		**description:**
series:	**No:**	
Zaekks-z	33 72 7937 501-4	Derailed with three wheels, found in the zone of track on its wheels
Zaes-z	33 72 7993 510-6	Overturned on the hip, acetic acid is leaking
Zaes-z	33 72 7993 519-7	Overturned on the hip, acetic acid is leaking
Zaes-z	33 72 7993 520-5	Overturned on the hip, there is no leaking in the accident occurred
Zaes-z	33 72 7993 516-3	Derailed with all the axles, found on their wheels on the embankment, obliquely relating to the axis of the track
Zaces-z	33 72 7977 585-8	Derailed with all the axles, found on their wheels in the zone of the track
Zaces-z	33 72 7977 519-7	Overturned on the hip, acetic acid is leaking
Zaekks-z	33 72 7937 503-0	Derailed with first bogie and remained on it s wheels in the zone of the track

On the point of derailment, the track was completely ruined, so it was not possible to determine the first trace of derailment.

The view of the derailed wagon is shown in Fig. 3.4.4.1, 3.4.4.2, 3.4.4.3, 3.4.4.4. and 3.4.4.5.

Fig. 3.4.4.1: The view of derailed and turned over wagons

Fig. 3.4.4.2: The view of turned over wagons

Fig 3.4.4.3: The view of the broken rail

Fig 3.4.4.4: The view of derailed wagons

Fig 3.4.4.5: The view of derailed and turned over wagons

On the locomotive 661-243 speeding equipment of manufacturers Hasler were installed including: registering speeding RT9i device type, serial No. N08.144 and indicating speeding A16 device type, serial No. L0.110. Both speeding devices are tested, with a validity of certificates until 19.09.2018.

Analysis of the data registered on speeding tape taken from registering speeding devices of the driving the locomotive 661-243 train No. 53527 (Data from speeding tape number 37-3/2017-739 from 15.01.2018) it was determined that the train No. 53527 from the station Kikinda was dispatched at 11:50. During the drive from the station Banatsko Miloševo to the formation of the respective accident train No. 53527 had a two (2) stoppings (due to unsecured crossings at km 137+361 and km 127+344). After starting after stopping in km 127+344 and to the formation of a respective accident, the train was moving at the speed of 30 km/h. At km 122+250, at a speed of 30 km/h, the train suddenly stopped at 13:10. The times are given by the timer of speeding devices.

Based on the data from speeding tape of the locomotive 661-158, it was stated that the train did not exceed the speed limit on this section of railway line (30 km/h) prescribed by timetable booklet 5.1.

3.5. Traffic operation and management

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

The traffic of the train No. 53527 on the route from Banatsko Miloševo - Novi Bečej was operating in station department. Before of the dispatch of the train No. 53527, for it it was determined the permission in accordance with the apllicable regulations and there existed no irregularities.

Train staff, via accompanying documents, received orders and notifications on the train traffic on this section.

3.5.2. Exchange of voice messages in relation to the accident

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

Communication between the staff that regulates the traffic and the train driver was achieved after the occurrence of the respective accident with the purpose of informing on the accident occurred, in a manner that the train driver of the train No. 53527, via the telephone line of mobile operator has informed the dispatcher of the station Novi Bečej.

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

After the occurence of the respective accident, the part of the regional line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia) between the station Novi Bečej and Banatsko Miloševo was closed for traffic.

Immediately after the accident, due to possible consequences on the lives and health of the railway workers, from the rest of the train driving locomotive was uncoupled and moved to the station track.

Given the fact that the train No. 53527 stopped after the respective accident on the part of the railway line that is horizontal (no slope), specific measures to ensure the train from self-rolling were not undertaken.

To protect life and health and environment, police representatives (to secure the accident site), the workers of "MSK"a.d. Kikinda (in order to neutralize leaked acetic acid with flakes of NaOH) and firefighters who were taking adequate measures (dilute the acid with water) in order to reduce the effects of acid leakage, were engaged.

3.6. Interface between man, machine and organisation

3.6.1. Working hours of the staff involved

For the railway staff, information was submitted based on which it is clear that the train driver and the train driver assistant of the locomotive 661-243 and train dispatcher and switchman of the station Novi Bečej had legally stipulated rest before coming to work and that on work they did not spend a period longer than the maximum specified by law.

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

For railway staff data were submitted which show that the train driver and assistant locomotive driver who have been in service with the train No. 53527 were trained and medically fit to perform the job. From the Undertaking "Srbija Kargo"a.d. the train driver received the confirmation of receipt of the application and the requirements for a license to operate the traction vehicle I-01-1 No. 340-45/2017 of 10.01.2017 issued by the Directorate of Railways.

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

On the part of the regional line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia), between the station Novi Bečej and Banatsko Miloševo maximum permitted speed is 30 km/h and the maximum permissible load is 160 kN/axle, and 48 kN/m.

According to the projected condition, traffic on the respective track is regulated into the station departments.

Management of the locomotive is done by train driver and assistant engine driver via commands from the driver's cab, designed for the production of locomotives. At the locomotive 661-243 all the shortcomings identified in the systems and control devices are eliminated, so they are not registered any complaints or defects.

At projected technical-exploitation characteristics of wagon series and at the maintenance of wagon series Za there are not registered any complaints or defects.

3.7. Previous accidents of similar nature

Based on data obtained from the "IŽS"a.d, for the period from 01.01.2008 until 23.12.2017 at the regional railway line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia), there has been an emergence of eighteen (18) accidents, derailments of trains. A review of the accident is given in Table 3.7.1.

Fig. 3.7.1: Review of accidents occurred in the period from 01.01.2008 until 23.12.2017

No.	date	time	short description	cause
1	17.02.2011	16:40	During the shuntung in the station Zrenjanin, at km 89+605, derailment of locomotive 644-006.	Track gauge widening because of rotten sleepers and poor track accessories.
2	27.02.2011	07:15	Upon entering the st. Zrenjanin, at km 88+380derailment of train No. 53520 with three loaded wagons of series Za.	Track gauge widening because of rotten sleepers and poor track accessories and poor and badly made ballast.
3	24.09.2011	00:10	Upon entering the st. Banatsko Miloševo, at km 141+625, derailment of No. 53523 with one wagon of series Za (repair).	Technical flaw in the wagon – cracking of tank screw belt of braking device and fall off the tank.
4	19.06.2012	21:20	During the shunting in st. Banatsko Miloševo, at km 141+720, derailmet of one wagon of series Ua (repair).	Technical flaw in the wagon – cracking of braking triangle and falling under the wheel.
5	10.02.2013	12:10	Upon entering the st. Novi Bečej, at km 121+199, derailment of train No. 2521 (DMV 812/816-306).	Track gauge widening due to alienation of track accessories.
6	27.02.2013	16:15	Upon the shunting at the st. Zrenjanin, at km 88+314, derailment of two loaded wagons of series Za.	The brakeage of rail with a length of 51 cm under the wagon diring the shunting.
7	04.11.2014	14:30	In the station Kikinda, at km 160+360, during the unload, derailed one loaded wagon of series Ea.	Unofficial handling with excavator during the unload - the user of the transport
8	16.11.2014	09:35	In the station Kikinda, at km 160+197, during the unload derailment of one loaded wagon of series Ea.	Track gauge widening due to the brakage of rail produced in 1891 and dilapidation of sleepers.
9	16.12.2015	11:15	Upon the shunting, at km 160+600, derailment of two loaded wagons of series Ea.	Bad condition of the track, polluted ballast, soggy and full of dirt, without crushed stone, bad conditions of sleepers, bad weather conditions - heavy rainfall
10	29.10.2016	17:10	Upon entering the st. Zrenjanin, at km 88+328, derailment of train No. 56502 with locomotive 661-143 and one loaded wagon of series E.	Bad weather conditions, heavy rainfall. Two breakeage on the left rail and dilapidation of track accessories and rails produced in 1882 and 1892.

No.	date	time	short description	cause
11	20.11.2016	08:05	Upon the shunting at the st. Kikinda, at km 160+600, derailment of two loaded wagons of series Ea.	Bad weather conditions, heavy rainfall. Poor condition of the track, polluted ballast, wet and full of dirt, without crushed stone, bad conditions of sleepers and track accessories.
12	22.11.2016	07:46	Upon entering the train No. 53502 at the st. Banatsko Miloševo, at km 141+732, derailment of three loaded wagons of series Za.	Bad weather conditions, heavy rainfall. Collecting of greater quantities of water at the tracks, ballast polluted with dirt - wet, dilapidation of the sleepers, track accessories and rail produced in 1882.
13	11.02.2017	20:40	Upon entering the train No. 56502 at the st. Zrenjanin, at *km* 88+310, derailment of four loaded wagons of series *Za.*	Bad weather conditions, heavy rainfall. Poor condition of the track, polluted ballast, wet and full of dirt, without crushed stone, muddy planum, dilapidation of the rails, track accessories and the rails prodiced in 1882, 1889 and 1912.
14	13.04.2017	13:15	Upon the shunting at the st. Kikinda, at km 159+514, derailment of empty wagon of series Ga (casation).	Technical flaw on the wagon - defection of lever type brake that it hit at the heart of the switch.
15	21.09.2017	04:00	During the turnout of the wagons from the MSK's industrial track, derailment of two loaded wagons of series Za at km 6+200.	Breakage of the rail under the wagon on the transition weld, increased number of overweight shipments, rails produced in 1931.
16	22.09.2017	21:40	During the turnout of the wagons from the MSK's industrial track, derailment of two loaded wagons of series Za at km 6+280.	Track gauge widening on the switch M1/No.3, increased number of overweight shipments.
17	15.10.2017	22:00	Upon the shunting at the st.Kikinda, at km 160+660, derailment off loaded wagons of series Ea.	Polluted ballast, dilapidation of the sleepers, track accessories and rails produced in 1914.
18	28.10.2017	17:00	Upon the shunting at the st. Zrenjanin, at km 89+000, derailment of empty wagon of series Za (repair).	Technical flaw on the wagon that were sent to repair after the accident occurred on 21.09.2017 in Kikinda.

In all the acidents occurred there were no dead nor injured.

4. Analyses and conclusions

4.1. Final review of the course of events and adoption of conclusions about the occurrence based on facts determined during the investigation and interviews

According to the documentation submitted by the "IŽS"a.d, train No. 53527 was dispatched 23.12.2017 at 11:45 from the station Kikinda, and the station Banatsko Miloševo the train passed at 12:29.

The accident happened on 23.12.2017 at 13:15 at km 122 + 250 of the regional railway line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia). Train No. 53527 was pulled by locomotive the 661-243 and was composed of 14 (fourteen) loaded wagons of series Za, 9 (nine) empty wagons of series Za and 1 (one) empty wagon of series Ea.

At the entrance to the station Novi Bečej, near by the input signal, there occurred a derailment of 8 (eight) wagons loaded with acetic acid, out of which 4 (four) wagons turned over.

On the overturned wagon-tanks No. 33 72 7993 510-6, 33 72 7993 519-7 and 33 72 7977 539-7, there was a leakage of acid. Track is damaged from km 122+173 to km 122+270, at a distance of 97m. There was in total damaged 8 (eight) wagons of series Za. After the accident, the railway line was closed to traffic for 6 (six) days. During the interruption of traffic, trains for passenger transport were canceled on the route between Novi Bečej and Kikinda, and freight trains are operated via the auxiliary transport route.

4.2. Analyses of facts determmined during the investigation

4.2.1. Review of derailed wagon

Based on the submitted documentation, derailed wagons (eight in total) after the accident the first time reviewed by the "IŽS"a.d, OJ for TKP Zrenjanin (letter "IŽS"a.d. No. 17/2018-IV2-7 of 11.01.2018). Wagon No. 33 72 7937 501-4, the first derailed wagon in the train composition (second to the locomotive) was examined at the station Novi Bečej. Then it was stated that it did not have any damage and that the internal distance of the wheels of all wheelsets, as well as the characteristical dimensions of the profile of wheels are within the acceptable limits. The remaining 7 (seven) derailed wagons suffered greater damage, and they were carefully transfered to the first in station Banatsko Miloševo. At the station Banatsko Miloševo workers of workshop for maintenance of cargo wagons Kikinda "Srbija Kargo"a.d. on 18.01.2018 performed the necessary interventions before sending the wagons to "MSK"a.d. Kikinda (Letter "Srbija Kargo"a.d. No. 33-10/2018-37 of 19.01.2018).

The wagons were on 12.02.2018 sent from "MSK"a.d. Kikinda to the maintenance workshop for cargo wagons Kikinda "Srbija Kargo"a.d. for preparing for shipping at overhauler (letter "Srbija Kargo"a.d. No. 33-10/2018-37/2 of 13.02.2018). In the workshop in Kikinda detailed examination and measurement of characteristic measures of wheelsets relevant to this investigation (see section 3.3.2.) were conducted, where it is established:

- that the characteristic dimensions of the profile of all wheels, all wagons are in the acceptable limits,
- that the internal spacings of the wheels (dimension L), and the distance of wheel flanges were measured 10 mm under the circle of rolling (dimension K) at all axles, at all wagons are within the acceptable limits.

On that basis, the condition of geometry of wheelsets did not contribute to the occurrence of the accident.

Leakage of acetic acid was found in the 3 (three) of the 4 (four) overturned wagons, on the covers of the openings for filling on the upper chamber. Based on the consignment notes and control measurements (weighing) after transfusion, it was found that the total amount of acetic acid that has leaked during the accident amounts to 4.59 t, (Letter "MSK"a.d. Kikinda No. 19-63/2018 dated 01.02.2018).

4.2.2. Review of maintenance documentation of derailed wagon

Reviewing the documentation submitted for the wagons of the following series and individual numbers:

1. Zaekks-z No. 33 72 7937 501-4,
2. Zaes-z No. 33 72 7993 510-6,
3. Zaes-z No. 33 72 7993 519-7,
4. Zaes-z No. 33 72 7993 520-5,
5. Zaes-z No. 33 72 7993 516-3,
6. Zaces-z No. 33 72 7977 585-8,
7. Zaces-z No. 33 72 7977 519-7,
8. Zaekks-z No. 33 72 7937 503-0,

submitted by the owner of "MSK"a.d. Kikinda established the following:

- the wagons had valid license, as well as certificates of inspection of tanks,
- the person responsible for maintenance is "MSK"a.d. Kikinda,
- regular repair of wagons (big repair) were carried out during 2015, 2016 and 2017, in the workshops "MIP-RŠV"d.o.o. Ćuprija, "Šinvoz"d.o.o. Zrenjanin and "TVB"d.o.o. Subotica.
- By plan of preventive maintenance of wagon-tanks, locotractors and industrial tracks of MSK (MSK-PL-2250-0001, edition No. 02 of 27.09.2010, the excerpt shown in Fig. 4.2.2.1.) deadlines of five years for regular repair and 30 months for inspections are planned. The wagon at the time of the accident was within the prescribed limits of maintenance.

MSK KIKINDA

Naziv dokumenta: Plan preventivnog održavanja vagon cisterni, lokotraktora i industrijskog koloseka MSK

Šifra: MSK-PL-2250-0001

	Br.	Datum:
Izdanje:	02	27.09.2010.
Izmena:	- -	- - -
Autor:	Popov J. Dragan	
Odobrio:	Babić Vojin	
Strana:	9 Od:	13

Redni broj	Oznaka opreme	Naziv opreme	Broj opreme	Klasa opreme	OTS									STP				Dokument za vezu	Napomena
					Pregled vag.cist. po dolasku u MSK	Pregled vag. cisterne pre utovara	Pregled vag.cist. nakon utovara	Zamena zaptivača na podnom ventilu	Tekuća opravka	Tehničko održavanje lokotraktora	Železničko održ. loko traktora i ind. koloseka	Kontrolni pregled	Redovna opravka	Stalni nadzor loko traktora i ind.koloseka	Provera Uređaja za istakanje i utakanje	Pregled vag.cist. nakon utovara	Pregled vag.cist. pre otpreme iz MSK		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
151	430CS063	Vagon cist. za sir.kis.	33 72 797 7565-0	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
152	430CS064	Vagon cist. za sir.kis.	33 72 797 7566-8	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
153	430CS065	Vagon cist. za sir.kis.	33 72 797 7567-6	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
154	430CS066	Vagon cist. za sir.kis.	33 72 797 7568-4	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
155	430CS067	Vagon cist. za sir.kis.	33 72 797 7569-2	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
156	430CS068	Vagon cist. za sir.kis.	33 72 797 7570-0	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
157	430CS069	Vagon cist. za sir.kis.	33 72 797 7571-8	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
158	430CS070	Vagon cist. za sir.kis.	33 72 797 7572-6	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
159	430CS071	Vagon cist. za sir.kis.	33 72 797 7573-4	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
160	430CS072	Vagon cist. za sir.kis.	33 72 797 7574-2	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
161	430CS073	Vagon cist. za sir.kis.	33 72 797 7575-9	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
162	430CS074	Vagon cist. za sir.kis.	33 72 797 7576-7	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
163	430CS075	Vagon cist. za sir.kis.	33 72 797 7577-5	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
164	430CS076	Vagon cist. za sir.kis.	33 72 797 7578-3	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	
165	430CS077	Vagon cist. za sir.kis.	33 72 797 7579-1	1	UPR	UPR	UPR	PP30M	PP	/	/	30M	5G	/	UPR	UPR	UPR	MSK-RI-2250-0012	

Fig. 4.2.2.1: Excerpt from the plan of the preventive maintenance

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

4.2.3. The condition of covers for closing the filling openings

The letter "Measures and actions that are taken after an emergency event in Novi Bečej on 23.12.2017" from 20.03.2018, which was delivered by "MSK"a.d. Kikinda states:

"*It was found that of the eight wagon-tanks that participated in the accident, on the three overturned there is a leak in the upper opening for filling. Tanks on which there was a leak are:*

1. *33 72 7977 519-7,*
2. *33 72 7993 519-7 and*
3. *33 72 7993 510-6.*

In the course of the afternoon hours, the team from MSK arrived which stopped leaking from the tank 33 72 7977 519-7 by tightening the bolts. On the other tanks, from which there was acetic acid leaking, it was not possible to stop the leak, but it was reduced by tightening."

Based on this, it can be concluded that insufficient tightening when closing the covers of tanks or unforeseen damages to the seals, or damaged leaning surfaces probably contributed to the leakage of considerable amounts of hazardous substances into the environment. Since the covers and their environment in the accident have not suffered a direct hit or even visible damage, leakage could probably have been avoided with adequate tightening when closing the covers of tanks or timely noticing of damaged seals or damaged leaning surface. This is supported by the fact that the fourth overturned tanker did not leak.

"MSK"a.d. Kikinda submitted to CINS (Letter No. 19-60/2018 dated 31.01.2018) detailed description of the procedures for closing the openings for filling in series and the types in which the process of the sealant and the condition of surface, as well as the way of tightening of the bolts on the cover is described. Description of the procedure is not a part of any official bylaw in use at "MSK"a.d. Kikinda, but it is a work material for the training of employees.

4.2.4. Reports on condition of the track

On the part of the regional railway line between the official positions Novi Bečej (km 121+624.00) and Banatsko Miloševo (km 141+291.00) track was built in 1883 with a rail type "I" of length L=9.00 m and in1931 the rails type "C" of length L=12.00 m were installed. Installed rails in the track have been non-standard, the type 35a, 35b, I, C (Fig. 4.2.4.1.), Xa and 8a with the respective non-standard arrangements of connecting and fastening accessories (mounting of rails with rail nails and sleeper screw Fig. 4.2.4.2.). The rails are connected by classic compositions that are floating (Figure 4.2.4.3.).

Sleepers installed on the part of the regional railway line between the official positions Novi Bečej (km 121+624.00) and Banatsko Miloševo (km 141+291.00) are wooden, and according to the list of sleepers from 2017, from embedded 28571 pieces, due to the large amount of rottenness, 6021 pieces are unusable (bad connection rail-sleeper Fig. 4.2.4.4.), which constitutes 21.1% of the total number of the built-in sleepers. At many places there are three or more rotten sleepers in a row ("nests" of rotten sleepers - Figure 4.2.4.5.), which directly affects the stability and geometry of the track. Ballast way is formed from highly polluted crushed stone (over 50% - Figure 4.2.4.6.)

Fig. 4.2.4.1: Non-standard rail type"*C*"

Fig. 4.2.4.2: Fastening of rail with rail nails and sleeper screws

Fig. 4.2.4.3: Floating composition

Fig. 4.2.4.4: Sleeper-rail connection

Fig. 4.2.4.5: Nest of rotten sleepers

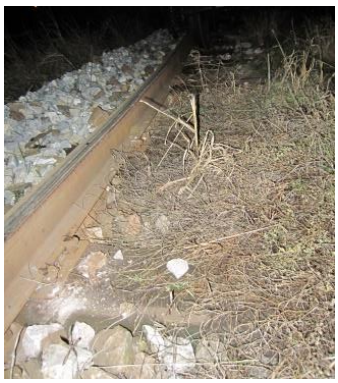


Fig. 4.2.4.6: A ballastway

On the railway line with limited speed of 30 km/h are used locomotives of series 661 with the axle load of 183 kN and a load of 59.5 kN/m, which further influences the rapid collapse of the railway line. Also, based on the letter of "IŽS"a.d. from 28.09.2018 it was established that during 2017 from a total of 644 freight trains, 220 was operating with an overload, which indicates that this practice is not an exception, but the rule. "MSK"a.d. Kikinda via e-mail of 28.09.2018 submitted the information that all of their deliveries in 2017 have had an overload (with a load of 18 t/axle and 5.32 t/m). As a consequence of the aforementioned, the Fig. 4.2.4.7. displays a rail after the respective accident, which appearance has the character of a fracture due to the occurrence of fatigue damages to the rails.

Fig. 4.2.4.7: Review of the fracture of rail at the accident site

Speed allowed by the timetable booklet 5.1. which was valid at the time of occurrence of an accident, between the official positions Kumane (km 112+469.00) and Banatsko Miloševo (km 141+291.00) is V_{max}=30 km/h, and the allowed axle load is 160 kN, and a load of 48.0 kN/m.

By Minutes of the technical inspection of the railway section No. 46 - Pančevo Main Station - Zrenjanin - Banatsko Miloševo from km 16+825.00 to km 141+576,00 from 30.11.2015, the Committee formed based on the decision of Acting Director of "IŽS"a.d. No. 1/2015-2238 from 20.11.2015, has adopted the following conclusions:

" *... In order to maintain the train traffic at a satisfactory level until the necessary overhaul of the sections from km 27+270.00 to km 56+846.00* ***and from km 64+212.00 to km 141+576.00*** *(last overhauled in 1935, and 1964 by non-standard type of track) with the existing speeds and loads weight of 16 t/axle and the overrun of 2 t/axle, it is necessary to do the following:*

1) *procure and install 7500 used wooden sleepers, 30 m^3 of the switch rail structure and 100 pieces of the bridge sleepers for improvement and remediation of the worst parts of rail grid,*
2) *also procure and install used track accessories of non-standard type, as follows: DŽ55-60000 pieces (sleeper screw), DŽ106-2000 pieces (common base plate), DŽ105-2000 pieces (connectives), DŽ53-8000 pieces (connecting track accessories) and DŽ70-8000 (double elastic pad),*
3) *procure kit AT portions for welding of rails Xa - 50 sets,*
4) *Addition with the crushed stone 1000 m^3.*

Upon completion of the work abovementioned in point 1, 2, 3 and 4, ***the Committee sets forth the following conditions for*** *safe operation of traffic with the prescribed and an overshot load in accordance with the Rulebook 325 on the categorization of the railway track, Instruction 99 for the transport of special consignments and Rulebook 20 on the transport of special consignments:*

1. *For each load of special consignment (overload), it is required to notify the authorized Section of infrastructure, OC ZOP Zrenjanin and OC ZOP Pančevo,*
2. *While formation of each train in the departure station carry out check weighting of loaded wagons,*
3. ***For the traction of trains to use the locomotives series 661 (lighted****),*
4. ***Maximum speed of trains V=20 km/h****,*
5. *In all stations on the way of transport necessarily operate through the running track,*
6. *Prohibited pushing the train on the open track,*
7. *Prohibited the sudden starting and stopping of the train,*
8. *During the extremely high and low temperatures in the rail and in the high snow cover (+50℃, –10℃, over 15 cm), OC ZOP Zrenjanin and OC ZOP Pančevo have the right to prohibit the transportation of special consignments with an overload,*
9. *In night traffic intervals not to operate the special consignment with an overload,*
10. *To provide technical persons with an official vehicle or TMD to freely control railway track after the transport of special consignments with an overload.*

The above conditions are of significance for three months, after which the Committee will inspect the new situation on the track and if necessary, determine the further conditions of carrying of special consignments with overload."

The documentation submitted does not contain information on whether the Committee has after three months in early 2016, examined the state of the line and what the conclusion it has made.

4.2.5. Record of track inspection coach

In the letter of the Chief of the Section ZOP Zrenjanin No. 20/2018-2.3.-55/1 of 22.01.2018 the Section of traffic operations, for the regional railway line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia), section Novi Bečej - Banatsko Miloševo states:

"…. given that the Instruction on the technical requirements and maintenance of the superstructure of railway track number: 340-201-2/2016 ("Official Gazette of RS" No.39/16 and 74/16) predicts that on the regional line the track inspection is carried out twice a year, in spring and autumn, on the territory of railways maintained by Section ZOP Zrenjanin in the period from 01.01.2015 until 31.12.2017, measurement with track inspection coach was carried out only once a year and thus, gauge and cross level are measured once a year. Since we received the letters from the Sector of construction works on the faults of track inspection coaches EM 80L late as a Section we were not able, due to weather conditions, priority tasks and labour shortages, to perform the measurement of gauge and cross level of the track."

From the submitted numerical record from measurement of condition of the track with track inspection coach between Kumane and Kikinda in the area of the derailment of train No. 53527 (km 122+250.00) in the summary part of the Report, from km 122+000.00 to km 123+000.00, it can be seen that:

1) at measuring from 27.10.2015 appear errors type “B” in a length of 99 m,
2) at measuring from 12.04.2016 appear errors type “B” in a length of 85 *m* and errors type “*C*“ in a length of 2 *m*, and
3) at measuring from 30.05.2017 appear errors type “B” in a length of 143 *m* and errors type “*C*“ in a length of 26 *m*.

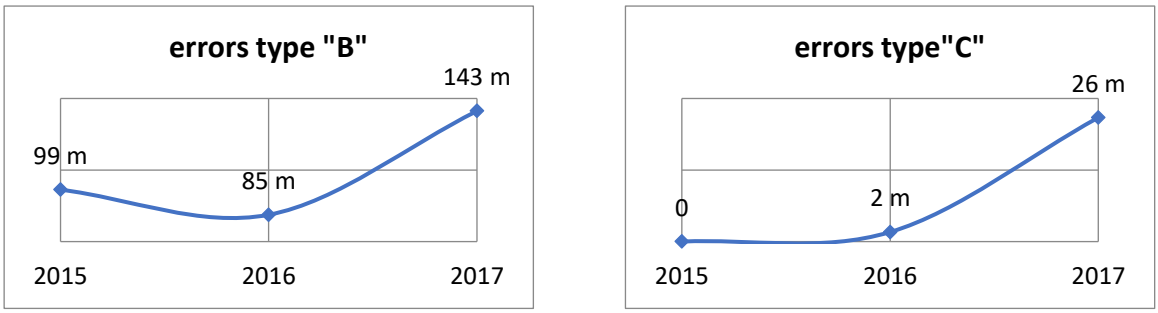


Chart 4.2.5.1: Review of errors type “B” and type “C” with time

On the basis of the applicable Instruction on common criteria for control of the condition of railways track on the network JŽ, Instruction 339 (*“Official Gazette of ZJŽ” No.2/2001 and 4/2004*), according to the record of measuring with track inspection coach, track in the derailment area was not in in satisfactory condition in April 2016, as well as in May 2017.

It is unacceptable that the condition of the track defined by Instruction 339 as “unsatisfactory” and errors are over the exploitation boundaries of endangering traffic safety, are tolerated, i.e. eliminated by reducing the speed limit.

Regarding the respective accident, regular and corrective track maintenance was not carried out with applicable regulations.

In Fig. 4.2.5.1, 4.2.5.2. и 4.2.5.3. excerpts of graphic record are shown in the critical zone of the track in October 2015, April 2016 and May 2017, and Fig. 4.2.5.4. and 4.2.5.5. excerpts of numerical records of the track inspection coaches in the critical zone of the track from April 2016 and May 2017.

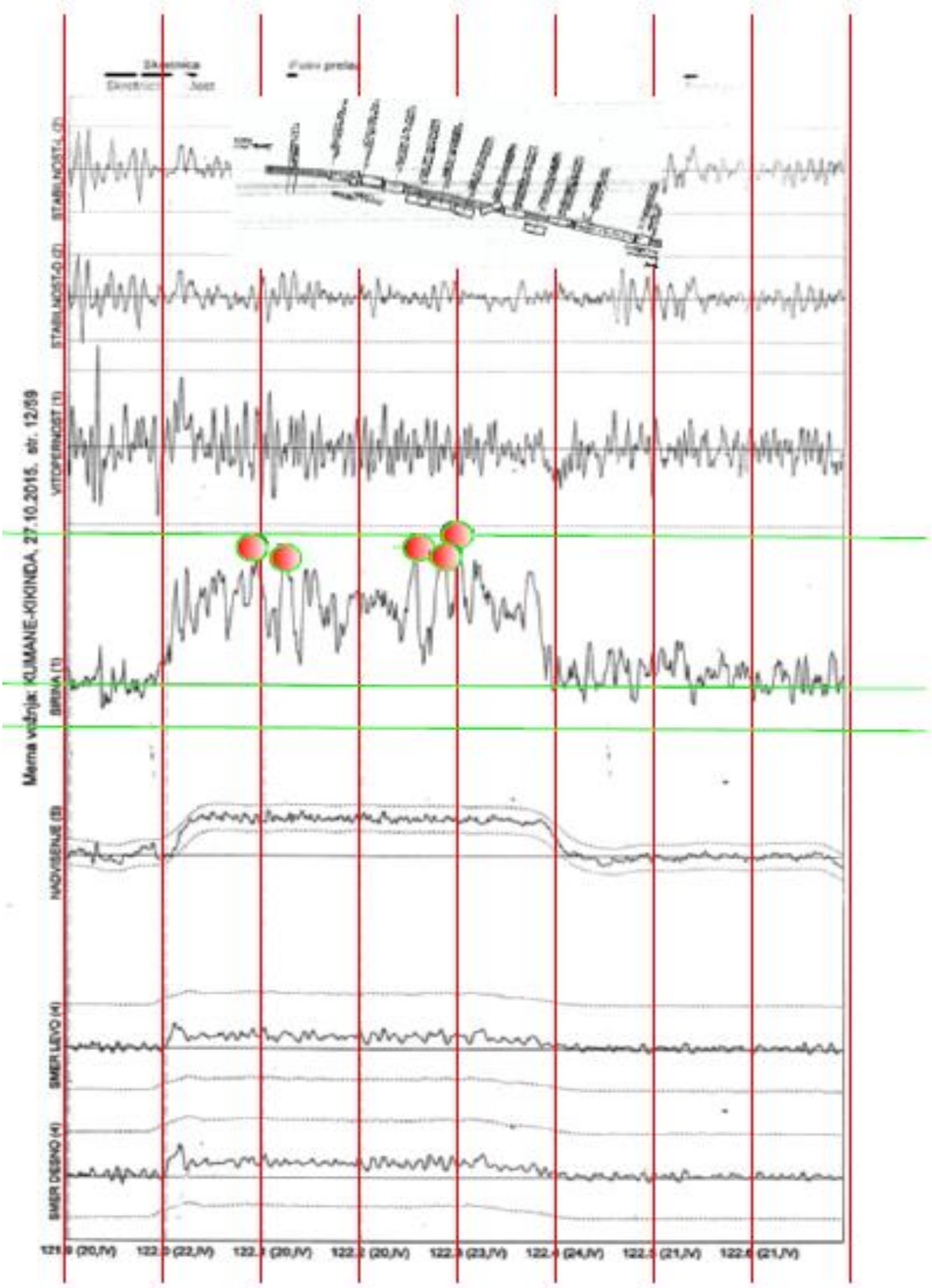


Fig. 4.2.5.1: Graphic record of track inspection coach from 27.10.2015

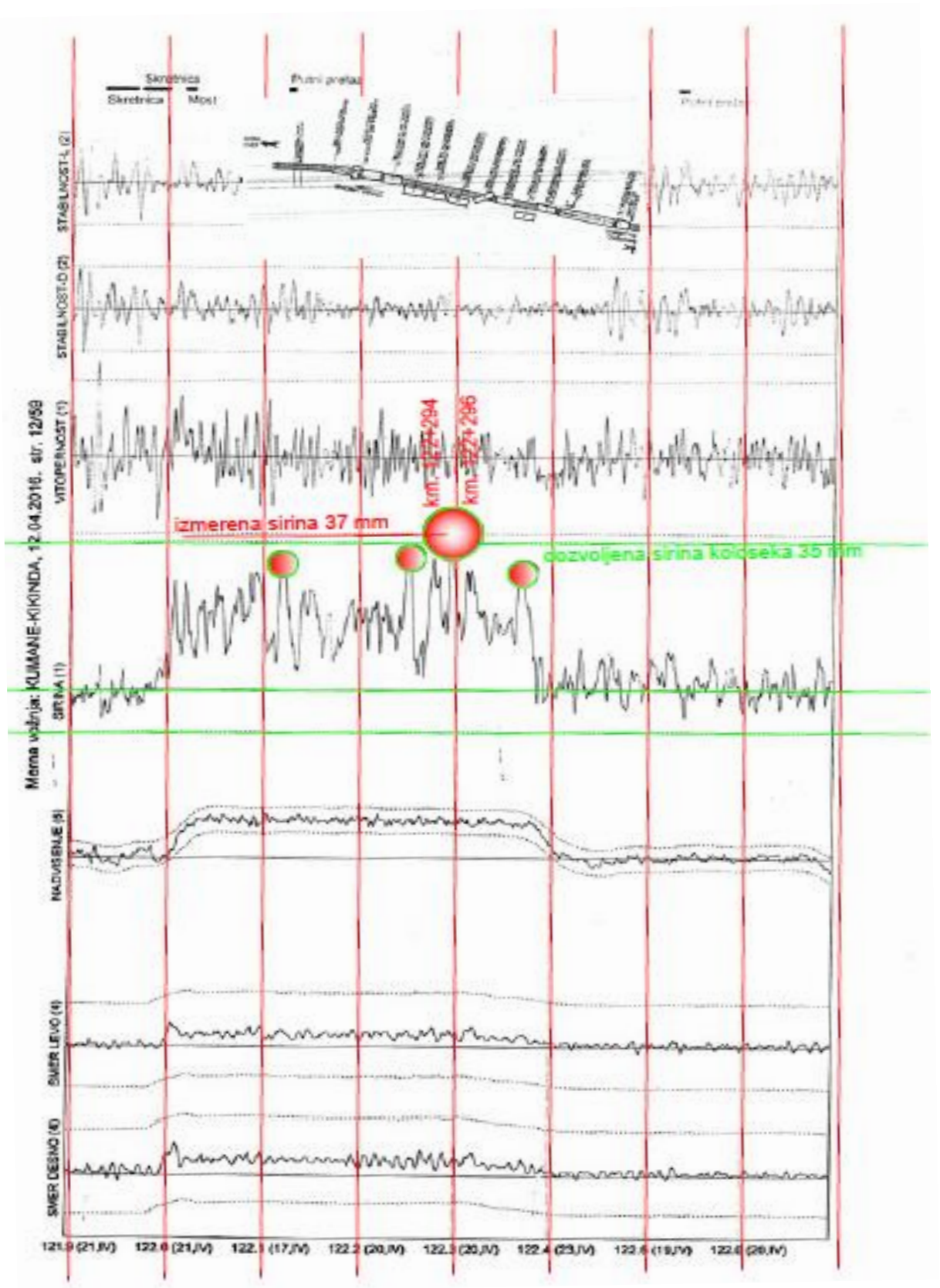


Fig. 4.2.5.2: Graphic record of the track inspection coach from 12.04.2016

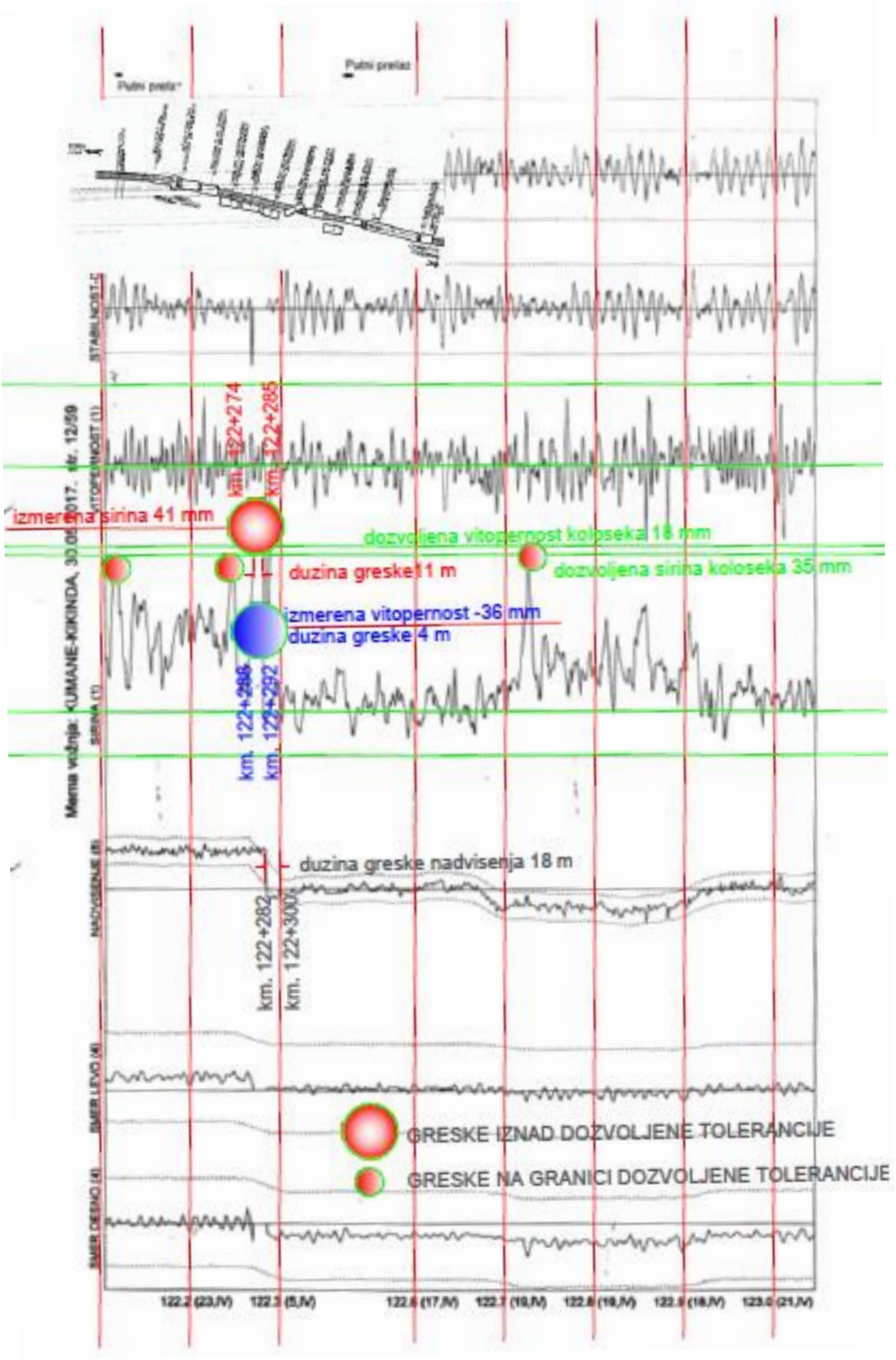


Fig. 4.2.5.3: Graphic record of track inspection from 30.05.2017

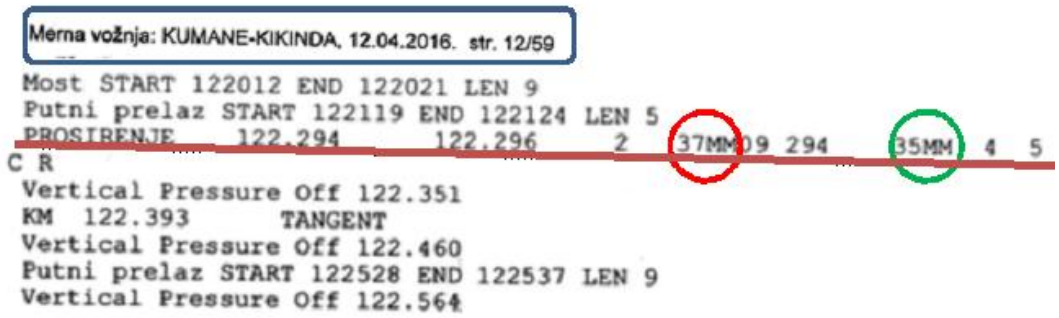


Fig. 4.2.5.4: Numerical record of track inspection coach from 12.04.2016

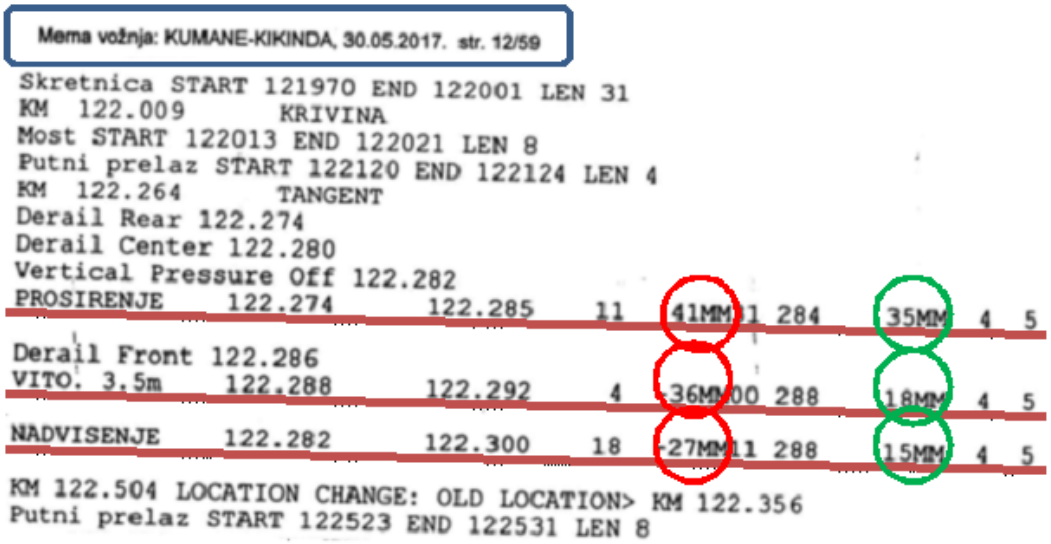


Fig. 4.2.5.5: Numerical record of track inspection from 30.05.2017

In the letter K-40 from 31.05.2017 of Section ZOP Zrenjanin addressed to Chief of track section Banatsko Miloševo, after the conducted analyses of track inspection from 30.05.2017, it is stated:

„ … it is required that the Head of track section on their section IMMEDIATELY starts with eliminating of errors of TWIST that directly affect the road safety…"

In the Report No. 10/17 from 06.06.2017, of the track section Banatsko Miloševo, on the measures undertaken on irregluarities noticed when measuring with track inspection coaches on 30.05.2017, it is visible that the noticed erros in the zone of derailment are partly eliminated (twist has been, but track gauge widening and cross level have not).

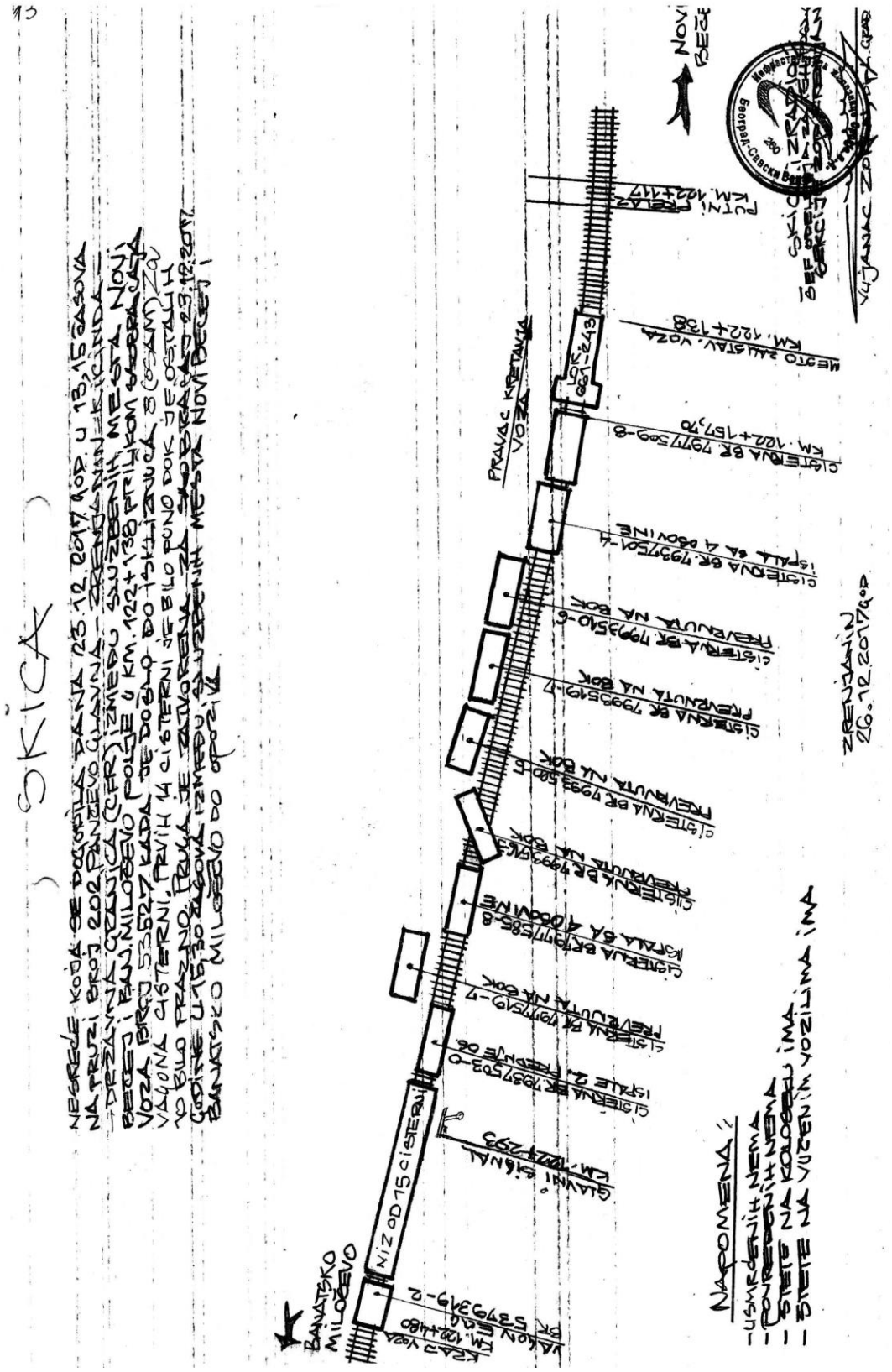


Fig. 4.2.5.6: The sketch of the accident (Souce: "IŽS"a.d.)

Note: Figure 4.2.5.6. states: "… remaining 10 were empty.", and the correct is: "… 9 Za wagons and 1 Ea wagon were empty."

4.2.6. The condition of sleepers and fastening accessories

Falling of wheel in track can take place due to movement of the wheels on the axle (looseness of interference fit) in the direction of reducing the internal distances of wheels, or due to the spacing of rails.

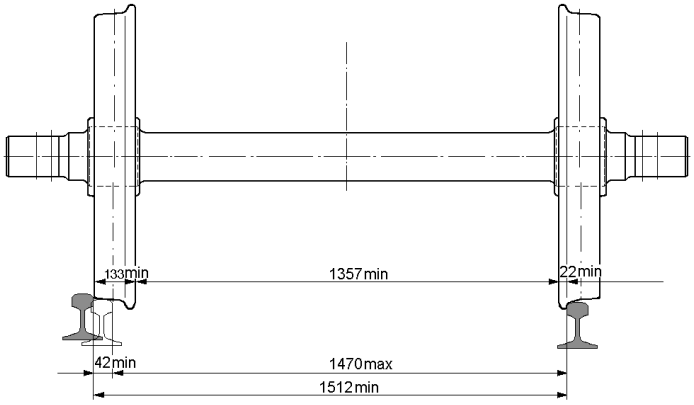


Fig. 4.2.6.1: Condition for falling the wheel into the track

Fig. 4.2.6.1. illustrates needed ratio of track dimension and wheel set to lead to falling of the wheel into the track when the authoritative dimensions are in the permitted limits. It can be seen that it is necessary that the rails due to a loose or missing fastening accessories or rottenness of sleepers, are parted by at least 42 mm over the permitted limit of 1435 + 35 mm. Since the record of track inspection coach shows that in more places there is extension of track greater than the exploitation level of +35 mm, in such places the fall of wheel in the track is possible and at a lower additional spacing of the rails.

Reviewing the condition of sleepers and fastening accessories was noted that in the wider area around the point of fall of wheel into the track, the track in a state of disrepair due to a loose or missing fastening accessories, fastening plates that are shifted and cracked or rotted sleepers. Bearing in mind that the railroad was built in the period from 1883 to 1889, but it was repaired from 1961 to 1964 (from km 57+108.00 to km 113+500.00) and since 2004 until 2005 (from km 57+108.00 to km 64+212.00), with new and used material sleepers are over 57 years old.

The condition of sleepers and fastening accessories in the zone of fall of wheel into the track is illustrated in Fig.: 4.2.6.2, 4.2.6.3, 4.2.6.4. and 4.2.6.5.

Fig. 4.2.6.2: Local rot under the support of rail and longitudinal crack of the sleeper

Fig. 4.2.6.3: Rail sleeper connection with a supporting plate, fastening with sleeper screws

Fig. 4.2.6.4: Rail sleeper connection with the supporting plate, fastening with track nails

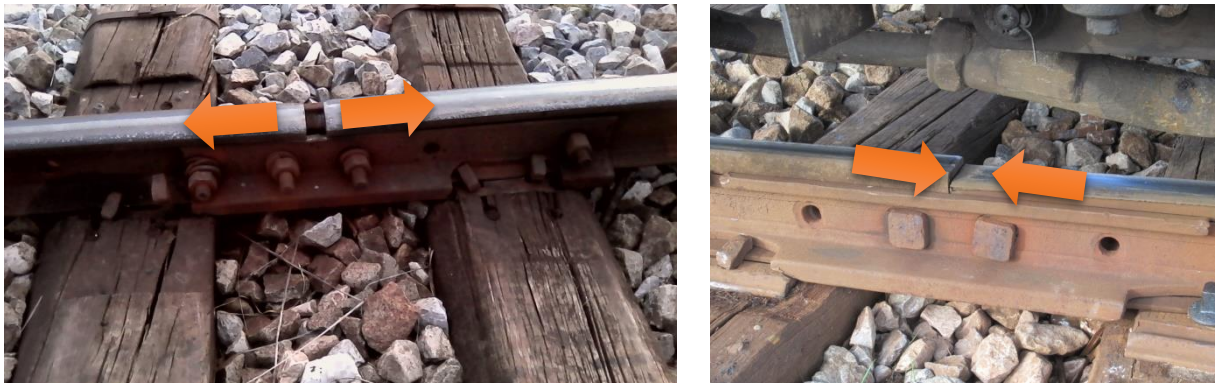


Fig. 4.2.6.5: Connection rail - floating composition

The shown state is not in line with the requirements of the applicable 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)*, see the point 3.3.4.

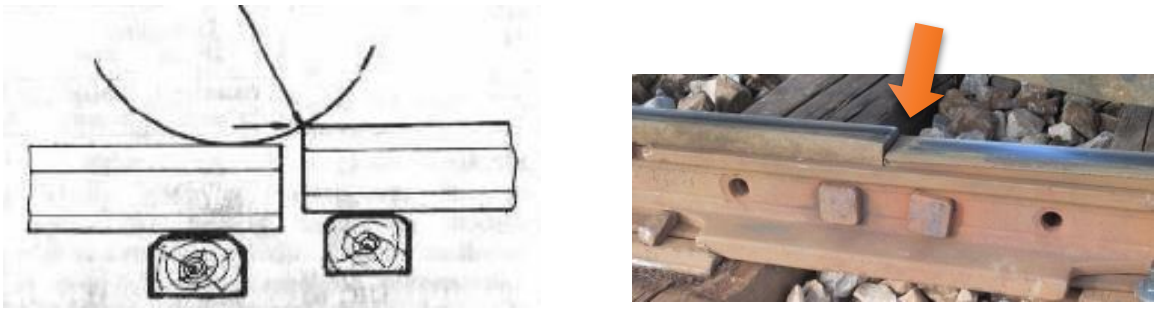


Fig. 4.2.6.6: The influence of the wheel on the rail composition

Due to the operation of the horizontal longitudinal forces especially when braking or starting of the train, as well as the temperature changes, when there is reduced friction between the fastening accessories and the rails and between the rail leg and its substrate, there happens a longitudinal movement of the track ("travel of rail"). The connection of rail composition on many places is achieved with a smaller number of connecting bolts (Figure 4.2.6.6.).

All of this leads to uneven movement of the rail compositions (Fig. 4.2.6.5.), which is in contrast with 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*), article 4 and article 77.

4.3. Conclusions

4.3.1. Direct cause of the accident

The direct cause of the accident was the unsatisfactory condition of the railway track on the section where the accident occurred. The direct cause is the missing and loose fastening and connecting accessories, rotted and cracked series of sleepers, combined with the track gauge widening (41 mm), cross level (- 27 mm) and twist (36 mm) of the track in the zone of derailment, which is over the maximum exploitation limit.

4.3.2. Basic causes deriving from skills, procedures and maintenance

Maintenance of the track on the observed section is below the technically accepted minimum.

4.3.3. Causes deriving from legal framework and safety management system

The main cause is the long-standing practice of using the railway track with trains with an overload, i.e. with loads that exceed the designed load of track in daily use, combined with the maintenance of the track below the technical minimum.

By Instruction on unique criteria for control of the condition of tracks on the network JŽ, Instruction 339 (*"Official Gazette of ZJŽ" No.2/2001 and 4/2004*) it was introduced that in the case of "unsatisfactory" status of track (errors in the geometry of the track above the limits of exploitation "C") as an alternative measure of "speed reduction", which in previous editions of Instruction 339 (in 1989) did not exist. Also, the passage has been deleted from the previous issue of Instruction 339 of 1989 which stipulated that prior to reaching the limits of exploitation take measures to prevent their overdraft. Applicable Rulebook on technical conditions and maintenance of the superstructure of railways No. 340-201-2/2016 (*"Official Gazette of RS" No.39/16 and 74/16*) as well as Instruction 339 do not define explicitly and clearly exploitation boundaries for state of sleepers and fastening systems in which, due to security risks immediate corrective measures must be taken or closing the railway transport.

4.3.4. Additional observations on deficiencies and shortcomings established during the investigation, but without relevance for conclusions about the causes

From the submitted reports of "MSK"a.d. Kikinda it can be seen that leakage of the acetic acid is resulting from three overturned tanks, while at the fourth overturned tank there was no leak. Also, after the accident, by tightening of the bolts on the cover on one tank, stopped the leakage. This is an indication that the covers on some of the tanks were probably not sufficiently tightened or seals or sealing surfaces were not in good condition, which could contribute to leakage of hazardous cargo from wagon-tanks and potential threats to the environment.

"MSK"a.d. Kikinda in its guidelines does not prescribe the procedure for closing the opening for filling on the tanks, but the procedure is only the part of the program for the training of workers.

5. Measures taken

After the formation of the respective accident, Section ZOP Zrenjanin acceded to the determination of the damages occurred and developing a plan to organize work on the repair of the damage the tracks. Works on the remediation of the railway began on 23.12.2017 and lasted until 29.12.2017 until 14:30, when the railway was opened to traffic of trains with a speed limit of 30 km/h according to the timetable booklet 5.1.

Within the course of works dismantling of the damaged track with the removal of it was carried out, laying of the new track in classical composition with used rails of non-standard type "C" on the new wooden sleepers with non-standard new and used rail accessories, unloading of crushed stone with manual planning of ballast and manual and machine regulation of the track according to the direction and level. While the works were carried out, 186 wooden sleepers were replaced, 204.00 m of the rails, 1300.00 kg of track accessories and 52.00 m^3 of crushed stone.

After the occurrence of the respective accident employees of "MSK"a.d. Kikinda organized and joined the transfusion of acetic acid from derailed and overturned wagon-tanks in road vehicles-tanks. The damaged wagons were sent with the repair company to remediate the damage and repair.

6. Safety recommendations

Aiming to achieve the possible improvement of railway safety and to prevent occurrence of new accidents, CINS issued the following safety recommendations:

To the Railway Directorate:

SR_27/18 Railway Directorate that in short deadline defines in the applicable Rulebook on technical conditions and maintenance of the superstructure of the railway tracks (*"Official Gazette of RS" No.39/16 and 74/16*) the boundary conditions of elements of superstructure of the track, which require urgent elimination or closing the track for traffic until removal of unsatisfactory state.

"IŽS"a.d:

SR_28/18 "IŽS"a.d. to conduct amendments to the Instruction on unique criteria for control of the condition of railway tracks on the network JŽ, Instruction 339 (*"Official Gazette of RS", No.2/2001 and 4/2004*), which is by the decision of the "IŽS"a.d. No. 4/2015-51-17 from 29.12.2015 is still applicable in "IŽS"a.d., pursuant to the provisions of Instruction 339 of 1989 which are listed in clause 3.3.5. For future track inspection coaches the parameters are recommended in accordance with standards: *SRPS EN 13848-1, SRPS EN 13848-2, SRPS EN 13848-6*.

SR_29/18 "IŽS"a.d. that, due to inadequate maintenance and condition of the track, sleepers and fastening systems, conducts an assessment of risk of train traffic on the regional railway line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia) and take measures to reduce risk to an acceptable level. Based on this, to conduct a technical assessment of the minimum required resources (material, machinery, work force) for track maintenance.

SR_30/18 "IŽS"a.d. to review the procedures and criteria for the approval of the traffic of trains with an overload and that this process is confined to the extreme and rare individual occasions, and not as a daily practice.

Ministry of Construction, Transport and Infrastructure:

SR_31/18 Ministry of Construction, Transport and Infrastructure, Sector for Inspection, Group for Railway Inspection to carry out extraordinary check of railway infrastructure on the regional line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia) and take measures within their jurisdiction.

"MSK"a.d. Kikinda:

SR_32/18 "MSK"a.d. Kikinda to additionally pay attention to the procedure of closing the openings for filling the wagon-tanks for acetic acid and to conduct additional training of the staff.

SR_33/18 "MSK"a.d. Kikinda to define the procedure for closing the opening for filling the wagon-tanks by bringing the instruction and therein to prescribe the moment of tightening of bolts on the covers of openings for filling.