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

No: ŽS - 01/24

No: 340-00-2/2024-02-1-70

Date: 22.07.2025.

FINAL REPORT ON ACCIDENT INVESTIGATION

Accident type:	Train collision
Train Nos:	7112 and 52601
Location:	Belgrade, Vračar tunnel, between the station Vukov Spomenik and Pančevački Most junction and halt.
Date:	17.05.2024.
Time:	18:24

This Report presents the results of investigation of a accident, collision of the consecutive trains No. 7112 and 52601, which occured on 17.05.2024. at 18:24 on the main arterial route No. 107 Belgrade Centre - Pančevo glavna - Vršac - state border - (Stamora Moravita) between the station Vukov Spomenik and junction and halt Pančevački Most.

The Working Group for investigation of this accident was formed by the Director of the Center for Investigation of Accidents in Transport of RS, by Decision No. 340-00-2/2024-02-1-15 of 24.05.2024. and by Decision No. 340-00-2/2024-02-1-62 of 07.05.2025.

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

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

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

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

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

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

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

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

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

Professional activities related to safety investigations are independent of judicial inquiry or any other parallel investigations which objective is to determine responsibility or the degree of guilt. The investigation and discovery of the causes of accidents is not intended to determine criminal, economic crime, misdemeanour, disciplinary, civil or any other liability.

Glossary:

CINS	Center for Investigation of Accidents in Transport
RS	Republic of Serbia
IŽS	Infrastructure Railways of Serbia
ZJŽ	Community of Yugoslav Railways
ŽS	Railways of Serbia
SP	Traffic affairs
ETP	Electrotechnical affairs
SKP	Traffic commercial affairs
OJ	Organizational unit
SS	Safety signalling
TT	Telegraph-telephone/Telephone-telegraph
APB	Automatic track block
RDV	Radio dispatch leading
EMV	Electro motor train
ECM (eng.)	Entity in Charge of Maintenance
a.d.	Joint stock company
d.o.o.	Ltd.
OJT	Basic Public Prosecutor
MUP	Ministry of Interior
PU	Police Directorate
PI	Police Unit
TKP	Technical and wagon affairs
JŽ	Yugoslav Railways
MMI	Man Machine Interface
ZOP	For track maintenance
SFRJ	Socialist Federal Republic of Yugoslavia
BROS	Axle counter

C O N T E N T :

1. Summary

1.1. Short description of the accident

On 17.05.2024. at 18:24 at km 4+392 of the main arterial route No 107 Beograd Centar - Pančevo Glavna - Vršac - state border - (Stamora Moravita) between the station Vukov Spomenik and Pančevački Most junction and halt (in the area of the city of Belgrade, on the part of the line situated in the tunnel under the inner city centre), on the right track of the double-track line, there occurred overtaking and collision of the trains No 7112 (EMV 412/416-005/032, railway undertaking "Srbijavoz"a.d.) and 52601 (locomotive 193-912 and 28 (twenty-eight) empty wagons of E series, railway undertaking "Srbija Kargo"a.d.).

The collision occurred when the front of the train No 7112 (the front part of the motor coach 412-005), which was moving from the station Vukov Spomenik towards the Pančevački Most halt, after passing the protective signal Su92, hit the end of the train No 52601 (the last wagon No 31 72 5959 453-7), which was standing in the area of the Pančevački most halt, in front of the protective signal To2. After the collision, the trains continued to move for approximately 10 m and then stopped. On that occasion, the motor coach 412-005 of EMV 412/416-005/032 of train No 7112 derailed with both bogies, while the last wagon No 31 72 5959 453-7 of train No 52601 derailed with one bogie.

In this accident there were no fatally injured. The total number of injured is seven (passengers and railway workers of "Srbijavoz"a.d. and "Srbija Kargo"a.d. who were on the trains Nos 7112 and 52601), out of which two persons were seriously injured and five persons were slightly injured.

There is material damage on the infrastructure and railway vehicles.

1.2. Accident causes determined by investigation

The direct cause of the accident is that two trains were at the same time on an one block section, where one train was standing still (train No 52601), while the other train was moving (train No 7112), which is contrary to the provision of paragraph 3 of Article 122 of the Traffic Rulebook ("Official Gazette of the RS" No. 34/22 and 107/22).

The train driver of the train No 7112 passed the protective signal Su92 which was showing aspect of a signal 4: "Stop", which is contrary to the provision of paragraph 2 of Artricle 15 of the Rulebook on types of signals, signal markings and line markings ("Official Gazette of the RS" No 51/20 and 29/25).

Since the train driver of the train No. 7112 did not have an order to pass the protective signal Su92 prohibiting further travel, issued by General Order I or by phonogram from the person regulating traffic (train dispatcher), he was obliged to stop the train, in accordance with the provisions of paragraph 2 of Article 15 of the Rulebook on types of signals, signal markings and line markings ("Official Gazette of the RS", No. 51/20 and 29/25). If he had stopped in front of the protective signal showing a signal for prohibited travel, the train driver would have had the option to request notification from the train dispatcher of the next station (Pančevački Most junction and halt) by telephone after three minutes at the respective signal, in accordance with the

provisions of paragraph 8 of Article 228 of the Traffic Rulebook ("Official Gazette of the RS", No. 34/22 and 107/22), which he had not done.

The reasons for this action of the train driver may be contained in his short professional experience and the fact that he received the order via General Order I on permitted running past the automatic block signal T12 which prohibited further running and is located at the inter-station distance Pančevački Most - Krnjača, not at the Pančevački Most junction, but at the Vukov Spomenik station (see points 3.3.3, 3.3.4, 3.5.1, 4.2.7.1, 4.2.7.4. and 4.2.8.3.4.).

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

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

To the Directorate for Railways:

BP_08/25 "IŽS"a.d. should amend the Buisness order of the Vukov Spomenik station, part I, document No. 31/18-I-2252 of 28.12.2018 and the Instructions on the organization and operation of the operational service on parts of railway lines between the Beograd Centar, Pančevo Glavna, Rakovica and Topčider stations, No. 4/2019-1250/1-291 of 14.01.2019 of "IŽS"a.d. in order to harmonize its provisions with the applicable regulations and real situation on site (see points 3.3.6, 3.3.7 and 4.3.4).

BP_09/25 "IŽS"a.d. should take measures to ensure that train dispatchers working on the MMI device log in to the device with their own user account (name and password) at the beginning of the shift, and log out of their account on the device at the end of the shift (see points 3.4.1.4. and 4.3.4.).

BP_10/25 "IŽS"a.d. should analyze the reasons for the occurrence of disturbances with longer duration on SS devices. After assessing the safety risks that have arisen as a result, they should take measures to eliminate safety deficiencies (procurement of necessary resources, spare parts, mechanization, workforce), and in accordance with the requirements of Article 5 of the Law on Railway Traffic Safety ("Official Gazette of the RS" No. 41/2018) (see points 3.4.1.2. and 4.3.4.).

BP_11/25 "Srbijavoz"a.d. should carry out professional training for train drivers in accordance with the provisions of paragraph 2 of Article 15 of the Rulebook on types of signals, signal markings and line markings ("Official Gazette of the RS", No. 51/20 and 29/25) and paragraph 8 of Article 228 of the Traffic Rulebook ("Official Gazette of the RS", No. 34/22 and 107/22) (see points 4.2.7.4. and 4.3.2.).

2. Direct facts on the accident

2.1. Accident basic data

2.1.1. Date, time and location of the accident

The accident occurred on 17.05.2024 at 18:24 in the area of the City of Belgrade, at *km* 4+392, on the right track of the main arterial route No 107 Beograd Centar - Pančevo Glavna - Vršac - state border - (*Stamora Moravita*) between the station Vukov Spomenik and junction and halt Pančevački Most, on the part of the railway line situated in the tunnel under the inner city centre.

The appearance of the accident in shown in the Figure No 2.1.1.1.

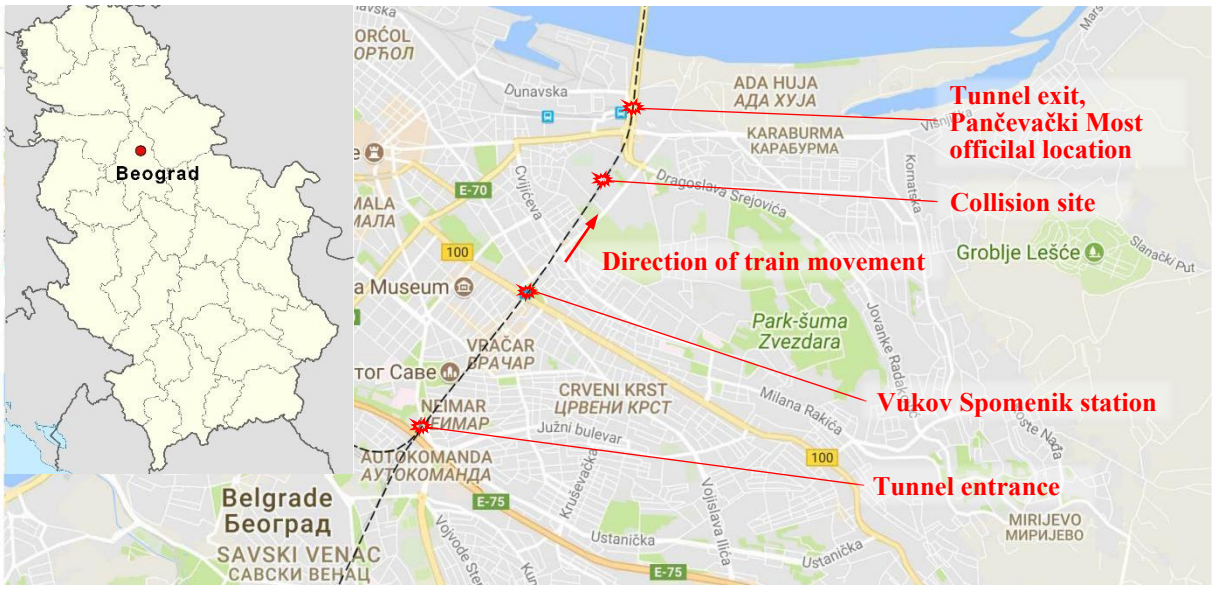


Figure 2.1.1.1: Map of the area of the acident site (Google maps)

2.1.2. Accident description and location and the work of emergency and rescue services

On the main arterial route No 107 Beograd Centar - Pančevo Glavna - Vršac - state border - (Stamora Moravita) between the station Vukov Spomenik and Pančevački Most junction and halt, on the right track of the double-track line, at km 4+392 occurred overtaking and collision of the consecutive trains No 7112 (EMV 412/416-005/032, railway undertaking "Srbijavoz"a.d.), which was moving, and 52601 (locomotive 193-912 and 28 (twenty-eight) empty wagons of the *E* series), railway undertaking "Srbija Kargo"a.d.), which was standing still. The collision occurred when the front of the train No 7112 (front part of the motor coach 412-005), which was moving, hit the end of the train No 52601 (the last wagon No 31 72 5959 453-7), which was standing in front of the protective signal *To 2* of the location Pančevački Most.

Upon impact, due to the kinetic energy of the train No 7112 in motion, the train No 52610 was displaces. After the impact, the trains continued to move for approximately 10 m and then

stopped. On that occasion, the motor coach 412-005 of EMV 412/416-005/032 of the train No 7112 derailed with both bogies, while the last wagon No. 31 72 5959 453-7 of the train No 52601 derailed with one bogie (the second bogie in the direction of travel).

There were no fatalities in this accidents. A total of seven individuals (passengers and railway workers of "Srbijavoz"a.d. and "Srbija Kargo"a.d. who were on the trains No 7112 и 52601) were injured, of which two were seriously and five slightly injured.

At the scene, to provide assistance to the injured, personnel from the Belgrade Institute for Emergency Medicine (emergency medical service), members of the RS Ministry of Interior, the Emergency Situations Sector, the Belgrade Emergency Situations Administration, the Zvezdara, Voždovac and Borča Fire and Rescue Units, as well as members of the RS Ministry of Interior, the PU Belgrade, were deployed.

There is material damage on the infrastructure and railway vehicles.

The mitigation of the consequences of this accident was carried out by engaging the expertise and resources of "IŽS"a.d, "Srbijavoz"a.d. and "Srbija Kargo"a.d.

Due to this accident, there was a disruption in railway traffic between the station Vukov Spomenik and Pančevački Most junction and halt on both tracks of the double-track railway line. The traffic on the left track was disrupted until 18.05.2024. at 01:17. After removing the damaged vehicles from tracks and repairing the damaged infrastructure, the traffic was also re-established on the right track on 20.05.2024. at 14:10.

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

The Main Investigator in Railway Traffic received the initial notification aobout the accident on 17.05.2024 at 19:21 via phone from the main wagon dispatcher of "Srbija Kargo"a.d, and then at 19:28 via phone from the Head of Central Operations Department of "IŽS"a.d. and at 20:44 via phone by the Dispatcher of the Central Operations Department of „Srbijavoz"a.d. Based on the received information and facts established by the investigation team of CINS at the scene of the accident, CINS initiated an investigation of the accident in accordance with Law on Investigation of Accidents in Air, Railway, and Maritime Traffic ("Official Gazette of RS" Nos. 66/15 and 83/18).

The composition of the Working Group for the investigation of the accident was determined by the Decision No 340-00-2/2024-02-1-15 of 24.05.2024 and Decision No 340-00-2/2024-02-1-62 of 07.05.2025 of the Director of the CINS on the basis of articles 6 and 32 of the Law on the Investigation of Accidents in the Air and Railway Traffic ("Official Gazette of the RS" Nos. 66/15 and 83/18).

2.2. Accident background

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

In the accident was involved a train driver of the train No 7112, employed by the railway undertaking "Srbijavoz"a.d, Traction Sector Beograd, Traction Section Beograd, conductor on the train No 7112, employed by the railway undertaking "Srbijavoz"a.d, SKP Sector Beograd, SKP Section Beograd and train driver of the train No 52601 (locomotive 193-912), employed by the railway undertaking "Srbija Kargo"a.d, Traction Sector and TKP Beograd, Traction Section and TKP Beograd, OJ for traction and TKP Beograd, dispatcher of the station Vukov Spomenik, employed by the infrastructure manager "IŽS"a.d, SP Sector, SP Section Beograd, station Zemun, and dispatcher of the junction and halt Pančevački Most, employed by the infrastructure manager "IŽS"a.d, SP Sector, SP Section Beograd, station Vukov Spomenik.

Other staff, contractors, other individuals and witnesses were not involved in the accident.

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

2.2.2.1. The train No. 7112

The train No. 7112 of the railway undertaking "Srbijavoz"a.d, is a train from the "BG train" system. During the accident, it operated in the composition of the EMV 412/416-005/032.

According to the working timetable 0.1 BG:VOZ, train No. 7112 regularly operates on the route Lazarevac - Ovča, with departure from the station Lazarevac at 17:05. Exceptionally, due to a malfunction EMV 412/416-083/084 that should have operated as train No 7112, on 17.05.2024. the train No. 7112 was cancelled on the part of the route between the station Lazarevac and Karađorđev Park halt. At 18:15 from the station Beograd Centar a reserve EMV 412/416-005/032 departured on the route of the train No. 38039 and arrived to the halt Karađorđev Park. After that, at 18:18 (according to the Working Timetable 0.1 BG:VOZ), it continued the journey as train No. 7112.

The EMV series 412/416 were manufactured for operation at the railway lines with normal track gauge of 1435 *mm*, with electrified single-phase system of voltage 25*kV*, 50 *Hz*. The trains were manufactured in the Union of Soviet Socialist Republic in the city of Riga, today's Republic of Latvia, in the factory Riški vagonski zavod. For the needs of the former JŽ, this factory delivered several rakes of coaches of this train starting from 1980.

The appearance of the EMV series 412/416 is shown in Figure 2.2.2.1.1.

Figure 2.2.2.1.1: The appearance of EMV series 412/416

One rake of coaches consists of two equal double-part sections. A section is composed of a motor coach and trailer.

Basic technical data on the EMV series 412/416:

Basic composition of the train	M-P-P-M
Axle arrangement	*Bo'-Bo' + 2'-2' + 2'-2' + Bo'-Bo'*
Weight of the train basic composition	217,2±6,5 *t*
Total length over buffers	102160 *mm*
Height of the motor coach from GIŠ*)	*3893 mm*
Height of the motor coach from GIŠ*)	4650 *mm* (to the upper point of the low pantograph)
Body width at end points	2810 *mm*
Maximum constant speed	120 *km/h*

*)GIŠ = upper rail edge

According to the data obtained from "Srbijavoz"a.d. (submitted by letter 1/2024-890 of 11.07.2024), EMV series 412/416, which operated in the composition of the train No. 7112 from the Karađorđev Park halt to the location of the accident, viewed from the front of the train, consisted of motor coach No. 412-005 (year of construction 1980, in the exploitation since 03.02.1981, have an authorisation for placing in public railway service 02. No. 146-9/81 of 03.02.1981), trailer 416-013 (year of construction 1982, in the exploitation since 21.05.1982, has an authorisation for placing in public railway service 02. No. 634-25/82 of 21.05.1982), trailer 416-095 (year of construction 1989, in the exploitation since 04.09.1989, has an authorisation for placing in public railway service No. 02. 2751/89-38 of 04.09.1989) and motor coach 412-032 (year of construction 1983, in the exploitation since 24.11.1983, have an authorisation for placing in public railway service No. 02. 1040-81/83 of 24.11.1983).

EMV series 412/416 has been in operation with the above mentioned composition since 17.07.2006 (after a regular repair carried out in AD "Šinvoz" Zrenjanin). The last regular repair (overhaul and modernisation) of this EMV was carried out in 2019. After having been place in service after the regular repair (telegram No. 20 of 03.06.2019 "Srbija Voz"a.d, Sector for train traction), EMV has travelled 340940 S.

The motor coach 412-005 has been registered in the National Vehicle Register as vehicle No. 94 72 4412 005-3 and motor coach 412-032 has been registered in the National Vehicle Register as vehicle No 94 72 4412 032-7. According to the registrations in the National Vehicle Register, the owner, keeper and entity in charge of maintenance (ECM) of these motor coaches is "Srbija Voz"a.d. The data on the registration of the trailers 416-013 and 416-095 in the National Vehicle Register has not been submitted.

2.2.2.2. The train No. 52601

The train No. 52601 of the railway undertaking "Srbija Kargo"a.d. operated on the route Vreoci - Vršac. The train consisted of a locomotive 193-192 and 28 (twenty-eight) empty wagons of E series (letter designations Eas, Eas-z, Eanoss and Eanoss-z), of a total length of 424 m (116 axle) and a total gross weight of 711 t.

According to the data obtained from the railway undertaking "Srbija Kargo"a.d. (data sent via e-mail of 21.05.2024, e-mail of 04.07.2024 and e-mail of 17.07.2024), the locomotive 193-912 of a unique number 91 80 6193 912-3, was manufactured on 18.10.2019. The owner and entity in charge of maintenance (ECM) is "Srbija Kargo"a.d. For the locomotive 193-912 , "Srbija Kargo"a.d. has an authorisation for placing in service (EIN) No. RS5120200002 issued on 10.02.2020 by the Directorate for Railways. Since its placing in service, the locomotive 193-912 has travelled in total 392722 km.

The locomotive of series 193-912 is a four-axle multi-system electric locomotive "Vectron" X4-E-LOK-AB, variant A26, manufactured by „Siemens" Mobility GmbH, Austria, made for operation on railway lines with standard gauge of 1435 mm, intended for traction of all types of trains on all categories of railway lines. There is a driver's cab on both ends of the locomotive.

The appearance of locomotive 193-912 is shown in the Figure 2.2.2.2.1.

Figure 2.2.2.2.1: Appearance of the locomotive 193

Basic technical data on the locomotive 193:

Total length over buffers	18980 mm
Max height above upper rail edge	3860 mm (above driver's cabs) 4276 mm (at the pantograph)
Manufacture date	2019
Own mass	89 t
Axle arrangement	Bo' - Bo'
Max allowed speed	160 km/h

The wagons with the letter designations Eas, Eas-z, Eanoss and Eanoss-z are four-axle flat wagons, intended for transport bulk freight such as coal, ore, stone, sand and parcels. They can be used in domestic or international railway transport on track gauge of 1435 mm.

The appearance of the wagon with the letter designation Eas-z is shown in Figure 2.2.2.2.2.

Figure 2.2.2.2.2: The appearance of the wagon with the letter designation Eas-z

The table 2.2.2.2.1. shows an overview of the wagons that formed the composition of the train No. 52601.

Table 2.2.2.2.1: Overview of the wagons in the train No. 52601 (viewed from locomotive 193-912)

Wagon No.	Letter designation of the wagon series	Individual wagon No.	Owner	Keeper	*ECM*
1	*Eas-z*	31 72 5959 509-6	*SLOV-VAGON a.s.*	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
2	*Eas-z*	31 72 5952 907-9	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
3	*Eas-z*	31 72 5957 881-1	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
4	*Eas-z*	31 72 5963 191-7	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
5	*Eas-z*	31 72 5959 588-0	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
6	*Eas-z*	31 72 5959 439-6	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
7	*Eanoss*	31 72 5379 152-7	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
8	*Eas-z*	31 72 5958 816-6	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
9	*Eanoss-z*	31 72 5379 202-0	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
10	*Eas-z*	31 72 5959 568-2	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
11	*Eas-z*	31 72 5952 362-7	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
12	*Eas-z*	31 72 5959 013-9	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
13	*Eas-z*	31 72 5959 575-7	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
14	*Eas-z*	31 72 5957 944-7	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
15	*Eas-z*	31 72 5965 712-8	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
16	*Eanoss*	31 72 5379 602-1	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
17	*Eanoss*	31 72 5379 635-1	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
18	*Eas-z*	31 72 5957 939-7	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
19	*Eanoss*	31 72 5379 614-6	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
20	*Eanoss*	31 72 5379 495-0	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
21	*Eas-z*	31 72 5957 930-6	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
22	*Eas*	31 72 5967 033-7	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
23	*Eas-z*	31 72 5952 072-2	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
24	*Eas-z*	31 72 5959 536-9	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
25	*Eas-z*	31 72 5956 501-6	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
26	*Eas-z*	31 72 5963 253-5	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
27	*Eanoss*	31 72 5379 603-9	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.
28	*Eas-z*	31 72 5959 453-7	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.	"Srbija Kargo"a.d.

2.2.3. Infrastructure and SS system

The description of the railway line and facilities in the following text were given according to the date obtained from "IŽS"a.d. (attached to the letter No. 1/2024-720 of 22.07.2024 and by e-mail of 27.07.2024, 06.08.2024 and 13.08.2024).

2.2.3.1. Infrastructure

The main arterial route No. 107 Beograd Centar – Pančevo Glavna - Vršac - state border - (Stamora Moravita), between the stations Beograd Centar and Ovča is a double-track electrified line.

On the part of the line between the halt Karađorđev Park (beginning of the tunnel), station Vukov Spomenik and Pančevački Most junction and halt (end of tunnel) each track of the double-track line is situated in a separate tunnel tube (left and right tunnel tube).

On the right track of the main arterial route No 107 between the halt Karađorđev Park and Pančevački Most junction and halt (situated in the right tunnel tube) there are three curves, namely from km 1+346 to km 1+486 right curve R=600 m, from km 3+023 to km 3+226 right curve R=10000 m and from km 4+227 to km 4+586 left curve R=500 m). The rest of the railway line is in a straight line.

Overview of the gradient profile on the right track of the main arterial route No 107 between the halt Karađorđev Park and Pančevački Most junction and halt (situated in the right tunnel tube) is shown in table 2.2.3.1.1.

Table 2.2.3.1.1: Gradient profile (viewed in direction of the growing stationing)

No.	Gradient break stationing		Gradient [‰] (± - rise/fall)	Length[*m*]
	(start)	(end)		
1	1+163,00	1+770,00	-3,0	607,00
2	1+770,00	1+970,00	-2,60	200,00
3	1+970,00	2+320,00	-9,60	350,00
4	2+320,00	2+540,00	-8,20	220,00
5	2+540,00	2+743,00	-9,30	203,00
6	2+743,00	3+064,00	-3,00	321,00
7	3+064,00	3+484,00	-9,10	420,00
8	3+484,00	4+218,00	-1,50	734,00
9	4+218,00	4+691,00	7,08	473,00
10	4+691,00	4+991,27	-0,50	300,27

According to the Instructions on the organisation and operation of the operational service on parts of railway lines between the Beograd Centar, Pančevo Glavna, Rakovica and Topčider stations No. 4/2019-1250/1-291 of 14.01.2019 "IŽS"a.d, on the part of the main arterial route No. 107 Beograd Centar – Pančevo Glavna - Vršac - state border - (Stamora Moravita) between the station Beograd Centar and Pančevački Most junction and halt, allowed mass per axle is 225 kN allowed mass per running meter is 80 kN, and the length of braking distance is 700 m.

The designed speed on this part of the main arterial route No 107 between the halt Karađorđev Park and Pančevački Most junction and halt is 80 km/h on the right track and100 km/h on the left track.

According to the working timetables 0.1, 0.1 BG:VOZ and 6.1 (which were applicable at the time when the accident occurred), on the part of the line between the station Beograd Centar and Pančevački Most junction and halt, the maximum allowed speed was 70 km/h on both tracks. According to the same working timetable, on the mentioned part of the line there were not any limited speeds.

At the time when the accident occurred, there was no restricted-speed running on the part of the main arterial route No. 107 between the station Karađorđev Park and Pančevački Most junction and halt.

On the part of the main arterial line No. 107 between the station Beograd Centar and passing point Krnjača, the train traffic is regulated in the same way as on double-track lines equipped with

APB devices for either direction working in block sections, in accordance with the provisions of Article 171 of the Traffic Rulebook ("Official Gazette of the RS", No. 34/22 and 107/22). On the part of the railway line between the station Beograd Centar and Pančevački Most junction and halt there are also special provisions that apply to the operation of certain trains provided for in Article 32 of the Instructions on the organisation and operation of the operational service on parts of railway lines between the Beograd Centar, Pančevo Glavna, Rakovica and Topčider stations (Instruction No. 4/2019-1250/1-291 of 14.01.2019 "IŽS"a.d).

Although the traffic is regulated with devices of APB in block sections, for operation of trains on that part of the line it is mandatory to request and receive an authorisation.

The stations on the above mentioned part of the line are equipped with completely centralized station SS devices, which means that commands for changeover of switches, reception and dispach of trains can be centrally given from one dispatcher workplace via signalized routes in the area of one station.

Traffic regulation and securing of routes on the section of the railway line between the Beograd Centar station and the Pančevački Most junction and halt are carried out by train dispatchers of the Beograd Centar station and the Pančevački Most junction and halt, with the obligatory presence of the train dispatchers of the Vukov Spomenik station. In this case, the Vukov Spomenik station is not considered a station that can directly participate in traffic regulation. Traffic regulation and securing of routes on the distance between stations Pančevački Most - Krnjača are carried out by train dispatchers of the Pančevački Most junction and halt and the passing point of Krnjača.

For the purpose of traffic regulation, on the section of the railway line between the Beograd Centar station and the Pančevački Most junction and halt, automatic block signals and protective signals displaying two-digit signal signs have been installed. For train protection, track balises have been installed in addition to the signals.

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

At the request of the CINS, the "IŽS" a.d. did not submit a permit for use of the Vračar tunnel. The Decision No. 351-46/82-04 of 21.09.1982 of the Republic Committee for Transport and Communications of the SFRJ was submitted, which was adopted upon the proposal and report of the Commission for the technical review of the works performed on the construction of the left and right tunnel tubes of the "Vračar" tunnel, with the aim of continuing the works on laying the superstructure, building the contact line and installing SS and TT devices and facilities. The decision grants the Working Organization for the Construction of the Railway Junction "Beograd" the use of the left and right tunnel tubes of the "Vračar" tunnel in order to continue the work on laying the superstructure, constructing the contact line and installing SS and TT devices and facilities, provided that the investor and the contractor act upon the observations established in the Report of the Technical Inspection Commission. The decision stipulates the obligation to submit a request to the Committee for a subsequent technical inspection, after eliminating the identified deficiencies. Data on whether a subsequent technical inspection was performed, as well as the acceptance of the works after laying the superstructure, constructing the contact line and installing SS and TT devices and facilities, were not submitted by "IŽS" a.d. Also, no data (decision or any other document) was provided regarding the opening to traffic of the railway line in the "Vračar" tunnel.

2.2.3.2. SS system

On the section of the main arterial route No. 107 between the Beograd Centar station and the passing point of Krnjača, on the distances between stations Beograd Centar - Pančevački Most and Pančevački Most - Krnjača, APB devices are installed. Traffic is carried out on the right-hand side in block interval, with the possibility of sending train-on-line message. Distances between stations are ensured by electrical relay SS devices of the SpDrS-64-JZ type manufactured by Siemens (EI/FSU-Galeb). For the control of the block sections between the Beograd Centar station and the Pančevački Most junction and halt, rail current circuits are used, and between the junction and halt Pančevački Most and the passing point of Krnjača, the BROS axle counter system manufactured by the Mihajlo Pupin Institute is used.

On this part of the line, the stations are secured as follows. The Beograd Centar station, together with the Dedinje junction and the Karađorđev Park junction, is secured by an electronic signal box with a computer control level, a computer execution level and a contactless interface for external devices, type ESA-11 SB, manufactured by AŽD Praha (a microprocessor system with electronic control of the routes and control of switches, signals and station sections). The ACS 2000 axle counter system, manufactured by Frausher, is used for the control of the station sections. The Pančevački Most junction and halt and the passing point of Krnjača are secured by electrical relay SS devices, type SpDrS-64-JZ, manufactured by Siemens (EI/FSU-Galeb). The BROS axle counter system, manufactured by the Institute Mihajlo Pupin, is used for the control of the station sections. The device has achieved complete dependence of the signal signs shown by the main signals with the position of the switches. The Pančevo Most junction is equipped with light protection signals and caution signals.

Commands and the graphical display of the status of station signal elements in real time at the Pančevački Most junction and the Krnjača station are given by using the electronic monitoring and control system HMI (HMI - Human Machine Interface) type MMI10 manufactured by the Mihajlo Pupin Institute. The mentioned HMI device has the ability to register and archive assigned commands and changes of the status of the relay of the internal SS device in real time. The data is stored in the form of a diagnostic record on the device's hard disk.

Figure 2.2.3.2.1. shows the display of the *MMI* device at the junction and halt Pančevački Most.

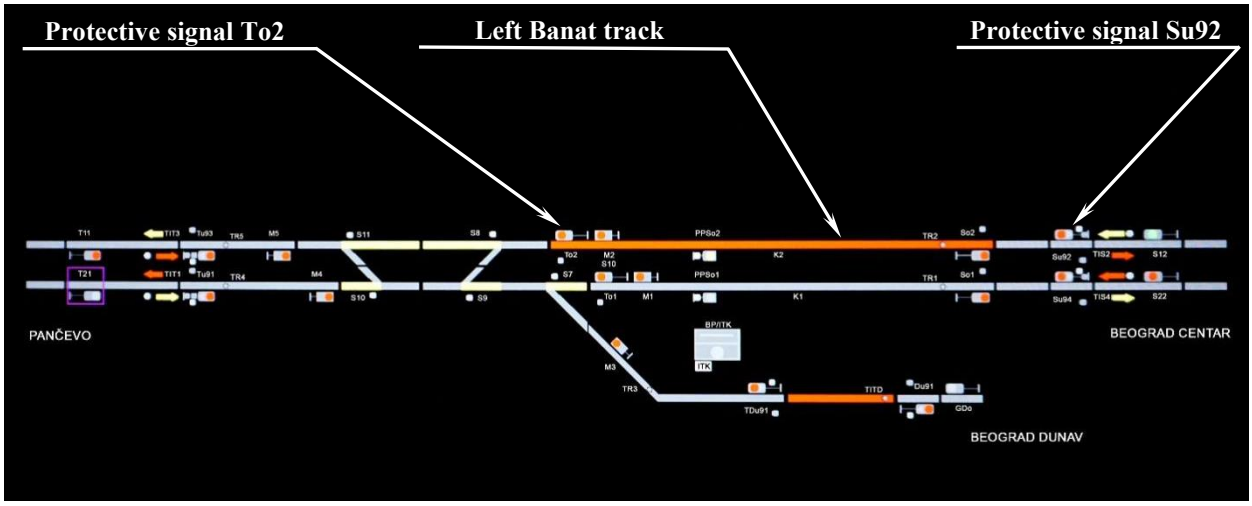


Figure 2.2.3.2.1: Display of the MMI device at the Pančevački Most junction and halt

Figure 2.2.3.2.2. shows a schematic representation of the station sections and elements of the SS devices protection at the Pančevački Most junction and halt.

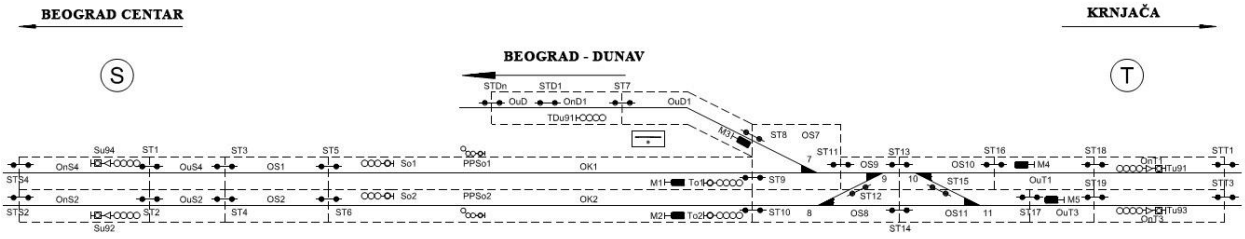


Figure 2.2.3.2.2: Section plan at the junction Pančevački Most

On the section of the main arterial route No. 107 between the Beograd Centar station and the Pančevački Most junction and halt, on the right track in the direction from the Beograd Centar station towards the Pančevački Most junction and halt, on the right side of the right track, at km 2+350, a light automatic block signal S12 was installed and at km 3+717, a light protective signal Su 92 was installed. Also, on the right track in the same direction, in the area of the Pančevački Most junction and halt, at km 4+746, a light protective signal To2 was installed. Between the Pančevački Most junction and halt and the passing point of Krnjača, on the right track in the direction from the Pančevački Most junction and halt to the passing point of Krnjača, on the right side of the right track, at km 6+359, a light automatic block signal T 12 was installed and at km 7+380 light entry signal Tu92 of the passing point Krnjača.

The Vukov Spomenik station does not have separate SS facilities, but is located between the automatic bloc signals whose control is carried out in the neighbouring stations, the Beograd Centar station and the Pančevački Most junction and halt. For the direction from the Beograd Centar station to the Pančevački Most junction and halt, on the right track, the Vukov Spomenik station (positioned at *km* 2+900) is located between the automatic block signal S12 (at km 2+350) and the protective signal Su 92 (at km 3+717).

2.2.4. Means of communication

The description of the means of communication in the following text is given according to the data received from "IŽS"a.d. (attached to the letter No. 1/2024-720 of 22.07.2024 sent by e-mail on 27.07.2024, 06.08.2024 and 13.08.2024).

On the section of the main arterial route No. 107 between the Beograd Centar station and the Pančevački Most junction and halt, communication between the personnel regulating traffic on the line is carried out by telephone via a local TT connection. All stations on the railway line are included in the communication line. Conversations conducted on this line are registered (recorded) on a recorder located in the Beograd Centar TT section and therefore represents proof communication.

To enable mutual communication between the traction vehicle personnel and the traffic operating personnel (the BG.VOZ traffic dispatcher and the competent train dispatchers), the

section of main arterial route No. 107 between the Beograd Centar station and the Pančevački Most junction and halt is equipped with RDV devices (channel A, B-63) and block telephones installed near the main signals. Conversations on these lines are recorded on a recording device located at the Beograd Centar station and therefore represent proof communication. In addition to the above lines, communication with the train dispatcher of the Pančevački Most junction and halt can also be achieved by calling the fixed telephone line of the operator "Telekom Srbija", which is included in the recording device and also represents proof communication.

2.2.5. Works executed at or near the accident site

No works were carried out near the site of the accident.

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

The public railway infrastructure manager "IŽS"a.d. and railway undertakings „Srbijavoz"a.d. and "Srbija Kargo"a.d. notified CINS, the Main Investigator in railway traffic accidents, about the accident. The public railway infrastructure manager "IŽS"a.d. and railway undertakings „Srbijavoz"a.d. and "Srbija Kargo"a.d. formed a joint investigation committee that conducted an investigation in accordance with applicable regulations. Upon completion of the investigation, an Investigation Report was drafted, document No. 136/24 of 01.08.2024 "IŽS"a.d.

Immediately after learning that the collision had occurred, the train dispatcher at the Pančevački Most junction and halt notified the emergency medical service and the police. Police and ambulance officers began arriving at the scene in a short time because they had already received the notification from passengers on the train No. 7112.

The train driver and conductor of the train No. 7112 did not participate in providing assistance to the injured because they themselves were seriously injured in the accident.

After the emergency services completed their intervention to provide assistance to the injured and an on-site inspection by interested parties, activities began to repair the consequences of the accident.

The consequences of this accident were remedied by engaging the professional services and resources of "IŽS"a.d, "Srbijavoz"a.d. and "Srbija Cargo"a.d.

In order to enable the work on separating EMV 412/416-005/032 and the last wagons of the train No. 52601, first, by engaging workers and an auxiliary locomotive 661-224 of the railway undertaking "Srbija Kargo"a.d, a part of the train No. 52601 (locomotive 193-912 and the first 27 wagons) was pulled out from the scene of the accident and transferred to the Pančevo Glavna station. During the movement of the part of the train No. 52601, the 26th wagon (wagon No. 31 72 5963 253-5), viewed from the front of the train, derailed with one bogie. During the movement of the derailed wagons through the Pančevo Most station, the sleepers and SS devices (several axle counter detector modules and one track autostop balise) were damaged. On the expansion joint on the steel bridge over the Danube, the derailed bogie returned to the track.

The separation of the damaged vehicles (the last wagon No. 31 72 5959 453-7 in the train No. 52601 and EMV 412/416-005/032 which was part of the train No. 7112) and their placement on the track was carried out by engaging a breakdown train owned by "IŽS"a.d., the Centre for Breakdown Train Operations, OJ for Breakdown Train Operations Belgrade, with the engagement of traction vehicles of the railway undertaking "Srbija Kargo"a.d. and expert services of the

railway undertaking "Srbijavoz"a.d. After the separation, the last wagons in the train No. 52601 (wagon No. 31 72 5959 453-7) were transferred to the Pančevo Varoš station, the damaged motor coach 412-005 was transferred to the Danube track at the Pančevački Most junction and halt, and the rest of the EMV 412/416-005-032 (which was not damaged) was brought to the Zemun TPS.

After the railway vehicles were removed from the scene, the technical personnel of the ZOP Section Beograd, Civil Engineering Sector Beograd, "IŽS"a.d. repaired the damage to the track (deformation in direction and level over a length of 30 m).

The interruption of traffic between the station Vukov Spomenik and Pančevački Most junction and halt lasted until 18.05.2024 at 01:17 on the left track and until 20.05.2024 at 14:10 on the right track.

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

Due to this accident, in order to provide assistance to the injured and secure the accident site, members of the Institute of Emergency Medicine Beograd (emergency medical service), members of the MUP RS, the Emergency Situations Sector, the Emergency Situations Authority in Belgrade, the Fire and Rescue Units of Zvezdara, Voždovac and Borča, as well as members of the MUP RS, PU in Belgrade were engaged.

According to the data provided by the Institute of Emergency Medicine Beograd (letter No. 5635 dated 03.07.2024), the Emergency Medical Service of the Institute of Emergency Medicine Beograd received a notification of the accident by telephone on 17.05.2024 at 18:26 from the train driver of the BG train. Given that the call was received at the very end of the day shift and the beginning of the night shift, three medical teams from the day shift, as well as two medical teams from the night shift, went to the scene. One medical team consists of a doctor, a medical technician and a driver. During the intervention of the medical teams, four patients were treated and all were transported and treated in the Emergency Centre of the University Clinical Centre of Serbia. All patients were treated by the day shift teams. There was no need for assistance from the night shift teams.

The MUP RS, Emergency Situations Sector (letter 07 No. 217 1311/24 dated 08.07.2024), provided information that on 17.05.2024 at 18:42, the Command and Operations Center of the Emergency Situations Authority in Belgrade received a report from the Duty Service for the City of Belgrade that there had been a collision between two trains in the Vračar tunnel, closer to the exit to the Pančevo bridge. Upon learning of the accident, 25 firefighters and rescuers with seven vehicles from the Fire and Rescue Units of Zvezdara, Voždovac and Borča were sent to the scene. Fire and rescue teams arrived at the scene at 18:48 and began the intervention by surveying the terrain and positioning vehicles in the immediate vicinity of the entrance to the platform of the halt Pančevo Most, after which a team was formed with the aim of arriving at the scene and assessing the current situation. Upon arrival at the scene and visiting the passenger train, injured persons were found. The information was forwarded to the Command and Operations Center of the Emergency Situation Authority and the equipment necessary for the continuation of the intervention was requested, as well as additional teams from the Emergency Medical Service. At the scene, the teams rescued six people from the coach, who, accompanied by members of the fire and rescue units, were directed to the exit from the tunnel in the direction of the Pančevo Most and handed over to the Emergency Medical Service for further care. Since three people from the first coach (the train driver, the conductor and one passenger) were seriously injured, and their

evacuation in the direction of the Pančevo Most was not possible, the Emergency Medical Service performed primary triage of the people with the aim of safe transport to the evacuation exits near the student residence "Karaburma". At the same time, firefighters and rescuers opened the evacuation exits on site, cleared the access roads to the tracks and, accompanied by members of the Emergency Medical Service, organized the transport of the endangered people in rescue troughs to the evacuation exits, where they were then taken over by the teams deployed at that location. The intervention in the depths of the tunnel was completed at 20:27.

The Secretariat of the MUP RS (letter 02 No. 011-95/24-9 dated 06.09.2024) provided information that on 17.05.2024. at 18:25, the Emergency Medical Service reported to the Duty Service of the PU for the City of Belgrade, at the number "192", that a train collision had occurred near the "Pančevo Most". Officers from the Palilula Police Station were sent to the scene of the incident where they determined that on the main arterial route Beograd Centar - Pančevo glavna - Vršac - State Border, in the tunnel between "Vukov Spomenik" and "Pančevački Most", a passenger train "Srbijavoz"a.d. and a freight train "Srbija Kargo"a.d. had collided. The scene of the incident was inspected by the public prosecutor on duty at the First Basic Public Prosecutor's Office in Belgrade. On that occasion, police officers from the Traffic Police Station "Sever", the Traffic Police Directorate, PU Belgrade, also arrived at the scene of the incident and regulated traffic in order to enable other organizational units to take the necessary measures and actions. In addition to the above, police officers from the Traffic Police Directorate conducted a breath alcohol test on the train driver of the freight train, while the breath alcohol test on the passenger train driver was not conducted, since he was urgently transported to a health facility for medical assistance. Upon the verbal order of the public prosecutor on duty at the First Basic Public Prosecutor's Office in Belgrade, blood samples were taken from the train drivers and sent for further analysis. In connection with the incident in question, acting in accordance with the order of the public prosecutor on duty, police officers from the Department for Investigation of Explosions, Fires and Accidents, Criminal Police Directorate, PU Belgrade, conducted official actions at the scene of the accident to collect the necessary information regarding the aforementioned incident.

2.3. Fatally injured, injured and material damage

2.3.1. Passengers, third persons and the railway staff including contractors

According to the data provided by the Emergency Center of the University Clinical Center of Serbia (letter No. 172 dated 24.06.2024) and the Institute of Emergency Medicine Belgrade (emergency medical service, letter No. 5635 dated 03.07.2024), as well as according to the e-mail dated 17.07.2024 sent by "Srbija Kargo" a.d., there were no fatalities in this accident. A total of seven people were injured. Of the total number of injured people, two people were seriously injured, railway workers of "Srbijavoz" a.d. (train driver and conductor, they were on the train No. 7112). Five people were slightly injured, one railway worker of "Srbija Kargo" a.d. (train driver of the train No. 52601) and four passengers who were on the train No. 7112. A tabular overview of the number of fatalities and injured persons is shown in Table 2.3.1.1.

Table 2.3.1.1: Overview of fatalities and injured persons

	Passengers	Railway staff	Third persons	Total
Fatalities	-	-	-	-
Seriously injured	-	2	-	2
Slightly injured	4	1	-	5

2.3.2. Goods, luggage and other assets

In this accident there was no damage to goods, luggage or other assets.

2.3.3. Railway vehicles, infrastructure and the environment

Railway vehicles and infrastructure were damaged in this accident. There was no material damage to assets of third persons.

The structure of the caused material damage is given according to the following:

Damage to EMV 412/416-005/032:	45 950 000,00	RSD
Damage to the wagon of individual number 31 72 5959 453-7:	990 789,84	RSD
Damage to the infrastructure occurred during the accident:	330 710,00	RSD
Damage to the infrastructure occurred during the repair of the consequences of the accident, after movement of a part of the train No. 52601:	4 214 784,00	RSD
Cost of the intervention done by the breakdown train of "IŽS"a.d:	635 359,00	RSD
Cost of hiring traction vehicles of "Srbija Kargo"a.d:	229 150,00	RSD
Total direct material damage:	**48 136 008,84**	RSD

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

According to the official middle exchange rate of the National Bank of Serbia on 17.05.2024, which is 1 EUR (Euro) = 117,1050 RSD (Dinar), the total material damage incurred in the accident amounts to 411 049,99 Euros (EUR).

The material damage in this report is presented based on invoices, estimates, i.e. documents confirming the reported damage amounts provided by "IŽS"a.d, "Srbijavoz"a.d, and "Srbija Kargo"a.d.

2.3.4. External circumstances - weather conditions and geographical features

The scene of the accident is located in the area of the city of Belgrade, on the part of the railway line situated in a tunnel under the inner city centre.

The geographical coordinates of the accident site are: 44º 48' 49,1" *N* and 20º 29' 15,2" *E*.

The letter of the Republic Hydrometeorological Institute No.: 925-1-219/2024 dated 24.06.2024 provided data that on 17.05.2024. in the area of the Pančevački Most junction and halt, the maximum air temperature was 23.2°C, the minimum 13.6°C, and the minimum air temperature 5 cm above the ground was 12.5°C. The ground was dry from 16:00 to 20:00, moist at 20:00, and wet from 17.05.2024. at 21:00 to 18.05.2024. at 01:00. A stormy wind blew, the maximum gust of which was from 17,2 to 20,7 m/s from the southeast. Meteorological visibility from 16:00 to 19:00 was 30 km, and at 20:00 it was 20 km. As for the meteorological phenomena, heavy rain was observed from 21:08 to 21:30, light to moderate rain from 22:08 to 22:30 and moderate rain showers from 23:19 to 23:31. The amount of precipitation was 3,6 mm. Hourly air temperature values were: at 16:00 19.8°C, at 17:00 18.6°C, at 18:00 17.4°C, at 19:00 15.9°C, at 20:00 14.8°C, at 21:00 14.7°C, at 22:00 14.3°C, at 23:00 13.6°C, on 18.05.2024 at 0:00 14.0°C and at 01:00 13.8°C. Meteorological visibility is the transparency of the atmosphere, expressed as the greatest distance at which an observer with normal vision can distinguish familiar objects in the environment, when observing during the day, and light sources when observing at night. Precipitation is measured at 07:00 and represents the amount that was precipitated in the previous 24 (twenty-four) hours (from 07:00 of the previous day to 07:00 of the current day).

Given that the accident occurred in a tunnel, the investigation was conducted under difficult conditions.

3. Minutes on investigation and examination

The data, facts, and evidence regarding the accident were collected and determined based on:

- Investigation conducted by the Working Group of CINS at the scene,
- Material provided by the infrastructure manager "IŽS"a.d,
- Material provided by the railway undertaking "Srbijavoz"a.d,
- Material provided by the railway undertaking "Srbija Kargo"a.d,
- Material provided by the Emergency Situations Sector MUP RS,
- Material provided by the Secretariat of MUP RS,
- Material provided by the First Basic Public Prosecutor's Office in Belgrade,
- Material provided by the Institute of Emergency Medicine Belgrade,
- Material provided by the Emergency Center of the University Clinical Center of Serbia,
- Material provided by the Republic Hydrometeorological Institute.

3.1. Summary of testimonies

The CINS working group conducted hearings with the employees who participated in the accident on 01.07.2024 and 15.07.2024 in the premises of the CINS and on 30.09.2024. in the home of the train driver of the train No. 7112.

From the employees of "IŽS" a.d., the train dispatcher of the Vukov Spomenik station and the train dispatcher of Pančevački Most junction and halt, who were on duty at the Vukov Spomenik and Pančevački Most official location at the time of the accident, were heard.

From the employees of "Srbija Kargo"a.d., the train driver who was in possession of the locomotive 193-912 of the train No. 52601 at the time of the accident was heard.

From the employees of "Srbijavoz"a.d, the train driver of the train No. 7112 (EMB 412/416-005/032) who was in service at the time of the accident was heard. Due to the long-term recovery from the injuries he sustained in the accident in question, the conductor who was on duty in the train No. 7112 (EMV 412/416-005/032) was not heard.

"IŽS"a.d. and "Srbija Kargo"a.d. submitted the Minutes of the hearing of the train crew of the train No. 52601 (train driver), the train dispatcher at the Vukov Spomenik station and the train dispatcher at the Pančevački Most junction and halt, who were on duty at the time of the accident. There were also submitted: the Report of the train crew on irregularities on the route (S-5) dated 22.05.2024 on the Belgrade - Pančevo railway line for the freight train 52601, which was drafted by the train driver, as well as the Reports of the train dispatchers on irregularities during work (SP-9) No. 0001426 dated 17.05.2024 drafted by the train dispatcher of the Vukov Spomenik station and No. 0113944 dated 18.05.2024 drafted by the train dispatcher of the Pančevački Most junction and halt.

"Srbijavoz"a.d. submitted the Minutes of the hearing of the train driver of the train No. 7112. Due to the fact that he was seriously injured in the accident, the conductor of the train No. 7112 was not heard. Also, the train driver and the conductor provided a Report of the train crew on irregularities on the route (S-5), i.e. a Report on irregularities - inconveniences (K-91).

The summaries of testimonies of the train dispatcher at Vukov Spomenik station, the train dispatcher at the Pančevački Most junction and halt, the train driver of the train No. 52601 and the

train driver of the train No. 7112 were provided based on the hearings conducted by the CINS Working Group.

3.1.1. Railway staff

The train dispatcher at Vukov Spomenik station stated that he started his shift at the Vukov Sponeminik station a little before five o'clock. Before that, he worked a shift on 15/16.05.2024. (night shift) at Batajnica station. That was his first shift as a replacement at Vukov Spomenik. There are no signal boxes or devices at the workplace at Vukov Spomenik station. The train dispatcher is an intermediary between the stations Beograd Centar, Rakovica and Pančevo Most and is on duty alone during the shift. He does not call anyone, he only answers the phone and receives information about train traffic. On that day (17.05.2024), orders were given to BG trains and Vršac trains related to faults on the SS devices between Pančevo Most and Krnjača on the automatic bloc signal. He knows that for monts orders have also been issued for disruptions on the distance between stations Ovča - Pančevo Glavna for passenger trains going to Vršac. When they issue written orders, they communicate the content of that order to the train driver of passenger trains. A colleague whom he replaced at Vukov Spomenik told him that it was the order of the station manager. He has only indirect information about the occurrence of disruptions or malfunctions in the operation of the SS equipment on the section of the track between the stations Beograd Centar and Krnjača from the stations Beograd Centar or Pančevački Most. When the train No. 52601 passed through the station Vukov Spomenik, he was standing on the platform, he followed the train's passage and made sure that the train had a end signal (two square ones). He did not need to communicate with anyone. When the train No. 7112 stopped at the station, he got out and handed the train driver a general order and verbally informed him that there was a fault on the automatic block signal between the Pančevački Most and Krnjača and that there was a station gap there. That was also written in the order. He informed the train driver about the contents of the order twice because he was not sure that the train driver understood him. He told him that the order referred to the section of the track between the Pančevački Most and Krnjača. The train driver signed that he had received the order, but did not answer him verbally. The train driver was alone in the driver’s cab. The conductor was at the first door to the driver’s cab and gave the signal “about to depart“. The doors closed and he (the train dispatcher) gave the departure signal. During the communication (conversation) with the train driver, he heard loud music from the driver’s cab. The train driver turned down the music a little when he was verbally informing him about the contents of the order. When he had dispatched the train No. 7112, he returned to the office. Two minutes later, his colleague from the Pančevački Most called him and said that the passenger train had collided with a freight train. He stated that upon learning about the accident, he was under great stress. Apart from the information he had received from his colleague from the Pančevački Most, he had no other information.

The train dispatcher of the Pančevački Most junction and halt stated that he started his shift at 18:00. He points out that one train dispatcher works at the Pančevački Most per shift and performs all tasks alone. The duties of the train dispatchers at the station Pančevački Most are to create routes on the section of the railway assigned to them (for which they have control), monitor train traffic, report disruptions, communicate with traffic dispatchers, BG train dispatchers and technical dispatchers, dispatch trains, provide information to passengers about train delays, about which track the trains are coming on, in the event of disruptions, they give orders, in the case when they give orders for trains that are traveling towards Krnjača, they must cross to the other side through the underpass. They have a track behind the station, far from the office (Danube track),

where they often have to go (it takes them more time). When he took over his shift, on the distance between stations Pančevački Most - Krnjača there was a occupancy between the automatic block signal T12 and Krnjača and he had information that the SS mechanics were working to eliminate the faults. There were no trains at the station Pančevački Most. He was expecting the trains No. 52601 and 7112, which had already been registered into the records (train record book). He registered the train No. 6008 from Krnjača. After the train No. 52601, he was expecting the train No. 7112 on the right Banat track, coming from the Vukov Spomenik station, i.e. Beograd Centar. When the train No. 52601 stopped on the second track in front of the To2 protective signal, he went out onto the first track platform (the platform closer to the train dispatcher's office), stood opposite the driver's cab of the locomotive 193-912 of the train No. 52601 and informed the train driver about the traffic situation (that he was waiting for the order, that there was a station gap and that he was waiting for the train No. 6008 from Krnjača to arrive so that he could turn on To2), after which he entered the office. He saw on the counter that train No. 6008 was "travelling 80 meters" in front of the signal. He went out onto the platform in front of the office to watch the train No. 6008 coming off the bridge, when he saw wagon moving (squeezing) on the other track near train No. 52601. The train driver informed him that he thought something had hit it. He then entered the office and saw on the MMI screen that there was no indication for the train No. 7112. He stated that he felt terrible considering the nature of the trains. He thought there were injured and dead people.

The train driver of the train No. 52601 stated that he started his shift at the Pančevo Glavna station at 10:00, when he took possession of the locomotive 193-912. He inspected the locomotive together with his colleague who worked before him (from whom he took over the locomotive). When taking over the shift at the Pančevo glavna station, he noted that everything was fine on the locomotive 193-912. He first ran on the Pančevo Glavna - Vreoci route. At the Vreoci station, he took over the train No. 52601. He stated that in a psychophysical sense (health) while driving the train No. 52601, everything was fine. Regarding the information about the SS devices (signals) on the section of the railway line from Resnik station to Ovča station (i.e. to the Pančevo Glavna station), he received an order stating that from Ovča to Pančevo Glavna there was a station gap. He cannot remember whether it was in Vreoci or in Resnik. He usually receives such an order either at Resnik station or at Ovča station. After leaving Resnik station, he was alone in the driver's cab of the locomotive 193-912. While the train was running between the stations of Resnik and Pančevački Most, he had no communication with the personnel regulating traffic. While running between the stations of Resnik and Pančevački Most, the signaling was working. All the signals he passed were green, except on the section of the railway from Karađorđev Park to Pančevački Most, where the signals were yellow. He is certain that the Su 92 signal was on yellow when he passed it (he knows that for sure). At the Pančevački Most station, the To2 protective signal was red, so he stopped the train No. 52601 in front of the signal (To2) so that the dispatcher could give him the order for the station gap. When he stopped, he released the train. Very soon after he released the train, there was a hit that threw his train some 20 m forward (according to the train driver's estimate). After the impact, he inspected the locomotive both outside and inside and found that there was no damage. He received information from the train dispatcher that it had apparently been hit by a BG train. After that, he tidied up the locomotive, informed the TK dispatcher in Belgrade about the accident, and stayed on the locomotive. He cannot remember how long it was before someone came to him, he thinks about an hour, an hour and a half. He stated that during that hour, while he was alone on the locomotive, he felt great psychological tension. He was worried about whether there were any dead or injured. It was only when the firefighters came out of the tunnel and said that there were no dead that he felt better. At that moment, he did not feel any pain. It was only when the police officers took him to the emergency center to give blood

samples for analysis, while he was lying between two blood draws, that he began to feel pain in his neck on the left side.

The train driver of the train No. 7112 stated that he was working the second shift, which starts at 14:00 and lasts until 22:00. He started the shift at the Beograd Centar station by reporting to the supervisor. On that day, the EMV (was standing at the station as a spare set) was in his possession and it was started for the train No. 7112. From the Beograd Centar station, the EMV departured between 17:40 and 17:50. It travelled to take up duty to the Karađorđev partk halt, and from Karađorđev Park it continued as the train No 7112. He stated that he was familiar with the section of the track between the Beograd Centar and Ovča stations. He knows that the track is equipped with APB. He is not sure what all the signals (signal markings) were that he was supposed to pass. He cannot remember whether he received any orders from the train dispatcher when he departed from the Beograd Centar station. From the Beograd Centar station, the train started from the eighth track. At the Karađorđev Park halt, it arrived on the track in the direction of Ovča (there are two tracks). When it stopped at the halt, it opened the door to the EMV. The passengers got in. The conductor was at the door and showed him that it was ready to depart, after which he closed the door and continued driving. Between the Karađorđev Park halt and the Vukov Spomenik station, upon entering the tunnel, there is an automatic block signal. Due to the configuration of the terrain (curves), he could only see the signal when he left the halt. He cannot remember its designation, but he thinks that it was showing a yellow steady light. While operating the train 7112 at the Vukov Spomenik station, he saw the train dispatcher with whom he had verbal communication. The dispatcher approached the driver's cab window to give him a general order. In doing so, the dispatcher read the order to him (verbally communicated its contents) and handed it to him. He read the order. The lighting in the driver's cab of this set was a little dimmer, so he relied more on understanding the train dispatcher's verbal message, rather than on his own reading of the order. He understood (comprehended) the train dispatcher's verbal message. In addition, the train dispatcher told him (something that is not in the message) that the next signal did not apply to him. As for the train dispatcher's verbal message, and what was written in the message, he told him that from Vukov Spomenik to Krnjača, the train was operating at station distances. He does not remember that the train dispatcher mentioned any signals to him regarding the content of the order itself. After the Vukov Spomenik station, from where he was standing in the station, he saw a signal and it was red. He thinks that the signal he saw was marked Su91 or Su92 and that it was a protective signal. The train dispatcher did not mention to him that there was a freight train in front of his train. While standing at the Vukov Spomenik station, he saw the conductor standing at the door of the first motor coach in the direction of travel, in which was the driver's cab where he was. After the conductor standing at the door gave the signal ready for departure, he closed the doors on the train, after which the train dispatcher gave the departure signal. All controls on the EMV functioned properly. On that section of the track, the permitted speed is 70 km/h. The external lighting on the EMV was in order. It was clear. While driving the train No 7112, he was feeling good. He was alone in the driver's cab. He had no communication with the passengers. As for the conductor, when departing from the Beograd Centar station, he entered the driver's cab to leave his belongings (a bag and a coat), but he did not disturb him. Shortly after that, the conductor entered the driver's cab once again and asked if he could put his phone to charge, which he allowed him to do. When driving, he always keeps his phone in front of him with the "speakerphone" turned on so that he could follow the signals and drive. He played music on the conductor's phone, which was charging in the driver's cab, but before arriving at the Vukov Spomenik station, he turned the music on the phone down. He did not have headphones on. He was making a phone call from his own mobile phone when departing from the Belgrade Center station and ended the conversation during the departure. After departing from the Vukov Spomenik station, he passed

the Su91 or Su 92 signal (he cannot remember the exact designation) and it was showing a red steady light (the "Stop" signal). Since the train dispatcher had verbally informed him that the signal did not apply to him and that driving past it was permitted, before passing that signal (within two meters) he pressed the running on order button (red button) in order to continue to the Pančevački Most. After passing the signal, the first thing he saw was the rear end of the train No. 52601 at a distance of approximately 200 to 250 m. He does not remember seeing the end signal. The train (No. 52601) on the track in front of his train was not moving. As soon as he saw the rear end of the freight train, he braked quickly and he was braking for approximately three to four seconds, thinking that he would still be able to stop without hitting the freight train. When he saw that he would not be able to stop and that a collision was inevitable, he turned towards the door, grabbed the handle, he does not know if he managed to take a single step, he felt a strong blow, after which complete darkness set in (without lighting). He was conscious the whole time. After the collision, he was in the passenger compartment of the motor coach 412-005 where there were two other passengers and the conductor. He was injured and also felt fear due to the shock. From the mobile phone that he borrowed from a passenger, he called the fire brigade and an ambulance. He states that he started working (on the railway) on 01.06.2022. He first attended the theoretical part of the training and after seven to eight months, passed the theoretical part of the exam the second time. After that, he had the practical part of the training, then took the exam, after which he started working. He thinks that he passed the practical part of the exam in May 2023. He completed the training only for EMV series 412/416. Since he passed the practical part of the exam and started working independently as a train driver, until the accident in May 2024, he did not have any knowledge tests, neither regular nor extraordinary. He believes that he received a high-quality theoretical training from a school instructor who monitored and taught him. He underwent the practical part of the training with various fellow train drivers from whom he learned a lot. Once he passed the practical part of the exam, he worked in a two-person driver's cab for several months, gaining experience with his colleagues.

3.1.2. Other witnesses

Witnesses to this accident (passengers on train number 7112) were not questioned and no statements were obtained from them.

3.2. Safety management system

3.2.1. Organizational Frame and Method of Issuing and Executing Orders

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

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

In accordance with the current Safety Management System Rulebook, "Srbija Kargo"a.d.. notified CINS about the accident.

The infrastructure manager "IŽS"a.d. and railway undertakings "Srbijavoz"a.d. and "Srbija Kargo"a.d, in accordance with the Law on Railway Traffic Safety ("Official Gazette of the RS" No. 41/18), formed a joint investigation committee that conducted the accident investigation.

Upon completion of the investigation, an Investigation Report was compiled (document No. 136/24 of 01.08.2024 "IŽS"a.d.).

3.2.2. Requirements that railway staff must meet and the manner they are applied

"Srbijavoz"a.d. has ensured the management of competencies through the Safety Management System (SMS) Rulebook, i.e., processes to ensure that all employees directly involved in the conduct of railway traffic are trained and competent, as well as the planning of workload.

In relation to the accident involving the train driver and conductors employed at "Srbijavoz"a.d, all activities related to professional training, competence, and working time planning were carried out in accordance with applicable regulations.

"Srbija Kargo"a.d. has ensured the management of competencies through the Safety Management System (SMS) Rulebook, i.e. processes to ensure that all employees directly involved in the conduct of railway traffic are trained and competent, as well as the planning of workload.

In relation to the accident involving the train driver employed at „Srbija Kargo"a.d, all activities related to professional training, competence, and working time planning were carried out in accordance with applicable regulations.

"IŽS"a.d. has ensured the management of competencies through the Safety Management System (SMS) Rulebook, i.e. processes to ensure that all employees directly involved in the conduct of railway traffic are trained and competent, as well as the planning of workload.

In relation to the accident involving the train dispatchers employed at "IŽS"a.d, it can be stated that all activities related to professional training, competence, and working time planning were carried out in accordance with applicable regulations.

3.2.3. Procedures for internal audits and controls and their results

"IŽS"a.d. as the infrastructure manager, has established the Safety Management System (SMS) Rulebook. The Safety Management System encompasses the organization and all procedures and processes established within "IŽS"a.d. for the safe conduct of railway traffic.

Risk control related to the maintenance of railway infrastructure (subsystems of infrastructure, energy, control, management, and signalling - trackside) and railway vehicles used for maintenance by "IŽS"a.d. is based on the implementation of defined activities for regular and extraordinary maintenance and their monitoring and control. Regular and extraordinary maintenance includes continuous supervision, controls, inspections, repairs, and overhauls.

The requirements, standards, and procedures for maintenance at "IŽS"a.d. are established based on legal regulations, general and specific company acts, manufacturer instructions, and standards.

Regarding the accident, it can be stated that on the part of the railway line between the station Beograd Centar and Pančevački Most junction and halt, "IŽS"a.d. partially performed maintenance of the different elements of the SS and telecommunication devices (see point 3.4.1.1.) of the public railway infrastructure in accordance with applicable regulations.

“Srbijavoz”a.d, as a railway undertaking, has established the Safety Management System (SMS) Rulebook. The general purpose of the Safety Management System (SMS) is to ensure that “Serbia Voz”a.d. achieves its business objectives in a safe manner.

The purpose of establishing the Safety Management System (SMS) in “Srbija Voz”a.d. is to ensure the safe management of its activities in accordance with the provisions of the Law on Railway Traffic Safety (“Official Gazette of the RS” No. 41/18) and the Statute of the Joint Stock Company for Passenger Railway Transport “Srbijavoz“, Belgrade (“Official Gazette of the RS“ No. 60/15 and “Official Gazette of the RS“, No. 14/17, 57/19, 16/23 and 36/23).

Rolling stock must maintain the prescribed technical level of reliability and follow maintenance plans (EV-62) and their cycles of control-technical inspections and regular repairs to be as reliable as possible in operation, in accordance with the Rulebook on the Maintenance of Railway Vehicles and other legal acts and by-laws that are part of the Safety Management System Rulebook of “Srbijavoz”a.d.

Regarding the accident, regular and extraordinary maintenance of the railway vehicle (EMV 412/416-005/032) in “Srbijavoz”a.d was carried out in accordance with applicable regulation.

“Srbija Kargo“a.d. as a railway undertaking, has established the Safety Management System (SMS) Rulebook. The general purpose of the Safety Management System (SMS) is to ensure that “Srbija Kargo“a.d. achieves its business objectives in a safe manner.

Rolling stock must maintain the prescribed technical level of reliability and follow maintenance plans and their cycles of control-technical inspections and regular repairs to be as reliable as possible in operation, in accordance with the Rulebook on the Maintenance of Railway Vehicles and other legal acts and by-laws that are part of the Safety Management System Rulebook of “Srbija Kargo“a.d.

Regarding the accident, regular and extraordinary maintenance of the railway vehicle (locomotive 193-912) in “Srbija Kargo“a.d. was carried out in accordance with applicable regulation.

3.3. Relevant international and national regulations

3.3.1. Law on Railways ("Official Gazette RS" Nos. 41/2018 and 62/2023)

II Railway infrastructure

...

1. Public railway infrastructure management

...

Obligations of the infrastructure manager

Article 10 (excerpt)

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

…

3.3.2. Law on Railway Traffic Safety ("Official Gazette RS" No. 41/18)

III Safety management system in railway traffic

Guaranteeing safety in railway transport

Article 5 (excerpt)

The Ministry in charge of transport activities (hereinafter referred to as: the Ministry), the Directorate, the Centre in Charge of Accident Investigation (hereinafter referred to as: the Centre), the infrastructure manager (hereinafter referred to as: the manager) and railway undertakings must, each in accordance with their own activities, guarantee the following:

1) that railway safety is maintained in the railway system, as well as continuously improved where justified and feasible, whereby priority shall be given to accident prevention,

2) that safety rules are applied in a transparent and non-discriminatory manner, and

3) that the development of a single railway system is accelerated.

The manager and the railway undertakings are responsible for the safe operation of the railway system and for risk control related to it, by implementing necessary risk control measures, where appropriate in cooperation with each other, by applying national safety rules and standards and by establishing safety management systems in accordance with this law.

...

3.3.3. Rulebook on types of signals, signal markings and line markings (”Official Gazette of the RS” No. 51/20 and 29/25)

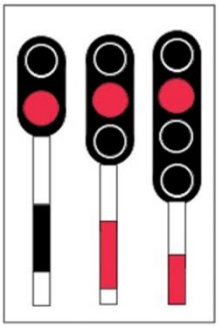
Aspects of a signals of mandatory signals

…

Aspect of a signal 4: ”Stop”

Article 15

The shape and colour of the aspect of a signal 4: ”Stop” are given in Figure 1.



Day and night sign:

One red light

Figure 1

Aspect of signal 4: ”Stop” means that further running from the signal is prohibited and that you must stop in front of the signal that says ”Stop”.

3.3.4. Traffic Rulebook (”Official Gazette of the RS” No. 34/22, 107/22)

X. Informing the traction vehicle staff

...

General order

Article 87 (excerpt)

A general order regularly informs and orders:

...

2) about the invalidity of permanent signals, exceptional invalidity of mandatory signals, failure of mandatory signals or pre-signals and failure to operate mandatory signals, stating the type and designation of the signal, and for automatic bloc signals also the kilometre position of the signal, as well as how to proceed with the signal; this shall not be given when there is a malfunction or fault of the pre-signal that displays the signal sign for running with care, as well as in the case of malfunctions or faults of signals that display the signal sign: ”Cautionary entry into the station at 10 km/h”;

...

XIII. Regulation of train operation

1. General provisions on the regulation of train operation

...

Spatial Interval

Article 122. (excerpt)

For the need of regulation of train operation in Spatial Interval, railway lines are divided into:

…

3) block sections, where the operation of consecutive trains is regulated by setting automatic block signals to show a signal sign for prohibited or permitted running by the train.

...

In one block section, on the same track and at the same time, there is only one train.

2. Regulation of train operation on the railway lines equipped with an automatic block, inter-station dependency device and remote control

General provisions on regulation of train operation

Article 126. (excerpt)

Train operation is regulated by the train dispatcher from the station signal box, and on the telecomande line by the telecomande dispatcher from the central signal box.

...

XV. Movement of train on the railway line

1. Train movement

...

Procedure at the mandatory signal showing a prohibited operation sign

Article 228. (excerpt)

When the mandatory signal shows a prohibited operation sign the train must stop in front of it.

Running beyond an entrance signal or protective signal displaying a prohibited running sign is permitted when the route protected by that signal is secured in one of the following ways:

...

2) by phonogram given to the train driver via RDV;

3) by phonogram given to the train driver by telephone at the respective signal;

...

Further running from a automatic block signal showing a signal sign for prohibited running is permitted when the next block section is free, in one of the following ways:

1) by phonogram given to the train driver via RDV;

2) by phonogram given to the train driver by telephone at the respective signal;

3) by a general order issued by the train dispatcher or an authorized station worker based on the order of the telecomande dispatcher at the previous station.

...

When the train stops in front of the mandatory signal showing a signal for prohibited movement, the train driver, after three minutes, requests notification by telephone from the train

dispatcher of the next station or from the telecomande dispatcher at the respective signal. If the traction vehicle is equipped with a RDV device, notification is requested before the train stops.

...

XVII. Procedures in cases of interference or malfunctions in signaling and safety devices or means of communication

...

3. Regulation of train operation during disruptions and falures on APB device

...

Informing of traction vehicle staff

Article 293. (excerpt)

...

The notification is given by the station that dispatches the train in the station gap. If the train does not have a stop at that station, the traction vehicle personnel are notified via the station where the train last stopped before, and if this is not done, the train stops at the station that dispatches the train in the station gap for the purpose of delivering the general order.

...

3.3.5. Rulebook on maintenance of signalling and safety devices ("Official Gazette of the RS", No. 136/20)

Periodic testing and measurement

Article 8.

All signalling and safety devices shall be functionally tested at least once every two years, unless a shorter period is specified in this rulebook or the manufacturer's instructions. On this occasion, the device parameters shall be measured and, if necessary, adjusted within the permitted limits.

...

5. Regular maintenance of the track side automatic train stop device

Article 22.

Regular maintenance of the track side automatic train stop device includes the following activities:

1) every two months the track side automatic train stop device is checked to ensure that:

(1) the device is not mechanically damaged;
(2) the device is at the prescribed distance from the nearest rail;
(3) the device is at the prescribed height in relation to the nearest rail;
(4) that there is no damage to the fastening equipment;
(5) that there is no damage to the cable, protective hose, and cable glands;

2) every six months, the correct operation of the automatic train stop device during the operation of the frequency signal is checked with a special measuring instrument:

(1) 500 Hz;

(2) 1.000 Hz;
(3) 2.000 Hz.

3) once a year, the functional correctness of the track side of the automatic train stop device is checked by a vehicle with a built-in locomotive part of the automatic train stop device.

3.3.6. Instructions on the organization and operation of the operational service on parts of railway lines between the Beograd Centar, Pančevo Glavna, Rakovica and Topčider stations No. 4/2019-1250/1-291 of 14.01.2019 "IŽS"a.d.

Subject of the instructions

Article 2. (excerpt)

...

2. In the current conditions on the section of the Pančevački Most – Beograd Dunav railway line, only feeder trains are operating, which serve the manipulative and industrial tracks of the Beograd donji grad station. At the request of railway undertakings, in order to serve the tracks of the Beograd donji grad station, the Beograd Dunav station is temporarily occupied by a train dispatcher.

The method of providing operational services under the above conditions is prescribed by the provisions of the Instructions on servicing the manipulative and industrial tracks of the Beograd donji grad station in the absence of a dispatcher at Beograd Dunav and Beograd donji grad stations (Instruction No. 15/2018-893 of 12 July 2018, registration number 61 "Infrastructure of Serbian Railways" a.d.

...

4. This instruction also prescribes certain executive provisions in the event of interference or malfunctions in signalling and safety devices or communication means, as well as certain procedures in special cases of accidents and incidents.

...

Description of a part of infrastructure capacities of the section Beograd Centar – Pančevo Glavna station.

...

Vukov Spomenik station

Article 8. (excerpt)

...

7. The train dispatcher at Vukov Spomenik station does not regularly issue general orders to train staff. He will only issue general orders to train staff at the express request of neighbouring stations that regulate train operation if this is necessary for safety reasons.

8. The train dispatcher at the Vukov Spomenik station does not regularly give or receive checkouts. He is obliged to observe the passing train and, if he notices any irregularity on the train, immediately inform the neighbouring stations.

...

3. Executive provisions for the performance of operational service

...

Special provisions for the section Pančevački Most - Krnjača

Article 32. (excerpt)

1. The condition of the steel bridge on the Danube River (Pančevački Most) is such that during the regulation of train operation at the distance between stations Pančevački Most - Krnjača in the area of the steel bridge:

on the right track from *km* 5+292 to *km* 6+359 (mileage given on the right track) on the left track from *km* 5+189 to *km* 6+256 (mileage given on the left track), taking into account both tracks, only one freight train or two passenger trains can operate at the same time.

...

Working posts involved in the regulation of train operation

Article 34. (excerpt)

I. On the sections of the railway lines to which the provisions of this instruction apply, regulation of train operation and securing of the routes are carried out by train dispatchers:

а) on the section Beograd Centar – Pančevački Most junction, the train dispatchers of the station Beograd Centar and Pančevački Most junction with the mandatory presence of a dispatcher of the Vukov Spomenik station,

б) on the section Beograd Dunav - Krnjača (in case of occupancy of the station Beograd Dunav for the needs of servicing of manipulative and industrial tracks of the station Beograd Donji Grad, the train dispatcher of the stations Beograd Dunav and Krnjača and Pančevački Most junction,

в) at the distance between station Pančevački Most - Krnjača, train dispatchers of the Pančevački Most junction and Krnjača station.

...

Procedures in the event of disturbances and malfunctions

Article 45. (excerpt)

...

4. In cases of interference on SS devices when there is a need to introduce station distance, it must be introduced exclusively between stations that are occupied. In this case, the Vukov Spomenik station is not considered a station that can directly participate in the regulation of train operation, i.e. in these cases, station distances can only be Beograd Centar – Pančevački Most, or Rakovica - Pančevački Most and vice versa.

...

12. In cases of interference or malfunctions in SS devices when trains are dispatched in the station block section, in accordance with the provisions of Art. 34, item 29 of Rulebook 2 (“Official Gazette of the ZJŽ“, No. 3/94, 4/94, 5/94, 4/96 and 6/03), it is mandatory to inform the train crew by means of a general order on the block sections in which the train operates on certain sections of the railway line about the (in)validity of all protective signals at the junctions and the (in)validity of certain automatic block signals on a certain section of the railway line.

3.3.7. Business order of the station Vukov Spomenik I part, No. 31/18-I-2252 of 28.12.2018

A - Description of infrastructure facilities and the related distances between stations

...

1.2. Data on neighbouring and subordinate stations (excerpt)

The neighbouring stations are:

The junction Pančevački Most is at km 4+660 (the middle of the station building) of the mileage of the railway line Beograd Centar – Pančevo varoš – Vršac – state border.

This station is a junction for only one direction within the meaning of Article 7, point 2 of the Traffic Instructions ("Official Gazette of the ZJŽ" No. 6/80, 3/82, 6/83, 2/84, 4/88, 8/88, 9/90, 2/91, 2/94 and 2/01) and allows trains to pass to the terminating line towards Beograd Dunav and vice versa only from the direction of the station Pančevo glavna. At the same time, in terms of traffic, it is a halt for the Beograd Centar - Pančevo varoš - Vršac – state border railway and for a part of the Beograd Dunav - junction Pančevački Most - Pančevo glavna railway.

...

Б - Provisions regarding the organization and regulation of traffic

...

1.3. Train dispatcher's workplace (excerpt)

...

The tasks of the train dispatcher of Vukov Spomenik are as follows:

...

• exceptionally, by order of neighbouring stations, General Order S-51 is issued

...

6.3. Traffic regulation in conditions of disruptions and malfunctions (excerpt)

...

To manage the train operation in cases of disruptions to TC and SS devices and disruptions to means of communication, all actions must be taken in accordance with the provisions of Article 77 and Article 79 of the Traffic Regulations ("Official Gazette of the ZJŽ", No. 3/94, 4/94, 5/94, 4/96 and 6/03).

3.4. Functioning of the railway vehicles and technical installations

3.4.1. Control, management and signalling

On the section of main arterial route number 107 between the Beograd Centar station and the Pančevački Most junction and halt, the control, management and signalling devices were in good working conditions and functioning. At the time of the accident, there was no recorded fault or malfunction in the devices.

On 17 May 2024, at 13:00, a malfunction was reported at the Su92 signal, located on the section of the track between the Vukov Spomenik station and the junction and halt Pančevački Most, with the description "not running normally". The malfunction was eliminated by the competent section for the SS facility on the same day at 16:10.

At the time of the accident in question, there was a disturbance on the right track at the distance between the Pančevački Most junction and halt and the Krnjača passing point (false occupation of the TIT2 block section due to a faulty ST1 sensor at the Krnjača passing point). Due to this disturbance, the train crew was given a general order to operate trains from the Pančevački Most to Krnjača on the left track.

An on-site inspection, the CINS working group found that in the tunnel near the Su92 protective signal there was installed an autostop track balise. It was undamaged.

The appearance of the Su 92 protective signal and the autostop track balise is shown in Figure 3.4.1.1.

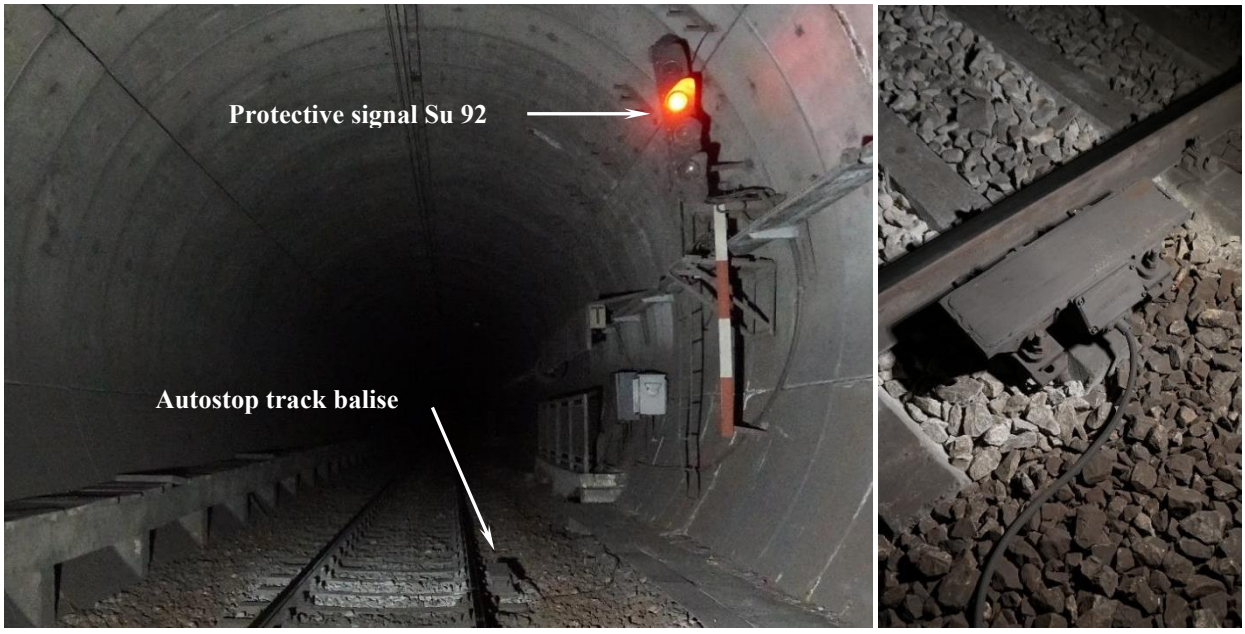


Figure 3.4.1.1: The appearance of the autostop track balise installed at the Su92 protective signal

3.4.1.1. Review of SS devices maintenance documentation

"IŽS"a.d., attached to the letter No. 1/2024-720 dated 22.07.2024, also submitted a letter from the ETP Sector No. 21/2024-836 dated 09.07.2024, which contains copies of the issued work orders for regular maintenance of the OJ for the SS Makiš, as well as measurement lists of periodic tests and measurements on SS devices on the section of the Beograd Centar - Krnjača railway line for the period from 01.05.2023 until the time of the accident.

From the submitted work orders of the Makiš OJ for the SS, it can be concluded that the work on regular maintenance of SS devices on the Beograd Centar - Krnjača section of the railway is carried out regularly in accordance with the provisions of Article 8 of the Rulebook on the Maintenance of SS Devices ("Official Gazette of the RS", No. 136/20). It has been noticed that in some regular maintenance orders, work related to extraordinary maintenance is added if there are disturbances or malfunctions in SS facilities at the station in question. It is assumed that this is a consequence of the rationalization of the workforce engaged in the maintenance of SS devices.

By reviewing the submitted measurement lists for regular maintenance of SS devices, it can be concluded that the work on periodic measurements and tests is carried out by the competent section for maintenance of SS devices.

The submitted material contains measurement lists of measured electrical parameters on track autostop devices, as follows:

- Measurement list dated 14.11.2023 for track autostop devices installed next to the mandatory station signals at the Pančevački Most junction (including the Su92 protective signal), and

- Measurement list dated 23.11.2023 for track autostop devices installed next to automatic block signals controlled from block locations BS1 and BS2 (railway section Karađorđev Park junction - Pančevački Most junction).

All measured electrical parameters in the aforementioned measurements of track autostop devices are within the specified values. These measurements are carried out based on the provisions of Article 22, paragraph 1, item 2) of the Rulebook on the Maintenance of SS Devices ("Official Gazette of the RS", No. 136/20) every six months, using a special instrument for measuring the correctness of the track autostop device.

The measurement list or report on the performed check of the correctness of the track autostop device based on the provisions of Article 22, paragraph 1, item 3) of the Rulebook on the Maintenance of SS devices ("Official Gazette of the RS", No. 136/20), which is carried out once a year, using a vehicle with a built-in locomotive part of the auto-stop device, has not been submitted.

In addition to the aforementioned measurement lists for track autostop devices, the functionality of which is important for conducting the investigation of the accident in question, the submitted material also includes measurement lists for other track autostop devices, axle counters, sections, power supply devices, automatic level crossing devices on the Beograd Centar - Krnjača railway section. The submitted material does not contain measurement lists or protocols on the periodic measurements and tests of light signals, MMI devices, and electric point mechanisms.

3.4.1.2. Interference on SS devices

Attached to the letter No. 21/2024-836 dated 09.07.2024 of the ETP Sector, "IŽS" a.d., a tabular overview of disturbances at SS facilities, recorded by the technical dispatcher for the period from 01.05.2023 to 18.05.2024 for the Beograd Centar - Krnjača railway section, was submitted.

In the table provided, in a period of slightly more than a year, on the Beograd Centar - Krnjača section of the railway (including these two stations), a total of 407 disturbances were recorded on SS devices for a total duration of 1,539,481 minutes, and with an average duration of disturbances of 3,782.5 minutes.

Of the total number of recorded disturbances on SS devices on the mentioned section of the railway, 296 disturbances (72.7% of the total number) lasted up to 180 minutes, 76 recorded disturbances (18.7% of the total number) lasted between 180 minutes and 1440 minutes (24 hours), while 35 recorded disturbances (8.6% of the total number) lasted longer than 1440 minutes (24 hours).

Table 3.4.1.2.1 provides an overview of disturbances the duration of which was longer than 24 hours.

Table 3.4.1.2.1: Overview of disturbances on SS devices, the duration of which is longer than 24 hours, on the section of the Beograd Centar - Krnjača railway line, for the period from 01.05.2023 to 17.05.2024.

No.	Disturbance reporting time	Disturbance cessation time	Station	Device	Description	Disturbance duration [*min*]
1.	29.12.2023 14:00	30.12.2023 14:30	Krnjača	Automatic PP	PBG-1 out of order. Defective brake in left EPS, needs replacement. Replaced brake in left EPS.	1470
2.	05.04.2024 17:40	06.04.2024 20:10	Krnjača	Automatic PP	PBG-2 out of order. Left mechanism brake faulty. Right EPS brake, RUM relay and micro switch no.3 replaced.	1590
3.	02.07.2023 09:50	03.07.2023 12:40	Pančevački Most	APB sections	Occupancy TIT-1. Defective left sensor pair on the left rail of the left track at BT-1. Replaced fasteners in the connection head of the ST-P1L sensor pair, and moderated the sensor pair.	1610
4.	04.12.2023 10:30	05.12.2023 15:30	Pančevački Most	Signals	T-02 does not run freely. Defective group 170 (overrun route group), the section does not have a spare. Replaced group 170.	1740
5.	06.07.2023 09:45	07.07.2023 18:30	Pančevački Most	Station IO	Occupancy on Su-94. Faulty ST-1 sensor pair. Replaced ST-1 sensor pair.	1965
6.	16.08.2023 16:45	18.08.2023 11:00	Krnjača	Axle counter	Occupancy on Ik-4, IS-8. Faulty card on BROS of sensor pair ST-18. Replaced card on BROS.	2535
7.	07.09.2023 19:15	09.09.2023 16:00	Pančevački Most	APB sections	Occupancy TIT-1, TIT-3. Defective card for modem connection to BT-1. Card replaced and short circuit removed on modem circuit from station to BT-1.	2685
8.	09.03.2024 11:42	11.03.2024 09:30	Beograd Centar	Axle counter	Occupancy in section TIB-3. Sensors reset, occupancy still ongoing. CRCS notified (Nikola at 12:57). Occupancy removed by CRCS.	2748

No.	Disturbance reporting time	Disturbance cessation time	Station	Device	Description	Disturbance duration [*min*]
9.	03.12.2023 09:00	05.12.2023 13:35	Krnjača	Automatic PP	PBG-2 out of order. Due to interference on APB (faulty PNK cable). Short circuit on PNK cable removed, occupancies removed. Reset with buttons.	3155
10.	24.11.2023 16:37	27.11.2023 10:20	Beograd Centar	Switches	S-1b has no position control in the direction. Main left switch, notified ZOP service- Matijašević chief welder at 16:55. Notified ZOP Welders-Stamenković 26. 11. 2023 at 16:11. ZOP intervened.	3943
11.	19.05.2023 13:15	22.05.2023 12:00	Krnjača	Automatic PP	PBG-2 out of order. Traffic under counter-consent (cable between BG-1 and PBG-2 device broken). The interference on the cable between BG-1 and the relay room at the Krnjača station was eliminated, the diode on the frame head at point 041h was replaced at 11:45. The device was restored from the out of order using the buttons.	4245
12.	17.12.2023 00:10	19.12.2023 23:00	Krnjača	Automatic PP	PBG-2 out of order. Short circuit in the PNK cable from the relay room to PBG-2. Poles secured in the upper position so as not to disrupt road traffic. After eliminating the short circuit in the PNK cable, the device was placed in service.	4250
13.	17.12.2023 00:10	19.12.2023 23:00	Krnjača	APB sections	Occupancy on both tracks towards Ovča. Short circuit in the PNK cable from the relay room to PBG-2. The short circuit on the PNK cable was removed, 60m of cable was inserted and 3 extensions were made, the occupancy was removed.	4250
14.	15.07.2023 16:47	19.07.2023 11:30	Pančevački Most	Signals	PPS-01 out of order. Defective white light module. Replaced wire in cable from signal cabinet to PPS-01.	5443
15.	01.12.2023 10:20	05.12.2023 13:35	Krnjača	APB sections	Occupancy on both tracks towards Ovča. Short circuit in PNK cable from Krnjača station to PBG-2. Short circuit on PNK cable removed, occupancies removed.	5955
16.	08.06.2023 06:37	12.06.2023 12:45	Beograd Centar	Axle counter	Occupancy on Z-21, TiZ-1. Replaced bridges on plug 4/2 on APB frame on BZ-2.	6128
17.	12.05.2024 02:33	17.05.2024 13:00	Pančevački Most	Axle counter	Occupancy on IS-11 and Tu-93. ST-17 sensor out of order. Sensor replaced.	7827
18.	25.11.2023 09:00	01.12.2023 16:00	Krnjača	Point heaters	The point heaters are out of order. On block I, the heaters on S-3, 4, 5, 6 were enabled at 17:55, for S-1, 2, replacement of FID switch 1 is required. On block II, the heaters on S-7, 8, 9, 10 were enabled (28. 11. 2023 at 14:00), for S-11, 12, replacement of switch is required. On block I, FID 1 switch was replaced, on block II, switch K-3 was replaced.	9060

No.	Disturbance reporting time	Disturbance cessation time	Station	Device	Description	Disturbance duration [*min*]
19.	23.03.2024 19:50	30.03.2024 10:30	Pančevački Most	Signals	Signal S-02 flashes red light on the console. The module has been reset from the red light.	9520
20.	09.05.2024 08:50	17.05.2024 18:40	Krnjača	Axle counter	Occupancy of the Tu-92, TiT-2, T-12 section. Defective right sensor of sensor pair ST-1. Sensor replaced.	12110
21.	14.08.2023 06:30	23.08.2023 10:45	Pančevački Most	Axle counter	Occupancy on section TiT-3. Defective modem on BT-1, section does not have a spare. BROS enabled on BT-1.	13215
22.	05.04.2024 23:10	15.04.2024 11:00	Krnjača	Other SS devices	Defective TSC button. Defective output card on MMI. Replaced output card on MMI.	13670
23.	09.06.2023 02:16	21.06.2023 11:15	Krnjača	Axle counter	Occupancy on TiT-1, TiT-3. Loss of modem connection. Contractor intervention required. Modem card on BT1 replace.	17819
24.	27.07.2023 11:00	14.08.2023 15:30	Krnjača	APB sections	Occupancy TIG-1, G-21. Defective cards. Card replaced.	26190
25.	21.03.2024 07:14	15.04.2024 10:00	Krnjača	Signals	Train departure signal alarm on G-04. Group of trains departure out of order. Group of trains departure replaced.	36166
26.	19.07.2023 22:00	14.08.2023 15:30	Krnjača	Axle counter	Occupancy on TIG-3, Gu-93. Defective left sensor of sensor pair ST-28. Sensors and BROSA cards replaced.	37050
27.	21.07.2023 21:50	22.08.2023 18:30	Krnjača	Axle counter	Occupancy of all sections. Impossible to start the racks, manufacturer's intervention required (Pupin). Contractor Janjić notified at 7:05. PBG-1 device disconnected from service (traffic signals darkened, poles removed) at 11:30. Crossing enabled and put in service.	45880
28.	19.07.2023 22:00	22.08.2023 18:30	Krnjača	Automatic PP	PBG-2 out of order. Due to occupancy of Gu-93, TIG-3. Device disconnected from service and signals blacked out (24. 07. 2023. at 10:15). Crossing enabled and put in service.	48750
29.	20.02.2024 08:37	06.04.2024 12:20	Krnjača	Axle counter	Occupancy at TIT-4, T-22. Defective sensor pair STT-1L, no spare. Sensor pair replaced.	66463
30.	25.12.2023 06:55	15.02.2024 15:00	Pančevački Most	Signals	TDu-91 sometimes does not show line clear. Defective green light module. Needs replacement, no spare. Green light LED module replaced.	75365
31.	30.01.2024 15:30	05.04.2024 23:00	Krnjača	Station IO	IS-7 fake image of section occupancy. Defective TSC button. Defective central control panel on MMI. Control panel replaced.	95490
32.	07.11.2023 16:30	31.01.2024 14:30	Krnjača	Signals	GO-4 stops. Green light module out of order, the section does not have a spare. Module replaced.	122280

No.	Disturbance reporting time	Disturbance cessation time	Station	Device	Description	Disturbance duration [*min*]
33.	05.12.2023 12:03	05.03.2024 12:50	Krnjača	Point heaters	The point heaters on the G side do not have control. Three relays in the control and signal box are out of order. The defective relays have been replaced.	131087
34.	06.09.2023 11:00	09.02.2024 02:30	Beograd Centar	Signals	PPB-09 off. Defective white light module, requires KM shutdown. Module replaced.	224130
35.	19.05.2023 13:15	20.03.2024 14:30	Krnjača	Signals	Input signal Gu-93 does not show line clear. Defective yellow light module, needs replacement. Yellow light LED module replaced.	440715

It can be concluded that in order to eliminate faults, the duration of which from the moment of recording is longer than one day, it is necessary to replace technically defective parts in order to return the device to its designed state. The duration of eliminating the fault leads to the conclusion that the competent maintenance department does not have the necessary spare parts in its warehouse. The lack of spare parts significantly extends the duration of faults on SS devices, whereby the devices are not in a state of maximum functionality, which has as a direct consequence. Namely, in addition to train delays due to unforeseen stopping, it leads to reduced safety and difficulties in the operation of rail traffic.

3.4.1.3. Disturbances in SS devices on the day of the accident

Table 3.4.1.3.1 provides an overview of faults on SS devices on the Beograd Centar - Krnjača section of the railway line for the period from 01.05.2024 until the moment of the accident in question.

Table 3.4.1.3.1: Overview of faults on SS devices on the Beograd Centar - Krnjača section of the railway line for the period from 01.05.2024 until the moment of the accident in question

No.	Disturbance reporting time	Disturbance cessation time	Station	Device	Description	Disturbance duration [*min*]
1.	17.05.2024 13:00	17.05.2024 16:10	Pančevački Most	Signals	Su-92 does not show line clear. Two spare lines of cable 110 (40x0, 9) have been inserted from KO 110 to the Su-92 signal box.	190
2.	12.05.2024 02:33	17.05.2024 13:00	Pančevački Most	Axle counter	Occupancy on IS-11 and Tu-93. Defective ST-17 sensor. Sensor replaced.	7827
3.	11.05.2024 20:07	11.05.2024 21:20	Pančevački Most	Axle counter	Occupancy on IS-11, Tu-93. Sensor pair ST-17 moderated.	73
4.	11.05.2024 09:20	11.05.2024 14:00	Pančevački Most	Axle counter	Occupancy oIS-7, Tu-91. Sensor pair ST-17 moderated.	280
5.	09.05.2024 17:15	09.05.2024 18:20	Krnjača	Axle counter	PBG-2 out of order. Restricted-speed running(8053). Restored by buttons.	65
6.	09.05.2024 08:50	17.05.2024 18:40	Krnjača	Axle counter	Occupancy of the sections Tu-92, TiT-2, T-12. Defective right sensor of the sensor pair ST-1. Sensor replaced.	12110

Р.Бр.	Време пријаве сметње	Време одјаве сметње	Станица	Уређај	Опис	Трајање сметње [*min*]
7.	08.05.2024 10:15	08.05.2024 12:50	Krnjača	Axle counter	Occupancy of the sections Tu-92, TiT-2, T-12. Right sensor of the sensor pair ST-1 moderated.	155
8.	08.05.2024 05:32	08.05.2024 06:00	Beograd Centar	Station IO	The occupation of IS-42 after the completion of the cable service works was removed after the train passed.	28
9.	07.05.2024 11:50	07.05.2024 13:20	Krnjača	Station IO	Occupancy of the TIT-2, OuT-2. BROS reset.	90
10.	07.05.2024 11:47	07.05.2024 13:20	Pančevački Most	APB sections	Occupancy of TIT-3. BROS reset.	93
11.	06.05.2024 19:15	06.05.2024 20:30	Pančevački Most	Axle counter	Occupancy on TiT-3, T-21. The caution signal group has been restored to its regular position.	75
12.	06.05.2024 15:00	06.05.2024 15:50	Krnjača	Signals	Tu-92 does not turn green. Group151 replaced.	50
13.	06.05.2024 10:04	06.05.2024 11:45	Krnjača	Axle counter	Occupancy on Tu-92 and T-12. OPT-2D card reset.	101
14.	01.05.2024 22:31	01.05.2024 23:19	Krnjača	Automatic PP	PBG-2 remained down after the train passed. Card K11d1 reset.	48

From Table 3.4.1.3.1. it can be concluded that on the day of the accident in question (17.05.2024) there were three malfunctions in the SS devices. These are the malfunctions in Table 3.4.1.3.1. shown under numbers 1, 2 and 6.

The faults from Table 3.4.1.3.1. under numbers 1 and 2 were eliminated by the competent maintenance service before the accident occurred. On the section of the line between the stations Beograd Centar and Pančevački Most at the time of the accident in question, there were no recorded faults on the SS devices.

At the time of the accident in question, on the section of the railway line between the Pančevački Most and Krnjača stations, the obstruction shown in table 3.4.1.3.1. under number 6 was not eliminated.

3.4.1.4. Analysis of diagnostic log data from the MMI 10 device

Attached to the letter No. 21/2024-836 dated 09.07.2024 of the ETP Sector, "IŽS"a.d., a diagnostic record from the command and control device of the MMI10 train dispatcher at the Pančevački Most junction was submitted. According to the information in the letter, the diagnostic file was downloaded on 19.05.2024, two days after the accident in question, in cooperation with the equipment manufacturer.

The diagnostic record contains data on commands given by the train dispatcher, with the specified time of command, as well as data on the status of the SS device at the Pančevački Most junction. The submitted diagnostic record contains 8519 events (commands and indications) recorded on 17.05.2024 in the time period from 00:00 to 19:26.

The diagnostic record will be analysed below in order to observe the functioning and availability of the SS devices, as well as to perform additional checks of the chronology of train traffic at the Pančevački Most station before the accident in question occurred.

In the submitted diagnostic record, in the column containing the name of the operator logged into the system at the time of recording the event, for all recorded events in the time period from 00:00 to 19:26, the names of the train dispatchers who were on duty during the specified period (three train dispatchers in three different shifts) were not entered, but the name of the person who was not on duty during the specified period. From this, it can be concluded that the train dispatchers do not log into the MMI device with their own username and password.

3.4.1.5. Analysis of diagnostic record data immediately before the accident occurred

Table 3.4.1.5.1 shows a part of the diagnostic record, which contains events recorded on 17.05.2024, in the time interval from 17:49:08 to 18:25:20 (according to the diagnostic device clock).

This part of the diagnostic record shows automatically recorded events, from which, based on a review of the assigned commands and information on section occupation/release and signal status indications, the process of railway operations at the Pančevački Most station can be reconstructed and an assessment of the proper technical functionality of the SS device can be given.

Given the complexity and large volume of the diagnostic record caused by the number of events recorded for each individual train and the volume of traffic at the Pančevački Most station, the complete diagnostic file will not be shown, but only its individual parts, based on which the operation of the SS device at the Pančevački Most station will be analysed.

Compared to the original diagnostic record, in order to reduce the volume of the material, the columns with the date and name of the operator reported on the MMI device have been removed from this table. In order to make it easier to analyze the recorded events, two columns have been added. A column with information about the train to which the event relates has been added, as well as a column in which an additional explanation of the observed event was provided during the analysis. In order to reduce the burden of the presented material, certain records that do not contain data relevant to the analysis have been removed from the table (data on the blockage of individual elements within the given route, as well as data on the changeover of the switch during the setting of that route). Given that after the start and target commands were given, the given route was realized and the selected route start signal began to show the signal for permitted running, it is considered that the data recorded during the formation and blockages of the given route additionally burden the analysis and have therefore also been removed from the table.

Based on the train operation times, data on train numbers was taken from copies of traffic logs kept at the Pančevački Most and Vukov Spomenik stations (provided by “IŽS“a.d.).

For the sake of clarity of the table, events related to different trains are shown in different colours.

Table 3.4.1.5.1: Presentation of a part of diagnostic record

No.	Time	Event	Element	Type of event	Train	Meaning
7866	17:49:08	Start of the route	M3	COM.	6011	Specifying shunting route M3 - TR5
7896	17:49:26	Signal given for shunting movement	M3	EVENT	6011	M3 line clear
7899	17:49:29	Shunting signal M3 - TOPV	M3	COM.	6011	Cancellation of shunting route M3-TR5
7904	17:50:39	Chosen exit running	TDu91	COM.	6011	Specifying exit route TDu91 → TIT3
7931	17:50:49	Permitted running	TDu91	EVENT	6011	TDu91 shows aspect of a signal for permitted running
7937	17:51:54	Permission mechanism section occupation	TIS2	EVENT	8333	Occupation of the block section TIS2
7938	17:52:09	Section occupation	S7 - kosi	EVENT	6011	Train departure, occupation of the firt section in PV
7977	17:53:55	Permission mechanism section occupation	TIT3	EVENT	6011	Occupation of the block section TIT3
7979	17:55:02	Start of the route	Su92	COM.	8333	Specifying entry route Su92 → To2
8004	17:55:18	Permitted running	Su92	EVENT	8333	Su92 show aspect of a signal for permitted running
8005	17:55:30	Section occupation	Su92	EVENT	8333	Occupation of the first station section
8008	17:55:30	Section clear	TIT3	EVENT	6011	Clearing of the block section TIT3
8021	17:56:23	Permission mechanism section occupation	TIS2	EVENT	8039	Occupation of the block section TIS2
8022	17:57:24	Chosen exit running	To2/To21	COM.	8333	Specifying exit route To2 → TIT3
8040	17:57:35	Permitted running	To2/To21	EVENT	8333	To2 shows aspect of a signal for permitted running
8041	17:57:49	Exit signal To2 - TGPV	To2/To21	COM	8333	To2 turned on aspect of a signal 78 “Start“
8045	17:58:35	Top of switch occupation	S8	EVENT	8333	Train departure, first section occupation
8062	17:59:04	Permission mechanism section occupation	TIT3	EVENT	8333	Occupation of the block section TIT3
8064	17:59:10	Start of the route	Su92	COM.	8039	Specifying entry route Su92 → To2
8080	17:59:20	Permitted running	Su92	EVENT	8039	Su92 shows aspect of a signal for permited running
8081	17:59:50	Section occupation	Su92	EVENT	8039	Frist station section occupation
8086	17:59:59	Permission mechanism section clear	TIS2	EVENT	8039	Clearing of block section TIS2
8093	18:00:37	Section clear	TIT3	EVENT	8333	Clearing of block section TIT3
8094	18:01:28	Start of the route	Tu91	COM.	8328	Specifying entry route Tu91 → So1
8114	18:01:40	Running permitted	Tu91	EVENT	8328	Tu91 shows aspect of a signal for permitted running
8118	18:04:18	Exit running chosen	To2/To21	COM.	8039	Specifying exit route To2 → TIT3
8119	18:04:21	Permission mechanism section occupation TIT1	TIT1	EVENT	8328	Occupation of the block section TIT1
8144	18:04:30	Permitted running	To2/To21	EVENT	8039	To2 shows aspect of a signa for permitted running
8145	18:04:47	Exit signal To2 - TGPV	To2/To21	COMM.	8039	To2 turned on aspect of a signal 78 “Start“
8149	18:05:52	Top of switch occupation	S8	EVENT	8039	Train departure, frist section occupation
8151	18:06:01	Switching contact activated 80m	Tu91	EVENT	8328	Interlocking signal contact Tu91 stepped on
8162	18:06:16	Section occupation	Tu91	EVENT	8328	First station section occupation
8169	18:06:17	Stop	Tu91	EVENT	8328	Tu91 show aspect of signal for prohibited running
8173	18:06:28	Permission mechanism section clear	TIT1	EVENT	8328	Clearing of block signal TIT1

No.	Time	Event	Element	Type of event	Train	Meaning
8176	18:06:28	Permission mechanishm section occupation	TIT3	EVENT	8039	Occupation of block signal TIT3
8198	18:08:02	Section clear	TIT3	EVENT	8039	Clearing of block signal TIT3
8200	18:08:33	Exit route chosen	So1	COMM.	8328	Specifying of exit route So1 → TIS4
8203	18:08:39	Permitted running	So1	EVENT	8328	So1 shows aspect of a signal for permitted running
8209	18:10:48	Occupation of permission mechanism section TIT1	TIT1	EVENT	8040	Occupation of block signal TIT1
8214	18:11:28	Section occupation	IS2	EVENT	8328	Train departure, occupation of the first section
8223	18:11:59	Permission mechanism section occupation	TIS4	EVENT	8328	Occupation of block section TIS4
8225	18:12:14	Permission mechanism section occupation	TIS2	EVENT	52601	Occupation of block section TIS2
8229	18:12:41	Start of the route	Su92	COMM.	52601	Specifying of entry route Su92 → To2
8242	18:12:49	Start of the route	Tu91	COMM.	8040	Specifyign of entry route Tu91 → So1
8244	18:12:50	Permitted running	Su92	EVENT	52601	Su92 shows aspect of a signal for permitted running
8257	18:12:57	Switching contact activated 80m	Tu91	EVENT	8040	Interlocking signal contact Tu91 stepped on
8260	18:12:59	Permitted running	Tu91	EVENT	8040	Tu91 shows aspect of a signal for permitted running
8262	18:13:23	Section occupation	Tu91	EVENT	8040	Occupation of the first station section
8265	18:13:25	Stop	Tu91	EVENT	8040	Tu91 shows aspect of a signal for prohibited running
8267	18:13:29	Switching contact activated 80m.	Su92	EVENT	52601	Interlocking signal contact Su92 stepped on
8270	18:13:37	Permission mechanism section clear	TIT1	EVENT	8040	Clearing of block section TIT1
8273	18:13:44	Section occupation	Su92	EVENT	52601	Occupation of entry station section OuS2
8275	18:13:47	Stop	Su92	EVENT	52601	Su92 shows aspect of a signal for prohibited running
8282	18:14:01	Section occupation	IS1	EVENT	52601	Occupation of station section OS2
8285	18:14:09	Track section occupation	K2	EVENT	52601	Occupation of arrival track (2nd track)
8289	18:14:12	Permission mechanism section clear	TIS2	EVENT	52601	Clearing of block section TIS2
8299	18:14:37	Section clear	Su92	EVENT	52601	Clearing of entry station section OuS2
8293	18:14:20	Permission mechanism section clear	TIS4	EVENT	8328	Clearing of block section TIS4
8295	18:14:22	Track section occupation	K1	EVENT	8040	Occupation of arrival section track K1
8301	18:14:37	Top of the switch clear	S7	EVENT	8040	Clearing of switch section OS7
8303	18:14:49	Section clear	IS1	EVENT	52601	Clearing of the last section of the route
8304	18:16:10	Exit route chosen	So1	COMM.	8040	Specifying exit route So1 → TIS4
8309	18:16:16	Permitted running	So1	EVENT	8040	So1 shows aspect of a signal for permitted running
8312	18:17:23	Section occupation	IS2	EVENT	8040	Train departure, occupation of the first section
8315	18:17:30	Stop	So1	EVENT	8040	So1 shows sign for prohibited running
8320	18:17:50	Permission mechanism section occupation	TIS4	EVENT	8040	Occupation of block section TIS4
8322	18:18:19	Start of the route	Tu91	COMM.	6008	Specifying of entry route Tu91 → TITD
8323	18:18:19	Section occupation	*TIS3	EVENT	7112	Occupation of block section TIS3

No.	Time	Event	Element	Type of event	Train	Meaning
8345	18:18:29	Permitted runnning	Tu91	EVENT	6008	Tu91 shows aspect of a signal for permitted running
8347	18:19:23	Secton clear	*TIS3	EVENT	7112	Clearing of block section *TIS3
8348	18:19:23	Permission mechanism section occupation	TIS2	EVENT	7112	Occupation of block section TIS2
8350	18:19:23	Stop	S12	EVENT	7112	Automatic block setion S12 prohibited running
8351	18:20:30	Permission mechanism section clear	TIS4	EVENT	8040	Clearing of block section TIS4
8355	18:20:53	Occupation of permission mechanism section TIT1	TIT1	EVENT	6008	Occupation of block section TIT1
8360	18:22:14	Switching contact activated 80m	Tu91	EVENT	6008	Interlocking signal contact Tu91 stepped on
8361	18:22:25	Section occupation	Tu91	EVENT	6008	Occupation of the first (entry) station section OuT1
8362	18:22:27	Stop	Tu91	EVENT	6008	Tu91 shows aspect of a signal for prohibited running
8363	18:22:27	Section occupation	Su92	EVENT	7112	Occupation of the first (entry) station section OuS2
8365	18:22:34	Permission mechanism section clear	TIT1	EVENT	6008	Clearing of block section TIT1
8366	18:22:34	Permission mechanism section clear	TIS2	EVENT	7112	Clearing of block section TIS2
8372	18:22:42	Top of the switch occupation	S10	EVENT	6008	Occupation of switch section OS10
8373	18:22:42	Section occupation	IS1	EVENT	7112	Occupation of station section OS2
8374	18:22:47	Exit running chosen	To2/To21	COMM.	52601	Specifying of exit route To2 → TIT3
8375	18:22:47	Section clear	Su92	EVENT	7112	Clearing of entry station section OuS2
8376	18:22:54	Section clear	Tu91	EVENT	6008	Clearing of entry station section OuT1
8382	18:22:54	Top of the switch occupation	S9	EVENT	6008	Occupation of switch section OS9
8385	18:22:54	Secton clear	IS1	EVENT	7112	Clearing of station section OS2
8398	18:22:55	Permitted running	To2/To21	EVENT	52601	To2 shows aspect of a signal for permitted running
8401	18:23:06	Top of the switch clear	S10	EVENT	6008	Clearing of switch section OS10
8403	18:23:08	Top of the switch occupation	S7	EVENT	6008	Occupation of switch section OS7
8420	18:23:32	Top of the switch clear	S9	EVENT	6008	Clearing of switch section OS9
8422	18:23:37	Section occupation	S7 - kosi	EVENT	6008	Occupation of section OuD1
8423	18:24:02	Section occupation	TDu91	EVENT	6008	Occupation of arrival section track OuD
8424	18:24:03	Top of the switch clear	S7	EVENT	6008	Clearing of switch section OS7
8426	18:24:27	Section clear	S7 - kosi	EVENT	6008	Clearing of section OuD1
8427	18:25:20	Exit signal To2 - TSC	To2/To21	COMM.	52601	Command to set To2 to “Stop“

Table 3.4.1.5.1. shows relevant events from which the operation of trains No. 6011, 8333, 8039, 8328, 8040, 52601, 7112 and 6008 (shown in different colours in the table) over the track capacities of the station Pančevački Most can be reconstructed. For trains that were in the area of the station Pančevački Most at the time of the accident, slightly more details are shown compared to other trains, primarily details about the movement of the trains themselves through data on the occupation and clearing of sections in the route.

For all of the above trains, except for train 7112, commands for setting the route were given from the MMI control-command device of the train dispatcher. All given commands were implemented by the station SS device.

By analyzing the data given in Table 3.4.1.5.1, it can be concluded that the command to enter the second station track of the Pančevački Most station was given to train No. 52601 at 18:12:41 (No. 8229), while the train was in the last block section before the Pančevački Most station (TIS2 section, protected by automatic block signal S12). After giving the command, and setting up and blocking the route for train No. 52061, the Su92 entry signal was set to show the signal sign for permitted running (8244). At 18:13:44, train 52601 occupied the OuS2 entry station section (8229), at 18:13:47 the Su92 entry signal switched to show the aspect of a signal sign for prohibited running. At 18:14:11, train 52601 occupies section OS2 (8282, section of the future switch for the deviation to Karaburma), then at 18:14:49 it occupies the section of the destination of the route - track 2 (8285), after which the clearing of the sections begins, namely the block section TIS2 (8229) at 18:14:12, the entry section OuS2 (8299) at 18:14:37 and finally the section OS2 (8303) at 18:14:49, after which train 52061 is completely on the section of the second station track.

Parallel to the entry of freight train No. 52061 into the Pančevački Most junction and halt, a route was set for train No. 8040, which was operating from the direction of Krnjača station towards Beograd Centar on the left track. For train 8040, the entry route was set from the Tu91 signal to the first station track at 18:12:49 (8242), train 8040 occupies the first station track at 18:13:23 (8295), then the exit route was set from the So1 exit signal at 18:16:10 (8304), and the train occupies section OS2 (8312) at 18:17:23, which is the closest time of the train's departure from the Pančevački Most junction and halt.

Immediately after the departure of train 8040, the entry route for the consecutive train, train number 6008 from Krnjača station, is set from the entry signal Tu91 to the “Danube“ track at 18:18:19 (8322). After giving the command, setting and blocking the entry route for train 6008, the entry signal Tu91 is set to show the signal sign for permitted running at 18:18:29 (8345).

Before the train 6008 enters the Pančevački Most junction area, the train 7112 occupies the *TIS2* block section at 18:19:23 (8348), and the S12 automatic block signal starts to show the prohibited running aspect of a signal (8350). No entry route has been set for train 7112.

During the entry of the train 6008, the following sections are occupied and cleared: entry section OuT1 occupied at 18:22:25 (8361), switch section S10 occupied at 18:22:42 (8372), entry section OuT1 cleared at 18:22:54 (8376), switch section S9 occupied at 18:22:54 (8382), switch section S10 cleared at 18:23:06 (8401), switch section S7 occupied at 18:23:08 (8403), switch section S9 cleared at 18:23:32 (8420), switch section OuD1 occupied at 18:23:37 (8422), route destination section OuD occupied at 18:24:02 (8423), clearing of the S7 switch section at 18:24:03 (8424) and finally clearing of the OuD1 section at 18:24:27 (8426).

According to the statement of an employee of “IŽS”a.d. who, at the time of the accident in question, was performing the duties of a train dispatcher at the Pančevački Most junction during a hearing at the premises of the CINS, it was stated that the freight train 52061 was held on the station track until the passenger train 6008 entered the Danube platform, due to the prohibition of the simultaneous passage of a freight train and a passenger train over the bridge.

During the entry of the train 6008 onto the “Danube” track at the Pančevački Most junction, the train 7112 arrives, which, without a specified entry route (entry signal Su92 shows aspect of a signal 4: “Stop”), enters the second track of the Pančevački Most junction, occupying and clearing the following sections: it occupies the entry section OuS2 (8363) at 18:22:27, then clears the block section TIS2 at 18:22:34 (8366), occupies the section OS2 at 18:22:42 (8373), clears the entry section OuS2 at 18:22:47 (8375) and clears the section OS2 at 18:22:54 (8385). After this event, the train 7112 entered the previously occupied section - the second track on which the train 52061 was located.

3.4.2. Infrastructure

The accident site is located on the right track at km 4+392 in a left curve with a radius of R=500 m (from km 4+227 to km 4+586) and on an incline of 7.08‰ (from km 4+218 to km 4+691).

According to the Timetable 0.1 BG:VOZ (which was valid at the time of the accident), on the section of the railway line between the Beograd Centar station and the Pančevački Most junction and halt, the maximum permitted speed was 70 km/h on both tracks. According to the same timetable, there were no speed limits on the section of the railway in question.

At the time of the accident, there was no restricted-speed running on the section of the main arterial route number 107 between the Karađorđev Park and Pančevački Most junction and halt.

3.4.3. Means of communications

At the time of the accident, on the section of main arterial route No. 107 between the Beograd Centar station and the Pančevački Most junction and halt, there were no recorded disturbances or failures that had not been eliminated on the means of communication for traffic control staff and on the means of communication between traffic control staff and train crew (train drivers).

During an on-site inspection by the CINS working group, it was determined that a Temax telephone was installed in the tunnel near the Su92 protective signal, from which it was possible to establish contact with train dispatchers at the Vukov Spomenik and Pančevački Most junction and halt. It was in good condition and in operation.

The appearance of a Temax type telephone set built into the Su 92 protective signal is shown in Figure 3.4.3.1.

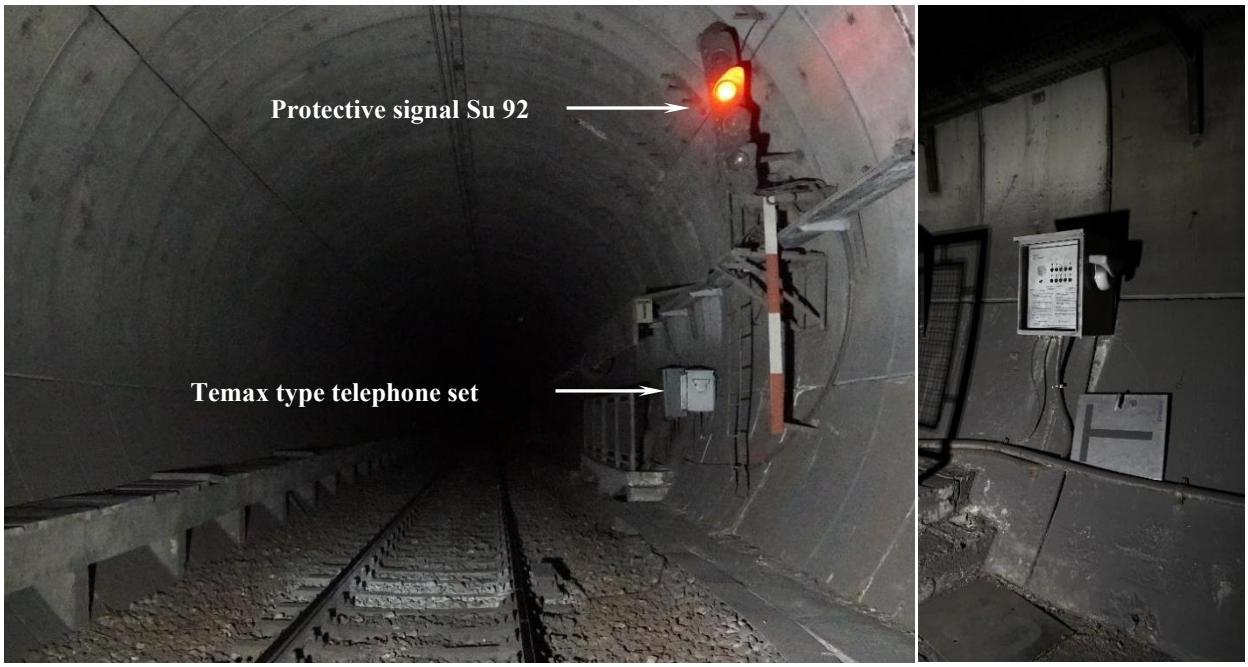


Figure 3.4.3.1: Appearance of a Temax type telephone set built into the Su92 protective signal

3.4.4. Railway vehicles

The train No. 52601 (locomotive 193-192 and 28 (twenty-eight) empty wagons of the E series) was operating on the Vreoci - Vršac route. The train was assembled and braked in accordance with applicable regulations. The train driver was operating the locomotive from the driver's cab "2". Before the accident, the train No. 52601 was moving on the right track of the double-track railway, in the direction from the Beograd Centar station to the Pančevački Most junctions and halt (from the beginning to the end of the railway line, in the direction of the growing mileage).

In accordance with the traffic situation on that section of the railway line, at the time of the accident, the train No. 52601 was standing at the Pančevački Most junction and halt in front of the To2 protective signal, which indicated a prohibited running signal. After standing for seven minutes and twenty-eight seconds, the front of the train No. 7112 hit the rear of the train No. 52601.

At the scene of the accident, due to the extent of damage to the last wagon No. 31 72 5959 453-7 in the train No. 52601, the position and extent of damage to EMV 412/416-005/032 from the train No. 7112, it was not possible to determine the existence of a end signal on the train No. 52601. According to the statement of the train dispatcher at Vukov Spomenik station, when the train No. 52601 was passing through the station, he noticed two square-shaped end signals at the end of the last wagon in the train, based on which it can be concluded that the train No. 52601 was provided with the appropriate signals.

The appearance of the last wagon No. 31 72 5959 453-7 in the train No. 52601 after the collision is shown in Figures 3.4.4.1. and 3.4.4.2.

Figure 3.4.4.1: Appearance of the wagon No. 31 72 5959 453-7 in the train No. 52601 after the accident

Figure 3.4.4.2: Appearance of the wagon No. 31 72 5959 453-7 in the train No. 52601 after the accident

According to the data provided by "Srbija Kargo"a.d. by e-mail dated 21.05.2021. locomotives of the 193 series do not have a built-in speed indicator as a separate piece of equipment, but this function is implemented by the PZB/LZB devices (which are an improved autostop device) and ETCS (as a completely new safety system). All data on the train's movement is recorded and stored in the TRU device, from where data on the speed and movement of the locomotive can be downloaded. There are ETCS, LZB, TZB and MIREL safety devices on the 193 series locomotives. Each of these devices has its number of revolutions indicator. The data they record is systematically compared with the data recorded by GPS and in the event of any deviation in the data, the system would indicate an error. According to the submitted documentation, which relates to the maintenance of speed sensor devices and checking the authenticity of records, certification of these devices is not foreseen.

The processing of data stored on 17.05.2024 in the Alstom type TRU device, installed on the locomotive 193-912 of the train No. 52601, was carried out at "Srbija Kargo"a.d, Train Traction and TKP Section Belgrade, in connection with which the document Data registered with an electronic speedometer device, No. 17/2024-253 of 21.05.2024 was issued (sent by "Srbija Kargo"a.d. by e-mail of 21.05.2024).

By processing the data taken from the memory of the electronic speedometer of the locomotive 193-912 of the train No. 52601, it was determined that the locomotive was operated from the driver's cab "2". During the operation, the 1000 Hz Indus monitoring was active. The

train No. 52601 passed the Karađorđev Park halt at 18:10:00 at a speed of 21.2 km/h. In the next 291 m, the speed decreased and at 18:10:52 it was 19.5 km/h, after which the speed increased and after 746 m, at 18:12:02 it was 61.3 km/h. At that moment, the effect of the active 1000 Hz track balise was registered with the use of the "acknowledge" button. The train continues its movement, with the increasing speed and after 396 m at 18:12:25 it is 66.8 km/h, after which the speed begins to decrease and after 474 m at 18:13:00 it is 36.9 km/h. During the further journey, the train accelerates and after 510 m at 18:13:38 it is 59.4 km/h. At that moment, the effect of the active 1000 Hz track balise was registered with the use of the "acknowledge" button. During the further journey, the train accelerates to a speed of 61.0 km/h in the next 171 m, after which it begins to decrease and after 916 m the train stops at 18:15:31. In the period from 18:22:59 to 18:23:09, a movement of the locomotive (train) was registered in a length of 10 m at a speed of up to 11.6 km/h. The next movement of the locomotive 193-912 was registered on 18.05.2024 at 09:49:55. Times are given according to the speedometer clock.

The train number 7112 operates regularly on the Lazarevac - Ovča route. Exceptionally, due to a breakdown of EMV 412/416-083/084, which was planned to operate as train No. 7112, on 17.05.2024, the train No. 7112 was cancelled on the section of the route between the Lazarevac station and the Karađorđev Park halt. At 18:15 from the Beograd Centar station, the reserve EMV 412/416-005/032 was launched, which arrived at the Karađorđev Park halt along the route of the train No. 38039, after which at 18:18 (according to the Timetable 0.1 BG:VOZ) it continued on as train No. 7112. After traveling a distance of approximately 1500 m from the departure from the Vukov Spomenik station, the front of the train number 7112 collided with the rear of the train No. 52601.

The appearance of the motor coach 412-005 of EMV 412/416-005/032 of the train number 7112 after the collision is shown in Figures 3.4.4.3, 3.4.4.4. and 3.4.4.5.

Figure 3.4.4.3: Exterior view of the motor coach 412-005 of the train No. 7112 after the accident.

Figure 3.4.4.4: View of the passenger compartment of the motor coach 412-005 of the train No 7112 after the accident

Figure 3.4.4.5: View of the driver's cab of the motor coach 412-005 of the train No. 7112 after the accident

Speedometers manufactured by Hasler are installed on EMV 412/416-005/032. The driver's cab of the motor coach 412-005 is equipped with a registering speedometer type RT12, serial No. D08.436, with a certificate validity period until 11.09.2024, and the driver's cab of the motor coach 412-032 is equipped with a registering speedometer type RT12, serial No. E04.317. with a certificate validity period until 12.09.2024.

The speedometer tape was removed from the speedometer recording device of the motor coach 412-005 of the train No. 7112 on 17.5.2024 at the scene of the accident, during the investigation, and was seized by police officers according to the order of the Public Prosecutor from the First OJT in Belgrade. Pursuant to Order KTR No. 6644/24 of 22.05.2024 of the First OJT in Belgrade, the speedometer tape was examined on 03.06.2024 at the Faculty of Mechanical Engineering, University of Belgrade, Center for Forensic Engineering in Belgrade.

From the document Expert Opinion according to the order of 22.05.2024 in the case KT No. 6644/24, number 21.02-2024-06-03 of 03.06.2024 of the Faculty of Mechanical Engineering, Centre for Forensic Engineering (submitted by the First OJT in Belgrade in attachment to the letter KT No. 3756/24 of 06.11.2024.), it can be stated that EMV 412/416-005/032, before departure on 17.05.2024, stood in place for approximately 39 hours. On 17.05.2024, the EMV was started at 15:51 (according to the speedometer clock). After the departure, the time recording section on the speedometer tape did not function properly, while the speed, distance travelled and AS device activation data were recorded correctly. The autostop device was operating in "driving mode 2" (V_{max}=80-100 km/h). After leaving the station, the EMV started from the Beograd Centar station, accelerated to 56 km/h and after approximately 1200 m it stopped at the Karađorđev Park halt. After that, it departured from the Karađorđev Park halt, accelerated and after 580 m reached a speed of 70 km/h. At that speed, it travelled another 440 m, i.e. a total of 1020 m from the departure from the Karađorđev Park halt, when the effect of the active 1000 Hz track balise was registered with the use of the "acknowledge" button. After approximately 560 m, the train stopped at the Vukov Spomenik station. After operations at the Vukov Spomenik station, the train departed from the station and after traveling approximately 780 m at a speed of 61 km/h, the effect of an active 2000 Hz track balise was registered with the "ride on the order" button activated. After traveling an additional 200 m, the train reached a speed of 66 km/h and after traveling another 340 m, braking began from a speed of 63 km/h. After approximately 100 m of braking, the regular recording flow was interrupted at a speed of 44 km/h. According to data on the location of the Su92 protective signal, the location where EMV 412/416-005/032 was found after the accident, as well as data on the distance travelled registered by the speedometer, the interruption of the regular recording flow corresponds to EMV 412/416-005/032 colliding with the last wagon of the freight train No. 52601.

The speedometer tape was removed from the speedometer recording device of the motor coach 412-032 of the train No. 7112 on 22.07.2024 at 13:30 at the Zemun TPS. The processing of the data recorded on the speedometer tape removed from the speedometer recording device of the motor coach 412-032 of the train No. 7112 was carried out at "Srbijavoz"a.d, Train Traction Section Belgrade, in connection with which the document Data from the speedometer tape No. 34/2024-1004 of 24.07.2024 was issued (delivered by "Srbijavoz"a.d. by e-mail of 26.07.2024).

By processing the registered data, it was determined that on 17.05.2024, no movement of EMV 412/416-005/032 was registered from the driver's cab on the motor coach 412-032.

3.5. Traffic management and regulation

3.5.1. Action undertaken by the staff that manages the traffic regulation and control and signaling

The operation of trains No. 52601 and 7112 on the route Rakovica - Pančevački Most and Beograd Centar - Pančevački Most took place in block sections.

The departure of the train No. 52601 from Rakovica station (the train passed through the station) towards the Pančevački Most junction and halt was carried out after the train dispatcher of the junction and halt gave permission for the operation of this train.

The departure of the train No. 38039/7112 (see point 2.2.2.1.) from the Beograd Centar station in the direction of the Pančevački Most junction and halt was carried out after the train dispatcher of the junction and halt gave permission for the operation of this train.

The given and received permissions for the trains No. 52601 and 38039/7112 were recorded by the train dispatchers in the appropriate records they keep at their workplaces.

The train No. 52601 was stopped in front of the To 2 protective signal at the Pančevački Most junction and halt for traffic reasons (waiting for the arrival of the train No. 6008 from the opposite direction because only one train is allowed to operate on the steel bridge over the Danube River at a time and for the delivery of an order to operate at station distance on the Pančevački Most - Krnjača route due to interference with SS devices).

During regular operations at the Vukov Spomenik station (passenger handling provided for in the timetable material), the train driver of the train No. 7112 was given an order by the train dispatcher at the Vukov Spomenik station to operate the train at the station distance between the Pančevački Most junction and halt and the Krnjača passing point due to interference with the SS devices.

According to the provision of point 7 of Article 8 of the Instructions on the organization of traffic and the operation of traffic services on sections of the railway lines between the stations Beograd Centar, Pančevo Glavna, Rakovica and Topčider, No. 4/2019-1250/1-291 of 14.01.2019 "IŽS"a.d. (see point 3.3.6.), the train dispatcher of the Vukov Spomenik station does not regularly issue a general order to the train crew. Only at the express request of the neighboring stations that regulate train operations, will he issue a general order to the train crew if this is necessary for safety reasons.

Also, according to the provision from point 1.3. Part B of the Station's business order of the Vukov Spomenike station, Part I, file no. 31/18-I-2252 of 28.12.2018 (see point 3.3.7.), it is stated that it is the duty of the train dispatcher of the Vukov Spomenik station to exceptionally, upon the order of the neighboring stations, issue a general order.

"Srbijavoz"a.d. submitted several Reports on irregularities in work (EV-38) in which the train drivers state that due to a malfunction in the SS devices, on the day of the accident in question, at the Vukov Spomenik station they received General Order I for operation in the station distance between Pančevački Most and Krnjača.

When, during disruptions and failures of the APB device, the regulation of train operation in station distance is introduced, according to the provision from paragraph 3 of Article 293 of the Traffic Rulebook ("Official Gazette of the RS" No. 34/22, 107/22), the staff of the traction vehicle shall be notified thereof by a general order. The notification (general order) shall be given by the

station that dispatches the train in the station distance. If the train does not have a stop at that station, the staff of the traction vehicle shall be notified via the station where the train last stopped before, and if this has not been done, the train shall stop at the station that dispatches the train in the station distance for the purpose of delivering the general order.

Also, according to the provision of point 3) paragraph 3 of Article 228 of the Traffic Rulebook ("Official Gazette of the RS" No. 34/22, 107/22), running beyond the automatic block signal indicating a prohibited running aspect of a signal is permitted by a general order issued by the train dispatcher at the previous station.

According to the timetable material in use at the time of the accident, the train No. 7112 was scheduled to operate at both the Pančevački Most junction and halt.

3.5.2. Exchange of the voice messages related to the accident

Immediately before the accident, communication was established between the staff regulating traffic, i.e. between the train dispatchers of the Rakovica station, Beograd Centar, Vukov Spomenik and the Pančevački Most junction via telephone connection for evidence communication. Communication was established on three occasions, on 17.05.2024 at 17:55, at 18:05 and at 18:09. The content of the communication related to the operation of the trains No. 52601 and 7112. During the conversation, the BG Voz dispatcher was also present on the line and took part in the communication with the aim of providing information about the operation of the train No. 7112.

Immediately before the accident, communication was established between the driver of the train No. 52601 and the traffic control staff, i.e. the train dispatcher of the Pančevački Most junction and halt. The communication was established verbally in order to inform the driver of the train No. 52601 about the reasons why he was waiting in front of the To2 protective signal, which prohibited further travel.

During the operation at the Vukov Spomenik station to handle passengers, communication was established between the train driver of train No. 7112 and the train dispatcher of the Vukov Spomenik station. The communication was established verbally when delivering Order No. I/38 of 17.05.2024 stating that between the Pančevački Most junction and halt and the Krnjača pasing point, the train operates at station distance due to interference with the SS devices.

Immediately before the accident, communication between the traffic control staff and the train crew (train drivers of the trains No. 52601 and 7112) was not conducted via telephone at the mandatory signals (automatic bloc signal and protective signal) installed on the section of the track between the Karađorđev Park halt and the Pančevački Most junction and halt, nor via the RDV.

3.5.3. Measures undertaken to secure the accident site

After the accident, part of the main arterial route No. 107 Beograd Centar - Pančevo Glavna - Vršac - state border - (Stamora Moravita) between the Beograd Centar station and the Pančevački Most junction and halt and between the Rakovica station and the Pančevački Most junction and halt was closed to train traffic on both tracks of the double-track line and the voltage in the contact network on both tracks of the double-track line was turned off.

According to the data provided by the Secretariat of the MUP RS (letter 02 No. 011-95/24-9 dated 06.09.2024), immediately upon learning about the accident, police officers from the Palilula Police Station were sent to the scene of the incident, who secured the scene until the arrival of the

Public Prosecutor from the First OJT in Belgrade. Police officers from the Traffic Police Station "North", the Traffic Police Directorate and the PU for the City of Belgrade also arrived at the scene of the event and regulated traffic in order to enable other organizational units to take the necessary measures and actions.

No other measures were taken to secure the accident site.

3.6. Interface between people, machines and organization

3.6.1. Work time of the staff involved

The public railway infrastructure manager "IŽS"a.d. and the railway undertakings "Srbijavoz"a.d. and "Srbija Kargo"a.d. provided data based on which it can be concluded that the train driver and conductor who occupied EMV 412/416-005/032, the train driver who occupied locomotive 193-912, the train dispatchers who worked at the Vukov Spomenik and the Pančevački Most junction and halt took a rest as prescribed by law before starting work and that they did not spend more time at work than the maximum time specified by law.

3.6.2. Health and personal circumstances that have effect on the accident, including the presence of physical or psychological stress

The public railway infrastructure manager "IŽS"a.d. and the railway undertakings "Srbijavoz"a.d. and "Srbija Kargo"a.d. provided data based on which it can be concluded that the train driver and conductor who occupied EMV 412/416-005/032, the train driver who occupied locomotive 193-912, the train dispatchers who worked at the Vukov Spomenik and the Pančevački Most junction and halt had passed the professional exam and were medically fit to perform their duties.

The railway undertaking "Srbijavoz"a.d. submitted a copy of the Train Driver's Licence, No. RS 71 2023 0038, issued on 28.03.2023 by the Directorate for Railways, valid until 28.03.2033, for the train driver who operated EMV 412/416-005/032. They also submitted the Complementary Certificate for Operating Certain Types of Traction Vehicles on Certain Infrastructures, reference No. 045590, issued on 28.03.2023 by the employer, valid until 28.03.2033. The Complementary Certificate states that the train driver is authorized to operate vehicles of the 412/416 series and is authorized to operate on the infrastructure of the Belgrade Interchange.

The railway undertaking "Srbija Kargo"a.d. submitted a copy of the Train Driver's Licence No. RS 71 2019 0546, issued on 01.06.2023 by the Directorate for Railways, valid until 01.06.2029, for the driver who operated the locomotive 193-912. They also submitted the Complementary Certificate for Operating Certain Types of Traction Vehicles on Certain Infrastructures reference No. 00044848, issued on 01.06.2019 by the employer, valid until 01.06.2029.

The public railway infrastructure manager "IŽS"a.d, , for the train dispatcher who was on duty at the Vukov Spomenik station at the time of the accident, submitted a copy of the Permit for Regulating Railway Traffic issued on 01.08.2018 by "IŽS"a.d. (No. 15-2018/931-102) with a validity period until 01.08.2024. Also, for the train dispatcher who was on duty at the Pančevački Most junction and halt at the time of the accident, they submitted a copy of the Permit for Regulating Railway Traffic issued on 06.06.2019 by "IŽS"a.d. (No. 15-2019/901-1339) with a validity period until 06.06.2024.

The public railway infrastructure manager "IŽS"a.d. and the railway undertakings "Srbijavoz"a.d. and "Srbija Kargo"a.d. submitted information that the alcohol testing of the participants in the accident was not carried out by the joint investigation commission of the manager and the undertaking.

According to the data provided by the Secretaritat of the MUP RS (letter 02 No. 011-95/24-9 dated 06.09.2024), the police officers of the Traffic Police Station "North", Traffic Police Directorate, PU for the City of Belgrade, conducted an alcohol breath test on the train driver of the train No. 52601. The alcohol breath test was performed with a breathalyzer of the brand "Alcoquant" with serial No. 21110218, certificate No. - EM43/24-10 (valid until 31.10.2024), and no presence of alcohol was detected in the tested train driver, i.e. the value read was 0.00 ‰. The alcohol breath test on the train driver of the train No. 7112 was not conducted by police officers of the traffic police.

According to the data provided by the first OJT in Belgrade (attached to letter KT. No. 3756/24 dated 06.11.2024), toxicological-chemical analyses of blood samples taken from the train driver of the train No. 52601 and the train driver of the train No. 7112 did not prove the presence of ethanol.

According to their own statements, all participants in the accident showed signs of stress resulting from the accident.

3.6.3. Manner of design of equipment that has an effect on the interface between the user and the machine

The main arterial route No. 107 Beograd Centar - Pančevo Glavna - Vršac - state border - (Stamora Moravita) between the Beograd Centar station and the Pančevački Most junction and halt (right track of the double-track line) is designed so that in all parameters it meets the criteria for safe train operation at the speeds prescribed in the timetable.

The locomotive series 193 is controlled by the train driver using commands from the train driver's cabs, designed during the production of the locomotive. No complaints or deficiencies were registered with the control systems and devices of the locomotive 193-912.

No comments or shortcomings were registered regarding the designed technical and operational characteristics of the Za series wagons.

The EMV series 412/416 is controlled by the train driver using commands from the driver's cabs, designed during the production of the EMV. No complaints or defects have been registered with the EMV 412/416-005-032 control systems and devices.

3.7. Previous accidents and incidents of similar character

Based on the data received from "IŽS"a.d. (submitted in the attachment to the letter No. 1/2024-720 dated 22.07.2024 and by e-mail dated 06.08.2024), in the period from 01.01.2013 to 17.05.2024, on the main line No. 107 Beograd Centar - Pančevo Glavna - Vršac - state border - (Stamora Moravita), a total of five accidents (collision of a train with a railway vehicle) and incidents (avoided collision of a train with a railway vehicle) occurred. Out of the total of five accidents and incidents, there were two collisions of a train with a railway vehicle (40.0%) and three avoided collisions of a train with a railway vehicle (60.0%).

In the same period (from 01.01.2013 to 17.05.2025) on the railway network of "IŽS"a.d. a total of 60 accidents (collision of a train with a railway vehicle) and incidents (avoided collision of a train with a railway vehicle) occurred. Out of the total 60 accidents and incidents, there were 14 collisions of a train with a railway vehicle (23.3%) and 46 avoided collisions of a train with a railway vehicle (76.7%).

An overview of the accidents and incidents that occurred is given in table 3.7.1.

Table 3.7.1: Overview of collisions and near-collision events from 01.01.2013 to 17.05.2025.

No.	Date	time	Short description	cause
1	**02.05.2013**	**13:15**	**At km 8+073, between the Tošin Bunar halt and the Zemun station, on the right track, there was a collision between train number 2204 with locomotive 441-701 and train number 2402 with EMV 412/416-063/064.**	**The negligence of the train driver of train number 2402, who failed to stop the train in a timely manner in front of the automatic block signal that showed a prohibited train operation**
2	13.09.2013	06:10	At the Novi Sad Ranžirna station, a collision was avoided between train number 52421 with locomotive 444-010 entering the seventh track and train number 53400 with locomotive 444-022 standing on the seventh track.	Faul of a pointsman who incorrectly set the route of the train and the supervising pointsman
3	**16.02.2014**	**06:39**	**At the Sopot Kosmajski station, a collision occurred between train number 44151 passing through the station and train number 52189 standing on the third track.**	**The negligence of the train driver of train number 44151, who passed the station entry signal without permission, which was showing a prohibited running sign**
4	19.02.2014	18:05	At the Belgrade Ranžirna station, in the receiving yard, a collision between train number 44263, which was entering the sixth occupied track, and a gross vehicle, which was standing on the sixth track, was avoided.	The case has not been concluded.
5	25.04.2014	07:34	At the Subotica station, a collision was avoided between train number 2401 with locomotive 441-703, which was started from the first track, and train number 40764 with locomotive 444-015, which was entering the station on the fourth track.	Fault of the external train dispatcher, who dispatched train number 2401, even though no route had been established for it
6	17.07.2014	21:33	Between the Novi Beograd and Zemun stations, on the left track, a collision between consecutive trains number 6097 and 8099 was avoided.	An error in the work of the internal train dispatcher who incorrectly assumed that the indication of the exit section being occupied was false and that the indication of the next section being occupied came from train 6097, and therefore gave train number 8099 permission to pass the exit signal that showed a signal for prohibited running.

No.	Date	time	Short description	cause
7	**21.08.2014**	**18:20**	**At km 92+050, between the Velika Plana and Markovac stations, overtaking and collision of train number 56702 with train number 56900**	**The negligence of the train driver of train number 56702, who, without permission, passed the automatic block signal, which was showing a signal sign for prohibited running.**
8	20.03.2015	17:26	Between the Putinci and Ruma stations, on the left track, a collision between opposing trains number 2209 and number 34200 (locomotives 441-604) was avoided.	The negligence of the train driver of train 34200, who did not stop at the Putinci station to deliver the General Order, as well as the negligence of the train dispatcher at the Putinci station
10	18.06.2015	11:00	At the Beli Potok station, a collision was avoided between train number 66700, which left from the third track of the station, and train number 40839/59951 from the opposite direction, which had a passage through the fourth track of the station.	The negligence of the train driver of train number 66700, who started the train without permission and passed the exit signal of the Beli Potok station, which was showing a prohibited running sign
11	02.08.2015	07:45	At Belgrade station, a collision was avoided between train number 432, which was entering the third track, and train number 337, which was granted permission to exit from the second track.	The failure of the internal train dispatcher who, due to the slow entry of train number 432 into the station, cancelled the entry route with a phonogram and did not set the signal to the prohibited position, and then gave approval for the departure of train number 337
12	12.12.2015	18:05	At Belgrade station, a collision was avoided between train number 343, which had entry to the fourth track, and train number 336, which had entry to the third track.	Fault of the supervising pointsman and the pointsman, who did not place switch number 30b in the correct position for the entry of train number 343
13	08.01.2016	02:52	At Predejane station, a collision was avoided between train number 40873 entering the station and train number 44700 standing on the third track.	The negligence of the train driver of train number 40873, who passed the entry signal of the Predejane station without permission, which was showing a signal sign prohibiting running
14	10.01.2016	19:47	At Belgrade station, a collision was avoided between train number 3902 (EMW 412/416-005/032), which was entering the station, and train number 729 (EMW 413/4147-001/002), which was standing on the eighth track.	Fault of the supervising pointsman and the pointsman, who did not place switch number 9 in the correct position for the entry of train number 3902
15	25.03.2016	21:30	At the Dragačevo station, a collision was avoided between train number 52981 and locomotive 621-108, which entered the station during a maneuver on the fourth track.	The negligence of the train driver and assistant train driver of train number 52981, who passed the entry signal of the Dragačevo station without permission, which was showing a signal sign prohibiting running

No.	Date	time	Short description	cause
16	03.06.2016	19:23	At the Bačka Topola station, a collision was avoided between train number 1137 (locomotives 441-501), which was entering the station, and train number 45610, which was standing on the third track.	Train dispatcher's negligence
17	01.08.2016	16:48	Between the Ovča and Pančevo Glavna stations, a collision between train number 53001 (locomotive 661-116) and train number 2503 (DMV 711-031/032) was avoided.	Failure in the work of the telegraph operator at Pančevo Glavna station and the train dispatcher at Ovča station
18	13.08.2016	15:43	At Klenje station, a collision was avoided between train number 46167, which was entering the second track, and train number 52185, which was entering the station from the opposite direction.	The negligence of the train driver of train number 52185 (railway undertaking "Srbija Kargo" a.d.), who passed the entry signal of the Klenje station without permission, which was showing a signal sign prohibiting running
19	17.08.2016	00:42	Between the Vodanj and Kolari stations, a collision was avoided between train number 40820, which passed the Kolari station without stopping, and train number 72613, which was running in the opposite direction.	The omission of the train dispatcher of the Kolari station and the TC dispatcher of the TC center Belgrade
20	01.10.2016	01:25	Between the stations of Suva Morava and Priboj Vranjski, a collision between train number 45792 and train number 45795 from the opposite direction was avoided.	The negligence of the train dispatcher at the Priboj Vranjski station who dispatched train number 45792 without obtaining permission
21	**11.01.2017**	**19:15**	**Between the Sajlovo junction and the Kisac station, a collision occurred between train number 6424 (DMV 711-017/018) and train number 47610 (locomotive 444-010), which was stopped due to a defect.**	**The negligence of the train driver of train number 6424, who passed the automatic block signal indicating a prohibited running sign without permission**
22	11.02.2017	16:55	Between Petrovaradin and Novi Sad stations, a collision was avoided between train number 752 (EMV 413/417-023/024) and train number 40872, which was standing in front of the Novi Sad station entry signal showing a prohibited running sign.	The negligence of the train driver of train number 752 (railway undertaking "Srbija Voz" a.d.), who passed the automatic block signal showing a prohibited running sign without permission
23	26.03.2017	21:00	At km 144+420, at Kaona station, a collision was avoided between train number 52795, which was entering the station, and a gross vehicle located on the first manipulative track.	The train dispatcher's failure to set switch number 1 in the direction position, that is, in the correct position for the train to pass through the station
24	**04.07.2017**	**03:30**	**At the Belgrade Ranžirna station, a collision (side impact) between train number 42802 (locomotive 461-024), which was leaving track 35, and a shunting train (locomotive 621-109), which was standing on track 19.**	**Failure in the work of the internal train dispatcher, external train dispatcher, shunting operator and train driver (carrier "Srbija Cargo" a.d.)**

No.	Date	time	Short description	cause
25	09.07.2017	14:08	At the Staro Trubarevo passing point, a collision was avoided between train number 1491, which was entering the station and passing the entry signal showing a prohibited running sign, and train number 52920, which was standing on the first track.	Inconsistency in the function of the SS devices
26	30.07.2017	04:02	At the Crveni Krst station, a collision was avoided between train number 52964, which was starting from the fifth track, and train number 71303, which was standing on the sixth track and which had an exit route formed.	The negligence of the train driver of train number 52964 (railway undertaking "Srbija Kargo" a.d.), who started the train from the third track without permission and burst open the switch number 5a
27	**22.08.2017**	**01:25**	**At the Subotica station, a collision occurred between train number 45631 entering the seventh track and locomotive 461-127 moving on the fourth track.**	**Failure of the train driver of the locomotive 461-127 (railway undertaking "Serbia Cargo" a.d.)**
28	**01.08.2018**	**05:35**	**At km 27+369, between the stations Ripanj Tunel and Klenje, a collision of consecutive trains, number 2990 (EMV 413/417-033/034) and train number 70922, only locomotive 661-162, which stopped on the open track**	**The negligence of the train driver of train number 2990 (railway undertaking "Srbija Voz" a.d.), who, without permission, passed the automatic block signal showing a signal sign for prohibited running**
29	**29.09.2018**	**21:40**	**At km 16+565, at the Pančevo Glavna station, a collision between shunting locomotive 644-006 (hit the fifth car) and train number 53601, which was exiting the sixth track.**	**The train driver of locomotive 644-006 (railway undertaking "Srbija Kargo" a.d.), who passed the shunting signal for track protection showing the signal "Shunting prohibited"**
30	01.12.2018	09:49	At km 149-840, at the Uzići passing point, a collision was avoided between train number 45779 (locomotive 461-106), which passed through the passing point, and train number 4831 (DMV 711), which was dispatched from the Sevojno station towards the Uzići passing point and stopped in front of the passing point entry signal, which was showing a prohibited running sign.	The negligence of the train driver and assistant train driver of train number 45779 (railway undertaking "Srbija Kargo" a.d.), who passed the exit signal of the Uzići passing point without permission, which was showing a signal sign for prohibited running
31	29.03.2019	10:35	At the Vlaško Polje station, a collision was avoided between train number 40878, which was leaving the station, and train number 40773, which was entering the station from the opposite direction.	The negligence of the train driver of train number 40878 (railway undertaking "Srbija Kargo" a.d.), who passed the exit signal of the Vlaško Polje station without permission, which was showing a signal sign for prohibited running
32	30.03.2019	03:31	At the Džep passing point, a collision was avoided between train number 45703, which was leaving the passing point, and train number 4900, which was moving towards the passing point, from the opposite direction.	The negligence of the train driver of train number 45703 (railway undertaking "Srbija Kargo" a.d.), who passed the exit signal of the Džep passing point without permission, which was showing a signal sign for prohibited running

No.	Date	time	Short description	cause
33	12.04.2019	02:50	At km 3+050, on the "B" junction, a collision was avoided between train number 45023 (loc. 461-106, railway undertaking "Srbija Kargo" a.d.) and train number 52964 (loc. 441-031, railway undertaking "Srbija Kargo" a.d.), which was moving in the opposite direction.	The negligence of the train dispachers of the Resnik station, junction "K" and junction "B"
34	10.06.2019	13:40	Between the stations Mladenovac and Kovačevac, a collision was avoided between train number 42001 (locomotive 441-316, railway undertaking "NCL") and train number 53990 (locomotive 441-513, railway undertaking "Kombinovani prevoz" d.o.o), which was moving in the opposite direction.	The negligence of the train dispacher of the Mladenovac station
35	27.06.2019	14:15	At Zemun station, a collision between train number 78022 and train number 8017 from the opposite direction was avoided.	The negligence of the train driver of train number 78022 (railway undertaking "Srbija Voz" a.d.), who passed through Zemun station without permission.
36	04.07.2019	21:02	At Zmajevo station, a collision was avoided between train number 840 (DMV 711-051/052) and train number 4407 (DMV 711-065/066), which was traveling in the opposite direction.	The negligence of the train driver of train number 840 (railway undertaking "Srbija Voz" a.d.), who passed the exit signal of the Zmajevo station without permission, which was showing a signal sign for prohibited running
37	10.07.2019	22:55	At km 90+090, at Velika Plana station, a collision was avoided between train number 46872, which was passing through the fourth track of the station, and train number 53971, which entered the fourth track of the station from the opposite direction.	The negligence of the train driver of train number 53971 (railway undertaking "Srbija Kargo"a.d.), who passed the entrance signal of the Velika Plana station without permission, which showed a signal sign for prohibited running
38	28.10.2019	00:40	At the Banatsko Miloševo station, a collision was avoided between train number 53501 (locomotive 644-017, railway undertaking "Srbija Kargo" a.d.), which entered the station on the fourth track, and the gross train on the fourth track.	The omission of the train dispatcher at Banatsko Miloševo station, who failed to provide any notification of the train entering the occupied track
39	04.02.2020	19:47	At the Ripanj station, a collision was avoided between train number 52182 (railway undertaking "Srbija Kargo"a.d.) entering the station and train number 45400 (railway undertaking "Srbija Kargo"a.d.) standing on the third track.	The negligence of the train driver of train number 52182 (railway undertaking "Srbija Kargo" a.d.), who passed the entrance signal of the Ripanj station without permission, which was showing a signal sign for prohibited running
40	06.02.2020	15:30	At the Belgrade Center station, a collision was avoided between train number 8022 (EMW 412/416-027/028) exiting the third track and train number 78067 (EMW 413/417-015/016) entering the sixth track from the opposite direction.	Fault of the external train dispatcher, who dispatched train number 8022 without the order of the internal train dispatcher

No.	Date	time	Short description	cause
41	**23.05.2020**	**19:33**	**At the Ralja station, a collision occurred between train number 46871 (railway undertaking "Srbija Kargo" a.d.) entering the fourth track and train number 62185 (railway undertaking "Srbija Kargo" a.d.) leaving the station.**	**The negligence of the train driver of train number 62185 (railway undertaking "Srbija Kargo" a.d.), who passed the border track signal and the station exit signal without permission, which showed a signal sign for prohibited running**
42	19.10.2020	20:54	Between the stations Zemunsko Polje and Zemun, a collision was avoided between train number 8045 (EMV 412/416-064/092, railway undertaking "Srbija Voz" a.d.), which was leaving the third track, and train number 8036 (railway undertaking "Srbija Voz" a.d.), which was entering the station on the fourth track.	The omission of the train dispatcher at Zemunsko Polje station, who gave approval for the departure of train number 8045, before the formation of the route and the arrival of train number 8036
43	10.12.2020	15:02	At the Vlaško Polje station, a collision was avoided between train number 46931 (railway undertaking "Srbija Kargo" a.d.) passing through the fourth track and train number 47746 (railway undertaking "Srbija Kargo" a.d.) entering the station from the opposite direction.	The negligence of the train driver of train number 46931 (railway undertaking "Srbija Kargo" a.d.), who passed the exit signal of the Vlaško Polje station without permission, which was showing a signal sign for prohibited running
44	26.12.2020	08:16	At the Novi Beograd station, a collision was avoided between train number 8009 (EMW 412/416-099/100) entering the station and train number 8004 (EMW 412/416-091/096) standing on the fifth track.	Omission of the pointsman at block 2 of Novi Beograd station, who incorrectly formed the route for train number 8009
45	10.03.2020	23:50	At the Belgrade Ranžirna station, a collision between train number 52300 (railway undertaking "Srbija Kargo" a.d.) and runaway wagons from the "Lola" industrial track was avoided.	Unauthorized handling of the parking brake by an anonymous person
46	13.09.2021	13:00	At Ruma station, a collision was avoided between train number 72210 (locomotive 647-004, railway undertaking "Kombinovani Prevoz" d.o.o), which was entering the station, and train number 62290, which was standing on the eleventh track.	The negligence of the train driver and assistant train driver of train number 72210 (railway undertaking "Kombinovani Prevoz" d.o.o.), who passed the entrance signal of Ruma station without permission, which was showing a signal sign for prohibited running
47	13.10.2021	05:00	At the Vlaško Polje station, a collision was avoided between train number 73380/52936 (railway undertaking "Kombinovani Prevoz" d.o.o.), which was entering the third track, and train number 52913 (locomotive 193-917, railway undertaking "Srbija Kargo" a.d.), which was standing on the third track.	The omission of the TC dispatcher of the TC Center Belgrade, who, in conditions of disruptions or indications of occupation on the third and fourth tracks, formed a route for train number 73380/52936 on the occupied track
48	13.04.2022	13:50	At the Zaječar station, a collision was avoided between locomotive train number 70708 (locomotive 664-111, railway undertaking "Srbija Kargo" a.d.) which was leaving the first track and train number 73721 (TMD 915-105, infrastructure manager IŽS), which was entering the second track.	The omission of the train driver and assistant train driver of train number 70708, who started the locomotive without permission, cutting the switch

No.	Date	time	Short description	cause
49	05.05.2022	10:05	Between the Smederevo and Radinac stations, a collision was avoided between train number 6755 (DMV 711-071/072, railway undertaking "Srbija Voz" a.d.) moving towards the Radinac station and locomotive 441-040 (railway undertaking "Srbija Kargo"a.d.) which was performing shunting work at the station.	The negligence of the train driver of locomotive number 441-040, who left the Radinac station without permission
50	**29.06.2022**	**02:55**	**At the Pančevo Glavna station, a collision occurred between train number 57601 (railway undertaking "Srbija Kargo" a.d.), which was started from the fifth track, and locomotive 441-009 (railway undertaking "Srbija Kargo" a.d.), which was stationary (standing).**	**The omission of the train driver and assistant train driver of train number 57601 (railway undertaking "Srbija Kargo"a.d.)**
51	**28.11.2022**	**03:30**	**At Požega station, a collision occurred between train number 53110 (railway undertaking "Srbija Kargo"a.d.), which was started from the fifth track, and locomotive 193-910 (railway undertaking "Srbija Kargo" a.d.), which was standing on the fifth track.**	**The omission of the internal and external train dispatcher of Požega station, as well as the train driver of train number 53110**
52	**01.01.2023**	**09:50**	**Between Resnik and Bela Reka stations, a collision between train number 70111, which was moving from Resnik station, and the defective train number 52600**	**The omission of the train driver of train 70111 (railway undertaking "Srbija Kargo" a.d.)**
53	19.09.2023	09:17	At Zemun station, a collision was avoided between train number 432, which was entering the ninth track of the station, and train number 2407 (EMV 413/417-017/018), which was leaving the eighth track of the station.	The negligence of the train driver of train number 2407 (railway undertaking "Srbija Voz" a.d.), who started the train from the eighth track without permission and passed the exit signal of the Zemun station, which was showing a signal sign for prohibited running
54	12.10.2023	01:05	Between the Stalac station and the Stevanac passing point, a collision was avoided between train number 47842 (locomotive 1141-387, railway undertaking "PIMK" d.o.o.), which was leaving the second track of the Stevanac passing point, and train number 51331 (railway undertaking "Srbija Kargo"a.d.), which was moving towards the Stevanac passing point.	The negligence of the train driver of train number 47842 (railway undertaking "PIMK"d.o.o.) who started the train without permission and passed the exit signal of the Stevanac passing point, which was showing a prohibited running sign (the autostop device on the locomotive was turned off due to a malfunction)
55	01.11.2023	07:20	At the Ovča station, a collision was avoided between train number 2601 (railway undertaking "Srbija Voz"a.d.), which was given permission to enter the third track at a time when the exit route had already been formed for train number 8302 (railway undertaking "Srbija Voz" a.d.), which was standing on the third track.	The omission of the internal train dispatcher of the Ovča station and inattention of the train driver of train number 2601

No.	Date	time	Short description	cause
56	**17.11.2023**	**18:42**	**At km 56+050 between the stations Ratkovo and Odžaci, a collision of consecutive trains number 25412 (DMV 711-077/078, railway undertaking "Srbija Voz" a.d.) and 49028/73478 (railway undertaking "Transagent Operator" d.o.o.) which were standing on the open track**	**Omissions in the work of the train dispatcher of the Ratkovo station**
57	**13.01.2024**	**06:45**	**At km 27+550 between the stations of Vrčin and Lipe, a collision occurred between auxiliary locomotive number 193-912, which was operating as train 70966, and the locomotive of train number 51132 (loc. 461-124 and 24 Eas empty wagons, railway undertaking "Srbija Kargo" a.d.) which was stopped due to a locomotive defect.**	**Omissions in the work of the train driver of the auxiliary locomotive 193-912 (railway undertaking "Srbija Kargo"a.d.)**
58	23.03.2024	12:37	At km 30+728 between the Dolac passing point and Ostrovica station, a collision was avoided between train number 49036 (railway undertaking "S Rail" d.o.o.) and train 45005 (railway undertaking "Srbija Kargo"a.d.)	Omissions in the work of the train driver of train number 49036 (railway undertaking "Srbija Kargo" a.d.)
59	27.03.2024	06:47	At the TK Ralja station, a train collision was avoided when train number 7902 (railway undertaking "Srbija Voz" a.d.) passed the entry signal Gu 91 at km 35+750), which prohibited running, and stopped at an isolated section of switch number 12 at km 35+138, which led to the 3rd track where train number 51111 (railway undertaking "Srbija Kargo" a.d.) was standing.	Omissions in the work of the train driver number 7902 (railway undertaking "Srbija Voz" a.d.)
60	11.04.2024	19:00	At km 50+449 at Ratkovo station, a train collision was avoided, as train number 51447 (railway undertaking "Global Neologistics" d.o.o.) did not stop inside the fourth track, but passed the fouling point, burst open the switch number 2, continued to move towards the station exit and stopped 50 m in front of the entrance signal from the Gajdobra station at the time when train number 5434 (railway undertaking "Srbija Voz" a.d.) was coming from the opposite direction.	Omissions in the work of the train driver of train number 51447 (railway undertaking "Global Neologistics"d.o.o.)

According to the Investigation Reports of the joint investigation commission of the infrastructure manager and the railway undertakings, these accidents and incidents were mostly (in 57 cases, or 95.0%) caused by personal negligence of railway workers (in 34 cases, the train driver and/or assistant train driver; in 19 cases, the train dispatcher, TC dispatcher, telegrapher and/or switch operators; in 4 cases, joint liability). In one case, the cause was stated to be a SS

device, while in one case, the liability of an unidentified person was stated. One case has not yet been concluded (the investigation has not been completed).

The structure of the causes of accidents and incidents of a similar nature in the period from 01.01.2013 to 17.05.2024 on the railway network of "IŽS"a.d. is shown in Chart 3.7.1.

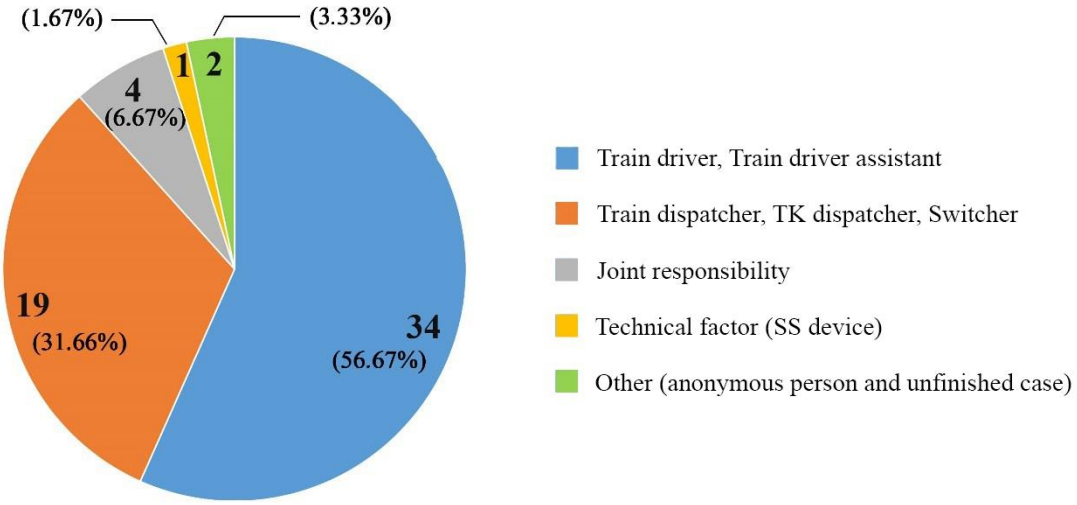


Chart 3.7.1: Structure of causes of accidents and incidents of a similar nature in the period from 01.01.2013 to 17.05.2024 on the railway network of "IŽS" a.d.

4. Analysis and conclusions

4.1. Final review of the event process and drawing conclusions about the event based on the facts established during the investigation and examination

On the section of the main arterial rout No. 107 between the Beograd Centar station and the Krnjača passing point, at the distances between stations Beograd Centar - Pančevački Most and Pančevački Most - Krnjača, traffic is regulated by APB devices at block intervals, with the possibility of turning of the permission mechanism.

According to the data provided by "IŽS"a.d. (attached to letter No. 1/2024-720 dated 22.07.2024 and by e-mail dated 27.07.2024, 06.08.2024 and 13.08.2024), on 17.05.2024, two faults were recorded on SS devices on the section of the main arterial route No. 107 between the Beograd Centar station and the Krnjača passing point. The fault was recorded on 12.05.2024 at 02.30 at the Pančevački Most junction and halt, with the description "occupancy at switch No. 11 and section Tu93", and was eliminated on 17.05.2024 at 13:00 by replacing the faulty ST-17 sensor pair. At 13:00, a fault was reported at the Su92 safety signal, which is located on the right track on the section of the railway between the Vukov Spomenik station and the Pančevački Most junction and halt, with the description "not running at line clear". The competent section of the SS facility eliminated the disturbance on the same day at 16:10. These two disturbances were eliminated before the accident occurred. The disturbance recorded on 10.05.2024. at 09:05 on the section of the track between the Pančevački Most halt and the Krnjača passing point (on the right track), with the description "occupation at the automatic block signal T12 and the entrance section Tu92", was eliminated on 17.05.2024 at 18:40 by replacing the faulty right sensor pair ST-1. Due to this disturbance, traffic on the right track on the section of the track between the Pančevački Most junction and halt and the Krnjača passing point was taking place at station distances, of which the rolling stock was informed by order through general orders.

By reviewing the Traffic Logs of the Beograd Centar station, Vukov Spomenik station and the Pančevački Most junction and halt, it can be concluded that permission was obtained for the traffic of trains No. 52601 (on the Rakovica – Pančevački Most route) and 38039/7112 (on the Beograd Centar – Pančevački Most route) in accordance with the applicable regulations and that a notice was issued for them.

The train No. 52601 (locomotive 193-912 and 28 empty E series wagons, railway undertaking "Srbija Kargo"a.d.) stopped at 18:20 at the Pančevački Most junction and halt on the right track of the double-track railway in front of the To2 protective signal showing the "Stop" aspect of a signal. The train stopped for traffic reasons; in order to wait for the train to arrive from the opposite direction (according to the telegram "IŽS"a.d. No. 65 dated 09.12.2016 and letter No. 30/2017-2853 dated 27.11.2017, only one freight train or two passenger trains can be on the steel bridge over the Danube River at the same time, even though the bridge has a double-track railway) and for the reason of the delivery of a general order - an order that on the section of the railway line between the Pančevački Most junction and halt and the Krnjača passing point, a train operates within station distance.

EMV 412/416-005/032 (railway undertaking “Srbijavoz“a.d.) was launched from the Beograd Centar station at 18:15 and operated as train No. 38039 to the Karađorđev Park halt. After stopping at the Karađorđev Park halt, it continued as train No. 7112. On the section of the track between the Karađorđev Park halt and the Vukov Spomenik station, train No. 7112 passed the automatic block signal S12, which showed the signal “Caution, expect Stop” (yellow light) with the use of the “acknowledge“ button by the train driver. While stopping at the Vukov Spomenik station, the train dispatcher handed the train driver of train No. 7112 General Order (S-20) No. 38, which contained an order that on the section of the track between the Pančevački Most junction and halt and the Krnjača passing point, train No. 7112 would operate at station distance and that the T12 automatic block signal would not apply to train No. 7112. After departing from the Vukov Spomenik station, the train passed the Su92 protective signal, which was showing the “Stop“ aspect of a signal, with the train driver using the “ride on the order“ button.

Under these circumstances, trains No. 52601 (locomotive 193-912 and 28 empty wagons of the E series, railway undertaking “Srbija Kargo“ a.d.) and 7112 (EMV 412/416-005/032, railway undertaking “Srbijavoz“ a.d.) overtook each other and collided.

The collision occurred when the front of train No. 7112 (the front part of EMV 412/416-005/032, i.e. motor coach 412-005), which was moving, hit the end of train No. 52601 (the last wagon No. 31 72 5959 453-7), which was standing in front of the protective signal To2.

Figure 4.1.1 shows a sketch of the accident.

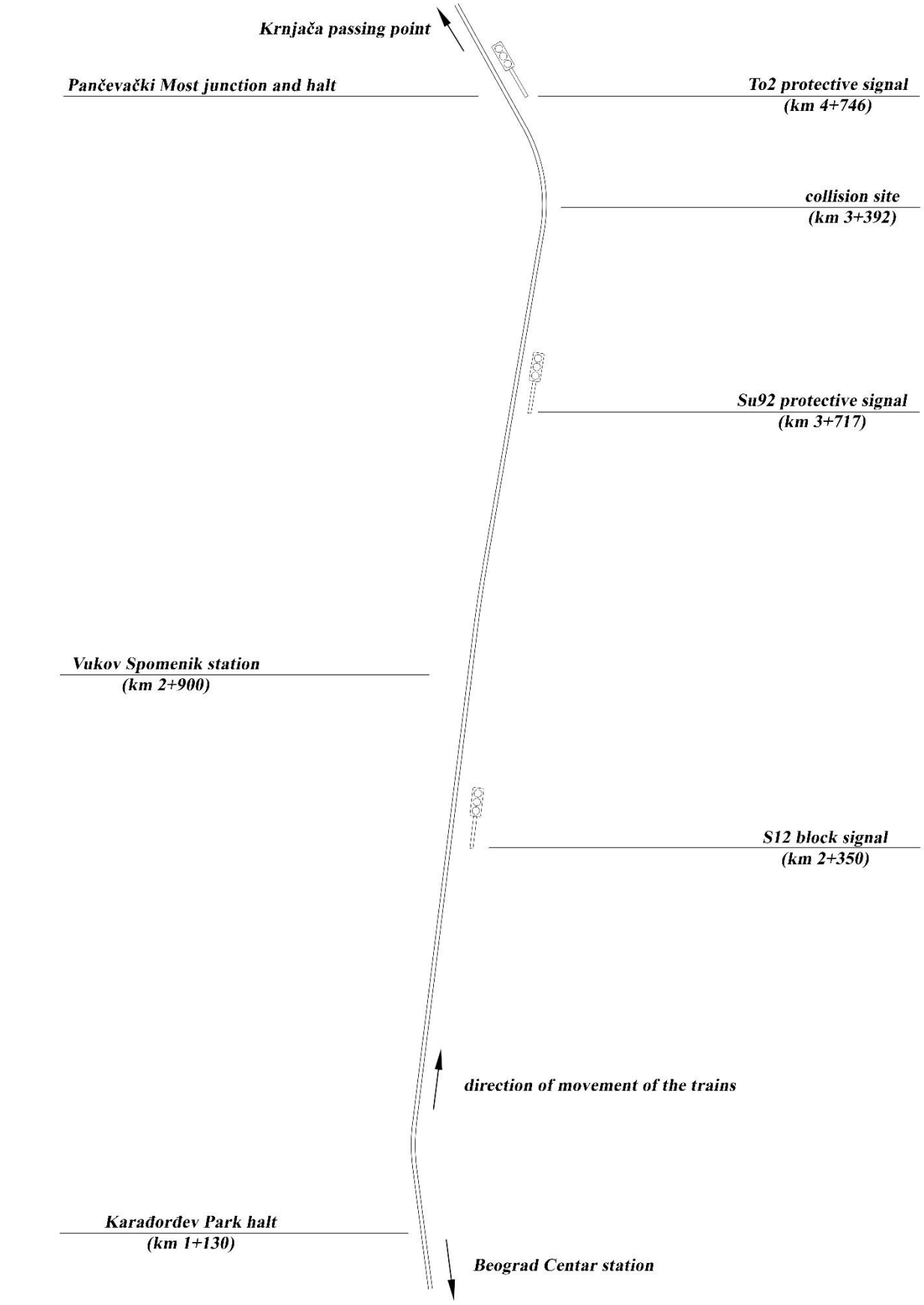


Figure 4.1.1: sketch of the accident

After the collision, due to the action of the kinetic energy of the train No. 7112 (which was moving), the train No. 52601 (which was stationary) moved from its place and continued moving for a length of approximately 10 m. On this occasion, the front part of the body of the motor coach 412-005 was deformed in the area of the driver's cab and passenger compartment, and the deformation of the wagon No. 31 72 5959 453-7 occurred. Motor coach 412-005 derailed with both bogies.

The appearance of the deformations on EMV 412/416-005/032 from the train No. 7112 and the rear part of the last wagon No. 31 72 5959 453-7 from the train No. 52601 found at the accident site is shown in Figures 4.1.2, 4.1.3 and 4.1.4.

Figure 4.1.2: Appearance of damage to the front of the motor coach 412-005 of the train No. 7112 after the accident

Figure 4.1.3: Appearance of deformations in the passenger compartment of the motor coach 412-005 of the train No. 7112 after the accident

Figure 4.1.4: Appearance of deformation of the wagon No. 31 72 5959 453-7 of the train No. 52601 after the accident

4.2. Analysis of facts determined during investigation

4.2.1. Analysis of rolling stock maintenance

4.2.1.1. EMB 412/416-005/032

According to the data provided by "Srbijavoz"a.d. (attached to letter No. 1/2024-890 of 11.07.2024), EMV in the composition 412-005/416-013/416-095/412-032 has been in operation since the regular maintenance carried out on 17.07.2006 at AD "Šinvoz" Zrenjanin. The last regular (investment) maintenance (repair and modernization) of the EMV was carried out on 31.05.2019 at AD "Šinvoz" Zrenjanin. Since the last regular maintenance, the EMV had run 340,940 km until the accident.

In the period from 01.05.2023 until the accident (17.05.2024), a total of 11 regular inspections were performed on EMV 412-005/416-013/416-095/412-032, as follows:

- Seven inspections of level P1,
- Two inspections of level P3,
- One inspection of level P6 and
- One inspection of level P12.

Table 4.2.1.1.1. shows data on the dates of regular inspections (KTP).

Table 4.2.1.1.1: Overview of the dates of regular inspections (KTP) of EMV 412/416-005/032 in the period from 01.05.2023 to 17.05.2024

Month	KTP level P1	KTP level P3	KTP level P6	KTP level P12
2023				
May		30.05		
June	27.06.			
July				
August	03.08.			
Septembre				04-08.09.
Octobre	13.10.			
Novembre	17.11.			
Decembre		26.12.		
2024				
January	21.01.			
February	23.02.			
March			27.03.	
April	22.04.			

Based on the submitted documentation, it can be concluded that regular inspections were carried out within the deadlines and to the extent stipulated in the Instructions for Maintenance of Traction Vehicles of "Srbija Voz"a.d. No. 4/2016-16-4 of 23.02.2016.

According to data (EV63 lists) provided by "Srbijavoz"a.d., in the period from 01.05.2023 to 17.05.2024, a total of 90 emergency repairs were carried out on EMV 412-005/416-013/416-095/412-032.

Table 4.2.1.1.2 provides an overview of the number of emergency repairs by month in the period from 01.05.2023 to 17.05.2024.

Table 4.2.1.1.2: Overview of the number of emergency repairs on EMV 412/416-005/032 in the period from 01.05.2023 to 17.05.2024

Month	**2023**		**2024**	
	Number	Note	Number	Note
January	-		9	
February	-		5	
March	-		6	
April	-		7	
May	4		3	
June	8		-	
July	-		-	
August	5		-	
Septembre	10		-	
Octobre	15		-	
Novembre	8		-	
Decembre	10		-	

Within the scope of emergency repairs, the largest number of repairs related to the following subassemblies: earthing relay (26 failures), electric braking (14 failures) and autostop device (4 failures). All recorded failures and malfunctions had no impact on the occurrence of the accident. After each repair, the EMV was placed in service in good condition.

At the time of the accident, no malfunction or irregularity was recorded (reported) on the EMV.

Based on the documentation submitted by "Srbijavoz"a.d., regular and extraordinary maintenance of EMV 412-005/416-013/416-095/412-032 at "Srbijavoz"a.d. was carried out in accordance with applicable regulations.

4.2.1.2. Locomotive 193-912

The railway undertaking "Srbija Kargo"a.d. (by e-mail dated 04.07.2024) submitted data on regular and extraordinary maintenance of the locomotive 193-912, with unique No. 91 80 6193 912-3. According to the submitted data, the locomotive 193-912 was manufactured on 18.10.2019, and has been in service on the public railway infrastructure network of the RS since 10.02.2020. The locomotive 193-912 had run a total of 392,722 km by 31.05.2024.

In the period from 10.02.2020 until the accident (17.05.2024), a total of 11 regular inspections were performed on the locomotive 193-912, as follows: 9 level N inspections (Follow-up inspection N), one level I1 inspection (Inspection I1) and one level I2 inspection (Inspection I2). All inspections were performed in accordance with the recommendations of the locomotive manufacturer (document X4EVIM - Maintenance Program - Complete List, issued by Siemens Mobility GmbH).

In the period from 10.02.2020 to 19.05.2024, 22 extraordinary repairs were carried out, mainly related to wheel treatment, pantograph damage and repairs after accidents (derailments and collisions). All recorded failures and malfunctions had no impact on the occurrence of the accident. After each repair, the locomotive 193-912 was placed into service in good condition.

After the accident, on 19.05.2024, in the workshop of the Makiš depot, Section for Maintenance Rolling Stock (ZOVS) Belgrade, "Srbija Kargo"a.d., an inspection of the locomotive 193-912 was carried out by the railway undertaking "Srbija Kargo"a.d. in accordance with the provisions of Article 6 of the Rulebook on the Maintenance of Railway Vehicles ("Official Gazette of the RS" No. 144/2020). During the inspection, it was determined that there were no damages or defects on the locomotive. After the inspection, the locomotive 193-912 was placed in service.

Based on the documentation provided by "Srbija Kargo"a.d., regular and extraordinary maintenance of the locomotive 193-912 was carried out in accordance with applicable regulations.

4.2.2. Analysis of the braking proces before the occurence of the accident

Based on the data recorded by the speedometer on the motor coach 412-005 EMV 412-005/416-013/416-095/412-032 (see point 3.4.4.), immediately before the accident, braking began from a speed of 63 km/h. After approximately 100 m of braking, at a speed of 44 km/h, a collision occurred (interruption of the regular flow of the recording).

According to the Commission Regulation (EU) No 321/2013 of 13 March 2013 concerning the technical specification for interoperability relating to the subsystem "rolling stock - freight wagons" of the rail system in the European Union and repealing Decision 2006/861/EC, for a stopping distance of 700 m, the average deceleration from 100 km/h must be at least 0.6 m/s^2. This data is generally valid and can be applied to this case.

The *EN 16834 (2018)* standard recommends the following formula for calculating the average deceleration value:

$$a_{bi} = \frac{v_{i-1}^2 - v_i^2}{2s_i}$$

where:

a_{bi} ···· average deceleration rate [m/s^2] v^2_{i-1} ···· speed at the beginning of braking [m/s]
s_i ···· distance traveled during braking [m] v^2_i ···· speed at the end of braking [m/s]

By applying the recommended formula, according to the data recorded by the speedometer, during braking immediately before the accident, from a speed of 63 km/h to a speed of 44 km/h, EMV 412-005/416-013/416-095/412-032 achieved an average deceleration of 0.82 m/s^2.

From the previously given calculation, it can be concluded that at the time of the accident, the braking system on EMV 412-005/416-013/416-095/412-032 achieved the minimum required deceleration prescribed by European Commission Regulation (EU) No. 321/2013 of 13.03.2013.

According to data recorded by the speedometer, when passing the Su92 protective signal, at a speed of 61 km/h, the impact of an active 2000 Hz track balise was registered with the "ride on the order" button turned on, which deactivated the autostop device and did not initiate forced braking.

Taking into account the speed of the EMV passing the Su92 protective signal and the calculated deceleration during braking before the collision, in the event of emergency braking, using the formula recommended by the EN 16834 (2018) standard, the distance traveled from the beginning of the maximum braking force to the complete stop of the EMV would be 175 m. To this distance should be added the distance traveled by the EMV in the time from the moment of emergency braking by the autostop device to the development of maximum braking force, which

is from 2 to 4 s. During this time, the EMV, at a speed of 61 km/h, would have traveled between 34 and 68 *m*.

According to the calculated values, if the Su 2 autostop had applied emergency braking while passing the safety signal, the EMV would have stopped after traveling 243 m, thus avoiding an accident.

4.2.3. Analysis of the operation of the train protection system on EMV 412/416-005/032

According to the Instructions for Repair of Autostop Devices I 60 (document G.102 from September 2003) prepared by the "Kirilo Savić Institute" Belgrade, the EMV series 412/416 is equipped with autostop devices of the type "Indusi" I 60, manufactured by "Siemens". This Instruction is an integral part of the project of Technical Repair Documentation for EMV series 412/416.

The autostop device serves to stop the train if, for any reason, the driver has not responded in a timely manner to the signal terms "stop" or "running with care".

The locomotive autostop device receives information from the track, transposed at a frequency of 1000 Hz or 2000 Hz. The mutual inductive effect is manifested by a decrease in the current in the resonant circuit of the locomotive receiving head, which is transmitted to other elements of the autostop device, and in connection with the aspect of a signal, the processes of time speed control or forced braking of the train take place.

If the signal is faulty or if it is in the "red" position, and the train driver has a written order to cross it, the autostop is brought, by pressing the "ride on the order button", into such a state that the active part of the 2000 Hz track balise has no effect on it.

All processes of the track balises and locomotive autostop device are registered on speedometer recording devices. These devices, in addition to registering the speed throughout the journey, also register all functions performed by the autostop device, so that all "events" and actions of the driver during the journey can be read on the recording strips.

From the data recorded by the speedometer on the motor coach 412-005 EMV 412-005/416-013/416-095/412-032 (see point 3.4.4.), it can be concluded that the autostop device on the EMV functioned correctly, i.e. the influences of the 1000 Hz and 2000 Hz track balises were registered. While train No. 7112 was running from the Karađorđev Park halt to the scene of the accident, the effect of the 1000 Hz track balise was registered with the use of the "acknowledge" button (at the automatic block signal S12) and the effect of the 2000 Hz track balise was registered with the use of the "ride on the order" button (at the protective signal Su92).

A vigilance control device (automatic vigilance device) is a safety device that controls the train driver's vigilance while operating a train.

According to the Instructions for Repair of the Electronic Block EDB-1 of the vigilance device (document G 101 from August 2002) prepared by the "Kirilo Savić Institute" Belgrade, an active impulse automatic vigilance device of the UB1 type is installed on the EMV series 412/416. This Instruction is an integral part of the project of the Technical Repair Documentation of the EMV series 412/416.

When operating properly, the train driver must hold down one of the alertness buttons (foot and hand), release it and press it again within an interval of 25 s (standby time). If he holds down the alertness button for longer than 25 s, or releases it, he will be warned by a red flashing light of

the signal lamp for 2.5 s, then by an audible warning for 2.5 s and if the train driver does not react, the train will be forced to brake. If the train driver reacts to the light or audible warning and presses one of the alertness buttons, or releases the button and presses it again, the 25 s standby time will begin again.

In the event that the train driver is not vigilant, or is incapable of performing his duties, aftr the audible warning the train traction is stopped and automatic appliation of the bake is performed, wile audible warning is still on. The ability to record the activity of the automatic vigilance device on the speedometer recording device is not used on EMV series 412/416

The electronic unit starts working, i.e. starts monitoring alertness at a speed greater than 10 km/h.

4.2.4. Elements of passive safety on EMV 412/416-005/032

Passive safety elements are not provided for EMV series 412/416. At the time of the procurement of this series of trains, the then applicable laws did not provide for the installation of this type of element.

4.2.5. Control of EMV 412/416-005/032 that participated in the accident

After the accident, EMV 412-005/416-013/416-095/412-032 was removed from the scene. The motor coach 412-005 was transferred to the station Pančevački Most on the Danube track, and trailers 416-013 and 416-095 and motor coach 412-032 were transferred to the Technical Passenger Station Zemun (hereinafter referred to as TPS Zemun) "Srbijavoz" a.d.

By order of the First OJT, in cooperation with CINS, an inspection of EMV 416-013/416-095/412-032 was carried out in accordance with the provisions of Article 6 of the Rulebook on the Maintenance of Railway Vehicles ("Official Gazette of the RS" No. 144/2020).

Based on the Order of the First OJT (KTR. No. 6644/24 of 22.05.2024), on 02.07.2024, a commission composed of expert representatives of FŽV "Želvoz" d.o.o. Smederevo, carried out an extraordinary technical inspection of EMV 412-005/416-013/416-095/412-032, namely, motor coach 412-032 and trailers 416-013 and 416-095 at the TPS Zemun "Srbijavoz"a.d. on the track in the workshop hall and of the motor coach 412-005 in the area of the Pančevački Most station on the Danube track. Representatives of the CINS did not attend the inspection because FŽV "Želvoz" d.o.o. Smederevo did not notify the Chief Investigator for Railway Transport CINS about the inspection date, although according to the Order of the First OJT, it was obliged to do so.

After the inspection, a Report No. 43//2024 dated 17.07.2024 was drafted by FŽV "Želvoz" d.o.o. Smederevo on the extraordinary technical inspection of the EMV, to which were attached the Measurement Lists of the geometric measurements of the axle assemblies (submitted as an attachment to the letter of the First OJT KT. No. 3756/24 dated 06.11.2024).

During the inspection, deficiencies and damage were visually identified. The performed measurements did not require disassembly, i.e. a complete measurement of the parameters of the cast wheels was performed.

It was found that the bogies are complete with visible equipment deformations. It was not possible to inspect the bogie of the motor coach 412-005, which suffered the biggest damage due

to large deformations of the chassis. The deviations on the bogies do not prevent the functional movement of the EMV, except for some deformations that occurred as a result of the accident.

From the submitted measurement lists, it can be concluded that the characteristic measurements are within the prescribed limits, except for the height of the flanges and the q_r measurements, which are slightly above the prescribed limits, but have no impact on the cause of this accident.

For the purpose of testing the brakes, the motor coach 412-032 (where it was possible) was connected to the workshop compressed air with a pressure of up to 6 bar, to which the trailers 416-095 and 416-013 were also connected. The brake test determined that the executive vital brake devices were in working order. The complete brake system could not be fully tested because the main and auxiliary compressor, as well as all the equipment powered by this device and the entire pneumatic system on the train, had no power supply, i.e. there were no conditions for connecting it to the workshop electrical connection or to high voltage.

It was not possible to perform any measurements or checks on the traction and buffer device of the motor coach 412-005 because they are extremely deformed. As for the buffer devices on the parts that did not suffer damage, the buffer height is within the prescribed limits.

A visual inspection of the EMV units determined that section 412-032/416-095 was without visible damage, while the trailer 416-013, which was located behind the severely damaged motor coach 412-005, had visible deformations of the supporting structure.

The train was on an external air connection up to 6 bar and under that pressure the pressure vessels were operational.

Due to extensive damage, it was not possible to perform any measurements or troubleshooting on the motor coach 412-005.

Based on the Order of the First OJT (KT.no. 3756/24 of 06.11.2024), the Group of Experts “Srbijavoz“a.d. on 19.11.2024 (at the location of the TPS Zemun, on the track between the facility number 5 and facility number 8), on 20.11.2024 (at the location of the Pančevački Most station, on the Danube track) and on 21.11.2024 (at the location of the TPS Zemun, in the depot hall), carried out an extraordinary technical inspection of EMV 412-005/416-013/416-095/412-032. In accordance with the Order of the First OJT, representatives of the CINS attended the inspection.

The motor coach 412-005 was inspected on 20.11.2024 at the Pančevački Most station, on the Danube track. The appearance of the motor coach 412-005 as found on site is shown in Figures 4.2.5.1, 4.2.5.2, 4.2.5.3. and 4.2.5.4.

Figure 4.2.5.1: Appearance of the motor coach 412-005

Figure 4.2.5.2: Appearance of damage to the bogies of of the motor coach 412-005

Figure 4.2.5.3: Appearance of damage to the front of the motor coach 412-005

Figure 4.2.5.4: Appearance of damage to the body of the motor coach 412-005

A visual inspection revealed that all vital subassemblies under the coach body were in place. Significant damage was observed on the subassemblies (front bogie, electrical and air equipment, front traction and buffer equipment), which occurred as a result of the accident. Vital brake parts (direct and indirect brake, aerial conductors, block cylinders with and without parking brake and compressed air reservoirs) are present and significantly damaged.

Significant damage was observed on the motor coach body and the front of the motor coach in the drivers cab area (see Figure 4.2.5.5.). Light and sound signaling devices, interior drivers cab, vigilance control, radio dispatch device, locomotive part of the autostop device and controller (direction of travel and traction/electric braking) are present and significantly damaged.

Figure 4.2.5.5: Appearance of the driver's cab of the motor coach 412-005

Also, upon inspection on site, the handles of both driver's automatic brake valves (direct and indirect) were found in the "release" position (see figures 4.2.5.6. and 4.2.5.7.), and the direction controller was in the forward position.

Figure 4.2.5.6: Appearance of the driver's automatic brake valve in the driver's cab of the motor coach 412-005

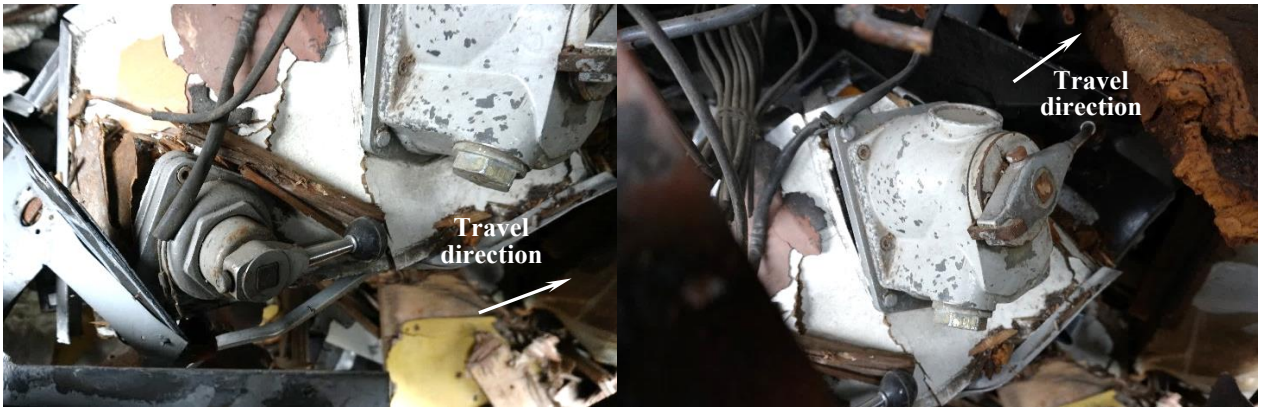


Figure 4.2.5.7: Appearance of the driver's automatic brake valve of the direct brake (left) and of the indirect brake (right) in the driver's cab of the motor coach 412-005

Due to significant damage to the system subassemblies caused by the accident, it was not possible to perform any checks or measurements on the motor coach 412-005.

The trailer vehicles 416-013 and 416-095 and the motor coach 412-032 were inspected on 19.11. and 21.11.2024 at the TPS Zemun "Srbijavoz"a.d.

A visual inspection of the trailers 416-013 and 416-095 and the motor coach 412-032 was carried out on 19.11.2024 at the Zemun TPS, on the track between the facility No. 5 and facility

No. 8. The appearance of the trailers 416-013 and 416-095 and the motor coach 412-032 as found on site is shown in Figures 4.2.5.8, 4.2.5.9 and 4.2.5.10.

Figure 4.2.5.8: Appearance of the trailer vehicles 416-013 and 416-095 and the motor coach 412-032

Figure 4.2.5.9: Appeareance of the trailer vehicle 416-013

Figure 4.2.5.10: Appearance of the motor coach 412-032

A visual inspection of the trailer vehicles 416-013 and 416-095 and motor coach 412-032 found that the two trailer vhicles and the motor coach are complete. All parts of the subassemblies are present in their places. The bogies are in good condition with the presence of deformations resulting from the accident (on the motor coach 412-032, the shunter's poles are bent and damage was observed on the body of the trailer vehicles 416-013, see pictures 4.2.5.11, 4.2.5.12. and 4.2.5.13.).

Figure 4.2.5.11: Appearance of the bogies of the motor coach 412-032

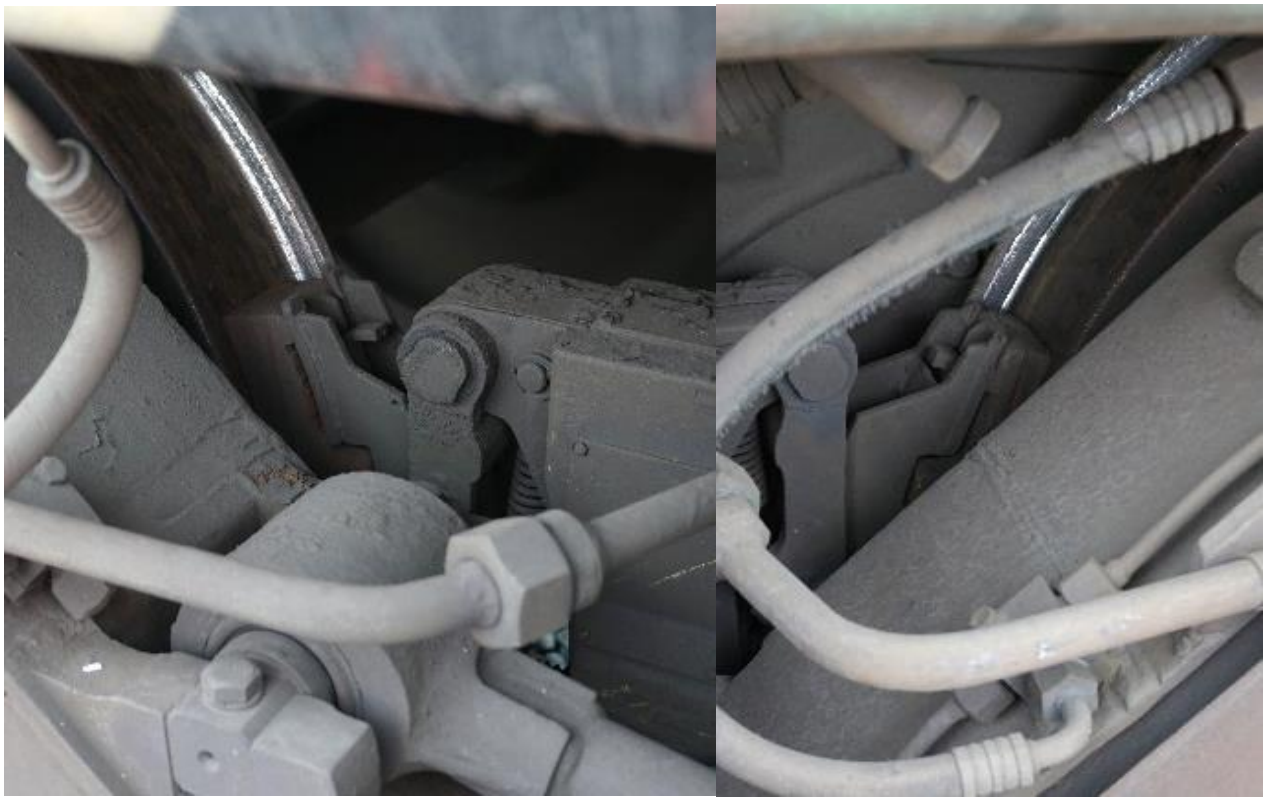


Figure 4.2.5.12: Appearance of the brake blocks at the bogies of the motor coach 412-032

Figure 4.2.5.13: Appearance of the damage on the body of the trailer vehicle 416-013

Given the limitations of visual inspection, it was determined that it was necessary to place the trailer vehicles 416-013 and 416-095 and motor coach 412-032 on the appropriate track in the depot hall for a more detailed inspection and connection to the pneumatic and electrical installation.

An inspection of a section of the track in the hall at TPS Zemun was carried out on 21.11.2024. For this purpose, the trailer vehicles 416-013 and 416-095 and motor coach 412-032 were placed in the hall and connected to the workshop's air and electrical installation.

The appearance of the trailer vehicles 416-013 and 416-095 and the motor coach 412-032 on the section of track in the hall is shown in Figures 4.2.5.14. and 4.2.5.15.

Figure 4.2.5.14: View of the trailer vehicle 416-013 on a section of track in the hall

Figure 4.2.5.15: View of the motor coach 412-032 on a section of track in the hall

During the inspection, a brake test was performed (in position) by applying the brake and releasing it by operating the driver's automatic brake valve of the indirect brake located in the driver's cab of the motor coach 412-032, as well as a test of the safety devices: the autostop device and the vigilance control device (automatic vigilance device) on the motor coach 412-032.

The appearance of the driver's cab of the motor coach 412-032 is shown in Figure 4.2.5.16.

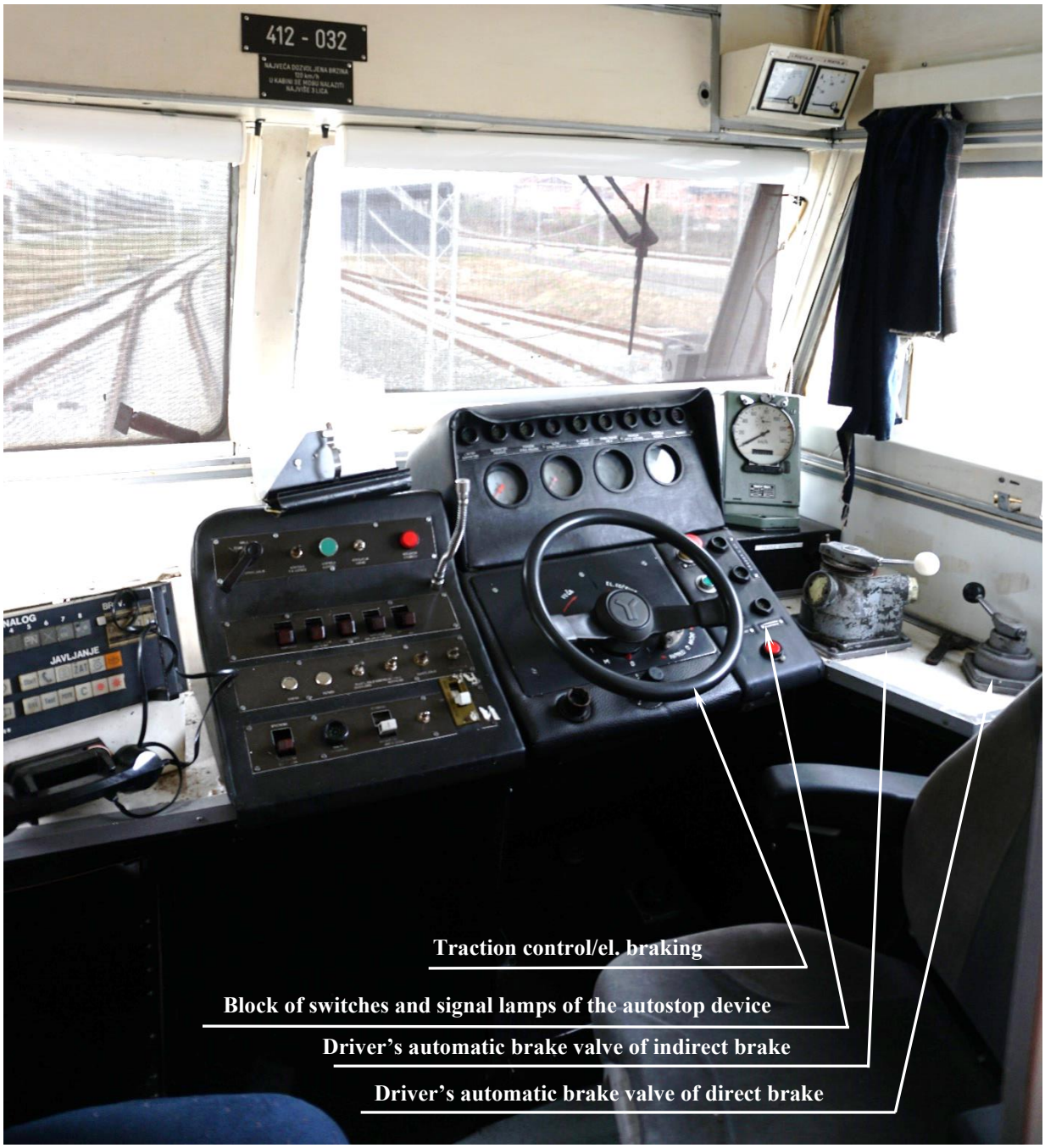


Figure 4.2.5.16: Appearance of the driver's cab of the motor coach 412-032

During the brake test in place, it was found that all vital brake devices (main and auxiliary compressed-air reservoir, main air conductor, brake cylinders, brake blocks, ...) were in good condition and functioning (see Figures 4.2.5.17. and 4.2.5.18.).

Figure 4.2.5.17: Appearance of the brake indicator on the trailer vehicle 416-013 (in the released position) and trailer vehicle 416-095 (in the locked position)

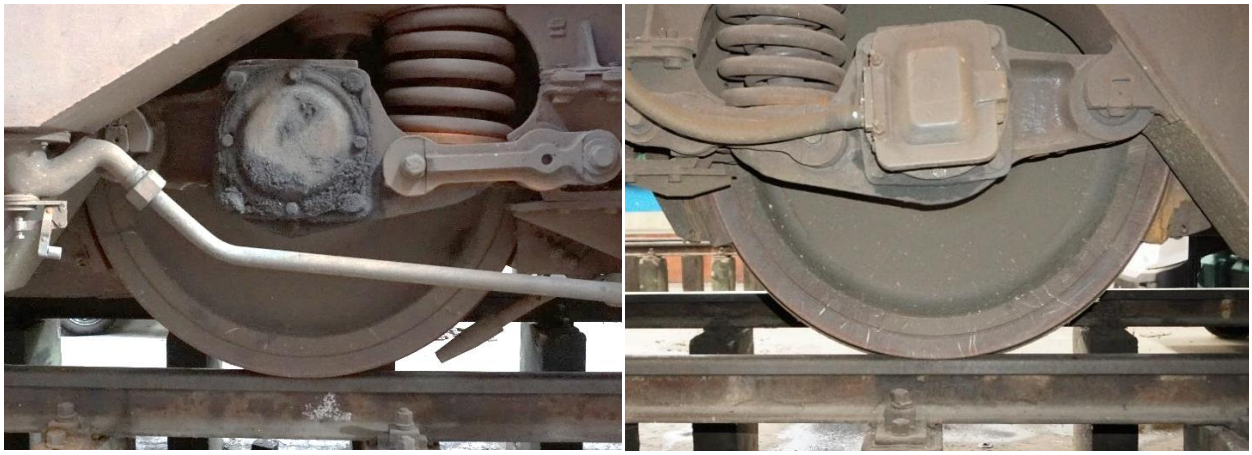


Figure 4.2.5.18: Appearance of brake blocks in the released position (left) and locked position (right)

The autostop device was tested by simulating the impact of the track autostop balise on the locomotive receiver head of the autostop device and by monitoring the indications in the driver's cab of the 412-032 motor coach. It was found that the autostop device responded correctly to frequencies of 1000 Hz (passing through a yellow signal) and 2000 Hz (passing through a red signal) and initiated forced braking if the "acknowledge" or "ride on the order" buttons were not operated, respectively.

Figure 4.2.5.19 shows the appearance of the block of switches and signal lamps of the autostop device on the console in the driver's cab of the motor coach 412-032.

Figure 4.2.5.20 shows the use of the "acknowledge" button and the indication of the activation of the timed speed control after the autostop device responds at a frequency of 1000 Hz.

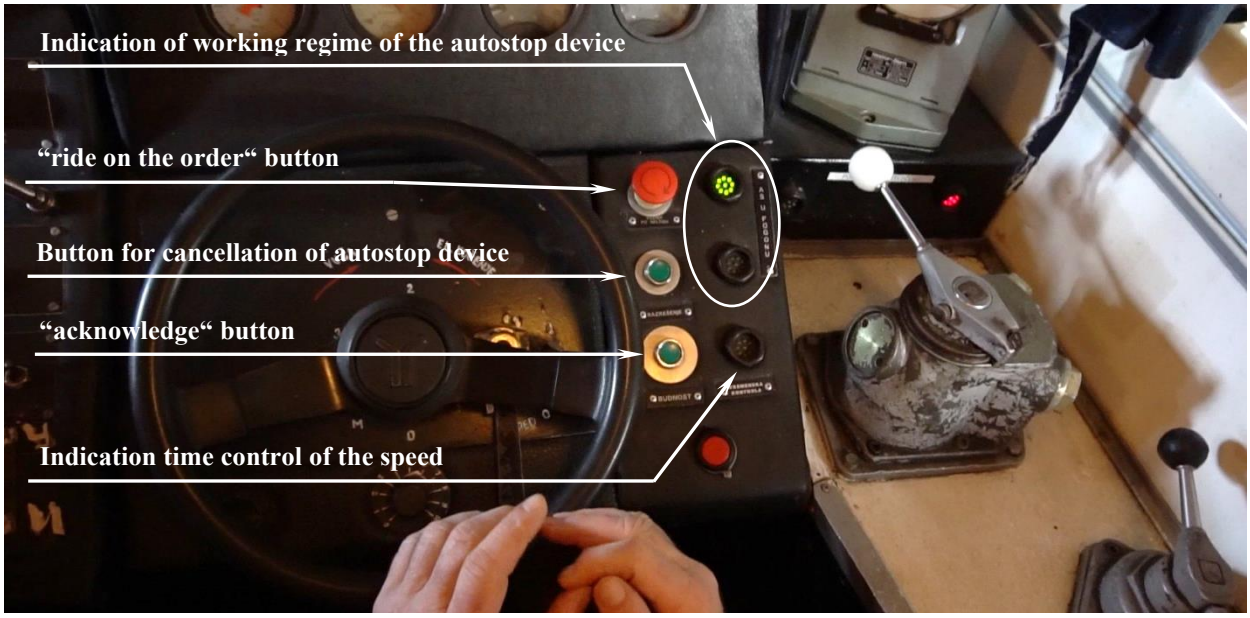


Figure 4.2.5.19: Appearance of the block of switches and signal lamps of the autostop device

Figure 4.2.5.20: Appearance of the use of the “acknowledge“ button and the indication of the time speed control

Also, in the driver’s cab of the motor coach 412-032, the operation of the vigilance control device (automatic vigilance device) was checked by simulating operating an EMV at a speed of 25 km/h. The automatic vigilance device reacted correctly even after the light and sound indication, initiating the forced braking mode in the event of possible irregularities (continuously holding the foot or hand control for more than 25 s or lack of pressure on the control after 2.5 s). It was found that the automatic vigilance device functioned properly during the test.

Figure 4.2.5.21 shows the appearance of the light indication of the automatic vigilance device warning of irregular operation by the train driver in the driver's cab of the motor coach 412-032.

Figure 4.2.5.21: Appearance of the light indication of the automatic vigilance device

During the inspection, it was found that in the driver's cab of the motor coach 412-032, two identical lamps were installed on the ceiling to illuminate the driver's cab area, one lamp next to the window on each side, closer to the rear wall of the driver's cab. Each lamp is equipped with one incandescent bulb with a nominal voltage of 110 V and a power of 40 W.

The position and appearance of the lamps in the motor coach 412-032 is shown in Figures 4.2.5.22. and 4.2.5.23.

Figure 4.2.5.22: Position of lights in the driver's cab of the motor coach 412-032

Figure 4.2.5.23: Appearance of the lamp in the driver's cab of the motor coach 412-032

4.2.6. Overview of the functionning of the SS device

Based on a review of the diagnostic record from the MMI device at the Pančevački Most junction and halt, it can be concluded that no entry route was set for the train No. 7112, and that the train No. 7112 passed the entry signal Su92, which was showing aspect of a signal 4: "Stop".

Based on a review of recorded disturbances on the SS devices, it can be concluded that there were no disturbances on the SS devices at the Pančevački Most junction immediately before the accident occurred.

The last measurements of the track autostop device installed at the Su92 entry signal were carried out on 14.11.2023 by the employees of the competent maintenance service of the OJ for SS Makiš. After this, there were no recorded disturbances on the said autostop device, and it can be concluded that the balise at the Su92 signal was correct on the day of the accident in question.

At the time of the accident in question, signalized through routes were set up for trains traveling from the direction of the Krnjača passing point on the left track towards the Beograd Centar and towards the Danube track at the Pančevački Most station by giving the departure and arrival route commands, i.e. the station SS devices had the maximum level of availability for these trains. For trains traveling from the Pančevački Most junction on the right track towards the Krnjača station, the station SS device at the Pančevački Most junction had a high but not the highest level of availability, taking into account that the train dispatcher for the outgoing part of the route had to issue a general order for traffic in within the station distance due to a malfunction on the APB SS device.

4.2.7. Analysis of the accident participants' work

4.2.7.1. Train dispatcher at the Vukov Spomenik station

According to the traffic situation, on 17.05.2024, in connection with the operation of consecutive trains No. 52601 and 7112, on the right track (right Banat track), communication was established several times via telephone between the train dispatchers of the Rakovica, Beograd Centar and Vukov Spomenik stations, and the Pančevački Most junction and halt. The train dispatcher of the Vukov Spomenik station was present on the telephone during the communication and duly entered all the necessary data (permission, notice) in the traffic log (S-9) regarding the operation of trains No. 52601 and 7112. The communication (conversations that were conducted) was recorded by a recorder.

According to the entry in the traffic log (S-9) of the Vukov Spomenik station, permission was given for the train No. 52601 at 17:50, a notice was received for it at 18:11 and the train passed the Vukov Spomenik station at 18:13.

Also, according to the entry in the traffic log (S-9) of the Vukov Spomenik station, the train No. 7112 was given permission at 18:10, a notice was received for it at 18:16, the train arrived at the Vukov Spomenik station at 18:21, it left the station at 18:22 and General Order I-38 was issued for the train.

While the train No. 7112 was operating at the Vukov Spomenik station, the train dispatcher at the Vukov Spomenik station approached the driver of the motor coach 412-005 EMV 412/416-005-032 (which was part of the train No. 7112) and handed the driver the order book, which was recorded by a surveillance camera installed on the second platform at the Vukov Spomenik station.

Surveillance camera footage was submitted by "IŽS"a.d. in the attachment to letter No. 1/2024-720 of 22.07.2024. During the handover of the order book, the footage shows that there was verbal communication between the train dispatcher and the train driver. The audio was not recorded in the surveillance camera footage, so it is not possible to determine the content of the communication between the train dispatcher of the Vukov Spomenik station and the train driver of the train No. 7112. After the train driver returned the order book to the train dispatcher, the train started and continued running towards the Pančevački Most junction and halt.

Figure 4.2.7.1.1 shows the layout of the General Order No. I/38 for the train No. 7112 dated 17.05.2024 (a copy of the order that remains in the General Order book after being handed over to the train driver). The copy of the General Order No. I/38 for train number 7112 dated 17.05.2024 that was handed over to the driver of the train No. 7112 was not found after the accident.

By reviewing the register of General Order No. I/38 for the train No. 7112 dated 17.05.2024, it can be seen that the train driver confirmed receipt of the order with his signature.

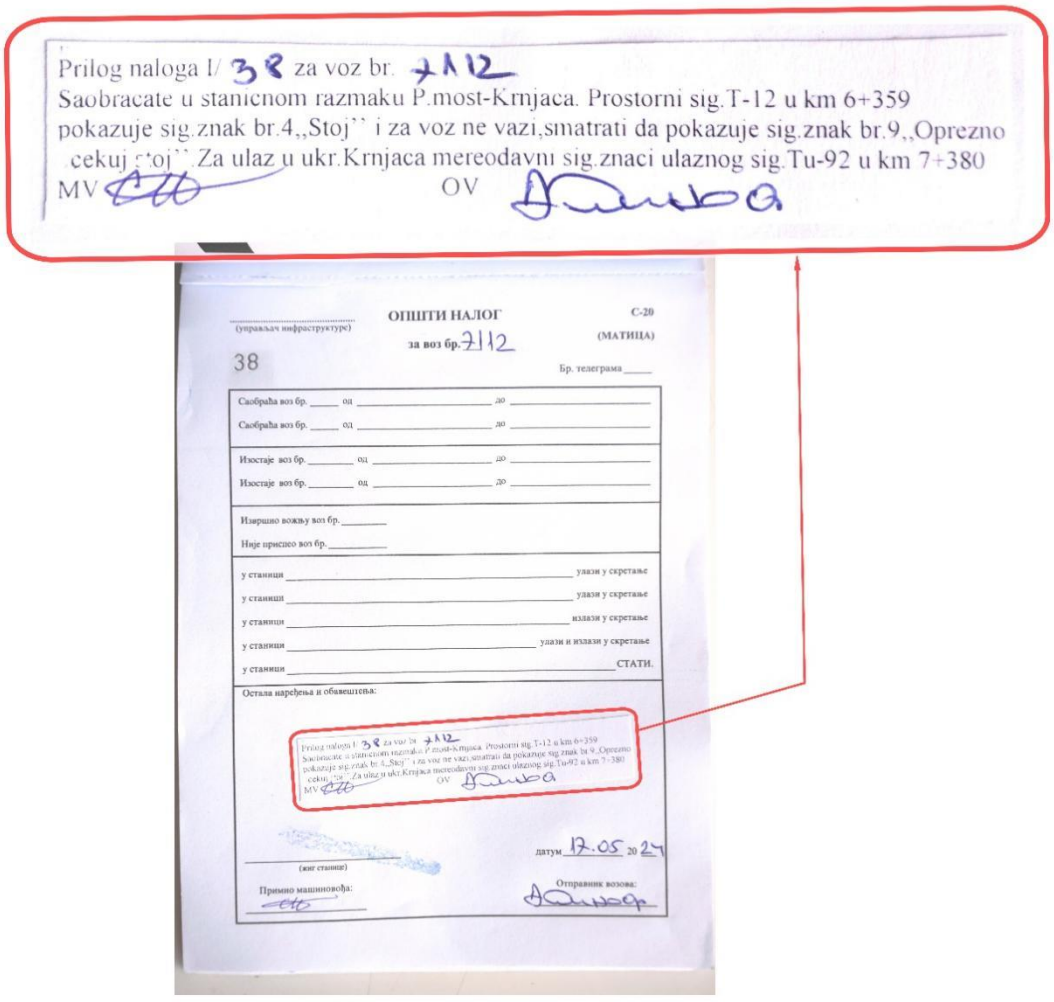


Figure 4.2.7.1.1: Layout of the General order No. I/38 of the Vukov Spomenik station

4.2.7.2. Train dispatcher of the Pančevački Most junction and halt

According to the traffic situation, on 17.05.2024, the train dispatcher of the Pančevački Most junction and halt, via telephone, gave permission for the operation of the consecutive trains No. 52601 and 7112, on the right track (right Banat track) in the direction from the Resnik and Beograd Centar stations, respectively, to the Pančevački Most junction and halt, and for the operation of the train No. 6008 on the left track in the direction from the Krnjača passing point to the Pančevački Most junction and halt. He duly entered all the necessary data (permission, notice) regarding the operation of the trains No. 52601, 7112 and 6008 in the traffic logbook (S-9). The communication (conversations that were held) was recorded with a voice recorder.

Taking into account that only one freight train can be on the steel bridge over the Danube River (see point 4.1.), and the need to give the train driver a general order (order on the failure of the automatic block signal), the train dispatcher stopped the train No. 52601 in front of the protective signal To2.

4.2.7.3. Train driver of the train No. 52601

According to the data registered by the speedometer on the locomotive 193-912 (see point 3.4.4.), the train No. 52601 passed the Karađorđev Park halt at 18:10:00, passed the automatic block signal S12 at 18:12:02 and the protective signal Su92 at 18:13:38, and at 18:15:31 the train stopped at the Pančevački Most junction and halt in front of the protective signal To2. When the train No. 52601 passed the automatic block signal S12 and the protective signal Su92, the effect of the active 1000 Hz track balise was registered with the train driver using the “acknowledge“ button. The train was standing in front of the To2 protective signal until the accident occurred (in the period from 18:22:59 to 18:23:09, the speedometer registered a movement of the locomotive, i.e. train, over a length of 10 m at a speed of up to 11.6 km/h).

Based on the data recorded by the speedometer on the locomotive 193-912, it can be concluded that the train driver operated the train No. 52601 at a speed in accordance with the timetable material.

4.2.7.4. Train driver of the train No. 7112

The train driver started operating EMV 412/416-005/032 at the Beograd Centar station. It operated as train No. 38039 until the Karađorđev Park halt and, after the passenger handling, it continued its journey towards the Vukov Spomenik station as train No. 7112. According to the data recorded by the speedometer on EMV 412/416-005/032 (see point 3.4.4.), while running between the Karađorđev Park halt and the Vukov Spomenik station, the train driver passed the S12 automatic block signal when the effect of the active 1000 Hz track balise was registered with the use of the “acknowledge“ button. While operating at the Vukov Spomenik station, the train dispatcher handed the train driver General Order No. I/38, which the train driver confirmed with his signature in the general order book (master record). After handling the passengers and handing over the General Order, the train driver started the train and continued running towards the Pančevački Most junction and halt. While running between the Vukov Spomenik and Pančevački Most stations, the train driver passed the Su92 protective signal, when the effect of the active 2000 Hz track balise was registered using the “ride on the order” button. After passing the

protective signal and traveling 540 m, the train driver noticed the previous train that was stopped and initiated braking procedures.

Based on the data recorded by the speedometer on EMV 412/416-005/032, it can be concluded that the train driver operated the train No. 7112 at a speed in accordance with the timetable material and that after noticing an obstacle in the form of a previous train that was stopped, he initiated braking procedures.

4.2.8. Psychological analysis of the event

4.2.8.1. Human factor importance in the accidents and incidents analysis

Psychological analysis of accidents and incidents is a very important segment as it deals with the human factor, which plays a significant, practically primary role in the realization of all human activities. The manifestations and aspects of the influence of the human factor are numerous. They appear through the synthesis of various elements, which in their combined action have an impact on the results of work. By increasing the quality of the human factor, the number of human errors is significantly reduced, optimizing the symbiosis between humans and technical-technological achievements. Understanding the interaction between organizational, individual, and team work factors is crucial for establishing principles that ensure a reliable management system and reduce the risk of errors. Effectively identifying critical points on the human factor map represents a proactive approach in comprehensive preventive actions aimed at reducing accidents and incidents.

Organizations need to identify all sources of risk, events, and/or sequences of circumstances that could signal the occurrence of a risky event and their potential consequences. The goal of any analysis of accidents and incidents is to consider all combinations of possible factors of accidents and incidents in order to compile a comprehensive list of risks based on those events and circumstances that imply the reduction, prevention, or slowing down of the achievement of set goals. By identification, systems should encompass all potential hazards, regardless of whether they are under the system's control or not, and regardless of whether they are currently relevant or not. A quality identification process involves the use of relevant and up-to-date information. Accurate information about previously occurred events and the results and conclusions of their analyses are of great importance.

The consequences that arise from the realization of a risky event represent the central point of the risk management system. Specifically, the degree of uncertainty of a risky event or accident directly depends on the extent of knowledge regarding the consequences of the event itself. Understanding the effect that accidents and incidents have on organizational systemic values is essentially important in knowing how to prevent or reduce their occurrence. Preventing or mitigating the consequences of accidents is achieved by taking various measures. This means that during the activities of organizational systems, there should be continuous adjustment of planned strategies to new conditions to minimize potential risks of harmful events and possible losses due to risky events or accidents.

The control process encompasses an organized system of monitoring the implementation of activities and the occurrence of risky events, along with the permanent modification and adaptation of planned actions and strategies. This organized control process includes all subprocesses of risk identification, risk assessment, and development of alternatives, which are interconnected into an efficient and flexible system that can be quickly and effectively applied.

Considering the human factor in accidents and incidents in railway traffic is a complex issue that requires a multifaceted approach. Global scientific research has highlighted the importance of addressing human error, fatigue, and safety culture. Integration of technology and psychological aspects are key points to reduce accidents. Continuous efforts to understand and mitigate these factors are essential for improving railway safety worldwide. Implementing evidence-based strategies, fostering a strong safety culture, and using technology to support railway workers are crucial to reducing the human factor in railway accidents and incidents.

4.2.8.2. Elements of human factor influence on accidents and incidents

What can be specifically highlighted and examined in the psychological analysis of the human factor and its impact on accidents and incidents in railway traffic are the following defined elements:

1. *Lack of knowledge (experience),* this implies unfamiliarity, inability to cope, or non-compliance with work procedures (instructions, regulations/rules, legal solutions, etc.), relying on improvisation in work;

2. *Lack of resources*, refers to performing duties without sufficient resources, leading to the inability to adequately complete assigned tasks;

3. *Disregard for norms*, represents ignoring defined rules according to which the system operates, requiring systematic work without improvisations, working from memory, and outside procedures;

4. *Lack of teamwork*, involves a low degree of mutual understanding and cooperation, ineffective joint actions, and decision-making;

5. *Lack of communication*, refers to unsuccessful communication between all participants in the activity implementation to achieve optimal information exchange;

6. *Exposure to stress*, significantly affects the psychophysical abilities and characteristics of people, leading to significant behavioral disturbances;

7. *Work pressure*, refers to performing work tasks without the right/ability to make mistakes;

8. *Routine*, involves the executor's work based on the feeling that something is correct just because there have been no problems or disruptions up to that point;

9. *Fatigue*, physical or mental, results in distraction, loss of concentration and attention, and reduced perceptual abilities;

10. *Low level of work awareness* (reduced responsibility, reliability, work discipline) and *moral awareness* (lack of moral values);

11. *Lack of motivation*, reduced motivation for work and dissatisfaction with the job and working conditions;

12. *Lack of assertiveness*, involves an environment where there is no practice of openly expressing opinions, attitudes, and needs positively and productively without endangering others;

13. *Lack of situational/event awareness*, represents a state of not recognizing the consequences of a particular action taken;

14. *Psycho-physical incapacity*, refers to mental and physical incapacity caused by various somatic diseases, personality disorders, and old age;

15. *Absence*, refers to divided attention/distraction of the executor's priorities, caused by various factors (financial, family, personal, etc.).

The human factor plays a significant role in the occurrence of accidents and incidents in railway traffic, a topic widely researched in scientific papers around the world. Understanding these factors is crucial for improving safety measures and reducing accidents and incidents in the railway sector. Here we will highlight the key aspects of the human factor in railway accidents and incidents, based on the findings of global scientific studies. Human error is often cited as the leading cause of railway accidents and incidents. Errors can occur at various levels, including operational staff, maintenance teams, and management. *Operational errors* include mistakes by operational staff (railway workers), while *maintenance errors* can include insufficient inspection or repair. *Management errors* relate to safety culture, inadequate training, or improper resource allocation. Research indicates that improving training, implementing advanced safety systems, and fostering a strong organizational and safety culture can significantly reduce these errors. Additionally, *fatigue* among railway workers, particularly train drivers, train dispatchers and TK dispatchers, has been identified as a key risk factor for accidents. Scientific studies have shown that fatigue can impair judgment, reaction time, and decision-making abilities. Implementing work schedules that allow for adequate rest, along with monitoring and managing workload, can mitigate the risks associated with fatigue. *The organizational safety culture* within railway operations significantly influences the incidence of accidents and incidents. A positive safety culture, where safety is prioritized at all levels of the organization, can lead to lower accident rates. Research highlights the importance of leadership in promoting a safety culture, continuous safety training, and open communication about safety issues. *Safety culture is defined as a phenomenon that encompasses awareness of legal obligations, attitudes towards their execution, written and unwritten rules of conduct, a specific ethical code, and a developed mechanism for preventive and repressive action regarding the occurrences and bearers of threats to the vital values of the organization or society. The psychological state* of railway employees, including work overload, stress, anxiety, and job satisfaction, can affect the incidence of accidents and incidents. Studies have explored the relationship between employee well-being and safety performance, suggesting that improving workplace conditions and providing psychological support can enhance safety. While not strictly a human factor, the interaction between people and technology plays a significant role in railway safety. *The introduction of advanced safety systems* has been shown to reduce the likelihood of accidents caused by human error. However, the effectiveness of these technologies depends on their integration with human operators, including training and adaptation to these systems.

4.2.8.3. Psychological assessment of the behavior of direct participants in an accident

The assessment was carried out based on a structured interview with the accident participants held on 01.07. and 15.07.2024. in the premises of the CINS and on 30.09.2024. in the home of the train driver of train No. 7112.

4.2.8.3.1 Train dispatcher of the Pančevački Most junction and halt

The train dispatcher at the Pančevački Most junction and halt has been a railway worker for 13 years. During the interrogation, he appears calm and composed, listens attentively and answers clearly and specifically.

He describes his job in detail and clearly, stating that he carries out all activities as a train dispatcher according to the job description and work order, which includes forming the train route on the section of the railway that has been determined and for which there is control, dispatching trains, providing information to passengers, etc. At the end of the hearing, he expresses his opinion that, given the volume of work and the intensity of traffic, the number of staff in this station is insufficient.

He is systematic and rational in observing and presenting facts. He captures the essence of the overall situation. He provides a description of the event based on valid data and assessment base on his experience. He has a responsible behavior with an empathetic and analytical approach. Immediately after the accident, he demonstrates conscientious behavior with an altruistic approach. Also, he behaves professionally in accordance with organizational rules. On a personal level, he does not feel responsible for the accident, nor did he have information about the cause of the accident during the accident. After experiencing stress/shock, he does not show symptoms of avoidance, i.e. does not avoid facts related to the traumatic event. He maintains stability and psychological balance with continuity of motivational forces for high-quality performance of his work. He approaches the problem constructively, trying to find the optimal solution in this situation as well.

4.2.8.3.2 Train dispatcher of the station Vukov Spomenik

The train dispatcher at the Vukov Spomenik station has been a railway worker for 30 years working as a train dispatcher. During the interrogation, he appears calm and composed, listens carefully and answers clearly and specifically. He provides precise, clear, detailed information about all activities and the sequence of events, as well as a description of his job. He states that he experienced the event itself as very stressful, with fear for the outcome of the passengers in terms of injuries and fatalities.

During the interrogation, he observes the situation very rationally. He clearly and precisely presents the factual situation with significant support of his experience. He acts competently, seriously and maturely. In the given situation, he behaves in a controlled, pragmatic, responsible, conscientious manner with an altruistic need towards the participants in the accident. A highly professional attitude towards all aspects is observed. In surviving a highly stressful situation, i.e. the accident, adequate self-awareness and rational reasoning are present. In the conversation, he does not name the person responsible of this accident, but emphasizes the fact that the train driver of the passenger train was very young. During the conversation, when handing over the order to the train driver, he repeated the content of the order several times in some doubt that the train driver did not understand him.

After experiencing stress/shock, he does not show symptoms of destabilization and psychological intolerance to work under stress. During the interview, he showed visible nervousness and a sense of fear due to the seriousness of the situation and personal responsibility. There is a feeling of guilt, discomfort and burden, and moral conscience, just from the knowledge that, after so many years of work experience, he was an indirect participant in the accident.

4.2.8.3.3 Train driver of the train No. 52601

The train driver of the train No. 52601 has been a railway worker in the position of train driver since 2018. During the interview, he appears calm and composed, listens carefully and answers

clearly and specifically. He presents information about all activities and the sequence of events, as well as his job description, precisely, clearly and in detail. In terms of difficult working conditions, he states that it often happens that the signals do not work, so they are used to running at red lights, giving examples of this.

In his statement, he gives the impression of a calm and responsible person. He acts professionally and politely and he is focused. He clearly states the factual situation, although there is a time gap between the accident itself and the time of the hearing (approximately two months). He is a focused person who takes on the task and this implies his conscientious attitude towards organizational rules. He also takes an analytical approach to the situation and problems encountered on the railway. He views his mental state after the experienced collision rationally, calmly and in a stable manner, with fear for the outcome of the passengers in terms of injuries and fatalities. On a personal level, he has no sense of responsibility for the aforementioned accident, nor did he have information about the cause of the accident during the accident.

4.2.8.3.4 Train driver of the train No. 7112

The train driver of the train No. 7112 is a railway worker who has been working as a train driver since 01.06.2022.

During the interrogation, he initially showed visible nervousness and uncertainty, but as time went on he became more relaxed and open in his communication. It is necessary to take into account the time gap between the accident and the interrogation (more than four months), during which certain facts related to the accident may be forgotten.

In presenting the facts, he gave incomplete answers, possibly out of fear of consciously taking the blame as a key actor in the accident. He gave specific answers to questions about which he was certain. In verbalizing and describing the event, he chooses his words carefully and pays attention to expression. At some points, in considering the entire situation, he did not show analytical and purposeful reasoning. He also did not show awareness of the seriousness of the situation, which can be attributed to his age and modest work experience. He is not focused on important things and facts, but is more concerned with the global picture. In his behavior, insufficient emotional and social maturity can be observed, as well as a reduced level of self-confidence. He also shows an insufficient degree of responsibility and conscientiousness in work, with reduced concentration and attention, as well as a possible misunderstanding of the instructions given. There is a feeling of insufficient internal motivation to perform this work with motives for self-realization, i.e. motives for personal success and development. In communication, he is pleasant, decent and cooperative, without the presence of intrusiveness and aggressive behavior. Considering that this is a young person who has not yet completed his maturation stages, this behavior is understandable.

After the accident, he was in shock. He had a present feeling of great concern about the consequences of the accident.

4.2.8.4. Analysis of accident and incident causes

From the analysis of data obtained from “IŽS“a.d. on accidents - collision of a train with a railway vehicle and incidents - avoided collision of a train with a railway vehicle, occurring in the period from 01.01.2013 to 17.05.2024 on the railway network of “IŽS“a.d. (see point 3.7.), it can

be concluded that out of a total of 60 cases, in 57 cases (95.00%) the cause of the occurrence was the human factor (fault of railway workers). In the remaining cases (3 cases, i.e. 5.00%), the cause was a technical factor (SS device), the responsibility of an unidentified person and one case was not concluded (the investigation was not completed). The railway workers who caused the aforementioned accidents and incidents were workers who operated traction vehicles (train driver/assistant train driver, 34 cases, or 59.65%), workers who managed traffic (train dispatcher, TC dispatcher, telegrapher and pointsman, 19 cases, or 33.33%) and joint liability of workers (4 cases, or 7.02%).

The structure of accidents and incidents (collision and avoided collision) caused by railway workers in the period from 01.01.2013 to 17.05.2025 on the railway network of "IŽS"a.d. is shown in Chart 4.2.8.4.1.

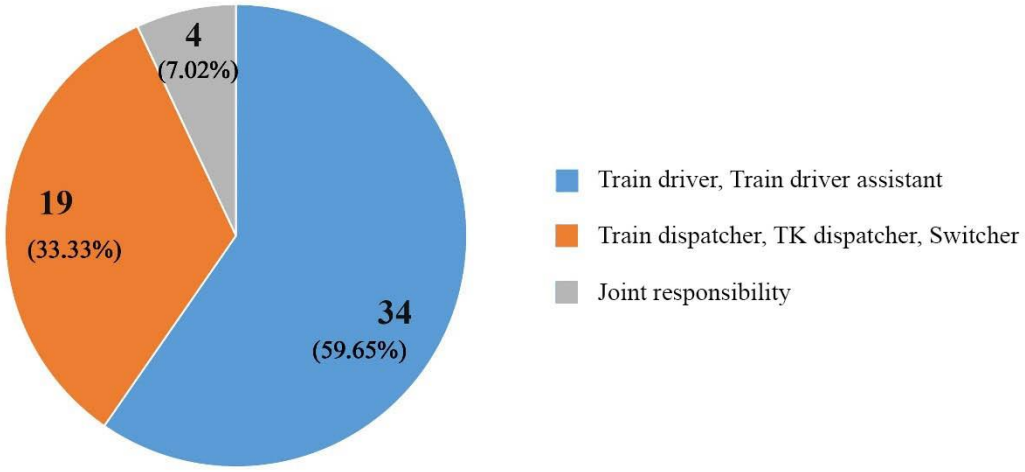


Chart 4.2.8.4.1: Structure of accidents and incidents caused by railway workers in the period 2013 - 2024 on the railway network of "IŽS"a.d.

The provided overview of accidents and incidents in railway traffic lacks elements regarding the influence of human factors because specific data on these aspects unfortunately do not exist (e.g., fatigue, decreased responsibility, poor communication, routine, stress impact, etc.). It is certain that accurate information about events and the results and conclusions of their analysis are of great importance. Therefore, the use of relevant and updated information is necessary for a quality process of identification. This includes identifying all sources of risk, events, and/or a series of circumstances that may signal the occurrence of a risky event, accident factors, incidents, and their potential consequences.

Considering the above, it is necessary to conduct analyses of accidents and incidents prioritizing the assessment of the impact of human factors based on the elements mentioned above (point 4.2.8.2.). To develop a model of critical elements, it is essential to classify them according to importance and rank their prevalence. The formation of a model of critical elements related to human factors serves as the basis for effectively structuring preventive measures and predicting human behavior in crisis situations.

4.2.8.5. Similar accidents that CINS investigated

According to the Law on Investigation of Accidents in Air, Railway, and Waterborne Traffic ("Official Gazette of RS" No. 66/15 and 83/18), CINS conducts investigations following accidents in the railway system with the aim of enhancing railway safety and preventing new accidents caused by the same or similar causes.

Although CINS is obliged to conduct an investigation after serious accidents on the railway system, in order to improve safety on the railway system and prevent new accidents caused by the same or similar causes, CINS, among other things, conducted an investigation into the accident related to the train collision, as follows:

1. On 01.08.2018 at 05:35 at km 27+369 of the main arterial route E70/E85: Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), between the stations Klenje and Ripanj Tunel, there was an overtaking and collision of the trains No. 2990 (EMV 413/417-033/034) and 70922 (locomotive 661-162 alone) (ŽS - 03/18, Final accident investigation report number: 340-00-2/2018-02-3-51 dated 27.06.2019).

In order to improve safety in the railway system and prevent new accidents caused by the same or similar causes, CINS has, among other things, issued a safety recommendation to the Directorate of Railways relating to "Srbijavoz"a.d., which reads: "Srbija Voz"a.d. to form a Team for the Assessment of Human Factor Elements in the Occurrence of Accidents and Incidents in order to develop a model of critical elements, classifying them according to importance and drafting a ranking list of their presence (identification of all risks) in order to work on the meaningful structuring of preventive measures and predicting human behavior in crisis situations in order to reduce the impact on the occurrence of new accidents and incidents.

The Directorate for Railways submitted a report - letter I-01 No. 340-1164/2019 dated 21.08.2019, a report - letter I-01 No. 340-805/2020 dated 30.07.2020 and a report - letter I-01 No. 340-834/2021 dated 27.07.2021, safety recommendation BP_22/19 was accepted and implemented. "Srbija Voz"a.d., by Decision No. 1/2020-108 dated 23.01.2020 issued by the General Director, formed a Team for the Assessment of Human Factor Elements in the Occurrence of Accidents and Incidents. "Srbija Voz"a.d. submitted a report on the activities and work of the Team for the Assessment of Human Factor Elements in the Occurrence of Accidents and Incidents (letter No. 16/2024-142 dated 08.07.2024). The implementation of the activities of the Monitoring Plan for the Safety Management System in "Srbijavoz"a.d. began in 2022 when interviews were conducted with individual train drivers and conductors at the Novi Sad, Belgrade, Lapovo and Niš nodes as part of the work of the Team for the Assessment of Human Factor Elements in the Occurrence of Accidents and Incidents. In 2023, the monitoring plan was partially implemented. So far, it has been implemented in Subotica, while other activities in all other nodes have been transferred to 2024. By the end of 2024, all collected data will be systematized and in 2025 external experts will be engaged to define preventive and possibly corrective measures in terms of increasing the safety of rail passenger transport.

In its previous work, the team has noticed that conductors, participants in railway accidents, are most often not directly responsible for the accidents, so it was concluded that the focus of the future work should be on train drivers.

4.3. Conclusions on the accident causes

4.3.1. Direct cause of the accident

The direct cause of the accident is that two trains were at the same time on an one block section, where one train was standing still (train No 52601), while the other train was moving (train No 7112), which is contrary to the provision of paragraph 3 of Article 122 of the Traffic Rulebook ("Official Gazette of the RS" No. 34/22 and 107/22).

4.3.2. Basic causes that derive from skills, procedures and maintenanc

The train driver of the train No. 7112 passed the protective signal Su92, which was showing aspect of a signal 4: "Stop", which is in violation of the provision of Article 15, paragraph 2 of the Rulebook on types of signals, signal markings and line markings ("Official Gazette of the RS", No. 51/20 and 29/25).

Since the train driver of the train No. 7112 did not have an order to pass the protective signal Su92 prohibiting further travel, issued by General Order I or by phonogram from the person regulating traffic (train dispatcher), he was obliged to stop the train, in accordance with the provisions of paragraph 2 of Article 15 of the Rulebook on types of signals, signal markings and line markings ("Official Gazette of the RS", No. 51/20 and 29/25). If he had stopped in front of the protective signal showing a signal for prohibited travel, the train driver would have had the option to request notification from the train dispatcher of the next station (Pančevački Most junction and halt) by telephone after three minutes at the respective signal, in accordance with the provisions of paragraph 8 of Article 228 of the Traffic Rulebook ("Official Gazette of the RS", No. 34/22 and 107/22), which he had not done.

The reasons for this action of the train driver may be contained in his short professional experience and the fact that he received the order via General Order I on permitted running past the automatic block signal T12 which prohibited further running and is located at the inter-station distance Pančevački Most - Krnjača, not at the Pančevački Most junction, but at the Vukov Spomenik station (see points 3.3.3, 3.3.4, 3.5.1, 4.2.7.1, 4.2.7.4. and 4.2.8.3.4.).

4.3.3. The main causes arising from the conditions established by the legal framework and the application of the safety management system

N/A.

4.3.4. Additional remarks on deficiencies and defects found during the investigation, but not relevant to the conclusions about the causes

By analyzing the diagnostic record from the MMI 10 device, it can be concluded that the train dispatchers on duty are not logging into the device with their own username and password. For any of the recorded events in the time period from 00:00 to 19:26, the names of the train dispatchers who performed the service in the specified period were not entered in the column containing the operator name (see point 3.4.1.4.).

In the Operating Rurels of the Vukov Spomenik station, part I, document No. 31/18-I-2252 of 28.12.2018, in part B - provisions regarding the organization and regulation of traffic, point 6.3. Traffic regulation in conditions of disruptions and malfunctions refers to the application of regulations that are no longer valid (see point 3.3.7.). Also, in part A - description of the station's infrastructure facilities and associated distances between stations, point 1.2. data on neighboring and subordinate stations, stations and tracks that are no longer in function are listed (see point 3.3.7.).

The Instruction on the organization of traffic and the operation of traffic services on sections of the railways between the Beograd Centar, Pančevo Glavna, Rakovica and Topčider stations, No. 4/2019-1250/1-291 of 14.01.2019. of "IŽS"a.d., point 2 of Article 2 and point 12 of Article 45, lists the locations and railway lines that are no longer in function and refers to the application of regulations that are no longer valid (see point 3.3.6.).

Except for the mentioned parts of the Operational rules fo the Vukov Spomenik station, Part I (Regulation No. 31/18-I-2252 of 28.12.2018) and the Instructions on the Organization of Traffic and the Provision of Traffic Services on Sections of the Railway Lines between the Beograd Centar, Pančevo Glavna, Rakovica and Topčider stations (No. 4/2019-1250/1-291 of 14.01.2019, "IŽS"a.d.), the same or similar phenomena can be observed throughout the text of the mentioned documents.

By analyzing the duration of disturbances on SS devices, it can be concluded that the lack of spare parts is the cause of the long duration of disturbances. The duration of disturbances has a direct consequence in reduced safety of railway traffic (see point 3.4.1.2.).

5. Measures taken

"IŽS"a.d. did not take any measures regarding this accident.

"Srbijavoz"a.d, in its letter No. 1/2024-890 dated 11.07.2024, submitted information that, upon completion of the work of the joint investigation commission and determination of the cause and responsibility for the accident, it will take appropriate measures to improve the safety of railway transport. The Board of Directors of "Srbijavoz"a.d. adopted Decision No. 4/2024-2016-387 dated 29.05.2024 on additional measures to improve safety related to the work of school instructors and the development of an online platform that will enable testing and evaluation of train drivers. The Train Traction Department issued Order No. 2 dated 10.07.2024 on taking measures in the Train Traction Departments to improve the safety of railway transport.

"Srbija Kargo"a.d. submitted information by e-mail dated 21.05.2024 that, after the investigation by the joint investigation commission of the infrastructure manager and the railway undertaking is completed, in accordance with the conclusions of the joint investigation commission, the accident and incident analysis team of "Srbija Kargo"a.d. will propose topics for professional development of railway staff.

6. Safety recommendations

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

To the Directorate for Railways:

BP_08/25 "IŽS"a.d. should amend the Operational rules of the Vukov Spomenik station, part I, document No. 31/18-I-2252 of 28.12.2018 and the Instructions on the organization and operation of the operational service on parts of railway lines between the Beograd Centar, Pančevo Glavna, Rakovica and Topčider stations, No.4/2019-1250/1-291 of 14.01.2019 of "IŽS"a.d. in order to harmonize its provisions with the applicable regulations and real situation on site (see points 3.3.6, 3.3.7 and 4.3.4).

BP_09/25 "IŽS"a.d. should take measures to ensure that train dispatchers working on the MMI device log in to the device with their own user account (name and password) at the beginning of the shift, and log out of their account on the device at the end of the shift (see points 3.4.1.4. and 4.3.4.).

BP_10/25 "IŽS"a.d. should analyze the reasons for the occurrence of disturbances with longer duration on SS devices. After assessing the safety risks that have arisen as a result, they should take measures to eliminate safety deficiencies (procurement of necessary resources, spare parts, mechanization, workforce), and in accordance with the requirements of Article 5 of the Law on Railway Traffic Safety ("Official Gazette of the RS" No. 41/2018) (see points 3.4.1.2. and 4.3.4.).

BP_11/25 "Srbijavoz"a.d. should carry out professional training for train drivers in accordance with the provisions of paragraph 2 of Article 15 of the Rulebook on types of signals, signal markings and line markings ("Official Gazette of the RS", No. 51/20 and 29/25) and paragraph 8 of Article 228 of the Traffic Rulebook ("Official Gazette of the RS", No. 34/22 and 107/22) (see points 4.2.7.4. and 4.3.2.).