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

No.: ŽS - 03/18

No.: 340-00-2/2018-02-3-51

Date: 27.06.2019.

FINAL REPORT ON ACCIDENT INVESTIGATION

Accident type:	Trains collision
Train No.:	2990 and 70922
Place:	City of Belgrade, muncipiality Voždovac, settlement Ripanj, open track between the stations Klenje and Ripanj Tunel
Date:	01.08.2018.
Time:	05:35

This report presents the results of investigation of accident, collision of the consecutive trains No. 2990 and 70922, which occurred on 01.08.2018. at 05:35 on the arterial route E70/E85: Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), between the official positions Klenje and Ripanj Tunel.

The Working group for investigation of this accident was formed by Director of the Center for Investigation of Accidents in Transport of the Republic of Serbia by Decision No. 340-00-2/2018-02-3-3 from 08.08.2018.

In accordance with the Article 33 of the Law on Investigation of Air, Rail and Water Traffic Accidents ("Official Gazette of RS" No. 66/15 and 83/18) and the Article 23 of the Directive 2004/49/EC of the European Parliament and of the Council, Center for Investigation of Accidents in Transport drafted and published the Final Report.

In this report, all sizes and measurements are expressed in accordance with the International System of Units (*SI*).

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

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

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

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

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

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

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

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

Glossary:

CINS	Center for Investigation of Accidents in Transport
IŽS	Infrastructure Railways of Serbia
ZJŽ	Community of Yugoslav Railways
JŽ	Yugoslav Railways
RS	Republic of Serbia
a.d.	Joint stock company
OJ	Organizational Unit
JŽTP	Public Railway Transport Company
OJT	Basic Public Prosecutor
MUP	Ministry of Interior
RDV	Radio Dispatch Management
KM	Contact line
TKP	Technical vehicular works
ETP	Electrotechnical works
TOJ	Territorial organizational unit
SS	Safety signalling
APB	Automatic track block
ZOVS	For maintenance of rolling stock
TRPV	Driving route release button
TOPV	Driving route cancelation button
TT	Telegraph-telephone/telegraphic-telephonic
TK	Telecommand
TMD	Heavy motor car
ZOP	For track maintenance

C O N T E N T :

1. Summary

1.1. Short description of the accident

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, upon driving in the direction from the Ripanj Tunel station to Klenje station, on the open track, in the vicinity of the level crossing (which is located at km 27+634), at km 27+369 there came to gaining close to and collision of trains No. 2990 (EMV 413/417-033/034) and 70922 (mere locomotive 661-162). The collision occurred so that the head of the train No. 2990 (EMV 413/417-033/034), which was moving, hit the end of the train No. 70922 (the locomotive 661-162), which was standing. After the collision, the trains were moving at the length of 19 m, after which they stopped. On that occasion, the EMV 413/417-033/034 from the train No. 2990 derailed with a single bogie (the first bogie in the direction of movement).

There were no dead in this accident. 23 (twenty-three) passengers from train No. 2990 received minor injuries.

1.2. The causes of the accident determined by investigation

Direct cause of the respective accident was the fact that two trains were found at the same time at one automatic block section, upon which one train was standing (the train No. 70922), while the other train was moving (the train No. 2990), which is in contradiction with the provision of the Article 37, Point 7 Rulebook 2, Traffic Rulebook ("Official Gazette of ZJŽ", No. *3/94, 4/94, 5/94, 4/96 and 6/03*).

On the occurrence of the respective accident the following had an influence:

1) failure to comply with the railway regulations on passing along the signal that prohibits further driving by the train driver of the train No. 2990,
2) faults and failures of SS devices that are repeated over a longer period of time,
3) unsecured minimum prescribed distance of visibility of the main signals,
4) untimely detection of the obstacle on the track (of the stopped locomotives) due to the vegetation near the railway track,
5) incomplete notification of train driver No. 2990 on train traffic situation by TK dispatcher,
6) frequent alienation of railway property - of certain parts of the SS devices by third parties,
7) weather conditions - extensive rainfall from 30.07.2018. on the mentioned railway section which contributed to the deterioration of the state of functioning of the SS devices.

Considering that the train driver's of the train No. 2990 had no order to pass the automatic block signal that prohibited further driving, issued by the General Order I nor by a phonogram by the traffic regulator (TK Dispatcher), he was obliged to, pursuant to the provisions of Article 6, under Đ, Point 20, Paragraph 2 of Rulebook 1, the Signalling Rulebook ("Official Gazette of ZJŽ" No. 4/96, 5/96 and 1/97), stop the train. In case that he is unable to establish a connection with the TK Dispatcher, in accordance with the provisions of Article 79, Point 5, under a) of Rulebook 2, Traffic Rulebook ("Official Gazette of ZJŽ" No. 3/94, 4/94, 5/94, 4/96 and 6/03), after standing for 3 minutes, he had the possibility to pass a automatic block signal that prohibits further driving and with careful driving according to the transparency of the track, but with at most 30 km/h,

continue driving to the first next automatic block signal. The reasons for such an action of the train driver can be the simultaneous influence of technical factors (long distance driving in conditions of technical defects on SS devices resulting in a lot of information and instructions to the train driver via General Order I or via RDV; this type of drive deviates from the usual driving mode when signaling and traffic control devices function properly) and psychological factors (in conditions when he continuously for a certain period of time, repeatedly performed a uniform action, or repeatedly used the "drive-by-order" button, it can not be ruled out that the train driver of the train No. 2990 was thinking routinely, mechanically and reacted, which is the expected motoric action in the recurring movement scheme).

It was found that all necessary periodical measurements were not performed on the SS devices prescribed by the provisions of the Rulebook on maintenance of the SS devices ("Official Gazette of RS" No. 80/15). Additionally, a number of technical defects was noted in which, due to a technical failure or otherwise caused damage to external SS devices, replacement of certain parts of the device is required. These interferences are characterized by their long duration, by which, as a result of deviation from the designed state, the safety of the railway traffic is reduced. In the submitted documentation from "IŽS"a.d. there is no reliable data on whether a periodic check of the orientation and visibility of the light main signals, pre-signals and repeater of pre-signaling was performed. For automatic block signal E 51, there is no minimum visibility distance prescribed by the provisions of Article 6 of Rulebook 1, Signaling Rulebook ("Official Gazette of ZJŽ" No. 4/96, 5/96 and 1/97).

The Rulebook on maintenance of the SS devices ("Official Gazette of RS" No. 80/15) does not define the maximum permissible interference or defect time on SS devices. Only the maximum deadline by which the workers which are working on maintenance, begin eliminating interference or a defect on the SS device from the reception of notification on interference or defect.

The Rulebook on maintenance of SS devices ("Official Gazette of RS" No. 80/15) does not define that monitoring the condition of SS devices is carried out by the workers that maintain safety-signalling devices with the aim of determining their usability and correctness. It is defined that it should be done only by the workers that operate the safety-signalling devices.

The Rulebook on Technical Requirements for SS Devices ("Official Gazette of RS" No. 18/2016 and 89/2016) does not define electrical parameters to describe the technical condition of the track balises, similar to the provisions that were defined in the currently inapplicable Instruction 427, Instructions for the application, installation, testing and maintenance of track-mounted autostop devices on the railway lines of JŽ ("Official Gazette of ZJŽ" No. 1158/75).

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

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

To the Directorate for Railways:

SR_14/19 Directorate for Railways to define in the Rulebook on Technical Requirements for SS Devices ("Official Gazette of RS" No. 18/2016 and 89/2016) electrical parameters describing the technical condition of the track balises.

SR_15/19 Directorate for Railways to define, in addition to the maximum prescribed deadline by which the workers which are working on maintenance, begin eliminating interference or a defect on SS device, to define the maximum allowed duration of interference or a defect on SS devices after which it is necessary to undertake special measures with the aim of returning the device in the designed state, in the Rulebook on maintenance of SS devices ("Official Gazette of RS", No. 80/2015). Taking into account the specificity of each individual case, Directorate for Railways prescribes special measures that are necessary to be undertaken.

SR _16/19 Directorate for Railways that in the Rulebook on maintenance of SS devices "Official Gazette of RS" No. 80/2015) define that monitoring the state of SS devices with the aim of determining their usability and correctness, beside the workers that operate safety-signalling devices, is carried out also by the workers that are maintaining the safety-signalling devices.

„IŽS" a.d.:

SR_17/19 "IŽS" a.d. to perform the procurement and installation of the missing and due to technical malfunctioning of the track off auto-stop devices on the railway section Resnik - Velika Plana, as well as to see the possibility of the installation of the track balises and on other exit signals that are not on the main running tracks.

SR_18/19 "IŽS"a.d. to regularly check and continuously maintain the prescribed distance of the visibility of light signals in accordance with the provisions of Article 15 of the Rulebook on maintenance of the SS devices ("Official Gazette of RS", No. 80/2015).

SR_19/19 "IŽS"a.d. when, due to weather conditions or some other reason, an interruption in the operation of the TK device occurs, it shall dispose stations by the train dispatchers whose signals are considered unusable after the interruption in the operation of the TK device.

SR_20/19 "IŽS"a.d. to form a Human Factor Assessment Team for the Accidental and Incidental Cases in order to make Critical Elements Models (see point 4.2.6.2.), by classifying them according to the importance and ranking list of representation (identification of all risks) in order to work on the prudent structuring of preventive measures and anticipation of human behavior in crises situations in order to reduce the impact on the emergence of new accidents and incidents.

„Srbija Voz" a.d:

SR_21/19 "Srbija Voz" a.d. to perform the quality additional training of the train drivers with the aim of proper handling of traffic regulation in the cases of interferences on SS devices and interferences on communication means.

SR_22/19 "Srbija Voz" a.d. to form a Human Factor Assessment Team for the Accidental and Incidental Cases in order to make Critical Elements Models (see point 4.2.6.2.), by classifying them according to the importance and ranking list of representation (identification of all risks) in order to work on the prudent structuring of preventive measures and anticipation of human behavior in crises situations in order to reduce the impact on the emergence of new accidents and incidents.

„Srbija Kargo" a.d.:

SR_23/19 "Srbija Kargo" a.d**.** to form a Human Factor Assessment Team for the Accidental and Incidental Cases in order to make Critical Elements Models (see point 4.2.6.2.), by classifying them according to the importance and ranking list of representation (identification of all risks) in order to work on the prudent structuring of preventive measures and anticipation of human behavior in crises situations in order to reduce the impact on the emergence of new accidents and incidents.

2. Direct facts of the accident

2.1. Basic data about the accident

2.1.1. Date, time and place of the accident

The accident occurred on 01.08.2018. at 05:35 in the area of the settlement Ripanj in the city municipality Voždovac in the city of Belgrade, on the main arterial route *E70/E85:* Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), between the stations Klenje and Ripanj Tunel, on the open section in the vicinity of the point of level crossing with a field road (level crossing). The area where the respective accident occurred is not populated.

The appearance of the accident site is shown in Fig. No. 2.1.1.1.

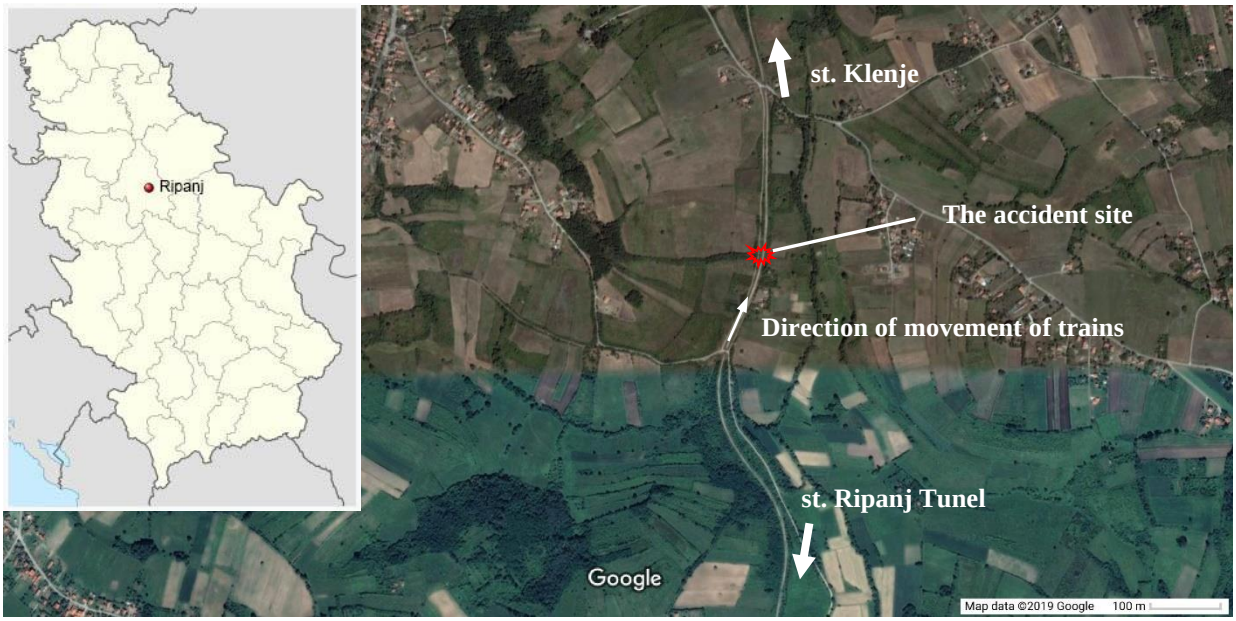


Figure 2.1.1.1: The area of the accident site (source: *Google maps*)

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

On the main arterial route *E70/E85:* Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), upon driving in the direction from the station Ripanj Tunel to the station Klenje, on the open track, in the vicinity of the level crossing (which is found at km 27+634), at km 27+369 it came to gaining close to and collision of the trains No. 2990 (EMV 413/417-033/034) and 70922 (the mere locomotive 661-162). The collision occured in a way that the head of the train No. 2990 (EMV 413/417-033/034), which was moving, has hit the end of the train 70922 (the mere locomotive 661-162), which was standing.

Upon collision, due to the kinetic energy of the train No. 2990, which was moving, there was a movement of the train No. 70922. After the collision, the trains moved in the length of 19 m, after which they stopped. On that occasion, the EMV 413/417-033/034 has derailed from the train No. 2990 with a single bogie (the first bogie in the direction of movement).

There were no deaths in this accident. 23 (twenty-three) passengers from train No. 2990 received minor injuries.

On the site, members of the City Institute for Medical Aid and members of the police came out to help the injured.

Remediation of the consequences of this accident was carried out by engaging professional services and resources of „IŽS"a.d, „Srbija Voz"a.d. and „Srbija Kargo"a.d.

Due to this accident, there was an interruption of the railway traffic between the stations Klenje and Ripanj Tunel. The interruption of traffic lasted until 01.08.2018. at 19:49.

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

First notification of the accident occurred the Main Investigator for railway traffic received on 01.08.2018. at 06:46 via telephone by the Assistant Director of the Operations Department of „IŽS"a.d., and then by e-mail at 07:08 by the traffic dispatcher of the Central Operational Department of „Srbija Voz"a.d. On the basis of the information received and the facts identified by the CINS investigative team by an on-site investigation, CINS launched an investigation of the respective accident in accordance with the Law on Investigation of Accidents in the Air, Rail and Water Traffic ("Official Gazette of RS" No. 66/15).

The composition of the Working Group for Investigation of the respective Accident was determined by Decision No. 340-00-2 / 2018-02-3-3 of 08.08.2018. of the Director of CINS, on the basis of Articles 6 and 32 of the Law on Investigation of Accidents in the Air, Rail and Water Traffic ("Official Gazette of RS" No. 66/15).

2.2. Accident background несреће

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

The driver of the train No. 2990 was involved in the accident, employed by the railway undertaking „Srbija Voz"a.d, Sector for Traction, Section for Traction Lapovo, conductors of the train No. 2990 (two conductors), employees of the railway undertaking „Srbija Voz"a.d., Department for traffic and commercial affairs, Section for traffic and commercial affairs Lapovo, train driver and train driver assisstant of the train No. 70922 (locomotive 661-162), employed at the railway undertaking „Srbija Kargo"a.d., Cargo Section Belgrade, OJ for traction Belgrade and TK dispatchers (two TK dispatchers) in TK Center at Marshalling Yard Belgrade "B", employed at the infrastrcture manager „IŽS" a.d., Sector for Traffic Operations, Section for Traffic Operations Belgrade.

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

2.2.2. Railway vehicles involved in the accident and their composition

2.2.2.1 The train No. 2990

The train composition of the train No. 2990 consisted of EMV series 413/417, owned by „Srbija Voz“ a.d. according to the following: the power car No. 94 72 0413 033-2, the trailer No. 55 72 2417 033-1, the trailer No. 55 72 2417 034-9 and the power car No. 94 72 0413 034-0. For the stated EMV „Srbija Voz” a.d. has a License for Use in Traffic I-02-2 No. 340-518-3/2015 from 15.10.2015. issued by the Directorate for Railways.

EMV series 413/417 manufactured by Stadler Bussnang AG, Switzerland, are designed for traffic on standard track gauges of 1435 mm, electrified single-phase system of 25 kV, 50 Hz. They are intended for the transport of passengers on suburban and intercity routes (regional traffic). EMV is a four-part set, composed of two power cars and two trailers, whose interior is connected to a single spacious unit with comfortable seats and a place intended for standing. The passenger compartment is fully air-conditioned, equipped with security video surveillance. EMVs of this series are characterized by a low mass and high installed power of the electric motors and are equipped with a diagnostic and control system.

The appearance of the EMV series 413/417 is shown in the Fig. 2.2.2.1.1.

Figure 2.2.2.1.1: The appearance of the EMV series 413/417

Techical data (some characteristics):

Total length via bumpers	77100 mm
Vehicle width	2820 mm
Mass (working mass with equipment, without passengers)	128 t
Number of axles	10
Axle arrangement	Bo’-2’-2’-2’-Bo’
Number of seats	224
Number of seats for standing (at 4 persons/m^2)	230
Maximum speed	160 km/h

According to the concept L-4275 ZS-Serbia Vehicle Description 401-417_V02_srp_ 21.07.2014, published by the manufacturer Stadler Bussnang AG, Switzerland, the EMV series

413/417 is equipped with security electronic devices installed in a distribution cabinet on the rear of the driver's cab, leaving enough room for future ETCS S equipment.

Safety devices, consisting of a single speedometer (the type of TELOC 1500 of the HaslerRail manufacturer, from Berne) and two autostop devices (type RAS 8385 of the ALTPRO manufacturer), are connected by a wired bus for internal communication. The CAN interface of the TELOC device communicates with the vehicle control units (VCUs) for operation management.

The Figure 2.2.2.1.2. presents security devices (taken from the L-4275 ZS-Serbia Vehicle Description 401-417_V02_srp_21.07.2014).

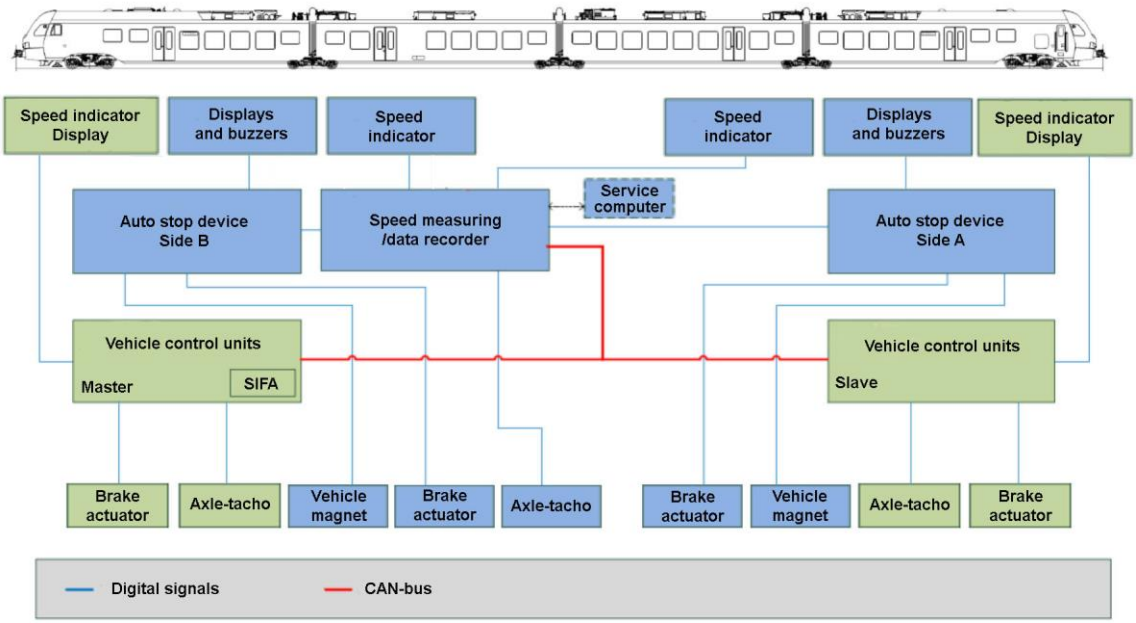


Figure 2.2.2.1.2: Display of security devices on EMV series 413/417

2.2.2.2 The train No. 70922

The composition of the train No. 70922 consisted of the locomotive series 661-162, the manufacturer General Motors - EMD from the United States of America, the property of „Srbija Kargo" a.d. For the mentioned locomotive „Srbija Kargo" a.d. has a License for the release of the traction vehicle series 661-162 in public rail transport No. 376/91-129 of 26.09.1991. issued by the JŽTP "Beograd", the Sector for the Organization of Traction and TKP.

The 661-162 locomotive is a six-axle diesel electric locomotive designed for traffic on a standard 1435 mm track gauge, intended for tration all types of passenger and freight trains on all categories of railroads. The locomotive body is divided into a shorter and longer part by a driver's cab. In the longer part there are drive and auxiliary devices, and in the shorter part there is a part of braking devices. The bridle between the driver's cab and the longer part makes the cabinet with electrical equipment.

The appearance of the locomotive series 661 is shown in Figure 2.2.2.2.1.

Figure 2.2.2.2.1: The appearance of the locomotive series 661-162

Technical data (some characteristics):

Total length via bumpers	18491 mm
Construction year	1960.
Total mass	112 t
Axle arrangement	Co' - Co'
Locomotive power	1342 kW/1800 KS
Maximum speed	120 km/h

2.2.3. Infrastructure and safety-signalling system

On the main aterial route *E70/E85:* Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), on the section between the stations Resnik and Velika Plana, which is one-track, the stations Klenje and Ripanj Tunel are found.

The stations Klenje and Ripanj Tunel are secured by electrorelay SS devices of the type SpDrS64-JŽ of the manufacturer "Siemens-EI". These devices of complete, station centralization enable the control and management of all external elements by electrical means. Driving routes are signaled by light main signals and pre-signals whose aspects of a signal are schemotecnicallly compulsorily dependent on the positions of the switches, the state of the level crossing and the condition of release of station and automatic block sections by railway vehicles, in accordance with the provisions of Article 34, Paragraph 1, Point 3 of the Law on safety in railway traffic ("Official Gazette of RS" No. 41/18).

The open section between the stations Klenje and Ripanj Tunel is a single-track line equipped with APB for traffic in both directions, which allows the regulation of the traffic of consecutive trains in block sections. By using these devices, the distance between the stations is divided into block sections, which are protected by automatic block signals or exit station signals whose aspects of signal are technically dependent on the condition of the automatic block sections and automatically change aspects of a signal in the function of traffic. On the section between the stations Klenje and Ripanj Tunel there are major climbs and falls, so the special solution of the „divided sections" was applied to achieve optimum bandwidth. In this technical solution, the number of automatic block sections regulating the sequence of trains in one direction of travel

differs from the number of automatic block sections for the opposite direction of travel. In the direction of the rise of the track, in order to let more trains pass, shorter sections are used, while longer sections are used in the direction of the fall of the track, so the number of automatic block sections in different directions is different. For the direction of movement of trains from Klenje to RipanjTunel, this distance between stations is divided into five automatic block sections, while for the opposite direction of the Ripanj Tunel - Klenje route, this distance is divided into three automatic block sections. The release, i.e. the occupation of automatic block sections by railway vehicles, is done by using the track circuits.

All light signals in the stations and on the open track show two-way aspects of a signal. Automatic block signals, entrance signals and exit signals on the main running tracks are equipped with combined 1000/2000 Hz track balises, and the 500 Hz track balises are not intended by the Securing Project on this section of the track.

Command assignment, tracking of train traffic, correctness and operation of the SS devices is done with the controlling-command box located in the train dispatcher office, as well as remotely via the TK device whose TK Center is located at Marshalling Yard Belgrade "B".

Overview of the main signals at the distance between stations Klenje and Ripanj Tunel		
Entrance	Eu91	25+550
Automatic block	E12	25+860
Automatic block	E22	26+560
Automatic block	E31	26+660
Automatic block	E42	27+300
Automatic block	E51	27+730
Automatic block	E62	28+060
Entrance	Eu92	28+760

Legend:	
IpE2	Mark of the automatic block section
T L ⅂	Isolated composition
	Interrail bond
Eu92	Enterance signal and its mark
E42	Automatic block signal and its mark
Isolation / 27+360	Element marking / Kilometer's position

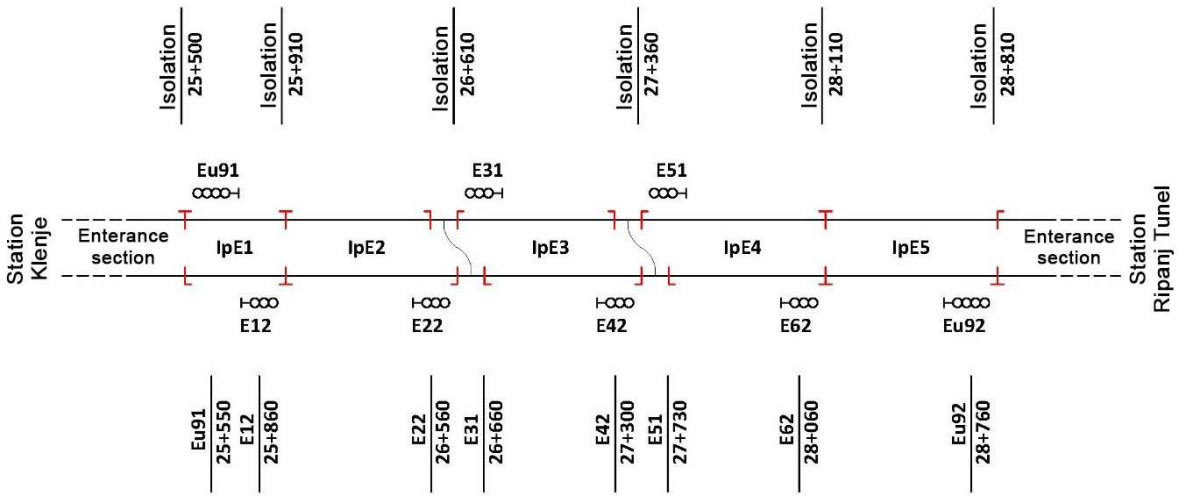


Figure 2.2.3.1: Sketch of arrangement of automatic block sections and signals at distance between stations Klenje - Ripanj tunel

All mileages shown in Figure 2.2.3.1 are in accordance with the cable layout list, which is part of the valid SS Project on the distance between stations of the Klenje - Ripanj Tunel, delivered by "IŽS"a.d. by e-mail from 26.10.2018.

2.2.4. Communication tools

Communication between staff regulating traffic on the track is done by telephone via local TT connection. The line for communication includes all official positions on the track and TK dispatcher at the workplace TK Jug 1 in the TK Center at the Belgrade station "B". Communication on this line is registered (recorded) on the registrar device located in the TT section of Makiš (the Marshalling Yard Belgrade "B"), so this type of communication is considered evidence-based communication.

This track is equipped with RDV devices that are in function and via which communication between the traction train staff and traffic regulation staff (TK Dispatcher) is possible. Communication conducted by RDV is registered (recorded) on a register device located in the TT section of Makiš (the Marshalling Yard Belgrade "B"), so this type of communication is considered evidence-based communication.

For communication with the staff of the traction vehicle, in the TK Center at the Belgrade station "B" is also in use a fixed telephone line connected to the registrer's device located in the TT section of Makiš (the Marshalling Yard Belgrade "B"), so this type of communication is considered evidence-based communication. Communication is carried out by calling from the mobile telephony network (traction vehicle staff) to a fixed telephone line (TK Dispatcher).

2.2.5. Works at or near the accident site

In the vicinity of the accident site there were no works carried out.

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

Infrastructure manager "IŽS" a.d. and the railway undertaking "Srbija Voz" a.d. informed CINS on the accident occurred, that is, the Main Investigator for Railway Traffic. Infrastructure manager "IŽS" a.d. and the railway undertakings "Srbija Voz" a.d. and "Srbija Kargo"a.d. formed a joint investigative committee which has carried out investigation of the respective accidnet in accordance with applicable regulations. Upon finishing the investigation, the Report on the accident U-265/18 was made.

Immediately after the collision, the train conductors which were following the train, informed on the accident the intersted parties in "Srbija Voz"a.d. and emergency medical service, after which they performed giving first aid to the injured passengers and preventive work on the prevention of panic among passengers. After the team of emergency medical service and police arriving at the site, in coordination with them, they carried on with giving aid to the passengers.

According to the judgement of the conductor, at the moment of collision in the train No. 2990 (EMV 413/417-033/034) there was between 60 (sixty) and 70 (seventy) passengers.

Passenger evacuation was carried out in such a manner that the passengers that were not transported to health facilities, under supervision and with the help of the conductors, were transferred into EMV 413/417-025/026, which was delivered to km 26+920 (level crossing in the vicinity of the accidnet site), to accept the passengers from the train No. 2990, so that after acceptance of the passengers it was dispatched to Belgrade at 07:57 as the train No. 2990.

TK dispatcher at the TK Center at the Belgrade station "B" at the workplace TK Jug 1 received the first information on the accident that occurred received at 05:40 from the train dispatcher of the Resnik station. The train dispatcher of the station Resnik received the information about the

train collision through the mobile operator's line from the colleagues train dispatcher, who came to the shift and was in the train No. 2990. Immediately after knowing this, the TK dispatcher informed the interested parties at "IŽS"about the accident., and the police.

After the on-site investigation was carried out, activities were initiated to remediation the consequences of the accident. In order to enable work on the lifting of the derailed EMV, firstly the locomotive 661-162 was pulled out from the site to the station Klenje at 11:30.

The lifting of the derailed EMV was carried out by the engagement of a breakdown train owned by "IŽS"a.d, Section for TKP Beograd. In order to ensure the conditions for the work on the lifting of the derailed EMV, the team KM from "IŽS"a.d. was engaged.

The voltage in KM is off at 11:50. The work on the lifting of the derailed EMV was carried out between 13:00 and 18:30. Voltage in KM is turned on at 19:05.

After finished lifting of the derailed EMV, it was transferred from the accident site, at 19:40, to the Klenje station, where from it was dispatched as the train No. 78900 for the Zemun station with Vmax = 20 km/h.

The interruption of the traffic between the stations Klenje and Ripanj Tunel lasted until 01.08.2018. at 19:49 when the track was opened for train traffic.

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

According to the allegations contained in the Letter on the Accident Information from MUP RS, Police Directorate, Police Directorate for the City of Belgrade, Criminal Police Administration, Department for Investigation of Explosion, Fire and Accidents 03/16//2/6 No. 1263/18 from 21.09.2018., data was submitted that on 01.08.2018. around 05:50. a patrol from the Beli Potok Police Station, consisting of Commander, Deputy Commander of the branch office and two patrol officers who came out to secure the site of the accident.

By letter of the Second OJT in Belgrade KTR 3412 / 18 dated 18.10.2018. the Report of the Ministry of the Interior of the Republic of Serbia, the Police Directorate, the Police Administration for the City of Belgrade, the Criminal Police Administration, Department for Investigative Operations No. D-5696/18 of 01.08.2018. was submitted to CINS, in which it is stated that the duty deputy prosecutor of the Second OJT in Belgrade was informed and that he did not go to the accident site, but he gave oral permission to perform the on-site investigation, to exclude from the site all necessary items and traces, as well as to draft a report under D number and submit it to the competent Prosecutor.

By letter of the City Emergency Medical Service in Belgrade, No. 9841 dated 24.08.2018. the data were submitted that on 01.08.2018. at 06:00, a police team informed a medical team (a doctor, a medical technician and a driver) who arrived at the site at 6:20. Due to the large number of injured that were to be transferred to the duty hospital, at 6:32, the first medical team informed the second medical team. The first acting doctor examined 11 (eleven) injuried who complained of ailments and were transported in a stable condition to a duty hospital by two medical teams and one transport vehicle. The examined patients initially had minor injuries (injuries to the head, face, chest, abdomen and knees), but it was necessary to do additional diagnosis in the duty health institution. By the medical service of the Military Medical Academy in Belgrade, by letter No. 7393-2 dated 30.08.218. CINS was informed that on 01.08.2018, regarding the respective accident 21 (twenty-one) passengers were taken care of, and no one was held for more than 24 hours.

2.3. Dead, injured and material damage

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

There were no dead in this accident.

In this accident 23 persons in total were injured. All the injured were the passengers of the train No. 2990, and according to the Report of MUP RS, Police Directorate, the Police Administration for the City of Belgrade, the Criminal Police Administration, Department for Investigative Operations D5696/18 from 01.08.2018., which was delivered to CINS by deputy Public Prosecutor of the Second OJT in Belgrade (KTR.3412/18 from 18.10.2018.), 20 (twenty) persons were taken care of in the Military Medical Academy in Belgrade, and in the Emergency Center in Belgrade 9 (nine) persons were taken care of, among which 3 (three) were with light injuries and, wheras with 6 (six) persons the injuries were not identified.

From the train driver assistant of locomotive 661-162, employed at "Srbija Kargo"a.d. the report of the medical specialist from the general hospital "Stefan Visoki" from Smederevska Palanka was submitted from 08.08.2018. in which it was stated that the assistant train driver was injured in a train collision on 01.08. 2018. and from that time he feels pain on the left side of the chest and the fracture of the 9th rib on the left is indicated.

2.3.2. Goods, luggage and other assets

In this accident there was no damage done to the goods or other assts.

2.3.3. Railway vehicles, infrastructure and environment

In the respective accident the railway vehicles were damaged. There was no damage on the infrastructure. No material damage was done to the property of third parties.

In order to lift the derailed EMV, except a breakdown train, it was also necessary to engage the KM team.

The structure of the material damage is as follows:

Damage on EMV 413/417-033/034:	35 000 000.00	RSD
Damage on locomotive 661-162:	394 400.00	RSD
Total costs of lifting the derailed EMV	247 533.52	RSD
Costs of engaging the team of KM:	112 300.00	RSD
Total direct material damage:	**35 754 233.52**	**RSD**

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

According to the official middle exchange rate of the National Bank of Serbia on 01.08.2018., which is 1 EUR (Euro)= 118.0618 RSD (Dinars), the total material damage caused in the respective accident amounts 302 843.37 EUR

The material damage in this report is stated based on invoices, evaluations i.e. documents with which the aforenebtioned amounts of damage are confirmed, delivered by "IŽS"a.d. and "Srbija Kargo" a.d. and "Srbija Voz" a.d.

2.3.4. External conditions - weather conditions and geographic characteristics

The site of respective accident is located in the area of the city of Belgrade, muncipilaity Voždovac, setllement Ripanj in the unpopulated area. The landscape in the vicinity of the occurrence of the respective accident is mainly hilly.

The geographic coordinates of the place of accident are: : 44º 37' 8.1" N и 20º 32' 0.1" E.

At the time of the accident, the weather was sunny. The air temperature was 21°*C*. During the on-site investigation the weather was sunny, without wind. The air temeprature was 32°*C* .

3. Minutes on the investigation and interviews

Information, facts and evidence related to the occurrence of the respective accident were collected and determined based on the following:

- On-site investigation that the Working Group of CINS has carried out on the site,
- Materials submitted from infrastructure manager "IŽS"a.d.,
- Materials submitted from undertaking "Srbija Kargo"a.d.,
- Materials submitted from undertaking "Srbija Voz"a.d.,
- Materials submitted from Second OJT (Public Prosecutor) in Belgrade,
- Materials submitted from Emergency Medical Institute and
- Material submitted from Military Medical Academy in Belgrade.

3.1. Summary of testimonies

The Working Group of CINS has, on 24.11.2018. at the CINS premises, carried out hearing of the employees that were involved in this accident.

From the employees of "Srbija Voz"a.d., a train driver who was at the time of the accident in charge of EMV 413/417-033/034 from the train No. 2990 was examined.

From the employees of "Srbija Kargo"a.d, a train driverer and a train driver assistant were examined who were at the time of the accident in 661-162 locomotive from train No. 70922.

From the employees of "IŽS"a.d., TK Dispatchers who were working at the TK Center at the Belgrade Marshalling Yard station "B" at the workplace TK Jug 1 were examined.

From "IŽS"a.d, "Srbija Voz"a.d. and "Srbija Kargo"a.d. Minutes on hearing the train staff of the train No. 2990 (the train driver and two conductors), the train staff of the train No. 70922 (the train driver and train driver assistant) and the staff that regulates the traffic.

From "IŽS"a.d., Report on the irregularities during operation (S-23) No. 0001288 of 01.08.2018. was obtained from train dispatcher issued by the TK Dispatcher at the TK Center at the Belgrade station „B" at the workplace TK Jug 1 who performed the service at the time of the respective accident (employee regulating the traffic on the respective track section).

The testimony of the train driver of the train No. 2990, the driver of the train No. 70922, the assistant train driver of the train No. 70922, the TK dispatcher (driving dispatcher) and the TK dispatcher (operator) was given according to the hearing which on 24.11.2018. was carried out by the CINS Working Group, while the summary of testimonies for train conductors of the train No. 2990 was given according to the Record of Hearings obtained from "Srbija Voz"a.d.

The statements taken on the site on the day of the accident from the participants in the accident coincide in all the relevant facts with the testimonies given at the hearing on 24.11.2018. in CINS premises.

3.1.1. Railway staff

The train driver of the train No. 2990 stated: "I took over the shift in the Lapovo station. At the part from Velika Plana, everything was red on that morning. I drove in accordance with the General Orders I received from train dispatchers and from telecomand via an RDV order. Forty-something signals I passed from Velika Plana to the site of the accident. They were all red. I respected everything and the speed and protocol that the dispatcher himself told me and everything that was needed. Everything was regular until the accident site. To emphasize that this is not the first time I am driving under such conditions. In recent years, I can not accurately specify how much, but for many years behind it had been done according to this principle. It happens that the whole way nothing is working. Just that section of the track where this accident happened was long under orders that nothing was working. I came to the entrance signal of the Ripanj Tunel, which was red. I have established a connection with the TK Dispatcher via RDV. He told me that I would wait few minutes just to get a train come to his station. He told me that a freight train was entering and that there would be a crossing of trains; everything else will be done on a regular basis. The TK dispatcher did not tell me that a train was going in front of me - mere. A regular entrance signal was on. I went to the station to turn. By that signal (entrance signal), I did not have an exit, but when I reached the exit signal itself, the exit signal switched on, from red it transferred to a limited speed, expect freely or cautiously, meaning yellow blinking green still. If there was a train (locomotive) in that section or that the APB was defective, he could not have switched on this signal that was switched on. In practice, when such a signal appears, you are sure to have two automatic block sections free. If my speed had been limited, expect standing (yellow blinking, yellow still), of course, I would have known that the next one was red. By approaching the first automatic block signal (E 51), I noticed a signal. That section of the track is in curve. Nothing has disturbed my vision. Everything was regular, I saw a signal. On two meters in front of me, the signal fell on stop. From green to red. There was no signal blinking. Even before, in practice, it happened that the signal changed in front of me. Not so often, but it happens. This is normal with us. It happens on that section of the track at a station distance, for example, and to have all the other signals green. It happens that one automatic block signal is red, the next is already green, or it is even automatic block signal green, and the next automatic block signal is red. In the section between Velika Plana and Resnik, we are not so much handled by the train dispatcher. We are more connected to the TK dispatcher. We communicate via RDV, as much as it is possible, because there are days, times that RDV devices are not working. Then we communicate via private mobile telephone to the stable line at telecommand. They assured us that this conversation is recorded. On that day RDV was working, it was functional. There were no interferences, it could be heard. When I passed the red signal (and carried out „drive by order"), via RDV I called TK dispatcher, to hear him, but it was not possible. And after the collision I called him again from the cab, but it was not possible, so we communicated via mobile phone and that stable line. When this happened, it was already dawn, it was not clear, there was some tiny drizzle. Visibility was good.

There was no mist. I drive a very long time, for seventeen years, and for seventeen years I had no stain. If someone has been conscientious as a train driver, that was me.When I passed the automatic block signal that changed to red in front of me, I served a „drive by order“ because, considering the exit signal, I thought that two automatic block sections were free. As soon as it was green, then it changed to red, I thought it was a voltage change or some malfunction, so I mechanically responded in this way. I have done that before. Ninety percent of colleagues that I have talked to after the accident had told me that they would react the same way in that case. With regard to numerous failures, I have not had any problems until now. I can function equally in conditions of disturbance and when everything is right. I consider myself to be a perfectionist in terms of driving.To improve the state (thinking about the correctness of the SS device), it would surely be easier and better for us, but we were just used to it. I should have let the autostop device stop me and respect the protocol. I would not use a „drive by order“. This is how I acted, perhaps, because of the situation on the site that lasts for many years. I personally thought I should do it. After the accident, I was aware of everything; the situation. I did not have any injuries. I was scared and stressed, but I was really aware. When I get back to the wheel, I'll do everything by the rules, definitely. I would only add that on the site after the collision, there was a large quantity of cans, where they were trying to expose oil from the tank at the moment. This was clearly seen. The engineers were not on a locomotive at the time of the collision. They were next to the locomotive with a few other people I did not know. I have nothing more to say.”

The train driver of the train No. 70922 stated: “before the accident, the locomotive went as a pushed locomotive to Ralja. It was a freight train and then we should return to Resnik. When I returned I got in contact with the TK Dispatcher in Ripanj Tunel. I heard from the exit signal from the first track of the Ripanj Tunel station, then I was told to cross one train, that exit could be switched on, and for the rest to call it from the entrance signal at the Klenje station. When I was supposed to get out of Ripanj Tunel, the exit signal showed me a limited speed, expect the stop, „yellow blinking, yellow still“. Since I was told to call from the entrance signal in Klenje, it means that it is either a station distance or there are problems with the SS devices. We know that there are a lot of problems on that section of the railway track; Ralja, Resnik is problematic with this signaling. It happened to me many times that, in front of the train, there was a signal dropping for no reason. I'm calling TK Dispatcher, and he says I have regular, it's switched on at me. When I exited the Ripanj Tunel and approached the automatic block signal E 51, I think he switched from green to yellow. I was bothered by the bushes and plants to see the aspect of a signal on the automatic block signal E 51 well, there are a couple of moments when it can be seen, you must be well known with the railroad to know where you can see it; because of vegetation. At one point you see a part of the signal, and at one point nothing can be seen, when I was passing it was green. Very often, the pre-signaling is not consistent with the meaning of the aspect of signal of the next signal. In the case of driver's safety device, it often happens that a foot key is stuck, from dust, from all, maintenance is inadequate, and if I write to someone about it, there is no use. When the locomotive went as a pushed locomotive to the Ralja station, I turned off the driver's safety device so that I would not have problems, that is, not to break the train. I turned off the driver's safety device on a box; electronics. I did not break the seal on the switch because the workers in the ZOVS leave that little nut longer, because it is not known whether the machine will be on pushed or not. When I went from Ralja station to the Ripanj Tunel station, driver's safety device was turned on. He began to stuck, to make problems. On several occasions, I managed to solve it on the release button , but this time, he literally did not want to react, the locomotive was stopped. I tried the foot button, the manual button, on release and it was not working, I headed towards the valve, towards the shorter end of the locomotive to turn off completely driver's safety device, and I intended to drive it down to the first station Klenje and to contact the TK dispatcher that the

machine was defective. I went to that valve and then it came to the hit. I went between the commanding units because the door were on the other side andI was there at the moment of collision. From the moment of stopping to the moment of hitting, four to five minutes maximum has passed. I went down the locomotive to see what happened, there were no other persons near the locomotive. Looking the whole, I have many objections to maintaining infrastructure and rolling stock. When I point to an irregularity on a locomotive, I have "pressure" from the superiors to drive. My rule is, if it's a defective machine, I will not drive. Lately locomotive reservoirs have not been locked because locomotives are ending up in different stations, but not all of them have the keys. The train drivers do not have the keys to these locks. After the collision, I called the machine dispatcher to tell him what happened."

The train driver assistant of the train No. 70922 stated: "at the station Ripanj Tunel, we waited for the crossing of two trains from the opposite direction for about twenty minutes to half an hour. The train driver descended on the railway telephone, and the dispatcher told him that after the passage of these two trains, he would switch on our exit. When the two trains passed, the exit was on. The exit signal at the station Ripanj Tunel showed „yellow still and yellow blinking". The first automatic block signal was green. In the previous drive, when the locomotive was pushing, the driver's safety device was turned on, we had no problems with the driver's safety device, the train driver did not complain. The driver's safety device problems occurred after the automatic block signal (E 51), the train driver began to complain, he asked me if I was holding a foot of a driver's safety device. I said I did not hold it and it stopped us. The train driver tried to fix the malfunction, tried to release it, he could not, tried on a box of driver's safety device, it did not want, then he opened those cabinets, watched, shuddered. He went to the valve of the driver's safety device to close it. It did not pass a lot of time, three to four minutes, I turned my back on and the collision came. I fell off the chair. Due to the collison I experienced both psychological and physical pain. It took me ten minutes to get to myself. The the train driver was next to me. I stood up by myself and I went down from the locomotive to see what was with the passengers and my colleague. When I went down, I did not see if the lock was unlocked on the tank. Because of the indignation of the passengers, I had to return to the driver's cab until the ambulance and the police arrived. I did not sign up for help, because I thought that I was getting stung and that it would pass, and the commission was supposed to come in and I should have given a statement. At the moment of the collision, I was in the driver's cab on the left, sitting on a chair. When I'm working on a shunting, I have no objections to the work of colleagues from other services, there are many problems and we all work in difficult conditions. Our job is very responsible and difficult. Now there is not as much bad situation with maneuvering locomotives, but it is with the staff, many people have left, there are no enough shunters. I always sleep before night shift. The previous day (the day before shift) I was at the celebration of the railwaymen at the station. I have nothing more to say."

TK dispatcher (driving dispatcher) stated: "two of us are working in a shift. For example, first I work as a driving dispatcher, and my colleague as an operator, and after that, we change, so, mostly six hours, six hours. In the first part of the shift, I worked as an operator, and about half past one we replaced, and I was a driving dispatcher. As for the APB device, from Velika Plana to Resnik, a small part was working. They were difficult conditions of work. There were sections where APB was working. I can not remember where, but part of the Ripanj Tunel - Klenje was not occupied, just where it happened. When the 70922 train entered the Ripanj Tunel, I communicated with the diesel lomotive train driver. He asked me what he was waiting for. I said he was waiting to cross the train, I think it was „Chinese", and when he enters, he will get a regular exit. The train came in, got a regular exit and started off. "The Chinese" stayed there waiting for "Lapovac", on 2990. The train driver of the train No. 2990 called me, I mean on RDV. He asked me for the entrance. I told him that the train was on the other side entering and that he would have

a regular passage. I can not remember if I told him that in front of him mere locomotive is going. Well, that's it, you have ten trains, one calls you to “town”, one on RDV; you tell him that he will pass, that the traffic is taking place, and now, will you remember whether he called on RDV. It is important that he is going, that he is not standing. This is the most important thing in these conditions. I do not remember if I told him that a locomotive was going in front of him. He could have guessed what he expected ahead of him if he was exiting on one signal. We can not watch nonstop on the board. We did this, as far as the work goes; then I'm typing a train into a computer, since we have to do it also, I draw a chart and then you can not watch all the time there. I plotted it and called that freight train to go out and that freight train was coming out and it happened afterwards. Yes, it is the operator's obligation to draw a chart, but it is literally impossible to work in these conditions with occupation. My colleague is here next to me, he helps me and he enters it into the computer, but I draw on the chart, because I see, I'm here. It is impossible for everyone to do their job strictly. We are forced to do this because the device is malfunctioning. They need to deal with these interferences and failures so that everyone can do their job. This situation has a lot of stress on us. When we come to work, we literally pray to God that we end these twelve hours that nothing happens. It's really hard to work. We do not see neither the switcher, nor whether the train has entered. We struggle with this for years. Surely there are two years that it's getting worse and worse every day. We write disturbances and we gave telegrams and nothing; it's just said that there are no parts and that's it. We write down every interference. Since these interferences last for two years, it has lost the sense of enrolling them every day. When a new interfence arises, we just write it. When the device is running, all assigned commands are executed. The device works and locks the driving route, and that's for us safety. When it does not exist, we do it all by hand. It happened that the train drivers report a strange signal display. I recall, Glibovac - Kusadak, the train driver says, what is this, light show, the yellow, red, green blinking. The mechanic goes to look, everything is regular. The train drivers did not report bad pre-signalling of signal to me. On the section of the Ripanj Tunel - Klenje on that day in automatic block sections, there was no occupancy after the train passed. Generally, it happens that there is an occupation after passing the train, we have a key and we do our part. We would love that everything is working, it would be easier for us. If it were not for the mobile phones with which we communicate with the train drivers, to be honest, communication would be nonexistent. Sometimes it happens that RDV has interferences. Mostly the train drivers do not call from the signal, they know, they were coming down, there is no phone next to the signal, it was robbed. If there is fortune that everything is right, that RDV, the phones next to the signals and stations are working. During the collision, on the board of the TK Center there was a busy automatic block section that is protected with the E 51 signal and the exit section from the Ripanj Tunel station. These two sections were busy. I have nothing more to say.”

TK dispatcher (operator) stated: “As a TK dispatcher I worked from 19:00 to 02:00 in the morning. After that, my colleague and I were replaced. I worked as an operator, and he as a TK dispatcher. The one behind the train control section, working on the train control, I input the trains into the computer, arrivals, departures, the effect we're working on, I plot a chart, and similar. That night I was next to my colleague. The chart was next to him. I occasionally got up. There was no traffic jam; It was all clean. I learned about a collision from a colleague who worked as a TK dispatcher. At that moment I was paralyzed. For twenty-two years, I worked as a train dispatcher and I never had an accident or something like that. I have the habit to keep looking at the traffic control section while I'm working. There was no occupation on that part of the Ripanj Tunel - Klanje railway line; There were no disturbances. The APB was working. After the collision, as far as I remember, the diesel was on the first block section. The approval section was also occupied. So these two positions were on the control section occupied for us. For the rest of the track, what

I know for sure is that since I arrived at the telecomand, there is a distance between stations between Ripanj Tunel and Ralja. The same for Ralja - Sopot Kosmajski. Now they fixed the Ripanj Tunel - Ralja. Now, I cannot remember the lower part of the railway line, from Sopot to Mladenovac, it's often between Vlasko Polje and Mladenovac, now I do not know if that night there was. We were constantly reporting; they went out, fixing the interference. Pinosava was a busy. We had an interference at the crossroads here. I remember that because they came to work that morning. They go out, they are constantly fixing. It works for a while and then again it happens. Working in these conditions is difficult. It takes a concentration of twelve hours of viewing into this board. Especially now Jug 2; Mala Krsna. It's literally everything occupied there. One must take care and be concentrated. To know at any time, according to the chart, where each train is, where I will carry out the crossing, which train with which train, the train's ranking must be taken into account also. During the shift, I sit next to my colleague. I only move when it's lunch or something. I sit, I'm listening to the phonograms that my colleagues give to the trains. I'm always there. One must be concentrated; it must be kept focused. As far as I'm concerned, there are no conversations, a story, some relaxation. During the time I worked as a TK dispatcher, I did not encounter some fatigue in those six hours. I did not try it longer, but I think that these six hours are quite enough to be able to follow, to be concentrated in order to make it all right. Communicating with the train driver who have RDV, we hear through RDV, if everything is fine, if there is no blockage. It happened, I heard him, he did not hear me. Then we have to go through the city line, because otherwise we cannot communicate. The train drivers do not call from the signal very often. When giving phonograms to the train drivers, I try to inform them correctly about the (traffic) situation, I think to emphasize, when train driver calls. I have nothing more to say."

First conductor stated: "I was in the first part of the set. Upon completion of the check-up of the tickets of the passengers who entered the Ralja station, I sat down in front of the driver's cab where I was at the moment of the collision. The hit kicked me off the seat and I fell to the floor. I immediately got up because the screaming and shout of scared passengers began. There were plenty of them on the floor and I immediately began to help them get up and asked if they were hurt. I concluded that there were no serious injuries and immediately I called the operative to report about the event. Then I called for ambulance. I tried to calm the passengers so as not to cause panic. And the train driver came out of the drivers cab to ask if there were any injured. After about ten minutes, emergency aid came and they helped the injured people. Passengers suspected of having injuries were taken to Belgrade. Although I felt pain on the left side of my shoulder belt, I accepted to accompany travelers (who were not transported to medical institutions) to Belgrade with a set they had sent to take passengers from train No. 2990. Upon arrival of the set, I took the necessary measures to safely move passengers from the train No. 2990 in a new set. I followed the train to Belgrade station. I have nothing more to say."

The final conductor stated: "at the moment of the collision I was in the back of the set. There were about 60 to 70 people in the whole train. I reacted in a moment because a hysteria began among the passengers lying all over the floor. I went from one to the other, helping to get back to the seats. I tried to calm the start of panic with a humorous tone. I had a bottle of water with me and I gave water to the frightened passengers. In the meantime, I called the operative, and my colleague called an emergency. In the record time, the police and ambulance came and I can only praise the cooperation with them. Passengers suspected to have been injured were taken to Belgrade. My colleague went with the passengers, and I remained in the train set of 2990. I have nothing more to say."

3.1.2. Other witnesses

There were no witnesses of this accident.

3.2. Safety management system

3.2.1. Organizational frame and manner of issuing and executing orders

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

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

Infrastructure manager "IŽS"a.d. and railway undertakings "Srbija Voz"a.d. and "Srbija Kargo"a.d. in accordance with the Law on Safety in Railway Traffic ("Official Gazette of RS" No. 41/18), established a joint investigation committee that conducted the investigation of the accident. Upon completion of the investigation, the Investigation Report U-265/18 was made.

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

"Srbija Voz"a.d. through the Rules of the Safety Management System (SMS) has provided management of competences, i.e., processes that all employees directly involved in the performance of rail transport are trained and competent as well as workload planning.

Regarding the respective accident, involving train driver and conductors employed by "Srbija Voz"a.d, all activities related to professional training, competence and work time planning were conducted in accordance with applicable regulations.

Through the Safety Management System Manual (SMS), "Srbija Kargo"a.d. by its operation ensures that all employees, including employees of other contractors, who directly participate in the performance of rail transport and have responsibility in the system for safety management, are trained and competent to enable the effective, efficient and safe execution of the set goals.

In relation to the respective accident, involving the train driver and assistant train driver, employees of "Srbija Kargo"a.d, all activities related to professional training, competence and work time planning were conducted in accordance with applicable regulations.

"IŽS"a.d. through the Rulebook of the Safety Management System (SMS) provided management of competences, ie, processes that all employees directly involved in the performance of rail transport are trained and competent as well as workload planning.

In relation to the accident, in which TK Dispatchers, employees of "IŽS"a.d participated, all activities related to professional training, competence and planning of working hours were conducted in accordance with the applicable regulations.

3.2.3. Procedures for internal controls and checks and their results

"IŽS"a.d. as the infrastructure manager has established the Rulebook of Safety Management System (SMS). The safety management system includes the organization and all procedures and procedures established in the "IZS"a.d. for the safe conduct of rail traffic.

Risk control related to the maintenance of the railway infrastructure (subsystems of infrastructure, energy, control, control and signalization-for tracks) and rail vehicles used for maintenance by "IŽS"a.d. is based on the implementation of defined regular and corrective activities and their tracking and control. Regular and corrective maintenance involves continuous monitoring, controls, inspections, checks, and repairs.

Requirements, standards and procedures for maintenance at "IŽS"a.d. are determined on the basis of legal regulations, general and individual acts of the company, instructions of the manufacturer and standards.

"IŽS"a.d. as an infrastructure manager, through the Rulebook of the Safety Management System (SMS) defines: procedures that ensure that the personnel who are entrusted with competencies within the organization have the authority, professional competence and necessary resources to respond to their tasks, clearly defined areas of responsibility relevant to safety and distribution responsibilities for functions related to them and their interfaces, clearly defined areas of responsibility relevant to safety, and the allocation of responsibilities to functions related to them and their interfaces, a procedure that ensures that safety-relevant tasks are clearly defined and delegated to staff possessing the necessary professional competence, a description of how responsibilities are assigned to each safety-relevant process in the organization of infrastructure managers, a procedure for the regular supervision of the execution of tasks by superiors who intervene if tasks are not carried out properly, procedures that ensure that staff and its representatives are adequately represented and consulted in defining, proposing, checking and improving the safety aspects of performing activities involving staff.

Regarding the respective accident, regular maintenance of the SS device has not been carried out in accordance with the applicable regulations.

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

The purpose of establishing a Safety Management System (SMS) in the company "Srbija Voz"a.d. is to ensure the safe management of its own activities in accordance with the provisions of the Law on the Safety and Interoperability of the Railway ("Official Gazette of RS" No. 104/13, 66/15 - other Laws and 92/15) and the Statute of joint stock company for railway undertaking "Srbija Voz", Belgrade ("Official Gazette of RS" No. 60/15).

Planning in the safety management process in certain elements that are relevant to the safety management process, is done by adopting other plans: Maintenance plans for rolling stock in order to increase technical safety and achieve greater safety in the traffic of rolling stock, the Framework plan and the program for teaching executives in the company "Srbija Voz"a.d. and their proficiency check, Plans for checking the health skills of executive officers and operative workers.

Rolling stock must be maintained in the prescribed technical level of correctness and must follow maintenance plans (EV-62) and its cycles of inspection and execution of scheduled repairs in order to be as reliable as possible in traffic, in accordance with the Regulations on the Maintenance of Railway Vehicles and other legal and bylaw acts which are an integral part of the Rules of the Safety Management System "Srbija Voz"a.d.

Within the company "Srbija Voz"a.d. internal control is organized in all organizational parts, which is especially expressed in the field of maintenance of rolling stock during the execution of regular tasks, in the control and technical examinations, in the case of rolling stock, and especially the control of the executive service officers in the application of regulations, the use of alcohol,

rest between two shift and more. In addition to this type of control, control is also carried out through the Center for Internal Control, which is tasked with controlling at all levels in all organizational parts of the Company, on all relevant issues.

All mentioned activities and business processes of "Srbija Voz"a.d. are a risk generator in traffic. These risks have been identified and quantified through the definition of operational business processes. In the work processes, instructions, rules, technical documentation and legal regulations are applied, which implements instructions, as well as the management of defined records and business documentation.

Regarding the accident, regular and corrective maintenance of rolling stock (EMV 413/417-033/034) in "Srbija Voz"a.d was performed in accordance with applicable regulations.

"Srbija Kargo"a.d. as the railway undertaking has established the Safety Management System Manual. The general purpose of the safety management system is to ensure that "Srbija Kargo"a.d. achieves its business goals of providing rail freight services in a safe way. These goals must be fulfilled in today's constantly changing and complex railway environment, providing evidence that "Srbija Kargo"a.d. meets all the safety requirements that apply to it.

In addition to safety, the adoption of a structural method enables identification of hazards and continuous management of risks associated with transport business activities in order to prevent accidents and incidents. By adequate implementation of all relevant elements of the safety management system "Srbija Kargo"a.d. provides the necessary guarantee to control, in all conditions, and to continue to control all identified risks associated with its activities.

"Srbija Kargo"a.d. as a railway undertaking through the Manual of the Safety Management System defined the performance of medical examination and determination of fulfillment of health conditions, regular training and periodic improvement of existing knowledge and skills, conducting regular periodic checks of the professional training of employees directly involved in the performance of rail transport, supervision of employees in terms of health abilities and necessary corrective measures in accordance with regulations.

"Srbija Kargo"a.d. must approach safe maintenance in the various processes. The exchange of information within the Safety Management System with the ECM (person in charge of maintenance) in "Srbija Kargo"a.d. implies operational information regarding the safety of the maintenance and control of the technical safety of the vehicle.

The maintenance system includes several functions that are described in the procedure relating to the maintenance of freight wagons.

Requirements regarding the maintenance of rolling stock (locomotives, freight wagons and facilities, equipment and devices) are described in the appropriate procedures as well as the procedure for their maintenance, which is determined on the basis of legal conditions, technical documentation and manner of use and required performance of the vehicle in terms of reliability and availability.

Regarding the accident, regular and corrective maintenance of locomotive 661-162 rolling stock in "Srbija Kargo"a.d was performed in accordance with applicable regulations.

3.3. Relevant international and national regulations

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

Article 10, Paragraph 1:

The infrastructure manager is obliged to ensure safe and smooth organization, regulation and management of the railway traffic, smooth access and use of the public railway infrastructure and access to the service facilities entrusted to him with the management and services he provides in those facilities to all interested applicants for the allocation of the capacity of the infrastructure, under equal, non-discriminatory and transparent conditions, as well as permanent, continuous and quality maintenance and protection of railway infrastructure.

3.3.2. Rulebook 1, Signalling Rulebook ("Official Gazette of ZJŽ" No. 4/96, 5/96 and 1/97)

Section III

PERMANENT SIGNALS

Main signals

Article 6 (excerpt)

Basic provisions

1. The main signals are for giving the necessary orders or notification on prohibitions or permission for further driving.

…

B. Types of main signals and locations for their installation

9. Main signals are: entrance, exit, automatic block and protective.

…

Automatic block signal prohibits or allows a train to enter the next automatic block section; at the same time, it also denotes the boundary of the exit, that is, the block section.

….

V. Distance of visibility of the main signals

16. The smallest distance of visibility of the main signals whose aspect of signals are presignalled, either by the previous main signal or by a special pre-signal, must be the following for the maximum permissible speeds on the track:

- up to 50 km/h	100 m,
- 65 km/h	150 m,
- 80 km/h	200 m,
- 100 km/h	250 m,
- 120 km/h	300 m,
- 140 km/h	400 m,
- 160 km/h	500 m.

When the value of the maximum allowed speed on the track is between the boundaries speeds indicated for each distance of visibility, the smallest distance of the visibility of the main signals is determined by interpolation in proportion to the speed.

…

G. Procedure when the aspect of a signal is unclear or the lights are off

17. The train must unconditionally stop in front of the main signal that shows suspicious or unclear aspects of a signal, as well as in front of the switched off light signal, i.e. in front of the visual mechanical main signal whose signal lamps are turned off at night or show normal white light. A further ride from the main signal can only be resumed when the main signal shows the aspect of a signal for the allowed ride, or when the approval from the official position that handles or controls this signal is obtained, and in the case of visual mechanical signals when the train driver is assured that the signal shows the daily aspect of a signal for the allowed driving.

...

Đ. Aspects of a signal and their meaning, purpose and use

20.Aspect of a signal 4 "Stop"

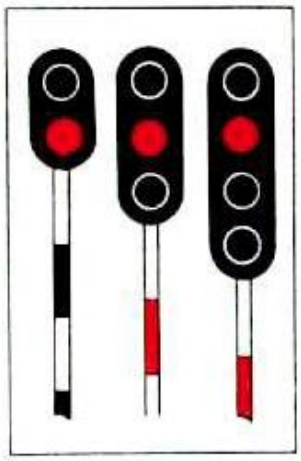
At all light signals:

Day and night aspect:

One red light (see Fig.1.)

...

Figure 1:



Aspect of a signal 4: "Stop" signifies that further drive from the signal is forbidden and must stand in front of the signal that indicates "Stop".

…

3.3.3. Rulebook 2, Traffic Rulebook ("Official Gazette of ZJŽ" No. 3/94, 4/94, 5/94, 4/96 and 6/03)

SECTION VIII
REGULATION OF TRAIN TRAFFIC

…

Article 37 (excerpt)

Basic conditions for movement of trains

…

7. In one automatic block section, only one train can be located on the same track and at the same time.

...

Article 38 (excerpt)

Regulation of train traffic on tracks equipped with automatic track block, interstation dependence device or telecommand.

…

4. The release of the first automatic block section from the train that is dispatched from the station, which is indicated in a certain way on the control section, is a check-out for the respective train.

The consecutive train can be dispatched from the station as soon as the conditions from the previous paragraph are fulfilled given the prescribed intervals of sequence.

…

SECTION XVII

TRAFFIC REGULATION IN CONDITION OF INTEREFERENCES ON SS DEVICES AND INTEREFERENCES COMMUNICATION MEANS

…

Article 79 (excerpt)

Traffic regulation during interferences on communication means

…

5. In the event of stopping the train on the open line during the time when the means of communication with the adjacent stations or the TK dispatcher are defective, the rolling stock shall act as follows:

a) if the train has stopped in front of the automatic block signal indicating an aspect of a signal for a prohibited ride, then it may continue to run only after the change of the aspect of a signal for a permitted or cautious ride; if the signal change is not made within 3 minutes of stopping, or if the train has stopped in front of the automatic block signal because the signal is not switched on, it will continue driving after 3 minutes by careful driving according to the transparency of the track, but at most 30 km/h to the next automatic block signal; if this signal indicates an aspect of a signal for the allowed ride, the train will resume driving at a regular speed, otherwise it will stop and after 3 minutes it will continue with a caution drive until the first signal indicating the aspect of a signal for the allowed travel, or the entrance signal;

…

3.3.4. Rulebook on maintenance of safety-signaling devices ("Official Gazette of RS" No. 80/2015)

II GENERAL PROVISIONS ON MAINTENANCE OF SAFETY-SIGNALING DEVICES

…

Monitoring the condition

Article 6

Monitoring the condition of signaling and safety devices is a continuous process carried out by railway workers handling signaling and safety devices in order to determine their usability and correctness.

...

Corrective maintenance

Article 9 (excerpt)

…

Workers who work on maintenance, approach the removal of interference or malfunction on the signaling and safety device within two hours of receiving the notification of interference or malfunction.

…

III MAINTENANCE OF PARTICLUAR SAFETY-SIGNALING DEVICES

...

2. Regular maintenance of light signals

...

Periodic testing and measurement

Article 15 (excerpt)

Functioning and visibility of light signals are checked at least once a year, both in daytime and in night conditions.

…

The visibility of the light signals from the prescribed distance is continuously maintained.

...

3. Regular maintenance of railroad circuits

...

Periodic tests and measurements of railroad circuits

Article 20 (excerpt)

Checking the electrical parameters of the rail current circuits and their adjustment, as well as the electrical parameters of the associated isolated assemblies, shall be performed at least once in six months.

…

5. Regular maintenance of the track section of the auto stop device

Article 23

Regular maintenance of the track section of the auto-stop device includes the following activities:

1) Every two months on the track section of the auto-stop device is checked:

(1) that the device is not mechanically damaged;
(2) that the device is at a prescribed distance in relation to the nearby rail;
(3) the device is at a prescribed height in relation to the nearby rail;
(4) there is no damage on the fixing attachment;
(5) that there is no damage to the cable, protective hose, cable intakes,

2) Every six months, it is checked whether within the allowed limits of the change in the nominal current measures for individual aspects of a signal, in the operation of the signal of frequency:

(1) 500 *Hz*,
(2) 1000 *Hz*,
(3) 2000 *Hz*.

3.3.5. Rulebook on maintenance of the railway vehicles ("Official Gazette of RS" No.101/2015, 24/2016 and 36/2017)

3.Maintenance of the parts of railway vehicles important for safe regulation of rail traffic

…

Maintenance of the locomotive part of the autostop device

Article 29

The manner and deadlines for maintaining the locomotive part of the autostop are given in Annex 12 - Maintenance of the locomotive part of the autostop device, which is printed with this Regulation and makes it an integral part.

Maintenance of speedometer and registering devices

Article 30

The manner and deadlines for the maintenance of speedometer and registering devices are given in Annex 13 - Maintenance of speedometer and registering devices, which is printed with this Rulebook and makes it an integral part.

…

Annex 12 (excerpt)

Maintenance of the locomotive part of autostop device

1. The maintenance work on the locomotive part of the autostop device (hereinafter referred to as: AS device), type I 60, consists of:

1) Periodic inspection of the device, when minor defects are eliminated on the spot and adjust the quantities in which during the exploitation there is a deviation;
2) works after the workmanship of the wheel flange or the change of the wheel rim;
3) unplanned repairs,

2. Periodic check include:

1) daily examination by the train driver;
2) half-month testing of AS devices;
3) monthly testing of AS devices.

Tests from point. 2) and 3) must be aligned with the maintenance schedule of the towing vehicle.

3. Daily testing is carried out daily before dispatch of locomotive from the depot and includes the impact of the 2000 Hz (and 1000 Hz *) magnet impact.

Upon departure from the depot, the traction vehicle passes above the permanently activated track balise of 2000 Hz (and 1000 Hz*).

…

*) Two active track balises can be installed at the exit from the depot, one behind the other 2000 Hz, and 1000 Hz. On the second balise (1000 Hz), the train driver does not press the button „acknowledge“ and checks the braking (correctness of the AS device) due to the effect of this balise. Checking an AS-capable device with an active 500 Hz bushing requires a speed of ≥ 40 km/h and can not be carried out in a depot.

…

Annex 13 (excerpt)

Maintenance of speedometer and registering devices

1. Maintenance of speedometer and registering devices is performed by specialized workshops that have adequate professional work force and necessary equipment for this type of work.

2. Maintenance of speedometer and registering devices shall be performed according to the cycles and deadlines of regular maintenance, and shall be carried out according to the manufacturer's instructions for each type of device.

3. Periodic review is performed:

1) cleaning;
2) control of all joints and installations;
3) an overview of the sensors of measured values;
4) control of the illumination of the display device;
5) inspection and control of data recording media;
6) checking the lock for locking the registering device.

4. Every 12 months, and on a regular basis, the calibration device and registering device are calibrated.

…

3.3.6. Instruction for maintenance of the traction vehicle "Srbija Voz"a.d. No. 4/2016-16-4 from 23.02.2016.

2. Service check

Article 3 (Excerpt)

...

As part of a service check, it is necessary to:

- visually inspect and verify the correctness of the device and supplement supplies of propulsion material,

- inspect and check the rolling stock, brake system and other safety and safety devices.

...

The service inspection criterion is prescribed for each series of towing vehicles, and the deadline between two service inspections can not be longer than 7 days.

...

3.Periodic check

Article 4 (excerpt)

…

Depending on the series of traction vehicles, the types of periodic inspections and their order for a particular traction vehicle are determined, and their deadlines can not be longer than the deadlines prescribed in this manual.

On periodical inspections, in addition to the works prescribed by the manufacturer for a particular vehicle, it is mandatory:

- checking the functional correctness of parts and assemblies,

- replacement of worn and damaged parts and assemblies,

- checking and measuring the parameters of certain parts, circuits and devices and their bringing them within the prescribed values,

- change and refill of lubricants,

- dyeing of damaged places of internal formwork, bodies and stand.

...

The order for referral of vehicles to periodical inspections is determined by the criterion of kilometers traveled or during the previous calendar days, with the criterion being the one that was first fulfilled.

The periodic review criterion may be reduced or increased by 15%.

Depending on the towing vehicle series, the periodic review criteria is:

…

ELECTROMOTOR SETS

...

Series 413/417

Type of review	P1	P3	P6	P12
Weather criterion (days)	30	90	180	360
km Criterion (km)	15 000	45 000	90 000	180 000

Continuation of the table

Type of review	P24	P36	P48	P60
Weather criterion (days)	720	1080	1440	1800
km Criterion (km)	360 000	540 000	720 000	900 000

Continuation of the table

Type of review	P72	P84	P96	P100
Weather criterion (days)	2160	2520	2880	3000
km Criterion (km)	1 000 000	-	1 440 000	1 500 000

Continuation of the table

Type of review	P120	P144	P180	P192
Weather criterion (days)	3600	4320	5400	5760
km Criterion (km)	1 800 000	2 000 000	-	-

....

3.3.7. Instruction for maintenance of the traction vehicles ("Official Gazette of ZJŽ" *32/2015 and 22/2017*)

2. Service check

Article 4. (Excerpt)

...

As part of a service check, it is necessary to:

- visually inspect and verify the correctness of the device and refill supplies of propulsion material,
- inspect and check the rolling stock, brake system and other safety and security devices.

...

The service inspection criterion is prescribed for each series of towing vehicles, and the deadline between two service inspections can not be longer than 7 days.

...

4. Control check

Article 5. (Excerpt)

...

Control check of traction vehicles is done for periodic check of corretness of subsystems, sets and devices of the traction vehicle according to the cycles and in the scope which is determined under this Instruction.

Depending on the traction vehicle series, the types of inspection checks and their order for a particular traction vehicle is determined, and their deadlines can not be longer than the deadlines prescribed in this Instruction.

In the control check, in addition to the works prescribed by the manufacturer for a particular vehicle, it is mandatory:

- checking the functional correctness of parts and assemblies,
- replacement of worn and damaged parts and assemblies,
- checking and measuring the parameters of certain parts, sets and devices and their bringing them within the prescribed values,
- change and refill of the lubricants,
- dyeing of damaged places of internal formwork, bodies and stands.

...

The order for referral of vehicles to periodical checks is determined by the criterion of kilometers traveled or during the previous calendar days, with the criterion being the one that was first fulfilled.

Depending on the traction vehicle series, the periodic check criteria is:

...

- P1 diesel electric locomotive - at least once in 30 days or 15 000 km crossed, which can be increased by 15%;

- P3 diesel electric locomotive - at least once in 90 days or 45 000 km crossed, which can be increased by 15%;

- P6 diesel electric locomotive - at least once in 180 days or 90 000 km crossed, which can be increased by 15%;

- P12 diesel electric locomotive - at least once in 360 days or 180 000 km crossed, which can be increased by 15%;

...

3.4. Functioning of the railway vehicles and tecnical installations

3.4.1. Control, command and signalling

The stations Klenje and Ripanj Tunel are provided with electric relay SS devices of the type SpDrS64-JŽ by manufacturer “Siemens-EI”. At the time of the accident, the traffic in these stations was regulated by the remote control from the TK dispatcher from the TK Center at Marshalling Yard Belgrade “B”. An open rail track between these official positions is equipped with two-way automatic track blocks. At the time of the accident, there were no recorded interferences with APB devices on the track between the stations Klenje and Ripanj Tunel.

3.4.2. Infrastructure

Main arterial route E70/E85: Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), between stations Klenje (km 24+760) and Ripanj Tunel (km 29+592) is single-track, designed for a speed of 70 km/h. On the part of the main arterial route between km 21+935 to km 28+770, restricted speed running of 50 km/h was introduced due to the cutting of the continuous welded rail and the bad condition of the superstructure of the track (letter “IŽS”a.d., Construction Affairs Sector, Section for maintenance of railways Belgrade, Mladenovac track section No. 20/18-1-1-3-42 from 14.09.2018.).

The site of the accident is located on the section of the track, which is on a 12.6‰ slope (12.6‰ down in the direction of movement of the train) and the right curve, facing the direction of the rising mileage (left curve, viewed in the direction of movement of the train), radius R=490 m and total length l=280 m.

By on site investigation, the CINS Working Group, considering the place where the train No. 70922 was stopped (in the left curve, in the direction of movement the train) and on the vegetation present on the left side of the track (Figure 3.4.2.1), determined that from the perspective of the train driver of the train No. 2990, the possibility of detecting an obstacle on the track (stopped train No. 70922) was made difficult.

Figure 3.4.2.1: View of the back of the train No. 2990 after the respective accident

According to the provisions of Article 6 of Rulebook 1, the Signaling Rulebook ("Official Gazette of ZJŽ"No. 4/96, 5/96 and 1/97), for the projected speed, for automatic block signals that are built on this part of the railway track, it is necessary to provide the smallest distance of visibility of 167 m. Considering the fact that restricted speed running with 50 km/h was introduced on the observed part of the track, it is necessary to provide a minimum distance of visibility of 100 m for this speed.

On-site inspection, the CINS Working Group has determined that the automatic block signal E 51 does not have the prescribed minimum distance of visibility.

Namely, the automatic block signal E 51 is, according to the mileage obtained from the Section for ETP Belgrade, TOJ for SS (Annex 1 of the letter No. 21/2018-1-4079 of 03.10.2018.), built in km 27+730. The automatic block signal E 51 is on the ground opposite the pillar KM No. 48 (Figure 3.4.2.2.). Pillar KM No. 48, according to the mileage obtained from the Section for ETP Belgrade, TOJ for KM (letter No. 21/2018-1-4074 dated 03.10.2018.) is located at km 27+714.

Figure 3.4.2.2: Position of the automatic block signal E 51 opposite the pillar KM No. 48

Looking at the location on the track located: next to the pillar KM No. 53 (at km 27+869 at 155 m from the pillar KM No. 48; Fig. 3.4.2.3.), next to the pillar KM No. 52 (at km 27+839 to 125 m from the pillar KM No. 48; Figure 3.4.2.4.), and in addition to the pillar KM No. 51 (in km 27+804 at 90 m from the pillar KM No. 48; Fig. 3.4.2.5.), it is not possible to notice the automatic block signal E 51, and therefore and an aspect of a signal that the automatic block signal E 51 shows.

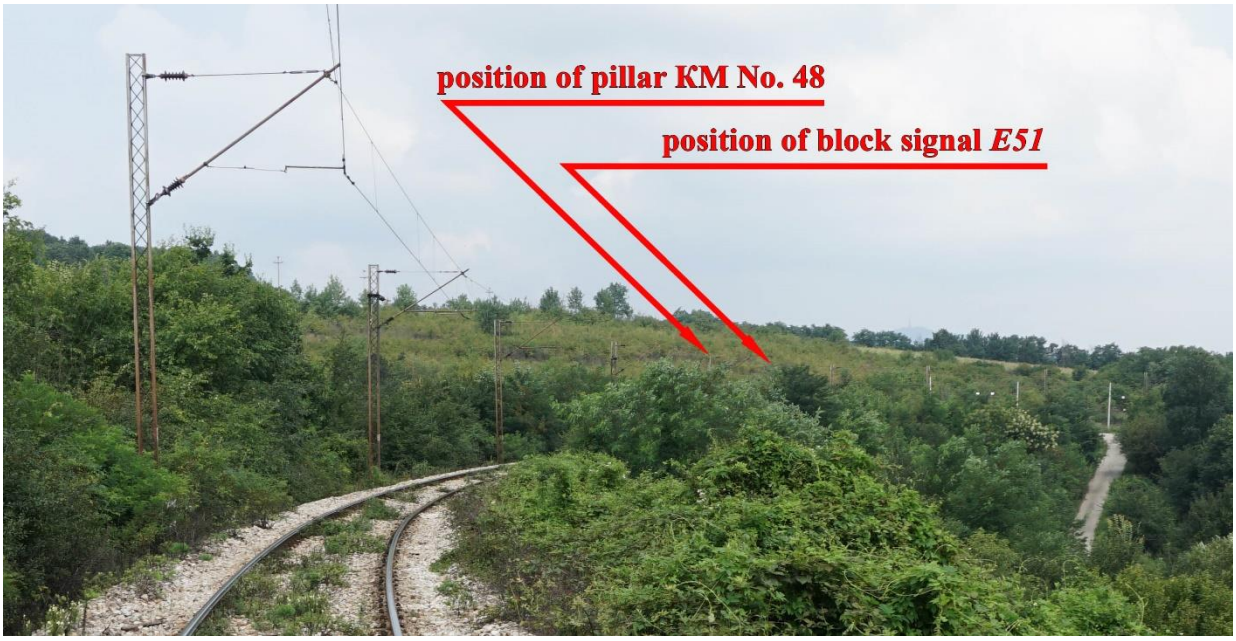


Figure 3.4.2.3: View from the point on the track next to pillar KM No. 53

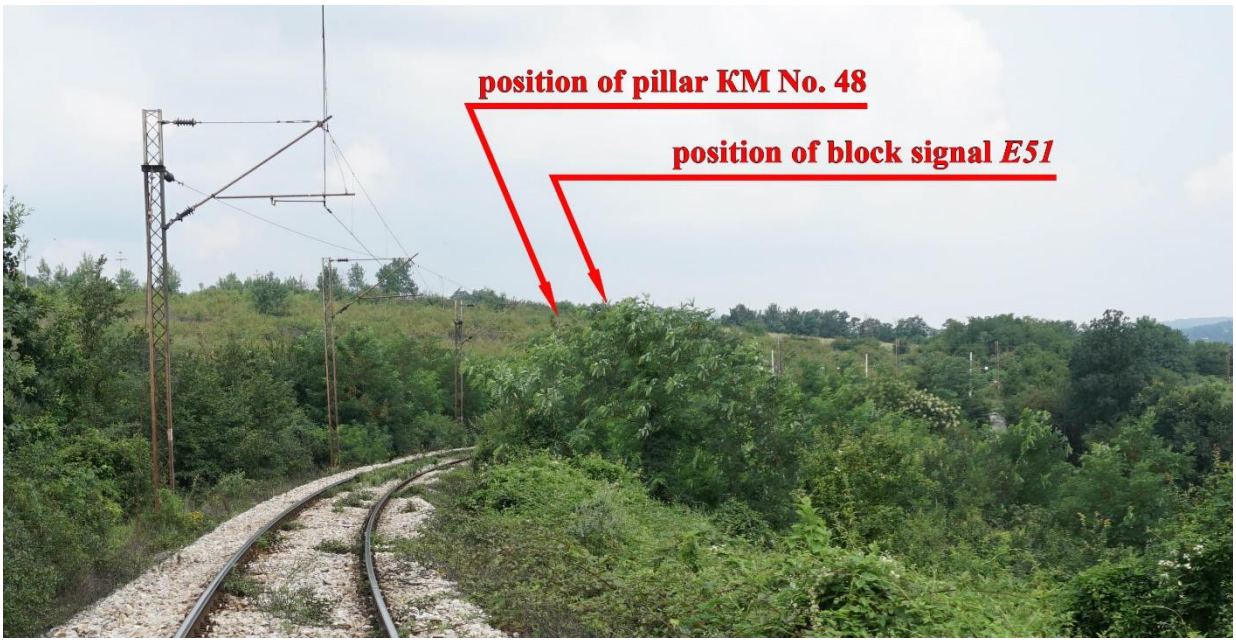


Figure 3.4.2.4: View from the point on the track next to pillar KM No. 52

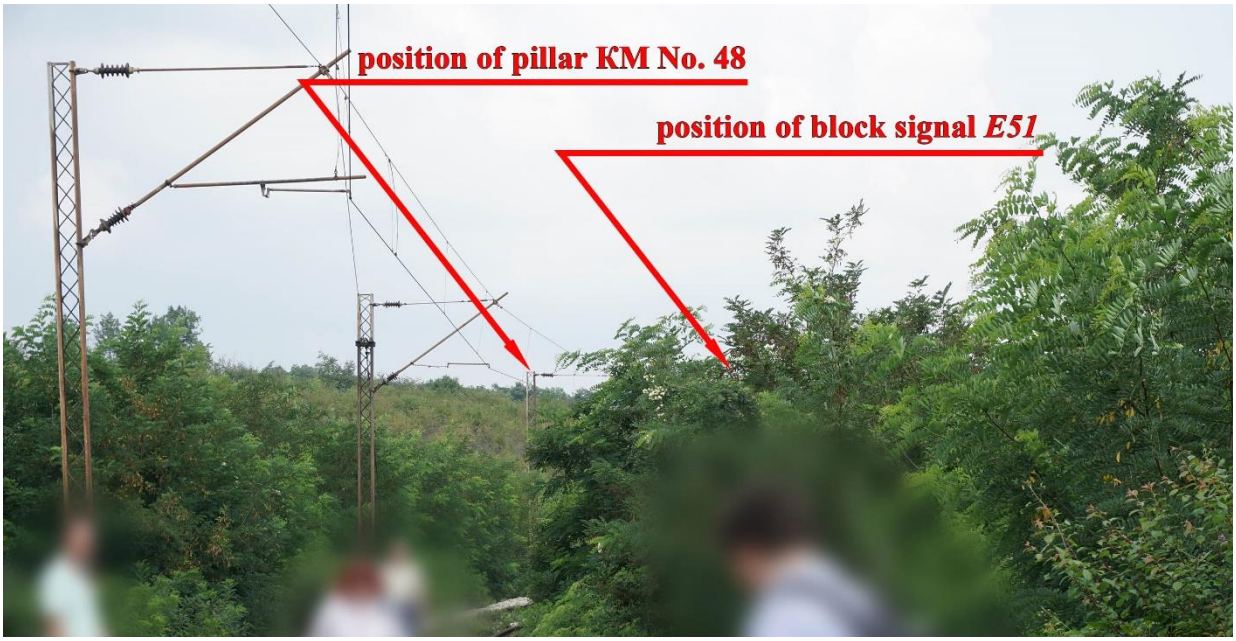


Figure 3.4.2.5: View from the point on the track next to pillar KM No. 51

Looking from the point on the track located: next to the pillar KM 50 (in km 27+74 at 60 m from the pillar KM No. 48; Fig. 3.4.2.6.) it is possible to spot the tip of the automatic block signal E 51, but it is not possible to notice the aspect of a signal which automatic block signal E 51 shows.

Figures: 3.4.2.1, 3.4.2.2, 3.4.2.3, 3.4.2.4, 3.4.2.5. and 3.4.2.6. are taken from the altitude of 1.8 m from the upper edge of the rail.

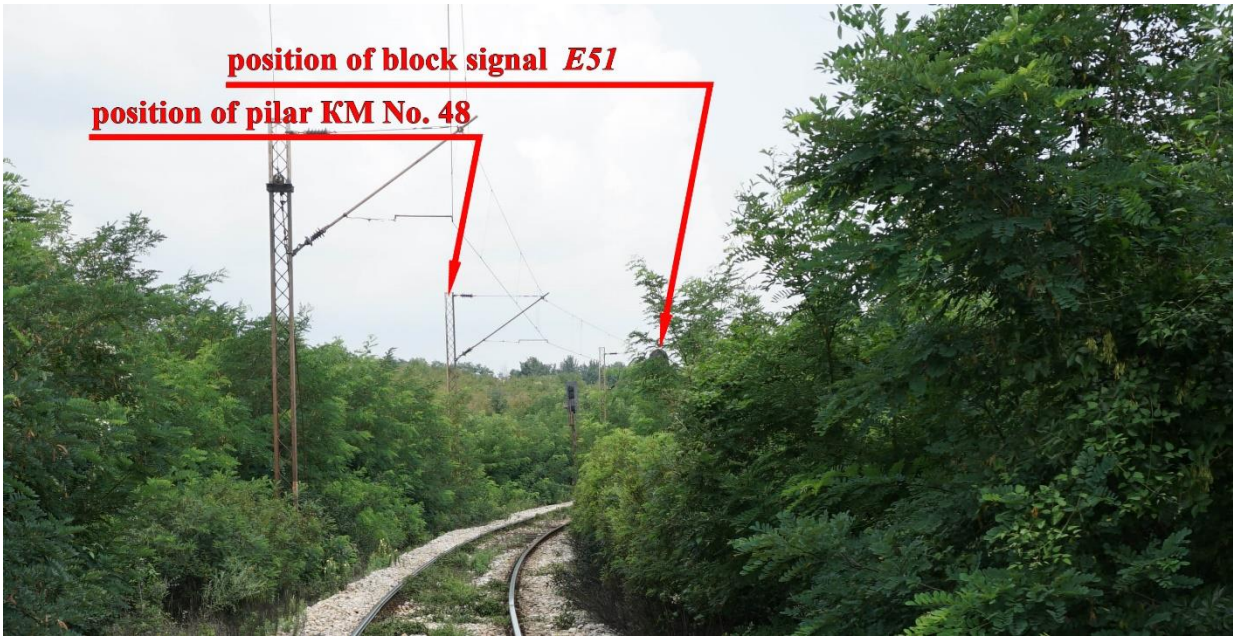


Figure 3.4.2.6: View from the point on the track next to pillar KM No. 50

"IŽS"a.d. submitted the information that in the period from 01.01.2018. until the respective accident occurred "IŽS"a.d. have not been delivered by the undertaker remarks of the train drivers registered in the EV-38 in terms of poor visibility of the signal or poor display of the aspects of a signal (letter No. 1/2018-2883 of 03.10.2018.).

"Srbija Voz"a.d. has submitted data that in the period from 01.01.2018. until the accident occurred, there were no written complaints (Reports on irregularities in work EV-38) by the train drivers for poor visibility of the signal or poor display of the aspects of a signal on the section between the stations Klenje and Ripanj Tunel (letters: Section for Traction Belgrade No. 30/2018-1022 of 03.09.2018., Section for Traction Lapovo No. 31/2018-654 dated 04.09.2018. and Section for Traction Niš No. 33/2018-646 dated 05.09.218.).

"Srbija Kargo"a.d. has sent an email on 23.10.2018. at 12:00, providing information that there were no reports of irregularities in work (EV-38) in connection with irregularities on the section between the stations Klenje and Ripanj Tunel.

By letter "IŽS"a.d, Section for ETP Belgrade, TOJ for SS plants, OJ SS Mladenovac No. 21/2018-1-4073 of 03.10.2018. data was given that in the period from 01.01.2018. until 01.08.2018. section OJ SS Mladenovac did not have any objections to the visibility of the signal on the section between the stations Klenje and Ripanj Tunel.

By e-mail of 26.10.2018. at 13:07 from "IŽS"a.d. it was found that there was no requirements for the cutting of plants in the zone of danger on the section between the stations Klenje and Ripanj Tunel, nor the notification of poor visibility of the signal for the electrical wiring. On 18.07.2018., a control check of KM KOP1 was carried out (work order No. 7745) and on that occasion there was no need for cutting of vegetation. The visibility check of the signal is not covered by any overview of the ETP, but around the signal on the section of the line between the stations Klenje and Ripanj Tunel there is no vegetation, that is no signal has grown into weeds and plants. The abovementioned facts are contrary to the situation established during the CINS accident investigation (see figures from 3.4.2.2 to 3.4.2.6).

3.4.3. Communication tools

At the time of occurrence of the respective accident, on the communication tools on the section between the stations Klenje and Ripanj Tunel there were no disturbances or interferences registered that were not removed.

By letter of "IŽS"a.d, Section for ETP Beograd, TOJ for TT plants No. 21/2018-1-4072 of 03.10.2018. the data was obtained that after the accident occurred, the expert services inspected and examined the TT devices on the respective section of the railway line and on that occasion found that all means of communication (radio station at 27 km , radio station Ripanj Tunel, telephone in the APB box E 42 - 51) are correct for operation and have been operational at the time of the accident.

By e-mail of 26.10.2018. at 13:07 from "IŽS"a.d. the data was received that the phones at the signal on APB boxes E 12, E 22 - 31, E 42, E 51, E 62 were correct at the time of the respective accident.

On-site investigation on 01.08.2018. the CINS Working Group established that TT cabinet was fastened to the pillar of automatic block signal E 51. The door of the cabinets was not closed and locked, and there is no phone in the cabinet (Figure 3.4.3.1.).

Figure 3.4.3.1: External and internal appearance of TT cabinet on the pillar of the automatic block signal E 51

The train driver of the train No. 2990 in its statement given to the CINS Working Group stated that there are occasional disturbances in the operation of the RDV device in terms of difficulty in establishing a connection on certain sections of the railway track. Just before the accident occurred, according to his own statement, the driver of the train No. 2990, while passing by the automatic block signal E 51, tried to establish a connection with the TK Dispatcher by the RDV device.

According to his own statement, the train driver of the train No. 2990 communicated with the TK dispatcher during the drive prior to the accident, via a RDV device, which the TK dispatcher confirmed in his statement. The last communication was when the train No. 2990 was located in front of the entrance signal of the Ripanj Tunel station.

At the request of CINS, from "IŽS"a.d. audio recordings of interviews conducted on RDV Jug 1 channel to the railway, registered on 01.08.2018. in the period from 03:45 to 06:00 on the register device in the TT section Makiš, were delivered. Recordings recorded on RDV Jug 1 channel from the track have not been delivered. On the subsequent request of CINS, by e-mail of 26.10.2018. at 13:07 from "IŽS"a.d. the answer was received that on 01.08.2018. during the period from 03:45 to 06:00 on the RDV Jug 1 channel from the railway line no conversations were conducted.

On the delivered audio recordings of conversations conducted on the RDV Jug 1 channel to the track, there are no TK dispatchers coversations conducted with the train driver of the train No. 2990.

3.4.4. Railway vehicles

The train No. 70922 (the mere locomotive 661-162) operated on the route Ralja - Marshalling Yard Belgrade. The train was assembled, signaled and braked in accordance with applicable regulations. Prior to the respective accident, the train No. 70922 was moving in the direction from the station Ripanj Tunel to the Klenje station (from the end to the beginning of the track, in the direction of the descending mileage). During the train ride, according to the statement of the train driver, due to a failure on the driver's safety device, it came to the forced stooping of the train. At the time of the respective accident, the train No. 70922 was standing on an open rail track.

At the site of the respective accident, it was found that on the locomotive 661-162 the switch of the electronic part of the driver's safety device was in the "ON" position, but the state of the seal was such that it was possible to place the switch in the "OFF" position without damaging the seal (Figure 3.4.4.1.).

Figure 3.4.4.1: View of the switch of the electronic part of the driver's safety device on the locomotive. 661-162

The train No. 2990 (EMV 413/417-033/034) operated on a regular basis, on the route Stalać - Belgrade. The train was assembled, signaled and braked in accordance with applicable regulations. At the time of the accident, the train No. 2990 was moving from the station Ripanj Tunel to the Klenje station (from the end to the beginning of the line, towards the descending mileage). After passing the E 51 automatic block signal for about 400 m, it came to the hit of the head of the train No. 2990 at the end of the train No. 70922.

The appearance of EMV 413/417-033/034 of the train No. 2990 after a collision is shown in Figures 3.4.4.2. and 3.4.4.3.

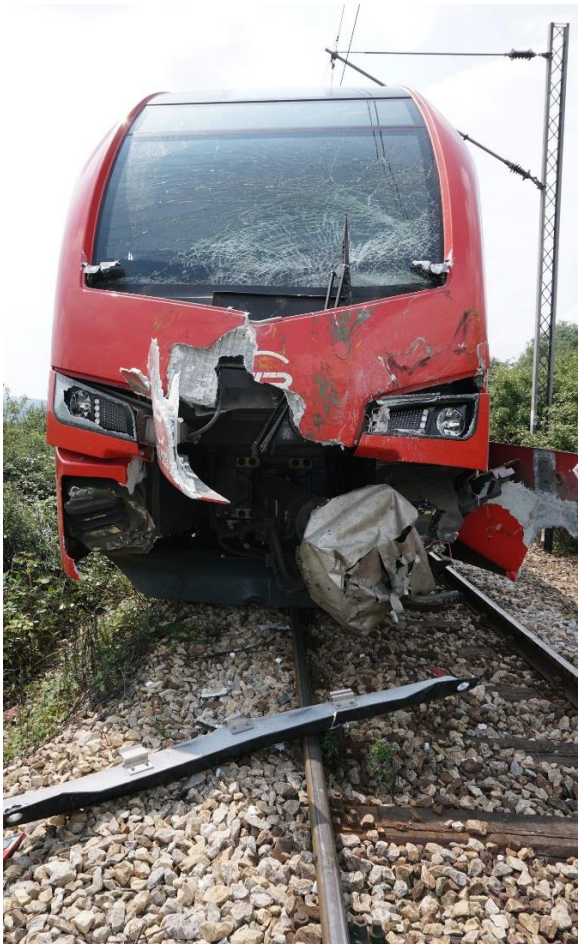


Figure 3.4.4.2: External part of the head of the train No. 2990

Figure 3.4.4.3: Appearance of the passenger compartment of the train No. 2990

On the locomotive 661-162, the Hasler speedometer devices are installed: registering speedometer type RT9, serial No. 16 884 and a display speedometer device A16, serial No. 14 809. Both speedometer devices are attested, with a validity period of attestation up to 20.06.2019. (document "Srbija Kargo"a.d., Cargo Section Novi Sad No. 35-1/2017-70-38 dated 20.06.2018.). By processing the data registered on the speedometer tape from the registration speedometer device of locomotive 661-162 (Data from the speedometer tape No. Z-103 of 02.08.2018.), it was determined that the train No. 70922 leaves from the Ralja station at 05:07 and stops in station Ripanj Tunel at 05:17. From the departure from Ralja station to stop at the station Ripanj Tunel, there was no stopping of the train. During the drive on the mentioned section, the speed of the train was between 22 and 45 km/h. From the station Ripanj Tunel, the train No. 70922 runs at 05:32, starts at a speed of 25 to 36 km/h in the length of 1559 m, when an abrupt speed reduction with a speed of 36 km/h was registered and after 154 m stops at 05:36. After 4 minutes standby, at 05:40, on the recording tape, in the length of 1.25 mm, an incorrect record of the time line was registered, speed diagram and line „A" and „C" lines in the part for recording of the drivers safety device. Further start-ups of the train were not registered until 09:00 when the registration tape was removed. All times are given by the timer of the speedometer device.

EMV 413/417-033/034 has a device for measuring and registering the speed of the type TELOC 1500 from manufacturer HaslerRail, from Berne, serial number 14112300. For this device, from "Srbija Voz"a.d. Report No. 59 on testing and verification of the correctness of the

device for measuring and registering the speed of TELOC 1500 from 31.03.2018. was delivered. and Certificate No. 59 on the correctness of the device for measuring and registering speed TELOC 1500 of 31.03.2018. confirming that the electronic speedometer device TELOC 1500, serial No. 14112300 is correct and in accordance with Annex 6 of Instruction 230.

By processing the data taken from the memory of the electronic speedometer EMV 413/417-033/034 (Data registered with electronic speedometer device No. 153 dated 01.08.2018.) it was determined that the train No. 2990 was from the departure from Stalać station at 02:20:38 (starting station of the train No. 2990) until stop after the accident at 05:37:45, passed past 8 active 1000Hz rail balises with the use of the "acknowledge" button, and in addition to 45 active 2000 Hz balises, with the use of the "ride on the order" button. From departure from the Lapovo station at 03:46:10 (when an the train driver who took part in the accident arrived at the EMV) until stopping in front of the entrance signal of the Ripanj Tunel station at 05:30:38, the train passed in addition to 5 active 1000 Hz rail balises with the use of the "acknowledge" button and a total of 43 Active 2000 Hz balises with the use of the "ride on the order" button (next to 34 with speeds greater than 30 km/h, and at 9 with speeds less than or equal to 30 km/h). From departure from the station in front of the entrance signal of the Ripanj Tunel station at 05:32:01 until the stop after the accident at 05:37:45, the train No. 2990, at a speed of 49 km/h, passed along an active track balise of 2000 Hz using the "drive by order" button.

The train No. 2990 stood in front of the entrance signal of the Ripanj Tunel station until 05:32:01, when moving of the train and the acceleration of up to 43 km/h in length up to 320 m was registered, after which the speed is reduced and after passing 215 m it is 25.5 km/h. In the next 528 m, the train first accelerates to 30.5 km/h, then slows down to 29.5 km/h, after which the speed in the next 226 m decreases to 1 km/h, after which the train accelerates in the next 197 m and it reaches a speed of 34 km/h and after passing 242 m, it reaches a speed of 36.5 km/h. After that, the train accelerates again and after 212 m, it reaches a speed of 49 km/h. In the next 766 m, the train moves with speeds between 49 and 50 km/h, when at 05:37:10, at a speed of 49 km/h, it passes to the active 2000 Hz balise with the use of the "drive by order" button.The train continues to drive at a speed of between 46.5 and 50 km/h. After 332 m, at a speed of 50 km/h, an intense reduction in speed has occurred (a reduction in pressure in the main air pipe is registered, electric braking and the beginning of pneumatic braking in all EMV cylinders), after reaching 65 m the speed was 34.5 km/h and after the next 19 m the train stopped at 05:37:45.

Until downloading data from the speedometer device memory at 10:24:38, no moving of the train is registered. All times are given by the timer of the speedometer device.

3.5. Traffic regulation and management

3.5.1. Actions taken by the staff that regulates and manages the traffic and signaling

The traffic of trains No. 70922 and 2990 on the route Ripanj Tunel - Klenje took place in block section in APB mode. The dispatch of trains from the station Ripanj Tunel in the direction towards Klenje station was done on a regular basis by setting up a command for the formation of the exit ways from the TK Center at Marshalling Yard Belgrade "B".

The train staff, through the accompanying documents, received all the necessary instructions and notices on the traffic of trains No. 70922 and 2990 on that section of the railway line.

3.5.2. Exchange of voice messages in relation to the accident

Immediately before the accident occurred (during the reception and dispatch of trains No. 70922 and 2990 from the Ripanj Tunel station) and after the accident (notification of the accident), there was communication between the train drivers of the train No. 70922 and 2990 and the traffic control staff, that is the TK dispatcher. Communication was accomplished by the phone next to the outgoing signal of the Ripanj Tunel station, which is included in the local TT connection, by the RDV devices and calling to the fixed telephone line at the TK Center at at Marshalling Yard Belgrade "B".

The communication between the TK Dispatcher and the train drivers during the reception and dispatch of trains No. 70922 and 2990 from the Ripanj Tunel station was not for the purpose of issuing orders for train traffic, but only for the purpose of informing about the reasons for stopping at certain signals.

The communication between the staff that regulates the traffic and the train driver was realized after the accident occurred in order to inform on the accident, as the train driver of the train No. 2990, by contacting via the mobile telephone network on a fixed telephone line, informed the TK dispatcher of the accident occurred.

3.5.3. Measures undertaken to secure and protect the accident site

After the accident occurred, part of the main arterial route E70/E85: Belgrade - Mladenovac - Lapovo - Nis - Presevo - state border - (Tabanovce) between stations Klenje and Ripanj Tunel was closed for traffic.

Considering the fact that the EMV 413/417-033/034 from the train No. 2990 derailed with a single bogie and that the locomotive 661-162 of the train No. 70922 was operating (the diesel engine was in operation) and it was braked and operated by the train driver and his assistant, no special measures have been taken to secure the trains from self-moving.

Upon arrival at the site (they arrived at about 5:50 am at the site), police officers secured the accident site.

Considering the fact that the trains did not transport the goods hazardous to the environment and lives of people, special measures to secure the accident site were not undertaken.

3.6. Interface between people, machines and organization

3.6.1. Working hours of the involved staff

For the railway staff, data were obtained showing that the train driver who operated the EMV 413/417-033/034, the train driver and the assistant of the train driver who operated the locomotive 661-162 and the TK dispatchers who worked at the TK Center at at Marshalling Yard Belgrade "B" on TK Jug 1 had a legally stipulated rest before coming the work and that at work they did not spend time longer than the maximum specified by the law.

3.6.2. Health and personal circumstances that had an effect on the accident, involving the presence of physical and pychological stress

For the railway staff, data were obtained showing that the train driver who operated the EMV 413/417-033/034, the train driver and the assistant train driver who operated the locomotive 661-162 and the TK dispatchers who worked at the TK Center at at Marshalling Yard Belgrade "B" at TK Jug 1 were professionally trained and medically fit to perform the service.

From the undertaking "Srbija Voz"a.d. for the train driver of the EMV 413/417-033/034 a photo copy of the License for operating the traction vehicle No. RS 71 2017 0656 issued by the Directorate for Railways was sent on 01.04.2017., with validity until 18.09.2022.

From the undertaking "Srbija Kargo"a.d. for the train driver who operated the locomotive 661-162 a Certificate on the take-over of a license for operating a traction vehicle was submitted, confirming that the train driver on 05.07.2018. took the license for operating the traction vehicle No. RS 71 2017 0913, and for the assistant train driver, a Certificate of the take-over of a license for operating a traction vehicle was submitted, confirming that the assistant train driver on 04.07.2018. took over the license to operate the traction vehicle No. RS 71 2017 0841.

Joint Investigation Committte composed of representatives of "IŽS"a.d., "Srbija Voz"a.d. and "Srbija Kargo"a.d. on 01.08.2018. at 07:12, performed an alcotesting for the driver of the train No. 2990, the driver of the train No. 70922 and the assistant train driver of the train No. 70922, the participants of the respective accident. Alcotesting was performed by the ethylometer of the manufacturer Dräger, the Alcotest 6820 model, the serial number ARKF-0793 for which, by the authorized service technician „Dräger Tehnika"d.o.o. from Belgrade, on 14.05.2018. The Controlling List of Periodic Control with a validity period of 6 (six) months was issued.

Alcotesting of the driver of the train No. 2990 and the driver of the train No. 70922, the presence of alcohol was not established. Alcotesting of the assistant train driver of the train No. 70922 determined the presence of 0.28 ‰ of alcohol.

Train conductors of the train No. 2990 were not alcotested.

According to their own statements, in all participants in the accident, the presence of stress caused by the accident occurred.

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

The main arterial route E 70/E 85: Belgrade - Mladenovac - Lapovo - Nis - Presevo - state border - (Tabanovce), between the stations Klenje and Ripanj The Tunel is designed in all parameters to meet the criteria for safe train traffic at the speeds prescribed by the Booklet.

According to the designed condition, there are APB devices that are included in the TK devices in the TK Center at Marshalling Yard Belgrade "B", so that traffic on that section of the railway track is regulated by the TK Dispatcher from the central location at the workplace TK Jug 1.

With the purpose of regulating traffic, the main signals (block sections, entrance and exit) that display two-way aspects of a signal are built on the line between the stations Klenje and Ripanj Tunel.

On the track section between the stations Klenje and Ripanj Tunel, communication between the staff regulating the traffic on the track and the staff of the traction vehicle is done by telephone via the local TT connection. This line is also equipped with RDV devices that are in function and with which communication between traction vehicle staff and TK dispatcher staff is possible. In order to communicate with the traction vehicle staff, in the TK Center at at Marshalling Yard Belgrade "B" the fixed telephone line, connected to the register device, is in function.

The operation of the locomotive of series 661 is carried out by a train driver and an assistant train driver by means of controls from the driver's cab designed upon the production of locomotives. For locomotive 661-162 all defects observed on systems and controlling devices have been removed so that no remarks or irregularities are registered.

Operation of the EMV series 413/417 is done by a train driver using control commands from the driver's cab, designed upon production of EMV. At EMV 413/417-033/034 no remarks or irregularities detected on control systems and devices are registered.

3.7. Previous accidents of the similar character

Based on data obtained from "IŽS"a.d, for the period from 01.01.2006. until 01.08.2018. on the main arterial route E70/E85: Belgrade - Mladenovac - Lapovo - Nis - Preševo - state border - (Tabanovce), between stations Resnik and Velika Plana, one accident of train collision occurred, when on 16.02.2014. at 06:44 in the area of the block 1 of Sopot Kosmajski station (at km 41+010), there came to collision of opposite trains Nos. 44151 and 52189, in a manner that when entering the station, the forehead of the train No. 44151 hit the head of the train No. 52189, which was standing on the third station track.

The cause of this accident are the gaps in the work of railway workers (passing along the entrance signal Gu 92 which prohibited further driving) in conditions of longer duration of failure on certain elements of SS devices caused by previous intentional and harmful actions of third parties and subjects in rail traffic in terms of theft and damages to railway installations and the inability to repair them.

Also, from "IŽS"a.d. data were obtained that in the period from 01.01.2008. until 01.08.2018. on the network of railway tracks "IŽS"a.d. a total of 101 accidents (train collision with a railway vehicle) and incidents (avoidance of a train collision with a railway vehicle and the passage of a train or rail vehicle past a signal forbidding further driving) occurred. Of this number, the train

collision with the railway vehicle was 8 (8%), the avoided collisions of the train with the railway vehicle 53 (52%) and the passage of the train or rail vehicle past the signal prohibiting further driving 40 (40%). According to the Reports on investigation, the cause of occurrence of these accidents and incidents is, in major part, in 96 cases, that is 95%, due to personal failure of the employees (in 52 cases the train driver, assistant train driver, the driver of TMD, and in 29 cases, train dispatcher, TK dispatcher, shunter, switcher, and in 15 cases mutual responsibility).

4. Analyses and conclusions

4.1. Final review of the sequence of events and making conclusions on the event based on the facts determined during the investigation and interviews

When driving in the direction from the station Ripanj Tunel to the Klenje station, on the open track, near the level crossing (located at km 27+634), at the km 27+369 there came to gaining close to and collision of trains No. 2990 (EMV 413/417-033/034) and 70922 (the mere locomotive 661-162). The collision occurred when the head of the train No. 2990 (EMV 413/417-033/034), which was moving, hit the end of the train No. 70922 (the locomotive 661-162), which was standing.

After the collision, the trains moved in the length of 19 m, after which they stopped. On that occasion, the EMV 413/417-033/034 from the train No. 2990 derailed with a single bogie (the first bogie in the direction of movement).

Figure 4.1.1: Appearnce of the train collision

On the site, locomotive 661-162 was found, so that the center of the locomotive was opposite the automatic block signal E 42 (Figure 4.1.2.). All wheels of the locomotive were found on the track (they did not derail).

Figure 4.1.2: Appearance of the part of the locomotive 661-162

The fuel tank located on the left side of the locomotive 661-162 (viewed in the direction of movement) was closed, but the chain with the lock was not connected to the tank cover.

On the crushed stone next to the track, on the left side, in the direction of movement of the train, between the automatic block signal E 42 and the pillar KM No. 37, a grease stain was found smelling in a similar way like the smell of diesel fuel. Near the pillar KM No. 37 in the shrub near the railway and on the track that connects the track and the path that runs parallelly with the track, a large number of scattered plastic canisters was noted. (Figure 4.1.3.).

Figure 4.1.3: Appearance of the stain and plastic canisters spotted near the accident site

EMV 413/417-033/034 was found so that the forehead of motor wagon 413-033 was leaned on the end of the locomotive 661-162 (Figure 4.1.1.). The first bogie of the motor wagon 413-033 derailed to the right, looking in the direction of the train movement. Other EMV bogies were found on the track (Figure 4.1.4.)

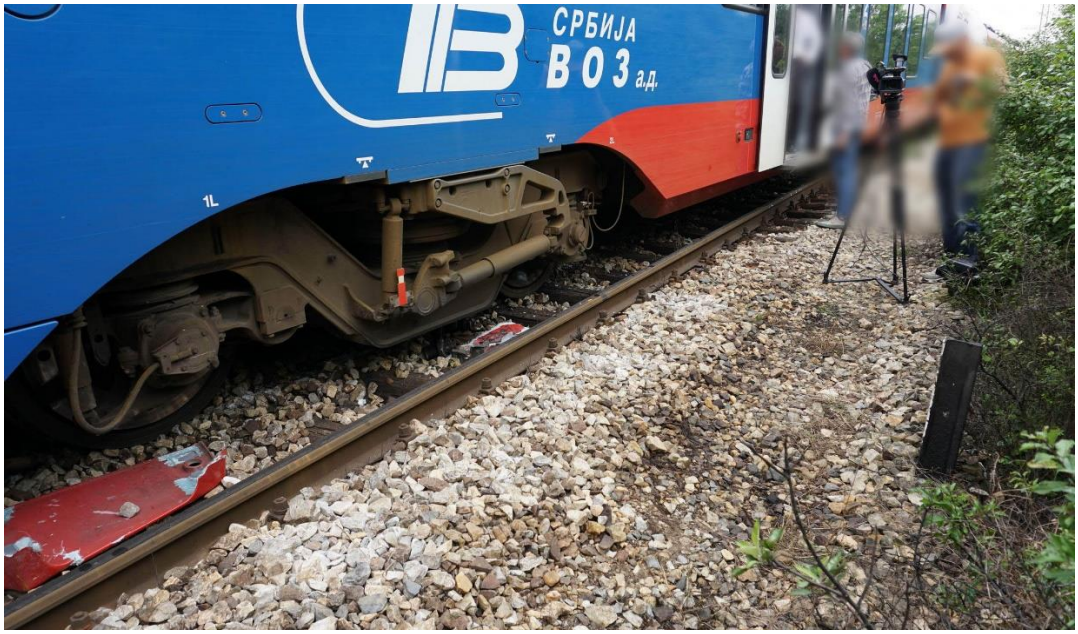


Figure 4.1.4: Appearance of the derailed bogie EMV 413/417-033/034

Automatic block signal that the trains Nos. 70922 and 2990 past before the collision is E 51. After the collision, by the on site investigation of the Working Group of CINS, it was determined that the automatic block signal E 51 was showing the aspect of a signal 4:“Stop“ (Fig. 4.1.5.).

Fig. 4.1.5: Appearance of the automatic block signal *E 51*

From the point where the CINS Working Group could spot an aspect of a signal that shows the E 51 automatic block signal, it was possible to spot it, but the intensity of the red light lantern was very weak. For the specified automatic block signal, the prescribed minimum distance of visibility is not provided (see point 3.4.2).

The isolated composition between the automatic block sections IpE3 and IpE4 is located below the trailer 417-034 (Figure 4.1.6.). Regarding the location of the collision and the length of the EMV, it was established with certainty that the locomotive 661-162 was located within the automatic block section IpE3 at the time of the occurrence of the respective accident.

Figure 4.1.6: Posiition of the isolated composition between the automatic block sections *IpE3* and *IpE4* relative to the EMV 413/417-033/034

Considering that, between stations Ripanj Tunel and Klenje, SS devices were correct and in function, the train No. 70922 was given a regular exit. After acquiring the conditions for the clearance of trains in the block automatic block sections after the train No. 70922 by giving a regular exit by the TK dispatcher at the TK Center at Marshalling Yard Belgrade "B", the train No. 2990 was sent from the station Ripanj Tunel.

According to the train driver's statement, the train No. 70922 entered the first track of the station Ripanj Tunel and stopped in front of the exit signal that prohibited further driving. After changing the aspect of a signal on the exit signal and moving from the first track, the train No. 70922 came out of the Ripanj Tunel station. During the drive on the distance between stations Ripanj Tunel and Klenje, according to the statement of the train driver, the driver's safety device on the locomotive 661-162 of the train No. 70922 started to cause problems. In the first case, the train driver managed to release driver's safety device by using the release button.

After passing the automatic block signal E 51, which, according to the statement of the train driver and assistant train driver, showed green light and entering the next automatic block section (IpE4), it came to stopping od the train No. 70922 (the end of the locomotive 661-162 stopped at km 27+369). The reason for stopping is, according to the statement of the train driver, a failure on the driver's safety device, which he tried to remove. Based on the submitted documentation by "Srbija Kargo"a.d. on the inspection of the locomotive 661-162 carried out after the accident occurred (Commission report on the inspection of locomotive 661-162 after the accident of

02.08.2018. which is attached to the letter No. 28/18-4138 of 03.08.2018. in the Sector ZOVS, Section ZOVS Belgrade), it can be seen that there are no irregularities found on the driver's safety device, that is, that it works properly. On the basis of the above, it can be concluded that there was no reason to stop the locomotive 661-162 on the open track.

Part of the single-track railway between Resnik and Velika Plana stations is equipped with TK and APB devices. Before the respective accident occurred, due to interruptions to the railway signal and telecommunication cable and faults on the SS devices, the train No. 2990 between the stations Velika Plana and Palanka was running at a station distance (General Order I No. 03 of 01.08.2018., station Velika Plana) between the stations Palanka and Mladenovac, the train No. 2990 transported at a station distance (General Order I No. 18 as of 01.08.2018. of the Palanka station) and between stations Mladenovac and Vlaško Polje, it was operating at a station distance (General Order I No. 28 of 01.08.2018. Mladenovac station).

There were no data on faults and interruptions on SS devices between the stations Vlaško Polje and Sopot Kosmajski and on the speedometer device of the train No. 2990 no active actions of the 2000 Hz balises and the use of the "drive by order" button were registered.

Also, at the distance between stations Sopot Kosmajski and Ralja, due to theft of track chokes at the block site BG2 by third parties, the traffic of the train No. 2990 was taking place at this section of the railway at a station distance. Due to the alienation of the track chokes at the block site of the BF2 by third parties, the traffic of the train No. 2990 between the stations Ralja and Ripanj Tunel was taking place at the station distance. In order to enter the station Sopot Kosmajski and at the section between the stations Sopot Kosmajski and Ralja, for the traffic of the train No. 2990 by the TK dispatcher from the TK Center at Marshalling Yard Belgrade "B" were issued the orders via the RDV device.

At the railroad line between the stations Ripanj Tunel and Klenje, the APB was correct and in function. The communication between the TK dispatcher and the train driver of the train No. 2990 was achieved through the RDV device at a time when the train No. 2990 was located in front of the entrance signal of the Ripanj Tunel station. Communication has been made to inform the train driver of the reasons from which the entrance signal prohibits driving. According to the statements of the train driver, of the train No. 2990 and the TK dispatcher, the communication was conducted via the RDV device. This conversation was not registered with the registrar device in the ETP Section Belgrade, TT section Makiš. According to the statement of the train driver of the train No. 2990 and the TK dispatcher, the communication was conducted via RDV device. This conversation was not registered with the registrar device in the ETP Section Belgrade, TT section Makiš. By the statements of the train driver and the TK dispatcher it can not be reliably determined the complete content of the abovementioned conversation, but there is a suspicion that the information about the reasons for the retention of the train No. 2990 in front of the entrance signal of the station Ripanj Tunel was not complete in the sense that the train driver of the train No. 2990 was not communicated by the TK dispatcher that in front of his train, at a block distance the train No. 70922 was operating (it was announced to him that the freight train with which the crossing should be done should enter from the opposite direction).

Entrance to the station Ripanj Tunel and exit from the station Ripanj Tunel for the train No. 2990 is given on a regular basis, by sending the commands from the TK Center at Marshalling Yard Belgrade "B".

On the section between the crossing point Pinosava and station Resnik due to interferences on the signalling cable on the "false busy" was also a automatic block section between the mentioned

official positions, so also in this section of the track the traffic of trains on 01.08.2018. was done at a station distance.

Analyzing the data registered with the speedometer device, it was determined that, after standing in front of the entrance signal of the Fu 91 station Ripanj Tunel, the train No. 2990 was started and after driving in the length of 1299 m with a speed up to 43 km/h, the speed is reduced to 1 km/h, after which increases again and the train passes the Eo 1 signal of the station Ripanj Tunel and exits to the distance between the stations of the Ripanj Tunel and Klenje. When passing beside the entrance signal of the Fu 91 station Ripanj Tunel, the speedometer did not register the use of active 2000 Hz balise and the use of the "drive by order" button. Considering that the train No. 2990 went through the first track of the Ripanj Tunel station, and that beside the exit signal Eo 1 there was no active track balise installed on that track, it is a logical fact that when the train No. 2990 was passing next to this signal, the speedometer did not register the active 2000 Hz balise, but based on the driving mode (slowing down the train to a speed of 1 km/h, then accelerating and continuing of movement) and the absence of reaction of TK dispatcher on the occurrence of occupancy at the first automatic block section of the interstate distance of the Ripanj Tunel - Klenje, it can be concluded that, immediately before the train No. 2990 arrived, the exit signal Eo 1 from the station Ripanj Tunel changed the aspect of a signal from the prohibited drive to the allowed drive.

While driving between stations Ripanj Tunel and Klenje, the train No. 2990, after acceleration to 34 km/h, for some time moves between 34 km/h and 36.5 km/h, after which it accelerates to 49 km/h and continues moving at a speed between 49 km/h and 50 km/h, in accordance with the "restricted speed runnings" information given by General Order I No. 13 of 01.08.2018. of the Lapovo station.

While driving on an open track at a speed of 49 km/h, on the speedometer device of the train No. 2990, the influence of the active track balise of 2000 Hz was registered with the use of the "ride by the order" button, after which the speed of the train first decreased to 46.5 km/h, and then increases to 50 km/h (the passage next to the block signal E 51, which prohibits further driving, without stopping).

Considering that the train driver of the train No. 2990 had no order to pass the automatic block signal that prohibited further driving, issued by the General Order I and by a phonogram by the traffic regulator (TK Dispatcher), he was obliged, pursuant to the provisions of Article 6, item Đ, Point 20, Paragraph 2 of Rulebook 1, Signalling Rulebook ("Official Gazette of ZJŽ" No. 4/96, 5/96 and 1/97), to stop the train.

In the event that he is unable to establish a connection with the TK Dispatcher, in accordance with the provisions of Article 79, Point 5,under a) of Rulebook 2, Traffic Rulebook ("Official Gazette of ZJŽ" No. 3/94, 4/94, 5/94, 4/96 and 6/03), after standing for 3 minutes, he had the opportunity to pass a automatic block signal that prohibits further driving and by careful driving according to the transparency of the track, but at most 30 km/h, continues driving to the first next automatic block signal.

4.2. Analyses of the facts determined during investigation

4.2.1. Analyses of the maintenance of the rolling stock

4.2.1.1 Locomotive 661-162

In the period from 06.08.2017. to 01.08.2018. total of 119 service checks have done. All the service checks were carried out in accordance with the Article 4 of the Instruction of maintenance of traction vehicles (Srbija Kargo) ("Official Gazette of ŽS" No. *32/2015 and 22/2017*) which prescribes that deadline between two service checks cannot be longer than 7 (seven) days. Not one service checks included the works on maintenance regarding the driver's safety device (release) which is stated as the cause of the stopping of respective locomotive on the track.

The largest number of periodic, control checks was performed within the deadlines stipulated in Article 5 of Instruction for maintenance of traction vehicles (Srbija Kargo) ("Official Gazette of ŽS" No. 32/2015 and 22/2017). There are certain, minor, deviations that do not affect the quality of the maintenance. There were no records in the checklists that related to the error of the driver's safety device.

In the period from 24.08.2017. until 19.07.2018. in total, 22 (twenty-two) corrective repairs were performed. In the checklists of corrective repairs there were no records relating to the failure of the driver's safety device.

The data from the speedometer tape are correctly taken with the note that the activation of valve of the driver's safety device is not registered on the registration tape, but only the switching on and off of the driver's safety device.

After the accident, the control of the diesel engine and auxiliary devices was done, the control of the condition of the diesel engine - the main generator connection, the control of the centric diesel engine - the main generator as well as the control of the axial gap of the diesel engine, were performed and no damage or malfunction was detected. Also, the operation of electric locomotive devices has been checked, and it has been established that a seal of the device was broadened and it was turned off. The test has determined that the device works properly. After the seal was completed at the place where the tapered valve was, the locomotive brake function was checked and the device was found to work properly. The locomotive weighing was carried out and the measures were within the allowed limits.

On the basis of documentation submitted by "Srbija Kargo"a.d., regular and corrective maintenance of locomotive 661-162 in "Srbija Kargo"a.d. was performed in accordance with applicable regulations.

4.2.1.2 EMV 413/417-033/034

In the documents submitted by "Srbija Voz"a.d. there are no data on daily examinations of the auto stop devices prescribed in Annex 12 of the Rulebook on Maintenance of Railway Vehicles ("Official Gazette of RS" No. 101/2015, 24/2016 and 36/2017).

In the period from 29.08.2017. to 15.06.2018. in total, 10 control checks were carried out. For each inspection, the Inspection List of the appropriate review rank as well as the Measurement List of the Auto Stop device were given. The measuring sheet contains 13 items, of which items 7 and 10 are filled in, whereas in item 12 Comment, it is noted that the device is sealed by the manufacturer, from which it follows that other items can not be checked in the workshop. No fault

in the operation of the auto-stop device and the safety device in general were found in one inspection.

In the period from 28.10.2017. to 07.05.2018. six corrective services were carried out and, as in the previous case, no faults were found related to the operation of the auto stop device and the safety device in general.

Based on the documentation submitted by "Srbija Voz"a.d, regular and corrective maintenance of EMV 413/417-033/034 in "Srbija Voz"a.d was performed in accordance with the applicable regulations.

Regarding the respective accident, regular and corrective maintenance of the vehicle EMV 413/417-033/034 in "Srbija Voz"a.d. was carried out in accordance with applicable regulations.

4.2.2. Anayses of functioning of the train protection system on EMV 413/417-033/034

According to the concept L-4275 ZS-Serbia Vehicle Description 401-417_V02_srp _21.07.2014., published by the manufacturer Stadler Bussnang AG, Switzerland, the EMV series 413/417 is equipped with an auto stop system of the type RAS 8385 of the manufacturer ALTPRO, based on inductive coupling (INDUSI, Punktformige Zugbeeinflussung - PZB), with two devices installed due to the length of the vehicle.

The communication from the rail to the train is done using the Indusi magnet type LLC 0512. The operational activities of the PZB are: "release", "override" and "acknowledge" and are done using standard operating keys.

The Auto Stop system is connected to the recording device so that all activities and signaling can be saved for future analysis and evaluation after any accident or incident.

The auto-stop device is configured to receive information from the track balises via the receiving heads. The information is transmitted by inductive influence with frequencies: 500 Hz, 1000 Hz and 2000 Hz.

When the traction vehicle passes over the active 2000 Hz balise, or when the main signal indicates the aspect of a signal 4 or 12a, if the "drive-by order" is switched on in the circuit of the auto-stop device, it comes to release of the circuit of resonant circuit of 2000 Hz. Otherwise, if the "drive by order" key is not switched on, the signal of the resonant circuit of 2000 Hz is transmitted to the relay box which activates the pneumatic part of the auto-stop device and the forced braking is carried out. The signal is also sent to register speedometer so that it can be reliably established when forced braking occurs due to the operation of the auto-stop device.

When crossing the traction vehicle through the active 1000 Hz balise, it is necessary to use the device with the "acknowledge" key, and then the time control signal is activated. If this procedure is not carried out, a forced braking of the train occurs. If, at a given time, the device is served, the speed must be reduced to a lower value than the allowed value for a certain period of time. Time and speed are defined by the selected driving mode. If the speed does not decrease below the defined, forced braking occurs.

From the data recorded by the electronic speedometer device (No. 153 dated 01.08.2018) it can be noted that the safety devices at EMV 413/417-033/034 were functioning correctly, i.e. the impacts of the track balises of 1000 Hz and 2000 Hz are recorded. During driving a train No. 2990 from station Stalać to the station Ripanj Tunel, 8 (eight) times the use of the "acknowledge" button was registered and 44 (forty-four) times the use of the "drive by order" button, with the train safely

passing all the main signals. At the distance between stations of the Ripanj Tunel and Klenje, the automatic block signal E 51, 45th (forty-fifth) time was registered the influence of the active track balise with the use of the "ride by order" and continued driving without reducing speed, after which there was a collision.

4.2.3. Test ride

In order to check the braking parameters - the length of the stopping path, the EMV 413/417 test ride was conducted under conditions similar to those at the time of the accident.

Taking into account the facts of the slope, configuration, permeability and frequency of traffic on the section of the railway where the accident occurred, as well as the purpose of the test ride (the necessary accuracy of the results), the main arterial route Belgrade Center - New Belgrade was selected for test ride. The section of the mentioned main arterial route, from km 1+600 to km 2+490 is in fall of 10.0‰ and from km 1+756 to km 2+229 is the left curvature of the radius R=800 m and the total length l=473 m, looking in the direction of a rising mileage. Such characteristics of the abovementioned track approximately correspond to the characteristics of the section of the track at which the accident occurred and, according to the CINS Working Group, are acceptable for the purpose of test ride.

For a test ride from "Srbija Voz"a.d. was provided an EMV 413/417-015/016. "IŽS"a.d. has, on 18.03.2019. introduced a train No. 17904 on the route Belgrade center - New Belgrade, with the elements of the booklet of the train No. 78020 and the rank lower than the passenger trains, with a departure at about 10:00 (telegram No. 113F dated 15.03.2019.).

The test ride was realized on 18.03.2019. by leaving the Belgrade Center station at 10:05 and arrival at the New Belgrade station at 10:12. Test drive (in EMV driver's cab) was attended by members of the CINS Working Group and representatives of "Srbija Voz"a.d. At the time of the test drive, the weather was sunny without wind and without precipitation. The air temperature was 16.8°C at departure from the Belgrade Center station and 17.5°C after arriving at the New Belgrade station (the temperature was given according to the outside temperature meter on EMV 413/417-015/016).

During the ride of the train No. 17904 (EMV 413/417-015/016), at the section of the track behind km 1+600 (viewed in the direction of the rising mileage or in the direction of movement of the train) at a speed of 50 km/h, braking was activated in the same way as during the respective accident. After stopping, the train was restarted and after reaching a speed of 30 km/h, braking was activated in the same way as when the accident occurred. According to the indicators in the driver's cab of the EMV 413/417-015/016, after activation of braking at a speed of 50 km/h the train passed a 109.4 m long journey before it stopped and after activation of braking at a speed of 30 km/h has passed a route of 42.7 m.

The method of activating of the braking is determined by the track record of the speedometer device of EMV 413/417-033/034 of 01.08.2018. and a statement by a train driver who was driving the train No. 2990 at the time of the respective accident.

After a test ride, from "Srbija Voz"a.d. the data recorded in the memory of the speedometer device of EMV 413/417-015/016 has been obtained and analyzed.

The electronic speedometer of EMV 413/417-033/034 records the data shown in Table 4.2.3.1. The data are transferred from the table display of data registered with electronic speedometer of EMV 413/417-033/034 delivered by "Srbija Voz"a.d. by e-mail of 20.03.2019.

Table 4.2.3.1: Data from the speedometer device of EMV 413/417-033/034

Time	Distance (km)	Speed (km/h)	Note
05:37:32.020	1848.334	49.89	Noticing the locomotive
05:37:33.020	1848.3471	49.89	Start of electric braking
05:37:34.760	1848.3712	49.89	Start of air braking
05:37:47.160	1848.4579	0	Stopping

On the basis of the data presented, the stopping path (braking only) was calculated as well as the stopping path to which a time period of 1 second has been added, as well as the reaction time of the train driver, from the moment of spotting the locomotive and the beginning of the activation of braking. The calculated data are shown in Table 4.2.3.2.

Table 4.2.3.2: Calculated stopping distances of EMV 413/417-033/034

Type of braking	Distance crossed (m)	Note	Stopping path (m)
-	13.1	Path to noticing the locomotive (1s)	
Electric braking	24.1		110.8
Electric and pneumatic braking	86.7		
Total stopping path	**123.9**		

The calculation data, the speed of movement and the stopping path are shown graphically in Figure 4.2.3.1.

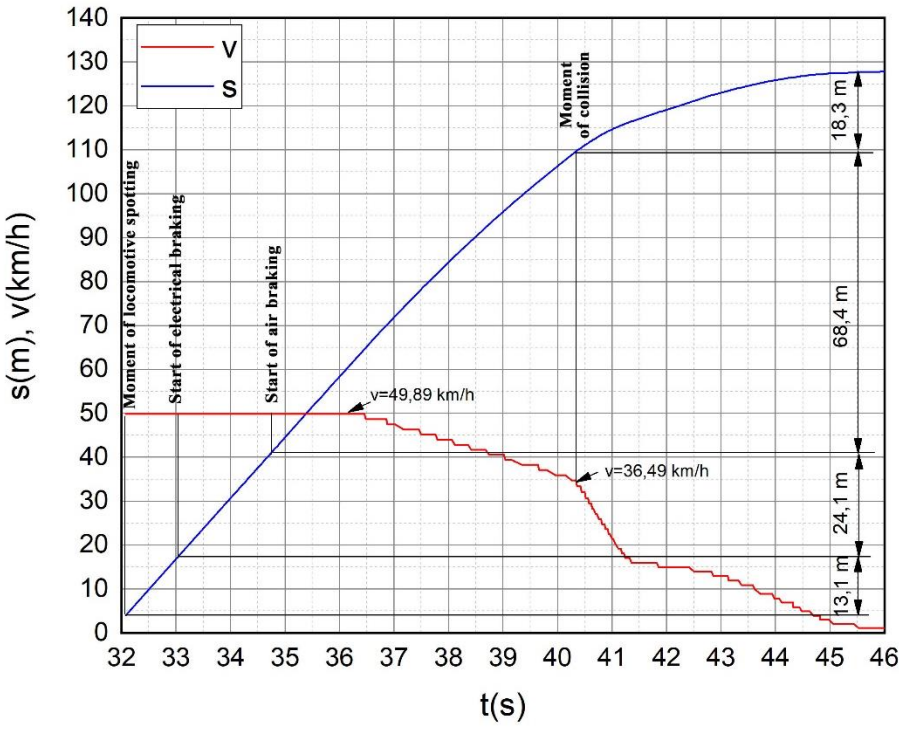


Figure 4.2.3.1: Diagram of braking EMV 413/417-033/034 during a collision

For the moment of spotting the locomotive, the moment 1 s before the brake was activated was taken, i.e. the activation of electric braking EMV 413/417-033/034. The speed at that moment was 49.89 km/h.

Crossed road:

- from spotting locomotive to braking activation 13.1 m
- from brake activation to collision 92.5 m

From the velocity diagram (the start of a sudden fall), it is concluded that a collision occurred at an EMV speed of 36.49 km/h.

After the collision, the EMV exceeds 18.3 m until stopping.

During the test ride, braking of the EMV 413/417-015/016 was activated at speeds of 50 km/h and 30 km/h. Data for speeds of 50 km/h are shown in Table 4.2.3.3. and Table 4.2.3.4, and for 30 km/h in Table 4.2.3.5 and Table 4.2.3.6.

Table 4.2.3.3: Data from speedometer device EMV 413/417-015/016 (with 50 km/h)

Time	Distance (km)	Speed (km/h)	Note
10:07:54.760	13.0874	49.65	-
10:08:02.200	-	49.65	Noticing the locomotive
10:08:02.200	13.1907	49.65	Start of electric braking
10:08:02.460	13.1943	49.65	Start of air braking
10:08:18.080	13.3005	0	Stopping

Table 4.2.3.4: Calculated stopping paths of EMV 413/417-015/016 (with 50 km/h)

Type of braking	Distance crossed (m)	Note	Stopping path (m)
-	13.79	Path to noticing the locomotive (1s)	
Electric braking	3.6		109.8
Electric and pneumatic braking	106.2		
Total stopping path	**123.59**		

Table 4.2.3.5: Data from speedometer device of EMV 413/417-015/016 (with 30 km/h)

Time	Distance (km)	Speed (km/h)	Note
10:09:38.080	13.4524	49.65	-
10:09:42.520	-	49.65	Noticing the locomotive
10:09:43.520	13.4965	49.65	Start of braking
10:09:54.220	13.5393	0	Stopping

Table 4.2.3.6: Calculated stopping paths of EMV 413/417-015/016 (with 30 km/h)

Type of braking	Distance crossed (m)	Note	Stopping path (m)
-	8.02	Path to noticing the locomotive (1s)	
Electric braking	-		42.7
Electric and pneumatic braking	-		
Total stopping path	**50.72**		

By analyzing the stopping paths obtained during test ride and accident, it is possible to establish the agreement of the stopping paths of Figure 4.2.3.2.

In the part of the deceleration from a speed of 50 km/h to 36.4 km/h, it can be concluded that the curves coincide. The minimal difference of events is evident as a result of the different slope of the track at the crash site and the place of the test drive. At a slowdown of 36.4 km/h to stop, the difference in speed reduction is significant because the deceleration during collision was significantly higher due to collision of EMV 413/417-033/034 to the locomotive 661-162.

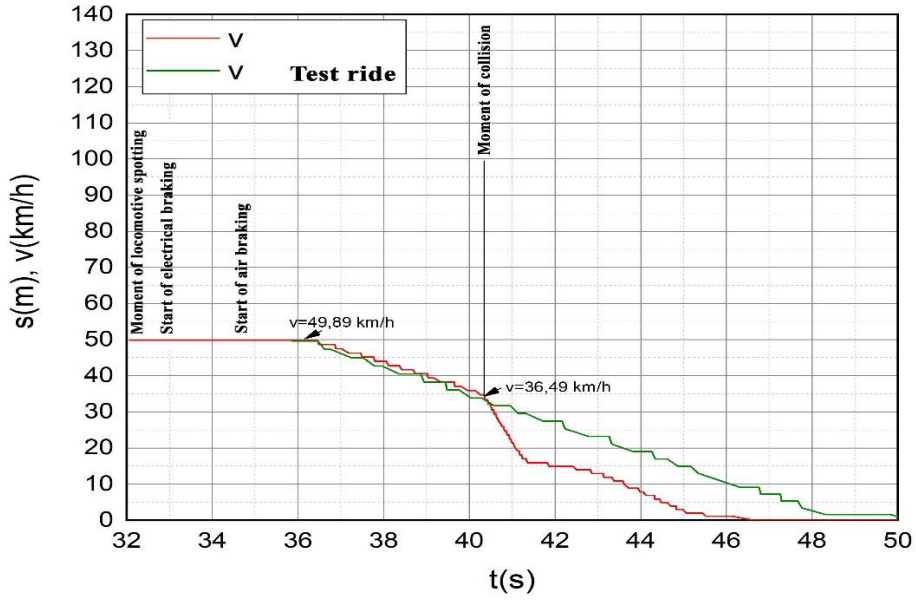


Figure 4.2.3.2: Comparative display of diagram of stopping of EMV during the test ride and collision

By comparing the length of the stopping path when braking at a speed of 30 km/h, obtained during the test ride and part of the stopping time from the beginning of the braking to the moment of collision, it can be concluded that if the train No. 2990 was moving at a speed not exceeding 30 km/h, the collision would not have happened.

4.2.4. Review of functioning of the SS system

4.2.4.1 Availability of SS devices on the section of the railway track Velika Plana-Resnik

At the railway track between the stations Velika Plana and Resnik, all official positions are secured with electric relay SS devices of the type SpDrS64-JŽ of the manufacturer "Siemens-EI", while the corresponding interstatial distances are equipped with APB devices. The abovementioned section of the track is equipped with TK devices.

From data on recorded disturbances on SS devices submitted in attachment of letter No. 21/2018-1199 of 03.10.2018. by "IŽS"a.d. it can be seen that from 01.08.2018. at 05:30 on the section of the passenger train line of the train No. 2990 between the stations Velika Plana and Resnik there were twenty undeclared disturbances on the SS devices. Out of the aforementioned twenty recorded interruptions, even seven interruptions lasted more than a month, and some of

them lasted longer than four months. It is noted that for removing disturbances, whose duration from the moment of recording is more than one month, it is necessary to replace the alienated or technically defective parts in order to return the device to the designed state, therefore it is assumed that the relevant maintenance sections do not have the necessary spare parts. The lack of spare parts considerably prolongs the interference duration of the SS devices, whereby the devices go into a state of lower security, which, in addition to the delayed trains, have a direct consequence, due to unforeseen stops, there is a decrease in safety and the difficulty in the operation of rail traffic.

On the main arterial route E70/E85: Belgrade - Mladenovac - Lapovo - Nis - Presevo - state border - (Tabanovce) there are a total of 15 (fifteen) official positions between the stations Velika Plana and Resnik, including the two aforementioned stations from which management and regulation of rail transport is done. On the day of the accident, the traffic of the trains on the Resnik - Velika Plana railway line took place in the interstatial distance at most part of the railway.

After heavy rains on the territory of Mladenovac municipality on 30.07.2018., at 18:40 at the Railway Station Mladenovac, the station control section and the TK "Jug 1" system were shut down. In addition, the next day, on 31.07.2018. at 07:00 there was a breakdown of the signal-telecommunication cable (STKA cable) between the stations Vlaško Polje and Mladenovac. Due to the mentioned events, remote control of the traffic of trains from the TK Center at Marshalling Yard Belgrade "B" was disabled on the section of the railway line between the official positions of Vlaško Polje and Velika Plana. Train traffic, as can be seen from General Orders I (S-51) No. 03 of 01.08.2018. of the station Velika Plana, No. 18 from 01.08.2018. stations Palanka and No. 28 from 01.08.2018. station Mladenovac for train No. 2990, at the railway line section between the stations Velika Plana and Palanka, Palanka and Mladenovac, Mladenovac and Vlaško Polje, was taking place at the station distances. Entrance and exit signals of the official positions of Velika Plana, Mala Plana, Palanka (only output signal), Glibovac, Kusadak, Kovačevac, Mladenovac (only exit signal), as well as all automatic block signals between stations Velika Plana and Vlaško Polje, on 01.08.2018. showed the aspect of a signal 4: "Stop" and for train No. 2990 were not valid. Also, all automatic road crossings between the stations of Velika Plana and Vlaško Polje on 01.08.2018. For the train No. 2990 were unsecured. After repairing damage to the STKA cable between the stations Vlaško Polje and Mladenovac, the TK "Jug 1" system was returned to normal operation on 02.08.2018. at 14:55.

Additionally, at the interstatial distance between stations Sopot Kosmajski and Ralja APB devices were not available from 04.05.2018., due to the theft of track chokes at the block site BG2, this section of the railway line was taking place at a station distance. Similarly, due to the alienation of the track chokes at the block site BF2 from 09.05.2018., the traffic between the Ralja station and the Ripanj Tunel was also taking place at the station distance. On the section of the railway line between Pinosava crossing point and the Resnik station, due to interference on the signal cable on the "false occupation", there was also a automatic block section between the aforementioned official positions, and on this section the train traffic was performed on 01.08.2018. at a station distance.

In Table 4.2.4.1.1. an overview of the reported technical defects on SS systems, which from the moment of registration until the moment of the accident, were not remedied (data obtained by analyzing the record of disturbances on SS devices from the appendix of the letter "IŽS"a.d. No. 21/2018-1199 of 03.10.2018.).

Table 4.2.4.1.1: An overview of the uncompleted technical defects on the day of the respective accident at the section of the railway track Velika Plana-Lapovo

Time of registration of interference	Station	Device	Description	Time of checkout of interference	Interference duration [min]
30.03.'18. 15:30	Ralja	Station IO	Occupation at IuG. The frequency on the card can not be adjusted.	-	-
04.05.'18. 06:05	Ralja	APB sections	Occupation at IpG2 and IpG3. Theft of both chokes on BG2.	-	-
09.05.'18. 17:10	Ripanj Tunel	APB sections	Occupation at IpF2 and IpF3. Theft of both chokes on BF2.	-	-
07.07.'18. 16:30	Mladenovac	Automatic PP	PBI3 out of function. Burnt FTC circiuit, replacement needed.	-	-
07.07.'18. 18:45	Glibovac	APB sections	Turn off L41. In disconnecting the PNK cable between BL1 and BL2. Replaced power supply unit, need replacing the board at UNORU. Replaced cards. Needed replace of group 123A for L41. A PNK cable extension is made.	29.08.'18. 14:50	76085
09.07.'18. 09:50	Ripanj Tunel	Relay devices	Fu91 does not resolve. Due to the theft of the choke, it is not possible to resolve it, it is possible to resolve it manually.	-	-
09.07.18 09:50	Klenje	Relay devices	Eu91 does not resolve. Invalid ARS2 card, the same is removed and taken for repair.	-	-
19.07.'18. 11:30	Pinosava	Station IO	Occupation at IUB. In short connection SPZ cable. A cable extension is made.	02.08.'18. 14:00	20310
19.07.'18. 11:30	Pinosava	APB sections	Occupation at IpB2. In short connection SPZ cable. A cable extension is made.	02.08.'18. 14:00	20310
28.07.'18. 07:00	Pinosava	Switches	S1 does not have control and occupation of section S1. In short connection SPZ cable. SPZ cable extended.	01.08.'18. 14:15	6195
29.07.'18. 07:03	Vlaško Polje	APB sections	Occupation on sections IpI1 and IpI2. In the termination of the PNK cable from the Vlaško Polje station to BI1. A PNK cable extension is made. Regulated and reset sensors on BI1, BI2. It arose after the train passed.	21.08.'18. 20:55	33952
29.07.'18. 07:19	Vlaško Polje	Automatic PP	The PBI2 device is faulty. Train under counter consent, due to occupation on IpI1, IpI2. Poor contact line 27. in cable 210 from the relay room to PBI2, the same is cleaned and dotted. Replaced batteries.	24.08.'18. 13:00	37781
29.07.'18. 09:05	Vlaško Polje	Axle counter	Occasionally occupy section Iu91. Invalid sensor at signal Iu91. Replaced sensor.	21.08.'18. 17:00	33595
30.07.'18. 05:50	Vlaško Polje	Automatic PP	PBI1 is faulty. Replaced control insert.	21.08.'18. 23:25	32735
30.07.'18. 09:05	Mladenovac	Diesel generator	Invalid clutch C1. Need to replace the clutch. Clutch C1 replaced.	05.08.'18. 16:15	9070
30.07.'18. 14:50	Kusadak	Automatic PP	PBK1 is defective. System B out of drive, returned to keys.	02.08.'18. 14:55	4325
30.07.'18. 16:40	TK Jug 1	TK device	System B out of drive. Heavy rainfall. Flood in the Mladenovac station. The station is shut down. The diesel engine did not start due to clutch malfunction C1. Upon arrival, the NUH relay was restored at 18:30. System B is still out of operation. 30m STK cable was inserted and two attachments were made.	02.08.'18. 14:55	4215

31.07.'18. 07:00	Mladenovac	Track cables	Termination of STKA cable from Mladenovac to Ralje, interruption of CDS, OV, CDeV connection as well as clock installations. From 13:30 The cable section is working on returning the cable to function. 35m STKA cable was inserted and 2 attachments were made.	02.08.'18. 13:20	3260
31.07.'18. 17:00	Mladenovac	Switches	S6, S13, IS3 have no position control. Submerged EPS, required replacement of the engine.	-	-
31.07.'18. 20:35	Klenje	Automatic PP	PBE1 is defective. Returned to the keys.	01.08.'18. 01:35	300

In short, on the day of the accident 01.08.2018. on the section of the Velika Plana - Resnik railway line, from a total of fourteen interstatial distances at only four interstatial distances, the Vlaško Polje - Sopot Kosmajki, Ripanj Tunel - Klenje, Klenje - Ripanj and Ripanj - Pinosava APB devices operated in accordance with the projected solution of the SS system for the observed section of the railway line. On other parts of the railway line the trains were running in a interstatial distance, and for trains that were transported on that day by the entrance, exit and automatic block signals that showed an aspect of a signal for a prohibited ride and extraordinarily, were not valid.

4.2.4.2 Review of interferences and defects on SS devices at official positions Klenje and Ripanj Tunel and belonging distance between stations

This chapter provides an overview of data on technical irregularities on SS devices according to data provided in the attachment of letter No. 21/2018-1199 of 03.10.2018. by "IŽS"a.d. within a time period of six months prior to the occurrence of a respective accident on devices whose operation directly or indirectly affects the operation of APBs of the APBs between the official positions of Klenje and Ripanj Tunel, a total of 12 technical defects were recorded. An overview of the above technical defects is shown in Table 4.2.4.2.1.

Table 4.2.4.2.1: Review of recorded technical defects on SS devices in the official positions Klenje and Ripanj Tunel and the adjacent interstitial distances

Time of registration of interference	Station	Device	Description	Time of checkout of interference	Interference duration [min]
11.02.'18. 14:05	Ripanj Tunel	APB sections	Occupation on E52 and E72 and signals off. Theft of choke at signal Eu92 and PNK 3×2, 5; SP3 10×0,9 и 16×0, 9 at length of 100m. On 23.02. at 12:30 new cables mounted. Signals E52 and E72 illuminated, occupation of the department and further until replacement of the choke. On 26.02 at 13:10 track choke replaced, occupation still on because the composition is not functioning at km 28+100 left. ZOP section intervened.	24.04.'18. 14:20	103695
24.04.'18. 14:20	Klenje	APB signals	Occupation on E21. Nonfunctioning left isolated composition at km 25+500. Welders notified at 17:24. Replaced composition.	25.04.'18. 17:00	1600
25.04.'18. 17:15	Klenje	APB sections	Occupation IpE2 (E21). ZOP section replaced the compos, occupation did not arise. Replaced group 122 on BE2 and Si-306 (1A) on BE1.	26.04.'18. 11:35	1100

26.04.'18. 20:45	Ripanj Tunel	APB sections	Occupation IpE5. Arose upon passage of the train.	26.04.'18. 20:50	5
27.04.'18. 20:02	Ripanj Tunel	APB sections	By giving entrance Eu92 occupation on IpE5 is made. Short cable connection 10×0,9 from KO to repeater PEu92. Continued broken line in cable 10×0,9 and replaced group 151.	07.05.'18. 13:30	14008
28.04.'18. 18:05	Ripanj Tunel	APB sections	Occupation on IpE4. Arose upon passage of the train, cause unknown.	28.04.'18. 18:30	25
30.04.'18. 05:45	Ripanj Tunel	APB sections	Occupation on the section IpE5. Interference on the cable. Arose.	30.04.'18. 20:00	855
07.05.'18. 18:05	Ripanj Tunel	APB sections	By giving entrance Eu92 occupation of the section E72. Replaced group 157.	08.05.'18. 14:00	1195
08.05.'18. 06:30	Klenje	APB sections	Occupation on IpE2. Faulty choke on BE2. Replaced choke on BE2.	03.07.'18. 11:40	80950
08.05.'18. 14:00	Ripanj Tunel	TK device	Signal E72 won't work on "Stop" on TK. Faulty group 122. Replaced group 122.	09.05.'18. 10:20	1220
07.06.'18. 02:30	Ripanj Tunel	APB sections	Occupation on IpE4. Arose upon passage of the train.	07.06.'18. 05:54	204
03.07.'18. 12:22	Ripanj Tunel	Relay devices	Approval cannot be turned to the station Klenje. Faulty group 125 on BE3. Replaced group 125.	03.07.'18. 20:50	508

In all cases where technical irregularities were detected on the SS systems, the devices were moved to a safer state (stricter regime) and all the intereferences were manifested by the "false occupation" of the section (indicating occupation of the section without the presence of the axle of the train, without the possibility of setting the signal to the concept of permitted driving) , with the exception of the interference recorded on 08.05.2018. at 14:00. The aforementioned interference refers to the indication in the center of the TK, which in functional terms represents the intermediary between the dispatcher and the station SS systems, and does not belong to the class of safety devices whose technical defect can not lead to the task of risky functions on the ground.

Reviewing the data on the intereferences submitted in the attachment of the letter No. 21/2018-1199 of 03.10.2018. by "IŽS"a.d. it is concluded that no irregularities have been recorded in terms of showing the wrong or incorrect aspect of a signal on the signals controlled from the stations Klenje and Ripanj Tunel.

4.2.4.3 Review of documentation on maintenance of SS devices

Infrastructure manager "IŽS"a.d. by letter No. 21/2018-1199 of 03.10.2018. has submitted data on periodic inspections and measurements of the characteristic parameters of the track auto stop devices and track circuits in the APB automatic block sections between the stations Klenje and Ripanj Tunel.

Measuring the parameters of the track circuits

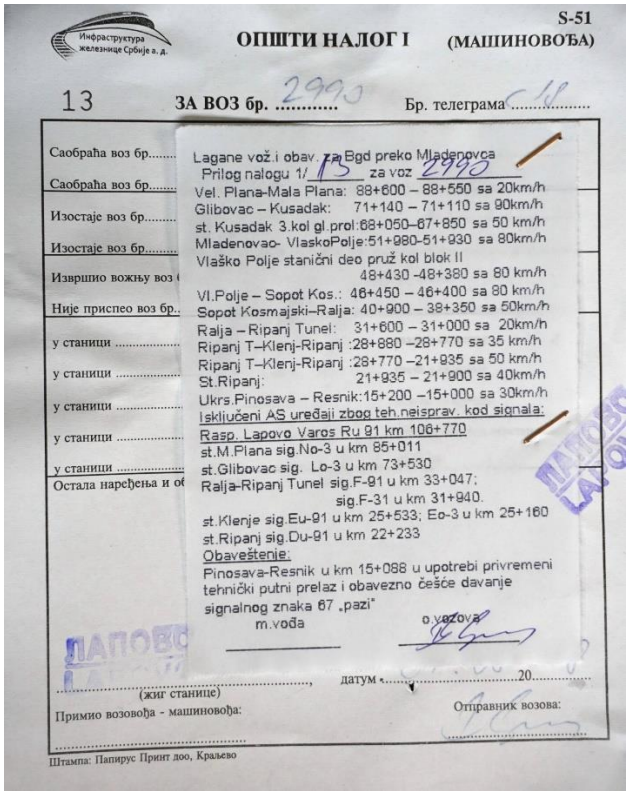
The last periodical measurement and testing of track circuits by the competent section for maintenance of the SS device, according to the submitted documentation - measuring list, was performed on 20.02.2018. It is noted that the measurement of parameters of track circuits was carried out in the period when, at the observed interstatial distance due to the alienation of the track choke from 11.02.2018. it was not possible to measure on an isolated section of IpE5. Measured electrical parameters on other track circuits on automatic block sections between the stations Klenje and Ripanj Tunel are in technically acceptable limits.

Review of work orders No. 0092486 of 13.04.2018. and 0092488 dated 17.04.2018. issued by the head of OJ SS Mladenovac, it can be concluded that the measurements and adjustments of the track circuits that are controlled at the block positions BE1, BE2 and BE3 were performed.

Track auto stop devices

From "IZS"a.d. a review of the six-month control measurement of the characteristic parameters and checking the operation of the track balises was performed in the period from 15.03.2018. to 16.04.2018., was submitted. The submitted documentation provides measured values for the track balises built in by the automatic block signals E 22, E 51 and E 62, and the measured paremeters are within the allowed limits. There are no data for the balises at the entrance signal at the Klenje Eu 91 station and the automatic block signals E 12, E 31 and E 42 in the submitted documentation, the note "unmeasurable" is written in the Eu 92 entrance signal at the station Ripanj Tunel. In the General Order I No. 13 of 01.08.2018. of the station Lapovo for the train No. 2990 (Figure 4.2.4.3.1.) it was stated that the track balise at the Eu 91 entrance signal at the Klenje station was switched off due to technical malfunction.

In addition to the mentioned General Order I, the driving staff is informed about technical faults on the track balises at the entrance signals: Du 91 in km 22+233 stations Ripanj and Ru 91 in km 106+770 at the station Lapovo Varoš, exit signals Eo 3 in km 25+160 in the station Klenje, Lo 3 in km 73+530 in Glibovac station and No 3 in km 85+011 in Mala Plana station, as well as on automatic block signals F 31 in km 31+940 and F 91 in km 33+047 at the interstatial distance of Ripanj Tunel - Ralja. Therefore, the driving staff are not informed about the possible technical failure of the balises on the automatic block signals E 12, E 31 and E 42, while on the other hand there is no data to verify their technical correctness.



Инфраструктура железнице Србије а. д.

S-51

ОПШТИ НАЛОГ I (МАШИНОВОЂА)

13 ЗА ВОЗ бр. 2990 Бр. телеграма

Саобраћа воз бр.....
Саобраћа воз бр.....
Изостаје воз бр.....
Изостаје воз бр.....
Извршио вожњу воз
Није приспео воз бр..
у станици .....
у станици .....
у станици .....
у станици .....
у станици .....
Остала наређења и об

Lagane voz.i obav. za Bgd preko Mladenovca
Prilog nalogu 1/ 15 za voz 2990
Vel. Plana-Mala Plana: 88+600 – 88+550 sa 20km/h
Glibovac – Kusadak: 71+140 – 71+110 sa 90km/h
st. Kusadak 3.kol gl.prol:68+050–67+850 sa 50 km/h
Mladenovac- VlaskoPolje:51+980–51+930 sa 80km/h
Vlaško Polje stanični deo pruž kol blok II
48+430 -48+380 sa 80 km/h
Vl.Polje – Sopot Kos.: 46+450 – 46+400 sa 80 km/h
Sopot Kosmajski–Ralja: 40+900 – 38+350 sa 50km/h
Ralja – Ripanj Tunel: 31+600 – 31+000 sa 20km/h
Ripanj T–Klenj-Ripanj :28+880 –28+770 sa 35 km/h
Ripanj T–Klenj-Ripanj :28+770 –21+935 sa 50 km/h
St.Ripanj: 21+935 – 21+900 sa 40km/h
Ukrs.Pinosava – Resnik:15+200 –15+000 sa 30km/h
Isključeni AS uređaji zbog teh.neisprav. kod signala:
Rasp. Lapovo Varos Ru 91 km 106+770
st.M.Plana sig.No-3 u km 85+011
st.Glibovac sig. Lo-3 u km 73+530
Ralja-Ripanj Tunel sig.F-91 u km 33+047;
sig.F-31 u km 31+940.
st.Klenje sig.Eu-91 u km 25+533; Eo-3 u km 25+160
st.Ripanj sig.Du-91 u km 22+233
Obaveštenje:
Pinosava-Resnik u km 15+088 u upotrebi privremeni tehnički putni prelaz i obavezno češće davanje signalnog znaka 67 „pazi"
m.voda
o.vozova

ЛАПОВО

..... (жиг станице) датум ..... 20.....

Примио возовођа - машиновођа:

Отправник возова:

Штампа: Папирус Принт доо, Краљево

Figure 4.2.4.3.1: Appearance of the General Order I No. 13 of 01.08.2018. of the station Lapovo

It should be noted that in the Rulebook on technical conditions for SS devices ("Official Gazette of RS" No. 18/2016 and 89/2016), as well as in the Rulebook on maintenance of SS devices ("Official Gazette of RS" No. 80/2015), there are prescribed characteristic parameters and their values that would be controlled during six-month periodical checks.

Visibility of the signal

The submitted documentation does not have reliable data on whether a periodic check of the orientation and visibility of main light signals, pre-signals and repeaters of pre-signaling was performed. Only the Report of the Chief of the OJ SS Mladenovac No. 21/2018-1-4073 of 03.10.2018. was submitted. which states that there were no objections to the visibility of the signal at the section Ripanj Tunel - Klenje.

From the above, it is concluded that all necessary periodical measurements on the SS devices prescribed by the provisions of the Rulebook on maintenance of the SS device ("Official Gazette of RS" No. 80/2015) have not been performed. Additionally, a number of interferences are observed in which, due to a technical failure or otherwise caused damage to external SS devices, replacement of certain parts of the device is required. These intereferences are characterized by their long duration, which, as a result of deviation from the projected state, reduces the safety of the railway traffic.

4.2.4.4 Overview of the commands given from TK Center "Jug 1"

Based on the information provided by "IZS"a.d. (Attachment 2 of the letter No. 21/2018-1-4079 of 03.10.2018. of the ETP Belgrade Section, TOJ for the SS) about the assigned commands for the station Ripanj Tunel from the TK Center at Marshalling Yard Belgrade "B" immediately prior to the accident with security reconstruction of the traffic operation can performed in the Ripanj Tunel station, as well as a partial confirmation of the operation of the SS device. It should be noted that the technical solution of the TK "Flexicode 560" device only supports recording of the assigned commands from the TK dispatcher, but not the recording of the status of external SS devices that are only displayed on the TK panel the form of an optical or acoustic indication after processing.

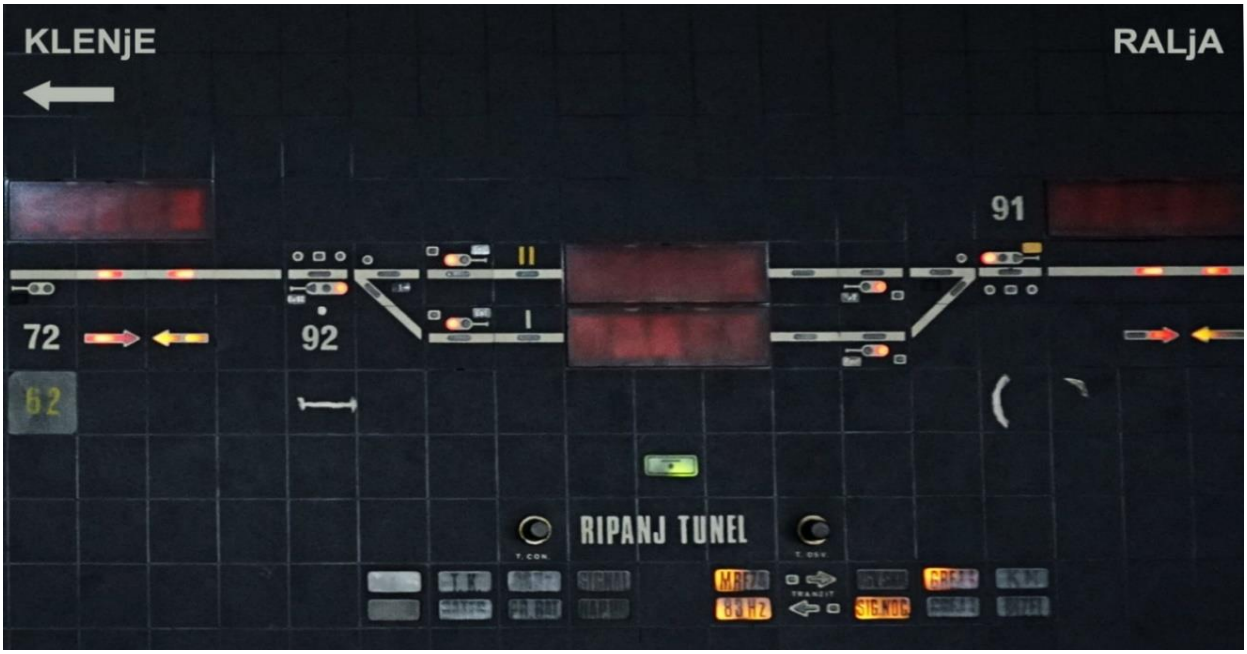


Figure 4.2.4.4.1: Appearance of the part of command-controlling panel at TK Centre, review of station Ripanj Tunel

In Table 4.2.4.4.1. the display of the given commands from the TK Center at Marshalling Yard Belgrade "B" from the position TK Dispatcher "Jug 1" for the Ripanj Tunel station in the time interval (according to the timetable of the TK device) from 05:09 (setting the entry drive for the train No. 70922) until 05:35 (assign command for exit train No. 2990).

Table 4.2.4.4.1: List of commands given at the station Ripanj Tunel from TK Center

Command given		Time of giving command	Comment
TRPV	ULAZ 91	05:09:41	Release of entrance drive Fu91, unclear reason for use
ULAZ 91	ST I ←	05:09:54	Entrance drive given Fu91 on the I track for the train No. 70922
TRPV	ULAZ 91	05:10:20	Previous command failed, release of Fu91
TRPV	ST I ←	05:10:25	Release of exit drive Eo1, unclear reason for use
ULAZ 91	ST I ←	05:10:30	Repeated command for the entry on the I track for the train No. 70922
TRPV	ST I ←	05:19:07	Release of exit drive Eo1, unclear reason for use
ULAZ 92	ST II →	05:19:28	Entrance drive given Eu92 on the II track for the train 40767
TRPV	ULAZ 91	05:20:41	Release of entrance driveFu91, unclear reason for use
TGTP	IZLAZ 92	05:29:37	Request for the reversal of approval after the arrival of the train No. 40767
TRPV	ULAZ 92	05:29:51	Release of the entrance drive Eu92, unclear reason for use
IZLAZ 92	ST I ←	05:30:16	Exit drive given Eo1 from the I track for the train No. 70922
TRPV	ST II →	05:30:29	Release of exit drive Fo2, unclear reason for use
ULAZ 91	ST I ←	05:31:20	Entrance drive given Fu91 on the I track for the train No. 2990
TRPV	ULAZ 91	05:31:56	Previous command not achieved, release of Fu91
TRPV	ST I ←	05:32:04	Release of exit drive Eo1, unclear reason for use
ULAZ 91	ST I ←	05:32:07	Repeated command for entrance on the I track for the train No.2990
TRPV	ULAZ 91	05:32:29	Previous command not achieved, release of Fu91
TRPV	ST I ←	05:32:33	Release of exit drive Eo1, unclear reason for use
ULAZ 91	ST I ←	05:32:37	Repeated command for entrance om the I track for the train No. 2990
IZLAZ 92	ST I ←	05:34:24	Exit drive given Eo1 from the I track for the train No. 2990
TGS	TS II-2	05:34:31	Command given for the crossing of the switch No. 2
TRPV	ST I ←	05:35:34	Release of the exit dive Eo1
TRPV	ULAZ 92	05:35:38	Release of the entrance drive Eu92, unclear reason for use
IZLAZ 92	ST I ←	05:35:42	Exit drive given Eo1 from the I track for the train No. 2990

By analyzing the given commands you can determine the following:

- Entry of the train No. 70922 into the station Ripanj Tunel from the direction of Ralja:

At 05:09:54, for the first time, the command for forming the entrance drive from the Fu 91 signal was first assigned to the first station track of the station Ripanj Tunel for the train No. 70922. For an unknown reason, the command failed.

After the previous command failed, the previously assigned command was canceled by releasing the driving path. At 05:10:30 for the second time the command for entry of the train No. 70922 was given, which was accepted and realized by the securing device.

- Entry of the train No. 40767 into the station Ripanj Tunel from the direction Klenje:

At 05:19:28, the command for the entrance drive from the Eu 92 signal on the second track for the train No. 40767, which comes from the direction of Klenje (Belgrade). After the entry of the train No. 40767, the established driving path was automatically released by covering the announcing point and isolated sections by the train.

- Exit of the train No. 70922 from station Ripanj Tunel:

At 05:30:16 there is a command for the formation of the exit path for the train No. 70922 from the first track, from the exit signal Eo 1, from the station Ripanj Tunel to the Klenje station. The train No. 70922 immediately left the station after forming the driving path. Since the next assigned command was the Fu 91 entrance to the first track, it is assumed that the exit path was automatically released by train No. 70922.

- Entry of the train No. 2990 to the station Ripanj Tunel from the direction of Ralja:

At 05:31:20, for the first time, the command for forming the entrance path from the Fu 91 signal was first assigned to the first station track of the Ripanj Tunel station for the train No. 2990. For an unknown reason, the command failed.

After the previous command failed, the previously assigned command was canceled by releasing the driving path. At 5:32:07 for the second time the command for the entry of the train No. 2990 was given, which was also not realized.

After the assigned command was not re-established, the command for the entry of the train was canceled by the release of the driving entry. Finally, at 05:32:37 for the third time the command for entry of the train No. 2990, which was accepted and realized by the securing device, was set for the third time.

- Exit of the train No. 2990 from Ripanj Tunel station:

At 05:35:42, an exit path was made for the train No. 2990 from the first track to the Klenje station.

Previous data analysis, in addition to the reconstruction of the traffic image in the Klenje station, shows the difficult task of commanding of the entrance and exit paths for driving, that is, before the successfully executed command, the command must be repeated two or three times. After the previously set command has not been delivered, in order to reset it and create the ability to repeat it, in all cases, the "TRPV" key has been used, which means that the station device has received the assigned command, and that the given driving path has been locked (in the case of unlocked driving path, the cancellation can be done using the "TOPV" button). The problem with non-execution of the given commands was not recorded in the basis of interferences on the SS devices in the period of six months prior to the accident. The difficult task of commanding from the TK Center at Marshalling Yard Belgrade "B" for the Ripanj Tunel station could not have affected the occurrence of the accident.

Additionally, from the TK Center Commands List, it is noted that in most cases immediately prior to commanding the entrance and exit driving commands, the TK Dispatcher instructs drivers to resolve the road paths that were not formed at that moment using the "TRPV" and the "START" buttons. Considering that during the analyzed period there were no recorded disturbances in terms of releasing the driving paths, there remains an unclear reason for giving of these commands. Also, from the analysis of the data provided, it is concluded that the entrance and exit driving paths were released automatically by the train.

4.2.4.5 Review of data given from the speedometer device of the train 2990 relevant to the analyses of SS systems functioning

Analysis of submitted data registered with electronic speedometer with EMV 413/417-033/034 (Data registered with electronic speedometer device No. 153 dated 01.08.2018.) for

driving a train No. 2990 on 01.08.2018. at the railway station from Stalac station to the site of the accident, the following can be concluded:

- the influence of the active track balise at the resonant frequency of 2000 Hz is registered (active on the signal indicating the aspect of a signal 4: "Stop" or in the event of a cable break or some other interference to the signal) using the "drive by order" button, in total 45 times,
- the influence of the active balise on the resonant frequency of 1000 Hz is registered with the use of the "acknowledge" button in total 8 times,
- on the entrance signal Fu 91 of station Ripanj Tunel the influence of the active resonant frequency balise 1000 Hz is not registered, given the made entrance signal to turn on the signal, an aspect of a signal 8 is expected: "Limited speed, expect Stop."
- immediately prior to the occurrence of the accident, the influence of the active track balise at the resonant frequency of 2000 Hz was recorded along the E5 1 signal.

4.2.5. Analysis of the traindrivers' statement

The minutes of the hearing of the train drivers who participated in the accident, by the joint investigation committee "IŽS"a.d, "Srbija Voz"a.d, "Srbija Kargo"a.d. it can be noticed that the display of the aspects of a signal of the Eo 1 output signal of the Ripanj Tunel according to the allegations of the train drivers given in the Record from the hearing is not in accordance with the requirements of the signal logic of the SS device functioning.

According to the driver of the train No. 70922 allegations, after the formed driving path to the Klenje station, the Eo 1 exit signal was showing the aspect of a signal "Limited speed expect Stop", and that during the drive, the first automatic block signal E 51 was "green". This aspect of a signal only shows the exit signal when the first automatic block section is free and when the signal that protects the next automatic block segment from the notion of a prohibited drive due to the occupation of another automatic block segment or for any other reason (for example, due to technical defects on the signal). For the train No. 70922, the exit from the station Ripanj Tunel to the Klenje station was formed immediately after the arrival of the train No. 40767 from the opposite direction. From the information provided on the given commands from the TK Center at Marshalling Yard Belgrade "B" from the TK Dispatcher "Jug 1" post, it can be seen that after the entry of the train No. 40767 at the station Ripanj Tunel the permission was neatly settled between the stations Ripanj Tunel and Klenje. The basic requirement for converting permission between the two stations is that all the distance between stations is free and in any of the stations between which it is converted, the exit drive is not started on the side on which it changes. Considering that no interference was recorded after the entry of the train No. 40767 and that the exit drive is set for a few moments after converting permission and that all automatic block sections were free in the field, at the Eo 1 output signal according to the requirements of signal logic, the aspect of a signal 9 is expected: "Limited speed, expect Free or Cautious".

Similarly, according to the allegations of the driver of the train No. 2990 at the station Ripanj Tunel, the Eo 1 exit signal showed the aspect of a signal "Limited speed, expect free or cautious", while during driving the first automatic block signal E 51 after showing green light "fell to red". Considering the fact that the train No. 2990 from the Ripanj Tunel station is dispatched in a block space department of only 3 to 4 minutes behind the train No. 70922, expected aspect of a signal at the exit signal Eo 1 according to the state of the field is aspect of signal 8: "Limited speed, expect Stop".

The described mismatch in displaying of the aspect of a signal on the Eo 1 exit signal at the Ripanj Tunel station is given in the statements of the train driver with the expected aspects of a signal according to the state of the field, viewed from the technical side, can be caused due to the occurrence of interference on the SS devices.

During a hearing at the CINS premises on 24.11.2018. the train driver of the train No. 2990 repeated that the E 51 automatic block signal from “green fell to red” before passing of the train next to this signal.

Here are briefly described basic elements of the APB's operating logic, which is schematically derived from the electrical connections between the relays, which are automatically controlled by these devices. In the event of any interference that would cause a different event or operation of the relay inside the device, the APB automatic block signal would permanently remain on the notion of a prohibited drive. When taking up a automatic block segment, the main signal that protects this segment does not change directly for aspect of a signal 5a: “Free, expect Free or Cautious” (green still light) to an aspect of a signal 4: “Stop”, but the red lamp is on with a time delay after the automatic block segment occupation was detected. The appearance of the axle of a railway vehicle on a automatic block section due to an electric short-circuit on a track (through the axles of a railway vehicle) “releases” a motor relay whose contacts immediately interrupt the current circuit of the green lamp, as well as the control relays of the block. The control relay of the block has a slow release of about two seconds during which release period a yellow lamp switches on on the signal. Only after the expiration of this slow release is the yellow lamp off and it turns red. In the opposite direction after the release of the automatic block section by the train, also through the implemented logic of the connection of the relay, the control of the train tracking is carried out, that is, the automatic block signal that protects the segment, must first get the conditions for turning on the yellow lamp (the next section is busy), and only after that the condition for switching on the green lamp (the next section is free).

The statement of the train driver drives of the train No. 2990 given during a hearing in the CINS premises of 24.11.2018. that the E 51 automatic block signal was directly changed from the aspect of a signal 5a: “Free, expect a Free or Cautious” on the aspect of a signal 4: “Stop” is in contravention of the technically conditioned logic of the operation of the APB device, which is explained here.

The possibile technical failures will be analyzed which may cause the described misrepresentation of aspects of a signal on the output signal Eo 1. Displaying of the apsect of a signal 9: “Limited Speed, Expect Free or Cautious” when the first space section is free, and occupied the other automatic block section and display the aspect of a signal 8: “Limited Speed, Expect Stand” when the first two automatic block sections are free can be the result of the wrong the reversal of a three-phase motor relay or due to a poor phase displacement of the phase or the failure of the relay group. In the submitted data with disturbances and in the submitted tasks of the OJ SS Mladenovac section, the fault of the relay group of the output signal Eo 1 has not been recorded. During the operation of track circuits this problem can arise in the following cases:

- Due to the breakdown of the isolated composition when the interference of the neighboring rail circuits interacts. Considering that the BE2 and BE3 blocks are charged from different power sources, BE2 is powered from the Klenje a BE3 station from the Ripanj Tunel station, in these block locations there is a special type of isolated assembly, the so-called “Zonder-štos”, which actually consists of two times isolated compositions between the grounded rail. The solution used avoided the possibility of poor interaction between adjacent isolated sections, due to the breakdown of an isolated composition. The correct selection of the phase at the point of transition from the double to the single track insulation allows for the

occurrence of a “false engagement” in the event of a breakdown of the isolated composition, which was confirmed after the interference recorded on 11.02.2018. at 14:05, when a track choke was alienated.

- Due to incorrectly connected connecting cables of the traction current or connecting cables of the track choke. In the case of incorrectly connected connecting cables from the choke for the permission direction from Klenje to Ripanj Tunel, after every in-driving path, based on the mechanism described in the previous section, on the IpE5 segment, which is protected by the E 62 signal, would remain a false occupation.

It should be noted that such interferences are not of a casual character, and that their existence would be manifested in every forming of the exit drive.

The exit signal Eo 1, as well as other signals that are not on the main running track on this section of the track, is not equipped with a combined track balise so that the data obtained by reading the speedometer devices of the train No. 2990, by the influence of the active resonant circuit 1000 Hz, can not determine the indication of aspect of a signal on signal Eo 1.

By the competent unit of maintenance based on the issued Work Order of the Head of the OJ SS Mladenovac No. 3 dated 07.05.2018., works were carried out to check all the driving paths in the Ripanj Tunel station. In the description of the works carried out under this Work Order, no other defect was observed in the checking of the driving paths in addition to the replacement of the 20/20W/12V signal lights.

Considering that from 24.04.2018. when, after the replacement of the alienated choke, the APB was again put into operation on this part of the railway line, and until the day of the accident, there was no notification of the wrong display of aspects of a signal, and that from 03.07.2018. and until 01.08.2018. on the same day, no disturbance was detected on SS devices at the Ripanj Tunel station and at the section between the stations Klenje and Ripanj Tunel, it is assumed that there was no interference on the Eo 1 signal or any other interference on the station SS device at the Ripanj Tunel station just before the formation the accident.

4.2.6. Psychological analysis of the event

4.2.6.1 The importance of human factor in analysis of the accidents

Psychological analysis of accidents is a very important segment because it deals with human factors, which has a significant, practical and primary role in the realization of all human activities. Manifestations and aspects of human factor influence are numerous. They arise through the synthesis of several different elements, which in a joint action have an impact on the results of the work. By increasing the quality of the human factor, the number of human mistakes decreases, which optimize the symbiosis of man and technical and technological achievements. Understanding the interaction between organizational, individual and teamwork factors is important for establishing the principles of providing a reliable management system and reducing the risk of errors. Effective identification of critical points on the map of the human factor represents a proactive approach in the overall preventive action in order to reduce accidents and incidents.

4.2.6.2 Elements of human behavior in accidents

What can be specifically distinguished and seen in the psychological analysis of the human factor and its impact on accidents (based on contemporary research by American authors led by A. Verna и E. J. Vauglan, as well as the Australian - New Zealand Advisory Standards) are the following defined elements: 1. *lack of communication*, which relates to unsuccessful communication between all actors in the implementation of activities, in order to optimize the exchange of information; 2. *lack of teamwork*, which implies a low level of mutual understanding and cooperation, ineffective joint action and decision-making; 3. *Lack of assertiveness* implies an environment in which practice there is no possibility of open expression of opinions, attitudes and needs in a positive and productive way without endangering others; 4. *lack of knowledge (experience)* implies ignorance, disregard or disregard of work procedures (instructions, regulations/rules, legal solutions, etc.), relying on improvisations in work; 5. *lack of resources*, refers to the fulfillment of obligations without sufficient resources leading to the inability to adequately execute set tasks, 6. *Lack of awareness of the situation/event* is a state of failure to recognize the consequences of a particular action being taken; 7. *absence*, refers to the divided attention/dispersion of the priorities of the perpetrator, caused by various factors (financial, family, personal, etc.); 8. *work pressure*, refers to the execution of work tasks without the right/possibility of error, 9. *Failure to comply with the norm* is to ignore the defined rules under which the system functions, and they require gradual work, without improvising, recruiting and out of procedure; 10. *The routine* that carries the perpetrator's work to feel that something is good, just because there were no problems or disturbances until that moment; 11. *fatigue*, physical or mental, results in diversity, loss of concentration and attention, decreased ability to perceive; 12. *low level of work awareness* (reduced responsibility, reliability, working discipline) and *moral awareness* (lack of moral values); 13. *lack of motivation*, reduced motivation for work and dissatisfaction with work and working conditions; 14. *exposure to stress* that significantly affects the psychophysical abilities and characteristics of people, leading to significant behavioral disorders; 15. *psycho-physical inability*, refers to mental, physical disability caused by various somatic diseases, personality disorders and age.

4.2.6.3 Former analyses of accident factors

From the analysis of data obtained from “IZS”a.d. on accidents - a collision of a train with a railway vehicle and incidents - avoided collision of a train with a railway vehicle and a passage of a train or a rail vehicle over a signal that prohibits further driving, which occurred in the period from 01.01.2008. until 01.08.2018. on the network of railways “IŽS”a.d. (see point 3.7), it can be seen that in 95% of cases, the cause of the origin is a human factor. In other cases (5%) it is due to technical and natural factors. Participants causing accidents and incidents are the staff that manages the traction vehicle - train driver, assistant train driver, TMD driver (54% - in the highest percentage), train regulating staff (30%) and shared responsibility (16%).

In the submitted review of accidents and incidents in the railway traffic, there are no elements of the influence of the human factor, because the concrete data for this, unfortunately, do not exist (eg fatigue, reduced responsibility, poor communication, routine, the influence of stress and the like). It is certain that accurate information about the events, as well as the results and conclusions of their analyzes, are of great importance, therefore the use of relevant and up-to-date information is necessary for a quality identification process. This implies the identification of all sources of risk, event and/or a range of circumstances that can signal the occurrence of a risk event, the accident and incident factors and their potential consequences.

In view of the above, it is necessary to conduct an analysis of accidents and incidents where the priority is to assess the impact of the human factor on the above elements (point 4.2.6.2). In order to create a model of critical elements, it is necessary to make a classification of them by relevance and a ranking list of representation. A formed model of critical elements related to the human factor is the basis for the purposeful structure of preventive measures and the prediction of human behavior in crisis situations.

4.2.7. Psychological assessment of behavior of direct participants of the accident

The assessment was made on the basis of interviews with the participants of the accident on 24.11.2018. in CINS premises based on structured questions.

4.2.7.1 The train driver of the train No. 2990

The train driver of the train No. 2990 had been determined and focused on the work task before the accident, did not come out of the established functioning, declaring that he did everything according to regulations. According to his own statement, so far, he has not had any omissions in his work. In the description of the event (the course of the accident) he showed a high degree of self-awareness, rationally considering the event's trajectory and the impact of his own mistakes in an accident. It fully identifies the necessary changes in its behavior, based on the perceived personal failings in the work. He confirms that before the accident he was restless and psycho-physically ready to do his job (according to his own statement, he rested for about six hours). However, according to modern scientific research, dr. I. Rosenzweig (an eminent expert in neurology and clinical neuropsychology dealing with the sleep and sleep physiology), considers that the optimal duration of rest-sleep in order to consolidate memory, conserve energy, thermoregulation and enhanced adaptation to adverse external factors, or revitalize the entire organism is eight hours.

The driver of the train No. 2990 showed the necessary emotional stability and balance with adequate internal control (after the accident he contacted the dispatcher, got out of the train, he followed the condition of the passengers and the damage to the trains, and gave a statement to the competent investigative authorities). After the accident, he did not show signs of psychological destabilization. He has a constant need for personal review, as well as a critical view of reality, in the doubt that he has not received the necessary information that he needed for a safe drive.

In the description and self-assessment of the events, just before the train collision, the train driver of the train No. 2990 was concentrated on light signals. Categorically, he claims to have seen a change in light signaling. He declares that he has a full concentration when tracking the light signals, because it works for years, so that his concentration and peripheral perception is increased during driving. It does not raise suspicion in seeing the change of the signal from green to red, does not give the possibility of own imagination, that is, the imagination of a phenomenon that did not exist. At the critical moment when he used the “drive by order” button, he stated himself that he worked routinely, and that he automatically reacted.

By processing the data taken from the memory of the electronic speedometer EMV 413/417-033/034, it was found that the train driver of the train No. 2990 from departure from the Lapovo station at 03:46:10, where he took control of the train, passing through the automatic block signal E 51 in 05:37:10, he used 43 times the “drive by order” button. During the passage along the E 51

automatic block signal, the train driver of the train No. 2990 had for the 44th time for a 111 minute time period used the “drive by order” button.

Since he has continuously for a short period of time, done for a number of times a single action, or used the “drive by order” key several times, it can be concluded that the train driver of the train No. 2990 routinely, mechanically thought and reacted, which is the expected motor action in patterns of recurring movements. The driver of the train No. 2990 described himself as a responsible and self-disciplined worker, with strong motivation for this job, but by the acquisition of circumstances, mechanical behavior, and the long-hindered working conditions affecting driving safety caused omissions in the work of this employee on that day. Given that this is a person with a built-in moral awareness, a worker whose competence corresponds to a given job as well as to someone who respects the organizational rules, his behavior in an accident can not characterize his personality profile as an unconscientious and irresponsible worker.

4.2.7.2 The train driver of the train No. 70922

According to a personal assessment of the event, the driver of the train No. 70922 lists nothing as problematic in his work behavior on that day. According to him, the activities were common to him, as well as in the case when his driver’s safety device went off. He explains in detail the parts of the event, through the changed perceptual prism. While giving a statement, he is acting tensely with great excitement. His self-assessment of the complete event is reduced to a superficial examination of the causes and consequences, without analyticity and self-criticism.

In the self-assessment of his role in events, he does not clearly see his failures, dealing with external factors and organizational failures. His self-esteem and responsibility has a half-image of an objective examination of the cause of the accident. He is only aware of his inner dissatisfaction and fatigue, because he has little time to rest, because of the currently unresolved existential problems, which additionally burden him (unsettled loans and work engagement in several consecutive jobs). He shows a degree of inconsistency and manipulation in the retrospective of the event, skillfully avoids critical points, shifts from the topic to the topic, highlights the contents he is imposing, without focusing on the essence. Avoids confronting with the assumption of personal responsibility, shifting it all to an organizational level. The driver of the train No. 70922 in a state of total dissatisfaction with business and life events, reduces personal responsibility and motivation to work, to the limits of demotivation, which forms a negative attitude towards all working aspects, with personal accent on poor working conditions, unresolved infrastructure, disrupted internal organizational communication, poor recruitment.

His work experience in these jobs of eighteen years is not a guarantee of continuous achievement of good results and dedication to the job. Also, some personality traits, temperament as well as individual character traits can affect his work potentials and attitude towards work, collective, and organization. Since external factors do not change, nor can it affect them, and which might possibly increase the level of its internal energy, enthusiasm and motivation, its lethargic and indifferent behavior and uncertainty of life goals are expected. Such a long-term state can provide conditions for occurrence of mistakes in work, irresponsible attitude and avoidance of work.

The driver of the train No. 70922, after the accident, reacted with the destabilization of the psychic state, which is manifested through anxiety response, with inadequate defense mechanisms, manifestation of aggressive behavior towards the environment. The overall dissatisfaction caused by the state of hopelessness, deep disappointment and antagonism is visibly enhanced.

4.2.7.3 Assistant train driver of the train No. 70922

More as a "passive" participant in the accident, the assistant driver of the train No. 70922 did not give an adequate assessment of all happenings in this event. The wear of physical and mental strengths and capacities, with present insecurity and reduced confidence, is noticeable. He changes parts of the statement in fear that he would not be sanctioned. He shows concern for his future employment status after the accident, because he will be soon retired. Easily subjected to beliefs and others' imposed attitudes. He can venture into risky situations that are not in his interest from ruthlessness and gullibility. He has no capacity to bear heavy efforts and burdens. The presence of alcohol found after the accident of the assistant train driver of the train No. 70922 indicates the consumption of alcohol before going to work, which may indicate a moderate tendency to abuse alcohol.

Although during the accident itself (according to his own statement) he was in a state of half-sleep, in written statements, he reconstructed the event as if he were in an awake state, indicating the fact that there is an intense emotion of fear for his future existence. After the event, the assistant train driver of the train No. 70922 showed psychic destabilization through anxiety response with depressive symptoms. He shows the level of guilty conscience for injured participants in the accident. From sympathy with others and fears for his own consequences, only a few days later he sought medical help, where he was diagnosed with injuries.

The role of this participant in an accident should be taken with reserve, because that day he was delegated a job that he does not perform daily. The fact that during the performance of his duties he was "napping", shows personal irresponsibility and lack of interest in the current performance of the given job.

4.2.7.4 ТК dispatcher– train dispatcher

During the conversation, he performs reasonably and calmly. He only presents the facts for which he is completely safe, he does not deal with suggestions and assumptions. He is focused on questions, specifically answering, clearly and concisely. He declares that he is doing his job responsibly and is complex and requires full concentration and mental engagement. He lists the difficulties that have been encountered so far, such as the difficult working conditions, which are minimally addressed. He believes that technical problems are the biggest, that they must manage themselves and find out the compulsory ways to avoid mistakes, which indicates his ability to navigate and quickly adapt. With a colleague with whom he worked in a shift, he has good communication, arranging activities in order to achieve the necessary efficiency and reliability, rotation in work, with good cooperation, professional attitude and collegiality. Recognizing that an accident has occurred, he reacts with a snap, conciliatory and rational approach to solving the problem, quickly decides and makes decisions appropriate to the situation, demonstrating experiential and expert approach.

4.2.7.5 ТК dispatcher - operator

According to his own assessment of his previous work engagement, he concludes that he is doing his job conscientiously and responsibly and is engaged maximally in six-hour dispatching activities. The statements showed a constant fear that there are no mistakes and omissions in the

work, which indicates more pronounced self-control and perfectionism, which can be an aggravating factor in the behavior of "work without error". He thinks he is capable of doing this job, he is highly motivated to do the job. In associate, team activities fosters good and positive relationships, because it considers that this significantly affects the quality of work.

He declares that he was responsible for doing his job on that day, and with his colleague monitoring the traffic situation, he was optimally concentrated on the control panel. Although the TK dispatcher - the operator claims that without load can monitor signal systems continuously for six hours without break, according to modern research, optimal alertness on complex tasks with specific requirements, such as this is four hours. It is possible to engage for several hours with up to eight hours but with breaks for rest. According to the works of American psychologists Jim Loer and Tommy Schwarz, the rhythm of maximum concentration is 90 minutes of work with rest breaks of 15 to 30 minutes. At that time, maximum work efficiency is achieved.

In the knowledge that an accident had occurred, he reacted agitated, blocking himself with the sense of fear for human lives, declaring that he was completely "paralyzed". It shows sensitivity to sudden stressful situations and work under pressure, reacting uncertainly and scared. It shows compassion to those involved in the accident with a sufficient dose of empathy and altruism. After unhappy events, his psychological state stabilized over time, with a reduction in the sense of guilt for the consequences of the accident, as he expressed his expressed responsibility during the event itself. Given that this is an employed person who has no experience in situations of an accident, his reaction and behavior is not surprising. Also, his personality structure is characterized as emotionally more sensible, rational more intelligible with a comprehensive analytical and self-critical approach to causes and consequences.

4.3. Conclusions of the causes of the accident

4.3.1. Direct cause of the accident

Direct cause of the respective accident was the fact that two trains were found at the same time at one automatic block section, upon which one train was standing (the train No. 70922), while the other train was moving (the train No. 2990), which is in contradiction with the provision of the Article 37, Point 7 Rulebook 2, Traffic Rulebook ("Official Gazette of ZJŽ", No. *3/94, 4/94, 5/94, 4/96 and 6/03*).

On the occurrence of the respective accident the following had an influence:

1) failure to comply with the railway regulations on passing along the signal that prohibits further driving by the train driver of the train No. 2990,
2) faults and failures of SS devices that are repeated over a longer period of time,
3) unsecured minimum prescribed distance of visibility of the main signals,
4) untimely detection of the obstacle on the track (of the stopped locomotives) due to the vegetation near the railway track,
5) incomplete notification of train driver No. 2990 on train traffic situation by TK dispatcher,
6) frequent alienation of railway property - of certain parts of the SS devices by third parties,
7) weather conditions - extensive rainfall from 30.07.2018. on the mentioned railway section which contributed to the deterioration of the state of functioning of the SS devices.

4.3.2. Basic causes deriving from skills, procedures and maintenance

Considering that the train driver of the train No. 2990 had no order to pass the automatic block signal that prohibited further driving, issued by the General Order I nor by a phonogram by the traffic regulator (TK Dispatcher), he was obliged to, pursuant to the provisions of Article 6, under Đ, Point 20, Paragraph 2 of Rulebook 1, the Signalling Rulebook ("Official Gazette of ZJŽ" No. 4/96, 5/96 and 1/97), stop the train. In case that he is unable to establish a connection with the TK Dispatcher, in accordance with the provisions of Article 79, Point 5, under a) of Rulebook 2, Traffic Rulebook ("Official Gazette of ZJŽ" No. 3/94, 4/94, 5/94, 4/96 and 6/03), after standing for 3 minutes, he had the possibility to pass a automatic block signal that prohibits further driving and with careful driving according to the transparency of the track, but with at most 30 km/h, continue driving to the first next automatic block signal. The reasons for such an action of the train driver can be the simultaneous influence of technical factors (long distance driving in conditions of technical defects on SS devices resulting in a lot of information and instructions to the train driver via General Order I or via RDV; this type of drive deviates from the usual driving mode when signaling and traffic control devices function properly) and psychological factors (in conditions when he continuously for a certain period of time, repeatedly performed a uniform action, or repeatedly used the "drive-by-order" button, it can not be ruled out that the train driver of the train No. 2990 was thinking routinely, mechanically and reacted, which is the expected motoric action in the recurring movement scheme).

It was found that all necessary periodical measurements were not performed on the SS devices prescribed by the provisions of the Rulebook on maintenance of the SS devices ("Official Gazette of RS" No. 80/15). Additionally, a number of technical defects was noted in which, due to a technical failure or otherwise caused damage to external SS devices, replacement of certain parts of the device is required. These interferences are characterized by their long duration, by which, as a result of deviation from the designed state, the safety of the railway traffic is reduced. In the submitted documentation from "IŽS"a.d. there is no reliable data on whether a periodic check of the orientation and visibility of the light main signals, pre-signals and repeater of pre-signaling was performed. For automatic block signal E 51, there is no minimum visibility distance prescribed by the provisions of Article 6 of Rulebook 1, Signaling Rulebook ("Official Gazette of ZJŽ" No. 4/96, 5/96 and 1/97).

4.3.3. Main causes deriving from conditions determined by legal framework and application of the safety management system

The Rulebook on maintenance of the SS devices ("Official Gazette of RS" No. 80/15) does not define the maximum permissible interference or defect time on SS devices. Only the maximum deadline by which the workers which are working on maintenance, begin eliminating interference or a defect on the SS device from the reception of notification on interference or defect.

The Rulebook on maintenance of SS devices ("Official Gazette of RS" No. 80/15) does not define that monitoring the condition of SS devices is carried out by the workers that maintain safety-signalling devices with the aim of determining their usability and correctness. It is defined that it should be done only by the workers that operate the safety-signalling devices.

The Rulebook on Technical Requirements for SS Devices ("Official Gazette of RS" No. 18/2016 and 89/2016) does not define electrical parameters to describe the technical condition of the track balises, similar to the provisions that were defined in the currently inapplicable

Instruction 427, Instructions for the application, installation, testing and maintenance of track-mounted autostop devices on the railway lines of JŽ ("Official Gazette of ZJŽ" No. 1158/75).

4.3.4. Additional remarks on lacks and flaws determined during the investigation, but without relevance on conclusions about the causes

Excerpt from the Project with external elements of the SS device delivered by "IŽS"a.d. by e-mail of 26.10.2018. uses different mileages in relation to field mileage. In the aforementioned document km 27+369, where the first contact of the trains No.2990 and 70992 was realized, it is located in the first automatic block section from the Ripanj Tunel to Klanje (sections IpE4 and IpE5 for this direction of travel represent one - the first automatic block section).

This nonconformity of mileages can lead to confusion that the locomotive 661-162 prior to the accident has been located on the first automatic block section. According to the insight on the site and then the photographs made, it can be seen that the locomotive 661-162 stopped after the collision, so that its half was approximately at the location of the automatic block signal E 42, located in the automatic block section IpE3 (the second section from the Ripanj Tunel to Klenje) and it is distant from the isolated structure (traffic-technical boundary of the section) at least 50 m. Given the length of the locomotive 661-162 of 18.5 m, and that after the first contact with the train 2990 it was disengaged 19 m with complete certainty, it can be claimed that the locomotive 661-162 was stopped before the collision in the second isolated section after crossing over the isolated composition for at least 20 m.

5. Measures taken

Based on the data obtained by the letter "IŽS"a.d. No. 1/2019-1094 of 12.04.2019. considering that the Investigation Report submitted by the Joint Investigation Committee of Infrastructure Managers and Undertakings did not determine the responsibility of infrastructure managers, "IŽS"a.d. it did not take any measures after the conclusion of the investigation committee's work.

Based on data received electronically (e-mail dated 12.04.2019. at 14:13), "Srbija Voz"a.d. did not undertake or adopt special preventive or educational measure as a result of the accident according to the Rulebook of Safety Management System "Srbija Voz"a.d. For the train driver who was driving the train No. 2990, the Work Departure Decision was issued and the same was submitted to an emergency medical examination and an extraordinary periodical exam after returning to work.

Based on the data received electronically (e-mail dated 12.04.2019. at 11:43), "Srbija Kargo"a.d. did not take any measures after the conclusion of the investigation committee's work. However, since the investigation revealed that the workers of "Srbija Kargo"a.d did a serious violation of their duties, they were terminated the contract of employment, although the aforementioned work violation was not the direct cause of the accident.

6. Safety recommendations

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

To the Directorate for Railways:

SR_14/19 Directorate for Railways to define in the Rulebook on Technical Requirements for SS Devices ("Official Gazette of RS" No. 18/2016 and 89/2016) electrical parameters describing the technical condition of the track balises.

SR_15/19 Directorate for Railways to define, in addition to the maximum prescribed deadline by which the workers which are working on maintenance, begin eliminating interference or a defect on SS device, to define the maximum allowed duration of interference or a defect on SS devices after which it is necessary to undertake special measures with the aim of returning the device in the designed state, in the Rulebook on maintenance of SS devices ("Official Gazette of RS", No. 80/2015). Taking into account the specificity of each individual case, Directorate for Railways prescribes special measures that are necessary to be undertaken.

SR _16/19 Directorate for Railways that in the Rulebook on maintenance of SS devices "Official Gazette of RS" No. 80/2015) define that monitoring the state of SS devices with the aim of determining their usability and correctness, beside the workers that operate safety-signalling devices, is carried out also by the workers that are maintaining the safety-signalling devices.

„IŽS" a.d.:

SR_17/19 "IŽS" a.d. to perform the procurement and installation of the missing and due to technical malfunctioning of the track off auto-stop devices on the railway section Resnik - Velika Plana, as well as to see the possibility of the installation of the track balises and on other exit signals that are not on the main running tracks.

SR_18/19 "IŽS"a.d. to regularly check and continuously maintain the prescribed distance of the visibility of light signals in accordance with the provisions of Article 15 of the Rulebook on maintenance of the SS devices ("Official Gazette of RS", No. 80/2015).

SR_19/19 "IŽS"a.d. when, due to weather conditions or some other reason, an interruption in the operation of the TK device occurs, it shall dispose stations by the train dispatchers whose signals are considered unusable after the interruption in the operation of the TK device.

SR_20/19 "IŽS"a.d. to form a Human Factor Assessment Team for the Accidental and Incidental Cases in order to make Critical Elements Models (see point 4.2.6.2.), by classifying them according to the importance and ranking list of representation (identification of all risks) in order to work on the prudent structuring of preventive measures and anticipation of human behavior in crises situations in order to reduce the impact on the emergence of new accidents and incidents.

„Srbija Voz" a.d:

SR_21/19 "Srbija Voz" a.d. to perform the quality additional training of the train drivers with the aim of proper handling of traffic regulation in the cases of interferences on SS devices and interferences on communication means.

SR_22/19 "Srbija Voz" a.d. to form a Human Factor Assessment Team for the Accidental and Incidental Cases in order to make Critical Elements Models (see point 4.2.6.2.), by classifying them according to the importance and ranking list of representation (identification of all risks) in order to work on the prudent structuring of preventive measures and anticipation of human behavior in crises situations in order to reduce the impact on the emergence of new accidents and incidents.

„Srbija Kargo" a.d.:

SR_23/19 "Srbija Kargo" a.d**.** to form a Human Factor Assessment Team for the Accidental and Incidental Cases in order to make Critical Elements Models (see point 4.2.6.2.), by classifying them according to the importance and ranking list of representation (identification of all risks) in order to work on the prudent structuring of preventive measures and anticipation of human behavior in crises situations in order to reduce the impact on the emergence of new accidents and incidents.