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

No.: ŽS - 05/17
33 No.: 340-00-10144/2017-20
Date: 18.05.2018.

FINAL REPORT ON SERIOUS ACCIDENT INVESTIGATION

Type of accident:	Serious accident at level crossing
Train no:	4905
Place:	Grdelica, open track between stations Grdelica and Predejane
Date:	09 October 2017
Time:	20:26

This report presents the results of investigation of serious accident, overtaking of the train No. 4905 on the passenger vehicle, occurred on 9 October 2017 at 20:26 h at the main arterial route E70/E85: Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border -Tabanovce, on the level crossing, ensured with the traffic signs on the road and the necessary visibility zone, which is located on the open track between the stations Grdelica and Predejane.

Director of the Center for Investigation of Accidents in Transport of the Republic of Serbia established the Working Group for the investigation of this accident by the Decision 33 No. 340-10144/2017-001 of 16 October 2017.

In accordance with the Article 33 of the Law on Investigation of Air, Rail and Water Traffic Accidents (*"Official Gazette of the RS" No. 66/15*) 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 the 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 and international cooperation carries out tasks within the competence of the Centre for investigation of accidents in traffic in relation to rail traffic with the aim of possible improvement of safety on the railways by issuing safety recommendations. The investigation procedure in the field of railway traffic is conducted on the basis of the provisions of the Law on Investigation of Air, Rail and Water Traffic Accidents (*"Official Gazette of the RS" No. 66/15*).

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

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

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

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

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

Glossary:

CINS	.....	Center for Investigation of Accidents in Transport
IŽS	.....	Serbian Railways Infrastructure
ZJŽ	.....	Community of Yugoslav Railways
JŽ	.....	Yugoslav Railway
RS	.....	Republic of Serbia
a.d.	.....	Join Stock Company
OJ	.....	Organizational Unit
SS	.....	Signaling Safety
APB	.....	Automatic track block
TT	.....	Telephone-Telegraph
TK	.....	Tele-command
RDV	.....	Ground-train radio link
TSI	.....	Technical specification of Interoperability
ŽTP	.....	Railway Transportation Company
ŽTO	.....	Railway Transport Organization
MUP	.....	Ministry of Interior
OJT	.....	Basic Public Prosecutor
ETP	.....	Electro-Technical Affairs
KM	.....	Contact Network
JP	.....	Public Enterprise

C O N T E N T:

1. Summary

1.1. Short description of the accident

On 09 October 2017 at 20:26 on the main arterial routeE 70/E 85: Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), at level crossing ensured with the traffic signs on the road and the necessary visibility zone, which is located on the open track between the stations Gdelica and Predejane at km 304+277, there has been overtaking of the train No. 4905 on the road passenger vehicle of the brand Opel typeAstra1.4/5, registration number LE 058-LR.

1.2. The causes of the accident determined by the investigation

The immediate cause of the accident is that the road vehicle entered onto the track immediately before the arrival of the train, which caused very dangerous situation related to the creation of this accident. The driver of the road vehicle had the possibility to notice on time from the limit of the dangerous area the train arriving.

The main cause is non-compliance with the Law on Traffic Safety on the roads (*"Official Gazette RS" No 41/2009, 53/2010, 101/2011, 32/2013 - decision US, 55/2014, 96/2015 - other laws and 9/2016 - US decision*) by the driver of the road vehicle. The fact that stipulated zone of visibility was not secured, in no way lessens the responsibility of the driver of the road vehicle, because he was obligated to respect the traffic sign *II-2*: "Obligation of stopping", to stop and to make sure if the train is approaching. Given the fact that speedometer with which the locomotive is equipped doesn't note the use of locomotive siren, and that in the statements relating to the use of siren just before the accident, there is a certain discrepancy, it cannot be determined with certainty whether the train driver had used the aspect of a signal 67: "Watch out", according to provisions of the Signaling Rulebook ("Official Gazette ZJŽ" No.4/96 and No.5/96). Not giving this aspect of a signal according to provisions of the Signaling Rulebook could cause this accident.

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

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

To the Ministry of Construction, Transport and Infrastructure:

SR_09/18 Ministry of Construction, Transport and Infrastructure should adjust the Rulebook on the mode of crossing the railway line and the road, pedestrian or bicycle path, a place where you can carry out the intersection and measures for ensuring safe traffic ("Official Gazette RS" No. 89/2016) with actual performances of the road vehicles (in the manner of adjustment by some countries in the region) and the actual state of the railway infrastructure. It is necessary to determine whether the speed of the road vehicle over the crossing which is used in this calculations by this Rulebook, and which amounts to 4 km/h is suitable for the actual performances of the rolling stock, or if this speed should be enlarged (for example, in the Republic of Slovenia the speed is 7 km/h). With the speed of 4 km/h, the large number of crossings cannot satisfy the minimal required zone of visibility that the Rulebook predicts.

Explanation for the Article 11 of the Rulebook, which is given in the Article 12, and which states:
"By securing the necessary zone of visibility from the Article 11 of this Rulebook, the participants in the road traffic are enabled with uninterrupted visibility on the railway track with both sides of the road, pedestrian or bicycle path, for noticing on time of the upcoming railway vehicles on the track so that they could stop the vehicle and stop the moving of the pedestrians or bicycles before they come to the railway, that is, in front of the traffic sign that indicates the point where the road comes over the railway track at the railway level" would make sense only in the case that in front of the crossing there is no traffic sign *II-2*:"The obligation of stopping". Situation on site confirms that the traffic sign *II-2*:"Obligation of stopping", exists on all the crossings with passive signalization, which we consider absolutely necessary.

In the expression:

$$t_a = \frac{m + n + d + s}{V_p} \cdot 3{,}6 \quad [s]$$

In front of ***s*** should stand a sign„-" , and not the sign„+" (see Fig. 3.4.2).

„IŽS"a.d:

SR_10/18 „IŽS"a.d. that given the existence of construction facilities, not even from the limit of dangerous area it is not possible to provide the necessary visibility in all directions, to consider introduction of active signaling, or to solve the problem in another way.

SR_11/18 „IŽS"a.d. to perform the expert- based risk assessment on the crossing. Having in mind that the accidents on the crossing (viewing them individually) are rare events, the risk evaluation cannot be done solely on the number of accidents that had happened on some crossings. The risk assessment should be done, as a measure of precaution, for all the crossing according to all the relevant parameters, whether there were accidents on them or not.

SR_12/18 „IŽS"a.d. that during the conduction of investigation of traffic accidents on the crossings, research committees should pay more attention to collecting relevant data, so that all the possible causes of the accident could be established, and with the goal of applying suitable measures.

SR_13/18 „IŽS"a.d. to do the act of "Programme for resolution of the level crossings" according to previously finished risk assessment, with the goal of taking certain actions to raise the level of safety in traffic.

„Srbija voz"a.d.:

SR_14/18 **„**Srbija voz"a.d. that during the conduction of investigation of traffic accidents on the crossings, research committees should pay more attention to collecting relevant data, so that all the possible causes of the accident could be established, and with the goal of applying suitable measures.

2. Direct facts about the accident

2.1. Basic accident data

2.1.1. Date, time and place of the accident

On 09 October 2017 at20:26 in the area of the settlement Gornje polje, at the main arterial route E 70/E 85: Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), on the open track between the stations Grdelica and Predejane, at km 304+277, on the level crossing secured with traffic signs on the road and with the zone of necessary visibility.

The view of the serious accident site is shown in the Fig. 2.1.1.1.

Fig.2.1.1.1: The view of the serious accident site (*Google maps*)

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

Level crossing in the settlement Gornje polje is located on the open railway track between the stations Grdelica and Predejane. It is secured with the traffic signs on the road and the zone of necessary visibility.

The road vehicle of the brand Opel type Astra 1.4/5 registration number LE 058-LR was moving the uncategorized road from the direction of Grdelica to the settlement Oraovica. By coming to the level crossing at km 304+277, the vehicle did not stop in front of the crossing, but continued to move and in the area of the level crossing has entered the profile of the track just before the train arrived.

The train No. 4905 was moving the main arterial road E 70/E 85: Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), from the direction of station Grdelica to the station Predejane. The train operated regularly, on the route Niš - Preševo. Viewed from the direction of driving, the train consisted of: locomotive 441-746 and two wagons of series B (wagon No. 51 72 2071 003-5 and No. 50 72 2076 012-2).

After being at the station Grdelica because of the needs of the passengers, the train No. 4905 was dispatched from the station Grdelica to the station Predejane. Moving towards the open track to the station Predejane, there has been overtaking of the train to the road vehicle, which just before the train arrived, has entered the profile of the railway track. Overtaking occurred so that the right part of the forehead of train locomotive struck the right port side of the road vehicle (as seen in the direction of moving of the train or road vehicle).

After the overtaking, the train continued moving at length of 129 m, after which it stopped, so that the forehead of the locomotive was found at km 304+406. On that occasion, the train pushed the road vehicle out of the track in right, viewed from the direction of moving of the train, i.e. in the direction of the growing mileage of the track. The vehicle was found at the right part of the track (viewed from the direction of the growing mileage) at 13,5 m from the crossing.

In the train, based on the judgment of a conductor, at the moment of the serious accident, there were 7 passengers.

In this serious accident, one person is dead, and one is injured.

On site of the accident came out members of Police from the Police Administration Leskovac, duty prosecutor of OJT Leskovac and Medical Service Team of the Health Center Leskovac, Department of Grdelica.

Due to the aforementioned serious accident, there was an interruption of traffic between station Grdelica and Predejane. The interruption of traffic lasted until 23:05, when it was normalized.

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

CINS was not informed immediately after the occurence of the serious accident, but (after four days). The main investigator for railway traffic received the first notification on the serious accident on 13 October 2017 at 11:12 electronically from Assistant Director of the Sector for operations of "IŽS"a.d. Based on the information and facts received, and facts concluded by additional visit of investigating team to the place of the accident, CINS launched the investigation of the accident in accordance with the Law on Investigation of Air, Rail and Water Traffic Accidents ("*Official Gazette of the RS" No. 66/15*).

Composition of the working group for the accident investigation was determined by the Decision 33 No. 340-10144/2017-001 of the Director of CINS, from 16 October 2017 and according to articles 6 and 32 of the Law on Investigation of Air, Rail and Water Traffic Accidents (*"Official Gazette of the RS" No. 66/15*).

2.2. Accident background

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

Train driver and conductor of the train No. 4905, employed at railway undertaking "Srbija Voz"a.d., train driver at the Section for Traction Niš, OJ for Traction Niš and conductors at Section for Traffic-commerical affairs Niš are involved in the serious accident.

Two other persons are involved in this accident, the driver of road vehicle of the brand Opel type Astra 1.4/5, registration number LE 058-LR, and the person who was the co-driver.

Staff of the railway infrastructure manager "IŽS"a.d. was not involved in the accident.

2.2.2. Train and road vehicle involved in the accident and their composition

The train No. 4095 and road passenger vehicle of brand Opel type Astra 1.4-5, registration number LE O58-LR participated in the accident.

The train, viewed from the direction of moving, consisted of: locomotive 441-746 and two wagons of series B (wagon No. 51 72 2071 003-5 and No. 50 72 2076 012-2).

Raod passanger vehicle of brand Opel type Astra1.4-5 is a compact passanger of C segment, for transport of persons, of approximate dimensions: lenght 4,2 m, width 1,7 mand height 1,4 m.

2.2.3. Infrastructure and signaling system

Main arterial route E 70/E 85: Belgrade - Mladenovac - Niš - Preševo - state border - (Tabanovce) between stations Niš and Preševo is a onetrack line. The maximum speed at the section between stations Grdelica and Predejane, according to the timetable booklet 9.3, is 50 km/h.

Part of the section between stations Medjurovo and Preševo is equipped with APB devices, which is set on the devices TK at TK centre Niš at which the traffic of the trains is regulated in block sections.

For the purpose of the traffic regulation, on the section of the railway line between the station Medjurovo and Preševo, spatial and protective signals that show two-way signs were installed.

Road crossing at the level at the *km* 304+277 (mileage according to the data provided by the Sector of construction affairs IZS a.d.) represents the point of crossing of arterial route *E 70/E 85* and uncategorized road who leads from Grdelica to setllements Gornje polje, Graovo and Oraovica (mark for the line is taken from the Regulation on the categorization of lines).

View of the crossing, as seen from the road is shown in the Fig. 2.2.3.1. and 2.2.3.2.

Fig. 2.2.3.1: The view of the crossing (view from the direction of Grdelica center)

Fig. 2.2.3.2: The view of the crossing (view from the direction of the settlement Oraovica)

On the respective uncategorized road, from the direction of center of Grdelica, just before coming to the crossing, on the carrier which is located at right from the road, the following traffic signs are set I-33: "Crossing of the road with the railway track without half-barriers and barriers" and I-35: "Approaching the point of crossing of the road and the railway track". On the clearance gate, which is located on 12,80 m from the near track of the railway, the traffic signs are set II-21: "Forbidden driving for vehicles whose summarized height is over the certain height" (height of 4,5 m, set over the road) and II-30: "The speed limit" (10km/h, set next to the road on the carrier of the clearance gate. On special carrier next to the road, 1,96 m away from the nearest track, traffic signs are set: "Andreja's cross" and II-2 "The obligation of stopping".

From the direction of settlement Oraovica, before coming to the crossing, on the clearance gate, which is 9,10 m away from the nearest track of the railway, the traffic signs: II-21 are set: "Forbidden driving for vehicles whose summarized height is over the certain height" (4,5 m, set above the road) and II-30 "The speed limit" (10 km/h, set next to the road, on the carrier of the clearance gate). On special carrier which is next to the road 2,13 m from the nearest track, the traffic signs have been set: I-34: "Andreja's cross" and II-2: "Obligation of stopping".

On the aforementioned uncategorized road, at both sides of the railway, there is no separation line. There aren't any signs on the road (longitudinal, transversal and other).

Near the crossing, the road on the uncategorized road is asphalt road. The width of the road on the right side of the crossing, viewed from the direction of the growing mileage of the track, is 3,60 m, and on the left side is 3,80 m. On the joint of wooden sleepers on the crossing and the asphalt road, on the right side of the crossing, viewed from the direction of growing mileage of the track, two smaller damages are noticed on the asphalt. On the left side of the crossing, viewed from the direction of growing mileage of the track, at length of approximately 7 m in the direction to the center of Grdelica, the damages in the form of "coronation" of asphalt have been noticed, under which the basis of the road is visible. Other damages on the road near the crossing have not been noticed. The noticed damages are shown in Fig. 2.2.3.3. and 2.2.3.4.

Fig 2.2.3.3: The view of the damage on the road

Fig 2.2.3.4: The view of the damage on the road

Local uncategorized road from the direction of Grdelica to the respective crossing is at rise**,** and from the direction Oraovica to the crossing in slight fall. The road at mere crossing is horizontal.

Viewed from the direction of the growing mileage (from the direction of the station Grdelica to the station Predejane) before coming to the respective crossing, the track is in line at length of 1037 m (from km 303+135 to km 304+172), after which, at km 304+172 the curve starts of the

radius R=1000 m and length l=391 m (from km 304+172 to km 304+563), behind which the track is again in line at length of 997 m (from km 304+563 to km 305+560).

Respective crossing is located at km 304+277, on the part of the circular curve, 105 *m* away from the beginning of the curve, viewed from the direction of the growing mileage. Grade of the track on the crossing is 0,44‰.

Angle of the crossing of the railway and the road is 90°. The width of a level crossing is 5,20 m, and the surface 31,20 m^2. The road structure at the level crossing is made of wooden sleepers. State of wooden sleepers is orderly, with no damages.

On the line before the arrival at the present crossing, signalling mark 209: "Watch out the crossing" from the direction of the station Grdelica to the station Predejane at km 303+774 and from the direction of the station Predejane to the station Grdelica at km 304+787 are built (mileage is determined according to mileage printed on the catenary support).

On the left side of the track, between the stations Grdelica and Predejane, viewed in the direction of increasing mileage, in front of the level crossing, there is a brick facility, a railway guard. The building is away from the left rail 4,23 m, and from the right edge of uncategorized road, viewed from the direction of Grdelica to the village Oraovica, away 3,70 m. In front of the facility, there is a fence made of woven wire, away from the left rail 2,86 m, and from the right edge of the road 1,30 m.

The view of the brick facility is shown in Fig. 2.2.3.5.and 2.2.3.6.

Fig. 2.2.3.5: The view of the facility- the guard

Fig. 2.2.3.6: The view of the facility-the guard

On the part of the railway between the respective level crossing (km 304+277) and the catenary support No. 34 (km 304+398), on the right side of the track, viewed in the direction of increasing mileage, in parallel with the track there is located on the access macadam road, which flows in the local uncategorized road Grdelica - Oraovica. The macadam road is in the infrastructure zone and leads to housing and ancillary facilities (house), which are on the right side of the macadam road, i.e. on the right side of the track. As part of the aforementioned housing and the auxiliary facilities, orchard and other seeds are found.

Housing and additional facility, orchard and vegetation are located from the respective level crossing in the direction towards the station Predejane at length of about 120 m and in part are

located in the infrastructure zone (from the right rail of the railway line closest parts of the premises and vegetation are located about 10 m).

Appearance of housing and ancillary facilities, lower trees and orchard is shown in Figures 2.2.3.7, 2.2.3.8, 2.2.3.9. and 2.2.3.10.

In abovementioned whole excels built housing facility (in Figs. 2.2.3.7,2.2.3.9 and 2.2.3.10. marked with an arrow), positioned so that the distance from the right rail of the railway track and the proximal end of the facility is 12 m.

Described housing and ancillary facilities, orchard and other plants are positioned so that when viewed from the direction of the level crossing to stop Predejane, form a single unit which prevents the view from the level crossing to the rail track and from the track to the crossing.

Fig. 2.2.3.7: The view of the access macadam road, the facility and the vegetation on the right side of the track

Fig. 2.2.3.8: The view of the access macadam road and the vegetation on the right side of the track

Fig. 2.2.3.9: The view of facility on the right side of the track

Fig. 2.2.3.10: The view of facility, orchard and the vegetation on the right side of the track

On the same side of the track (right, as viewed in the direction of increasing mileage) behind the described whole, on the part of railway between catenary support No. 34 (at km 304+398) and

No. 35 (at km 304+453) in infrastructure zone there are four large trees, whose crown prevent visibility of the level crossing on the railroad, and vice versa, from the track at the crossing. The trees, seen in the direction of increasing mileage, away from the railroad tracks right as follows: the first tree at 18,9 m, another tree to 11,4 m, the third tree on 13,0 m, fourth at 16,0 m.

At the same place, out of the infrastructure zone, at the distance between 25 and 30 m, there are two brick residential facilities - houses. The houses are positioned so that the aforementioned trees are located between the house and the railway.

The view of the trees and the facilities is shown in Fig. 2.2.3.11 and 2.2.3.12.

Fig. 2.2.3.11: The view of the trees and the facilities on the right part of the track

Fig. 2.2.3.12: The view of the trees and the facilities on the right part of the track

The spatial distribution and impact on visibility of the described facilities and plants located on the right side of the track, is shown in Figure 2.2.3.13

Fig. 2.2.3.13: Satellite video of the area of the crossing (source: *Google maps*)

2.2.4. Communication tools

On the section between the stations Grdelica and Predejane, communication between personnel in charge of traffic regulation and the personnel in traction vehicles is performed by

phone via local TT connection. The line of communication includes all official locations on the line and telephones alongside all the main signals and TK Dispatcher at the position TK “Jug“ at TK centre Niš. Communication on this line is recorded on the register device located in the ETP Section Niš, so this type of communication is considered as evidence-based communication.

This line is equipped with RDV devices, which are working and which enables the communication between the personnel in locomotive and TK Dispatcher. Communication performed by the RDV is recorded on the register device situated in TT section Niš, so this type of communication is considered as evidence-based communication.

For communication at TT Centre Niš, at the position of Senior Dispatcher, the stable line is working, which is connected on registerphone device which is at the ETP Section Niš, so this type of communication is considered as evidence-based communication.

2.2.5. Works at or near the accident site

No works were performed near the accident site.

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

Infrastructure Manager "IŽS"a.d informed CINS, i.e., the Main investigator for railway traffic afterwards, i.e. four days after the serious accident. The Railway Infrastructure Manager "IŽS"a.d and railway undertaking "Srbija Voz"a.d, established a joint investigation committee that conducted an investigation of the accident in accordance with applicable regulations. Upon completion of the investigation, the Investigation Report U-478/17 was drafted.

Given the fact that at the moment of the serious accident in the train No. 4905 there were 7 passangers present, conductors have immediately given them information on the new occasion. All of the passengers remained in the train, and after that continued their journey.

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

Due to this serious accident, memebers of the Police Station Leskovac were hired, OJT Leksovac and members of the Health Centre Leskovac, Department Grdelica.

At 20:30 a nurse from the Department Grdelica of Health Center was informed via telephone on the serious accident on the crossing by the persons whose house is near the crossing. The team of two nurses with the driver of the sanitary vehicle came on site.

The first injured party (co-driver in road vehicle) was brought on a stretcher, restless, disoriented, confused with signs of severe polytrauma. Because of his unrestness the team failed in an attempt to secure venous access, but urgently, without removal from the ambulance, escorted by nurses, transfered to Department of Urgent Medicine of the General Hospital Leskovac. Considering that the injuries collectively constitute life-threatening serious bodily injury, it is because of the nature and extensiveness it ended in death.

The other injured party (the driver in road vehicle) after the arrival of the ambulance just came out of it, conscious and oriented, with small cuts on his face and hands, complained of pains in the chest and the right shoulder. With the same vehicle, and he was transfered to the Department of

Urgent Medicine of the General Hospital Leskovac. The team which transported them came back at 22:00

MUP RS, Police Department, Police Department in Leskovac, the Department of Traffic Police, Traffic Police office of Leskovac on 09 October 2017 at 20:30 received notification of an accident occurred. Upon receipt of a notification, the police came to the site in 21:00 and started its investigation. Site investigation was completed at 22:15.

2.3. Dead, injured and material damage

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

In this accident one person died and one is seriously injured. The dead and the injured were in the road vehicle.

Among passengers of train and staff there were no dead or injured.

Fig. 2.3.1.1: The view of the dead and injured persons

	Passengers	Railway staff	Third parties	Summary
Dead	-	-	1	1
Seriously injured	-	-	1	1
Lightly injured	-	-	-	-

2.3.2. Goods, luggage and other assets

In this serious accident there was no damage to goods, luggage and other property of the railway vehicle. There are damages on the road vehicle. The damage on road vehicle, upon estimation, is 300 000,00 RSD.

According to the official middle exchange rate of the National Bank of Serbia on 9 October 2017, which is 1 EUR (Evro) = 119,1859 RSD (Dinars), the total material damage caused in the respective serious accident amounts to 2 517,08 Euro (EUR).

The material damage in this report is based on documents, delivered by OJT Leskovac, that confirm the stated damage amounts.

2.3.3. Railway cars, infrastructure and environment

In the respective serious accident the railway vehicles (locomotive 441-746) were damaged. On infrastructure installations there were no damages.

The structure of the material damage is as follows:

Concerning locomotive 441-746:	**96 376,00**	RSD
Total direct material damage:	**838 020,56**	**RSD**

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

According to the official middle exchange rate of the National Bank of Serbia on 9 October 2017, which is 1 EUR (Evro) = 119,1859 RSD (Dinars), the total material damage caused in the respective serious accident amounts to 808,92 Euro (EUR).

The material damage in this report is stated based on documents submitted by “Srbija Voz“a.d that confirm the stated damage amounts.

2.3.4. External conditions - weather conditions and geographic characteristics

The site of serious accident is located in the area of Grdelica (city Leskovac), on the section located in geographically plain terrain.

The geographic coordinates of the place of accident are: 42º 52' 56,49" N и 22º 4' 44,82"E.

Section on which there is a level crossing is in the curve of radius R=1000 m and in grade of 0,44‰ (rise, viewed from the direction of train driving).

At the time of the accident, it was night, the sky was clear and without any wind. There were no fog nor precipitation. Vision was not impaired by anything, except the usual conditions of exploitation at night. The air temperature was 6°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:

- Additional onsite examination conducted by the Investigation Team for Railway Traffic from CINS
- Materials delivered by the infrastructure manager “IŽS“a.d.;
- Materials delivered by the railway undertaking ”Srbija Voz”a.d.;
- Materials delivered by Health Centre Leskovac;
- Materials delivered by OJT Leskovac.

The investigation of the accident on site and the investigation were done by a joint investigation committee of the infrastructure manager “IŽS“a.d. and the railway undertaking “Srbija Voz“a.d.

Members of Police Station Leskovac conducted the investigation on site.

3.1. Summary of the testimonies

Written statements of “Srbija Voz”a.d. were obtained as well as Reports on irregularities in the train driver’s (EV-38) and conductor’s (K-91) work in the train No. 4905.

3.1.1. Railway staff

Train driver stated: „after the departure of the train after stopping at the station Grdelica, I rode the train properly, in accordance with the timetable booklet 9.3. Shortly before the arrival of the train at the present level crossing, on several occasions, I was giving the aspect of a signal: "Watch out". Upon arrival at the same level crossing, at about 10 m in front of the train encountered the respective vehicle. Overtaking of the passenger train on the vehicle was inevitable. I immediately activated the device for quickly braking, that after the collision and hit at the same (road vehicle) it stopped after 100 to 150 m. I immediately informed the dispatcher on duty through the RDV of locomotive 441-746. I came down from locomotive and approached the

spot. On the car, which was lying on its roof, the headlights were still on. At the moment of arrival at the site, the driver of the passenger vehicle was already out of the car, and people from nearby houses had taken out the co-driver from passenger car. Soon, on the site the police and ambulance came“.

The conductor I stated: "before the occurrence of the accident, after giving the aspect of a signal: "Ready for departure" and since no one had entered the train station Grdelica, me and colleague moved to compartment. Soon after that, I heard a siren from the locomotive, which was followed by braking of the train. The train stopped. I was going forward, through the car, to the train driver to ask why he stopped. When I opened the door, I saw the train driver who went to the end of the train. He told me that we had hit the car. Since the police from escort of the train had already left to the accident site, I stayed on the train for counting passengers and providing reports to superiors. At the moment of the accident in the train there were seven passengers. My colleague and I informed verbally the passengers about the event, passing through the train, that the train will not soon start due to the investigation. All passengers remained on the train after the completion of the investigation and continued traveling, so there was no need for evacuation“.

Conductor II stated: "before the occurrence of the accident, after giving the aspect of a signal: "Ready for departure" and since no one had entered the train station Grdelica, me and colleague moved into the compartment. Shortly after that, I heard a siren from the locomotive, which was followed by the train braking. The train stopped. From the window of the wagon I saw that there was an accident, I saw the overturned passenger car. Since it was dark, I saw the headlights of the car that were still on. A colleague and I stayed on the train, while the policemen escorting the train (there were two of them) went to the site. At the moment of the accident in the train there were seven passengers. By passing through the train, we informed the passengers about the event and the train will not start soon due to the investigation. All the passengers remained on the train after the completion of the investigation and continued traveling, so there was no need to evacuate“.

Reports on irregularities during operation that, one conductor (K-91), and train driver (EV - 38) delivered were sent to CINS. The delivered Reports on irregularities during operation and statements that conductors and train driver gave after the respective accident do not coincide in all relevant facts.

It is unacceptable, and it happened in this case, that during investigation, the statement of one conductor is given by copying the statement of the other conductor, by which the statement differs from what the conductor has written in the Report on irregularities (K-91).

From „IŽS“a.d. the Report on Irregularities during operation (S-23) delivered from TK dispatcher from TK Center Niš, who was in charge during the respective accident (the staff that regulates the traffic on the section), was submitted.

Report on Irregularities during operation (S-23) which was delivered by TK dispatcher at TK Centre Niš about the respective accident coincides in all the relevant facts with the statement of the train driver.

3.1.2. Other witnesses

The witnesses of this serious accident (passengers in the train No. 4095 and third parties) were not interviewed and no statements were obtained from them.

3.2. Safety Management System

3.2.1. Organisational frame and manner of issuing and executing orders

According to the Safety Management System Manual, ”IŽS“a.d. didnt inform all interested parties on the accident. IŽS a.d. informed CINS, that is, the Main Investigator for Railway Traffic four days after the occurrence of the serious accident. At the request of CINS, explained by the "IŽS" a.d. that untimely reporting of the respective accident occurred due to personnel changes within the Department responsible for reporting on accidents and incidents, and that they are informed and advised of the proper functioning of how such flaws would not occur in the future.

Railway infrastructure manager ”IŽS“a.d. and the railway undertaking ”Srbija Voz”a.d., according to the Law on railway safety and interoperability (”*Official Gazette RS No. 104/13, 66/15 - other law and 92/15*), established a joint investigating committee that carried out an investigation of the event. After the investigation, they drafted a Report on investigation U-478/17.

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

”Srbija Voz”a.d. insured through its Safety Management System (SMS) management of competencies, i.e, the process that all the employees participating directly in railway traffic are trained and competent, as well as the planning of the work load.

Regarding the respective accident, where the train driver and the conductor employed in ”Srbija Voz”a.d were involved, all the activities related to the professional training, competencies and the planning of working time were carried out in accordance with applicable regulations.

3.2.3. Procedures for internal audits and controls and their results

”Srbija Voz”a.d, as a railway operator has established Safety Management System. The general purpose of the Safety Management System (SMS) is to ensure that ”Srbija Voz”a.d. achieve its business objectives in a safe way.

Rolling stock must maintain the prescribed technical level of accuracy and must follow the maintenance plans (*EV-62*) and its cycles of control and technical inspections and execution of regular repairs, in order to be as reliable as possible in traffic, in accordance with the Rulebook on rolling stock maintenance and other laws and by-laws being part of the Safety Management System of ”Srbija Voz“a.d.

Regarding respective accident, regular and additonal maintenance, was done according to the valid regulations.

”IŽS“a.d. as an Infrastructure Manager has Safety Management Manual. It includes organization and all the procedures and activities done by ”IŽS“a.d. for the safe railway traffic.

Risk Management related to maintenance of railway infrastructure (subsystems infrastructure, energy, control, management and signalling-railway part) and railway vehicles that ”IŽS“a.d. uses for maintenance is based on application of defined activities of regular and additional maintenance and their tracking and control. Regular and additonal maintenance includes regular supervision, controls, checks, repairs.

Requests, standard and activities for maintenace of ”IŽS“a.d. were based on regulation, general and individual documents, instructions of manufacturers and standards.

Regarding respective accident, maintenance of crossings was not done according to valid regulation, in part that relates to the maintenance of the track and removing of vegetation at the track zone, as well as not applying the measures that would ensure the necessary zone of visibility.

3.3. Relevant international and national regulations

3.3.1. Law on Traffic Safety on the Roads (*"Official Gazette RS" No. 41/2009, 53/2010, 101/2011, 32/2013 – decision US, 55/2014, 96/2015 – Other laws and 9/2016 - decision US*

23. Traffic on the crossing over the railway

Article 100:

On crossing over the railway, the driver is obligated to pass the train vehicle move on the railway.

The driver who approaches the crossing over the railway is obligated to set the speed of the vehicle so that it can stop it in front of the device for closing of traffic on the crossing or in front of the device for giving signs to inform of the train approaching, i.e. that it can stop the vehicle before it comes on the railway.

3.3.2. Law on Railway (*"Official Gazette RS" No. /2013 and 91/2015*)

Article 8.

Infrastructure Manager makes the program of maintenance of railway infrastructure, organization and regulation of rail transport, as well as construction and reconstruction of railway infrastructure, approved by the Government.

Article 14, Paragraph 1:

Infrastructure Manager is required to provide a permanent, continuous and quality maintenance and protection of the railway infrastructure, uninterrupted use of railway infrastructure facilities and other devices for rail traffic, as well as the organization and regulation of safe and smooth rail transportation.

3.3.3. Law on Railway Safety and Interoperability (*"Official Gazette of RS" No. 104/2013, 66/2015 – other laws and 92/2015*)

Devices and traction vehicles gear, Article 78. (extract):

Locomotive must possess:

...

8) device for sound signalling;

...

3.3.4. Rulebook on the manner of crossing the railway and road, pedestrain or bicycle path, the point where the intersection can be done and the measures to secure the safe traffic (*"Official Gazette of RS" No. 89/2016*)

Article11.

Traffic signs on the way and zone of necessary visibility shall be providing traffic at the crossing of the railway and the road at the level of the tracks, if the maximum speed on the railway is up to 100 km/h, unless the security of traffic on the road crossing is not done as foreseen in Article 10 . Paragraph 2 point. 2) -4) of this Rulebook.

Article 12.

Security zone needed for visibility referred to in Article 11 of this Rulebook, the participants in road traffic are enabled unhindered and uninterrupted view of the railway line on both sides of the road, pedestrian and bike paths, for timely identification of the approaching railway vehicles on the track so they can stop a road vehicle and interrupt pedestrians or bike before taking the railway line, or in front of a road sign that marks the spot where the road crosses the railway tracks at the tracks level.

Article 13.

Zone of required visibility on the level crossing is measured along the axis of the railway line from its cutting with the axis of the road to one and the other side of the railway and along the axis of the road from its cutting to the axis of the railway line to the one and to the other side of the road, as shown by the determination of the zone of required visibility for road vehicles in Appendix 6, which is enclosed herewith as an integral part (hereinafter referred to as Appendix 6).

Size of the zone of necessary visibility is determined by the maximum permitted speed on the railway line so as to ensure that road vehicles can be promptly and safely stopped in front of a road sign that signals the crossing the railway line and the road or that road vehicles can safely finish started crossing railway tracks.

In the area of the necessary visibility the facilities cannot be built, items and materials cannot be left and there cannot exist vegetation that could impede visibility and cannot perform actions that impede the transparency of the railway line from the road. Size of the zone of visibility cannot be a reason for reducing the maximum permitted speed on the railway line. Maintaining of the necessary visibility zone is carried out in a part of the zone railway and the necessary visibility zone outside the railway zone.

The height of the zone of the necessary visibility covers the space ranges between 1,0 and 2,5 m above the level measured by the pavement, over a point on the path of that participant on the road should have a smooth and uninterrupted point of view of the required line of sight to the railway line, as well as space above the required visibility of the railway line, in the amount between 1,5 to 4 m as measured above the top of the rails of the railway line.

Article 14.

The necessary visibility is determined according to the formula:

$$L_{ppp} = AS = SC = t_{pdv}\frac{V_{\check{z}}}{3{,}6} \quad [m]$$

where:

L_{ppp} – the length of necessary visibility from the road to the railway (m);

t_{pdv} – the total period needed that the road vehicle of the greatest permitted length departs from the point B (point in front of the road sign, which indicates the place where the road is passing over the railway line) and its rear part to cross the border of free profile of the railway line on the other side of the level crossing (an imaginary line L is perpendicular to the axis of the road) (s);

$V_{ž}$ – the greatest permitted speed on the railway in the zone of the crossing (km/h).

The total time it takes for the road vehicle of maximum permissible length to pass through the level of the crossing area, or size " t_{pdv} " is determined by the:

$$t_{pdv} = t_a + t_v \quad [s]$$

where:

t_a – the time it takes for the road vehicle after starting to achieve Vp = 4 km/h with the assumed uniformly accelerated motion (*s*);

t_v – time of driving of the road vehicle from reaching Vp to crossing the line l with the rear part(*s*).

Time necessary that the road vehicle after starting reach the Vp, i.e. the size „t_a" is determined according to:

$$t_a = \frac{V_p}{3{,}6 \cdot a} \quad [s]$$

where:

V_p = 4 km/h – the speed of the road vehicle on the crossing;

a = 1 m/s^2 – acceleration of a road vehicle (from the initiation of point B to the point of achieving V_p).

During driving of a road vehicle from achieving Vp to the shift of line *l* with rear portion (s) or the size "t_v" is defined according to:

$$t_a = \frac{m + n + d + s}{V_p} \cdot 3{,}6 \quad [s]$$

where:

m – distance of a road sign which indicates the place where the road is passing over the railway line from the axis of the railway line, measured along the axis of road (m);

n – distance of the line L from the axis of the railway line, measured along the axis of the road (m);

d – the maximum length of the vehicle which is 25 (m);

s – the path that a road vehicle yarns starting from point B to achieving Vp (m);

V_p – the speed of the road vehicle on the crossing.

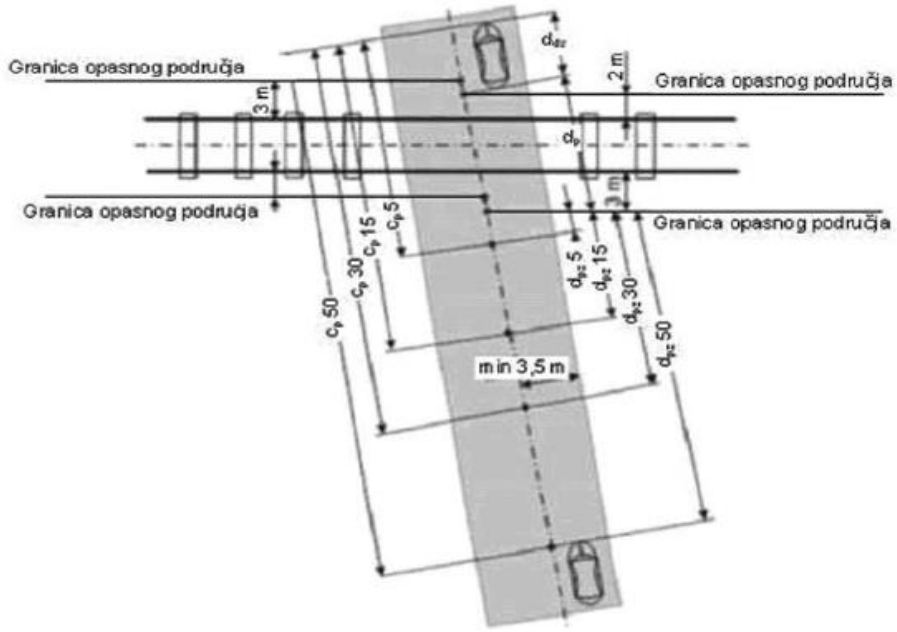
If on the road that crosses the railway line length of road vehicle is limited in length or greater length, then that restricted or increased length of road vehicle taken as authoritative for the calculation.

Article 15.

On the road in front of the level crossing is set a traffic speed limit sign, which represents the transition from the necessary visibility level crossing.

Traffic speed limit sign is placed in the location of the road where the necessary visibility zone starts (point B) in the stopping distance of a road vehicle, determined in Appendix 5, Appendix 6 and Appendix 7, which are attached to this Rulebook and are its integral part.

Appendix 5: Zone of the crossing over the railway on the level crossing

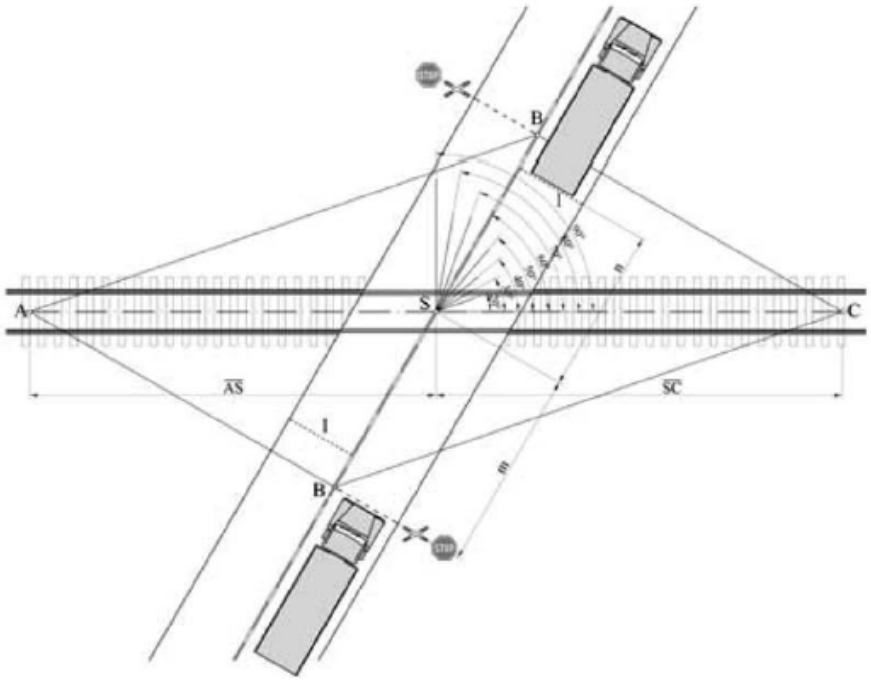


Where:

Z_p – Zone of crossing the road over the railway level crossing is a part of the way, from the point of which the driver of road vehicle should start braking so that the vehicle can safely stop before the traffic sign that indicates a place of the road crossing over the railway line, to the place where the longest road vehicle, with the most exposed part of the rear, crosses the level of the crossing zone and leave the dangerous area boundary on the side of the departure of the level crossing, which is: $Z_p=d_{pz}+d_{dv}+d_p$ (m);

t_{zp} – the time required for a road vehicle to leave safely the zone of transition. Time "t_{zp}" is calculated on the basis of the sum of the length of the stopping distance of a road vehicle "d_{pz}", the length of the longest vehicles "d_{dv}" and the length of level crossing "d_p", with respect to the speed of road vehicles: $t_{zp}=Z_p/V_{dv}$ (s), wherein "t_{zp}" is the time of leaving the zone of the level crossing, "Z_p" zone crossing of level crossing in meters and "V_{dv}" speed of the road vehicle expressed in" m/s". The minimum time required for a road vehicle to leave safely the zone of the level crossing "t_{zp}" is calculated based on the sum of the length of the stopping of the road vehicle, which is 5 m, the length of the longest road vehicle "d_{dv}" and length of the level crossing "d_p" with respect to speed of road vehicle is 5 km/h (1.38 m/s): $t_{zp}=Z_p/1{,}38$ (s), wherein: "t_{zp}" is the time of leaving the zone of level crossing in meters for the speed of road vehicles 5 km/h. Indices 50, 30, 15 and 5 indicate speed of driving of the road vehicle in km/h.

Appendix 6: The zone of necessary visibility on the crossing of the road over the railway (road crossing):

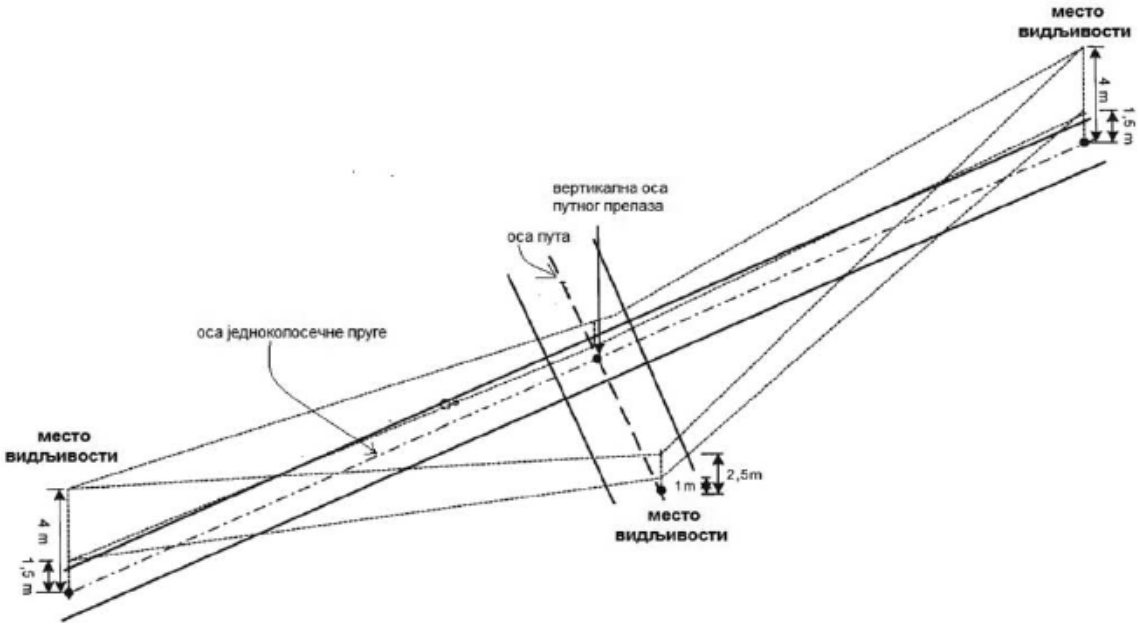


Where:

B – Place on the road from which the participant in road traffic, must when approaching the level crossing, due to the speed limit on the road, have a continuous overview to the point of visibility on the track at point A and C. Point of the visibility from the road on the railway is the length of the stopping distance of road vehicle before the traffic sign that indicates a place of crossing the road over the railway;

A and C – Point of visibility on the track away from the level crossing, at which a participant in road traffic must, from the point of visibility on the road at the point B, confidentially see the rail vehicle coming on the track and to stop the road vehicle before the traffic sign which represents the place of crossing the road over the railway. The point of visibility is determined by calculating the road of approaching the rail vehicle.

Appendix 7: Three-dimensional view of the zone of necessary visibility on the crossing over the railway:



3.3.5. Signaling Rulebook („*Official Gazette of ZJŽ"No.4/96 and No.5/96*)

Department V: Aspect of signals of train manning and sedentary staff

Aspect of signal of staff of traction vehicle

Article 29. (extract):

A. Basic provisions. Aspect of signals

1. By aspect of signals the staff of traction vehicles gives the necessary information and orders for trains and alerts the train staff, cellular and railway staff, and in some cases to other persons.

...

2. Aspect of signal of traction vehicle gives the train driver by using the siren of traction vehicle.

3. Aspect of signal 67: "Watch out", one long sound: ————

...

Б. The purpose and use of aspect of signals

11. Aspect of signal 67: "Watch out" gives the train driver

- for all the trains:

...

в) in front of the signaling mark “Track warning“ and according to the provisions of paragraph 5 of Article 46 of this Rulebook;

...

к) before each level crossings, higher notch, bridge and other large structures that prevent vision;

...

Track warnings

Article 46 (extract)

...

5. Signalling mark 209: “Watch out the crossing“ warns the train driver that at this sign he has to give aspect of a signal 67: “Watch out“ and repeat it several times until coming to the crossing, for alerting the participants of the road traffic that the train is approaching the crossing.

...

3.4. Functioning of railway vehicles and technical installations

3.4.1. Control, command and signaling

On the section between the station Grdelica and Predejane the devices for control, command and signaling were operating and functional.

3.4.2. Infrastructure

State of infrastructure (in terms of state of track and installations) on the section between stations Grdelica and Predejane was neat and in that sense, there were no irregularities that could adversely affect the safety of railway traffic.

On the main arterial route E70/E80 on both sides of the level crossing were installed signaling mark 209: "Watch out the crossing" in the manner prescribed by the provisions of Article 46 of the Signal Rulebook (*Official Gazette ZJŽ No.4/96 and 5/96*).

The length of the necessary visibility, according to Provisions of the Article 14 of the Rulebook of the manner of crossing the railway and the road, pedestrian or bicycle path, the point where the crossing can be done and measures to secure the safe transport (*Official Gazette RS, No. 89/2016*) is calculated according to the formulas:

$L_{ppp} = t_{pdv} \cdot V_ž / 3,6$ [m]

$t_{pdv} = t_a + t_v$ [s]

$t_a = V_p/(3,6 \cdot a)$ [s]

$t_v = ((m+n+d+s)/V_p) \cdot 3,6$ [s]

where for respective case:

$V_ž$= 50 km/h	m =2,13+0,8=2,93 m
V_p = 4 km/h	n = 2+0,8=2,8 m
a = 1 m/s^2	d = 25 m

t_a = 4 km/h /(3,6·1 m/s^2) = 1,11s

s = ((0+4)/(2 km/h·3,6)·1,11 s = 0,62 m

t_v = ((2,93m+2,8m+25 m+0,62 m)/4 km/h)·3,6 = 28,22 s

t_{pdv} = 1,11 s + 28,22s = 29,33 s

L_{ppp}=29,33·50 km/h/3,6 = 407,36 m

Calculation of the necessary zone of visibility is given in the Rulebook on the manner of crossing the railway and the road, pedestrian or bicycle path, the point where the crossing can be done and measures to secure the safe transport visibility (*Official Gazette RS, No. 89/2016*), in further text the Rulebook. This is done because the Rulebook is valid and in use.

We consider that the formula t_v is not correct.

Namely, according to the provisions of Article 14 of this Rulebook, the formula for calculating t_v is given as follows: t_v = ((m+n+d+s)/Vp)·3.6, wherein it is stated that s is the path that the road vehicle yarns from starting at the point B to reaching the maximum constant speed V_p to crossing the line of danger area with rear part of the vehicle. Thus, it would be proper to use -s instead of +s in the given formula.

The calculation with the corrected formula for t_v would give shorter $L_{ppp.}$

According to executed calculation, in case of the road vehicle stopping in front of the carrier on which there are traffic signs "Stop" and "Andreja's cross," it is necessary to provide such a zone of visibility for the driver of a road vehicle from that place must see the train which is on track at distance of 408 m from level crossing and closer to the road crossing.

In accordance with the Decision on the roads of the city of Leskovac *(“Official Gazette of the City of Leskovac" No. 10/2010 and 20/2011*), affairs of financing, construction, reconstruction, maintenance and protection of unclassified roads carry out the local communities from the funds allocated from the city budget, independent funds from voluntary, donations and various users of the road.

Between the Joint Stock Company for managing public railway infrastructure "Infrastructure Railways of Serbia", as the Manager of the railway infrastructure and JP "Urbanization and construction" Leskovac, as the Manager of road infrastructure is concluded contract on maintenance of level crossings on local and unclassified roads (“IŽS”a.d. No. 1/2017-3125 of 06 January 2017., and RS, city of Leskovac, Mayor No. 3165/2017-IV of 05 June 2017). The contract was concluded for an indefinite period. With this agreement the type and scope of work on maintenance of track, the height of the costs of ensuring safe and unobstructed traffic at level crossings, labor costs of railway workers who work at level crossings, payment of such costs and other issues are regulated.

In the period from 01 January 2016 until the occurrence of the respective serious accident, the supervising railway maintenance "IŽS"a.d. at respective level crossing and close to the level crossing executed the following works:

- cleaning grooves on the road crossing from the ice and clearing snow from the level crossing:
  - 13 January 2017 at km 304+270 to km 304+290 and
  - 15 January 2017 at km 304+270 to km 304+305;
- Regulating the road 22 June 2016 at km 304+300 to km 320+000;

- manual cutting of shrubs and vegetation along the railway 3 m left and right of the track axis.
  - 02 March 2016 at km 304+300 to km 304+600,
  - 04 March 2016 at km 303+200 to km 303+500,
  - 30 June 2016 at km 304+300 to km 304+400,
  - 05 July 2017 at km 305+025 to km 304+960,
  - 12 July 2017 at km 304+460 to km 304+510,
  - 13 July 2017 at km 303+900 to km 303+950 and
  - 14 July 2017 at km 304+100 to km 304+150.

Infrastructure manager "IŽS"a.d. by the letter No. 28/17-594 of 22 December 2017 submitted the data that in order to preserve the security of both types traffic Section for track maintenace Niš has sent the Notice No. 14-5/2017-289 of 21 February 2017 to the Manager of road infrastructure, JP"Urbanization and construction" Leskovac on the obligation to maintain the visibility and supplementing the missing traffic signs. The mere letter referred to was not delivered to CINS, so that its content is not known.

3.4.3. Means of communication

At the time of the respective serious accident, on the section between Grdelica and Predejane, the means of communication were safe and operational. No malfunctions or failures of communication devices were documented.

3.4.4. Railway vehicles

At the time of occurrence of the respective serious accident, the train No. 4095 was moving in the direction from the station Grdelica to the station Predejane (from the beginning towards the end of the railway line, in the direction of increasing mileage).

The train composition was the locomotive of series 441-746 and the two wagons of series B.

The locomotive of series 441-746 is a quad-axle monophase electrical locomotive system 25kV/50Hz for traction of passenger and freight trains by lowland and mountain railways. In accordance with Article 78 of the Law on railway safety and interoperability (*"Official Gazette" No. 104/2013, 66/2015 - other law and 92/2015*) locomotive is equipped with a device for giving audible signal (siren).

Wagon of the series B are intended for the carriage of passengers, equipped with 2nd class seats.

In the locomotive 441-746 speed meters of the manufacturer *Hasler* are installed, registering speed meter of the type *RT12i*, serial number *003,212* is installed, and indicating speed device type *A28i*, serial number *L07. 169.*

From registering speed device of the driving locomotive 441-746, registering lane was removed and made the processing of registered data. Treatment of the registered data, it was found that the train No. 4905 departed from the station Niš at 19:03. On the section between Niš and Grdelica, the train driver was driving according to the timetable booklet for that train, respecting all the predicted stops, maximum speeds, limited speeds and restricted speed runnings. After departure from the station Grdelica (at 20:23), the train crosses 2400 m by moving with the speed of 48 km/h, after which on the registering lane braking was registered and stopping of the train at

20:27. The braking distance was between 100 and 150 m long. All the times were given according to the clock of the speeding device.

Based on data from registering lane, it was noted that just before the occurrence of this serious accident, the maximum speed limit on this section of railway line was not exceeded (50 km/h).

3.5. Traffic operation and management

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

The operation of the train No. 4905 between the station Grdelica and Predejane was performed at block section lengths.

The train crew received in the accompanying documents all required orders and notifications about the operation of the train on that part of the section.

3.5.2. Exchange of voice messages in relation to the accident

Immediately before and during the respective serious accident, there was no communication between the train driver and the staff that manages traffic operation.

Communication between the staff managing the traffic operation and the train driver took place after the respective serious accident in order to notify about accident occurred, by the train driver of the train No. 4905 notifying the train TK dispatcher at TK Jug at TK Centre Niš.

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

After the accident has happened, part of the main arterial route *E 70/E 85*: Belgrade - Mladenovac - Lapovo - Niš-Preševo - state border - Tabanovce, between stations Grdelica and Predejane was closed for traffic.

The evacuation of passengers from the train No. 4905 was not performed, and after the investigation they carried on with their journey with the same train.

No other measures were taken to secure the place of accident.

3.6. Interface between man, machine and organisation

3.6.1. Working hours of the staff involved

For the railway staff, data was submitted based on which it is clear that the train driver and the conductor of the train No. 4905 had the legally stipulated rest before going to work and that they did not spend more time at work than the maximum working hours defined by law.

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

For the railway staff, information was submitted based on which it was clear that the train driver and the conductors of the train No. 4905 were qualified and bodily and mentally fit to perform their work. For the train driver of the train No. 4905 a certificate was issued by the

Railway Directorate to confirm that his application was submitted, and conditions were fulfilled that are required to issue the license for the operation of a traction vehicle.

According to the request of the Public Prosecutor from OJT Leskovac, the blood test of a train driver was done to test the presence of alcohol. In the blood sample taken from the train driver there was no presence of alcohol (determined level of alcohol in the sample was 0,00 *mmol/L).*

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

The main arterial route *E 70/E 85*: Belgrade - Mladenovac - Lapovo - Niš - Preševo - state border - Tabanovce, between the station Grdelica and Predejane was designed such that it satisfies, with regard to all parametres, the criteria for the safe operation of trains at speeds specified in the timetable booklet.

The railway line is equipped with APB devices in TK devices in TK Centre Niš, so that traffic at this section, from the central spot is regulated by TK Dispatcher at the position TK Jug at TK Centre Niš.

For the purpose of traffic management, on the part of the railway line between the station Doljevac and Pečenjevce automatic block and protective signals are installed that show binary signalling signs.

On the section between the station Doljevac and Pečenjevce, communication between the staff managing the traffic on the track and the staff in the traction vehicle is done by telephone via a local TT connection.

This railway line is equipped with RDV devices that are operational and with the help of which communication between the staff of the traction vehicle and TK Dispatcher.

The locomotive is operated by a train driver by way of commands from the driver's cabs, which were designed when the locomotive was manufactured. At locomotive 441-746 all defects noticed in the locomotive on systems and operating gear were removed, so that in that sense no remarks or defects were registered.

3.7. Previous accidents of similar nature

No data were obtained from the infrastructure manager “IŽS“a.d. about any accidents from 01 January 2013 to 21 August 2017 on the respective crossing.

4. Analysis and conclusions

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

On the 09 October 2017 at 20:26, on the level crossing at km 304+277 of the main arterial route E70/E85: Belgrade - Mladenovac - Niš - Preševo - state border - (Tabanovce), there has been overtaking of the train No. 4905 (locomotive 441-746 and two wagons of series B) on the road passanger vehicle of brand Opel type Astra registration No. LE 058-LR.

Serious accident occured at the crossing at open track between the station Grdelica and Predejane. The rail is arterial, onetrack and electrified. Road is considered a loal uncategorized road, local road Grdelica - Oraovica. The width of the road is 3,90 m and the width of the mere crossing is 5,20 m. The road is built from well-levelized wooden sleepers. Road is covered with asphalt, that at approach of the wooden sleepers has damages described in chapter 2.2.3. of this report. At the time of the accident, the road was clear and dry. The crossing was secured with the passive signaling. On the respective uncategorized road, from the direction of the center of Grdelica, before coming to the crossing, on the carrier located right from the road, the traffic signs have been set I-33: “Crossing of the railway track without barriers or semi-barriers”, and I- 35: “Approaching to the point of crossing of the road and railway”. On the clearance gate, which is 12,80 m away from the nearest track, the signs have been set: II-21: ”Forbidden traffic for vehicles whose summary height is over the certain height” (4,5 m, set above the road) and II-30: “Speed limit” (10km/h, set next to the road on the carrier of the clearance gate). On the special carrier that is next to the road 1,96 m away from the near track of the railway, the signs I- 34: “Andreja’s cross” and II-2: “Obligation of stopping” have been set.

On the track there are regular track warnings, signaling mark 209: “Watch out the crossing”. The road and the track are crossed at the angle of 90º.

Due to the geometry of the track and the facilities that are there at the crossing there is not the necessary visibility zone prescribed by the Rulebook on the method of crossing the railway line and the road, pedestrian and bicycle paths, a place where you can carry out the intersection and measures to ensure the safe transport (*“Official Gazette of RS "no. 89/2016*). Road vehicle driver was obliged to stop the vehicle in front of the traffic sign *II-2*: ”Obligation of Stopping” and make sure whether the train is coming.

He had the possibility that from the hazardous area limit (from where the traffic sign II-2: “Obligation of stopping” is set) in a timely manner notice the train approaching.

At the time of this serious accident the temperature was 6º*C*, it was clear, visibility was good, the road lighted with public lighting.

Road vehicle was moving from the direction of Grdelica to Oraovica. The train was coming from the direction of Niš and it was approaching the road vehicle on the right. According to the train driver, road vehicle came to the tracks directly in front of the train when the train was far from the level crossing about 10 m. According to his own statement, the train driver, when approaching a crossing, gave aspect of a signal 67: "Watch out," and repeated it several times. While hearing at the employer, both conductors identically stated: "Shortly after that, I heard a siren and then braking of the train”. One of the conductors in the report on irregularities (K-91) wrote: "After leaving the train station Grdelica the train started to brake and give audible signals“.

In this serious accident one person died, and the other was seriously injured. The interruption of the traffic lasted from 20:26 to 23:00. On locomotive 441-746 there are damages. The damage of the vehicle is total.

4.2. Discussion - Analysis of facts determined during the investigation with the purpose of drawing conclusions about the accident causes and the effect of the Emergency services

4.2.1. Analyses of moving of train and road vehicle

The train No. 4905 was after, by the timetable envisaged in dealing with TK station Grdelica, dispatched according to the official place Predejane. After passing about 2400 m, at a speed of 48 km/h, fast braking was introduced. The train stopped at *km304+430* (according to data from registering lane), and according to the sketch of the MUP at *km 304+402*. According to the train driver statement, road vehicle came to the crossing directly in front of the train (when the train was far from the level crossing at about 10 m). Based on the available documentation, it is not possible to determine the mode of movement of road vehicles shortly before the serious accident occurred.

4.2.2. Analysis of the effect of work of Emergency Service

Emergency services from Health Center of Grdelica came on site in a very short time, 10 minutes after the accident and transfered seriously injured persons to the Leskovac hospital, where one person died.

There was no need for the intervention of other rescue services.

4.3. Conclusions on causes of the accident

4.3.1. Direct and immediate causes of serious accident

The direct and immediate cause of a serious accident is that the road vehicle entered into the track just before the arrival of the train, thereby creating a dangerous situation of the occurrence of the serious accident.

Even though the prescribed zone of necessary visibility was not secured, the driver of the road vehicle had the opportunity to from the limit of dangerous area notice the train arriving in a timely manner.

4.3.2. Basic causes resulting from skills, procedures and maintenance

The main cause of this accident is non-compliance with the provisions of the Law on Road Traffic Safety (*"Official Gazette of RS" No. 41/2009, 53/2010, 101/2011, 32/2013 - decision US, 55/2014, 96/2015 - other Law and 9/2016 - decision US*) by the driver of the road vehicle. The fact that the prescribed zone of necessary visibility was not ensured, in no way diminishes the responsibility of driver of the road vehicle, because he was obliged to comply with a traffic sign *II-2*: "Obligation of Stopping" to stop and make sure whether the train is coming.

Since the registering speeding device with which the locomotive is equipped does not record the use of locomotive siren, and that in the statements relating to the use of sirens just before the

accident, there exist a certain contradiction, it cannot be reliably determined whether the train driver gave the aspect of a signal *67*:" Watch out", as required by the Provisions of the Signaling Rulebook (*"Official Gazette of ZJŽ", No. 4/96 and 5/96*). Failure of this aspect of a signal in the manner prescribed by the provisions of the Signaling Rulebook (*"Official Gazette of ZJŽ", No. 4/96 and 5/96*) could contribute to the occurrence of the accident.

4.3.3. Main causes based on the requirements defined in the legal framework and the application of the safety management systems

There are no main causes.

5. Measures taken

At the request of the MUP RS, Police Administration Leskovac, Traffic police branch No. 221-1773/2017 of 18 October 2017, referred to it under Article 156 paragraph 7 of the Law on Road Traffic Safety (*"Official Gazette of RS" No. 41/2009, 53/2010, 101/2011, 32/2013 - decision US, 55/2014, 96/2015 - other Law and 9/2016 - decision US*), road manager JP "Urbanization and construction" Leskovac has, after examining the site by their professional services, found that the functions of the road is in proper condition, that road according to traffic technical conditions allows the conditions for the smooth flow of traffic and that the respective road did not cause the accident. In order to improve passenger safety and railway traffic, road manager proposed a security measure of supplying the level crossing with half-barriers with light traffic signs. On given state and the proposal for securing the safety the road manager JP "Urbanization and Construction" Leskovac has notified MUP RS, Traffic Police Branch Leskovac with a letter No. 6680.

6. Safety recommendations

For potential safety improvement on the railway and prevention of new accidents, CINS issued the following 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 Ministry of Construction, Transport and Infrastructure:

SR_09/18 Ministry of Construction, Transport and Infrastructure should adjust the Rulebook on the mode of crossing the railway line and the road, pedestrian or bicycle path, a place where you can carry out the intersection and measures for ensuring safe traffic ("Official Gazette RS" No. 89/2016) with actual performances of the road vehicles (in the manner of adjustment by some countries in the region) and the actual state of the railway infrastructure. It is necessary to determine whether the speed of the road vehicle over the crossing which is used in this calculations by this Rulebook, and which amounts to 4 km/h is suitable for the actual performances of the rolling stock, or if this speed should be enlarged (for example, in the Republic of Slovenia the speed is 7 km/h). With the speed of 4 km/h, the large number of crossings cannot satisfy the minimal required zone of visibility that the Rulebook predicts.

Explanation for the Article 11 of the Rulebook, which is given in the Article 12, and which states:
"By securing the necessary zone of visibility from the Article 11 of this Rulebook, the participants in the road traffic are enabled with uninterrupted visibility on the railway track with both sides of the road, pedestrian or bicycle path, for noticing on time of the upcoming railway vehicles on the track so that they could stop the vehicle and stop the moving of the pedestrians or bicycles before they come to the railway, that is, in front of the traffic sign that indicates the point where the road comes over the railway track at the railway level" would make sense only in the case that in front of the crossing there is no traffic sign *II-2*:"The obligation of stopping". Situation on site confirms that the traffic sign *II-2*:"Obligation of stopping", exists on all the crossings with passive signalization, which we consider absolutely necessary.

In the expression:

$$t_a = \frac{m + n + d + s}{V_p} \cdot 3{,}6 \quad [s]$$

In front of ***s*** should stand a sign„-" , and not the sign„+" (see Fig. 3.4.2).

„IŽS"a.d:

SR_10/18 „IŽS"a.d. that given the existence of construction facilities, not even from the limit of dangerous area it is not possible to provide the necessary visibility in all directions, to consider introduction of active signaling, or to solve the problem in another way.

SR_11/18 „IŽS"a.d. to perform the expert- based risk assessment on the crossing. Having in mind that the accidents on the crossing (viewing them individually) are rare events, the risk evaluation cannot be done solely on the number of accidents that had happened on some crossings. The risk assessment should be done, as a measure of precaution, for all the crossing according to all the relevant parameters, whether there were accidents on them or not.

SR_12/18 „IŽS"a.d. that during the conduction of investigation of traffic accidents on the crossings, research committees should pay more attention to collecting relevant data, so that all the possible causes of the accident could be established, and with the goal of applying suitable measures.

SR_13/18 „IŽS"a.d. to do the act of "Programme for resolution of the level crossings" according to previously finished risk assessment, with the goal of taking certain actions to raise the level of safety in traffic.

„Srbija voz"a.d.:

SR_14/18 **„**Srbija voz"a.d. that during the conduction of investigation of traffic accidents on the crossings, research committees should pay more attention to collecting relevant data, so that all the possible causes of the accident could be established, and with the goal of applying suitable measures.