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FINAL REPORT ON THE INVESTIGATION INTO THE RAILWAY ACCIDENT – COLLISION OF REGIONAL PASSENGER TRAIN NO 600 WITH PASSENGER VEHICLE AT LEVEL CROSSING LC-87.4, SOLKAN 1, BETWEEN RAILWAY STATIONS NOVA GORICA AND ANHOVO



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1 SUMMARY

On 29 March 2009 at 05:30, regional passenger train no 600 collided with a passenger vehicle at a level crossing protected with illuminated road-traffic signs.

Regional passenger train no 600 was travelling along a single-track railway line from the direction of Nova Gorica towards Jesenice.

The passenger vehicle with Italian licence plates (from the town of Gorizia), [redacted], was travelling along Pot na Breg road from the direction of the bank of the Soča (the Kayak Centre) towards Cesta IX. Korpusa.

The road leading to the bank of the Soča has public-road status and runs across parcel of land no 2258/1 – with public-good status – of the Solkan cadastral municipality.

The road has a stabilised base and a composite asphalt concrete surface. The width of the asphalt concrete roadway at the level crossing is 4 m. The view of the railway line for road users travelling from the direction of the passenger vehicle in the direction of the oncoming train is blocked by a stone wall approximately 3 m high, overgrown with vines and topped by branches of a tree growing from behind the wall. Owing to a curve and the stone wall directly ahead of the level crossing, the illuminated road traffic sign warning road users of the approaching train is visible from this direction at a distance of 70 m. A road hump was constructed on the roadway a few metres behind the visibility range of the light signal to warn road users of the impending danger.



Figure 1: The red arrow marks the railway line and the direction of the travelling regional passenger train, while the blue arrow marks the public road and the travelling direction of the passenger vehicle; the black circle marks the site of the collision at the level crossing; the Kayak Centre and Cesta IX. korpusa are also marked.

Nova Gorica railway station is the station of departure for passenger train no 600. The train left Nova Gorica station at 05:28, as scheduled in the timetable.

At the LC-Solkan level crossing, at km 087+362, having travelled 1638 m from the station of departure, the train collided with the passenger car, pushing it forward for 154 m (up to km 087+208).

At the moment of collision, the speed of regional passenger train no 600 was 71 km/h. The maximum permitted speed on this section, as laid down in the timetable, is 70 km/h.
The driver and the other car occupant were killed instantly. In the collision, diesel motor unit 813-104 of train no 600 derailed (the first axle of the first bogie in the travelling direction leaving the rails).

It was established during the investigation that non-observance of the right-of-way rule was the direct cause of the collision of train no 600 and the passenger vehicle at the level crossing between Anhovo and Nova Gorica stations, at km 87+362, protected with illuminated road-traffic signs switched on and operating correctly, thus warning road users of the approaching train.

The indirect cause of the accident was driving under the strong influence of alcohol (1.41 g/kg of alcohol of the lowest value in the driver's blood), which significantly impaired the driver's physical and mental faculties.

Recommendations

The existing protection of the LC-Solkan level crossing, at km 87+362, between the Nova Gorica and Anhovo stations, allows road users to safely cross the railway line – provided they comply with road traffic and railway regulations; there is, therefore no need to raise the level of protection, given the volume of railway and road traffic.

To meet the requirements of traffic management, the railway infrastructure managing authority – Slovenske železnice d.o.o. – should develop two special Instructions on the operation and handling of devices protecting the LC-Solkan level crossing, 1 and 2, which are to form part of the Station Rules of Anhovo and Nova Gorica stations. Both Instructions are to include sketches of the level crossing.

In compliance with the regulations in force, the job titles of the traffic-management staff handling signalling and safety devices must be corrected in the Operating Instructions for the signalling and safety device on the Nova Gorica station on the Jesenice-Sežana railway line, Slovenske železnice, SVTK Pivka – 70120.34 of 5 May 2005, containing, *inter alia*, a description of the LC-Solkan 1 protection device as well as the operation of this device.

57. Article 57 of the Rules on traffic signs and equipment on public roads, Uradni list RS, No 56/2000 of 31 May 2000 must be amended to include a description of the flashing of illuminated signs at level crossings (the frequency of flashing 60 flashes/minute) and a description of the acoustic signal warning, which rings with the frequency of the light flashing.

1.1. Copies of the accident report with recommendations to:

Slovenske železnice, d.o.o.
Kolodvorska 11
1506 Ljubljana

Ministry of Transport
Minister Dr Patrick Vlačič
Langusova 4
1000 Ljubljana

Ministry of Transport
Roads Directorate
Langusova 4
1000 Ljubljana

Police Directorate Nova Gorica
Traffic Police Station Nova Gorica
Žnidarčičeva ulica 17
5290 Šempeter pri Gorici

Municipality of Nova Gorica
Trg Edvarda Kardelja 1
5000 Nova Gorica

Public Agency of the Republic of Slovenia for Railway Transport
Kopitarjeva 5
2000 Maribor

ERA – European Railway Agency
160 boulevard Harpignies
BP 20392
F-59307 VALENCIENNES Cedex

2 IMMEDIATE FACTS OF THE OCCURRENCE

Regional passenger train no 600 hit the side of the passenger vehicle at a level crossing protected with illuminated road traffic signs.
There is no specific speed limit for road users; since this is a town road, the maximum permitted speed is therefore 50 km/h.
At a distance of 50 m ahead of the level crossing, there is a road hump on the roadway in the travelling direction of the passenger vehicle involved in the accident, warning road users that they are approaching a danger spot – a level crossing.
The maximum permitted speed for train no 600 at this section of the railway line, from km 89+000 to km 86+200, as laid down in the timetable, is 70 km/h.
The speed recorded by the speedometer of train no 600 immediately before colliding was approximately 71 km/h.
Since the speedometer recorder of DMU 813-104 (forming part of train no 600 on that particular day) is a mechanical one, vibrations might have caused the oscillation of the speed recording stylus, which is one possible reason for the recorded increase of the train speed, 1 km/h higher than permitted. Another possible cause was the increased attention that the locomotive driver focused on developments at the level crossing, which brought the train speed to 71 km/h.
The speed of the passenger vehicle involved in the accident cannot be ascertained, since there were no marks on the road surface except for those of a car in the aftermath of the collision.
At this level crossing, the railway line becomes visible to road users arriving from the direction of the Kayak Centre towards Nova Gorica station as close as 13.9 m ahead of the level crossing danger zone, which begins 3 m ahead of the nearest railway track.
The level crossing of the road with the railway line is protected by light signals marking the road crossing the railway line and warning motorists of the approaching train.
The width of the road at the level crossing is 4 m viewed from the direction of the travelling passenger vehicle. The road is flanked by hard shoulders.

2.1 Date, exact time and location of the occurrence

The accident – regional passenger train no 600 colliding into the side of the passenger vehicle, Alfa Romeo, at the level crossing, at km 87+362 of the single-track railway line Nova Gorica-Jesenice – occurred on 29 March 2009 at 05:30.

2.2 Description of the events and the accident site

On 29 March 2009, regional passenger train no 600, which operates the service between Nova Gorica and Jesenice, pulled out of the Nova Gorica railway station on track no 1 at 05:28 as recorded in the P-4 traffic log book by the Nova Gorica traffic controller. It has been documented in the analysis of the recording tape of DMU 813-104 that train no 600 pulled out of Nova Gorica station at 05:29:30. The discrepancy of 1.5 minutes between the time recorded in the P-4 traffic logbook of Nova Gorica station and the time recorded by the speedometer of train no 600 is due to either the Nova Gorica traffic controller or the locomotive driver of train no 600 not having set their respective watches to the correct time, or to the Nova Gorica traffic controller having recorded the *timetabled* time of departure and not the *actual* time of the train's departure. It can be inferred from the departure time recorded in the P-4 traffic log book of Nova Gorica station that train no 600 collided with the passenger vehicle at 05:30, which is 1.5 minutes before the time recorded by the speedometer of train no 600.

The railway line between Nova Gorica and Jesenice stations is single track. Rail traffic is managed on the basis of inter-station spacing, which means that only one train can be positioned on the inter-station section at any time.

From the point of departure on track no 1 of Nova Gorica station – at km 89+000 – until the point where it stopped at km 87+208, the train travelled 1,792 m, and 1,638 m until the site of collision. The stopping distance of the train after the collision with the road vehicle was 154 m.

It is evident from analysis of the train's speedometer that, at the moment of collision, the train was travelling at a speed of 71 km/h, which is 1 km/h (0.28 m/s) higher than the permitted speed.

The flashing lights and acoustic signals warning road users of a train approaching the level crossing were in perfect working order.

At 04:34:17, the operation recorder of the safety device recorded activation of the road-light signals at the LC-Solkan 1 level crossing. The recorded time is neither correct nor accurate. When the safety device was examined immediately after the accident, it was established that, at the time of the accident, clock mechanisms had not yet been manually adjusted forward i.e. from winter to summer time (the change taking place on 29 March 2009 at 02:00). The one-hour shift was not accurate on account of the inaccurate operation of the recorder clock. The event recorder at LC-Solkan is inspected once every year in December, which is evident from plans and inspections of the device and the operation controls that have been implemented. Manual adjustment of the time is performed at the same time as inspection and control. Manual adjustment of the time is also carried out when daylight-saving time begins and ends.

The passenger vehicle, with Italian licence plates (from the town of Gorizia), [redacted], was travelling along the Pot na Breg road from the direction of the bank of the Soča (the Kayak Centre) towards Cesta IX. korpusa.

The road leading to the bank of the Soča has public-road status and runs across parcel of land no 2258/1 – with public-good status – of the Solkan cadastral municipality.

The road has a stabilised base and a composite asphalt concrete surface. The width of the asphalt concrete roadway at the level crossing is 4 m. The view of the railway line for road users travelling from the direction of the passenger vehicle in the direction of the oncoming train is blocked by a stone wall approximately 3 m high, overgrown with vines and topped by branches of a tree growing from behind the wall, which is 16.9 m away from the nearest railway track. Owing to a curve and the stone wall directly ahead of the level crossing, the illuminated road-traffic sign warning road users of the approaching train is visible from this direction at a distance of 70 m. There is a road hump on the roadway a few metres behind the visibility range of the light signal to warn road users of the impending danger.

The LC – Solkan 1 level crossing is protected with illuminated road-traffic signs warning motorists and pedestrians of the approaching train when red lights are flashing alternately, with accompanying acoustic signals – a specific ringing for additional warning.

When approaching the LC-Solkan level crossing, the locomotive driver of train no 600 noticed, to his left, a passenger vehicle approaching the level crossing. When the locomotive driver realised that the vehicle was travelling towards the level crossing too fast, he used the locomotive whistle to warn the driver of the approaching train. The driver of the passenger vehicle then reduced to some extent the speed of travelling towards the level crossing, yet continued. The locomotive driver realised that a collision was inevitable, and activated the high-speed brake. Despite these efforts, the locomotive driver was unable to prevent the collision of the train with the passenger vehicle.

In the collision, the front of train no 600 was slightly lifted, resulting in derailment of diesel motor unit 813-104 with the first axle of the first bogie leaving the rails.

The driver and the other vehicle occupant – trapped in the car – were both killed in the collision.

2.3 The body that established the investigation

The investigation procedure was launched by the Railway Accident and Incident Investigation Division of the Ministry of Transport of the Republic of Slovenia, Slovenske železnice, d.o.o. and the Nova Gorica Traffic Police Station.
The investigation procedures were conducted and completed separately.

2.4 The decision to establish an investigation, the composition of the team of investigators and the conduct of the investigation

The Railway Accident and Incident Investigation Division of the Ministry of Transport of the Republic of Slovenia launched an investigation to determine all direct and indirect causes, with the purpose of collecting information important for improving safety at this and similar level crossings. The accident was expected to attract greater media attention because the persons involved and killed were foreigners, which was an additional reason to launch an investigation.
The Chief Investigator of the Railway Accident and Incident Investigation Division at the Ministry of Transport of the Republic of Slovenia, conducted the investigation and brought it to a close himself. Slovenske železnice, d.o.o. conducted its investigation through an investigation commission, while the Nova Gorica Traffic Police Station's investigation was carried out by two police officers.

2.5 The background to the occurrence

The accident involved the 29-year-old driver of the passenger vehicle, a 27-year-old passenger and the 45-year-old locomotive driver of train no 600.

There is a speed limit of 50 km/h in force for road users of this section of the local road.

The maximum permitted speed for regional passenger train no 600 for this section of the railway line from Nova Gorica towards Jesenice, from km 89+000 to km 86+200, as laid down in the timetable, is 70 km/h.

Road users approaching the level crossing from the direction of the Kayak Centre have a limited view of the railway line on account of a stone wall to the right, and trees to the left.

The local road surface is made of coarse asphalt concrete. The driving surface was wet at the time of the accident.

Road traffic is light at this level crossing. There is an average of fifteen pairs of trains per day on workdays.

2.5.1 Staff involved

The driver of regional passenger train no 600 was an employee of Slovenske železnice d.o.o., Poslovna enota Vleka, Sekcija za vleko Divača, Delovna enota Nova Gorica, and a driver of DMUs since 1983.

The driver of the passenger vehicle was a 29-year-old Pole, permanently resident in the Italian Republic.

The other vehicle occupant was a 27-year-old citizen of the Italian Republic.

2.5.2 The trains and their composition, including the registration numbers of the items of rolling stock involved

Train no 600 consisted of diesel motor unit no 9579 8 813 104-2 and carriage no 9579 8 814 104-1. The diesel motor unit weighed 78 tonnes, had 8 axles and was 44 m long.

2.5.3 The description of the infrastructure and signalling system – track types, switches, interlocking, signals, train protection)

There are no signalling and safety devices installed in the Nova Gorica–Jesenice railway line. Rail traffic on this railway line is managed on the basis of inter-station spacing, which means that rail traffic is managed on the basis of arrangements made between the station-masters of two neighbouring railway stations. Only one train can be positioned on the inter-station section at any time; otherwise there is no train at all on the inter-station section.

The LC-Solkan 1 level crossing – between Anhovo and Nova Gorica stations, at km 87+362 – is provided with a safety device, LC Iskra KS, with control signals signalling to the locomotive driver whether the device at the level crossing is switched on or not. A control signal showing signal aspects 55 is installed at the braking distance in front of the level crossing: "Protection at the level crossing switched on" when one yellow light – with one white light flashing above it – and signal aspect 56 are illuminated: "Stop in front of the level crossing", when one yellow light is illuminated. For trains running from Nova Gorica station, the device is activated by means of the station's signalling and safety device. The activation of the LC-Solkan 1 safety device depends on Nova Gorica station's exit signals. For trains running in the direction of Jesenice, Nova Gorica station's exit signals change from position "Stop" to position "Clear" only when the LC-Solkan 1 protection device is activated and signal aspect 55 lights up on the control signal.: "Level crossing protection activated".

The local road and the railway line are perpendicular to each other at this level crossing.

The level-crossing roadway is covered with special rubber elements, laid both in the space between the tracks and on each outer side of the tracks to a width of approximately 60 cm. These rubber elements are laid on top of the asphalt concrete coat. Road users are warned of the approaching train by two illuminated road signs: "Triangle with a yellow background and with a black border and two parallel red lights in a yellow background" and a bell signal emitted by a special bell installed on a pole behind the sign. A St Andrew's Cross road sign is fastened above this sign.

Some 50 m ahead of the level crossing, a road hump – marked with yellow triangles on both sides of the approach – is built across the whole width of the roadway. The road hump is intended to warn road users of the level crossing and of the speed limit on this part of the road.



Figure 2: View of the Solkan 1 level crossing – equipment and visibility

2.5.4 Means of communication

Diesel multiple unit 813-104 with carriage 814-104 is not fitted with any telecommunications equipment. It is equipped with a mobile phone that can be used by the locomotive driver in emergencies.
Boxes containing telephones are set up next to level crossings protected with road light signals on the Nova Gorica-Jesenice railway line for direct telephone connection to the traffic controllers of the neighbouring railway stations.

2.5.5 Works carried out at or in the vicinity of the site

At the time of the accident, there were no building works in progress at the accident site or in its vicinity.

2.5.6. Trigger of the railway emergency plan and its chain of events

The Operation and Communication Centre of the Nova Gorica Police Directorate was informed of the accident by the locomotive driver of train no 600 and by the traffic controller of Nova Gorica station. Two police officers from the Nova Gorica Traffic Police Station were deployed to the accident site to inspect it and to document the situation after the accident.

2.5.7. Trigger of the emergency plan of the public rescue services, the police and the medical services and its chain of events

After the information had been provided by the locomotive driver of train no 600 and by the traffic controller of the Nova Gorica station, an emergency plan of rescue measures was set in motion. A doctor on duty at Nova Gorica Health Centre arrived at the accident site and – after examining the victims in the passenger vehicle – confirmed their deaths.
After the health service had confirmed their deaths, both victims were cut out of the vehicle by firefighters of the Nova Gorica Volunteer Firefighters Association, who arrived at the accident site in a fire engine.
The passenger vehicle trapped under the front of diesel multiple unit no 813-104 of train no 600 was removed by firefighters of the Nova Gorica Volunteer Firefighters Association. The duty crew of the emergency auxiliary train was called in to rerail the derailed axle of DMU 813-104.

The crew rerailed the axle of the DMU at 14.00. The DMU of train no 600 was withdrawn to Nova Gorica station at 14:30, at which time the railway line was re-opened to traffic.

2.6 Fatalities, injuries and material damage

Two people were killed in the accident – the driver of the passenger vehicle, a 29-year-old Pole, permanently resident in the Italian Republic, and the other vehicle occupant, a 27-year-old citizen of the Italian Republic, permanently resident in the Italian Republic.

Material damage was caused to the following railway equipment: broken hectometre mark on the railway line at km 87+300; torn out and destroyed magnetic track switch-off contact with protectors LC-Solkan 1, at km 87+355; bent sheet metal on the front of DMU 813-104; bent stairs leading to the entrance to the DMU 813-104 locomotive driver cab; bent fenders; damaged left-hand headlight and rear light at the front of DMG 813-104; damaged remote-control connecting cable; damaged 86-pin socket of the fastened remote-control cable; damaged Ackermann steering tubes of the DMU control line, torn conduits of the DMU primary air-pipe for the train's air-brake; damaged track cleaners and bent connecting rod; damaged right-hand sandbox with pneumatic valve; bent left-hand sandbox; bent brake bars of the first axle; damaged three-section air-pressure box with pertaining piping; bent protection of the connecting socket; bent vertical shock-absorbers of the first bogie; bent H-beam and bolts of the first bogie. Material damage according to a non-expert assessment amounted to EUR 14,500.

The passenger vehicle was totally wrecked in the accident. Material damage sustained by the wrecked passenger vehicle was EUR 5,000 according to a non-expert assessment.

2.7 External circumstances

Weather conditions at the time the accident occurred: Rainfall, +6°C, night.
The local road carriageway was wet, allowing for good grip.

3 RECORD OF INVESTIGATIONS AND INQUIRIES

On 29 March 2009, at 08:30, the Chief Investigator of the Ministry of Transport inspected the accident site immediately after the accident and launched an investigation.
On 29 March 2009, after the accident site was inspected and the first information obtained, a preliminary finding was drafted, describing the situation regarding the P-77 incident.
On 2 April 2009, the Railway Accident and Incident Investigation Division of the Ministry of Transport received Incident notification no 9/2009 submitted by Slovenske železnice d.o.o., Sekcija za vodenje prometa Postojna (Postojna Traffic Management System), Nadzorna postaja Nova Gorica (Nova Gorica supervisory station), dated 30 March 2009.
On 22 April 2009, the Railway Accident and Incident Investigation Division of the Ministry of Transport received the following documents from the Internal Supervision Service of Slovenske železnice, d.o.o.:

- A copy of the P-13 traffic logbook of Anhovo station covering the period of the accident;
- A copy of the P-13 traffic logbook of Anhovo station covering the period of the accident;
- A copy of the Daily report on emergency no 20/2009NG by the locomotive driver of train no 600, involved in the accident;
- A photocopy of the analysis of the speedometer tape of train no 600;
- A copy of the minutes of the interrogation of the employee – the locomotive driver of train no 600 – involved in the accident;
- A copy of the irregularity report submitted by train conductors of train K-91 involved in the accident;
- A copy of Decision no 351/C-451/79-81 on putting LC into operation, dated 31 August 1979;

- A copy of the analysis of the event recorder during the operation of LC-Solkan 1, marked MM-1, for the time from 04:30 to 04:40 on 29 March 2009;
- A copy of the record of failures and errors at LC-Solkan 1, V-11, for the period from 20 January to 29 March 2009;
- A copy of the measurement sheet (EML) of the safety device LC-Solkan 1 and 2 for the period from January to March 2009;
- A copy of the printout of the MM1-recorder installed on the safety device LC-Solkan 1 and 2 for the period from 04:30:03 to 04:40:01 on 29 March 2009.

On 12 May 2009, the Railway Accident and Incident Investigation Division of the Ministry of Transport received – from the Slovenske železnice d.o.o. investigation commission – Commission report on incident investigation no 9/2009 dated 11 May 2009;
On 15 May 2009, the Railway Accident and Incident Investigation Division of the Ministry of Transport received – from Nova Gorica Traffic Police Station – accident investigation material no 2240-241/2009/14 (3h611-1):

- Minutes of inspection of the accident site no 2240-241/2009/1 (3H611-16), dated 12 May 2009;
- Sketch of the accident no 2240-241/2009 dated 29 March 2009, and
- 15 photos showing consequences immediately after the accident occurred.

On 27 May 2009, the Chief Investigator of Railway Accidents and Incidents of the Ministry of Transport re-inspected the accident site for the purposes of the investigation procedure.

3.1 Summary of testimonies

In his Daily report on emergency no 20/2009NG of 30 March 2009, the locomotive driver of train no 600 stated that, at 05:30, train no 600 ran into a passenger vehicle at the Solkan 1 level crossing, despite the devices functioning correctly and despite the acoustic warning. He failed, despite applying the high-speed brake, to prevent the accident. Afterwards, the locomotive driver informed his superiors and the duty train dispatcher of the Nova Gorica station of the accident. After the procedure involving the police and an investigating judge was completed, the locomotive driver handed the DMU over to his shift replacement, and returned to the boiler room. One DMU axle derailed in the accident, thereby causing traffic difficulties – cancellations of trains.

In the minutes of the interrogation of the locomotive driver of train no 600, dated 8 April 2009, it is stated that the locomotive driver was given permission to move by the traffic controller in Nova Gorica; the exit signal was positioned at “Speed limit”. After entering the switch point, a white flashing light lit up on the control signal, showing that both level crossings were protected. When approaching the second level crossing, the driver noticed, to his left, a passenger vehicle approaching the level crossing. He realised that the vehicle was approaching the level crossing too fast, and used the acoustic signal to warn the driver. For a moment he thought that the car had slowed down, but it then continued driving. When the locomotive driver realised that a collision was inevitable, he activated the high-speed brake. The train hit the car at the level crossing, pushing it for approximately another 150 m. The front of the DMU stopped at km 87.208. The driver then called the Nova Gorica station, the rail-traction supervisor, the police and the rescue team. When the police arrived, he gave an oral statement to a police officer and was tested for alcohol. The speedometer tape was taken. He was asked to wait for the investigating judge, who subsequently allowed him to leave the accident site.

The traffic controller of the Nova Gorica station stated in his Report on emergency that, at approximately 05:30, a serious accident with a fatal outcome occurred at LC-Solkan 1, at km 87.362. Train no 600 hit a passenger vehicle at the level crossing protected with the prescribed signal aspects. Because of the accident, the Nova Gorica-Anhovo railway line was closed to traffic until 14.30. Train no 600 was out of service for the entire route i.e. 4292/4290 Nova Gorica-Podbrdo-Nova Gorica, 4294/4205 Nova Gorica-Most na Soči-Nova Gorica, and passengers travelling on this route were transported by bus with an approximate delay of 30

minutes, as recorded in P-4. Because of the derailed DMU, auxiliary train no 93000 was pressed into operation, an auxiliary machine, 92227, from Nova Gorica. The accident resulted in the damaged and derailed DMU 813-104, and switch-on contacts on LC. The defect at the signalling and safety device was corrected at 12.30. The debris caused by the accident was removed, the railway line inspected (SVP Lozar) and put back into use for the speed according to the timetable at 14.30. The auxiliary train left Nova Gorica at 14.45 as train 93001.

Three conductors on duty in train no 600 on 29 March 2009 stated in their K-91 irregularity report that there was an accident at the Solkan level crossing at km 78.360, the second from Nova Gorica station – a collision between a train and a passenger vehicle. It happened at around 05.31. At the level crossing, a passenger vehicle drove in front of the train and was pushed by the train for another 150 m. Two passengers in the vehicle sustained fatal injuries. The police, ambulance, fire crews and an inspector arrived at the accident site.

3.2 The safety management system

A joint device for automatic protection of traffic is installed at the level crossings at km 87+362 and km 87+509 (Solkan 1 and 2), by means of road light and acoustic signals for road traffic, and control signals of single construction for the railway traffic.

The device is automatically switched on when the railway vehicle drives onto the switch point from either side. Both switch points are marked with signal aspects 54: "Switch point, await control signal".

a) Control signal KS1 is installed at the right-hand side of the line in the travelling direction, at km 86+362.

Auxiliary control signal PKS is installed at the right-hand side of the line in the travelling direction, at km 86+953.

Control signal KS2 is installed at the left-hand side of the railway line, at km 88+190.

All the above control signals show the following signal aspects:

- signal aspect 56: "Stop at level crossing", one non-flashing amber light, - signal aspect 57: "Level crossing protection is on", one non-flashing amber light, and one flashing white light above it.

Control signals have a double-light signal head, while the auxiliary control signal is additionally provided with frosted reflection glass in a black frame, fastened onto the signal pole. The PKS auxiliary control signal is activated only for track vehicles travelling from the Anhovo direction towards Nova Gorica, and stopping at the Solkan stop for at least 20 seconds, and for vehicles moving at a speed slower than 10 km/h.

Road users are warned of rail vehicles moving across the level crossings LC Solkan 1, at km 87+362, and Solkan 2, at km 87+509, between Nova Gorica and Anhovo stations, immediately ahead of the crossing, by illuminated road traffic signs "Caution", of standard construction and erected at the right-hand side of the road/path in the travelling direction of road vehicles. Each light signal is equipped with two signal lights in a triangular field, alternately flashing red when in operation. A St Andrew's Cross for a single-track railway line is fastened at the top of the signal pole, as well as a bell ringing in the rhythm of the flashing red lights.

When rail vehicles are travelling from the Nova Gorica direction towards Jesenice, the two devices protecting the level crossings LC Solkan 1 and 2 are activated by the setting up of the exit route at Nova Gorica station. The level-crossing protection is activated through the first axle of the rail vehicle driving onto the switch electric isolation system of points no 6, which is active only when exit signal "C" is positioned to "Permission to travel". If rail vehicles are exiting on the basis of hand signals or the "Exit with caution!" signal, LC-Solkan 1 and LC-Solkan 2 are activated by means of two special push buttons on the control panel of the signalling and safety device.

The red lights of the road signals are activated at road level crossings, flashing alternately at a frequency of 60 flashes per minute. At the same time, warning bells are activated, ringing in the rhythm of the signal flashing light for as long as the device protecting the level crossing is on.

If the device is switched on in its entirety and is operating properly, a white flashing light is also activated on control signals, thereby signalling to the locomotive driver that the road crossing device is activated.
The LC-Solkan 1 and LC-Solkan 2 devices are switched off approximately 5 seconds after the last axle of the rail vehicle has passed over the disconnecting contact (IK 31) and contact (K 31) and IK 32 and K 32, respectively.



Figure 3: View of the control signal operation at level crossing Solkan 1 and 2 for rail vehicles travelling from the Anhovo direction

It returns to the original position after leaving the switch rail track isolation section IK 1 on the other side of the road crossings.

If, for whatever reason, the train stops travelling after passing the switch point, the automatic control for protecting the road crossing is switched off automatically; it returns to the original position within five minutes.

3.3 Rules and regulations

Crossings of road and railway at level crossings are defined and regulated by Article 10 of the Railway Transport Act (official consolidated text), Uradni list RS No 44/2007 dated 21 May 2007, Articles 51 and 52 of the Safety of Railway Transport Act, Uradni list RS No 61/2007 dated 10 July 2007 and Articles 50 and 51 of the Safety of Railway Transport Act (official consolidated text), Uradni list RS No 56/2008 dated 6 June 2008.

Crossings of roads and railways at level crossings are regulated in more detail in the Rules on railway level crossings published in Uradni list RS No 85/2008 dated 29 August 2008.

Protection of traffic at level crossings is governed by Article 160 of the Traffic Rules published in Uradni list RS No 124 dated 28 December 2007.

Level crossing railway signals are laid down in Chapter VII of the Signalling Rules published in Uradni list RS No 123 dated 28 December 2007.

Road-traffic signs at level crossings of roads with railways are stipulated by Articles 7, 55, 56 and 57 of the Rules on traffic signs and equipment on public roads, Uradni list RS No 46/2000 dated 31 May 2000. These Rules do not require an acoustic signal, warning road users of the approach of a train by means of a bell.

3.4 Functioning or rolling stock and technical installations

All Slovenske železnice d.o.o. diesel multiple units of series 813 are fitted with Hasler speed recorders, recording speeds up to 100 km/h. The speed recorder of this type also records individual events related to drivers' activities, operating the braking and security devices built into the DMUs.

The speed recorder recorded a train speed of 71 km/h, which implies that the locomotive driver activated the high-speed brake immediately before the train collided with the car. The train travelled approximately 100 m from the time the brake was activated until the time the train stopped. Taking into consideration the locomotive driver's reaction time of around 1 second, and the time from the activation of the brake until the start of its operation – in the present case around 3.5 to 4 seconds – it can be established that the speed brake was activated by the locomotive driver no later than approximately 98.6 m before colliding.

3.5 Documentation on the operating system

The level crossing between Nova Gorica and Anhovo stations, at km 87+362, is fitted with an Iskra LC KS device, which means that the locomotive driver is reminded by a control signal of the device being actuated at LC. The control signal is installed at the braking distance ahead of the level crossing. If, while a rail vehicle is in motion, the control signal is positioned to signal aspect 56: "Stop at the level crossing", the locomotive driver must act as if the traffic at the level crossing were not protected.

The operation and handling of the device at the LC-Solkan 1 level crossing is described in the Operating instructions for the signalling and safety device at the Nova Gorica railway station on the Jesenice-Sežana railway line, SVTK Pivka – 70120.34, of 5 May 2005-01.

The device protecting the LC-Solkan level crossing was put into use on the basis of the Decision of the Republic of Slovenia's Secretariat for Industry Ljubljana, No 351/C-451/79-81 on 31 August 1979.

3.6 Man-machine-organisation interface

There are no special devices to warn locomotive drivers and motorists to reduce speed and stop at the LC-Solkan 1 level crossing between Nova Gorica and Anhovo stations, at km 87+362. They operate their vehicles by pressing or releasing the accelerator and applying braking systems.
The diesel multiple units are fitted with a pneumatic braking system, which takes 3.5 to 4 seconds to become effective.
The locomotive driver of train no 600 who was involved in the railway accident had passed all the required qualifying examinations to operate diesel multiple units of the series 813; he was physically and mentally fit for driving, had had the statutory rest break between the two working shifts involved, and had not exceeded working hours in the shift.
The driver of the road vehicle, who sustained fatal injuries in the accident, was a holder of a statutory driving licence, category B, which complies with regulations for the operation of the road vehicle of this type. It was established during the investigation that the motorist was driving under the influence of alcohol. It was found during the post-mortem examination performed at the Institute of Forensic Medicine – which was ordered by the investigating judge and based on samples of bodily fluids – that the alcohol content in the driver's blood was 1.41 g/kg of alcohol of the lowest value, which had significantly impaired his physical and mental faculties. The driver thereby violated Article 130/4d-2 of the Road Traffic Safety Act-1.

3.7 Previous occurrences of a similar character

A similar accident had already occurred at this level crossing on 6 June 2002 at 11:50, when passenger train no 4210, also travelling from Nova Gorica station towards Jesenice, collided with

a passenger vehicle. The driver of the passenger vehicle suffered severe injuries in the accident, material damage was caused and rail traffic was halted for a shorter time.

4 ANALYSIS AND CONCLUSIONS

An analysis of the visibility of the LC-Solkan 1 level crossing was performed; the results obtained show that visibility at the time of the accident was reduced both for the passenger vehicle driver and for the locomotive driver, due to the weather conditions and night. The flashing road-traffic sign and the acoustic warning by means of a bell, both operating flawlessly at the time of the accident, were warning road users clearly enough of the approaching train. The impaired decision-making of the road vehicle driver, due to the influence of alcohol, and the reduced visibility due to heavy rainfall at the time of the accident are undoubtedly two reasons for the conduct of the passenger vehicle driver, which resulted in the accident.



Figure 4: View of the section directly ahead of the Solkan 1 level crossing from the direction of the Kayak Centre

4.1 Final account of the event chain

Taking into account the fact that the device protecting the LC-Solkan 1 level crossing at km 87+362 (illuminated road traffic signs with a bell), functioning flawlessly at the time of the accident, the car driver involved in the accident should have stopped his vehicle at the level crossing and yield right of way to train no 600 approaching the level crossing from the driver's right-hand side.

The driver had already been warned of the approaching level crossing by the I-40 traffic sign when travelling from the Kayak Centre direction along the Soča, at a distance of 80 m from the level crossing. The driver was additionally warned of the approaching danger by a road hump at a distance of around 50 m from the level crossing. The driver did not heed either of these warnings and was travelling in violation of the road-traffic regulations in force. Despite being warned of approaching a level crossing by a number of road signs and signals, and of the train also approaching the level crossing, the driver took no action and drove the vehicle in front of the train, which crashed into the middle of the car.

4.2 Discussion

Unimpaired physical and mental faculties are required for safe driving. Any factor impairing these

faculties can influence a driver's decision and this can prove fatal to the driver and other road users. Particularly dangerous moments in traffic are those when drivers encounter other much heavier means of transport. Such instances call for the utmost caution and level-headedness. Each instance of tempting providence usually proves fatal. Chiefly for reasons of personal safety, drivers must make absolutely sure at level crossings that there is no rail vehicle travelling along the track. Whenever drivers are warned by illuminated road signs or lowered barriers, these warnings must be heeded unconditionally; consequently, drivers must stop at the level crossing, yield right of way to rail vehicles and then wait for the device protecting the level crossing to return to the original position (barriers lifted, illuminated road sign off, ringing stopped), which signals the end of danger of a rail vehicle approaching the level crossing.

4.3 Conclusions

It was established during the investigation that non-observance of the right-of-way rule was the direct cause of the collision of train no 600 and the passenger vehicle at the level crossing between Anhovo and Nova Gorica stations, at km 87+362, protected with illuminated road-traffic signs switched on and operating correctly, thus warning road users of the approaching train.

The indirect cause of the accident was driving under the influence of alcohol (1.41 g/kg of alcohol of the lowest value in the driver's blood), which significantly impaired the driver's physical and mental faculties.

4.4 Additional observations

It was established during the investigation that the passenger vehicle driver was driving under the influence of alcohol, which considerably diminished his mental and physical faculties. The weather conditions at the time of the accident were another important factor. Due to rainfall and relatively high humidity, the vehicle windows had misted over, in all likelihood additionally impairing safe driving.

This is a well-lit level crossing, with two public lights nearby. The mixing of the light from the public lighting, the illuminated road signs and train headlights could, in the weather conditions at the time of the accident, be another cause of misjudgement on the part of the passenger vehicle driver regarding the train's distance from the level crossing.

4.5 Measures that have been taken

There is no record of any measures having been previously taken or taken as a result of the accident at this level crossing.

4.6 Recommendations

The existing protection of the LC-Solkan 1 level crossing, at km 87+362, between Nova Gorica and Anhovo stations, allows road users to safely cross the railway line – provided they comply with road traffic and railway regulations; there is therefore no need to raise the level of protection, given the volume of railway and road traffic at this level crossing.

To meet the requirements of traffic management, the railway infrastructure managing authority – Slovenske železnice d.o.o. – should develop two Instructions on the operation and handling of devices to protect LC-Solkan level crossings, 1 and 2, which will form part of the Station Rules of Anhovo and Nova Gorica stations. Both Instructions are to include sketches of the level crossing.

In compliance with the regulations in force, the job titles of the traffic-management staff handling signalling and safety devices must be corrected in the Operating instructions for the signalling and safety device at Nova Gorica railway station on the Jesenice-Sežana railway line, Slovenske železnice, SVTK Pivka – 70120.34 dated 5 May 2005, containing, *inter alia*, a description of the LC-Solkan 1 protection device as well as the operation of this device.

Article 57 of the Rules on traffic signs and equipment on public roads, Uradni list RS No 56/2000 dated 31 May 2000, must be amended to include a description of the flashing of illuminated signs

at the level crossings (the frequency of flashing: 60 flashes per minute) and a description of the acoustic signal warning, which rings with the frequency of light flashing.

5 REFERENCES

Railway Transport Act (official consolidated text), Uradni list RS No 44/2007 dated 21 May 2007
Safety of Railway Transport Act, Uradni list RS No 61 dated 10 July 2007
Articles 50 and 51 of the Safety of Railway Transport Act (official consolidated text), Uradni list RS No 56/2008 dated 6 June 2008.
Traffic Rules, Uradni list RS No 123 dated 28 December 2007
Signalling Rules, Uradni list RS No 123 dated 28 December 2007
Rules on brakes, safety devices, special devices and equipment of railway vehicles, Uradni list RS No 122 dated 28 December 2007
Rules on railway level crossings, Uradni list RS, No 85/2008 dated 29 August 2008
Rules on traffic signs and equipment on public roads, Uradni list RS No 46/2000 dated 31 May 2000

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