



KÖZLEKEDÉSBIZTONSÁGI
SZERVEZET

TRANSPORTATION SAFETY
BUREAU

FINAL REPORT

2007-0047-5 SERIOUS RAILWAY ACCIDENT

**Between Almásfüzitő and Komárom stations
6 February 2007**

The sole objective of the technical investigation is to reveal the causes and circumstances of serious railway accidents, accidents and incidents and to initiate the necessary technical measures and make recommendations in order to prevent similar cases in the future. It is not the purpose of this activity to apportion blame or liability.

This present investigation was conducted on the basis of

- Act CLXXXIV of 2005 on the technical investigation of aviation, railway and marine accidents and incidents (hereinafter referred to as Kbt.),
- MET Decree 7/2006. (II. 27.) on the regulations of the technical investigation of serious railway accidents, railway accidents and incidents.
- In absence of other related regulation of the Kbt., the Transportation Safety Bureau of Hungary conducted the investigation in accordance with Act CXL of 2004 on the general rules of administrative authority procedure and service,
- Kbt. and MET Decree 7/2006. (II. 27.) jointly serve the compliance with the following EU acts:
 Directive 2004/49/EC of the European Parliament and of the Council of 29 April 2004 on safety on the Community's railways and amending Council Directive 95/18/EC on the licensing of railway undertakings and Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification (Railway Safety Directive)
- The competence of the Transportation Safety Bureau of Hungary is based on the Kbt. until 31st December 2006 and on Government Decree 278/2006 (XII. 23.) from 1st January 2007 respectively.

Under the aforementioned regulations

- The Transportation Safety Bureau of Hungary shall investigate serious railway accidents.
- The Transportation Safety Bureau of Hungary under its discretion can investigate railway accidents and incidents which - in its judgement - would have resulted in serious accidents in other circumstances.
- The technical investigation is independent of any administrative, infringement or criminal procedures.
- This present final report shall not be binding, nor shall an appeal be lodged against it.

Incompatibility did not stand against the members of the IC. Persons participating in the technical investigation did not act as experts in other procedures concerning the same case and shall not do so in the future.

The IC shall safe keep the data having come to their knowledge in the course of the technical investigation. Furthermore, the IC shall not be obliged to make the data – regarding which the owner of the data could have refused the disclosure of the data pursuant to the relevant act – available to other authorities.

This present final report

was based on the draft report prepared by the IC and accepted by the Director-General of TSB. The draft report was sent to the relevant parties - defined by law - for reflections. At the same time, the relevant parties and organisations were also informed and invited to the closing discussion of the draft report.

The following organisations were represented at the closing discussion which was held on 5th August 2008:

- National Transport Authority,
- MÁV Zrt.
- MÁV-Trakció Zrt.
- MÁV Zrt. (Safety Directorate)
- ÖBB Traktion GmbH

Abbreviations

DB	German Railways
MET	Ministry of Economy and Transport
(GKM)	(Gazdasági és Közlekedési Minisztérium)
TSB	Transportation Safety Bureau
Kbvt.	Act CLXXXIV of 2005 on the technical investigation of aviation, railway and marine accidents and incidents
MÁV Zrt.	Magyar Államvasutak Zártkörűen működő Részvénytársaság (Hungarian State Railways Plc.)
ÖBB	Austrian Federal Railways
IC	Investigating Committee

SUMMARY

Reports and notifications

The head of traffic operations control of MÁV Zrt. reported the occurrence to the TSB duty services at 19 hours 00 minutes on 6th February 2007.

The on duty personnel of TSB

- reported the occurrence to TSB's head of department on duty at 19 hours 01 minutes, then
- to the duty personnel of MET.

The appointment of the Investigating Committee

The Director-General of TSB immediately appointed the following Investigating Committee (hereinafter referred to as IC) to investigate the serious railway accident:

investigator-in-charge	Zita Béleczi	accident investigator
members of the IC	Ferenc Pataki	field investigator technician
	László Gelléri	accident investigator
	Iván Lócsi	accident investigator
	György Kulcsár	accident investigator
	Róbert Karosi	accident investigator
	András Mihály	accident investigator

The IC membership of György Kulcsár terminated on 1st August 2007, since then he is no longer the civil servant of TSB.

The IC membership of László Gelléri terminated on 31st December 2007, since then he is no longer the civil servant of TSB.

The classification of the occurrence

Legal basis of the investigation: Article 19 (2) of Directive 2004/49/EC
7.§ (1) ac) of Act CLXXXIV of 2005 (Kbvt.)

Type of railway system: national

Type of main occurrence: serious railway accident

Character:: collision of trains

Consequences: ☒ Fatal
☐ At least 5 seriously injured persons
☒ Damage of at least HUF 500 million

Type of movement: regional passenger train and freight train

Location category: open track

Injuries:

	<i>Fatal</i>	<i>Serious</i>	<i>Minor</i>	<i>None</i>
<i>Passengers</i>	-	2	4	<input type="checkbox"/>
<i>Railway staff</i>	1	-	2	<input type="checkbox"/>
<i>LC users</i>				<input checked="" type="checkbox"/>

<i>Trespassers</i>				<input checked="" type="checkbox"/>
<i>Others</i>				<input checked="" type="checkbox"/>

Infrastructure manager: MÁV Zrt.

Operator: MÁV Zrt.
MÁV Cargo Zrt.

Category of the occurrence

Serious railway accident

Time of the occurrence

6th February 2007. 18 hours 43 minutes

Figure 2: Location of the accident

1. Factual information

1.1. Course of the event

On 6th February 2007 at 18 hours 43 minutes, between Almásfüzitő and Komárom stations at section no. 998+42, EUREGIO passenger train no. 9438 running from Tatabánya to Wien Südbahnhof (Vienna Southern Railway Station) with a speed of approximately 101 km/h collided with freight train no. 45224 which was running in front of the passenger train in the same direction with the speed of 9-10 km/h.

The engine driver of the passenger train died at the site of the accident, two passengers suffered serious injuries, another four passengers, the chief ticket inspector of the passenger train and the engine driver of the freight train suffered minor injuries. The electric locomotive (registration number 1116-017) of the passenger train owned by ÖBB sustained serious damage. 5 cars of the DB-owned freight train derailed, 4 of which sustained serious damage. The right track of the railway line sustained serious damage in approximately 120-meter-length, while the left track sustained less serious damage in approximately 30-meter-length. The catenaries over both tracks broke and two catenary supports fell.

It was found in the course of the investigation that the line signal box between Almásfüzitő and Komárom stations did not operate normally and the block signals were dark at the time of the accident.

As an immediate preventive action, TSB issued a recommendation to the NSA that the traffic operation staff should have the opportunity to switch over to “station-distance traffic” as soon as possible (even before the arrival of the technical staff) - if circumstances require doing so. Furthermore, the IC suggested that the light signal should be considered unserviceable if the signalling (reporting) on its normal operation ceases.



Figure 3: Site of the accident

1.2. Injuries to persons

Injuries	Staff	Passengers	Others
Fatal	1	-	-
Serious	-	2	-
Minor	2	4	-

The origin of the injuries:

Four passengers suffered minor injuries:

- As a consequence of the collision, a passenger sitting in the first carriage hit his/her head against the seat headrest.
- As a consequence of the collision, the skin over the eyebrow of a passenger sitting in the third carriage broke and his/her ankle got sprained.
- A passenger sitting in the fourth carriage suffered knee injuries, while another passenger in the same carriage suffered head, neck, shoulder and leg injuries as well as rib-contusion and concussion.

As a consequence of the collision, *the engine driver of train no. 45224* fell backwards, as a result of which he suffered knee-contusion and concussion.

Two passengers suffered serious injuries:

- As a consequence of the collision, a passenger sitting in the fourth carriage repeatedly hit his/her head against the seat, as a result of which he/she suffered concussion as well as strains in his/her back and arm.
- The IC has not received information on the other passenger who suffered serious injuries.

1.3. Damage to railway vehicles

- The electric locomotive of **ÖBB** (registration number 1116-017) sustained extensive damage,
- **Damages to the freight train:**
Reg. no. 31 80 495 4752-0 flat car derailed, and
Reg. no. 31 80 356 0015-0,
Reg. no. 31 80 451 5433-9,
Reg. no. 31 80 453 6061-3,
Reg. no. 21 80 442 6644-1 flat cars derailed and sustained extensive damage as they heaped up on one another and on the locomotive.

The IC did not receive information on the final amount of the damages by the completion of the draft report, however, it was ascertained at the site that this amount exceeded HUF 500 million (Euro 2 million).

1.4. Damage to infrastructure

- The right track of the railway line sustained serious damage in approximately 120-meter-length, while the left track sustained less serious damage in approximately 30-meter-length.
- The catenaries over both tracks broke and two catenary supports fell.
- The environment did not suffer damage. The trains did not transport dangerous goods.

The IC did not receive any information about further damage by the completion of the investigation.

The IC did not receive information on the final amount of the damages by the completion of the draft report.

1.5. Personnel information

Engine driver of train no. 9438

- 49-year-old man
- Qualification: railway mechanics technician, had passed electric engine driver examination in 1979, since then, he worked as an engine driver.
- Medical certificate valid until 18th January 2009.
- Regularly attended recurrent professional courses.
- He was in possession of a so called 'type-examination' certificate (for this type of locomotive) as well as accomplishing the compulsory 'line-knowledge' train journeys.

Other railway personnel involved

- signal box chief engineer (since 2002),
- chief of local signal box staff (since 2002),
- movements inspector at master signal box (in this position since 1995, employee of MÁV Zrt. since 1980),
- movements inspector at master signal box (in this position since 1997, employee of MÁV Zrt. since 1994),
- chief at master signal box station (in this position since 1975, employee of MÁV Zrt. since 1971).

1.6. Train information

Train number	9438
Train type	EUREGIO passenger train
Registration number of locomotive	1116-017
Owner of locomotive	ÖBB
Owner of carriages	ÖBB
Number of carriages	4
Registration number of carriages	50 81 29 35 522-0, 50 81 29 35 414-0, 50 81 29 35 108-8, 50 81 29 35 106-2
Length of train	95 m
Tonnage	150 t
Full weight	236 t
Prescribed braked weight percentage	126
Actual braked weight percentage	132

The IC did not find any entry in the technical log of electric locomotive no. 1116-017 which would have adversely affected the operation.

Train number	45224
Train type	freight train
Registration number of locomotive	V43-1333
Owner of locomotive	MÁV Zrt.
Number of cars	36

Length of train			695 m
Tonnage			709 t
Full weight			789 t
Prescribed	braked	weight	79
percentage			
Actual	braked	weight	101
percentage			

1.7. Meteorological information

At the time of the accident, the weather was calm with overcast sky. The outside temperature was approximately +5°C. The visibility was good with normal nightlight conditions. The distance visibility was normal.

As the meteorological conditions had no influence on the accident, their detailed description is not required.

1.8. Description of rail track and signal box

The structure of the rail track is of 60 kg per linear metre rail fitted on reinforced-concrete sleepers in ballast chips. The target speed for the line is 120 km/h. The permitted speed on the rail track was 100 km/h at the time of the accident.

The rail track runs in a right bend from Szőny station to approximately section no. 995, and then it is straight until and beyond the site of the accident (998+42). Compared to ground level, the rail track at the site of the accident lies on an approximately 4-6-metre-high embankment, in a sparse woody, bushy environment.

The site of the accident was not lit by outdoor source of light.

Track irregularities had no effect on the accident.

VES type electrodynamic signal box operates at Komárom station.

Due to its construction, the installation does not have a built-in system for registering operations.

The signal box of Komárom station had no effect on the accident, therefore its detailed description is not required.

Signal boxes at Almásfüzitő station

There is a 'Domino 55' type installation whose controlled area extends to Almásfüzitő and Almásfüzitő interchange stations. An 'Alcatel ESTW Elektra' type electronic signal box at Almásfüzitő felső station is connected to the Domino 55 signal box from the direction of the start point and endpoint of main line no. 1. The 'Alcatel ESTW Elektra' type electronic signal box is under direct dependence on the Domino 55 installation. The signal boxes are operated and controlled by a Domino control panel and electronic control surface installed in the traffic operation office.

Four block sections from the direction of Tata (start point), and three block sections from the direction of Komárom (endpoint) follow the station.

In the block section from the start point direction (Tata), there are light signals with longitudinal barriers and signals for the control and protection of level crossings (the target speed of the rail track in this block section is 160 km/h). In the endpoint block section (from the direction of Komárom) there are light signals with longitudinal barriers but without signals for the control and protection of level crossings (the target speed of the rail track in this block section is 120 km/h).

From the start point (Tata direction), automatic light signal and half barrier no. AS871 reports (line-clear messages) to Almásfüzitő station, while automatic light signal and half barrier no. AS855 reports to Tata station.

From the endpoint (Komárom direction), automatic light signal and half barrier no. AS947 – controlled from the station – reports to Almásfüzitő station, while automatic light signal and half barrier no. AS1005 reports to Komárom station.

The controlled area of D55 type signal box

At the start point side, the area controlled by D55 type signal box extends to entry signal "G" towards Tata and entry signal "A" towards Neszmély, while on the endpoint side it extends to entry signal "H".

Towards and from Almásfüzitő felső, platforms II-XI receive and also dispatch trains. The train service runs on traction platform IV connecting Almásfüzitő felső and Almásfüzitő.

Platforms XII and XIII are controlled by 'ALCATEL-ELEKTRA' type electronic signal box of Almásfüzitő felső station.

The controlled area of ESTW Elektra type electronic signal box

At the start point side, the area controlled by ESTW Elektra signal box extends to entry signal "B" of the right track, entry signal "C" of the left track, while at the endpoint side it extends to entry signal "D" of the right track and entry signal "E" of the left track. Towards Domino 55 type installation, it extends to signal "F" at the start point of the passenger station and to signal "J" at the endpoint of the station.

There are light signals with longitudinal barriers and signals for the protection of the level crossings of the station.

Lines fitted with 75 Hz coded track circuit automatic block signals are connected to the station at both ends.

Towards Domino 55 type installation it controls contra flow traffic.

Power supply of Domino 55 type signal box

A KDE-76 type power supplier provides the required voltage levels for the operation of the signal box.

I-5 inverter and its secondary inverter producing 220 V 75 Hz used in KDE-76 type power supplier - supplying the signal box of the line and ensuring the reports from Komárom station from Almásfüzitő direction (3 block sections and light signal no. AS1005) - were exchanged with PQ type inverters in 2005.

Power supply of station signal box

The installation is supplied by the public utility electric network on 3x400/230 V 50 Hz voltage. In the event of electric network interruption, it automatically switches over to a current generator network operated by diesel motor which starts automatically.

In the event of the failure of both the electric and the diesel network, I-5 inverters connected to a 2x48 V secondary battery supply the insulation of the switches and the electrically insulated rails of the reception sidings at the stations. In this case, both the station signals and the repeater circuits of the control panels of the signal boxes are supplied this way.

Power supply of line signal boxes

Inverters operated by a rectifier convert 3x400/230 V 50 Hz voltage to 220 V 75 Hz voltage.

In the event of electric network interruption, the inverters (I-5 and PQ) are supplied by a 48 V secondary battery, thus the supply of the line installations is uninterrupted. The 220 V 75 Hz voltage received from the inverters is converted to 500 V 75 Hz voltage by a transformer located in the same case as the inverters.

In the direction of Tata, the KDE-76 I-5 inverters provide the 75 Hz-supply on the line.

In the direction of Komárom, the PQ inverters provide the 75 Hz-supply on the line.

In the direction of Tata and Komárom, the 500 V 50 Hz-supply of light signals of the line is provided from Almásfüzitő station.

Signal boxes of the line

Automatic light signals on the line

In the railway section concerned, there is no installation which has a built-in system for registering operations.

The report on general “error signalling”

The errors in the installation are indicated by an acoustic signal. Furthermore, a white light turns on next to the ‘acoustic signal switch-off button’ in case of an error.

The acoustic signal indicating the error can be switched off by pressing the ‘acoustic signal switch-off button’. However, the white light continues to be on until the error ceases or is corrected.

If there was one error in the installation and the acoustic signal has been switched off, the installation does not indicate the occurrence of further errors either by acoustic signal or by another light signal until the correction of the first error.

A light over the ‘acoustic signal switch-off button’ continues to be on until all the errors have been corrected.

The power supply of ESTW Elektra electronic signal box

The main power supply is provided by the 3x400/230 V 50 Hz town electricity network. As a spare network, there is an automatic diesel aggregator which can also produce 3x400/230 V 50 Hz voltage. The power supply system can receive a portable diesel aggregator as well.

Operation of signals and signal boxes and statements regarding the automatic data recording of these installations

Station signal boxes

Domino 55 type all-relay interlocking box at Almásfüzitő station

Due to their construction, D 55 type signal boxes do not have a built-in system for registering operations.

ALCATEL EWST Elektra type electronic signal box at Almásfüzitő station

The installation has its own, built-in system for registering operations. It registers and stores the reports on the state and changes of the block sections and barriers of the line in the direction of Tata and Komárom stations and to Almásfüzitő station. The data of 6th February 2007 do not contain any entry regarding electric network interruption.

1.9. Communications

Both locomotives were fitted with locomotive radios which were operating normally. The engine driver of EUREGIO passenger train no. 9438 tested the radio before departure at Tatabánya station. According to the voice recorder, the radio worked normally. Subsequently, however, the voice recorder did not record any verbal communication until the occurrence of the accident.

The engine driver of freight train no. 45224 communicated through the locomotive radio before and after the occurrence of the accident. The radio worked normally.

Communications equipment had no effect on the accident, therefore their detailed description is not necessary.

Telecommunication

The telecommunications equipment worked adequately at the time of the accident. There was no entry in the error logs regarding deficiencies.

At the read-out of the recordings of voice recorders operated by Telecommunications Operation Sub-department at Operations Control Centre (16 Kerepesi út, Budapest) the IC found the following:

- The clock of the voice recorder was 2 (two) minutes fast (therefore the IC regarded the time of the recordings reduced by 2 minutes).
- The telephones (landline and mobile) used by the dispatcher at the "right side" signal box of 'Budapest Nyugat' ('Budapest West') are not connected to the data recorders – owing to lack of space – therefore their read-out was not possible.
- The communications - through mobile phone - of the engine drivers to the section controllers and to the locomotive running foremen are not recorded on the voice recorder, therefore their read-out was not possible.
- The 24-hour voice recording of the 163 MHz radio channel contains only noises.
- At present, there is a modern data recorder operating in test mode in the telecommunications office of the Operations Control Centre (16 Kerepesi út, Budapest), which is capable of recording various types of communications (mobile phone, landline, locomotive radios, etc.)

1.10. Station information

The characteristics of the station had no effect on the accident, therefore their detailed description is not required.

1.11. Data recorders of trains

Electric locomotive (registration number 1116-017) of ÖBB is equipped with a DEUTA DSK-20 system data recorder which operated normally at the time of the accident. There was no entry in the technical log regarding any technical deficiency which would have affected the operation of the locomotive.

The IC requested from ÖBB Railway Company the installation and maintenance documents of the data recorder of the locomotive. ÖBB complied with the request and sent these documents to TSB. These documents prove that the re-examinations of the data recorder had been regular and adequate. There was no data in the documents indicating deficiencies.

A TELOC system electromechanical data recorder operated on the electric locomotive (registration number V43-1333) of train no. 45224. The measuring limit of the recording tachometer is 150 km/h, and the measuring limit of the strip chart recorder inside the tachometer is 120 km/h. The time, the speed and the recordings on the electromechanical strip chart recorder are clearly visible and can be evaluated.

The chronometers of the locomotives showed a 6-minute-deviation compared to each other (the chronometer of locomotive V43-1333 was late by this scale).

An employee of MÁV Zrt. removed the data recorder tape from locomotive 1116-017 of ÖBB without the permission of TSB and that of the police. The information on the data recorder was read-out at the site by the expert of Siemens AG.

1.12. Tests and research

Results of tests and research conducted at Almásfüzitő station on 27th February 2007

- After switching off E-11 type charger of KDE-76 type power supply, a “general error” acoustic signal came on and a light signal appeared on the control panel of Domino 55 type signal box. The acoustic signal was stopped by pressing the ‘acoustic signal switch-off button’. When switching the charger back on, the light signal automatically ceased.
- By switching off the PQ type inverters, the error situation - same as it had been experienced on 6th February 2007 - could be evoked. All block sections in the direction of Komárom became virtually (falsely) occupied. Furthermore, the 75 Hz insulated rail sections („D/SR1” and „E/SR1”) - which turn the endpoint entry signals of Almásfüzitő felső to “Stop” position and thus induce trains to stop - also became virtually occupied owing to lack of 75 Hz reference input. By way of instrumental measuring, the IC established that while the „D/SR1” 75 Hz insulated rail section was virtually occupied, the 1-cycle signalling was uninterrupted on both the transmitter and the receiver sides (from entry signal “D” to level crossing “SR1”). Therefore, the vigilance warning devices and train control installations of all trains departing from the station with call signal detected the 1-cycle (yellow) signalling.

1.13. Organisational and management information

The engine driver of EUREGIO passenger train (no. 9438) finished work at 8 hours 00 minutes on 4th February, prior to the accident. He was off duty from 00:00 to 24:00 on 5th February. He started work at 9 hours 38 minutes on 6th February, so the required rest time was provided for him. This schedule is in accordance with the previously issued schedule plan.

The driver's cab of 1116-series electric locomotive is well designed in ergonomic aspects. Its transport safety installations comply with the regulations of both ÖBB and MÁV Zrt.

It was found in the course of the investigation that block section of Tatabánya signal box employs 5 persons, which is a sufficient number for performing the daily required troubleshooting tasks. However, these 5 persons can perform only a part of the maintenance work. The on-duty service can only be done by supplementing this workforce with employees from the engineering staff. Consequently, some of the personnel on duty do not have the required experience. So it happened that the person on duty (having come to correct the error) went past two switched off battery chargers (“E-11” type) - on which ‘low battery level’ error signal was indicated - without noticing its error signal. He then requested the assistance of the chief of the signal box staff via telephone. However, the IC found in the course of the investigation that the accident could not have been avoided even if the troubleshooting had been faster as the power supply could not have been switched back on immediately due to the low discharge of the batteries.

1.14. Additional information

The organisation of the traffic:

Since the appearance of the virtual occupation signal at 17 hours 45 minutes, trains were signalled out from Almásfüzitő station with call signal according to the previously set directions, in block section spacing order.

From 17 hours 45 minutes until train no. 9438 departed from Almásfüzitő felső station, trains were running according to the received signals, without problems.

Having noticed that the block signals were dark, the engine driver of freight train no. 45224 informed the competent section controller about this fact through the locomotive radio.

The section controller confirmed that block section distance traffic had to be maintained and trains had to run with reduced speed.

Securing of the site:

Having arrived at the location, the police enclosed the site of the accident. Nevertheless, a number of unauthorised persons - not participants of the investigation or the averting of damages - were inside the enclosed space while site surveys (for criminal and administrative proceedings by the authorities) were in progress.

2. Analysis

The staff of the signal box service arrived at Almásfüzitő station on 6th February 2007 (daytime) to search for and localise errors on the ALCATEL installation. At the same time, maintenance work was being performed on the power supply device, during which the chief of the signal box staff switched off the “E-11” type battery chargers - which provide the uninterrupted power supply of the signal box - in order to ‘rouse’ the 48 V storage batteries (quickly recharging them after a voltage drop) according to maintenance technology. In such circumstances, the installation does not indicate “power supply error” as the incoming main current is not missing and the inverters are still operating. During the maintenance work, the staff received a notification that they had to leave for troubleshooting elsewhere. When leaving the site, they forgot that the battery chargers had been left switched off and that further on the inverters („PQ”, „I-5” and 400 Hz inverters) had been operating from the weakening (constantly losing their capacity and voltage) 48 V storage batteries.

In the course of the subsequent tests (see 1.12), after switching off “E-11” type battery chargers (as a consequence of the adequate voltage drop of the storage batteries) a so called “general error signal” appeared on the control panel of Domino 55 type signal box. This general error is indicated by an acoustic signal and a white light. This light is next to the ‘acoustic signal switch-off button’ inscribed with the word “ZAVAR” (“ERROR” in English) – see Figure 4 below. The movements inspector on duty - who was also responsible for the control panel of the signal box - pressed the “ERROR” button automatically, without finding out the reason inducing the acoustic signal. However, the white light signal remained on. He was unable to answer to the question of the IC as to what might have caused the error. When the IC switched the battery chargers back on, the error signal automatically ceased, that is, the white light went out.

As the Domino 55 type signal box does not have a built-in system for registering operations, the operation and the errors cannot be checked subsequently. There was no entry in the error log regarding operational problems or errors. Presumably, the signal box personnel on duty in the morning of the day of the accident had handled the error similarly, and - disregarding the importance of the error signalling - did not inform the other signal box colleagues. Once the error signalling came on due to any error (e.g. burnt out light-bulb, etc.) and the signal box personnel switched off the ERROR button - however the white light continued to be on - a further error (in case of switching off the chargers) could not have been indicated either by acoustic signal or by another light signal – according to the construction of the error circuit. Therefore the signal box personnel could not have perceived a further error. The IC did not find entry in the error log regarding such further error.

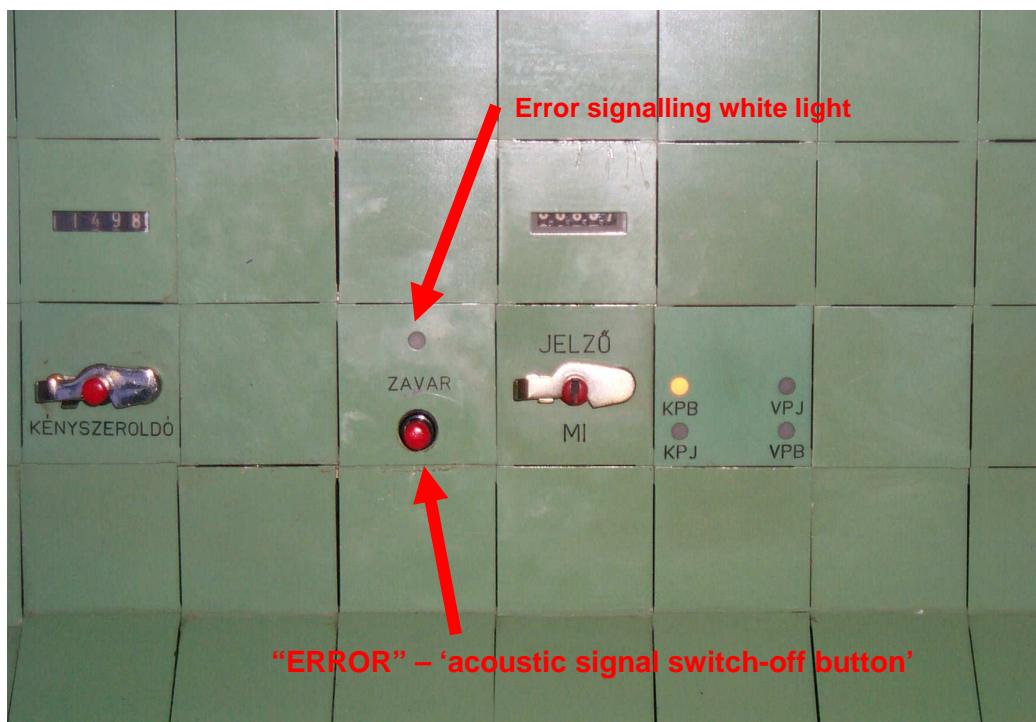


Figure 4: Control panel of Domino 55 type signal box

In the meantime, railway traffic was undisturbed on the line all day. The maintenance staff went home after work. It was growing dark while the capacity and voltage of the batteries were gradually decreasing. When reaching the previously set lower limit of battery voltage, the “PQ” type 75 Hz inverters automatically stopped (however, the “I-5” type 75 Hz inverters - which supply the insulated rails of Almásfüzitő station - were still operating as they require lower voltage level). Consequently, the power supply of the line in the direction of Komárom ceased. The block signals of both tracks between Almásfüzitő and Komárom stations became dark at 17 hours 45 minutes. The continuous signalling for trains in the 3-3 block sections of both tracks of the line ceased. „D/SR1” and „E/SR1” 75 Hz insulated rail sections of Almásfüzitő station (insulated rail sections turning the entry signals to “Stop” position - and thus inducing trains to stop) became virtually (falsely) occupied owing to lack of reference input (which is also produced from the voltage of “PQ” type 75 Hz inverters). The control panel of the signal box at Almásfüzitő station indicated the occupancy of the 3-3 block sections of both tracks in the direction of Komárom. Due to the above mentioned occupancies, trains running from the direction of Komárom station to Almásfüzitő station could only be signalled out with entry call signal, while trains running from Almásfüzitő station to the direction of Komárom station could only be signalled out with exit call signals. Furthermore, the signs indicating (reporting) the state of the line from Almásfüzitő direction on the control panel at Komárom station became dark, thus there was no information on the state of the block sections, neither the running directions nor the open track automatic light signal and half barrier no. AS1005. Therefore, trains departing from Komárom station towards Almásfüzitő could only be signalled out with exit call signal. At approximately 17 hours 54 minutes, open track light signal and half barrier no. AS947 at Almásfüzitő station - which are normally controlled from the station - was closed manually for trains running on either track. The light signal and half barrier were reopened nearly 3 hours later, after the occurrence of the accident.

At this time (contrary to the entry in the log used for registering the handing over of duties) already the movements inspector on the night shift was on duty at Almásfüzitő station. He reported the error to the signal box dispatcher who acknowledged the error report with a '225' code. The movements inspector of Almásfüzitő station entered this into the error log. The signal box chief of Komárom station telephoned the movements inspector of Almásfüzitő at 17 hours 59 minutes asking him whether he had informed the signal box dispatcher about the error. He told the signal box chief that he had done so and had received the '225' code. The signal box chief of Komárom station did not enter this fact into the error log and he told this information only verbally the other signal box chief to whom he handed over the duty for the night shift at approximately 18 hours 20 minutes (according to the entry in the log, he handed over the duty at 19 hours).

The dispatcher at the "right side" signal box of 'Budapest Nyugat' ('Budapest West') notified the signal box technical staff of Tatabánya as well as the signal box technical staff on duty at service post XII of Komárom station about the error. The Komárom staff on duty went to service post VI where they established that the signal was dark due to no supply from Almásfüzitő station. As the error could not be corrected at Komárom station, they returned to their posts. The on duty signal box staff arrived at Almásfüzitő station to correct the error. They entered the power supply room with their own key and with the traffic staff's knowledge. One of them went into the traffic office. The exact time of their arrival is unknown as they did not take off the sealed key of the relay room and therefore neither the time of taking the key off nor the start of the troubleshooting was entered in the log. Having entered the power supply room of D-55 type signal box, they went past the two switched off ("E-11" type) battery chargers and went to the "PQ" inverter (situated left from the charger) and opened its door. The door of the „PQ” inverter opens to (in front of) the case of the battery chargers, thus after opening this door, there is even less chance to notice the "Low battery level" signals - two red lights which were on at the subsequent test also - on the battery chargers.



Figure 5: E-11 type battery charger

As the “PQ” inverters had stopped (both the main and the secondary inverter), after telephoning and agreeing with the chief of the signal box staff and having suspected a short circuit in the cables on the line (without measuring the voltage levels), they tried to restart the inverters by disconnecting the 500 V 75 Hz output wire which supplies towards Komárom. However, the inverters still did not start. The reason why the inverters did not start was the lack of input voltage. At approximately 19 hours 00 minutes, the signal box dispatcher notified the signal box staff on duty that an accident had occurred in which a train had collided with the rear of another train between Almásfüzitő and Komárom stations. Subsequently, the technical staff reconnected the 500 V 75 Hz output wire which supplies towards Komárom and then they went to the traffic office. The driver set off to collect the chief of the signal box staff. The personnel on duty in the traffic office and the movements inspector noticed that according to the control panel of D-55 signal box, the insulated rail sections became virtually occupied one after another. At the same time, the capacity and voltage level of the 48 V storage batteries further decreased to a voltage level that was too low for the operation of the „I-5”- type 75 Hz and 400 Hz inverters. This was indicated on the control panel of Domino 55 by consequently appearing virtual (false) occupancies. Having noticed the above, the on duty personnel telephoned the chief of the signal box staff again and told him about the occurred situation. Hearing this information, the chief suddenly remembered that the chargers which had been switched off in the morning were not switched back on. He informed the on duty personnel about this fact, who tried to restart the charger but it was not possible until he raised the voltage level in the flat 48 V storage batteries by a so called manual charger. Then he was able to switch on the automatic battery chargers again which could charge the batteries to the required level. After reaching the required voltage level, the „PQ”, the I-5” and the 400 Hz inverters restarted and the disruption ceased. Thus only the actually occupied insulated rail sections remained indicated.

After the virtual occupancy signal, Almásfüzitő station signalled out trains with call signal running in block sections according to the previously set directions on the right track towards Komárom station.

Since 17 hours 45 minutes, the signals indicating the block sections between Komárom and Almásfüzitő stations as well as the line clear signal of no. AS1005 open track light signal and half barrier became dark on the signal box of Komárom station. From then on, Komárom station signalled out trains with call signal running in block sections according to the previously set directions on the left track towards Almásfüzitő station. Having reviewed the 'Written orders book', and having interviewed the personnel concerned, the IC found that the movements inspector of Komárom station had found the operation of open track light signal and half barrier no. AS1005 worrying and he notified - by entering this fact in the 'Written orders book' - the personnel of trains no. 9301 and 9323 departing from Komárom that the light signal and half barrier were unserviceable. Furthermore, he also notified the personnel of train no. 9433, however, this train did not run further on due to the occurrence of the accident. Nevertheless, he did not ask the movements inspector of Almásfüzitő station to notify the personnel of trains departing from Almásfüzitő station as, according to 3.15 point of no. F.2 Traffic Regulations in force at the time of the accident, light signals shall not be considered unserviceable in such cases.

Train no. 45224 departed Almásfüzitő station also with call signal running in the direction of Komárom. The 711-metre-long freight train with the electric locomotive (registration number V43-1333) departed from the station with the speed of approximately 9-10 km/h and was running with the same speed until the occurrence of the accident. The front of the train consisted of 14 empty box cars to which 22 empty flat cars were attached in the rear. The reflector type disk indicating the end of the train had been placed onto the last car and was found at the site of the accident.

EUREGIO train no. 9438 departed from Almásfüzitő station at 18 hours 30 minutes and arrived at Almásfüzitő felső at 18 hours 33 minutes from where it departed at 18 hours 34 minutes with the call signal of V12b exit signal. The train passed by the signal with a speed of 10-12 km/h – according to the regulations in force – and a red light signal appeared on the signal of the engine driver's cab. Subsequently, the train was running with this speed until insulated rail section D/SR1 which turns the endpoint entry signals to "Stop" position, then when running on the insulated rail, a yellow light signal appeared on the signal of the engine driver's cab. Normally, on D/SR1 insulated rail section - from "D" signal to SR1 light signal – there is a 75 Hz 1-cycle supply which is indicated by a yellow light signal on the repeating signal of the engine driver's cab. Responding to this yellow signal, the engine driver accelerated the train to 31 km/h, but when passing the "D" entry signal of the endpoint, the red signal reappeared and the train control installation stopped the train by automatic application of the brakes.

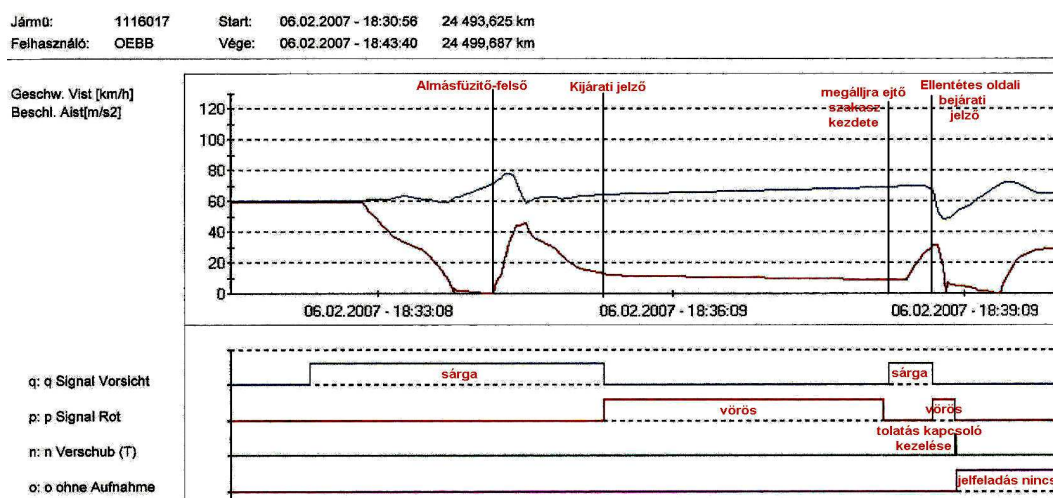


Figure 6: Recordings of the strip chart recorder of the locomotive (registration number 1116-017)

Based on the data read-out from the data recorder of the locomotive, it can be expressly established that 4 minutes after stopping, the train was put into 'shunting mode' (by applying the 'shunting mode handle' which is located in the driver's cab behind the engine driver on the left) for one minute, and then it was set back to 'train' mode. Consequently, the train control installation of the locomotive "forgot" the 15 km/h speed limit and further on it operated as if the train was running on a rail track section built without continuous signalling, and it did not serve its speed limiting function.

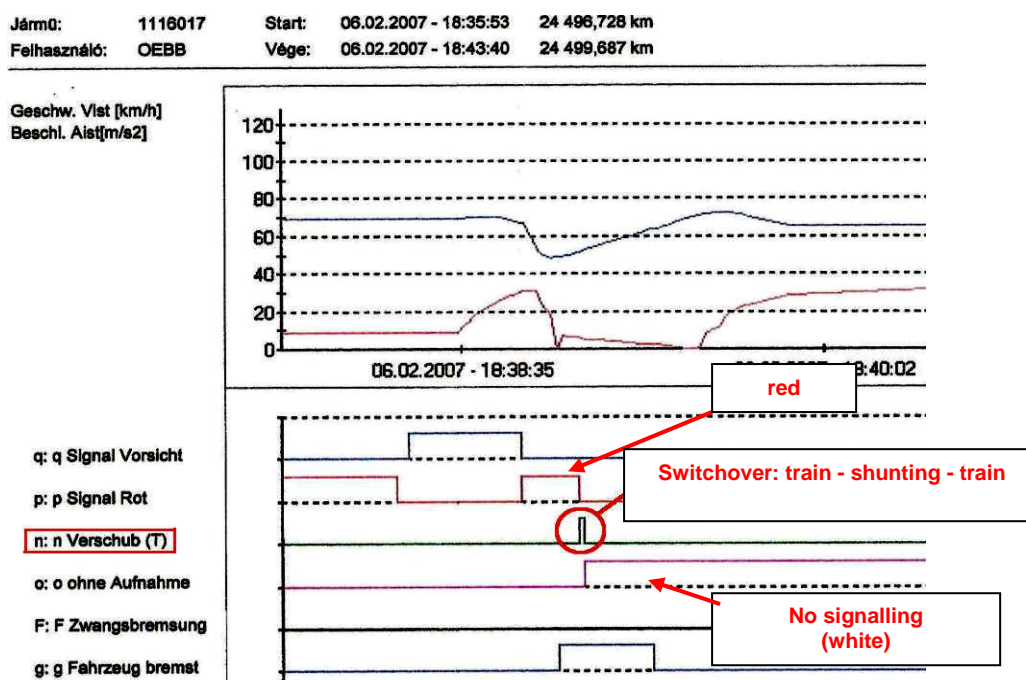


Figure 7: The train/shunting/train' switchover signal indicated on the recordings of the strip chart recorder

This switchover can be done in the front driver's cab - where the engine driver was - by a definite movement, which excludes the possibility that the switchover happened owing to circumstances beyond the engine driver's control.

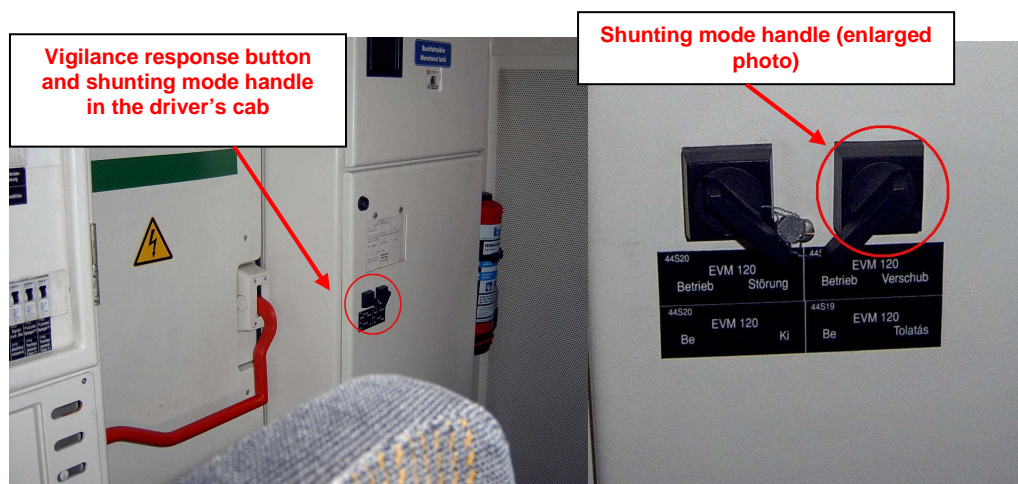


Figure 8: The location of the shunting mode handle in the driver's cab

After releasing the brake equipment, train no. 9438 restarted while freight train no. 45224 was running by the platform of Szőny station. Approximately at the same time, the engine driver of train no. 45224 made a call through the locomotive radio to the section controller and told him that all block signals were dark and he inquired as to why they had not switched over to station distance spacing order. He received the answer that the traffic regulations do not permit this, and trains had to run with the maximum speed of 15 km/h in such cases. The engine driver expressed his worry that an accident is likely to occur.

After restarting train no. 9438, the engine driver accelerated the train to 22 km/h and then – due to the track conditions – it reached the speed of 42 km/h at Szőny station, significantly exceeding the speed limit (still 15 km/h). However, at this time the train control installation did not interfere into the operation of the train due to the above mentioned switchover.

Train no. 9438 stopped at Szőny station according to schedule. At this time, freight train no. 45224 was approximately 450-500 metres in front of it, running with a speed of 9-10 km/h. Beyond Szőny station, the rail track runs in a right bend surrounded by sparse woods and bushes, therefore the end of the freight train was not visible in the dark night from the locomotive of the train at Szőny station.

Train no. 9438 departed from Szőny station at 18 hours 43 minutes. According to the data recorder of the locomotive, the train departed with intensive acceleration. Subsequently, at 18 hours 43 minutes 10 seconds, the engine driver responded to the first vigilance signal (acknowledged it) while he was gradually accelerating. At 18 hours 43 minutes 39 seconds, the engine driver stopped the tractive power, and then at 18 hours 43 minutes 41 seconds (before developing brake force) the train running with the speed of 101 km/h collided with the end of freight train no. 45224 which was running in front of it with 9-10 km/h speed.

ADS3 Nyersadatok - [c:\...\01772081.116] - Osszes adat - Maradékút tár.1

Jármű: 1116017 Start: 06.02.2007 - 12:44:30 0,000 km

Felhasználó: OEBB Vége: 06.02.2007 - 18:43:41 257,175 km

Adatok az útpozícióhoz 257,175: Zug-Nummer: 9438; Tf-Nummer: 2232973

					q q Signal Vorsicht j j MAV Betrieb p p Signal Rot k k Notbremse EVM n n Vershub (T) l l Betriebsart 160 o o ohne Aufnahme F F Zwangsbremsu F F Zwangsbremsu n n Vershub (T) g g Fahrzeug brems u u EVM MAX c c Makrofon o o ohne Aufnahme m m Makrofon EVM										
					Vist Geschw. Vist [km/h] Aist Beschl. Aist[m/s ²] BVZ Bremsverz. [m/s ²]										
Út/km	Idő	Vist	Aist	BVZ	q	p	n	o	F	g	c	m	Slight acceleration		
257,104	06.02.2007 - 18:43:38	100	0,235	—	—	—	—	o	—	—	—	—	j	—	o
257,116	06.02.2007 - 18:43:39	101	0,145	—	—	—	—	o	—	—	—	—	j	—	o
257,124	06.02.2007 - 18:43:39	101	0,097	—	—	—	—	o	—	—	—	—	j	—	o
257,133	06.02.2007 - 18:43:39	101	0,059	—	—	—	—	o	—	—	—	—	j	—	o
257,141	06.02.2007 - 18:43:40	—	—	—	—	—	—	o	—	—	—	—	j	—	o
257,149	06.02.2007 - 18:43:40	101	-0,001	—	—	—	—	o	—	—	—	—	j	—	o
257,158	06.02.2007 - 18:43:40	101	-0,009	—	—	—	—	o	—	—	—	—	j	—	o
257,166	06.02.2007 - 18:43:40	101	0,002	—	—	—	—	o	—	—	—	—	j	—	o
257,166	06.02.2007 - 18:43:40	—	—	—	—	—	—	o	—	—	—	—	j	—	o
x 257,175	06.02.2007 - 18:43:41	101	-0,014	—	—	—	—	o	—	—	—	—	j	—	o

o = no signalling, j = MÁV service, l = operation capacity up to 160 km/h

Figure 9: Recordings of the data recording and storing device – the last seconds of the operation of train no. 9438

Having evaluated the recordings of the data recorder of the locomotive (registration number 1116-017), the IC established that the engine driver stopped the traction approximately 34 meters before the collision. Based on the above described active, definite movements of the engine driver, it can be stated that the engine driver could not have become inert prior to the accident.

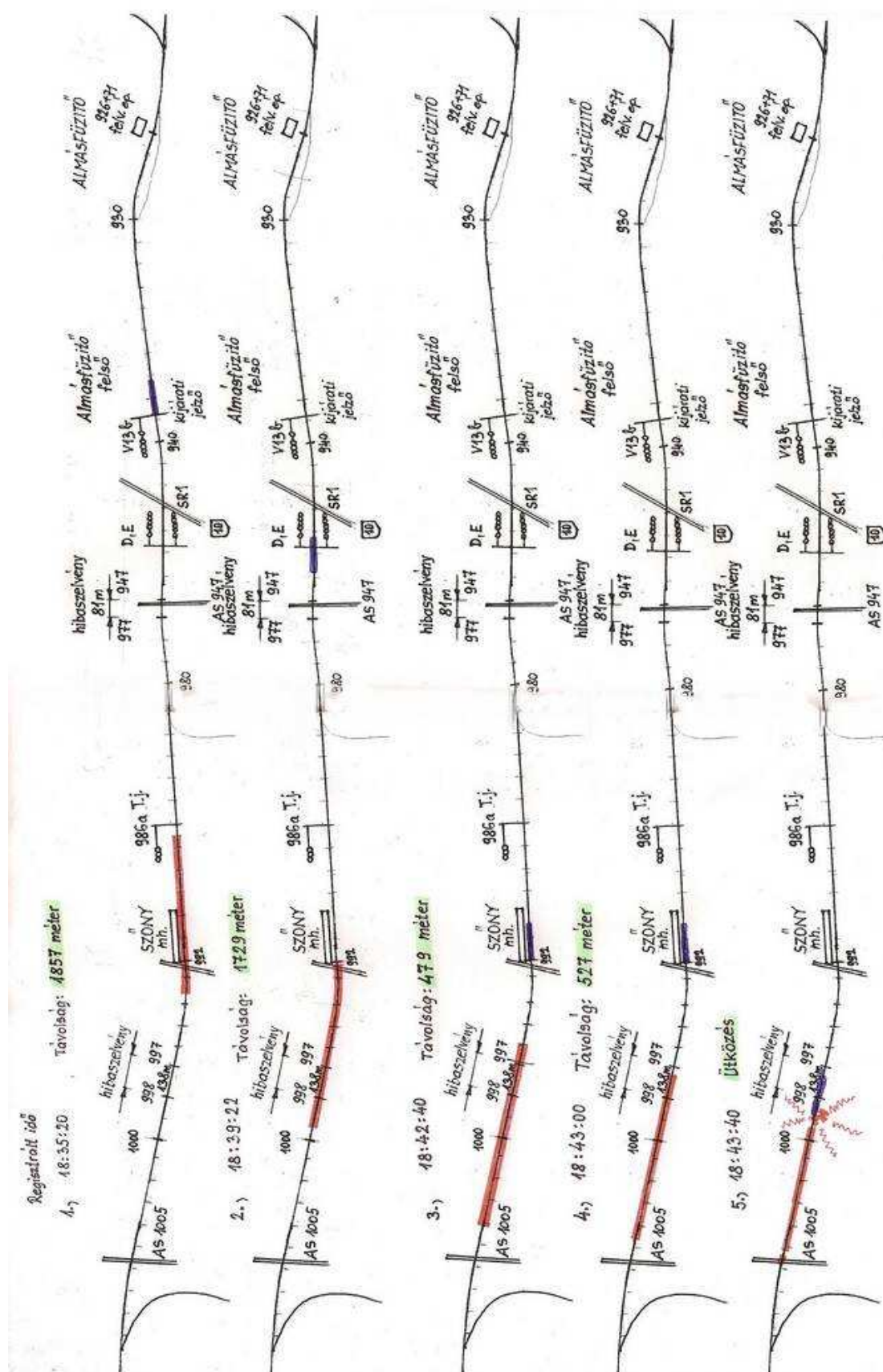


Figure 10: The position of train no. 45224 (red) and train no. 9438 (blue) prior to the accident

At approximately 18 hours 45 minutes, the on duty personnel of Szőny station reported via telephone that he had heard a loud banging sound from the direction of Komárom station. Approximately 1 minute later, the section controller instructed the movements inspectors of both stations that they shall not signal out any train because an accident had occurred.



Figure 11: Consequences of the accident

In the course of the investigation, an assumption came to the knowledge of the IC that the engine driver might have received information through his mobile phone regarding the traffic conditions prior to the accident. At the request of the IC, the police obtained data from the mobile phone service provider - with attorney's permission - , which clearly disproved this assumption.

3. Conclusions

3.1. Wrong procedures and measures

The direct cause of the occurrence of the accident was the switching the “EVM 120 vigilance warning device and train control installation” of the locomotive of train no. 9438 over to shunting mode and back to operation. As a result of this act, the train control installation stopped functioning as a speed limiting device and therefore the train exceeded the speed limit six-sevenfold.

The indirect causes of the occurrence of the accident:

- E-11 type battery charger of KDE-76 type power supply installation was not switched back on.
- The traffic regulations in force at the time of the accident did not permit the switchover to 'station-distance traffic' which would have been safer in the given situation (see the communication between the engine driver of train no. 45244 and the section controller as well as the text below Figure 8). For more detailed description, see 3.2.

3.2 Rules and regulations

- *According to 15.37 of F.2. Traffic Regulations in force at the time of the accident, the automatic block signal is unserviceable if*
 - *“it is not possible to reverse directions and therefore trains have to run (have to be signalled out) contrary to the previously set direction,*
 - *the signal box personnel have previously switched off the line signal box and therefore all the block signals are dark.”*

In this case there was no opportunity to switch over to the safer 'station-distance spacing order' which permits the running of only one train at a time between two stations. In 'station-distance spacing order' the frequency of trains on one track does not decrease significantly as the trains can run with higher speed, and at the same time the level of safety is increasing.

- 3.15. of F.2 Traffic Regulations defines the term of 'unserviceability of the open track and station light signals'. However, this definition does not include the case when it is not possible to ascertain the operating conditions of the light signals by evaluating the light signal buttons (reports) on the signal box.

3.3 Additional remarks

The station log (used for registering the handing over of duties) and the error log were not kept adequately - as prescribed - (a number of arrival and departure times were not entered into the logs and several entries were illegible). Due to the insufficient data recording and illegible handwriting, it is not possible to gain information.

On 12th October 2007 TSB (personally) informed the relatives of the deceased engine driver - as they requested - about the course of the investigation. They raised the question as to whether it might have been possible that a line-clear message appeared for a moment on the block signals between Almásfüzitő felső and Komárom, but this signal was not indicated/registered on the data recorder of the locomotive. The IC has established that this could not have happened owing to the construction of the signal box. As there were trains in each block section, even if the installation had 'revived', a red light would have appeared on the block signals. However, this situation could not have occurred as the storage battery was flat to such degree that when switching the input

back on, it started to supply the line with delay – after reaching a certain level of recharge.

4. Safety recommendations

4.1. Immediate preventive actions

On 19th February 2007, the IC suggested the following immediate preventive actions and issued safety recommendations to the National Transport Authority:

BA2007-0047-5-01: Until new regulations are issued, the IC recommends that F.2 Traffic Regulations should be complemented with the following: in track sections installed with automatic block signals, if it is not possible to ascertain the traffic conditions by evaluating the light signals (reports) on the signal box, the switchover to station-distance traffic should be ordered. Furthermore, the IC recommends a new regulation which permits the traffic operation staff to switch over to “station-distance traffic” before the arrival of the technical staff - if circumstances require doing so.

BA2007-0047-5-02: The IC recommends that F.2 Traffic Regulations should be further complemented with the following: light signals should be considered unserviceable, if the signalling (reporting) on their normal operation ceases.

4.1.1. Measures taken

BA2007-0047-5-01 immediate preventive action: The National Transport Authority accepted this recommendation and it was then included in 15.4.2.1. of F.2 Traffic Regulations coming into force on 6th April 2008.

BA2007-0047-5-02 immediate preventive action: This recommendation was indirectly included in the Traffic Regulations as follows: in case of the failure of the light signals on the signal box, the personnel shall act as prescribed in the Operating Manual. The IC requested the Operation Manual of a railway station at random, in which there was no such regulation. At the closing discussion of the draft report the representative of MÁV Zrt. told the IC that the revision and amendment of the Operating Manuals were in progress and MÁV Zrt. was going to check them.

4.2. Further safety recommendations

Based on the findings of the investigation, the IC issues further safety recommendations as follows:

BA2007-0047-5-03: The IC recommends railway undertakings operating traction vehicles to work out a solution to be able to control switchovers from train mode to shunting mode on the train control installations of locomotives and other traction-vehicles by checking the recordings of strip chart recorders – automatically where possible. This way, engine drivers would be obliged to operate the installation as prescribed.

Particular attention should be paid to check the operating of these installations as when the checks are not frequent and therefore the chance to reveal non-compliance with the rules is less, it is more likely that engine drivers act contrary to the rules. If the checkings were more effective, non-compliance would be revealed easier and therefore infringements were less frequent.

BA2007-0047-5-04: The IC recommends railway undertakings employing engine drivers that in the recurrent education of engine drivers, particular attention should be paid to special solutions and principles of signal boxes and train control installations which influence their daily work. (E.g. the recognition of the yellow light signal recorded by EVM 120 vigilance warning device and train control

installation on insulated rail sections turning D/SR1 entry signal to “Stop” position at Almásfüzitő station.)

The IC considers it important that engine drivers should be aware of technical solutions and processes differing from the usual, as this way, misunderstandings can be avoided and there is less chance to make decisions - owing to a possible wrong evaluation of the situation - that endanger safety.

4.2.1. Observations and opinions

BA2007-0047-5-03 safety recommendation: According to **MÁV Zrt. and MÁV-TRAKCIÓ Vasúti Vontatási Zrt. (Railway Traction Co.)**, the above mentioned switchovers can be and are checked at random at present.

Based on the final discussion of the draft report, it can be established that the effectiveness of the current checkings is questionable. According to the statement of the representative of MÁV TRAKCIO Zrt., recordings from a month period prior to the accident had been thoroughly checked and approximately 100 infringements had been revealed. In the view of the representative, this is not a significant ratio (less than 1% of the checked recordings). However, it means over 1000 occasions annually, which might lead to serious injuries and endanger the life of numerous people.

BA2007-0047-5-04 safety recommendation: At the closing discussion, the representatives of MÁV-TRAKCIÓ Zrt. noted that it was not obvious to them what the contents of the curriculum they should teach were. The participants of the discussion clarified and agreed that the curriculum should be compiled in agreement with the operators and maintenance organisations of the railway vehicles and the infrastructure concerned as they have the required expertise.

The representatives of MÁV-START Zrt. did not comment on the draft report; they acknowledged its contents.

Budapest, 12th August 2008.

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