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NATIONAL AIR, MARITIME AND RAILWAY TRANSPORT, ACCIDENTS
INVESTIGATION BOARD (NAMRTAIB)

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FINAL REPORT

from

**investigation of railway accident – fire in locomotive № 91520044202-7, serviced international
fast train № 464 between the stations Zmeyovo – Tulovo on 01.12.2023**



2024

OBJECTIVE OF INVESTIGATION AND EXTENT OF RESPONSIBILITY

In accordance with the requirements of Art. 22, of DIRECTIVE (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 regarding the safety of railway transport and a Decree of the Council of Ministers of the Republic of Bulgaria, was established an independent investigation body, National Air, Maritime and Railway Transport Accidents Investigation Board (NAMRTAIB) within the Council of Ministers, structured in three professional fields of the investigation of accidents in aviation, maritime and railway transport.

The investigation body referred to in Art. 22 in accordance with the requirements of Art. 20 of DIRECTIVE (EU) 2016/798 of the European Parliament and of the Council, the Railway Transport Act (RTA) and Ordinance No. 59 of 5.12.2006 on the management of safety in railway transport is guaranteed to carry out an independent investigation of significant accidents, accidents and incidents. The purpose of the investigation is to determine the causes, make safety improvements and prevent further accidents in the rail transport.

The investigation is performed in accordance with the requirements of art. 21 of DIRECTIVE (EU) 2016/798 of the European Parliament and of the Council, and with reference to para 4 is independent from each judicial investigation and does not involve the determination of guilt or liability.

The investigation report and related safety recommendations issued in accordance with Art. 26 of DIRECTIVE (EU) 2016/798 to the operators in the sector, in no case do not create a presumption of guilt or responsibility for the accident and in the context of the pre-trial proceedings.

The Investigation report is prepared as per the requirements of REGULATION (EU) 2020/572 of the Commission dated 24 April 2020 on the reporting structure for railway accident and incident investigation reports.

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ABBREVIATIONS, USED IN THE REPORT

TDRC – Train dispatching radio connection
VTU – Higher school of transport „Todor Kableshkov“ – Sofia
MAS – Main air switch of the locomotive
TOS – Train operation schedule
BDZ PS EOOD – „BDZ-Passenger services“ EOOD – state operator for passengers
SE NRIC – State entity „National railway Infrastructure Company “(railway infrastructure manager)
RS – Railway section – a Division within the railway infrastructure manager
RTA – Railway Transport Act
TOU – Traffic organization unit within the railway infrastructure manager
EI – Electric interlocking in WP 4
km – Kilometre along the rail track
OCL – Overhead contact line (catenary)
SPR – Small periodical repair
IFT – International fast train
Ordinance № 58 – on the rules for the technical operation, train traffic and signalling in the rail transport
Ordinance № 59 – Ordinance on the rail transport safety management
NAMRTAIB – National Air, Maritime, and Railway Transport Accidents Investigation Board
(Independent Accident Investigation Body of the Republic of Bulgaria)
RAEA/NSA – Railway Administration Executive Agency, National Safety Authority
TF – Task Force, established by the railway infrastructure manager
SE – Signalling equipment
SABS – Semi-automatic block system
RRS – Rail Rolling Stock
FEI – Fire-extinguishing installation
FAI – Fire-alarm installation
RSPSM – Rail self-propelled specialized machine of the railway infrastructure manager
TOMR – Train operation management and reporting
RD MoI – Regional directorate of the Ministry of Interior
RS FSaCP – Regional service Fire Safety and Civil Protection at MoI
SCM – Structure in charge of maintenance
SMS – Safety Management System
TI – Technical inspection of a locomotive
TOSAMD – Train operation and station activity management Division – division at the railway infrastructure manager
DCCM – Device for communications, connections and messages
PTC – Professional training centre at, Holding BDZ EAD
PRC-Personnel requalification centre for the staff of SE NRIC

1. Summary

1.1. Brief description of the event.

On 01.12.2023, at 07:32 a.m., IFT No. 464 arrived at Zmeyovo station consisting of 2 coaches, 8 axles, 88 tons with locomotive No. 91520044202-7. The train run with a delay of 5 minutes and after a delay of 1 minute, it departed at 07:33 a.m. An order form II-A was handed over for the movement of the train under special conditions, with the exit signal closed due to the repair of the railway switches at the Zmeyovo station. The movement of trains between Zmeyovo station and Tulovo station was provided by a telephone mode. Rolling stock and staff of the BDZ-Passenger Services EOOD railway undertaking serviced the train. The train run daily on the TOS from Dimitrovgrad station to Gorna Oryahovitsa station.

During the movement of the train between the Zmeyovo and Tulovo stations, before the neutral insert, the locomotive's MAS turned off. The driver stopped the train at 07:46 a.m. at km 226+900 and attempted to turn on the MAS, but without success. Through the window of the engine compartment, he saw that there was thick smoke. He sprayed a fire extinguisher but failed to put out the fire. He activated the fire system from the first cabin, but it did not activate, and then proceeded to the second command cabin, but it was inaccessible due to the thick smoke coming from the engine compartment.

At 08:25 a.m., the locomotive driver informed the traffic manager on duty at the Tulovo station that the locomotive had caught fire and asked help to remove the train. The head of the Tulovo station called the national emergency number 112 and informed about the fire that had occurred.

At 08:25 a.m., the traffic manager at Tulovo station notified the train dispatcher of the Stara Zagora - Dubovo section about the situation.

At 08:55 a. m. an electric locomotive No. 91520044180-5 was sent from the third track of Tulovo station to the interstation to pull the train with the burning locomotive from kilometre 226+900 to a suitable place to ensure access for the specialized fire-fighting vehicles of RS FSaCP at kilometre 226+642 where the locomotive fire extinguishing started.

At 09:24 a. m. the energy, dispatcher from Plovdiv TOU turned off the voltage in the catenary.

At 09:25 a.m. from RS FSaCP - Kazanlak and Stara Zagora, fire-fighting vehicles arrived at the scene and started extinguishing the locomotive.



Fig. 1.1. Locomotive № 91520044202-7 with IFT № 464 at km 226+642 between the stations Zmeyovo and Tulovo

At 11:30 a.m. the fire in the locomotive was extinguished.

At 12:40 p.m. IFT № 464 was towed from the interstation with locomotive № 91520044180-5 on 9-th track in Tulovo station.

On 07:46 a.m. to 14:41 p.m. the train movement between Zmeyovo and Tulovo was interrupted.

There were no injured passengers and personnel, material damages were caused to the locomotive. Material damages were caused to the railway infrastructure.

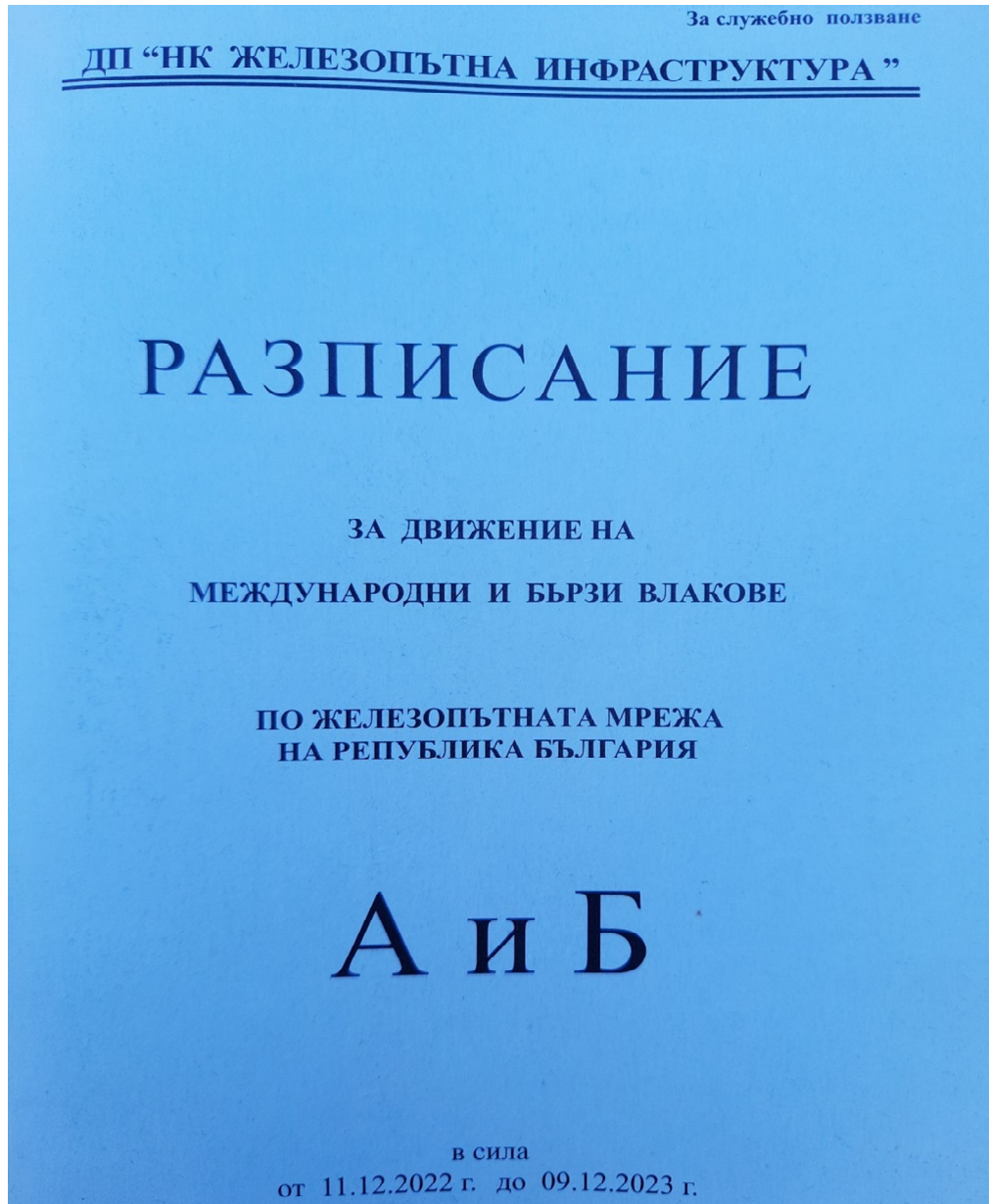


Fig. 1.2. Booklet schedule for the movement of international and fast trains for the period from 11.12.2022 to 09.12.2023

МБВ 464 300т 115% лок44							БДЖ-П
		ДИМИТРОВГРАД				06:00	
3.7	70	ДИМИТРОВГРАД СВ	5	06:05	1	:06	
12.8	40	МЕРИЧЛЕРИ	21	:27	1	:28	
1.9		МЕРИЧЛЕРИ СП	3.5	:32	0.5	:32	
8.5		ДИМИТРИЕВО	13.5	:46	0.5	:46	
6.7		МИХАЙЛОВО	12	:58	1	:59	
8.0	130	КАЛОЯНОВЕЦ	5	:	-	07:04	
14.4		СТАРА ЗАГОРА	8	07:12	1	:13	80580
5.4	75	КМ 247+700	5	:	-	:18	
8.8	65	ЗМЕЙОВО	9	:	-	:27	40621
13.1	75	ТУЛОВО	12	:39	1	:40	30131

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Fig. 1.3. Schedule for the movement of IFT № 464 – first part

МБВ 464							БДЖ-П
8.3	100	ДЪБОВО	8	07:48	9	07:57	3602
6.7	65	ЯВОРОВЕЦ	7.5	08:05	0.5	08:05	
10.1		РАДУНЦИ	13	:18	1	:19	
5.7		БОРУЩИЦА	7.5	:27	0.5	:27	
7.0		КРЪСТЕЦ	8	:35	4	:39	4631
3.1		БЪЗОВЕЦ	4.5	:44	0.5	:44	
13.6		ПЛАЧКОВЦИ	17	09:01	1	09:02	
3.7		БОЖКОВЦИ	4.5	:07	0.5	:07	
3.4		ТРЯВНА	4	:11	1	:12	
9.7		ЦАР. ЛИВАДА	14	:26	5	:31	4641
8.0		ДРЯНОВО	11	:42	1	:43	
4.8		ГАНЧОВЕЦ	7.5	:51	0.5	:51	
4.8		РП СОКОЛОВО	5.5	:57	0.5	:57	
7.5		ДЕБЕЛЕЦ	8	10:05	1	10:06	
6.6		ВЕЛИКО ТЪРНОВО	7	:13	1	:14	
8.4		САМОВОДЕНЕ	12	:	-	:26	
5.2		ГОРНА ОРЯХОВИЦА	9	10:35			
199.9			242		33		4ч. 35мин.

Fig. 1.4. Schedule for the movement of IFT № 464 – second part

1.2. Location and time of the event occurrence.

Between the stations Zmeyovo and Tulovo at km 226+900 at 07:46 a.m. a fire occurred in electrical locomotive № 91520044202-7, serviced IFT № 464. The locomotive driver stopped the train, and then auxiliary locomotive towed the train to km 226+642 for the locomotive extinguishing (fig. 1.5).



Fig. 1.5. IFT № 464, towed at km 226+642 (entrance signal at Tulovo station) by auxiliary locomotive № 91520044180-5

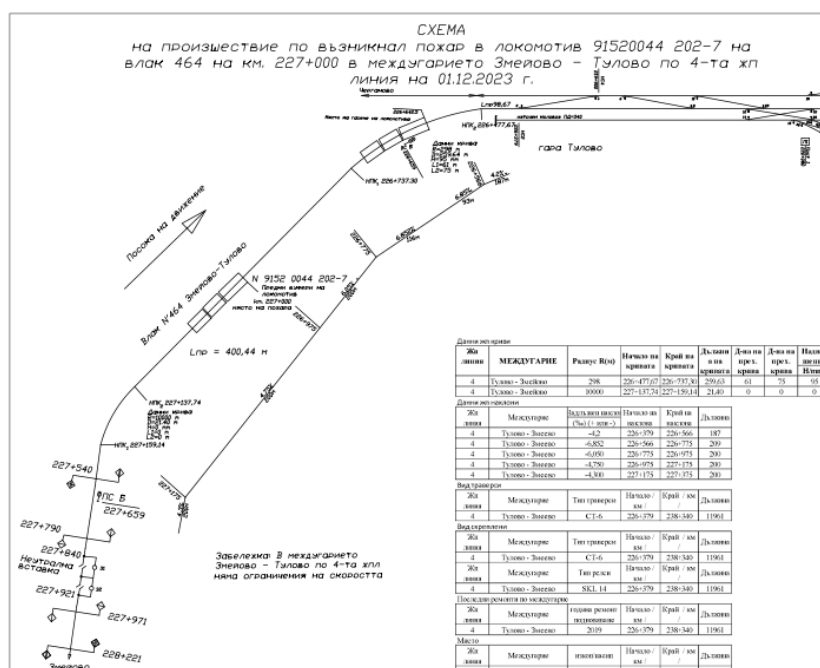


Fig. 1.6. Scheme of the fire occurrence in locomotive № 91520044202-7 between the stations Zmeyovo and Tulovo

1.3. Factors determining and contributing the event.

A determining factor to the occurrence of the accident was the continuous movement of the locomotive, respectively the train, without cooling the rectifier unit of the second group.

A contributing factor to the accident is probably also the lack of cooling the locomotive's rectifier in traction mode.

1.4. Direct causes and consequences of the event.

The most probable cause of the fire during movement in locomotive No. 91520044202-7, which serviced IFT No. 464, was the temperature overheating of the power unit 221, feeding the motor-compressor 235. The auxiliary rectifier 221, feeding the engine compressor, was not cooled at that time as the fans were turned off during the train movement on inertia.

When the engine driver activated the FEI, it did not work. That helped the fire to spread and caused material damage. Due to the heavy smoke in the engine compartment, extinguishing with manual fire extinguishers was not possible.

The consequences of the event were a significant fire and destruction of the main rectifier 022, as well as the auxiliary rectifiers 221 of the motor-fans and the motor-compressor of the second traction group of the locomotive.

1.5. Safety recommendations and addressees to which they are addressed.

In order to prevent other similar accidents, the Investigation Commission proposes to the National Safety Authority RAEA safety recommendations related to the railway undertaking “BDZ-Passenger Services” EOOD and SE NRIC.

- Recommendation 1, proposes that SE NRIC and "BDZ-Passenger Services" EOOD familiarize the interested personnel with the contents of the report;
- Recommendation 2 proposes that BDZ PS EOOD undertakes the replacement of electrolytic capacitors of the R-C groups with dry type capacitors of locomotive series 44 and 45;
- Recommendation 3 proposes that BDZ PS EOOD installs technical means (thermostats) for temperature control of rectifier groups 020 and 022 of locomotive series 44 and 45;
- Recommendation 4 that BDZ PS EOOD restores the power supply to the electronic unit for controlling the auxiliary machines Y2 from its own transformer 222, in accordance with the design schemes of the manufacturing plant for series 44 and 45;
- Recommendation 5 proposes that BDZ PS EOOD organizes and carries out renovation (overhaul) of the locomotives of series 44 and 45, which are due for overhaul.

2. Investigation

2.1. Decision for starting the investigation.

The decision to initiate the safety investigation was taken by the member of the Management Board of the NAMRTAIB in the Republic of Bulgaria, leading the investigation of railway accidents and incidents in accordance with art. 22, paragraph 3 of Directive (EU) 2016/798 of the European Parliament and of the Council. Given the severity of the accident and its impact on railway transport safety, the investigation is mainly focused on the finding of the causes and analysis, which aims to improve the safety, and to prevent other accidents.

2.2. Motives for the decision to initiate the investigation.

The member of the Management Board of the NAMRTAIB, leading the railway unit took the decision to initiate the investigation based on art. 20, paragraph 2 (a) and (c) of Directive (EU) 2016/798, art. 115к, paragraph 1, item 2 of RTA, and art. 76, par. 1, item 2 of Ordinance No 59 dated 5.12.2006.

The investigation was undertaken considering the circumstances that led to the fire in electric locomotive No. 91520044202-7 servicing IFT No. 464 during the movement of the train along an interstation, which resulted in material damage to the locomotive.

2.3. Scope and restrictions of the investigation.

The scope of the investigation included and analysed the organizational and human factors, the Safety Management System related to repair and maintenance, including the risk assessment with registered hazards of the traction rolling stock in the railway undertaking "BDZ-Passenger Services" EOOD and the normative acts to it.

Restrictions and delays during the investigation were not allowed, due to the rapid establishment of the causes of the fire in the locomotive.

2.4. Competences of the persons, involved in the investigation.

The member of the Management Board of the NAMRTAIB, head of railway transport field heads the Investigation Commission as per art. 22, paragraph 1 of Directive 2016/798. The members of the Commission are external independent experts - habilitated persons from the higher transport institutions and experts with qualification and professional orientation in fields of activity – human and organizational factor, railway infrastructure, rail rolling stock, and management and operation of the railway transport.

2.5. Communication and consultations with the persons and entities, involved in the event.

The Commission defined the parameters of the investigation and coordinated its actions with the Task Force, which includes heads of divisions and transport safety authorities of the two entities (BDZ PS EOOD and SE NRIC). The Task Force collected all the documents and samples, written statements of the personnel of the entities, the records from the recording devices of the locomotive No. 91520044202-7, which serviced IFT No. 464 on 01.12.2023. The materials and documents were provided to the head of the safety investigation at the NAMRTAIB. The Investigation Commission conducted an interview with the train staff (locomotive driver, assistant locomotive driver, the management of the Gorna Oryahovitsa Locomotive Depot) and got acquainted with the statements of the persons involved in the accident. BDZ PS EOOD additionally requested and provided information on the repairs and maintenance of the locomotive. Interviews were conducted with the safety authorities of the two entities, with the management of the railway undertakings BDZ PS EOOD and DP NRIC.

2.6. Degree of cooperation from the participating entities.

During the investigation on the part of the participating entities BDZ PS EOOD and SE NRIC provided full cooperation, and the necessary set of all the requested necessary materials and documents. Full access was provided to the burned locomotive No. 91520044202-7 at the Gorna Oryahovitsa Locomotive Depot for inspections, measurements and expertise.

2.7. Methods and techniques of investigation and analysis.

On 01.12.2023 at 10:15 a.m., the member of the Management Board of the NAMRATIB with competence to investigate railway accidents received a verbal notification on the mobile phone from the dispatcher on duty of BDZ PS EOOD. At 12:20 p.m. there was a written SMS notification from the on-duty senior dispatcher of the manager of the railway infrastructure (SE NRIC) about an accident that had occurred - damage to locomotive No. 91520044202-7, servicing IFT No. 464.

After instructions given by the member of the Management Board of the NAMRATIB with the competence to investigate railway accidents, inspections were organized and conducted at the accident site with representatives of the Ministry of Internal Affairs of Kazanlak, the railway undertaking BDZ PS EOOD and SE NRIC. A protocol was drawn up after the inspections.

At 12:40 p.m., written permission was given by the authorities of the RD of the Ministry of Interior of Kazanlak to carry out emergency recovery activities and release the burnt locomotive from supervision.

On 01.12.2023, locomotive No. 91520044202-7 was moved from the Tulovo station to the Gorna Oryahovitsa locomotive depot (place of residence).

In the period 02 ÷ 03.12.2023, the Investigation Commission of the NAMRATIB went to the Locomotive Depot Gorna Oryahovitsa, where it conducted an interview with the locomotive crew, which operated locomotive No. 91520044202-7, servicing IFT No. 464 on 01.12.2023 and together with the heads of BDZ PS EOOD in operation and repair of rolling stock and in safety, started an investigation to establish the circumstances and causes that led to the ignition of the locomotive. The commission carried out comprehensive inspections from the outside and in the engine compartment of the burned locomotive No. 91520044202-7. The burned machines and aggregates were dismantled from the engine compartment, which were subjected to additional inspections and measurements to establish their technical condition.

In the period 11÷13.12.2023, the Investigation Commission of the NAMRATIB in the Gorna Oryahovitsa Locomotive Depot conducted a second interview with the locomotive driver who operated locomotive No. 91520044202-7 for further clarification of the circumstances. The speedometer tape was removed from the recording device of locomotive No. 91520044202-7 and handed over to the head of the commission in order to decipher the information for the needs of the investigation. An external expert, a member of the Investigation Commission, deciphered the data from the speedometer tape for the movement of the locomotive, respectively the train.

On 13.12.2023, the head of the safety investigation at the NAMRATIB received from the head of the Task Force at TOSAMD - Gorna Oryahovitsa the collected materials and documents regarding the railway accident - a fire occurred in locomotive No. 91520044202-7, servicing IFT No. 464 on 01.12.2023.

The Investigation commission at the NAMRATIB continued the investigation of the accident until the causes were established and a final report was prepared.

2.8. Difficulties faced during the investigation.

During the investigation, the Investigation Commission of the NAMRATIB did not encounter any difficulties. The representatives of the Task Force and the safety authorities of the Railway Infrastructure Manager and the Railway Undertaking provided full cooperation to the safety Investigation Commission.

2.9. Interaction with the judicial authorities.

As per the Agreement, effective from 11.04.2023 on the Interaction between the bodies of the pre-trial proceedings and NAMRATIB, the DPO – Kazanlak, did not initiate a pre-trial proceeding for the accident.

2.10. Other important information for the investigation context.

During the movement of IFT No. 464, serviced by locomotive No. 91520044202-7 on 01.12.2023 at the Zmeyovo - Tulovo interstation, the train moved by inertia with a slope of the rail track 6.85 ‰ downhill. The engine compartment cooling fans of the locomotive had been turned off; causing the room temperature to rise significantly and that caused a short circuit in auxiliary rectifier unit 221.

3. Description of the event

3.1. Information on the event and the context.

3.1.1. Description of the event type.

On 01.12.2023 at 07:32 a.m., IFT No. 464 arrived at Zmeyovo station in a composition, 2 coaches - 8 axles - 88 tons and locomotive No. 91520044202-7, served by a locomotive driver and assistant locomotive driver and transport crew - train master and conductor. After a delay of 1 minute, the train departed at 07:33 a.m. with a delay of 5 minutes for the delivery of an order form II-A for the departure of the train from the station with a closed exit signal due to the repair of the railway switches at the Zmeyovo station. On that day, the movement of trains between Zmeyovo and Tulovo stations was provided by telephone mode. The train run daily according to the TOS schedule from Dimitrovgrad station to Gorna Oryahovitsa station. Staff and rolling stock of the railway undertaking „BDZ-Passenger Services“ EOOD served it.

During the movement of the train between Zmeyovo and Tulovo stations, before the neutral insert at km 228+221, the locomotive's MAS was switched off. The locomotive driver tried to turn it on after passing the neutral insert, but failed. He decided that the pressure in the tanks was low. Turned off all consumers and turned on the auxiliary compressor. He stopped the train at km 226+900 and attempted to turn on the MAS, which were unsuccessful.

Through the window, he saw that the engine compartment of the locomotive was heavily smoky. Sprayed a powder fire extinguisher in the engine compartment but failed to extinguish the fire, activated the fire extinguishing system but it did not switch on.

At 07:50 a.m. the train master contacted the traffic manager on duty at Tulovo station and informed him that black smoke was coming from the locomotive.

At 08:19 a.m., according to the information of the energy dispatcher in TMU Plovdiv, a disconnection of the voltage was registered in the traction substation supplying the catenary in the Zmeyovo - Tulovo section. At 08:20 a.m. the voltage in the catenary was switched on automatically.

At 08:25 a.m., the locomotive driver contacted the traffic manager on duty at the Tulovo station on the mobile phone and asked help to remove the train from the interstation. After 1 minute, it reconnected and asked for help due to the locomotive ignition.

The head of the Tulovo station notified the national emergency number 112 about the fire that had occurred.

At 08:30 a.m. the train dispatcher of the Stara Zagora - Dabovo section was notified of the fire by the traffic manager on duty at the Tulovo station.

At 08:41 a.m., the traffic manager on duty at Tulovo station exchanged a telephone message with the locomotive driver of locomotive No. 91520044202-7 to send auxiliary locomotive No. 91520044180-5 to collect IFT No. 464 at the station.

At 08:46 a.m. the train dispatcher at the Tulovo - Zmeyovo interstation stopped the movement of trains and vehicles with the exception of auxiliary locomotive No. 91520044180-5.

At 08:55 a.m., locomotive No. 91520044180-5 departed from the third track for the interstation and pulled IFT No. 464 from kilometre 226+900 to kilometre 226+642 to ensure access of the specialized cars of RS FSaCP to the burning locomotive.

At 09:19 a.m., the locomotive driver requested the disconnection of the voltage in the catenary from the energy dispatcher at TMU Plovdiv.

At 09:24 a.m. the energy dispatcher at TMU Plovdiv turned off the voltage in the catenary.

At 09:25 a.m., 3 fire fighting vehicles from the Kazanlak Railway Station arrived at the scene and started extinguishing the fire, and 3 more from the Stara Zagora Railway Station, which were involved in extinguishing the locomotive.

At 11:30 a.m. the fire in the locomotive was extinguished.

At 12:01 p.m., the voltage in the catenary was switched on.

At 12:40 p.m., IFT No. 464 with the burned locomotive No. 91520044202-7 was collected with auxiliary locomotive 91520044180-5 at the Tulovo station.

At 13:07 p.m., the head of the Tulovo railway section entered in the dispatcher's order log that the railway track and facilities from km 226+900 to km 226+642 were ready for the movement of trains and vehicles at the scheduled speed.

At 13:36 p.m., a train and electrical window were allowed to inspect the catenary in the Tulovo - Zmeyovo interstation from km 226+900 to km 226+642 with RSSPM No. 99529436513-6 in the "Electrical Distribution Tulovo" sub-district.

At 14:37 p.m., a catenary technician at Tulovo station wrote in the dispatcher's order log that the catenary was functional and voltage was applied.

At 14:41 p.m., the train dispatcher restored the movement of trains and vehicles at scheduled speed.



Fig. 3.1. Route of IFT № 464 and the place of the accident

- - Origin station of IFT № 464;
- - Main stations along the train alignment;
- - Final destination station of IFT № 464;
- Place of the accident;
- - Track, which IFT № 464 has passed;
- - Track, which IFT № 464 has been about to pass;

3.1.2. Date, punctual time and place of the event.

On 01.12.2023 at 07:37 a.m. IFT No. 464 was moving in the Zmeyovo interstation in the direction of Tulovo station. At 07:46 a.m., the locomotive driver stopped the train in the interstation at km 226+900, due to failures in the locomotive and the occurrence of a fire in the locomotive. The rail track was straight and had a profile with a slope of 4.75 ‰ downhill (Fig. 3.1).

The route of IFT No. 464 moved along main line No. 4 in the direction Dimitrovgrad – Stara Zagora – Gorna Oryahovitsa (fig. 3.2).

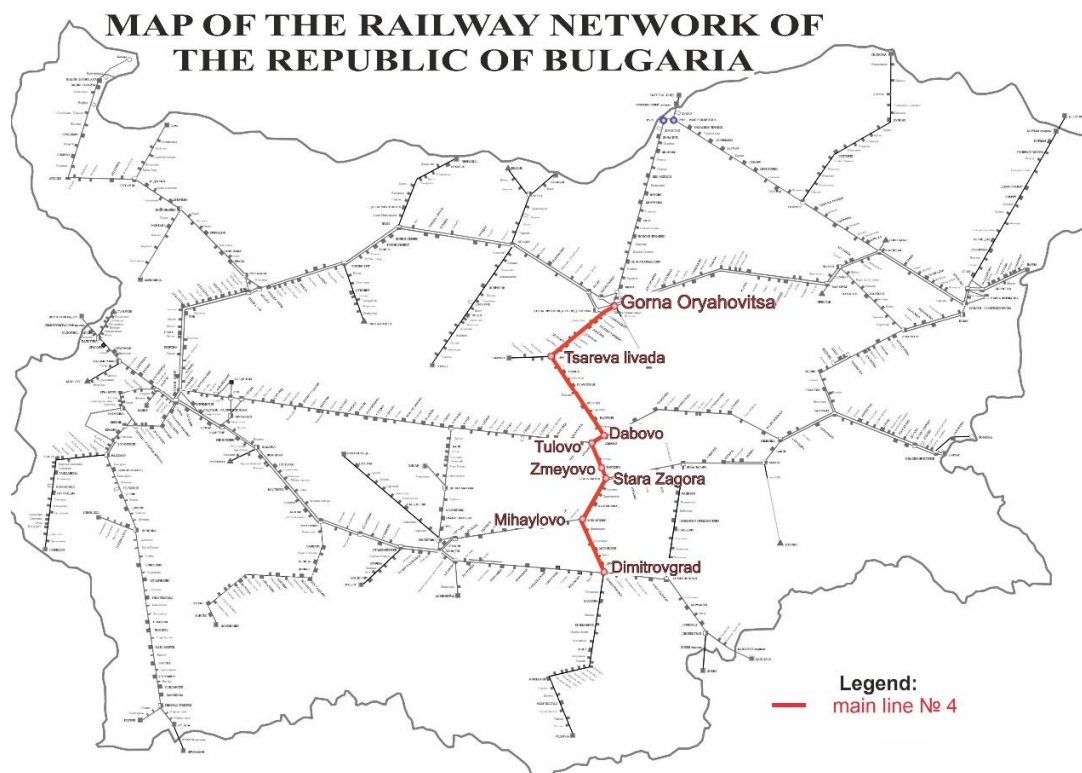


Fig. 3.2. Map of the route of movement of IFT № 464

3.1.3. Description of the place of event:

3.1.3.1. Location and place of the accident (fig. 3.3).

Geographic width: 42°33'58.11"N

Geographic length: 25°32'43.47"E

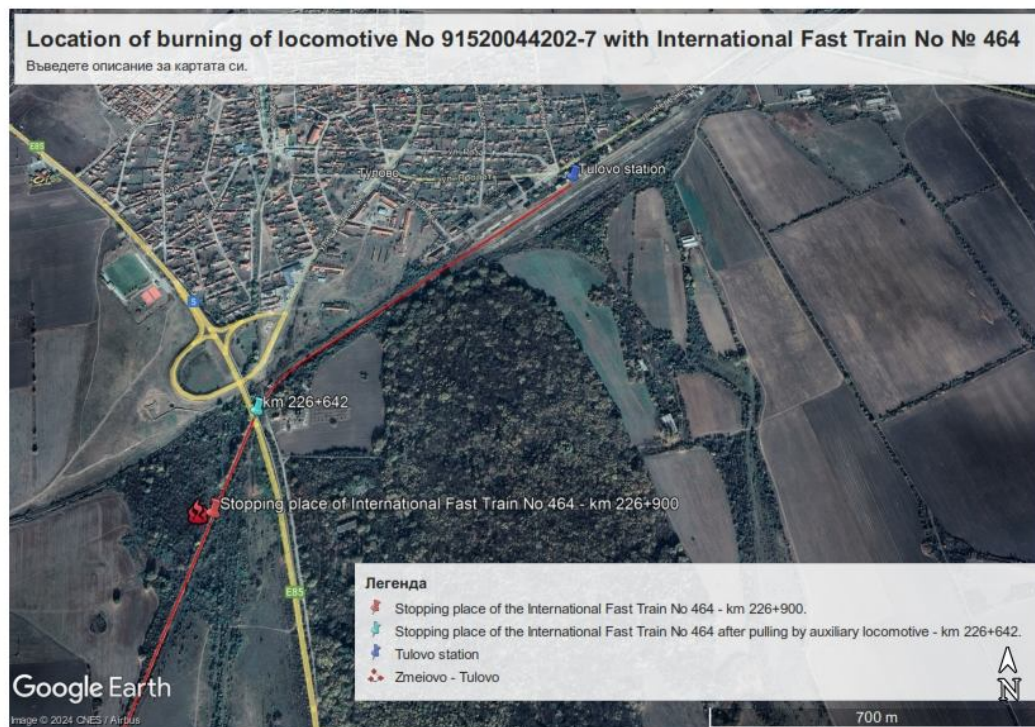


Fig. 3.3. GPS location of the accident km 226+900

3.1.3.2. Meteorological and geographical condition at the time of the event on 01.12.2023.

- In the light part of the day – 07:46 a.m. (under locomotive recording device data);
- Air temperature: -1,0°C;
- Wind speed and direction around 2 m/s from North-East;
- Weather – clear with normal visibility of the signals;
- Average relative humidity 52 %;
- There were no any registered rains.

3.1.3.3. Performance of construction activities on the site or in vicinity.

The manager of the railway infrastructure in the Zmeyovo - Tulovo interstation, carried out no construction works on the railway infrastructure (rail track and structures, catenary and signalling equipment). On that day, repairs were made to the railway switches at the Zmeyovo station.

3.1.4. Fatalities, injuries and material damages:

3.1.4.1. Employees of the railway infrastructure manager or railway undertaking.

None.

3.1.4.2. Other persons officially connected with the location of the event.

None.

3.1.4.3. Passengers.

None.

3.1.4.4. External persons.

None.

3.1.4.5. Cargo, luggage or other property.

None.

3.1.4.6. Rolling stock, infrastructure and environment.

- Caused damages to locomotive № 91520044202-7 – burnt engine compartment;
- Caused damages to passenger coaches – none;
- Account for damage, which BDZ PS EOOD presented for locomotive № 91520044202-7 amounting to 19 796,00 BGN;
- Damages caused to the rail track – none;
- Damages caused to the catenary – 682,00 BGN;
- Damages caused to the signalling equipment – none;
- Damages caused to the environment – none;
- Total caused damages: 20 478,00 BGN.

3.1.5. Description of other consequences, including the event impact on the usual activity of the participants.

In the period 08:46÷14:41 p.m. on 01/12/2023, the manager of the railway infrastructure and the railway undertakings generated additional costs for changing the schedule of the movement of trains and the capacity in the section.

- Deviated trains of the railway undertakings – none;
- Cancelled trains – 1 unit – 213,32 BGN;
- Assigned trains of railway undertakings – none;
- Delayed passenger trains – 4 units – 1057,50 BGN;
- Costs for rehabilitation means – none;
- Total other costs: 1270,82 BGN.

Railway infrastructure:

- SE NRIC personnel, involved in the accident:

- Railway undertaking:

- Personnel of BDZ PS EOOD involved in the accident:

- ### 3.1.7. Description of the respective parts of the railway infrastructure and signalling system:

The Zmeyovo - Tulovo interstation is 13,400 meters long, in the section of the fourth main line connecting the northern and southern part of the railway network. The rail track has UIC 60 type rails, ST-6 sleepers and SKL-14 fasteners. In the area before the accident from km 227+840 to km 227+921 there is a neutral insert of the catenary and the electric locomotives necessarily pass with the pantographs removed. In the direction of traffic of IFT No. 464, the mileage decreases, the rail track is straight with slopes of $6.05 \div 6.85$ % downhill. Zmeyovo station is an interstation between Stara Zagora and Tulovo

СХЕМА НА КОЛОВОЗНО РАЗВИТИЕ НА ГАРА ЗМЕЙОВО

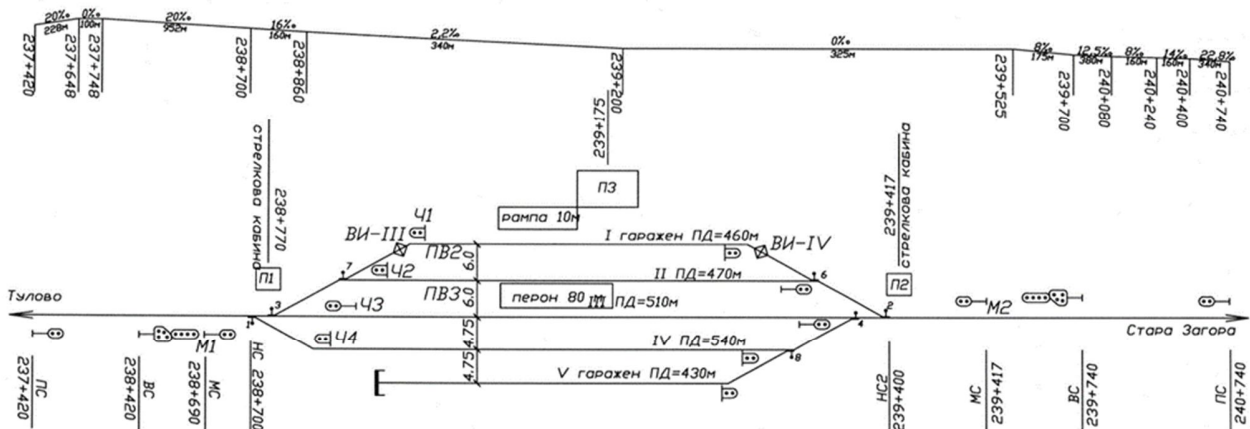


Fig. 3.4. Scheme of Zmeyovo station

with three acceptance-departure tracks. Tulovo station is a junction station with eight acceptance-departure tracks. In the rail network, Tulovo connects 3rd and 4th main lines (fig. 3.4 and 3.5)



Fig. 3.5. Scheme of Tulovo station

3.1.7.2. Interstation block system, station installation, type of signalling.

Interstation block system

The Zmeyovo - Tulovo interstation is equipped with an automatic block system without passing signals, with axle counters - at the time of the accident, the operation of the automatic block system was disabled due to repair work being carried out at the Zmeyovo station, the movement of trains in the interstation was carried out by telephone mode;

Station interlocking

Zmeyovo station is equipped with EI-1 – switched off;

Tulovo station is equipped with RRI type WSSB-1 – functional.

Type of signalling

The entrance and exit semaphores in both stations are under the speed signalling in Zmeyovo stations – switched off, in Tulovo station – functional;

3.1.7.3. Train protection systems.

Zmeyovo and Tulovo stations do not have train protection systems. The stations are equipped with train dispatching radio communication (TDRC), with the help of which the radio communication is carried out: the locomotive driver with the traffic manager on-duty, with the train dispatcher, with individual stations and with the trains in the relevant railway section - serviceable.

Locomotive No. 91520044202-7 is equipped with alertness device and tape tachograph type "Hasler RT9" and tachometer type "Hasler A16" - working order, with train control radio connection.

3.1.8. Other information referring the event.

3.1.8.1. Train documents of IFT № 464 at „BDZ-Passenger Services “EOOD.

The image shows the front part of a waybill for locomotive № 91520044202-7. The document is filled with handwritten information and stamps. Key sections include:

- ПЪТЕН ЛИСТ №** (Waybill No.): 1113
- ЛОКОМОТИВ №** (Locomotive No.): 91520044202-7
- ЛОКОМОТИВНА БРИГАДА** (Locomotive crew): Includes names like 'М. М. М. М.' and 'М. М. М. М.'.
- ПЪТНАТА СЛУЖБА** (Waybill service): Includes names like 'М. М. М. М.' and 'М. М. М. М.'.
- ПРИЕМАНЕ И ПРЕДАВАНЕ НА ЛОКОМОТИВА** (Acceptance and handing over of the locomotive): Includes names like 'М. М. М. М.' and 'М. М. М. М.'.
- ДОПЪЛНИТЕЛНО ПОЛУЧЕНО ГОРИВО ИЛИ МАСЛО** (Additional fuel or oil received): Includes names like 'М. М. М. М.' and 'М. М. М. М.'.
- ИНСТРУКТОР / ИНСПЕКТОР** (Inspector): Includes names like 'М. М. М. М.' and 'М. М. М. М.'.
- СТАРИЯ КОНДУКТОР** (Old conductor): Includes names like 'М. М. М. М.' and 'М. М. М. М.'.
- СВЕРКА НА ЧАСОВНИЦИТЕ** (Clock check): Includes names like 'М. М. М. М.' and 'М. М. М. М.'.
- ОСЛУЖУВАНЕ НА ВЪЗЛОВОС И ВЪЗНОВЕНА РАБОТА** (Service at stations and renewal work): Includes names like 'М. М. М. М.' and 'М. М. М. М.'.
- ДАНИИ ЗА СЪСТАВА НА ВЪЗЛОВОС** (Data for station composition): Includes names like 'М. М. М. М.' and 'М. М. М. М.'.

Fig. 3.6. Waybill of locomotive № 91520044202-7 front part

Accompanying bill of IFT № 464

[illegible]

**Fig. 3.10. Accompanying bill of IFT № 464
– front part**

СЪСТАВ НА ВЛАКОВАТА БРИГАДА												
Началник автог. 2310		Прен. средства	от автог.	до автог.	Конструктор	Прен. средства	от автог.	до автог.	Работи по			
Същ. Симеончева		10	03		Димитров	10	03		Димитров			
Кебаева		10	03		Влакова	10	03		Влакова			
Положителна бригада												
Положителна	Влакова	Матрица		Положителна матрица		Дата	от автог.	до автог.	Моб. телефон			
10-202	Матрица	Матрица		Матрица		10-202			082-733			
Друг персонал, обслужващ влака												
Име, фамилия, длъжност		Структура	от автог.	до автог.	Моб. телефон	Име, фамилия, длъжност - РЕЗ			от автог.	до автог.		
СЪСТАВ НА ВЛАКА												
Влаков:	Влаков											
	№	Скор.	Разход на влака	Акселерация	Сил.	Сил. сцепления	Скорост на влака	Тяга	Нето	Бруто	Дължина влака	Влаков
65	1100	1052	10	50	52	2	65	53	10	25	10	10
1	1100	1052	10	50	52	2	65	53	10	25	10	10
2					8		46	43	10	83	50	
Зам. №1: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №2: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №3: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №4: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №5: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №6: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №7: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №8: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №9: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №10: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №11: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №12: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №13: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №14: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №15: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №16: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №17: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №18: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №19: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №20: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №21: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №22: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №23: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №24: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №25: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №26: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №27: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №28: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №29: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №30: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №31: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №32: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №33: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №34: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №35: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №36: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №37: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №38: 1100, 1052, 10, 50, 52, 2, 65, 53, 10, 25, 10, 10												
Зам. №39: 1100, 1052, 10, 50, 52, 2, 65, 53, 10,												

**Fig. 3.11. Accompanying bill of IFT № 464
– rear part**

3.2. Factual description of the occurred.

3.2.2. *Immediate sequence of events that led to the accident, including:*

3.2.2.1. Actions that the involved in the event persons undertook.

Around 07:40 a.m. during the movement of IFT No. 464 with locomotive No. 91520044202-7, operated by the first cabin of the locomotive in the Zmeyovo - Tulovo interstation, before the neutral insert of the catenary turned off the locomotive's MAS. The engine driver tried to turn it on but failed. He decided that the cause was low pressure in the tanks. He turned off all consumers and turned on the auxiliary compressor.

At 07:46 a.m., the locomotive driver stopped IFT No. 464 in the interstation at km 226+900 and made several attempts to turn on the MAS again, which were unsuccessful.

Through the window, he saw that the engine compartment in the locomotive was smoky. He sprayed a fire extinguisher into the engine compartment, but was unable to extinguish the smoke. He activated the fire alarm system, but it did not turn on.

Around 07:50 a.m., the train master contacted the traffic manager on duty at Tulovo station and informed him that the train's locomotive was ignited.

The transport crew: train manager and conductor, promptly organized the removal of all passengers from the coaches with their luggage to a safe distance.

At 08:19 a.m., the energy dispatcher at TMU Plovdiv registered an emergency disconnection of the voltage in the catenary and at 08:20 a.m., the traction substation automatically supplied voltage to the catenary.

At 08:25 a.m., the locomotive driver contacted the traffic manager on duty at the Tulovo station and asked for help to remove the train. After 1 minute, it reconnected and requested firefighting assistance due to a fire occurring in the locomotive.

At 08:30 a.m., the traffic manager on duty at Tulovo station notified the train dispatcher at TMU Plovdiv on the Stara Zagora - Dubovo section about the fire that occurred in the locomotive of IFT No. 464.

The manager of the Tulovo station promptly informed the national emergency number 112 about the fire in the locomotive.

At 08:41 a.m., the locomotive driver exchanged a telephone message with the traffic manager on duty at the Tulovo station to request an auxiliary locomotive to take the train away.

At 08:46 the train dispatcher closed the Tulovo - Zmeyovo interstation for the movement of all trains and vehicles.

At 08:55 a.m. an auxiliary locomotive No. 91520044180-5 departed from the third track at Tulovo station to assist the burning locomotive of IFT No. 464 in the interstation and pulled the train from kilometre 226+900 to kilometre 226+642 with the possibility of approaching and extinguishing of the fire in the locomotive with the specialized cars of RS FSaCP.

At 09:19 a.m., the locomotive driver requested the voltage in the catenary to be turned off by the energy dispatcher at TMU Plovdiv due to the ignition of the locomotive.

At 09:24 a.m. the voltage in the catenary was switched off.

At 09:25 a.m., the specialized cars from RS FSaCP - Kazanlak and Stara Zagora, started extinguishing the fire in the locomotive.

At 11:30 a.m. the authorities of RS FSaCP extinguished the fire in the locomotive.

At 12:01 p.m., the voltage in the catenary was switched on.

At 12:40 p.m., the composition of IFT No. 464 with locomotive 91520044180-5 was withdrawn to Tulovo station.

At 13:07 p.m., the head of the Tulovo railway section inspected the rail track from kilometre 226+900 to kilometre 227+200 and entered in the dispatcher's order log that the rail track was ready for the movement of trains at the scheduled speed.

At 13:36 p.m., a train and electric window with RSSPM No. 99529436513-6 was authorized at the Tulovo distribution sub-district to perform an inspection of the catenary in the Zmeyovo - Tulovo interstation from km 226+900 to km 230+000.

At 14:37 p.m., a catenary electrical systems technician that the catenary network was functional and voltage was supplied made an entry.

At 14:41 p.m., the train dispatcher restored the movement of trains and vehicles at the scheduled speed at the Zmeyovo - Tulovo interstation.

3.2.2.2. Rolling stock and technical facilities functioning.

During the service of IFT No. 464, the locomotive crew of locomotive No. 91520044202-7 did not find any failures and damages that were prerequisites for a fire in the locomotive. The locomotive was regularly registered in the European Vehicle Register (EVR).

Until the time of the accident, the rolling stock of IFT No. 464 (the locomotive and two coaches) were technically sound.

Coaches with No. 50522150103-2 B₄ and No. 50522150094-3 B₄ from the composition of IFT No. 464 were serviceable, with regular registration in the European Vehicle Register (EVR).

At Zmeyovo station, the traffic manager on duty has ordered a route to receive IFT No. 464 with a stop at the station. Due to carrying out repair work on the railway switches in the station, the station interlocking was out of action and the IFT has left with a delivered written order Rev. II-A with the exit signal for Tulovo station closed.

3.2.2.3. Operational system functioning.

The operational system for managing train traffic on the main railway line No. 4 and between Zmeyovo and Tulovo stations before the accident was functional and functioning normally. Train traffic

in the Stara Zagora - Zmeyovo - Tulovo section was carried out on a single-track electrified railway line. The line was specialized for double-direction train movement.

During the time of the accident, the operational system for managing the train traffic between the Zmeyovo and Tulovo stations did not function from 08:46 a.m. to 14:41 p.m. on 01.12.2023, due to the occurrence of a fire in the locomotive and the extinguishing by the authorities of RS FSaCP.

3.2.3. Sequence of the events from the beginning of the occurrence until the end of the rescue services actions:

3.2.3.1. Undertaken measures for protecting and guarding the event location.

At 08:45 a.m., the authorities of the Kazanlak RD of the Ministry of Interior arrived at the scene of the accident and, after clarifying the situation, the area was restricted to external persons. The authorities of RS FSaCP and the interested officials of the two entities were accepted to the site.

3.2.3.2. Actions of the emergency rescue services.

At around 09:00 a.m., specialized vehicles of RS FSaCP Kazanlak and Stara Zagora arrived at the scene of the accident to extinguish the fire in the locomotive.

At 09:25 a.m., the specialized cars from RS FSaCP - Kazanlak and Stara Zagora, started extinguishing the fire in the locomotive.

At 11:30 a.m. the authorities of RS FSaCP extinguished the fire in the locomotive.

At 12:01 p.m., after permission from the authorities of RS FSaCP Kazanlak, voltage was applied to the catenary at the Zmeyovo - Tulovo interstation.

3.2.3.3. Actions of the emergency rehabilitation services.

At 13:07 p.m., the head of the Tulovo railway section entered in the dispatcher's orders log at the Tulovo station that the rail track from kilometre 226+900 to kilometre 227+200 was straightened and trains could move at scheduled speed.

From 13:32 p.m. to 13:45 p.m. in the Zmeyovo - Tulovo interstation from kilometre 226+900 to kilometer 230+000, an inspection of the catenary was carried out with a specialized machine RSSPM No. 99529436513-6. At 2:37 p.m., in the dispatcher's order log at the Tulovo station, it was written that the catenary was working and voltage was applied.

3.2.3.4. Actions undertook from SE NRIC and, BDZ-Passenger services“ EOOD for restoring the schedule and the capacity of the railway line

On 01.12.2023 at 12:01 p.m., after completion of the procedural-investigative actions, written permission was given by the RD Kazanluk of the Ministry of Interior to carry out emergency restoration activities.

At 12:40 p.m., the composition of IFT No. 464 with locomotive No. 91520044180-5 was withdrawn and stored on the ninth track at Tulovo station and the Zmeyovo - Tulovo interstation was freed. The passengers from the train were transhipped by bus in the direction of the train.

At 14:41 p.m., the train dispatcher restored the movement of trains and vehicles at the Zmeyovo - Tulovo interstation at the scheduled speed.

On 01.12.2023, at 19:10 p.m., the burnt locomotive No. 91520044202-7 arrived at Gorna Oryahovitsa station, hauled by locomotive No. 91520044180-5 and delivered to the Gorna Oryahovitsa locomotive depot.

4. Analysis of the event

4.1. Participation and responsibilities of the entities, involved in the event

4.1.2. Railway undertaking.

Analysis of the movement of IFT № 464.

The recordings from the recording device, registered on the speedometer tape of locomotive No. 91520044202-7, serving IFT No. 464 on 01.12.2023, were downloaded.

The registration of the main and most important parameters of the movement of the locomotive, respectively of the train, in speedometer installations of the "Hasler" type system, was done by recording on a speedometer control tape, which reports the following parameters:

- Instantaneous value of speed (V-S);
- Astronomical time by graphing and printing on the tape, as well as travel and stay time (T diagram);
- Distance travelled for individual track sections (through perforations on the tape – 2.5 mm = 0.5 km);

The following additional parameters can also be registered on the speedometer tape for RT type devices (such as those on locomotive no. 91520044202-7):

- Pressure in the main air duct;
- Direction of movement;
- Turning on the rheostat brake;
- Activation of the automatic brake (pneumatic registration);

The speedometer tape was checked and found:

- Has the prescribed maximum speed of the train been observed;
- Is the speed limited to the prescribed speed when crossing a section that requires a speed limit;
- Is the duration of reduced speed movement respected, i.e. to travel a distance equal to the length of the reduction plus the length of the entire train;
- Are there any unplanned stops on the interstation;
- Are there any slippages of the locomotive;
- Has a reduction in pressure been registered in the main air brake duct when performing the various tests;
- How the automatic air brake of the train was used and how the rheostat brake was used;
- Availability of additional registrations, in accordance with those provided for each series of TPRRS (traction rolling stock);
- Availability of all records for the relevant TPRRS.

The speedometer control strips can also be used for other clarifications in the movement of trains, namely:

- Delays in departure and arrival;
- Stopping in front of closed signals and in stations;
- When calculating energy consumption, etc.

Speedometer control tapes are considered a valuable objective document in the investigation of safety accidents.

Any falsification of the speedometer tape, wilful destruction, or wilful impact of the clock or recording mechanism are considered safety violations.

Locomotive No. 91520044202-7 is equipped with a "Hasler" type speedometer installation, which consists of a three-phase alternating current collector converter (geber) driven by one of the locomotive's track axles. The resulting three-phase voltage with a variable frequency, depending on the set speed of movement, drives the mechanical speedometer synchronous electric motors mounted to it (Fig. 4.12). One speedometer is installed in each locomotive cabin. Recording device (tape tachograph) RT9 in cabin No. 1 (fig. 4.1) and non-recording device (tachometer) A16 - in cabin No. 2 (fig. 4.2). The two speedometers have a range of 0÷150 km/h.

The tape tachograph measures and displays the following data on a visible dial when the



Fig. 4.1. Tape Tachograph RT9



Fig. 4.2. Tachometer A16

locomotive is moving:

- Track speed in km/h;
- Time in hours and minutes;
- The entire distance travelled in km (odometer);

The tachometer measures and displays on a clear dial the same data that the strip tachograph displays, without the distance travelled and without recording the information. It is electrically connected to the tachograph, and if the power cable is interrupted, the two devices stop reading the speed.

The recording equipment of the RT9 tachograph registers the following basic parameters:

- Track speed in km/h;
- Astronomical time, as well as the time of travel and stay;
- The distance travelled for individual track sections;
- Other parameters for the movement of the locomotive.

The recording (speedometer) tape is made of waxed paper. It has lined fields for recording the information transmitted by the tape tachograph (Fig. 4.3). The speedometer tape is a valuable objective source of data for the exact determination of the beginning, progress and end of processes related to locomotive movement.

On the speedometer tape are registered:

- The current value of the speed in km/h;
- Astronomical time;
- Travel time;
- The time of stay;

- The distance travelled for individual road sections;
- Air pressure in the main air duct (main air duct);

An analysis of the movement of the train was made in the area from Zmeyovo station to the place of the accident (the occurrence of the fire) (Fig. 4.3).

IFT No. 464 served by locomotive No. 91520044202-7 departed from Zmeyovo station at 07:33 a.m., accelerated to 22 km/h, then the speed decreased to 15 km/h and thus it travelled 300 meters in about 1 min. 50 sec. (fig. 4.3, item 1). After covering that distance, the speed started to increase again and in about 400 meters, it reached 70 km/h (Fig. 4.3, item 2). At that speed, it travelled about 400 meters, after which the speed decreased to 64 km/h and again increased to 72 km/h (Fig. 4.3, item 3). The train travelled about 1500 meters in 1 minute and 30 seconds in traction mode due to the profile of the rail track, which is uphill (fig. 4.3, pos. 4). From that moment on, the profile went downhill and the locomotive went into braking mode, traveling about 7,500 meters from 07:37 a.m. to 07:44 a.m. in 7 minutes (Fig. 4.3, item 5). During this time, the locomotive driver adjusts the speed with the help of the automatic train brake (pneumatic), (Fig. 4.3, pos. 6), and the speed changed from 62 to 73 km/h, with a

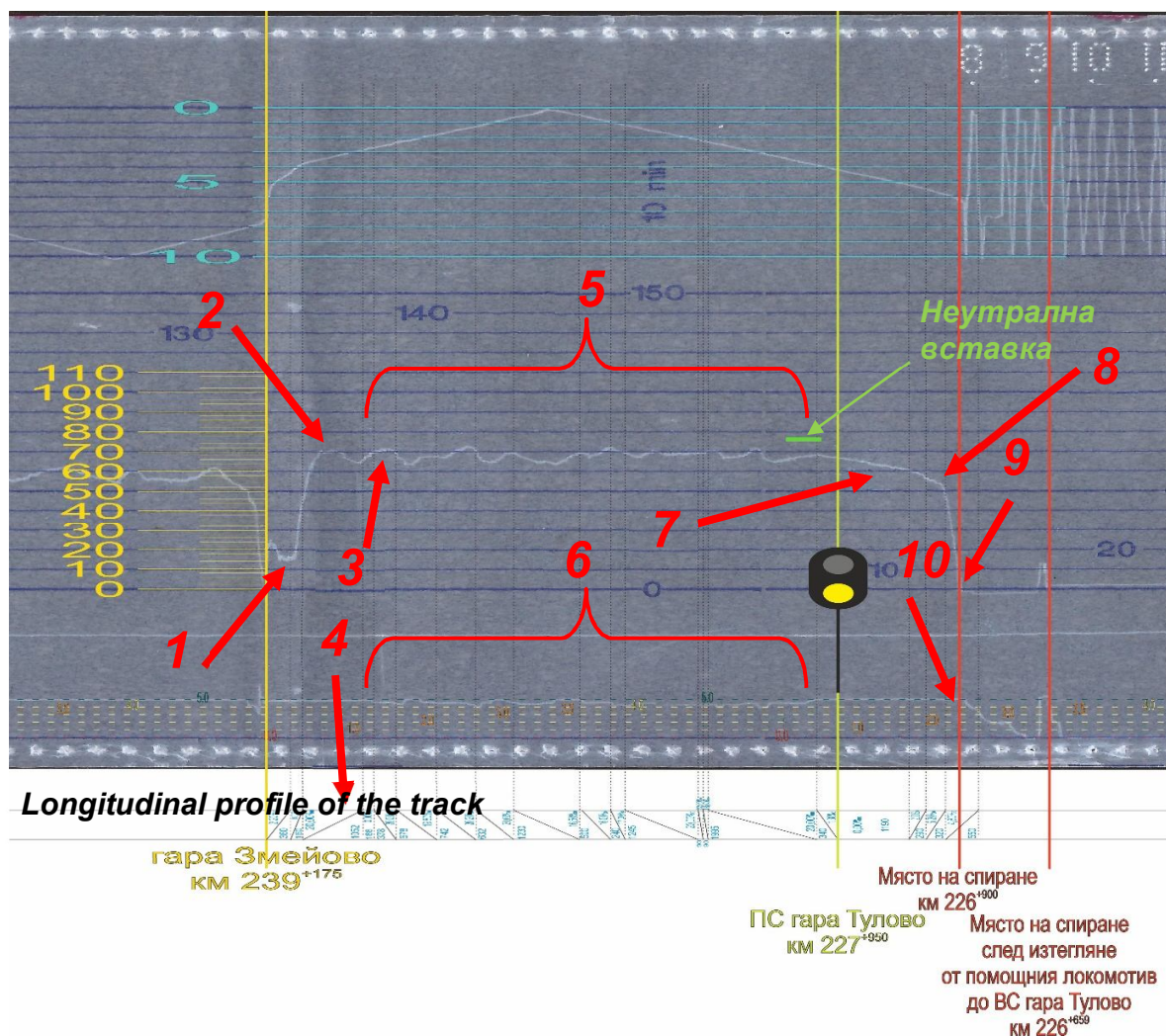


Fig. 4.3.

permissible speed of movement of 75 km/h in the interstation. About 340 meters before the warning semaphore (PS) at Tulovo station, the slope of the rail track decreased from 20 ‰ to 1.3 ‰, then became level (0 ‰) and followed a slight uphill with values of 2 ÷ 6 ‰. Therefore, the movement was carried out by inertia with a smooth decrease in speed from 68 to 54 km/h for 2100 meters in about 2 minutes (Fig. 4.3, item 7). At 07:46 a.m. the speed began to decrease at a much higher gradient, with a distinct

downward break on the bar graph (Fig. 4.3, item 8) without the automatic train brake applied (Fig. 4.3, item 9), and after about 30 seconds the train stopped at km 226+900 (fig. 4.3, item 10).

Analysis of the causes

The rectifier groups on the 44 series locomotives are of the cabinet type, each cabinet having its own separate traction group. The interior of the cabinet can be conditionally divided into three parts: upper, lower and side. In the upper part, the valves from the traction bridge are located, which work in traction mode together with the traction motors (Fig. 4.4, item 1). In the lower part, the elements of the four auxiliary bridges are collected, which are included in the circuits of the auxiliary machines (Fig. 4.4, pos. 2), and in the side part there are signal lamps, blinker relays and the R-C groups, which are composed of resistors and capacitors (Fig. 4.5)

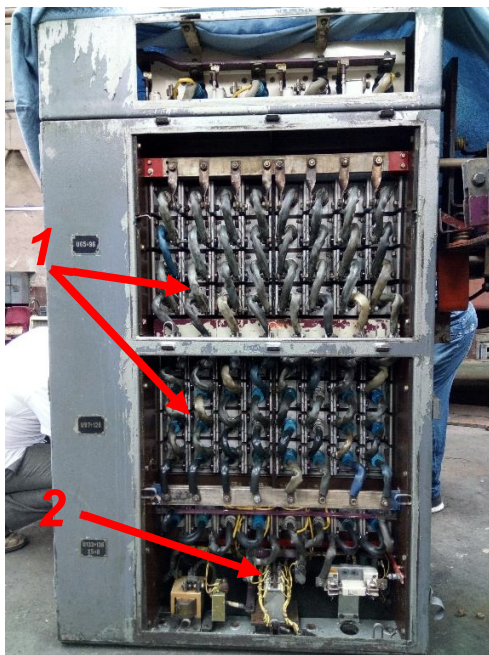


Fig. 4.4.

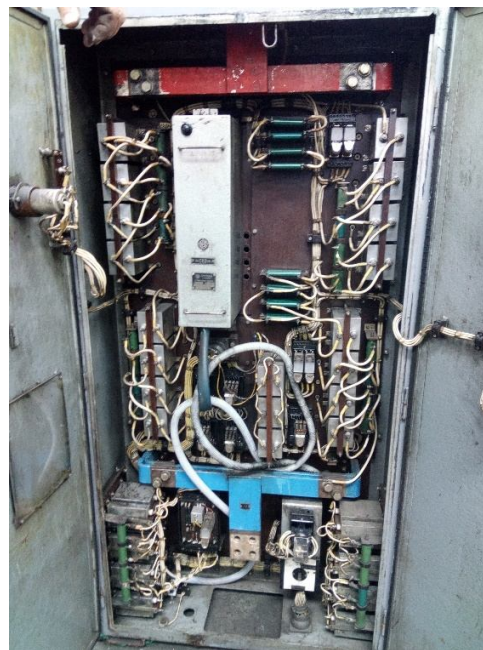


Fig. 4.5.

The cooling of the blocks is forced by air, which is sucked from the engine compartment (Fig. 4.6, item 1), enters through the upper opening of the cabinet, passes through it downwards, taking away part of the heat released by the drawbridge valves (Fig. 4.6, pos. 2), the already heated air passes down to cool the valves of the auxiliary bridges (fig. 17, pos. 3) and exits through the suction pan horizontal fan into the atmosphere (fig. 4.6, pos. 4). The side of the block is not cooled. With the scheme described in this way, the way in which the operation is carried out is particularly important, because when the fans of the cooling system are turned off, overheating of the rectifier unit occurs, and especially in its lower part, where the rectifier bridges of the auxiliary machines are located - fans and compressors. When the locomotive goes into traction mode, the valves heat up, give off a large amount of heat, and when the air passes through, they cool down. The same air, instead of cooling, additionally heats the rectifier bridges of the auxiliary machines, whose operation is not synchronized with that of the traction rectifier bridges. After switching the locomotive out of traction mode and into inertia moving mode, it is the practice of locomotive drivers to turn off the ventilation with the button on the locomotive control panel and stop the cooling of the rectifier units. Heat removal from the traction rectifier bridges continues, but without cooling. At the same time, the rectifier bridges of the auxiliary machines (compressors that consume a sufficiently large amount of energy) continue to work, because the auxiliary

machines work in a different mode than the traction motors. As a result, on insufficiently cooled auxiliary bridges, they continue to heat up, due to the heat emitted by the drawbridges, along with the heat they themselves emit during operation. All this affects the temperature in the side of the block and heats the capacitors located in this area. Their housing bursts, the electrolyte ignites and becomes a catalyst for igniting the entire block.

The findings of the Investigation Commission not only in this but also in other previous investigations and analyses lead to the conclusion that this is the main cause of many of the realized fires of locomotives of this series of locomotives in the recent years.

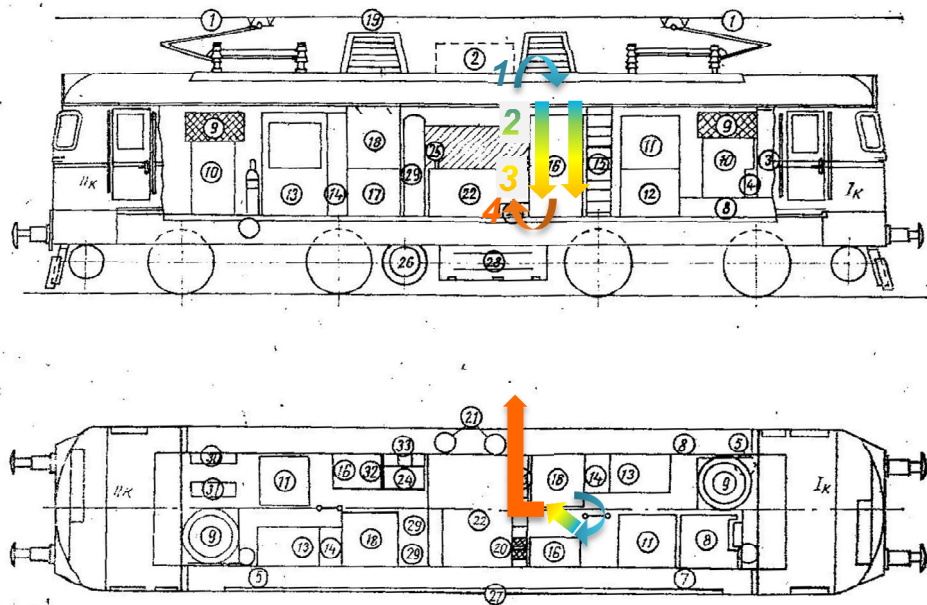


Fig. 4.6. Scheme of the movement of the air for cooling one of the rectifier blocks. By arrows is shown the direction of air passing through the rectifier blocks. The colors illustrate the passing through them and the changing temperature: cool, heated, warm, and hot.

Layout of the main facilities in locomotive series 44:

1. Current collectors;
2. MAD;
5. Portable fire extinguishers;
6. Non passage corridor;
7. Passage corridor;
9. Shunt resistors;
10. Vertical ventilators for cooling the TE and their shunts;
11. Engine-compressors;
12. Smoothing reactor;
13. Reverse cabinet;
16. Rectifying cabinet;
17. Engine-fan for the brake resistors;
18. Brake resistors;
19. Air outlet louvres for cooling the braking resistors;
20. Smoothing reactors for the auxiliary machines;
21. Fire protection tanks of FFI;
22. Traction transformer;
23. ATP;

Practice, which is wrongly applied by the locomotive drivers during the handling of locomotive series 44 and 45.



Fig. 4.7. Rectifying group 022

The Commission visited several times the Locomotive Depot Gorna Oryahovitsa, performed



Fig. 4.8. Image of the rectifying group 022

inspections and found the following facts:

- After the dismantling of the rectifying group 022 – (fig. 4.7 and fig. 4.8), it was found that totally melted the cooling bodies of the diodes of the rectifying group, and the auxiliary rectifiers 221 are totally destroyed as well 221;
- From the performed inspection of the auxiliary rectifier 221, feeding engine compressor 235 and engine-fans 222 and 223 it was found that it was destroyed, the temperature there were the highest. Probably the source for the fire occurrence is rectifier 221;



Fig. 4.9. Image of the brake fan

- After the inspection it was found that the engine fan of the brake resistor of fig. 4.9 was externally burnt. From the figure it is evident that the paint was burnt and the bellows of the fan was ignited;
- The aggregates around the rectifier group 022 were also burnt. In fig. 4.10 the remains of the rectifier diodes are visible;
- On fig. 4.11 remains of the melted power cables of the engine compressor are visible. Melt is also visible at the end of the cable. The motor-compressor power cable melted due to the high temperature and it is very likely that the fire started from there;
- Transformer 222 does not power the auxiliary machinery control block. This modified power supply contradicts the locomotive's factory schematics. The commission found, not for the first time, when investigating fires in locomotives series 44 and 45 that the power supply was changed and this led to unstable operation of the auxiliary machines 221.



Fig. 4.10. Image of the base of the rectifying group 022



Fig. 4.11. Image of the feeding cables of the engine compressor

Probable causes for the fire occurrence in the locomotive:

- **Insufficient cooling and increasing the temperature of the traction rectifier 022.** The train was moving for a long time (free running) and maintained speed with the automatic train brake. The auxiliary rectifier 221, feeding the motor-compressor at that time, was not cooled, since the fans were turned off during the coasting of the train (they worked in traction mode and in the zero position at the discretion of the engine driver).
- **Occurrence of an explosion in the capacitors of the R-C groups of the auxiliary rectifier 221, which supplies the motor-compressor 235.** The occurrence of the explosion in the capacitors (Fig. 4.12) occurred because of an increase in temperature in the power unit of the engine-compressor. It has risen due to not cooling the rectifier group 022. The location of the power auxiliary unit 221 is at the bottom of the rectifier group 022. It was cooled after the rectifier diodes 022 were cooled. The R-C groups of the power and auxiliary units 022 and 221 are for protection against external and internal overvoltage. The construction of the capacitors that participate in the R-C groups are metal boxes filled with liquid electrolyte. As the temperature increases, it expands and causes the capacitor to explode. The hot electrolyte falls on the heated surfaces of the rectifier diodes and on the power unit of the auxiliary rectifier, which leads to the ignition of the auxiliary rectifier. Initially, thick black smoke was formed, impenetrable due to the lack of oxygen, and subsequently ignited.



Fig. 4.12. Image of the burst capacitors.

When the door of the cabin to the passageway was opened, access to oxygen was ensured and the fire grew. The repair group was completely destroyed, due to the failure of the fire extinguishing system activated by both cabs of the locomotive.

4.1.3. Infrastructure manager.

Analysis of the railway infrastructure condition.

- Location of the neutral insertion from km 227+840 to km 227+921 with length 81 m. The same is correctly signalized as per Ordinance № 58;
- Place of stopping and ignition of the locomotive is at km 226+900 in a straight line section of the track and slope of 4,75 ‰ in downhill in train direction;
- First stop of the train at km 226+975;

- Second stop of the train at km 226+642, after its pulling with auxiliary locomotive №91520044180-5, in order to ensure possibility for the fire extinguishing;
- The entrance signal at Tulovo station is at km 226+659, in right curve with radius R=298 m, under the train movement direction;
- The place of the locomotive fire extinguishing is in a slope 6,85 ‰ in downhill;
- The movement speed under schedule in Tulovo – Zmeyovo interstation is 75 km/h;
- Tulovo station is at km 225+780;
- Zmeyovo station is at km 239+175;
- The distance between the two stations is 13 395 meters;
- The rail track structure is continuously welded track with reinforced concrete sleepers' type CT-6, rails type UIC 60 and fastening type SKL-14.

4.1.4. Entities in charge of the technical maintenance.

"BDZ-Passenger Services" EOOD holds a Certificate of an entity in charge of maintenance with EIN BG /31/0021/ 0001, valid from 19.04.2021 to 18.04.2026;

SE NRIC has a Certificate of an entity in charge of maintenance with EIN BG /31/0020/ 0003, valid from 01.07.2020 to 30.06.2025.

SE NRIC has a Certificate for an entity in charge of maintenance of vehicles with EIN BG/31/0023/0001, valid from 22.03.2023 to 21.03.2028.

4.1.5. Manufacturers or providers of rolling stock and railway products

Not applicable.

4.1.6. National Safety Authority.

Railway Administration Executive Agency is the National Safety Authority of the Republic of Bulgaria.

4.1.7. Notified bodies or Risk assessment authorities.

Not applicable.

4.1.8. Certifying bodies of the entities in charge of maintenance.

The Railway Administration Executive Agency as the National Safety Authority for railway transport performs certification of the entities in charge of the vehicles maintenance (ECM) in accordance with Directive 2004/49/EC and Regulation (EU) 445/2011, as per Ordinance No 59 on the railway transport safety management and on the maintenance functions in accordance with Directive 2004/49/EC and Regulation (EU) 445/2011.

From June 16, 2020 the RAEA performs certification of the ECM as per the Commission Implementing Regulation (EU) 2019/779 of 16 May 2019 laying down detailed provisions on a system of certification of entities in charge of maintenance of vehicles pursuant to Directive (EU) 2016/798 of the European Parliament and of the Council and repealing Commission Regulation (EU) No 445/2011.

4.1.9. Persons or entities involved in the event, documented or not in the respective safety management systems or indicated in register.

- SE NRIC implements Safety Procedure PB 2.09 "Methodology for determining, assessing and managing of the risk" version 05 effective from 01.03.2019, part of the SMS.

- BDZ PS EOOD implements Quality Procedure PK-2-15 "Safety Management of Passenger Transportation. Monitoring and information" from 13.12.2018 and Methodology for assessing the safety risk in BDZ PS EOOD from 23.02.2012.

4.2. Rolling stock and technical facilities

4.2.1. Factors, deriving from the design of the rolling stock, railway infrastructure or technical facilities.

Not applicable.

4.2.2. *Factors deriving from the installation and placing into service of the rolling stock, railway infrastructure and technical facilities.*

Not applicable.

4.2.3. *Factors deriving from manufacturers or other supplier of railway products.*

Not applicable.

4.2.4. *Factors, deriving from the technical maintenance and/or modification of the rolling stock or the technical facilities.*

Not applicable.

4.2.5. *Factors due to the entity in charge of the technical maintenance, workshops for technical maintenance and other technical maintenance service providers.*

Not applicable.

4.2.6. *Other factors or consequences considered as involved within the investigation objectives.*

Not applicable.

4.3. Human factor

4.3.1. *Individual human characteristics:*

4.3.1.1. *Training and development, including skills and experience.*

Railway undertaking:

- Locomotive driver first person of locomotive № 91520044202-7 – Certificate of qualification № 394 acquired qualification for a "Locomotive driver", training conducted in the period 20.04.÷29.06.1989, training institution PQC at BDZ - Sofia, issued by BDZ;

Locomotive driving license BG 71 2017 1262, issued by RAEA;

Certificate № VII-1086 for holding the position of "Locomotive driver" in BDZ PS EOOD dated 01.04.2021.

Additional certificate № 000002492172 from BDZ PS EOOD for rolling stock for which is permitted the locomotive driver to drive – series 43, 44, 45,000, 46200, 80,000 and EMU 32,000 dated 16.03.2022 along the national railway infrastructure of the Republic of Bulgaria until 15.03.2025.

- Assistant locomotive driver of locomotive № 91520044202-7 – Certificate of qualification №24907 acquired qualification for a "Locomotive driver", training conducted in the period 14.11.2022÷03.02.2023, training institution VTU „Todor Kableshkov – Sofia, issued by RAEA;

Certificate № VII-1300 for holding the position of "Locomotive driver" in BDZ PS EOOD dated 28.04.2023.

- Head of train, passenger traffic of FT № 464 – Certificate of qualification № 21350 acquired qualification for a „Head of train“, training conducted in the period 03.12.2018 ÷ 13.02.2019, training institution PQC at BDZ, issued by RAEA;

Certificate № VI-404 for holding the position Head of train, passenger traffic at BDZ PS EOOD dated 01.01.2021.

Railway infrastructure:

- Traffic manager in Zmeyovo station – Certificate of qualification № 24807, acquired qualification for a “Traffic manager“, training conducted in the period 18.04. ÷ 31.10.2022, training institution PQC at SE NRIC;

Certificate № 2289 for holding the position Traffic manager at TOSAMD – Plovdiv dated 01.03.2023.

- Traffic manager in Tulovo station – Certificate of qualification № 11590 acquired qualification for a „Traffic manager and Trade operation“, training conducted in the period 29.01.÷28.12.1990, training institution PQC at BDZ;

Certificate № 4387 for holding the position Traffic manager at TOSAMD – Plovdiv dated 05.12.2022.

4.3.1.1. Medical and personal circumstances, which influence the event, including the presence of physical and psychological stress.

Railway undertaking:

- Locomotive driver of locomotive № 91520044202-7:

Card for a periodic medical exam dated 16.02.2023, issued by Gorna Oryahovitsa Transport Hospital;

Conclusion: suitable for a locomotive driver.

Psychological certificate № 668/14.06.2021, issued by Psychological laboratory within Gorna Oryahovitsa Transport hospital for a locomotive driver.

Conclusion: accepted for a 3-year period.

- Assistant locomotive driver of a locomotive № 91520044202-7:

Preliminary medical exam card dated 18.04.2023, issued by Gorna Oryahovitsa Transport hospital;

Conclusion: suitable for an assistant locomotive driver.

Psychological certificate № 374/24.04.2023, issued by a Psychological laboratory within Gorna Oryahovitsa Transport hospital for an assistant locomotive driver.

Conclusion: accepted for a 5-year period.

- Head of train, passenger traffic of IFT № 464:

Medical exam card dated 19.05.2023, issued by Gorna Oryahovitsa Transport hospital.

Conclusion: suitable for a head of train, passenger traffic.

Psychological certificate № 1198/29.11.2013, issued by Psychological laboratory at Gorna Oryahovitsa Transport hospital for a head of train.

Conclusion: accepted for a 3-year period.

Railway infrastructure:

- Traffic manager in Zmeyovo station:

Single health information dossier dated 16.01.2023, issued by a National multi-profile transport hospital – Plovdiv.

Conclusion – suitable for traffic manager.

Psychological certificate № 141/01.02.2022, issued by Psychological laboratory – rail transport Plovdiv at Multi-profile hospital Plovdiv for a traffic manager.

Conclusion: accepted for a 5-year period.

- Traffic manager in Tulovo station:

Single health information dossier dated 22.11.2023, issued by Labour medicine Service at SE NRIC;

Conclusion: suitable for Traffic manager.

Psychological certificate № 886/15.07.2021, issued by Psychological laboratory – railway transport Plovdiv at Plovdiv Multi-profile hospital for a traffic manager.

Conclusion: accepted for a 3-year period.

4.3.1.2. Fatigue.

Railway undertaking:

- Locomotive driver of locomotive № 91520044202-7:

Rest: from 29.11.2023 hour 20 minutes 15 to 30.11.2023 hour 23 minutes 47

Started work: 30.11.2023 hour 23 minutes 47 – (27 hours and 42 min.)

- Assistant locomotive driver of locomotive № 91520044202-7:

Rest: from 28.11.2023 hour 22 minutes 20 to 30.11.2023 hour 23 minutes 47

Started work: 30.11.2023 hour 23 minutes 47 – (49 hours and 27 min.)

- Head of train of FT № 464:

Rest: from 28.11.2023 hour 08 minutes 20 to 01.12.2023 hour 00 minutes 00

Started work: 01.12.2023 hour 00 minutes 00 – (63 hours and 40 min.)

Railway infrastructure:

- Traffic manager Zmeyovo station:

Rest: from 29.11.2023 hour 07 minutes 00 until 01.12.2023 hour 07 minutes 00

Started work: 01.12.2023 hour 07 minutes 00 – (48 hours and 00 min.)

- Traffic manager in Tulovo station:

Rest: from 30.11.2023 hour 07 minutes 00 until 01.12.2023 hour 07 minutes 15

Started work: 01.12.2023 hour 07 minutes 15 (24 hours and 15 min.)

4.3.1.3. Motivation and attitudes

Not applicable

4.3.2. Work related factors:

4.3.2.1. Tasks planning.

• SE NRIC – railway infrastructure manager, carries out maintenance, repair and operation of the railway infrastructure. Prepares an annual schedule for the movement of all categories of trains on the main and secondary railway lines in the Republic of Bulgaria. Prepares schedules and timetables for additional requested trains and vehicles submitted by railway undertakings/carriers for movement on the railway network.

• "BDZ-Passenger Services" EOOD carries out railway transport of passengers according to the approved Plan for composing the trains, according to the contract for the transport of passengers with the State.

4.3.2.2. Constructive particularities of the facilities that influence the connection human-machine.

Not applicable.

4.3.2.3. Communication means.

The communication connections in Zmeyovo station are carried out with DCCM -8, and in Tulovo station, they are carried out with CAS-22.

In both cabins of the locomotive, TDRC devices are installed for radio communication between the locomotive driver and the traffic manager on duty at the respective station or with the train dispatcher. The operational staff working on a shift basis in the SE NRIC and BDZ PS EOOD are provided with official mobile phones for quick communication.

4.3.2.4. Practices and processes.

Not applicable.

4.3.2.5. Operation rules, local instructions, staff requirements, prescriptions for technical maintenance and applicable standards.

• BDZ PS EOOD and SE NRIC apply national and departmental normative acts, which are part of the SMS, relative to the activity of the undertakings and the company.

4.3.2.6. Working time of the involved personnel.

• The staff involved in the accident of BDZ PS EOOD and SE NRIC works in shifts regime of 12-hour working shift. In accordance with the requirements of the normative acts - Labour Code and Ordinance № 50 of 28.12.2001 for the working hours of the managerial and executive staff, engaged in providing the transportation of passengers and freights in the railway transport.

4.3.2.7. Risk treatment practices.

• SE NRIC implements a safety procedure PB 2.09 "Methodology for determining, assessing and managing risk" version 05 effective from 01.03.2019, part of the SMS.

- "BDZ-Passenger Services" EOOD implements the following procedures:

- Methodology for safety risk assessment in BDZ PS EOOD;

- Quality procedure PK-2-15 "Safety management of passenger transport. Monitoring and exchange of information";
- Register of hazards in the operation, repair and maintenance of RRS in BDZ PS EOOD.

4.3.2.8.Context, machinery, equipment and indications for shaping the working practices
Not applicable.

4.3.3. Organizational factors and tasks:

4.3.3.1.Planning of the working force and the working load.

BDZ PS EOOD and SE NRIC, in accordance with the requirements of the European and national normative acts, carry out their activities in accordance with established methodologies based on models of good European practices and professional experience. The work is planned and related to the staff directly responsible for the safety and operation of railway transport in accordance with the norms prescribed in the SMS.

4.3.3.2.Communications, information and teamwork.

Not applicable.

4.3.3.3.Recruitment, staffing requirements, resources.

- In BDZ PS EOOD, the selection of personnel is carried out according to an approved "Human Resources Management System", which includes:

- Recruitment and selection rules;
- Rules for appointment and changes in employment relations;
- Rules for staff training and development;
- Rules for ensuring HSLC, Ecology, and organization of the activity of STM.

The entity's personnel is selected and appointed with the relevant legal capacity, professional qualification and skills for working in the management and executive staff.

- SE NRIC has an approved "Strategy for the management of human resources 2021÷2025"

In the SE NRIC, the selection of personnel is carried out according to the established "Rules for recruitment, selection and appointment of personnel in the central administration of the SE NRIC" in force from 01.12.2020.

The recruitment, selection and appointment of personnel is carried out by the "Human Resources Management" department, which is responsible for:

- Recruitment;
- Maintaining a personnel database;
- Creating a system of selection techniques;
- Carrying out the selection together with the head of the unit;
- Documenting the process and communicating with staff;
- Appointment.

4.3.3.4.Implementation management and supervision

Not applicable

4.3.3.5.Compensation (remuneration).

- BDZ PS EOOD has approved "Internal rules for wages" effective from 01.07.2013, which regulate the general conditions for the organization of the working salary:

- Formation and distribution of funds for salary in the company;
- Determining and changing the basic salaries by position;
- Determination of the types and amounts of additional and other remunerations;
- Regulation of the order and manner of payment of staff salaries.

- SE NRIC has approved "Internal rules for wages" in force since 01.09.2014, which regulate issues related to the wages of the company's personnel:

- General provisions for the organization of the salary in the enterprise;

- Determining and distributing the funds for salaries - sources, order and way of forming the remuneration;

- Determination and amendment of salaries and additional remuneration;

- Regulation, order and method of payment of the working salaries.

4.3.3.6. Leadership, powers related issues.

Not applicable.

4.3.3.7. Organizational culture.

Not applicable.

4.3.3.8. Legal issues (including the respective European and national rules and provisions)..

Not applicable.

4.3.3.9. Regulatory framework conditions and applying of the safety management system.

Railway undertaking.

- Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety;
- Commission Delegated Regulation (EU) 2018/762 of 8 March 2018 establishing common safety methods on safety management system requirements pursuant to Directive (EU) 2016/798 of the European Parliament and of the Council and repealing Commission Regulations (EU) No 1158/2010 and (EU) No 1169/2010;
- COMMISSION IMPLEMENTING REGULATION (EU) 2019/779 of 16 May 2019 laying down detailed provisions on a system of certification of entities in charge of maintenance of vehicles pursuant to Directive (EU) 2016/798 of the European Parliament and of the Council and repealing Commission Regulation (EU) No 445/2011;
- COMMISSION IMPLEMENTING REGULATION (EU) No 402/2013 of 30 April 2013 on the common safety method for risk evaluation and assessment and repealing Regulation (EC) No 352/2009;
- Railway Transport Act;
- ORDINANCE No 59 dated 5.12.2006 on the management of railway transport safety.

Railway infrastructure.

- Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety;
- Commission Delegated Regulation (EU) 2018/762 of 8 March 2018 establishing common safety methods on safety management system requirements pursuant to Directive (EU) 2016/798 of the European Parliament and of the Council and repealing Commission Regulations (EU) No 1158/2010 and (EU) No 1169/2010;
- COMMISSION IMPLEMENTING REGULATION (EU) 2019/779 of 16 May 2019 laying down detailed provisions on a system of certification of entities in charge of maintenance of vehicles pursuant to Directive (EU) 2016/798 of the European Parliament and of the Council and repealing Commission Regulation (EU) No 445/2011;
- COMMISSION IMPLEMENTING REGULATION (EU) No 402/2013 of 30 April 2013 on the common safety method for risk evaluation and assessment and repealing Regulation (EC) No 352/2009;
- Railway Transport Act;
- ORDINANCE No 59 dated 5.12.2006 on the management of railway transport safety.

4.3.4. Environmental factors:

4.3.4.1. Labour conditions (noise, illumination, vibrations).

Not applicable for SE NRIC and BDZ PS EOOD.

4.3.4.2. Meteorological and geographic conditions.

The stations Zmeyovo and Tulovo are located in the Southern part of the rail network; Described in details in item 3.1.3.2.

4.3.4.3. Construction works, performed on the spot or in very proximity.

Described in details in item 3.1.3.3.

4.3.5 Any other factors for the investigation objective

Not applicable.

4.4. Feedback and control mechanisms, including risk and safety management, as well as monitoring processes.

4.4.1. Regulatory framework conditions.

Commission Delegated Regulation (EU) 2018/761 of 16 February 2018 establishing common safety methods for supervision by national safety authorities after the issue of a single safety certificate or a safety authorisation pursuant to Directive (EU) 2016/798 of the European Parliament and of the Council and repealing Commission Regulation (EU) No 1077/2012.

Commission Delegated Regulation (EU) 2018/762 of 8 March 2018 establishing common safety methods on the requirements for the safety management system pursuant to Directive (EU) 2016/798 of the European Parliament and of the Council and repealing Commission Regulations (EU) No 1158/2010 and (EU) No 1169/2010.

ORDINANCE No 59 dated 5.12.2006 on the management of the railway transport safety.

4.4.2. Processes, methods and results from the activities on the risk assessment and monitoring that the involved entities performed:

Railway undertakings.

- "BDZ-Passenger Services" EOOD implements the Quality Management System PK 2-15 "Passenger Transportation Safety Management. Monitoring and exchange of information". In section 6.7. "SMS implementation control, item 6.7.2. "Periodic control of the implementation of the SMS is carried out through internal audits: monthly and complex. Complex audits are conducted once a year on all safety-related structures."

- In accordance with the requirements of the "Methodology for safety risk analysis and assessment in force from 23.02.2012", the railway undertaking BDZ PS EOOD has not prepared and submitted monthly reports for the current year, as well as a complex (annual) audit previous year's risk monitoring report.

Infrastructure Manager

- SE NRIC implements safety procedure PB 2.09 "Methodology for determining, assessing and managing risk" version 05 effective from 01.03.2019, which is part of the SMS.

4.4.2.1. Entities in charge of the technical maintenance.

Railway undertaking

- "BDZ-Passenger Services" EOOD is a certified ECM with Certificate No. BG/31/0021/0001 valid until April 18, 2026;

Infrastructure Manager.

- SE NRIC is a certified ECM with Certificate No. BG/31/0020/0003 valid until 30.06.2025
- SE NRIC is a certified ECM for vehicles with Certificate No. EIN BG/31/0023/ 0001, valid from 22.03.2023 to 21.03.2028.

4.4.2.2. Manufacturers and all other participants.

Not applicable.

4.4.2.3. Reports for independent risk assessment.

No assessment has been made by an Independent Assessor (AsBo) of any changes in operating conditions or factors relevant to the occurred accident.

4.4.3. Safety management system of the involved:

Railway undertakings.

"BDZ-Passenger Services" EOOD implements the "Methodology for Analysis and Assessment of Safety Risk", which is part of the SMS.

Railway Infrastructure

SE NRIC implements safety procedure PB 2.09 "Methodology for determining, evaluating and managing risk version 05" effective from 01.03.2019, which is part of the SMS.

4.4.4. Safety Management System of the entities in charge of the technical maintenance.

Railway undertaking.

"BDZ-Passenger Services" EOOD implements an approved "Safety Management System" effective from 30.07.2017, which also regulates the technical maintenance of traction and non-traction rolling stock.

Infrastructure manager.

SE NRIC implements Safety Procedure PB 7.01 "Regulations for maintaining the signalling system (Signalling equipment)", which is part of the SMS;

SE NRIC implements approved "Rules for current maintenance of a rail track" in force from 2021, which is part of the SMS.

4.4.5. Results from the supervision, performed by the National Safety Authority

The results of the performed audits and inspections regarding the functioning of the Safety Management System of SE NRIC and "BDZ-Passenger Services" EOOD in accordance with the requirements of Regulation (EU) 2018/761, Regulation (EU) No. 1169/2010, Regulation No. 56 and Ordinance No. 59 to satisfy the specific requirements of European legislation and national rules for the design, maintenance and operation of the managed railway infrastructure, show that the companies maintain the SMS and can fulfil the requirements provided for in the relevant legal acts.

Infrastructure manager

In the period from 19.10.2020 to 30.10.2020, the National Safety Authority (RAEA) carried out an annual planned supervision of the SMS of SE NRIC.

In the period from 21.11.2022 to 25.11.2022, the National Safety Authority (RAEA) carried out an annual planned supervision of ECM, part of SMS of SE NRIC.

In the period from 24.04.2023 to 05.05.2023, the National Safety Authority (RAEA) performed an audit of the SMS for renewal of the safety authorization of the infrastructure manager (SE NRIC).

Railway undertaking

In the period from 08.02.2021 to 19.02.2021, the National Safety Authority (RAEA) carried out an annual planned supervision of the SMS of "BDZ-Passenger Services" EOOD.

In the period from 22.11.2022 to 09.12.2022, the National Safety Authority (RAEA) carried out an annual planned supervision of the SMS for issuing a single safety certificate of "BDZ-Passenger Services" EOOD.

In the period from 23.10.2023 to 03.11.2023, the National Safety Authority (RAEA) carried out an annual planned audit of the SMS of "BDZ-Passenger Services" EOOD.

4.4.6. Permits, certificates and assessment reports, provided by the National Safety Authority or other Conformity Assessment Bodies:

4.4.6.1. Safety authorization of the involved infrastructure manager.

SE NRIC holds Safety Authorization No IN EC BG 21 2023 0001, valid from 01.07.2023 to 30.06.2028.

4.4.6.2. Safety certificates of the involved railway undertaking

"BDZ-Passenger Services" EOOD owns a Single Safety Certificate with IN EC BG 10 2022 0298, valid from 31.12.2022 to 30.12.2027;

4.4.6.3. Authorizations for placing in service of permanently fixed facilities and authorizations for placing vehicles on the market.

Not applicable.

4.4.7. Other system factors.

Not applicable.

4.5. Previous cases of similar nature.

In the period from 2009 to 2023, NIB - BG investigated 15 accidents of a similar nature; fire occurred in electric locomotives series 44 and 45. In accordance with the requirements of Art. 24, paragraph 2 of Directive (EU) 2016/798 all investigations have been completed with final reports and in accordance with Art. 26, safety recommendations have been issued to the operators and regulators involved in the accident, as well as to the National Safety Authority (RAEA).

5. Conclusions

5.1. Summary of the analysis for the event causes.

The investigation commission carried out several inspections of the burned locomotive No. 91520044202-7 at the Gorna Oryahovitsa Locomotive Depot, got acquainted with the provided documentation on the technical condition (operation and repairs) of the locomotive before the accident.

The investigation commission carried out several comprehensive inspections of the engine compartment of the locomotive, as well as samples of individual machines and units. The Commission interviewed the personnel involved in the accident, the operations and maintenance managers and read their statements. The documentation related to the operation and maintenance of the locomotive was studied and analysed.

From the measurements carried out at the Gorna Oryahovitsa Locomotive Depot of the engine-compressor of the second traction group, it was established that the unit was upright and was not the cause of the fire in the locomotive.

From the inspections and findings, it can be concluded that the most likely cause of the fire during movement in locomotive No. 91520044202-7, serving IFT No. 464, was temperature overheating of the power auxiliary unit 221, feeding the engine-compressor 235. Auxiliary unit 221 was not cooled because the engine driver had continuously switched off the locomotive fans while the train was moving on inertia (visible in the engine driver's testimony).

Another probable cause of the fire was prolonged overheating of the rectifier block, due to lack of cooling by the fans when the locomotive was moving in traction mode.

The analyses and conclusions formulated by the Investigation Commission are based on technical inspections and measurements, as well as the data downloaded from the recording device registered during the movement of the locomotive, respectively the train.

These two causes probably are closely related to give rise to the possibility of fire.

5.2. Undertaken measures after the event occurrence.

The manager of the railway infrastructure SE NRIC undertook timely organization and actions to restore the traffic and the capacity of the railway infrastructure, through inspections and measurements of the rail track and catenary. Traffic was restored at 14:41 p.m. according to schedule.

After the accident, IFT No. 464 was canceled by TOS, and its passengers were taken by bus in the direction of the train to Gorna Oryahovitsa station.

The burned locomotive No. 91520044202-7, serving IFT No. 464, was moved with auxiliary locomotive No. 91520044180-5 to the Gorna Oryahovitsa Locomotive Depot (home location).

5.3. Additional findings.

At the time of preparation of the final report, renovation (overhaul) of 15 locomotives of the 44 and 45 series has been carried out in the fleet of BDZ PS EOOD, which show the reliability of fire safety parameters in operation.

The locomotives in operation from series 44 and 45 of BDZ PS EOOD, which have not been overhauled, their technical condition often leads to the risk of fires occurring during the service of passenger trains in motion. Because of these accidents, train traffic is stopped for a long time and the capacity of the railway infrastructure is limited, which worsens the schedule of trains in the affected section.

6. Safety recommendations

In order to improve the safety in the rail transport, the Chairperson of the Investigation Commission at the NAMRTAIB proposes the following safety recommendations to the National Safety Authority (RAEA), related to SE NRIC and "BDZ-Passenger Services" EOOD.

- Recommendation 1, proposes that SE NRIC and "BDZ-Passenger Services" EOOD familiarize the interested personnel with the contents of the report;
- Recommendation 2 proposes that BDZ PS EOOD undertakes the replacement of electrolytic capacitors of the R-C groups with dry type capacitors of locomotive series 44 and 45;
- Recommendation 3 proposes that BDZ PS EOOD installs technical means (thermostats) for temperature control of rectifier groups 020 and 022 of locomotive series 44 and 45;
- Recommendation 4 that BDZ PS EOOD restores the power supply to the electronic unit for controlling the auxiliary machines Y2 from its own transformer 222, in accordance with the design schemes of the manufacturing plant for series 44 and 45;
- Recommendation 5 proposes that BDZ PS EOOD organizes and carries out renovation (overhaul) of the locomotives of series 44 and 45, which are due for overhaul.

In accordance with the requirements of Art. 24 (2) of Directive (EU) 798/2016 and Art. 91, para. 3 and para. 94, (1) and (4) of Ordinance № 59 of 5.12.2006, the member of the MB in NAMRATIB on 06.02.2024, provides a final report containing information on the circumstances and causes that led to the accident with formulated and coordinated safety recommendations in order to improve the railway transport safety.

In connection with Art. 26, paragraph 3 of Directive (EU) 798/2016 the National Safety Authority (RAEA) and the railway undertakings to which the safety recommendations are addressed shall regularly report to the member of the management board of the NAMRATIB on the measures taken and planned as a consequence of the recommendations.

Chairperson:

Dr Eng. Boycho Skrobanski

Deputy President of the NAMRTAIB AB

Members:

- 1.....(s)..... (External expert)
- 2.....(s)..... (External expert)
- 3.....(s)..... (External expert)