



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

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FINAL REPORT
from

Investigation of railway accident – derailment of wagons of the IDFT № 40832 in Banya station
on 26.02.2023



2023

OBJECTIVE OF INVESTIGATION AND EXTENT OF RESPONSIBILITY

The National Air, Maritime and Railway Transport Accidents Investigation Board (NAMRTAIB), which is an independent body performs the investigation of significant accidents, accidents and incidents. The National Board is within the Council of Ministers (CM) of the Republic of Bulgaria, and aims to find the circumstances and causes that led to the accidents and incidents occurrence in order to improve the safety and to avoid such in future.

The investigation, which the NAMRTAIB performed is independent from any judicial investigation, and does not include the determination of fault or responsibility.

The investigation is performed in accordance with the requirements of DIRECTIVE (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway transport safety, the Railway Transport Act (RTA), Ordinance No59 dated 5.12.2006 on the rail transport safety management, as well as per Agreement dated 11.04.2023 on the interaction during investigation of accidents and incidents in the air, maritime and railway transport between the Prosecutor's Office of the Republic of Bulgaria, Ministry of Interior, and the National Air, Maritime and Railway Transport Accidents Investigation Board.

The Investigation reports follow 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

BTC – Big tonnage containers
DFT – Direct freight train
SE NRIC – State enterprise „National railway Infrastructure Company “(railway infrastructure manager)
„DB Cargo Bulgaria” EOOD – Railway undertaking for freight services
RS – Railway section
HSLC – Healthy and safe labour conditions
RTA – Railway Transport Act
TOU – Traffic organization unit
SPT – Suburban passenger train
km – Kilometre along the rail track
OCL – Overhead contact line (catenary)
EoTC – End of transitional curve
ECM – Entity in Charge of Maintenance
IDFT – International Direct Freight Train
Ordinance № 59 – Ordinance on the rail transport safety management
Ordinance № 58 – on the rules for the technical operation, train traffic and signaling in the rail transport
NAMRTAIB – National Air, Maritime, and Railway Transport Accidents Investigation Board
(Independent Specialized National Investigation Body)
TCB – Transitional curve beginning
RAEA/NSA – Railway Administration Executive Agency, National Safety Authority
TF – Task Force
SE – Signalling equipment
ABS – Automatic Block System
RRS – Rail Rolling Stock
TOMR – Train operation management and reporting
RWCO – Repair Workshop Central Office – Karlovo at „DB Cargo Bulgaria” EOOD
MoI – Ministry of Interior
CDMoI – Capital Directorate at the MoI
MUS – Multiple units system
SMS – Safety Management System
SCM – Structure in charge of maintenance
TMWI – Technician mechanic wagon inspector
TOSAMD – Train operation and station activity management Division
DCCM – Device for communications, connections and messages
WRD – Wagon repair depot
CDG – Central dispatching guide of the railway infrastructure manager
TAI at the MoI Plovdiv

1. Summary

1.1. Brief Description of the Event.

On 25.02.2023, IDFT No. 40832 departed from Kapikule station at 19:25 p.m. in a composition of 17 wagons loaded with full BTC, 100 axles, 1061 tons with locomotive No. 91521688025-1, served by a locomotive driver and an assistant locomotive driver. At Kapikule station, the train was handed over by the Turkish national railway undertaking to the railway undertaking for freight transport "DB Cargo Bulgaria" EOOD. At the Kapikule station, before the departure of IDFT No. 40832, the company's carriage inspector carried out a technical inspection. The train arrived at Svilengrad station at 19:45 p.m. and, after border and customs checks, it departed at 21:08 p.m. It arrived in Plovdiv marshalling yard at 23:14 p.m., where the locomotive crew was changed. At 23:30 p.m., the train departed from Plovdiv marshalling yard and passed without stopping at the stations to Banya station. During the train's movement, the locomotive crew observed the section speeds on the railway infrastructure. The staff on duty at the stations along the route of the train did not notice any irregularities.

For accepting IDFT No. 40832 at Banya station at 00:30 a.m. on 26.02.2023, the traffic manager on-duty ordered a route for the train to cross the second main track without stopping at the station. When the train entered in Banya station, the traffic manager on duty noticed sparks coming from the wheels of the last wagons and the train stopped. The locomotive crew felt the train pulled and noticed that the pressure in the main air duct dropped to 0.0 bar and the train stopped on the second track at 00:41 a.m. The Locomotive Driver and the traffic manager on-duty inspected the train and found that there have been derailed the last two wagons of the train, 16th wagon No. 37804953012-4 Series Sggrms has derailed with both wheelsets of the third bogie and 17th wagon No. 43714378583-4 Series Saagrss derailed with all four wheel-sets of the wagon (Fig. 1.1 and Fig. 1.2).



Fig. 1.1.



Fig. 1.2.

The locomotive driver reported the accident to the national emergency number 112.

At around 01:30 a.m., the authorities from the RU of the Ministry of Interior of Karlovo arrived at the place of the accident in Banya station, inspected the place until 02:30 a.m., and left the area.

At 03:50 a.m., the deputy chairperson of the Management Board at NAMRTAIB, head of the safety investigation, arrived at the place of the accident in Banya station. He carried out inspections of the derailed rolling stock, the rail track and facilities, and the signalling equipment.

Material damages were found to the rail track, signalling equipment and the two derailed wagons, no personnel were injured. Because of the derailment, the last BTC was displaced from the wagon platform; the cargo in it was not displaced and damaged.

From 00:41 a.m. to 13:15 p.m. on 26/02/2023, the movement of trains between Dolna Mahala and Banya stations was interrupted.

From 13:15 p.m. on 26/02/2023, the movement of trains through Banya station was restored on the third accepting-departing track with a speed of 15 km/h.

1.2. Location and time of the event occurrence.

The event occurred at Banya station at km 45+561, 289 m after the entrance semaphore at 00:41 a.m. on 26.02.2023. The derailment area of the wagon is in a left curve with radius $R=350$ m, elevation $H=135$ mm and profile= 0 ‰. In the area of derailment of the wagon, the rail track is jointed with rails type S 49, reinforced concrete sleepers' type ST-4 and fasteners type PAK-68 (fig. 1.3).

The Banya stations are located in the Filipovo - Karlovo section at the 82nd deviation, the line is a conventional single-track, electrified, with speeds of up to 80 km/h. The line is connecting between the 1st and 3rd main conventional railway lines.

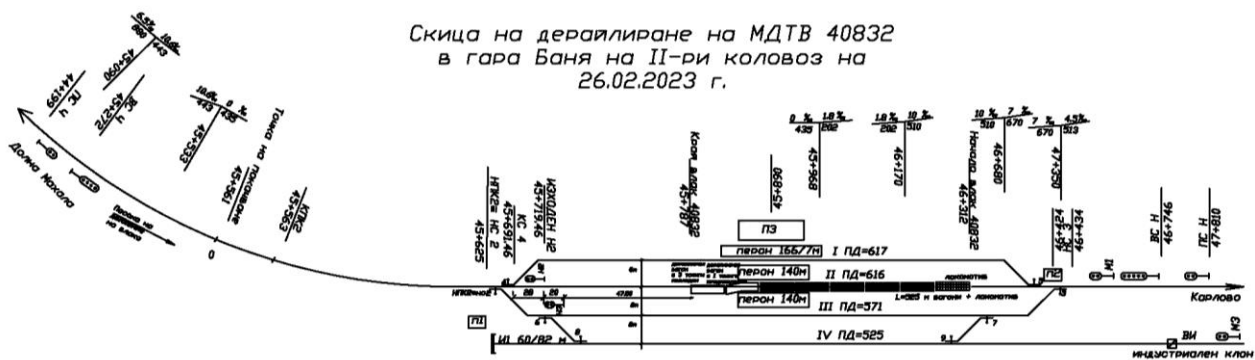


Fig. 1.3.

1.3. Factors determining and contributing the event.

1.3.1. Determining factor was the installation of an inappropriate leaf spring on the derailed wagon No. 43714378583-4, which led to the appearance of inadmissible differences in the load on the first two wheel-sets (left/right wheels) of the wagon. An aggravating circumstance is that a BTC of greater weight is loaded on this platform.

1.3.2. Contributing factor was the unfavourable combination of the geometrical parameters of the rail track under level in the derailment zone and the speed of movement of the IDFT No. 40832.

1.3.3. System factor was the insufficient communication and coordination found during the investigation between the entity, which performed the repair (the replacement of the broken leaf spring), and the entity in charge of the maintenance of the wagon. Turkish Railways did not notify the owner of the wagon about the repair. At the time of the accident occurrence, the SE NRIC between the two border stations of Kapikule and Svilengrad had a built-in system for controlling hot boxes and brake discs, but it did not have a system for controlling the load in the wheels and axles of the passing rolling stock. If such a system had been built, it would have prevented not only this accident, but also others like it in the future.

1.4. Direct causes and consequences of the event.

On 22.02.2023, after the arrival of IDFT No. 40832 at Kapikule border station, a malfunction was detected (broken leaf spring of the left wheel of the first wheel-set) of wagon No. 43714378583-4. The Turkish national railway carrier for repairs removed the carriage from the train. On 25.02.2023, the wagon was included in the composition of IDFT No. 40832. After the replacement of the spring, inadmissible differences in the weight distribution on the left/right wheel of the first and second wheel-set appeared, since the spring has different geometric parameters and characteristics from the original one. The technical staff did not detect the difference. During the static measurement at RWCO - Karlovo, after the derailment, an inadmissible "oblique-symmetrical load" was found (between the first two axles of the wagon). The large weight difference between the wheels in the left curve of the rail track caused the right wheel of the second wheel-set to rise on the head of the right rail and for 14 m, it derailed to the right. Subsequently, on switch No. 2, the other two wheel-sets of the wagon also derailed. The derailed 17th wagon to the right, on switch no. 4, also dragged the 16th wagon, which derailed to the right with the two wheel-sets of the third bogie.

Because of the event, the elements of switches No. 2 and No. 4 were damaged, the last wagon hooked and dragged the exit semaphore on the second track and damaged about 140 m of rail track and elements of the signalling equipment. Traffic on the railway line between Plovdiv and Karlovo was interrupted for thirteen hours.

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 SE NRIC and “DB Cargo Bulgaria” EOOD.

- Recommendation 1, proposes that SE NRIC and “DB Cargo Bulgaria” EOOD familiarize the interested personnel with the contents of the report.
- Recommendation 2, proposes that “DB Cargo Bulgaria” EOOD when accepting rolling stock at the border stations, which will be served by the railway company, to increase the quality and control when performing technical inspections.
- Recommendation 3, proposes SE NRIC to build a check point between Kapikule and Svilengrad border stations with the following functionalities:
 - Measurement of the vertical loading of the left/right wheel of the wheel-sets in motion of RRS;
 - Deviations from the wheels form (trenched and layered flanges) of RRS;
 - Clearance gauge framework.

2. Investigation

2.1. Decision for starting the investigation.

Decision to initiate a safety investigation was made by the member of Management Board of the NAMRTAIB in the Republic of Bulgaria, leading the investigation of railway accidents and incidents, given the severity of the accident and its impact on the railway safety. The investigation was focused on the organization of operation of platform wagons specialized for transport of BTC, aiming at the prevention of serious accidents.

2.2. Motives for the decision to initiate the investigation.

The member of the Management Board of the NAMRTAIB, leading the railway investigation section, took the decision to initiate the investigation based on art. 20, paragraph 2 (a) 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.

2.3. Scope and restrictions of the investigation.

The scope of the investigation examined and analysed the human factor, the railway system related to the repair, maintenance and operation of freight wagons for the carriage of BTC and the railway infrastructure, as well as the safety management system (SMS) in the participating entities.

The investigation was undertaken taking into account the circumstances and causes that led to the occurrence of the accident - the derailment of two wagons from the composition of IDFT No. 40832, which led to material damage to the rail track, the signalling equipment at the Banya station and the RRS.

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

The member of the Management Board of the NAMRTAIB, head of the railway transport unit headed the Investigation Commission. The members of the Commission are external experts for the Railway infrastructure manager and the licensed railway undertakings for transport of passengers and freights- qualified persons from higher transport educational institutions, scientific circles, experts with qualifications in the field of human factor, railway infrastructure and rail rolling stock.

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 representatives of the two entities ("DB Cargo Bulgaria" EOOD and SE NRIC). The Task Force collected the necessary documents and samples, written statements of the personnel involved in the accident, the records from the registering and recording devices of the train locomotive No. 91521688025-1, hauling IDFT No. 40832. The materials and documents were handed over to the Chairman of the Investigation Commission in the NAMRTAIB. The chair of the investigation commission conducted an on-site interview with the locomotive staff, the traffic managers on-duty from Banya and Dolna Mahala stations, the head of the railway section responsible for the repair and maintenance of the rail track. An interview was also conducted with the central dispatching management of the train movement, as well as with the unit for operational movement of the trains related to the accident at the SE NRIC railway station. Additional information regarding the appointment and development of the train schedule was requested and provided by the SE NRIC. Information was requested and provided on the repair and maintenance of the rail track at Banya station and at the Banya - Dolna Mahala interstation. "DB Cargo Bulgaria" EOOD requested and provided information on the registration, ownership, repair and maintenance of the derailed two wagons of the train. An interview was conducted with the safety authorities of the two entities and with the management of the railway company "DB Cargo Bulgaria" EOOD and SE NRIC.

2.6. Degree of cooperation from the participating entities.

During the investigation, the managers of the railway company "DB Cargo Bulgaria" EOOD and the SE NRIC provided full assistance and the necessary materials and documents to the Commission in the NAMRTAIB. In RWCO -Karlovo of "DB Cargo Bulgaria" EOOD, weight measurements of the two derailed wagons were carried out in the presence of the entities and the head of the safety investigation

at NAMRTAIB. In the presence of the customs services and the authorities for the pre-trial proceedings of the accident at the Ministry of Interior Plovdiv, the two containers loaded on the last wagon were opened to check the location of the cargo in them and/or damage and displacement of the cargo as a result of the derailment of the wagon. In RWCO -Karlovo, full access was provided to the Investigation Commission during the measurements of the derailed wagons. Documents and materials were provided regarding the legal capacity and completed training of the personnel involved in the accident, as well as documents regarding work organization and payment.

2.7. Methods and techniques of investigation and analysis.

On 26.02.2023 at 01:26 a.m., the member of the Board of NAMRTAIB with the competence to investigate railway accidents was notified by SMS by the senior dispatcher on duty in the CDR of the manager of the railway infrastructure about an accident that had occurred - derailment of the last two wagons of IDFT No. 40832 at 00:41 a.m. at Banya station. The member of the Management Board of NAMRTAIB analysed the received information and immediately went to the place of the accident. Orders the two entities (SE NRIC and "DB Cargo Bulgaria" EOOD) to take no action in order to preserve the situation of the accident until arriving on-site.

At around 01:10 a.m., safety and operations personnel of the railway infrastructure manager and the railway undertaking arrived at the scene of the accident at Banya station.

At around 01:30 a.m., authorities from the Karlovo Ministry of Interior arrived at the scene of the accident at Banya station, inspected the scene until 02:30 a.m. and left the area.

At 03:50 a.m. the member of the Management Board of NAMRTAIB arrived at the scene of the accident at the Banya station. Undertook inspections and preparation of photographic material of the derailed wagons from IDFT No. 40832, the rail track and the signalling equipment. In order to clarify the circumstances, the head of the safety investigation at the NAMRTAIB collected operational information by phone from the central dispatcher of the train movement in Sofia and from the train dispatcher at OMU - Plovdiv regarding the schedule and appointment in the traffic schedule of IDFT No. 40832. An interview was conducted with the traffic manager on duty at Banya station and at Dolna Mahala station, as well as with the locomotive crew of the train. During an inspection of the train, it was found that between the penultimate, last derailed wagons, the flexible connections of the main air duct had self-disconnected, and that caused the train to stop quickly. The penultimate wagon No. 37804953012-4 derailed with both wheel-sets on the third bogie. The last 17th wagon No. 43714378583-4 has derailed with all four wheel-sets of the wagon. The first two wheel-sets derailed to the right, the other two wheel-sets derailed to the left on the rail track, and with the wagon's ferry hook hooked and pulled out the exit mast semaphore for the second track. The exit semaphore was uprooted with the concrete foundation and dragged parallel to the second track for 70 m until the train stopped. Damage was caused to the signalling equipment controlling switches No. 2 and No. 4, electrical connections of the station interlocking for controlling the switches and semaphores in Banya station were interrupted (Fig. 2.1).

In the direction of the train movement, the first derailment was wagon No. 43714378583-4, the last in the train, 289 m after the entrance semaphore of Banya station. The wagon derailed first with the second track wheel-set. The right wheel of the second wheel-set rose to the head of the right rail at km 45+561 and moved along it for 14 m. The left wheel of the second wheel-set derailed at km 45+574 in the gauge, and the right wheel of the second wheel-set derailed to the right at km 45+575.

A track from the left wheel of the third wheel-set to the left of the rail track at km 45+624 in front of switch No. 2 was also found. At switch No. 2, the other two wheel-sets of the wagon also derailed. On switch No. 4, the derailed wagon also dragged the penultimate wagon No. 37804953012-4, which derailed with both wheel-sets on the third bogie.

Inspections were carried out of the catenary - unaffected by the accident.



Fig. 2.1.

In fulfilment of the requirements of Art. 89, para. 2 of Ordinance No. 59, the authorities from RD MoI Karlovo in writing gave permission for the restoration of the railway infrastructure at Banya station at 06:10 a.m., which in turn delayed the investigation undertaken by the head of the safety investigation at NAMRTAIB and subsequently the restoration of the railway infrastructure and the capacity.

After the given written permissions, SE NRIC and "DB Cargo Bulgaria" EOOD created an organization for lifting the wagons on the rails.

At 07:41 a.m. on 26.02.2023, after agreement and permission given by the head of the safety investigation at NAMRTAIB, IDFT No. 40832 with train locomotive No. 91521688025-1 and the non-derailed 15 wagons departed in the direction of the train to Karlovo - Iliantsi - Dragoman – Dimitrovgrad Zheleznitsa Srabska.

On 27.02.2023, the Investigation Commission went to Banya station, where with representatives of the two entities and the Task Force, additional inspections and measurements of the rail track and the facilities in the area of the train derailment were carried out.

On 27.02.2023, after the inspections at the Banya station, the Commission went to RWCO - Karlovo, where together with representatives of the two entities and the Task Force, control measurements were performed of the technical condition of the derailed wagons No. 43714378583-4, No. 37804953012-4 and the results were reflected in the protocols of findings reports for both wagons. On the same date, static weighing of the derailed wagon No. 43714378583-4 on axles and wheels was carried out on a certified electronic scale at RWCO -Karlovo. The established results were recorded in a protocol. From the measurements, differences in load between the left and right wheels of the first wheel set of wagon No. 43714378583-4 were found to be greater than 25%. On the second wheel-set, which was the first to derail the wagon, unacceptable differences in the static load of the left versus the right wheel were found 1360% when the wagon was empty and 622% when the wagon was loaded.

In the presence of officials from the pre-trial proceedings from the RTD to the Ministry of Interior Plovdiv and Customs Karlovo, the two BTCs loaded on wagon No. 43714378583-4 were opened for inspection regarding damage and distribution of the cargo in them. Displacement and damage were not detected.

On 06.03.2023, the Investigative Commission went to RWCO Karlovo, where with representatives of the two entities and the Task Force, they attended a crane overloading of BTC from the derailed wagon No. 43714378583-4 to wagon No. 31754952207-4. After the unloading of wagon No. 43714378583-4, new static weight measurements of the electronic scale on axles and wheels were carried out and the results were again confirmed, for which a protocol was drawn up with the reported results.

On 30.03.2023, the chair of the Commission for Safety Investigation in the NAMRTAIB received from the head of the Task Force in the Regional Inspectorate "Safety of Transportation" - Plovdiv the collected materials, documents and physical evidence (including photographic material) regarding the railway accident - derailment on IDFT No. 40832 in Banya station on 26.02.2023.

2.8. Difficulties faced during the investigation.

During the investigation of the accident, the representatives of the Task Force and the employees of the two entities, the manager of the railway infrastructure (SE NRIC) and the railway company/carrier („DB Cargo Bulgaria" EOOD), provided full assistance to the Commission for Safety Investigation from the NAMRTAIB.

2.9. Interaction with the judicial authorities.

In accordance with the Agreement (effective from 11.04.2023) on interaction between the pre-trial proceedings authorities from the RD Plovdiv of the Ministry of Interior and the Safety Investigation Commission at the NAMRTAIB, an exchange of information and materials was carried out in the process of the investigation.

2.10. Other important information for the investigation context.


From the recording device of locomotive No. 91521688025-1, serving IDFT No. 40832, the records were downloaded by representatives of "DB Cargo Bulgaria" EOOD and deciphered in graphic and tabular form. The Chair of the Investigation Commission in the NAMRTAIB was provided with an official decryption, as well as the records with the information about the train movement, by the Chief Safety Inspector of the railway company/carrier "DB Cargo Bulgaria" EOOD.

3. Description of the event

3.1. Information on the event and the context.

3.1.1. Description of the event type.

On 25.02.2023 at 19:25 p.m., IDFT No. 40832, departed from Kapikule station in a composition of 17 wagons, 100 axles, 540 meters, 1061 tons, served by locomotive No. 91521688025-1. On IDFT No. 40832 at Kapikule station, a technical inspection was carried out by a carriage inspector of the railway company "DB Cargo Bulgaria" EOOD, receiving the train. The train arrived at Svilengrad station at 19:45 p.m., a customs and border inspection of the train has been carried out, and at 21:08 p.m. it left Svilengrad station, passing without stopping Lyubimets, Simeonovgrad, Nova Nadezhda, Dimitrovgrad, Yabulkovo, Parvomai, Popovitsa, Katunitsa stations, Krumovo and at 23:14 p.m. arrived at Plovdiv marshalling yard. At the Plovdiv marshalling yard, a change was made of the locomotive crew serving the locomotive with a driver and assistant driver, locomotive, employees of the railway company "DB Cargo Bulgaria" EOOD (fig. 3.1).



Изпълнено разписание

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МДТВ 40832 Ди Би Карго 69% лок.88;86 / 25.02.2023

----- без договор -----

КАПЪ КУЛЕ	- :-	- 19:25 +255
60 км 317+400 10	2 :-	- :27 +255
100 СВИЛЕНГРАД	20 19:47 +255	82 21:09 +181
ЛЮБИМЕЦ	11 :-	- :20 +181
ХАРМАНЛИ	10 :-	- :30 +166
СИМЕОНОВГРАД	8 :-	- :38 +166
НОВА НАДЕЖДА	7 :-	- :45 +161
ДИМИТРОВГРАД	8 :-	- :53 +124
ЯБЪЛКОВО	7 22:00 +124	11 22:11 +135
КАРАДЖАЛОВО	7 :18 +135	4 :22 +139
ПЪРВОМАЙ	5 :-	- :27 +131
ПОПОВИЦА	8 :-	- :35 +130
КАТУНИЦА	12 :-	- :47 +131
КРУМОВО	4 :51 +131	13 23:04 +139
40 ПОР ИЗТОК	7 :-	- :11 +139
ПЛОВДИВ РАЗПР.	3 23:14 +139	18 :32 +128
20 ПЛОВДИВ	8 :-	- :40 +128
50 ФИЛИПОВО	9 :-	- :49 +128
80 ТРУД	7 :-	- :56 +128
ГРАФ ИГНАТИЕВО	5 :-	- 00:01 +128
КАЛОЯНОВО	6 :-	- :07 +130
ДОЛНА МАХАЛА	11 :-	- :18 +132
60 БАНЯ	19 00:37 +132	424 07:41 +556
КАРЛОВО	14 07:55 +554	86 09:21 +604
80 СОПОТ	6 09:27 +604	30 :57 +634

Вярно
с оригинала!

Fig. 3.1. Schedule of movement of IDFT № 40832 from Kapikule to Banya station.

At 23:30 p.m., IDFT No. 40832 departed from the Plovdiv marshalling yard and passed without stopping the Plovdiv, Filipovo, Trud, Graf Ignatievo, Kaloyanovo, Dolna Mahala stations to the Banya station.

For accepting IDFT No. 40832 at Banya station, the traffic manager on duty has ordered a route for the second main track with the station interlocking type RRC EC-1 for the train to pass without stopping. When the train entered the entrance gates of Banya station, the traffic manager on duty noticed strong sparks coming from the last two wagons of the train, after which it stopped at the station on the second track. The traffic manager on duty notified the train dispatcher, the concerned services and officials. The locomotive driver together with the traffic manager on duty inspected the train and found that there have derailed the last 2 wagons of the train. The penultimate 16th wagon No. 37804953012-4 derailed with both bogies on the third bogie and the last 17th wagon No. 43714378583-4 derailed with all four bogies. A violation of the integrity of the main air duct was detected, which led to a rapid stop of the train at 00:41 a.m.

It can be seen from the explanations of the locomotive crew, which served locomotive No. 91521688025-1 of IDFT No. 40832, when the train entered the second main track at the Banya station, they felt the train pull.

During the movement of IDFT No. 40832, served by locomotive No. 91521688025-1 from Svilengrad station to Banya station, the locomotive crews observed the section speeds and reductions on the rail track.

Damage was caused to the rail track, the signalling equipment and the last two wagons of the train. The distances for the first and third tracks at the Banya station and the Dolna Mahala station were closed.

In accordance with the "Safety Procedure" SP 2.03/03.05.2022 of the DP SE NRIC, a second category Task Force (TF) with representatives of the two entities was appointed at the Banya station, which undertake inspections of the accident site. It was found that the derailment occurred before Switch 2, with the last wagon with a second wheel-set derailing first, and after passing through switch 2, the remaining two wheel-sets derailed, dragging behind them the penultimate wagon that derailed on switch 4 with both wheel-sets of the third bogie. Mobile specialized recovery vehicles from Plovdiv Region and Stara Zagora Region were sent to the scene of the accident to lift the derailed two wagons at Banya station.

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

On 26.02.2023 at 00:41 a.m., IDFT No. 40832 at Banya station at km 45+574 and at km 45+575, derailed both wheels of the second wheel-set of the 17th last wagon No. 43714378583-4 of the train. On switch No. 4, the 16th penultimate wagon No. 37804953012-4 with the two wheel-sets of the third bogie derailed. The place of derailment is in a curve with radius $R=350$ m, elevation $H=135$ mm and profile=0 ‰. The rail track in the area of the wagon derailment is laid with rails type S 49, reinforced concrete sleepers type ST-4 and fasteners type PAK-68.

IDFT No. 40832 run according to schedule in the direction of Kapikule – Plovdiv – Karlovo – Iliantsi – Dragoman – Dimitrovgrad Zheleznitsa Srabska, passing along main line No. 1, secondary line No. 82 and main line No. 3.

3.1.3. Description of the place of event:

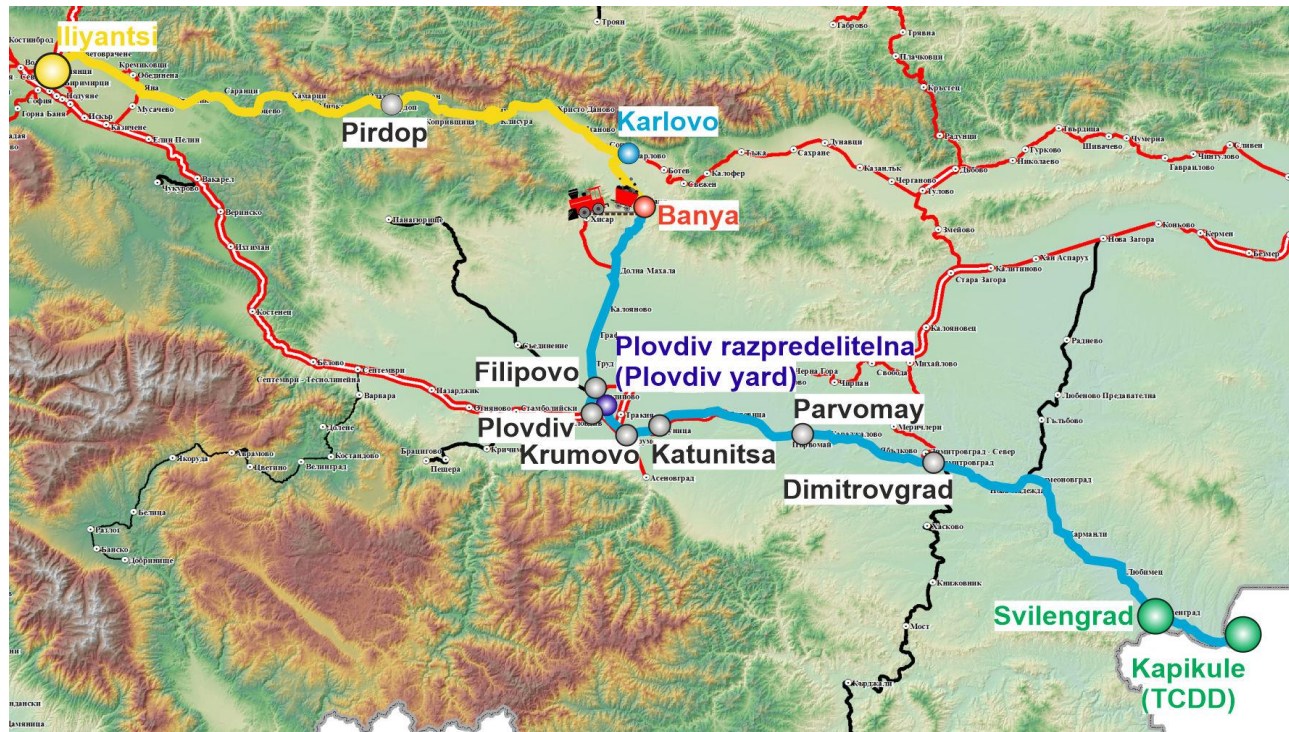


Fig. 3.2. Route of movement of IDFT № 40832 and the accident location.

- Origin station of the train;
- Main stations along the train alignment;
- Station, where the new crew undertakes the management;
- Final destination station of IDFT № 40832 – Vienna;
- Place of the accident – Banya station;
- Track, which IDFT № 40832 passed;
- Track, which IDFT № 40832 was about to pass.

Location of the accident place.

Geographic width: 42°32'24.12"C

Geographic length: 24°50'52.52"И (fig. 3.3)

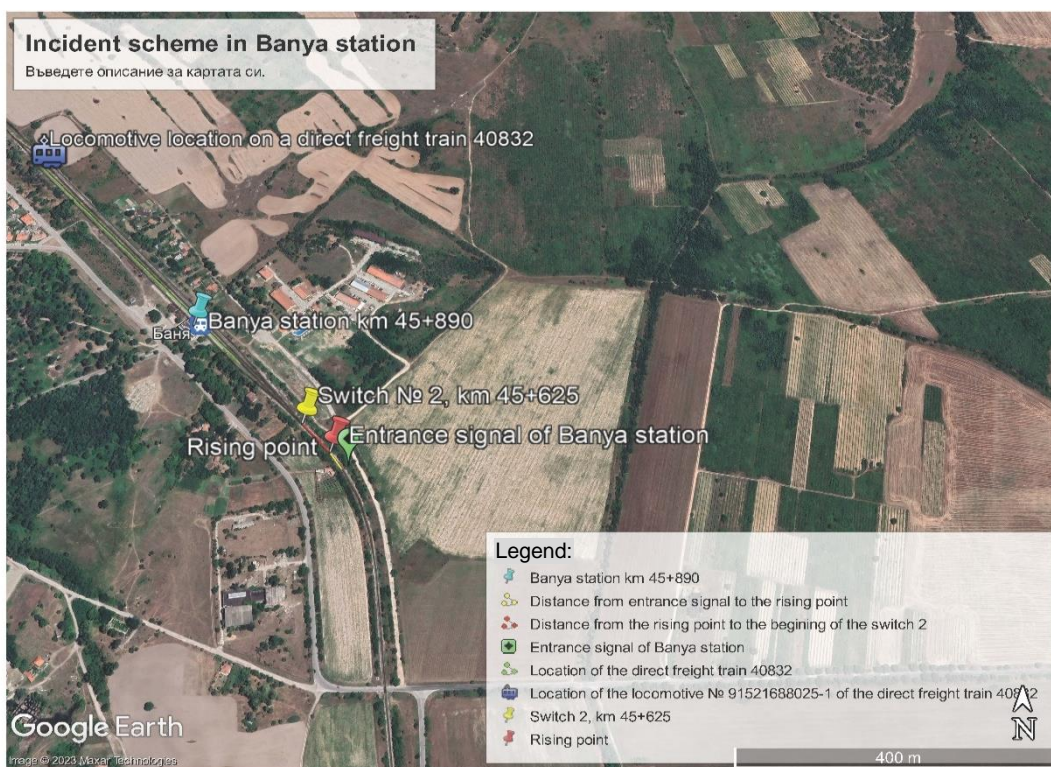


Fig. 3.3. GPS location of the accident place at km 45+561 in Banya station

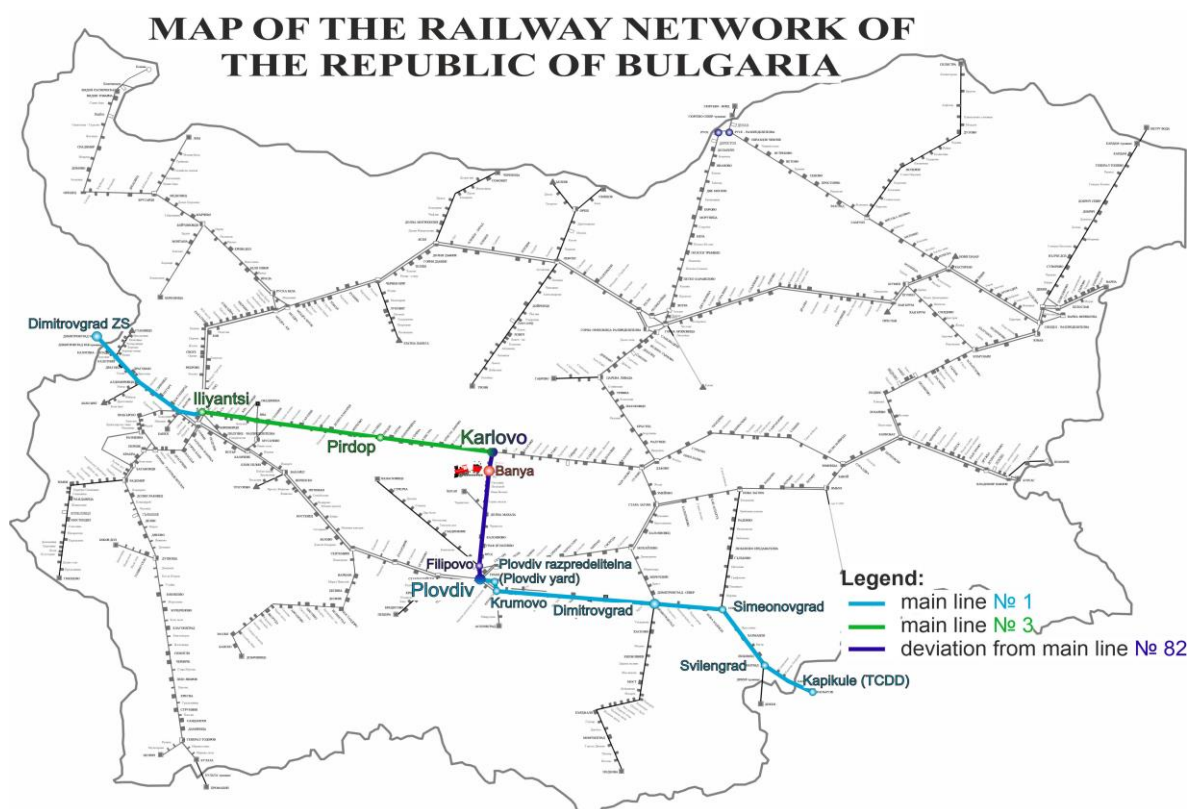


Fig. 3.4. Route of IDFT № 40832 from Kapikule station to Dimitrovgrad Zheleznitsa Srabska station

3.1.2.1. Meteorological and geographical condition at the time of the event.

- In the dark part of the day – 00:41 a.m. (as per the data of the locomotive recording device);
- Air temperature: +12°C;
- Wind speed and direction: 10 m/s, from north-west;
- Weather – cloudy with normal visibility of the signals;
- Geographically Banya station is located in the southern part of the rail network.

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

As of the date of the accident, no construction works have been carried out on the site or in its vicinity.

3.1.3. Fatalities, injuries and material damages:

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

None.

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

None.

3.1.3.3. Passengers.

None.

3.1.3.4. External persons.

None.

3.1.3.5. Cargo, luggage or other property.

None.

3.1.3.6. Rolling stock, infrastructure and environment.

- Material damage of freight wagon № 37804953012-4 series Sggmrs – derailed with both wheel-sets of third bogie, damages caused to the draft gear amounting to 14 190 BGN;
- Material damage of freight wagon № 43714378583-4 series Saagrss – derailed with four wheel-sets damages caused to the draft gear amounting to 29 420 BGN.;
- Material damages, caused to the rail track on the second track and to switches № 2 and № 4 in the accident area amounting to 16 203 BGN;
- Material damages caused to the signaling equipment in the accident area amounting to 6 270 BGN.;

Total damages: 66 083 BGN.

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

In the period 26.02÷28.02.2023, the railway infrastructure manager and the railway undertaking generated other costs due to modification of the train operation schedule along the section Filipovo-Karlovo.

- Deviated trains of the railway undertakings – none;
- Cancelled trains of the railway undertakings – 473,80 BGN;
- Appointed trains of the railway undertakings – 601,40 BGN;
- Delayed trains of the railway undertakings – 750,00 BGN;
- Costs for rehabilitation means – 1 382 BGN;

Total other costs: 3 207,20 BGN.

3.1.5. Identity of the participants and their functions.

Railway infrastructure:

- SE National railway Infrastructure Company has a Safety Authorization № BG 21/2018/0001 with validity period 01.07.2018 ÷ 30.06.2023.

Personnel of SE NRIC involved in the accident:

- Traffic manager on-duty in Banya station on shift;
- Head of railway section;

Railway undertaking:

„DB Cargo Bulgaria“ EOOD has:

License for railway transport services № 206, issued on 13.05.2010 – unlimited;

Personnel of „DB Cargo Bulgaria“ EOOD involved in the accident:

- Locomotive driver of locomotive № 91521688025-1 of IDFT № 40832;
- Assistant locomotive driver of locomotive № 91521688025-1 of IDFT № 40832;
- Wagon inspector in Svilengrad station, serviced IDFT № 40832.

3.1.6. Description of the respective parts of the railway infrastructure and signalling system:

3.1.6.1. Type of the track, railway switch, rail crossing etc.

The event occurred 289 meters after the entrance semaphore and 64 meters before switch number 2 in the Banya station area. The rail track is in a curve with radius of $R=350$ m, an elevation of 135 mm and a profile of 0 ‰, jointed rail track with type S49 rails, on reinforced concrete sleepers ST-4, with PAK 68I fasteners.

The second track is the main one at Banya station, a continuation of the current track to Dolna Mahala station and to Karlovo station. The useful length of the track is 616 meters. On the even side of the Banya station are switches 2, 4, 6 and 8, on the odd side are switches 3, 5, 7 and 9 (Fig. 1.3 and Fig. 3.5).

3.1.6.2. Interstation block system, station installation, type of signalling and messages.

The interstation Dolna Mahala – Banya – Karlovo are equipped with automatic block system (ABS) with axle counters – functioning;

Station installation:

Banya station is equipped with RRI EC-1 with routed shunting – functioning (fig. 3.5);

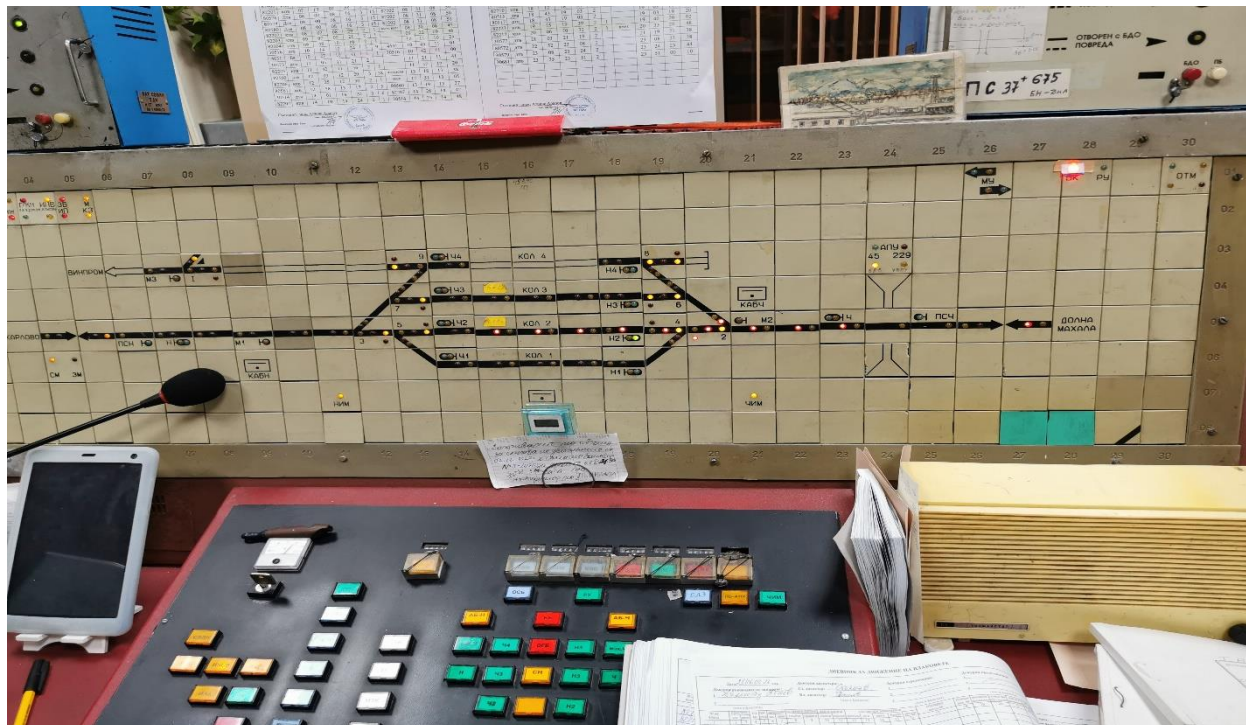


Fig. 3.5.

Type of signalling:

In Banya station the entrance and exit semaphores are under speed signalling – functioning before the accident and with caused damages after it (fig. 3.6);



Fig. 3.6.

Messages:

Banya Station is equipped with a Communications, Connections and Messages Device (UKSS-8) for incoming and outgoing messages of the station with the neighbouring stations and a train dispatcher - working. The staff on duty at the station is equipped with a mobile phone;

3.1.6.3. Train protection systems.

In the section from Filipovo station to Karlovo station, incl. and the Banya - Dolna Mahala interstation does not have a train protection system. The stations are equipped with a train dispatcher radio link (TDRL), through which the locomotive driver makes radio contact with the train dispatcher, with the traffic managers on duty in the stations and with the trains in the section.

Locomotive No. 91521688025-1 is equipped with an active type vigilance device, a Hasler Teloc 2200 type electronic recording device and a locomotive radio station for train dispatching radio communication (TDRC).

3.1.7. Other information referring the event.

The train documents „Way-bill“, „Nature sheet“, and „Brake mass certificate“ of IDFT № 40832 correspond to the hours of the actual movement of the train under the presented data of the locomotives encryption (fig. 3.7, 3.8, 3.9, 3.10).

DB Cargo Bulgaria

СЛУЖБА DB CARGO BG		ПЪТЕН ЛИСТ № 0063776		Вярно с оригинала		ЛОКОМОТИВ № 88-025,1		СЛУЖБА DBS СОБСТВ.		ДАТА 25.02.23	
основна служба, пункт				сер. номер		код		индекс		ден месец година	

ЛОКОМОТИВНА БРИГАДА				ЯВЯВАНЕ				предпътен преглед годен за работа				ОСВОБОЖДАВАНЕ				ПЪТУВАНЕ БЕЗ СЛУЖБА			
пункт	име, презиме, фамилия	инф.	пункт	час, мин.	замерка	пункт	час, мин.	замерка	пункт	час, мин.	замерка	пункт	час, мин.	вид трансп.	до пункт	час, мин.	подпис		
3469	Ат. Н. Атанасов	В	ПР	22:15	МЗ3	3469	Ат. Н. Атанасов	МЗ10	3469	Ат. Н. Атанасов	МЗ10	3469	Ат. Н. Атанасов	МЗ10	МЗ10	МЗ10	МЗ10		
23859	Хр. Н. Тонев	О	ПР	22:15	РЗСРБ	23859	Хр. Н. Тонев	ГАЛРБ	23859	Хр. Н. Тонев	ГАЛРБ	23859	Хр. Н. Тонев	ГАЛРБ	ГАЛРБ	ГАЛРБ	ГАЛРБ		

ПРИЕМАНЕ И ПРЕДАВАНЕ НА ЛОКОМОТИВА								ДОПЪЛНИТЕЛНО ПОЛУЧЕНО ГОРИВО ИЛИ МАСЛО								
пункт	лок. в технически годен за експлоатация съгласно НТИ	показания на километраж	наличено гориво	лок. машин.	час, мин.	предател	подпис	пункт	вид	мерка	количество	час, мин.	отпуснал	подпис	лок. машин.	подпис
ПР	278.38669	278.41683						ПР								

ИНСТРУКТОР/ИНСПЕКТОР				СТАРШИ КОНДУКТОР				СВЕРКА НА ЧАСОВНИЦИТЕ				
пункт	фамилия	от	до	пункт	фамилия	от	до	пункт	час, мин.	дежурен ръководител	старши кондуктор	лок. машин.
41		43	45	46		48	50	51				

ОБСЛУЖВАНЕ НА ВЛАСОВЕТЕ И МАНЕВРЕНА РАБОТА								ДАНИИ ЗА СЪСТАВА НА ВЛАСОВЕТЕ							
№ на вл.	гара	вх. сект.	пристига	тръгва	Бележки - приц. за спирене или зак.; нередк. по жел. път, конт. мрежа, сигнали; отчет налично гориво; вид ман. дейност - композиция, кантар, зар. клон и др.	лок. машин.	подпис	други лок. машин.	маса на състава	брой вагона	брой оси пътнически вагона	брой оси товар. ваг.	фамилия	подпис	
40832	ПР	61	06:35	07:38	Прода				600/1061	17	100	30			
	БАН	62	07:53	08:14	Прода				283.948	15					
	КА	63	09:27	09:53	Прода										
	ЛОП	64	10:43	11:00	Прода										
	АН	65	12:01												

Fig. 3.7. Waybill of IDFT № 40832 – front part.

ОБСЛУЖВАНЕ НА ВЛАСОВЕТЕ И МАНЕВРЕНА РАБОТА								ДАНИИ ЗА СЪСТАВА НА ВЛАСОВЕТЕ							
№ на вл.	гара	вх. сект.	пристига	тръгва	Бележки - приц. за спирене или зак.; нередк. по жел. път, конт. мрежа, сигнали; отчет налично гориво; вид ман. дейност - композиция, кантар, зар. клон и др.	лок. машин.	подпис	други лок. машин.	маса на състава	брой вагона	брой оси пътнически вагона	брой оси товар. ваг.	фамилия	подпис	
40832	ПР	61	06:35	07:38	Прода				600/1061	17	100	30			
	БАН	62	07:53	08:14	Прода				283.948	15					
	КА	63	09:27	09:53	Прода										
	ЛОП	64	10:43	11:00	Прода										
	АН	65	12:01												

Вярно
с оригинала!

ДРУГИ ВПИСВАНИЯ, ЗАБЕЛЕЖКИ 40832 - 0.00 - 03.2.2023 Атанасов Михаил Атанасов Христо Методи Тонев 40832 - 07.04.2023 Методи М. Методи											
ЯВЯВАНЕ в т. ПР БОРН, трезви, отпочинали Неупотребили употребени вещества. №5 Лок. машин. Ат. Н. Атанасов Лок. машин. Хр. Н. Тонев МЗ10 ГАЛРБ - прикритие 120 м. излизане											

ПРЕДАВАНЕ НА ПЪТНИЯ ЛИСТ				КОНТРОЛ НА РЕГ. ПАРАМЕТРИ				СТАТИСТИЧЕСКА ОТЧЕТНОСТ				ЕНЕРГИЙНА ОТЧЕТНОСТ							
пункт	бр. контр. лист	дата	час, мин.	лок. машин.	подпис	дата	констатиране нарушения	проверил фамилия	подпис	дата	констатиране нарушения	проверил фамилия	подпис	дата	час, мин.	отпуснат разход	наличено на преразход	проверил фамилия	подпис
80	81	82	83	84		85	86	87	88	89	90	91	92	93	94	95	96	97	98

Fig. 3.8. Waybill of IDFT № 40832 – rear part.

НАТУРЕН ЛИСТ НА ВЛАК №

40832

Отправна гара:

KK

Получаваща гара:

ДГ-ЖС

Дата и час на твърдяне

25.02.2023 г.

Дата и час на пристигане

[illegible]

КОЛИЧЕСТВО НА ВАГОНИТЕ ОТ ГАРА НА КОМПОЗИРАНЕ

ГАРА	ВАГОНИ	ПО СЕРИИ										ВСИЧКО	Пътнически	НЕТО	БРУТО	Дължина метри
		G,H,S,R,Res	E	F	T,U	U,Z	I	U	др.							
		Покрити	платформи	платформи	открити	седловидни	зърновози	цистерни	хладилни	циментовози	други					
	Пълни	17										17				
	Празни	0										0				
	Общо	17										17				
Брой оси		Пълни:		100		Локомотив №		88-025				600	1061	524,92		
		Празни:		0		Лок. машинист:		Найденев-Колев		437143785834		0		празни		

СЪСТАВИЛ:

Ж.Ангелова

ПРИЕЛ:

Вярно
с оригинала!

Fig. 3.9. Nature sheet of IDFT № 40832.

Превозвач: Ди Би Карго България ЕООД						Обр. ВП-11	
Удостоверение за спиратна маса							
Гара: У. Угм				Влак №: 40832		(К) 8	
Дата: 19.02.23							
Маса на влака: 1061 t				R: 19:05			
Спиратен процент: 69 %							
Необходима спиратна маса: 732 t							
Mg	—	оси	ABC (Автоматична влакова спиратка)	PC (Ръчна спиратка)			
R	—	оси					
P	100	оси	Спиратна маса, t	Оси бр.	Спиратна маса, t	Оси бр.	Забележка
G	—	оси					
Начална / останала маса / оси			1061	100			
Допълнителна маса / оси			—	—			
Всичко: Налична спир. маса / оси			1061	100			
Неплътност на локомотива			0.1	bar / min			
Неплътност на влака			0.3	bar / min (bar / 0.5 min)			
Влака натегнат / натегнат			Извършил пробата на спиратка: 19.02.23				
Дежурен ръководител движение: М. М. М.							
№ на вагон		Спиратна маса	№ на вагон		Спиратна маса		
338249612341		72					
336849534521		54					
338249611222		54					
6 0338249611292		67	17 / 100 / 1061		4		
378049540362		63	3 16		1746		
317549522215		65					
312549521134		59	14 / 84 / 887		2		
312549521260		54					
338249611324		72					
317549521621		65					
317549521662		61					
317549521512		63					
317549521918		68					
312549520011		73					
336849521016		59					
6 0372049530124		60					
6 0372143283234		53					

Забележка: Непълнотата се зачертава

Вярно
с оригинала!

Fig. 3.10. Brake mass certificate of IDFT № 40832.

3.2. Factual description of the occurred.

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

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

In his written testimony, the traffic manager on duty at Banya station reflected that at 00:18 a.m. IDFT No. 40832 departed from Dolna Mahala station, requested consent from Karlovo station and ordered a route for the train without stopping at the station with RRI EC-1. At 00:35 a.m., the traffic manager on duty at the Banya station went out to meet the train on the station platform for the second track. As the train passed through the entrance switches, he noticed that sparks were coming from the wheels of the last wagons and the train stopped quickly on the second track in the station. He notified the train dispatcher and went to the train. He found that the penultimate wagon No. 37804953012-4, loaded with two BTCs derailed with the two wheel-sets on the third last bogie, and the last wagon No.

43714378583-4, loaded with two BTCs, derailed with the four wheel-sets of the wagon. The traffic manager on duty notified the concerned services and officials in writing about the accident that occurred.

From the written testimony of the locomotive crew that serviced locomotive No. 91521688025-1 of IDFT No. 40832, from the decoding of the movement, as well as from the records of the train movement at the Plovdiv railway station, it is clear that the train from the Plovdiv marshalling yard to the Banya station moved without stopping and unhindered. The train route was arranged and locked with a permissive indication of the entrance and exit semaphores for the main track (second) without stopping at Banya station. When the train entered the station, after the entrance semaphore, the locomotive crew felt the train pull and a rapid decrease in the pressure in the main air duct to 0 bar and the train stopped on the track in the station. The locomotive driver and the traffic manager on duty at the Banya station inspected the train and found that the penultimate and last wagons of the train had derailed. The locomotive driver notified the dispatcher of the railway company, the train dispatcher about the accident and reported the emergency number 112.

It is evident from the written testimony of the wagon inspector at Kapikule and Svilengrad stations, who served IDFT No. 40832:

1. When the train entered in Kapikule station, the inspector "listened" to the train;
2. In Kapikule station, locomotives were being changed and locomotive No. 91521688025-1 was attached to IDFT No. 40832;
3. The wagon inspector performed a technical inspection and test A of the train at Kapikule station and did not find any irregularities in the composition;
4. The wagon inspector accompanied the train in the locomotive cabin from Kapikule station to Svilengrad station;
5. Before the departure of IDFT No. 40832 from Svilengrad station, the wagon inspector performed a D test of the train.

3.2.1.2. Rolling stock and technical facilities functioning.

IDFT No. 40832 was appointed according to an additional timetable in the TOS and moved along the route Halkali - Kapikule - Plovdiv - Karlovo - Iliantsi - Dragoman - Dimitrovgrad (Zhs) - Vienna and on the territory of the Republic of Bulgaria was served by the railway company "DB Cargo Bulgaria" EOOD.

On 22.02.2023, at Kapikule station, wagon No. 43714378583-4 was removed from IDFT No. 40832 due to an established technical malfunction (broken leaf spring on wheel No. 1 - left wheel of the first wheel-set). These circumstances were established by the correspondence exchanged between the Turkish national railway carrier and the railway company "DB Cargo Bulgaria" EOOD. The wagon is a four-axle bogie less, double-platform wagon for transporting containers. A technical person of the Turkish national railway carrier detected the malfunction. After removing the malfunction (replacing the broken one with a healthy spring), on 25.02.2023 the wagon was included in IDFT No. 40832 as the last one in the train (17th in a row). The Turkish railway carrier has documented that the rolling stock of IDFT No. 40832 consisting of seventeen wagons was technically sound.

From the decipherment made for the movement of IDFT No. 40832, it was established that when the train entered Banya station, the pressure in the main air duct dropped sharply as a result of the disconnection of the flexible connections of the MAD between the 16th and 17th wagons due to the derailment of the two wagons, after which the train stopped on a second track in the station.

3.2.1.3. Operational system functioning.

At the time of the accident, the operational system for managing the train traffic in the Plovdiv - Karlovo section and in the Dolna Mahala - Banya interstation was functional and functioning normally.

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

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

Authorities from the Karlovo Ministry of Interior arrived at Banya station around 01:30 a.m. to clarify the situation after receiving a signal from the 112 telephone; the area was not restricted for access

by the representatives of the interested parties. Procedural-investigative actions were carried out on the spot by the authorities of the Karlovo RD Ministry of Interior and by the head of the safety investigation from the NAMRATIB and the interested officials of the subjects.

3.2.2.2. Actions of the emergency rescue services.

Non-applicable.

3.2.2.3. Actions of the emergency rehabilitation services

The Plovdiv rehabilitation service was notified at 01:30 a.m. by a senior train dispatcher at the Plovdiv railway station and the UNIMOG rehabilitation vehicle left Plovdiv at 01:53 a.m., arriving at the scene of the accident at 02:53 a.m. at Banya station.

The Stara Zagora rehabilitation service was notified at 01:30 a.m. by a senior train dispatcher at the Plovdiv railway station and the IVECO rehabilitation vehicle left Stara Zagora at 02:00 a.m., arriving at the accident site at 03:30 a.m. at Banya station.

After the completion of the inspections by the head of the safety investigation by the NAMRATIB, at 06:10 a.m., written permission was given by the authorities of the RU Ministry of Interior of Karlovo to carry out emergency recovery activities.

By order of the train dispatcher at 08:43 a.m., the voltage in the catenary of the Banya station was turned off and the lifting of the two derailed wagons No. 43714378583-4, No. 37804953012-4 on the second track was allowed.

Wagon No. 37804953012-4, the 16th of the train, was lifted at 10:10 a.m. Wagon No. 43714378583-4, the 17th of the train, was lifted at 11:15 a.m.

TOU - Plovdiv has appointed diesel locomotive No. 98521756710-8 from Karlovo station to Banya station, arriving at 10:07 a.m. to transport the two raised wagons.

From Plovdiv station to Banya station at 10:47 a.m., a submersible machine arrived for the repair of the rail track and the damage to switches No. 2 and No. 4.

TOU - Plovdiv has appointed electric locomotive No. 91523186019-7 to run from Dolna Mahala station to Banya station to perform measurements and check the rail track for hidden gaps in the derailment area.

OT mechanic technician inspected and measured switch No. 2, at Banya station, which was reversed and locked for third track with "Hook bolt".

By order of the train dispatcher at 12:14 p.m., the voltage in the catenary of Banya station was switched on.

By order of the train dispatcher at 13:21 p.m., the movement of all vehicles diverted through switch No. 2 along the 3rd acceptance-departure track at Banya station was restored. All trains and vehicles should pass through switch No. 2 at a speed of up to 15 km/h.

TOU - Plovdiv appointed train No. 82892 diesel locomotive No. 98521756710-8 for movement at 21:07 p.m. and the two derailed wagons from the composition of IDFT No. 40832 were taken from Banya station to Karlovo station at a speed of up to 10 km/h. The train arrived at Karlovo station at 22:37 p.m. The two wagons were submitted at 22:45 p.m. at the Central Office Repair Base - Karlovo.

On 10.03.2023 until 16:00 p.m., restoration works were carried out, renewal of 144 meters of rail track and installation of a new exit semaphore on the second track and repair of an exit semaphore on the third track at Banya station. Repairs were made to switches No. 2 and No. 4. The movement of trains through Banya station was restored at a scheduled speed.

4. Analysis of the event

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

4.1.1. Railway undertaking.

Analysis of the movement of IDFT № 40832.

The traffic data of IDFT No. 40832 were downloaded from the recording device of locomotive No. 91521688025-1

On fig. 4.1 and fig. 4.2 in the upper part of the image, the graphs V(S) and pressure in MAD (S) are shown for locomotive No. 91521688025-1 and reflect the recorded data from the electronic speedometer installation of the locomotive during the movement of IDFT No. 40832 after departure from Plovdiv station at 23 :30 p.m. to the scene (indicated in the figures by arrows). Figures represent a graphical screen from the locomotive manufacturer's data analysis processor (TELOC-AS V 2.22).

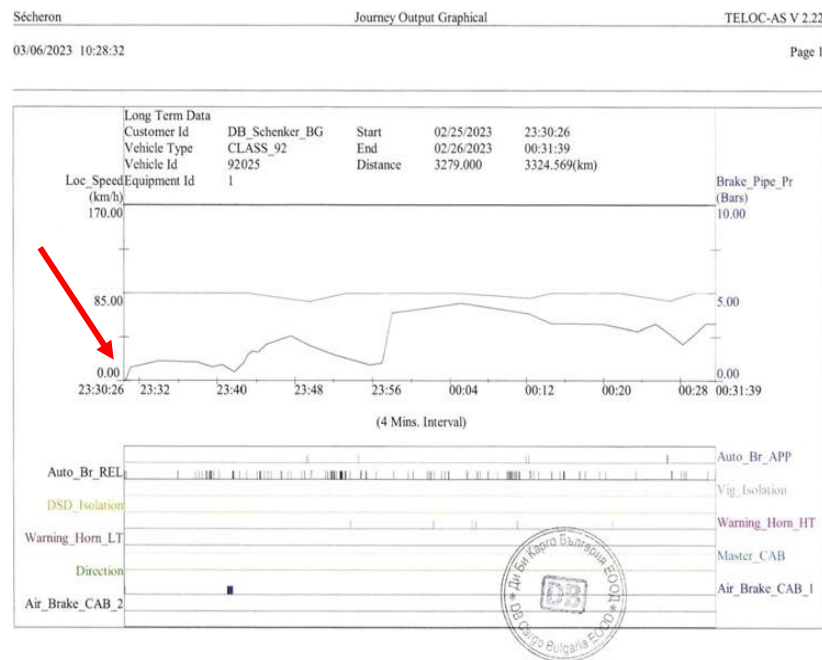


Fig. 4.1.

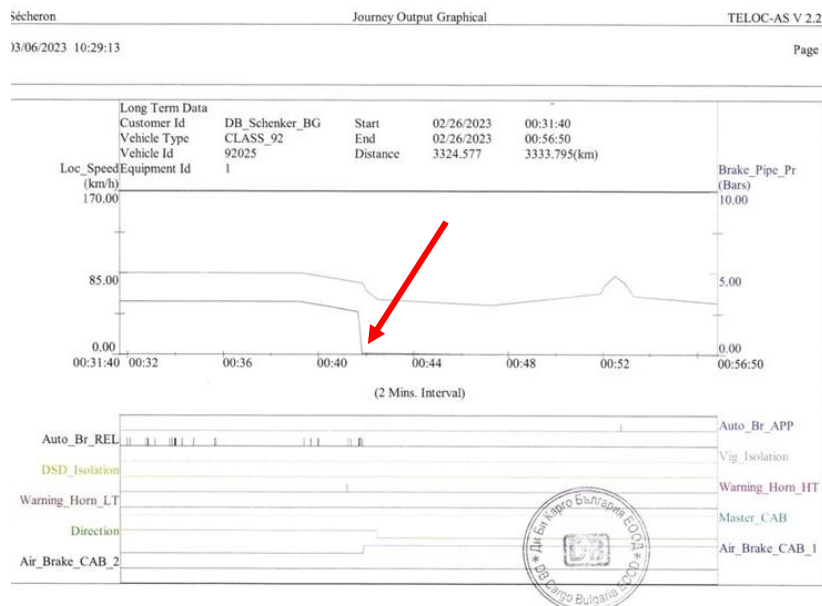


Fig. 4.2.

Table 1					HH, MM, SS,00	KM-indicator	S, km	V, km/h	Pmad, bar
					1	2	3	4	5
00:34:16,70	3326,979004	0,000000	55,07	4,99					
00:34:44,60	3327,406738	0,427734	55,07	4,99					
00:34:44,80	3327,409424	0,430420	55,07	4,99					
00:35:25,70	3328,032959	1,053955	55,07	4,99					
00:35:37,30	3328,209717	1,230713	55,07	4,99					
00:35:37,40	3328,211426	1,232422	55,07	4,99					
00:35:40,30	3328,255859	1,276855	55,07	4,99					
00:35:40,40	3328,257568	1,278564	55,07	4,99					
00:36:50,10	3329,322510	2,343506	55,07	4,99					
00:39:06,10	3331,402100	4,423096	54,99	4,98					
00:39:24,70	3331,683105	4,704101	54,99	4,98					
00:39:24,80	3331,684814	4,705810	54,99	4,98					
00:39:41,60	3331,940186	4,961182	54,99	4,98					
00:39:41,80	3331,943359	4,964355	54,99	4,98					
00:39:53,60	3332,122803	5,143799	54,99	4,98					
00:39:59,60	3332,213623	5,234619	54,99	4,98					
00:40:00,50	3332,227539	5,248535	54,99	4,98					
00:40:36,80	3332,778564	5,799560	54,99	4,98					
00:41:11,00	3333,297852	6,318848	54,99	4,98					
00:41:11,20	3333,300781	6,321777	54,99	4,98					
00:41:12,40	3333,319336	6,340332	54,99	4,98					
00:41:13,70	3333,339355	6,360351	54,99	4,98					
00:41:13,90	3333,342529	6,363525	54,99	4,98					
00:41:19,30	3333,426514	6,447510	54,99	4,98					
00:41:21,20	3333,455811	6,476807	54,99	4,98					
00:41:21,40	3333,459229	6,480225	54,99	4,98					
00:41:26,60	3333,540771	6,561767	54,99	4,98					
00:41:35,60	3333,680176	6,701172	54,99	4,98					
00:41:36,40	3333,691650	6,712646	54,99	4,98					
00:41:37,10	3333,701660	6,722656	54,99	4,98					
00:41:37,30	3333,704346	6,725342	54,99	4,98					
00:41:37,90	3333,711914	6,732910	44,81	4,98					
00:41:38,50	3333,719482	6,740478	44,81	4,98					
00:41:39,10	3333,727051	6,748047	44,81	4,98					
00:41:39,80	3333,734863	6,755859	44,81	4,98					
00:41:40,00	3333,737305	6,758301	44,81	4,98					
00:41:41,00	3333,748047	6,769043	37,15	4,98					
00:41:41,30	3333,750977	6,771973	37,15	4,98					
00:41:41,90	3333,757080	6,778076	37,15	4,98					
00:41:42,10	3333,758545	6,779541	37,15	4,98					
00:41:42,20	3333,759521	6,780517	37,15	4,98					
00:41:42,40	3333,761475	6,782471	37,15	4,98					
00:41:42,70	3333,764160	6,785156	28,43	4,98					
00:41:44,60	3333,778076	6,799072	28,43	4,98					
00:41:46,50	3333,787842	6,808838	19,45	4,98					
00:41:46,70	3333,788330	6,809326	11,32	4,98					
00:41:48,20	3333,792480	6,813476	11,32	4,98					
00:41:49,70	3333,793945	6,814941	3,88	4,98					
00:41:49,90	3333,793945	6,814941	0,00	4,36					
00:41:50,00	3333,793945	6,814941	0,00	4,36					
00:41:50,20	3333,793945	6,814941	0,00	4,36					
00:41:51,20	3333,794189	6,815185	1,29	4,36					
00:41:51,30	3333,794189	6,815185	1,29	4,36					
00:41:52,20	3333,794189	6,815185	0,00	4,36					
00:41:54,10	3333,794434	6,815430	0,00	4,36					
00:42:08,50	3333,794434	6,815430	0,00	3,89					
00:42:23,20	3333,794434	6,815430	0,00	3,35					
00:42:23,80	3333,794434	6,815430	0,00	3,35					
00:42:25,40	3333,794434	6,815430	0,00	3,35					
00:42:50,80	3333,794434	6,815430	0,00	3,35					

In order to make the V(S) and Pmad(S) diagrams more clear, the numerical data have been exported in Excel-format, processed, and visualized in this software product.

A sample of the numerical data from the recording speedometer installation of locomotive No. 91521688025-1 in the last approximately 7 kilometres before the accident is shown in Table 1. Column No. 3 marked in yellow colour was calculated based on the data from Column No. 2.

Figure 4.3 shows the running speed and command pressure of the automatic train brake in the last 100 meters or so before the stopping point after the accident. On the left ordinate axis, a step with a speed of 5 km/h is selected, and on the right ordinate axis, the pressure in the MAD is depicted as a function of the travelled path S. The image is shown in Fig. 4.3, and for the same reasons, the step along the travelled path S is chosen 0.01 km (i. e. 10 meters)

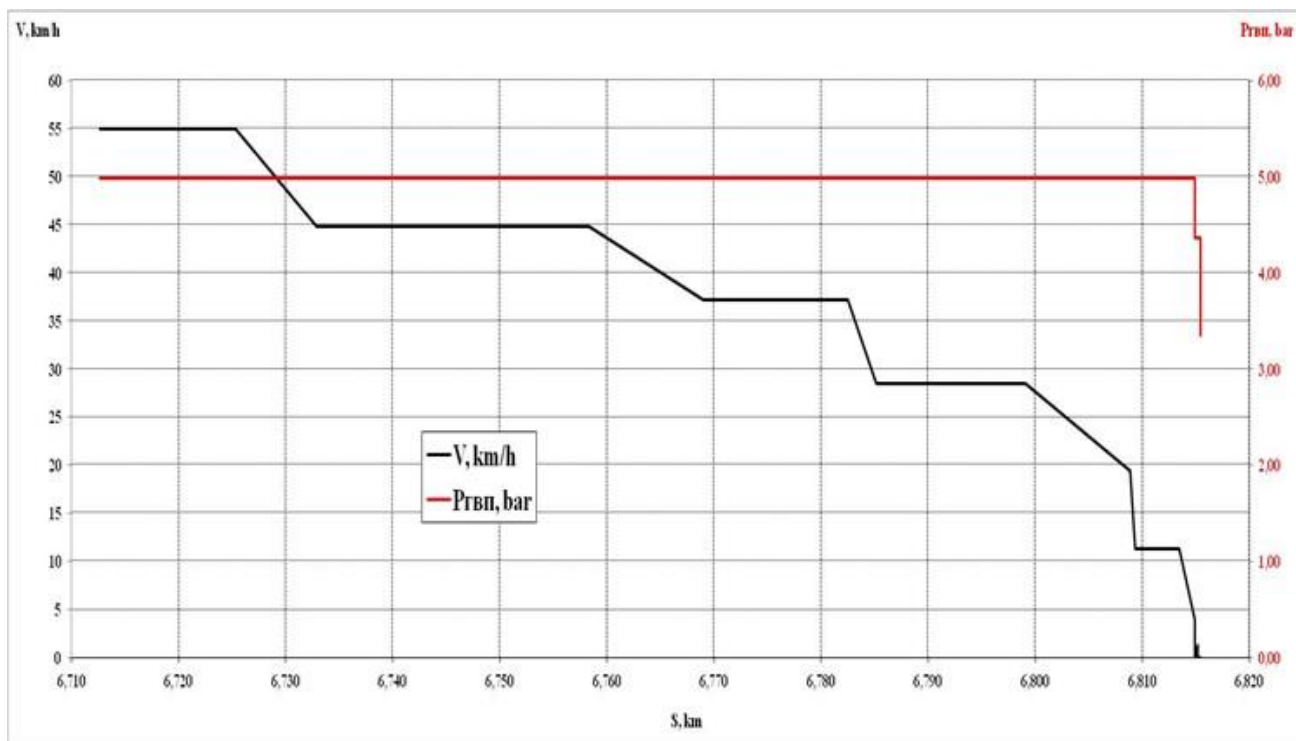


Fig. 4.3.

The deceleration started at 00:41:37.30 a.m. from km 3333.704346 and the train stopped at 00:41:54.10 a.m. at km 3333.794434 according to the Table. The process took 16.8 seconds, and the distance travelled was 90 meters.

From the above graphs, no over speeding by the locomotive during the movement of IDFT No. 40832 was found, therefore it had no relation to the accident that occurred.

Probable causes of the accident

In the course of the investigation into the causes that led to the occurrence of the derailment, inspections were carried out at the scene of both derailed wagons. Measurements of the vertical static load in the wheels of the two derailed wagons were carried out at RWCO -Karlovo.

In fig. 4.4 are shown the vertical static loads in the wheels of wagon No. 43714378583-4, loaded with the two containers, after the second container has been moved.

The calculated left/right (right/left) wheel ratios show that with an allowable difference of 1.25:1, the real for the first wheel set is 3.93:1 and for the second wheel set it is 6.22:1. For the third and fourth wheel sets, the ratios are normal.

The requirements for the permissible differences in the vertical loads of wheels and axles of wagons are given in Working Procedure WP - 4.10 "Instructions for loading and transporting oversized and heavy loads on the railway network of the Republic of Bulgaria" of the SE NRIC, part of SMS.

Wheel and axle load on wagon No: 43714378583-4					
Loaded, measured on 27.02.2023 in Karlovo repair base.					
Measured vertical load in the left wheels, kg.		Measured vertical load in the right wheels, kg.	Ratio left/right (right/left) wheel, %	Vertical load in the wheelsets, kg	
3 792	1 st wheelset	14 898	393%	18 690	3,93 Ratio left/right wheel, (max 1,25)
		Total load on the first and second wheelset, kg		36 873	1,03 Ratio first to second wheelset, (max 1,2)
15 666	2 nd wheelset	2 517	622%	18 183	6,22 Ratio left/right wheel, (max 1,25)
5 034	3 rd wheelset	4 309	117%	9 343	1,17 Ratio left/right wheel, (max 1,25)
		Total load on the third and fourth wheelset, kg		18 905	1,02 Ratio third to fourth wheelset, (max 1,2)
4 374	4 th wheelset	5 188	119%	9 562	1,19 Ratio left/right wheel, (max 1,25)
Total, kg: 28 866		Total, kg: 26 912	Measured weight of the wagon, kg 55 778		

Note:

1) With a broken blue line, the conditionally accepted two two-axle wagons making up wagon No. 43714378583-4 are outlined.

2) The ratios between the axle loads are calculated based on the conditional acceptance in item 1.

Fig. 4.4.

Fig. 4.5 shows the vertical static loads in the wheels of wagon No. 43714378583-4, measured after unloading the two containers from the wagon.

The calculated left/right (right/left) wheel ratios show that with permissible differences of 1.25:1, the actual for the first wheel set is 11.36 and for the second wheel set is 13.60. For the third and fourth wheel sets, the ratios are normal.

Wheel and axle load on wagon No: 43714378583-4					
Empty, measured on 06.03.2023 in Karlovo repair base.					
Measured vertical load in the left wheels, kg.		Measured vertical load in the right wheels, kg.	Ratio left/right (right/left) wheel, %	Vertical load in the wheelsets, kg	
569	1 st wheelset	6461	1136%	7030	11,36 Ratio left/right wheel, (max 1,25)
		Total load on the first and second wheelset, kg		12974	1,18 Ratio first to second wheelset, (max 1,2)
5537	2 nd wheelset	407	1360%	5944	13,60 Ratio left/right wheel, (max 1,25)
3024	3 rd wheelset	2710	112%	5734	1,12 Ratio left/right wheel, (max 1,25)
		Total load on the third and fourth wheelset, kg		12416	1,17 Ratio third to fourth wheelset, (max 1,2)
3001	4 th wheelset	3681	123%	6682	1,23 Ratio left/right wheel, (max 1,25)
Total, kg: 12131		Total, kg: 13259	Measured weight of the wagon, kg 25390		

Note:

- 3) With a broken blue line, the conditionally accepted two two-axle wagons making up wagon No. 43714378583-4 are outlined.
 4) The ratios between the axle loads are calculated based on the conditional acceptance in item 1.

Fig. 4.5.

On figure 4.6 is shown a photo of the box in the left wheel of the first wheel-set of wagon №43714378583-4.



Fig. 4.6.

On fig.4.7 is shown a picture of the dismantled leaf spring (marked with arrow in red colour) from the left wheel of first wheel-set of wagon № 43714378583-4 and the leaf spring in the original structure of the wagon (marked with arrow in yellow colour).

It is evident that the two leaf springs differ significantly on geometric size and form, and consequently under force-deformation characteristic.



Fig. 4.7.

The leaf spring sag is determined according to the expression:

$$f = \frac{3 \cdot \left(\frac{L}{2} - \frac{a}{2} \right) \cdot N}{E \cdot h^3 \cdot (1,5 \cdot n_o + n_H)}$$

where:

L – spring length;

a – spring clip width;

N – spring load;

E – modulus of elasticity under linear deformation;

h – beam thickness;

n_o – number of main sheets;

n_H – number of recruitment sheets.

In the course of the investigation, it was found that the original leaf spring of the first wheel-set, left wheel in the direction of train movement of wagon No. 43714378583-4 was replaced by the Turkish national railway carrier at Kapikule Station with a non-conforming one due to the breakage of the original one and moved to Banya station, where the accident occurred.

On fig. 4.8 are shown the measured vertical static loads in the wheels of wagon No. 43714378583-4, loaded with the two containers, after replacing the leaf spring of the left wheel of the first wheel set of wagon No. 43714378583-4 and placing an original leaf spring in RWCO -Karlovo, delivered by the owner of the wagon.

After replacing the spring, the calculated left/right (right/left) wheel ratios show that with an allowable difference of 1.25:1, the actual for the first wheel set is 1.19:1; for second wheel set is 1.00:1; for third wheel-set 1.06:1 and for fourth wheel-set 1.28:1. Therefore, the ratios are within the norm, and only on the fourth wheel- set there is a minimal deviation.

Wheel and axle load on wagon No: 43714378583-4					
Empty with replaced leaf spring, measured on 06.03.2023 in Karlovo repair base.					
Measured vertical load in the left wheels, kg.		Measured vertical load in the right wheels, kg.	Ratio left/right (right/left) wheel, %	Vertical load in the wheelsets, kg	
3 162	1 st wheelset	3 777	119%	6 939	1,19 Ratio left/right wheel, (max 1,25)
		Total load on the first and second wheelset, kg		12 798	1,18 Ratio first to second wheelset, (max 1,2)
2 923	2 nd wheelset	2 936	100%	5 859	1,00 Ratio left/right wheel, (max 1,25)
		Total load on the third and fourth wheelset, kg		12 240	1,11 Ratio third to fourth wheelset, (max 1,2)
2 989	3 rd wheelset	2 809	106%	5 798	1,06 Ratio left/right wheel, (max 1,25)
		Total load on the third and fourth wheelset, kg		12 240	1,11 Ratio third to fourth wheelset, (max 1,2)
2 823	4 th wheelset	3 619	128%	6 442	1,28 Ratio left/right wheel, (max 1,25)
Total, kg:		Total, kg:	Measured weight of the wagon, kg		
11 807		13 141		25 038	
Note: 1) With a broken blue line, the conditionally accepted two two-axle wagons making up wagon No. 43714378583-4 are outlined. 2) The ratios between the axle loads are calculated based on the conditional acceptance in item 1.					

Fig. 4.8.

From the performed analysis, the conclusion follows that the most likely reason for the derailment of wagon No. 43714378583-4 (17th in the composition) with four wheel-sets is the uneven load in the wheels of the first two axles of the wagon. The left/right wheel differences of these axles are many times greater than the permissible ones, establishing the so-called "oblique-symmetric load". Because of the derailment of the 17th wagon, the penultimate 16th wagon No. 37804953012-4 with the third bogie was also derailed.

No other malfunctions, either of the rolling stock (the locomotive and wagons) in the composition of IDFT No. 40832, or of the railway infrastructure, which contributed to the accident, were found.

The traffic analysis was carried out from the departure of the train from the Kapikule border station to its stop after the derailment at Banya station. The time of occurrence of the events is reflected in the readings of the clock on the locomotive recorder and may differ from the actual astronomical time.

From the decryption performed for the movement of IDFT No. 40832 from Svilengrad station to Banya station, it is evident that the train complied with the section speeds and reductions along the railway. The train stops correspond to the completed schedule.

IDFT No. 40832 enters in Banya station at a speed of 55 km/h (fig. 4.9, item 1). At 01:49:37 a.m. the speed started to decrease and at 01:49:51 a.m. it was already 0 km/h (Fig. 4.9, item 2). The pressure in the main air duct also began to decrease and at 01:50:09 a.m. it was below 3.5 bar, indicating that a quick hold with the autobrake had taken place. The fact that the brake applied after the start of the deceleration means that the brake was applied due to a violation of the integrity of the main air duct (Fig. 4.9, item 3). At the initial moment, there was a pullback due to the ploughing of the derailed wagons into the ballast prism (Fig. 4.9, pos. 4), after which the front wagons pulled forward and that led to the appearance of acceleration in the direction of train movement (Fig. 4.9, item 5)

From the moment of the start of the sharp decrease of the speed until the complete stop the train

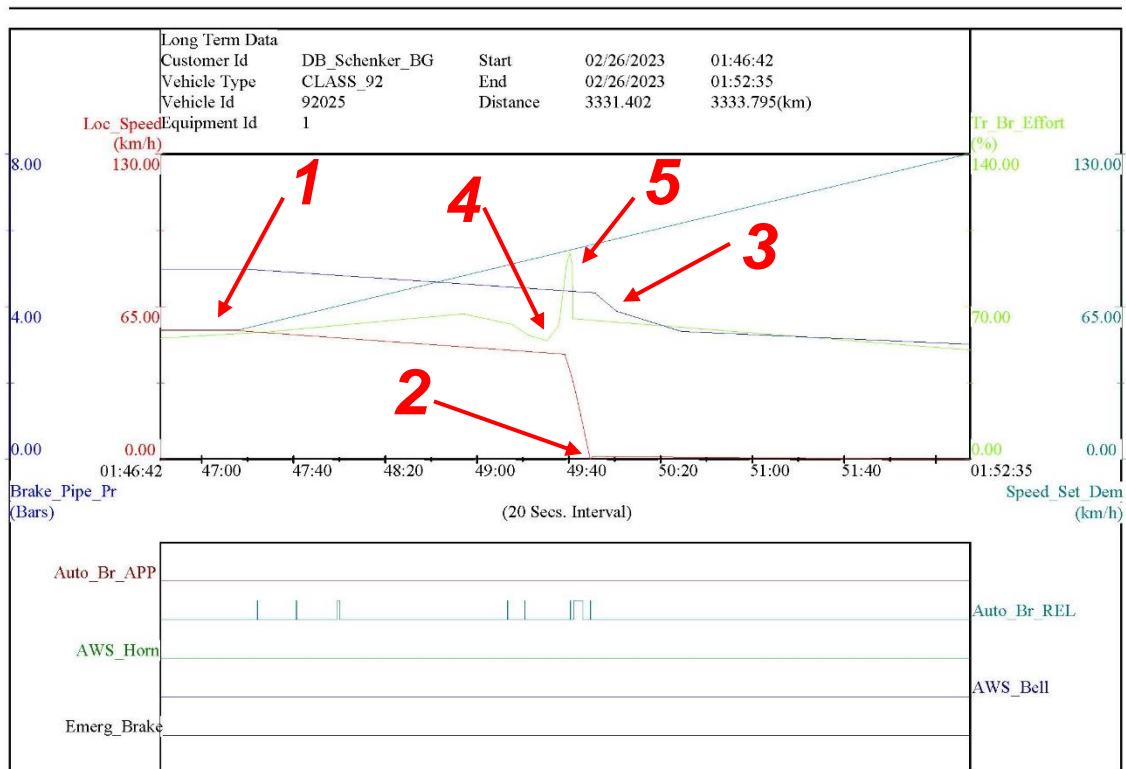


Fig. 4.9. Diagram of train movement under time.

had passed 74 meters (fig. 4.10, the distance between marker 1 and marker 2).

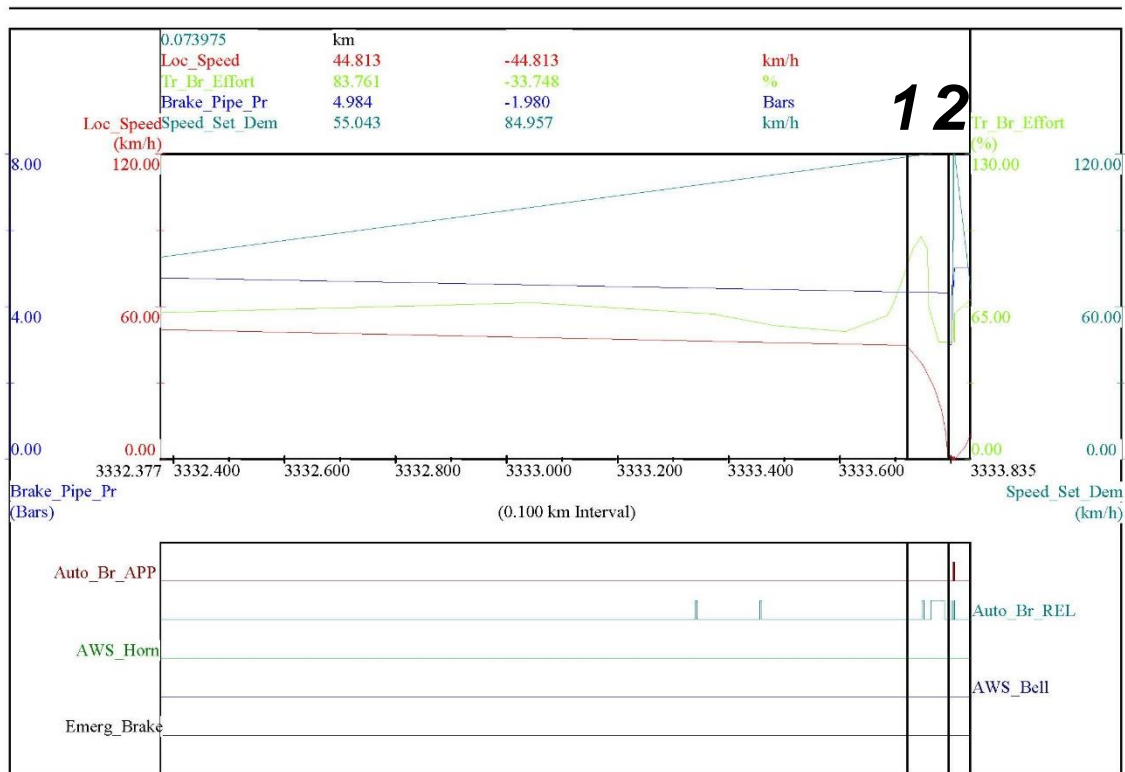


Fig. 4.10. Diagram of the train movement under passed track.

The Investigation Commission made several visits to the scene of the accident and got acquainted in detail with the circumstances surrounding it.

In addition, the Commission visited RWCO -Karlovo, where the derailed wagons from IDFT No. 40832 were stationed. Detailed inspections of the wagons, the condition of their undercarriage elements and the cargo were carried out.

The commission analysed the condition of the wagons and found the following:

- The derailed wagon No. 43714378583-4, the last of the train, is a two-platform, 4-axle, bogie less (fig. 4.11). The two platforms are connected to each other with an elastic connection, which consists of taller-free buffers - one on each platform, and a coupling (Fig. 4.12);
- During the inspection of wagon No. 43714378583-4, it was found that the transported second container No. CLXU4517719 had a smaller gross mass than the first container, it had shifted and came out of the fixing heels of the wagon, which was a consequence of the derailment (fig. 4.13);
- When inspecting the cargo in the containers, it was found that the cargo was placed correctly and was not moved during the loading and movement of the wagon (Fig. 4.14 and 4.15);
- During the inspection of wagon No. 43714378583-4, it was found that the height of the two buffers from the railhead is different, i.e. the left in the direction of movement (right in the photo) is located higher than the other (Fig. 4.16). This fact prompted the commission to carry out an even more detailed inspection, during which it was found that a leaf spring was installed on the box of wheel No. 1, different in appearance from the others installed on the other wheels (Fig. 4.17 and Fig. 4.18). Subsequently, it was found that the leaf spring in question was indeed different not only in appearance, but also in dimensions and characteristics (Fig. 4.19). Additionally, during the inspection, it was found that the bolts of the box guides were missing, as well as the box guides themselves (fig. 4.17, pos. 1), and the sub-box connection (ferbin) was distorted (fig. 4.17, pos. 2).



Fig. 4.11. General appearance of wagon № 43714378583-4.



Fig. 4.12. Appearance of the device connecting the two platforms of wagon № 43714378583-4.



Fig. 4.13. Displaced container from the heel of the wagon.



Fig. 4.14.

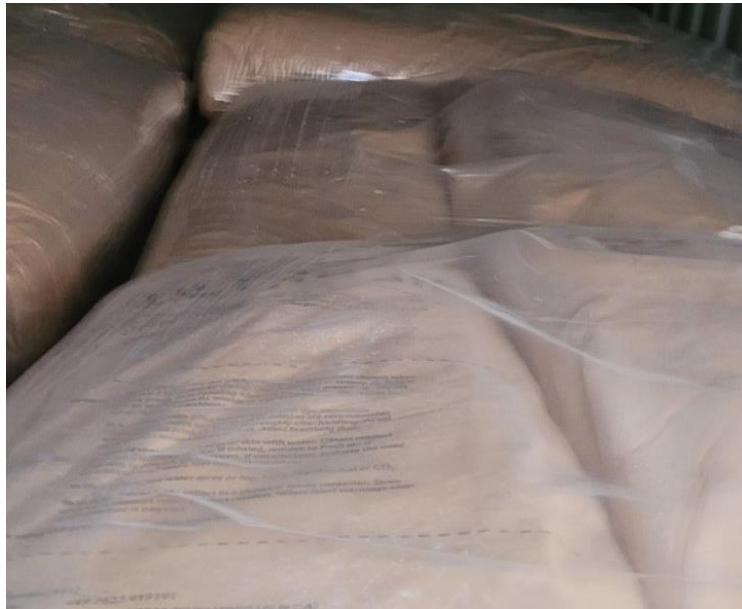


Fig. 4.15.



Fig. 4.16. On the image is shown the difference in height of the two buffers.

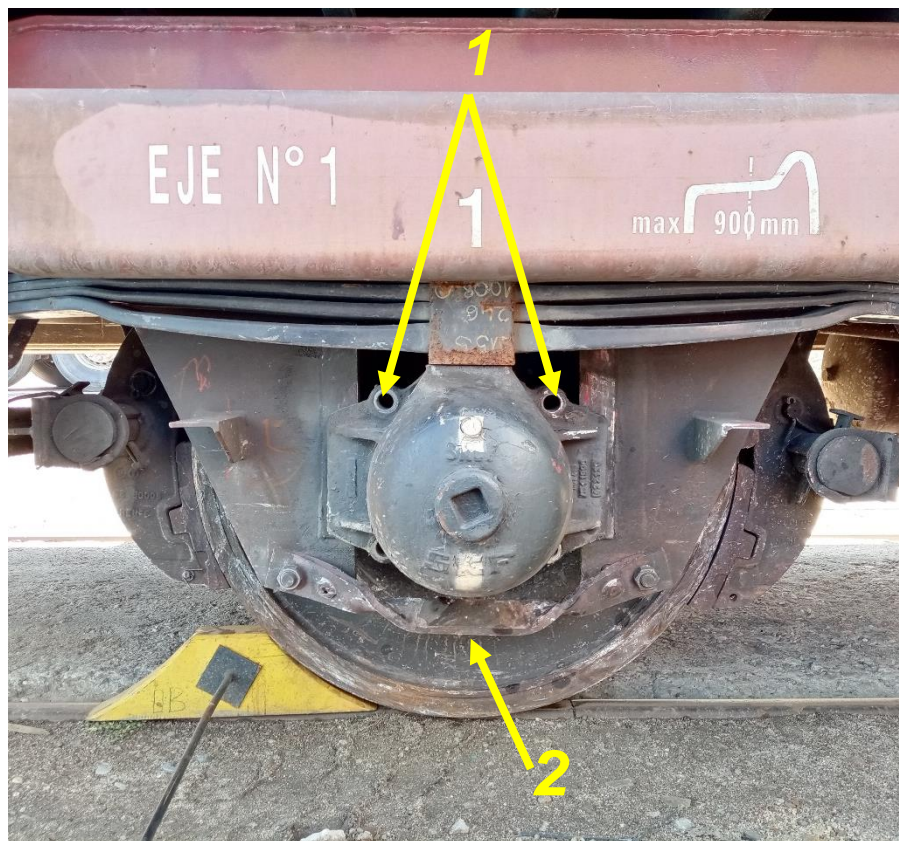


Fig. 4.17. Wheel № 1 (front left in the train movement direction) with installed spring with unsuitable dimensions and characteristics.



Fig. 4.18. Right wheel with original spring.

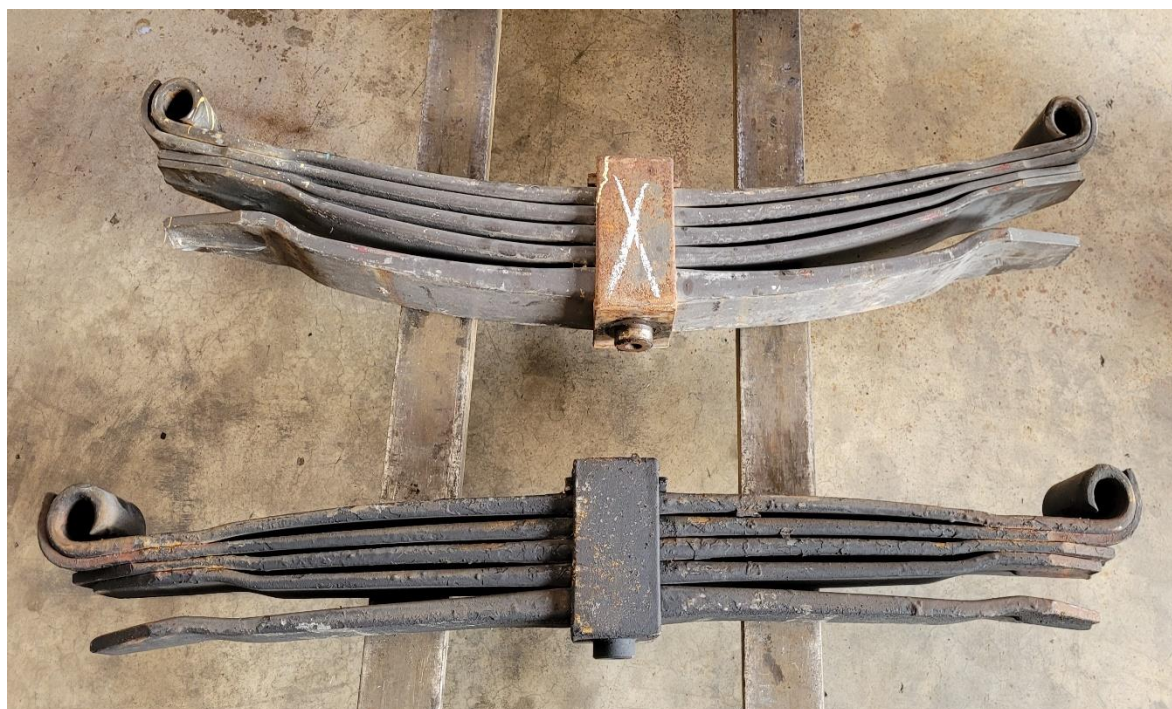


Fig. 4.19.

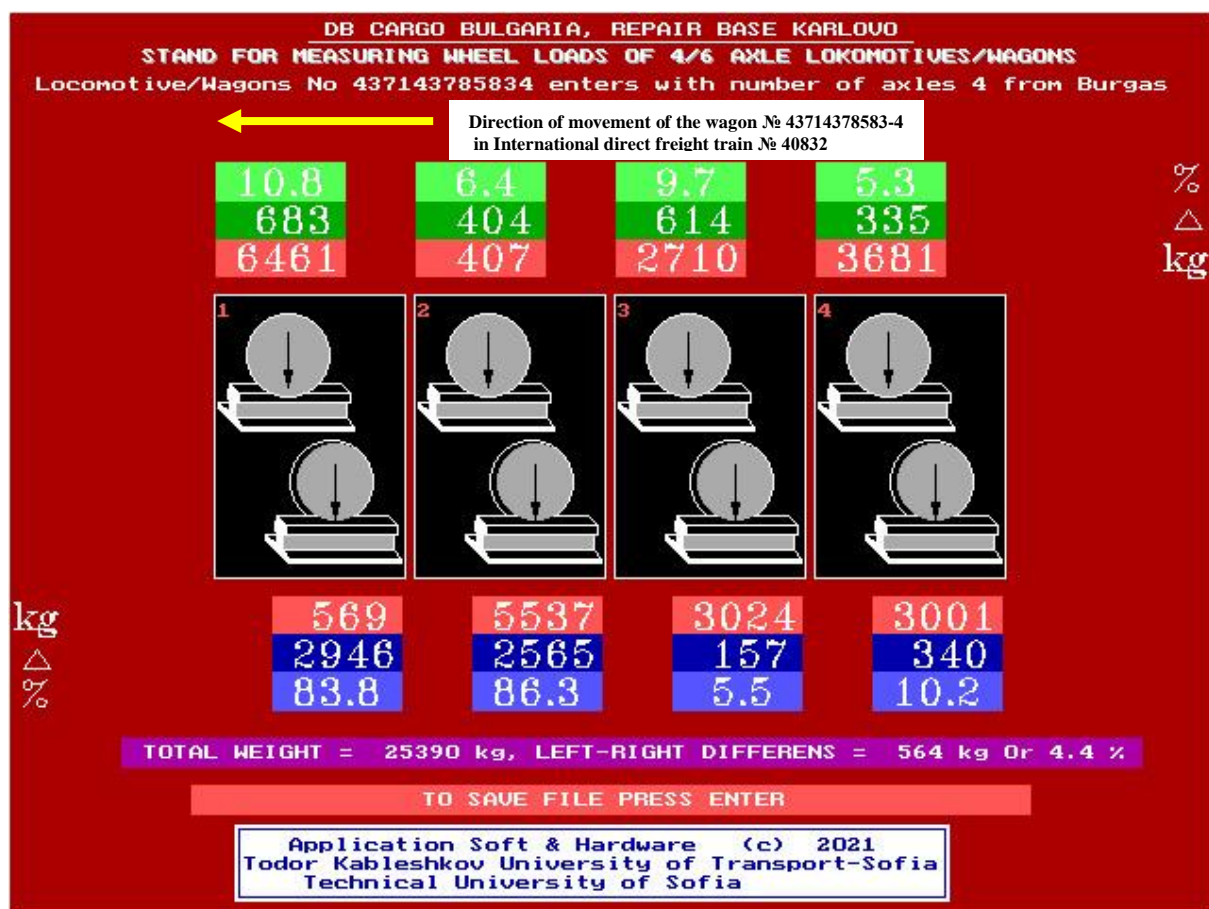


Fig. 4.20.

The facts established during the inspections gave the investigation commission a reason to measure the static load on the individual wheels of wagon No. 43714378583-4, where the following results were obtained (Fig. 4.20):

The divergent leaf spring unloaded the left front 1 wheel (in the direction of train movement), which loaded the right wheel on the first wheel-set.

The effect on the second track axle is reversed due to skew-symmetric loading, i.e. the left wheel on the second wheel-set is overloaded and the right wheel is unloaded.

When going into a left curve, the unloaded right wheel of the second wheel-set mounted on the head of the rail and subsequently derailed to the right

4.1.2. Infrastructure manager.

Analysis of the railway infrastructure condition.

The accident occurred in a left circular curve in the direction of the train, at km 45+561. The rise of the right wheel is 2 m before the end of the transition curve, which is at km 45+563 (Fig. 4.21);

The parameters of the curve are the following:



Fig. 4.21. View from second track to switches №№ 2 and 4.

Radius of curve $R=350$ m;

Elevation of the curve $H=135$ mm;

The total length of the curve is $L=261$ m, of which a circular curve with a length of $L=121$ m, a PNK with a length of $L=78$ m and a KPK with a length of $L=62$ m to switch No. 2 at Banya station.

The rise of the right wheel of the second wheel-set is at km 45+561 at point "0". Moving along the head of the rail for 14 m the wheel derailed to the right of the rail at km 45+575. The left wheel of the second wheel-set derailed in the track gauge at km 45+574, which is dependent on the clearance of

the track gauge and wheel-sets. The second trace of the derailed left wheel on the third wheel-set is at km 45+624.15, 0.85 m from switch 2, to the left of the left rail. Tracks on the right rail and the coupling from the right wheel on the third wheel-set were not identified.

Track gauge of the rail track:

It is evident from the railway measurement protocol of findings, prepared by the Task Force that the maximum gauge is 1461 mm at points 3, 4, 5 before the point of rise of the right wheel from the second wheel-set. This proves that the permissible deviations in gauge because of the operation are within the norms, according to item 3.1.3 of the "Instruction for current maintenance of the rail track and switches".

Level of the rail track:

In railway curves with different radius, the elevations of the rails are calculated according to the "Instruction for current maintenance of the rail track and switches". Depending on the radius of the corresponding curve, the speed of the trains is also calculated. In this case, the radius of the curve is $R=350$ m, correspondingly the speed is up to 60 km/h according to the Instruction. The location of the curve is between the entrance signal and the entrance switch No. 2 of Banya station Dolna Mahala side. In the curves, a permissible elevation is given depending on the radius, respectively the speed of movement. The main requirement is that less than the minimum allowable elevation should not be allowed in the curves. In this case, with this radius and the given elevation a permissible speed of up to 80 km/h can be guaranteed, calculated by the formula $H=\frac{8V^2}{R} \max$; as well as a speed of 65 km/h, calculated by the formula $H=\frac{11.8V^2}{R}$ rms speed.

It is evident from the investigative report on the state of the rail track of the Task Force that before the point of rise of the right wheel, the elevation varies from 143 mm to 147 mm, which according to the Instruction is within the limits.

After the corrections made to the points due to the measured hidden twists:

T.0 - 145 mm.

T.10 - 143 mm.

T.(-10) - 114 mm (it is kept). This point is in the transitional curve.

Transitions based on inter-axis and wagon wheel-sets.

1. Between the second and third wheel-set, item 0 = 145 mm; item 5 = 143 mm; difference 2 mm.

$$K = \frac{L}{H} = \frac{5m}{2mm} = \frac{5000mm}{2mm} = 2500; K = 1:2500$$

2. Between the third and fourth wheel-set; item 0 = 145 mm; item 10 = 143 mm; difference 2 mm.

$$K = \frac{L}{H} = \frac{10m}{2mm} = \frac{10\,000mm}{2mm} = 5000; K = 1:5000$$

The admissible deviations in the measured elevations are kept:

- For speed to ≤ 60 km/h are ± 15 mm.

Condition of the rail track in plan and operation of the outer rail in the curve.

From the visual inspections and measurements of the rail track, the following was found:

1. Good condition of the ST-4 reinforced concrete grid and PAK-68I fasteners. There are no missing clamping sets and no loose ones;
2. The ballast prism corresponds in size and has no tempers;
3. The rail track is jointed, rails type S49, with a length of 25 m;
4. Good connection of the rib pads with the rails and reinforced concrete sleepers through the anchor bolts;
5. There are no inclined reinforced concrete sleepers.

The rail track was measured with Track Measuring Laboratory E-120 on 24.10.2022, and the measured parameters are within the norms.

The last inspection of the rails was carried out on 21.04.2022 - no defects and malfunctions were found.

4.1.3. Entities in charge of the technical maintenance.

SE NRIC has a Certificate of Entity in charge of maintenance with scope of activity –freight wagons, passenger coaches and specialized cars for dangerous goods transport;

"DB Cargo Bulgaria" EOOD has a Certificate of Entity in charge of maintenance, with a scope of activity - diesel and electric locomotives, freight wagons and specialized wagons for the transport of dangerous goods;

"Express Service" Ltd. has a Maintenance Function Certificate with scope of activity for maintenance of electric and diesel locomotives, specialized vehicles for railway maintenance and other specialized vehicles.

4.1.4. Manufacturers or providers of rolling stock and railway products.

Non-applicable.

4.1.5. National Safety Authority.

Railway Administration Executive Agency is the National Safety Authority for railway transport in the Republic of Bulgaria.

4.1.6. Notified bodies or Risk assessment bodies.

Non-applicable.

4.1.7. 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.

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

ЖКRailway infrastructure

- SE NRIC implements Safety Procedure SP 2.09 "Methodology for determining, assessing and managing of the risk" version 06 effective from 01.09.2021, part of the SMS.

Railway undertaking

- "DB Cargo Bulgaria" EOOD implements Procedures "PR 22-05 Risk assessment in case of changes in the transport system, PR 22-05-01 Hazard identification and risk calculation and PR 22-05-03 Control and assessment methods of risk.

4.2. Rolling stock and technical facilities.

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

Non-applicable.

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

Non-applicable.

4.2.3. Factors deriving from manufacturers or another provider of railway products.

Non-applicable.

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

Non-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.*

Non-applicable.

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

Non-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 of locomotive № 91521688025-1:

- Diploma No. 000520 "Railway technology - electric locomotives", training conducted in the period 1990 ÷ 1993, issued by VNVTU "Todor Kableshkov" - Sofia;
- Locomotive driving license BG 71 2017 1339 issued by RAEA;
- Certificate No. 63 for holding the position "Locomotive driver" in "DB Cargo Bulgaria" EOOD from 01.10.2019.
- Additional certificate issued by "DB Cargo Bulgaria" EOOD for rolling stock for which the driver is allowed to drive - series E 43.000, 44.000 and 45.000 from 14.08.1993 and series E 86.000 and 88.000 from 25.03.2015, valid from 18.10.2017 to 18.10.2027 on the national railway infrastructure of the Republic of Bulgaria and at the border crossings of Kapikule and Dimitrovgrad (ZHS).

• Assistant locomotive driver of locomotive № 91521688025-1:

- Certificate of professional qualification No. 24485, with acquired professional qualification "Locomotive driver", training conducted in the period 18.04. ÷ 16.09.2022 educational institution, VTU "Todor Kableshkov" - Sofia issued by Railway Administration Executive Agency;
- Certificate No. 378 for holding the position of "Assistant engine driver, locomotive" in "DB Cargo Bulgaria" EOOD from 01.11.2022.

• Wagon inspector in Svilengrad station:

- Certificate of professional qualification No. 24562, with acquired professional qualification "Inspector wagons", training conducted in the period 20.06. ÷ 27.10.2022 training institution CPQ at BDZ, issued by Railway Administration Executive Agency;

- Certificate No. 385 for holding the position of "Inspector wagons" in "DB Cargo Bulgaria" EOOD from 01.11.2022.

Railway infrastructure:

• Traffic manager in Banya station:

- Diploma No. 19770, acquired qualification "Traffic and Commercial Operation Manager", conducted training in the period 1979 ÷ 1982, issued by PŽI, Todor Kableshkov - Sofia;
- Certificate No. 647 for holding the position of "Traffic Manager" in TOSAMD - Plovdiv from 20.09.2007.

• Manager RRS region – Karlovo:

- Diploma No. 209536, acquired qualification "Transport construction", training conducted in the period 1996-2001, issued by VTU "Todor Kableshkov" - Sofia;
- Certificate No. 242 for holding the position "Transport construction" in Railway section-Plovdiv from 12.12.2017.

• Head of railway section:

- Diploma No. 23882, "Transport construction", training conducted in the period 1988÷1991, issued by VNVТУ, Todor Kableshkov - Sofia;
- Certificate No. 19 for occupying the position of "Section Head" RRS of the Railway Station in the Railway Section - Plovdiv from February 15, 2016.

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

Railway undertaking:

- Locomotive driver of locomotive № 91521688025-1:

- Medical card dated 15.12.2022, issued by National multi-profile transport hospital Plovdiv.

Conclusion: suitable for locomotive driver.

- Psychological certificate № 932/15.09.2022, issued by National multi-profile transport hospital Plovdiv for locomotive driver.

Conclusion: allowed for a period of 5 years until 29.07.2026.

- Assistant locomotive driver of locomotive № 91521688025-1:

- Single health dossier № 1367 dated 01.06.2022, issued by National multi-profile transport hospital Sofia.

Conclusion: suitable for Assistant locomotive driver.

- Psychological certificate № 501/03.04.2023, issued by Psychological laboratory National multi-profile transport hospital Plovdiv for locomotive driver.

Conclusion: allowed for a period of 5 years until 03.04.2028.

- Wagon inspector in Svilengrad station:

- Medical card dated 26.05.2022, issued by National multi-profile transport hospital Plovdiv.

Conclusion: suitable for wagon inspector

- Psychological certificate № 664/03.06.2022, issued by Psychological laboratory at National multi-profile transport hospital Plovdiv for locomotive driver.

Conclusion: allowed for a period of 5 years until 03.06.2026.

Railway infrastructure:

- Traffic manager in Banya station:

- Single health dossier dated 04.08.2022, issued by Labour medicine service – Plovdiv.

Conclusion – suitable for traffic manager.

- Psychological certificate № 1064/13.09.2022, issued by Psychological laboratory at National multi-profile transport hospital Plovdiv for traffic manager.

Conclusion: allowed for a period of 3 years until 13.09.2025.

- Head of region RRS – Karlovo:

Medical card dated 30.08.2021, issued by National multi-profile transport hospital Plovdiv.

Conclusion – suitable for Head of region RRS.

- Head of railway section:

Medical card dated 26.08.2022, issued by National multi-profile transport hospital Plovdiv.

Conclusion – suitable for Head of railway section.

4.3.1.3. Fatigue.

Railway undertaking:

- Locomotive driver of locomotive № 91521688025-1:

Rest: from 23.02.2023 hour 07 minutes 30 until 25.02.2023 hour 22 minutes 15

Started work: 25.02.2023 hour 22 minutes 15 – (50 hours and 15 min.)

- Assistant locomotive driver, locomotive of locomotive № 91521688025-1:

Rest: from 23.02.2023 hour 22 minutes 15 to 25.02.2022 hour 22 minutes 15

Started work: 25.02.2023 hour 22 minutes 15 – (48 h. and 00 min.)

- Wagon inspector in Svilengrad station:

Rest: from 24.02.2023 hour 07 minutes 30 until 25.02.2023 hour 22 minutes 15

Started work: 25.02.2023 hour 18 minutes 00 – (24 hour and 00 min.)

Railway infrastructure:

- Traffic manager in Banya station:

Rest: dated 24.02.2023 hour 18 minutes 00 until 25.02.2023 hour 18 minutes 00

Started work: 25.02.2023 hour 19 minutes 00 – (24 hours and 00 min.)

- Head of RRS region – Karlovo:

Rest: from 24.02.2023 hour 17 minutes 00 until 25.02.2023 hour 08 minutes 00

Started work: 26.02.2023 hour 00 minutes 00 – (23 h. and 00 min.)

- Head of railway section:

Rest: dated 24.02.2023 hour 17 minutes 00 until 25.02.2023 hour 08 minutes 00

Started work: 26.02.2023 hour 00 minutes 00 – (23 h. and 00 min.)

4.3.1.4. Motivation and attitudes

Non-applicable

4.3.2. Work related factors:

4.3.2.1. Tasks planning.

Railway infrastructure:

• SE NRIC carries out maintenance, repair and operation of the railway infrastructure. Prepares timetables and schedules on requests submitted by railway undertakings/carriers for the movement of passenger and freight trains and vehicles on all main and branch lines of the railway network. According to the issued Certificate of ECM, they carry out maintenance activities for freight and passenger wagons, RSPM and wagons specialized for the transport of dangerous goods;

Railway undertaking:

• "DB Cargo Bulgaria" EOOD carries out rail transportation of cargo according to the Plan for composing the trains, according to the Schedule for the movement of trains and additionally requested and assigned by request to the manager of the railway infrastructure. The railway company is certified by the National Safety Authority to perform repairs on freight wagons. According to the issued ECM Certificate, they carry out maintenance activities for diesel and electric locomotives, freight wagons and wagons specialized for the transport of dangerous goods

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

Non applicable.

4.3.2.3. Communication means.

The communication links in Banya station, with the relevant switch posts in the station, with the adjacent stations and with the train dispatcher of the section are carried out with the DCCM. The station is equipped with a train dispatch radio link (TDRC),

The shift traffic manager on duty at the Banya station, as well as the locomotive crew of "DB Cargo Bulgaria" EOOD, are provided with official mobile phones.

Locomotive No. 91521688025-1 is equipped with a locomotive radio station for train dispatching radio communication (TDRC).

4.3.2.4. Practices and processes.

Non-applicable.

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

The entities apply national and departmental normative acts

4.3.2.6. Working time of the involved personnel.

The personnel of the two entities involved in the accident worked on a shift basis, for which a cumulative calculation of working time in a 12-hour work shift is applied. In accordance with the requirements for the working hours of the management and executive staff, who are engaged in ensuring the transport of passengers and cargo in railway transport, the activity is carried out in accordance with the provisions of Ordinance No. 50 of 28.12.2001. and the Labour Code.

4.3.2.7.Risk treatment practices.

Railway infrastructure

- SE NRIC applies safety procedure SP 2.09 „Methods of evaluation, assessment and management of the risk „version 06 effective from 01.09.2021, which is part of the SMS.

Railway undertaking

- "DB Cargo Bulgaria" EOOD implements the following procedures:
 - COMMISSION IMPLEMENTING REGULATION (EU) No. 402/2013 of April 30, 2013 on the common safety method for the determination and assessment of risk and repealing Regulation (EC) No. 352/2009;
 - "DB Cargo Bulgaria" EOOD implements, Procedures "PR 22-05 Assessment of risk in case of change in the transport system, PR 22-05-01 Identification of hazards and calculation of risk and PR 22-05-03 Methods of control and Risk Assessment

4.3.2.8.Context, machinery, equipment and indications for shaping the working practices

Non-applicable.

4.3.3. Organizational factors and tasks:

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

In both entities SE NRIC and "DB Cargo Bulgaria" EOOD, the work and workload of personnel directly related to the safety of rail transport is planned in accordance with the requirements of national regulations, approved methodologies and good European practices.

4.3.3.2.Communications, information and teamwork.

Non-applicable.

4.3.3.3.Recruitment, staffing requirements, resources.

Railway undertaking:

- At "DB Cargo Bulgaria" EOOD, personnel selection is carried out in accordance with the "WP-4401-01/3 Manual for an integrated quality and safety management system", which includes a Personnel Selection Procedure. "DB Cargo Bulgaria" EOOD has a certified quality management system according to the ISO 9001:2015 standard; "Staff training and development plan". The railway undertaking carries out an annual staff development assessment.

Railway infrastructure.

- SE NRIC has an approved "Strategy for Human Resources Management 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 database of the personnel;
- Creation of a system of selection techniques for recruitment;
- 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.

An independent assessor regarding protection of the ISO 9001:2015 Quality Management Certificate annually audits DB Cargo Bulgaria EOOD.

In the period 07.07.-08.07.2022, DB Cargo Bulgaria EOOD was audited by an independent assessor Bureau Veritas Certification Holding SAS - UK Branch, which certifies that the management system in the railway enterprise has been assessed and in compliance with the requirements of the Quality Management System standard in accordance with the requirements of ISO 9001:2015. The certificate was renewed on 21.07.2022;

4.3.3.5.Compensation (remuneration).

Railway undertaking:

• "DB Cargo Bulgaria" EOOD implements "Internal rules for salaries" in force from 01.05.2018, which regulate issues related to the salaries of personnel in the enterprise:

- General;
- Structure and organization of the salary;
- Procedure and method for determining and amending individual wages;
- Procedure and method for determining and amending the additional labour remuneration;
- Calculation of due wages;
- Protection of company secrets;
- Transitional and final provisions.

At "DB Cargo Bulgaria" EOOD, the staff involved in the operation is on a permanent basic employment contract. Remunerations are formed according to the employment contracts for each position. In the railway undertaking, there is an approved procedure in accordance with national regulations for additional pay considering the working conditions for each position.

Railway infrastructure.

• SE NRIC has approved "Internal rules for wages" in force from 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 entity;
- Determining and distributing the funds for wages - sources, order and way of forming the remuneration;
- Determination and amendment of wages and additional remuneration;
- Regulation, order and method of payment of wages.

4.3.3.6.Leadership, powers related issues.

Non-applicable.

4.3.3.7.Organizational culture.

Non-applicable.

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

Non-applicable.

4.3.3.9.Regulatory framework conditions and safety management system application.

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 railway transport safety management.

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 railway transport safety management.

4.3.4. Environmental factors:

Non-applicable.

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

Non-applicable.

4.3.4.2. Meteorological and geographic conditions.

- In the dark part of the day – 00:41 a.m. (from the recording device of the locomotive);
- Air temperature +12°C;
- Wind speed and direction: 12 m/s, north-west;
- Weather – cloudy with normal visibility of the signals;
- Banya station is located in the south part of the railway network;

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

On 26.02.2023, at the Banya station and the Banya - Dolna Mahala interstation, construction works on the railway infrastructure in the area of the accident were not carried out

4.4.5. Any other significant factor for the investigation objectives.

Non-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 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

ORDINANCE No 59 dated 5.12.2006 on the railway transport safety management

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

4.4.2.1. Railway undertaking.

- "DB Cargo Bulgaria" EOOD implements IMPLEMENTING REGULATION (EU) No. 402/2013 OF THE COMMISSION dated April 30, 2013 regarding the general safety method for the determination and assessment of risk and for the repeal of Regulation (EC) No. 352/2009 and procedures from SMS: Process "OD 22-05-01/01 Risk Assessment", procedure Methodology for determining and assessing risks in the case of changes in the railway transport system in "DB Cargo Bulgaria" EOOD, "Manual for safety management";

- Changes in the activity of "DB Cargo Bulgaria" EOOD, related to the accident that occurred and which fell under the definition of "substantial" in the sense of IMPLEMENTING REGULATION (EU) No. 402/2013, were not carried out.

Railway Infrastructure.

- SE NRIC applies Safety Procedure SP 2.09 "Methodology for identification, assessment and risk management" version 06 in force from 01.09.2021, which is part of the SMS.

- Changes in the activity of SE NRIC, related to the accident that occurred and which fell under the definition of "substantial" in the sense of IMPLEMENTING REGULATION (EU) No. 402/2013, were not carried out.

4.4.2.2. Entities in charge of the technical maintenance.

Railway undertaking

- "DB Cargo Bulgaria" EOOD holds a Single Certificate for an entity in charge of maintenance of locomotives and wagons No. BG/31/0021/0002 with a validity period from 21/05/2021 to 20/05/2026.

- "Express Service" Ltd. has a Maintenance Function Certificate No. FM/BGRA/2020/0003 of an entity in charge of maintenance of diesel and electric locomotives and specialized railway maintenance machines with a validity period of 30.07.2020 until 16.06.2025.

Railway infrastructure

- SE NRIC has a Certificate of ECM No. BG/31/0023/0001 valid from 22/03/2023 to 21/03/2028.

4.4.2.3. Producers and all other participants.

6.1.1. Owner of wagon No. 43714378583-4 – OMSAN LOGISTIKA SRL ROMANIA – derailed first from the composition of IDFT No. 40832 with regular registration in the European register of authorized types of vehicles and Entity in charge of maintenance – WAGONS MAINTENANCE SRL, member state where the vehicle is registered RO agent (ROMANIA);

6.1.2. Owner of wagon No. 37804953012-4 – VTG RAIL EUROPE GmbH – derailed second of the composition of IDFT No. 40832 with regular registration in the European register of authorized vehicle types and Entity in charge of maintenance – VTG Rail Europe GmbH, Member State in which it is registered vehicle DE (Germany).

4.4.2.4. 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 undertaking.

- "DB Cargo Bulgaria" EOOD implements the "Safety Management System Manual" effective from 05.05.2010, which includes Procedure "OD 22-05-01/01 Risk Assessment", procedure Methodology for determining and assessment of risks in the event of a change in the railway transport system in "DB Cargo Bulgaria" EOOD.

Railway infrastructure.

- SE NRIC implements a safety procedure SP 2.09 "Methodology for determining, assessing and managing the risk" version 06 effective from 01.09.2021, which is part of the SMS.

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

- "DB Cargo Bulgaria" EOOD implements the "Safety Management System Manual" effective from 05.05.2010, which includes Procedure "OD 22-05-01/01 Risk Assessment", procedure Methodology for determination and assessment of the risks in the event of a change in the railway transport system in "DB Cargo Bulgaria" EOOD.

- "Express Service" Ltd. implements an Integrated Management System, "Working Procedure WP 05-0-01/19.04.2023. Entity in charge of maintenance of diesel and electric locomotives and freight wagons.

Railway infrastructure.

- SE NRIC implements Safety Procedure WP 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.

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 "DB Cargo Bulgaria" EOOD in accordance with the requirements of Regulation (EU) 2018/761, Regulation (EU) No. 1169/2010, Regulation No. 56 and Ordinance No. 59 for meeting 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 an SMS and can fulfil the requirements provided for in the relevant legal acts.

In the period from 25.04.2023 to 05.05.2023, the National Safety Authority (NSA) carried out an annual planned supervision of the SMS of SE NRIC for the renewal of the Safety Authorization in accordance with Delegated Regulation (EU) 2018/762 of the Commission for the establishment of common safety methods in relation to the requirements for the SMS according to Directive (EU) 2016/798, no inconsistencies were found.

In the period from 04/03/2020 to 06/03/2020, the National Safety Authority (NSA) conducted an audit of "DB Cargo Bulgaria" EOOD within the framework of the procedure for issuing a Single Safety Certificate. No discrepancies were found during the audit.

In the period from 11.10.2022 to 12.10.2022, the National Safety Authority (NSA) conducted an audit of "DB Cargo Bulgaria" EOOD within the framework of the procedure for issuing a Single Certificate to the entities in charge of maintenance. No discrepancies were found during the audit.

In the period from 06.06.2023 to 07.06.2023, the National Safety Authority (NSA) conducted an audit of "Express Service" Ltd. for the issuance of a new certificate of conformity for an entity in charge of maintenance of vehicles according to the requirements of Commission Regulation (EU) 2019/779. Issued Certificate No. BG/31/0023/0003 for a railway carrier, valid until 12.06.2028.

During the audit, the activity was also supervised as an entity performing maintenance functions, according to the current Certificate FM BGRA/2020/0003, valid from 03.07.2020 to 16.07.2025 with the scope of the functions "Development of maintenance" ", "Management of maintenance" and "Performance of maintenance" of locomotives.

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

- SE NRIC has a renewed Safety Authorization No. BG 21/2023/0001, valid from 01/07/2023 to 30/06/2028;

- "DB Cargo Bulgaria" EOOD has a Single Safety Certificate BG 10 2020 0019, valid from 27.05.2020 to 26.05.2025;

- "Express Service" Ltd. owns a Railway Carrier's Certificate No. BGRA/2019/0008 valid from 24/11/2019 to 23/11/2024.

4.4.6.1. Authorizations for placing in service of permanently fixed equipment and permits for placing on the market of vehicles.

Non-applicable.

4.4.6.2. Entities in charge of the technical maintenance.

- SE NRIC has a Certificate of an entity in charge of maintenance No. BG /31/0023/0001, valid from 22.03.2023 to 21.03.2028 with scope of activity - Specialized vehicles for maintaining the railway infrastructure, Passenger coaches, second-class Bm and Freight wagons for transportation and maintenance of the railway infrastructure;

- "DB Cargo Bulgaria" EOOD has a Single Certificate of an entity in charge of maintenance of locomotives and wagons No. BG/31/0021/0002 with a validity period of 21.05.2026.

- "Express Service" Ltd. holds the Maintenance Function Certificate No. FM/BGRA/2020/0003 of an entity in charge of maintenance of diesel and electric locomotives, specialized vehicles for railway maintenance and other specialized vehicles with a validity period from 30.07.2020 to 16.06.2025.

"Express Service" Ltd., under a framework agreement with "DB Cargo Bulgaria" EOOD, performs maintenance functions for electric locomotives series 86.000 and 88.000 and diesel locomotives series 53.000, 56.000 and 07.000, according to the requirements of Ordinance No. 59/5.12.2006 for rail safety management.

4.4.7. Other system factors.

Non-applicable.

4.5. Previous similar cases.

Directing investigation of railway accidents in NAMRATIB has investigated an accident of a similar nature.

On 26.07.2022 at 12:30 p.m., DFT No. 30592 departed from Plovdiv marshalling yard, assigned with the schedule of SE NRIC with a route from Plovdiv marshalling yard to Iliyantsi station at the request of the railway company "Rail Cargo Carrier - Bulgaria" EOOD. The train was operated by the railway company "Rail Cargo Carrier - Bulgaria" EOOD, with a route of movement Svilengrad - Plovdiv - Karlovo - Iliyantsi, consisting of 20 wagons type R and S, loaded with containers/tanks, 80 axles, 1566 tons, with train locomotive No. 91811116111-6 and auxiliary locomotive in lead No. 91811116259-3. DFT No. 30592 arrived at Karlovo station at 14:20 p.m. and at 14:37 p.m., after reversing the direction of travel, the train departed. It arrived at Pirdop station at 15:36 p.m. to meet scheduled train No 30113. DFT No. 30592 departed from Pirdop station at 15:54 p.m. The train passed Stolnik station without stopping at 16:50 p.m., passed Yana station without stopping at 16:56 p.m. and in the Yana - Kremikovtsi interstation at km 19+041 at 17:01:03 p.m. five wagons from the end of the train derailed, which caused train break and it stopped at 17:01:43 p.m. After the inspection, the locomotive crew found that the train was separated in two places (the wagons were in three parts) and five wagons at the end of the train had derailed, they informed the traffic manager on duty of Yana station and the train dispatcher of the railway line. The wagons in the train were loaded with container/tankers full of cement. Because of the derailment, about 100 m of rail track were destroyed, the derailed wagons were also damaged.

Train traffic between Yana and Kremikovtsi stations was interrupted from 17:20 p.m. on 26/07/2022 until 15:00 p.m. on 29/07/2022, restored at a speed of 25 km/h.

On 30.09.2022, the movement of trains was restored at normal speed according to the schedule.

The accident occurred because of a combination of factors. The high temperatures in the rails caused their longitudinal slip of 130 mm, combined with the dynamic forces caused by the passing freight train, which resulted in the track being swept under the train in the transition zone from the jointed track on reinforced concrete sleepers to the jointed track on wooden sleepers. Due to the lower stability in the transition area, the wooden sleeper jointed track experienced vertical and horizontal track sweep during the passing train.

5. Conclusions

5.1. Summary of the analysis for the event causes.

The Investigation Commission was acquainted with the documentation collected and provided by SE NRIC and "DB Cargo Bulgaria" EOOD on the maintenance and operation of the railway infrastructure, as well as on the maintenance and operation of the derailed two wagons in the train.

The Investigation Commission carried out several detailed inspections of the rail track in the area of the derailment. It carried out inspections of the rolling stock, deciphering the speed of the train and the derailed two wagons. It conducted an interview with the staff of the two entities of SE NRIC and "DB Cargo Bulgaria" EOOD. The Commission analysed the circumstances related to the technical condition and parameters of the rail track and found that they were within the norms. The signalling systems at Dolna Mahala and Banya stations were technically sound and were working normally before the accident.

The Commission analysed the technical condition of the derailed two wagons from the composition of IDFT No. 40832. It found that the derailed first wagon No. 43714378583-4, loaded with two full BTCs, was not technically upright - a structurally inappropriate leaf spring on the first wheel set.

The place of derailment of IDFT No. 40832 at km 45+561 in Banya station was 289 m after the entrance signal, jointed track on reinforced concrete sleepers in a left curve with radius $R=350$ m in the direction of train movement. During the passage of IDFT No. 40832, the last wagon first derailed with the second wheel-set to the right of the rail track, and then at switch No. 2 the remaining two wheel-sets of the wagon derailed. Because of the derailment of the wagon, it dragged to the right also the penultimate wagon No. 37804953012-4, which had derailed to the right on the rail track with both wheel-sets of the third bogie.

The scheduled speed of the train between Dolna Mahala and Banya stations was 60 km/h, the recorded speed of the train at the time of the accident was 55 km/h.

According to the vehicle's documents presented by the Task Force group, before the accident, the IDFT No. 40832 was technically sound, provided with the necessary brake mass. The 16th and 17th wagons of the train were braked (with switched brake).

5.2. Undertaken measures after the event occurrence.

The Head of the investigation from the NAMRATIB, after coordinating the actions with the authorities from the RD Ministry of Interior Karlovo, gave permission to rehabilitate the rail track, lift and move the derailed two wagons to RWCO -Karlovo for measuring the technical parameters.

The manager of the railway infrastructure undertook the rehabilitation of the rail track, the facilities and the signalling equipment.

5.3. Additional findings.

1. The Investigation Commission found that the cargo in the two BTCs loaded on the last wagon No. 43714378583-4 was not damaged and displaced, which excludes the possibility that it was a probable cause for the derailment of the wagon.

2. In the presence of the Head of the investigation, the NAMRATIB carried out control measurements for hidden failures of the rail track in the area of derailment with the locomotive of "DB Cargo Bulgaria" EOOD. The measured values were normal.

6. Safety recommendations

In order to improve the safety in the rail transport, the Investigation Commission at NAMRATIB proposes to the Railway Administration Executive Agency (RAEA) the following safety recommendations adapted to SE NRIC and “BDZ-DB Cargo Bulgaria” EOOD.

- Recommendation 1, proposes that SE NRIC and “DB Cargo Bulgaria” EOOD familiarize the interested personnel with the contents of the report.
- Recommendation 2, proposes that “DB Cargo Bulgaria” EOOD when accepting rolling stock at the border stations, which will be served by the railway company, to increase the quality and control when performing technical inspections.
- Recommendation 3, proposes SE NRIC to build a check point between Kapikule and Svilengrad border stations with the following functionalities:
 - Measurement of the vertical loading of the left/right wheel of the wheel-sets in motion of RRS;
 - Deviations from the wheels form (trenched and layered flanges) of RRS;
 - Clearance gauge framework.

With reference to the requirements of art. 24, paragraph 2 of Directive (EU) 2016/798, and art. 91, paragraph 3 of Ordinance No 59 dated 5.12.2006, the member of the Management Board of NAMRATIB on 01.08.2023 provides a final report that contains information on the investigation of the accident with formulated and agreed safety recommendations in order to improve safety in railway transport.

In accordance with Art. 26, paragraph 3 of Directive (EU) 798/2016, that the National Safety Authority (RAEA) and other bodies or structures to which the safety recommendations are addressed, to report regularly to the member of the management board of the NAMRATIB on the measures taken or planned as a result (sequence) from 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)**

*I, the undersigned Giulietta Marinova Marinova-Popova, certify that this is a true and accurate translation done by me from Bulgarian into English of the attached document.
The translation consists of 53 pages
Translator: Giulietta Marinova-Popova*