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FINAL REPORT

from

Investigation of significant railway accident – derailment of full tank cars from the composition of direct freight train № 90593 between the stations Vetovo – Senovo on 23.04.2021



2021

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 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, without searching personal fault and 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 safety, which is transposed into the Railway Transport Act (RTA), Ordinance No 59 dated 5.12.2006 on the rail transport safety management, and Ordinance No H-32 dated 19.09.2007 on the coordination of the activities and information exchange during the railway accidents and incidents investigation, as well as per Agreement dated 17.04.2018 on the interaction during the 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 Ministry of Transport, Information Technology and Communications.

The Reports follow the requirements of Regulation (EU) 2020/572 of 24 April 2020 on the reporting structure for railway accident and incident investigation reports.

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ABBREVIATIONS, USED IN THE REPORT

ABS – Automatic Block System

ALS – Automatic Locomotive Signalling

BAS – Bulgarian Academy of Sciences

BDZ PS Ltd. – “BDZ Passenger Services” Ltd. – State railway undertaking for passenger transport

BRC A.D. – “Bulgarian railway company” A.D. licensed railway undertaking for freight transport

WIS – Wagon-inspection section

MAD – Main air duct (depending on the context)

MAS – Main air switch (depending on the context)

SE NRIC – State Enterprise “National Railway Infrastructure Company” (railway infrastructure manager)

DFT – Direct freight train

RTA – Railway Transport Act

RAEA – Railway Administration Executive Agency

km – kilometre on the railway infrastructure

OHCL – Overhead contact line (catenary)

ECM – Entity in Charge of Maintenance

IDFT – International direct freight train

RRI MH-68 – Route Relay Interlocking type MH-68

Ordinance № 59 – Ordinance on the rail transport safety management

NAMRTAIB – National Air, Maritime, and Railway Transport Accidents Investigation Board (Independent Specialized National Investigation Body)

TF – Task Force

FSaCP – Fires safety and civil protection

TOSARRT – Train Operation and Shunting Activity Rules in the Rail Transport

RRS – Rail Rolling Stock

LDP – BDZ-Cargo Ltd. Locomotive Depot Prescription

RITOR – Railway Infrastructure Technical Operation Rules

MRTO – Management and reporting of train operation

SMS – Safety Management System

TMIW – Technician-mechanic inspector of wagons

TCR EAD – “Transport Construction and Rehabilitation” EAD

DCCM – Device for communications, connections and messages

1. Summary

1.1. Brief Description of the Event.

On 20.04.2021, a freight train with 26 full tank cars with Belozem receiving station, Bulgaria, arrived at Giurgiu North station, Romania. On 20.04.2021 at 06:15 a.m. from Giurgiu North station, Romania departed freight train № 48521 consisting of 26 full tank cars for Ruse marshalling yard, Bulgaria. At Ruse marshalling yard, an open type E security wagon is attached to the train at both ends in accordance with the requirements of the Regulations for the International Carriage of Dangerous Goods by Rail (RID).

On 22.04.2021 at 23:30 p.m. train № 48521 departed as DFT № 90593 from Ruse marshalling yard to Belozem station consisting of: 28 wagons, of which 2 security wagons, one at the head and at the end of the train, and 26 tank cars filled with light fuel (petrol), 437 meters, 1831 tons. The train was serviced by 3 locomotives, led by an auxiliary locomotive №



Fig. 1.1.

№ 92530600685-7, train locomotive № 91530400605-8 and pushing auxiliary locomotive № 91520087020-1.

DFT № 90593 was accepted at Obratsov Chiflik station on the second acceptance-departure track at 23:55 p.m. After a stay of 11 minutes for uncoupling the auxiliary locomotive №92530600685-7 from the train, the same departed with 2 locomotives at 00:06 a.m. with train locomotive № 91530400605-8 and pushing auxiliary locomotive № 91520087020-1.

DFT № 90593 passed without stopping through the stations Yastrebovo at 00:19 a.m., and Vetovo at 00:33 a.m. to Senovo station. In the interstation Vetovo - Senovo the rail track was

signalled with with two reductions of the speed by 25 km/h. The first reduction the train passed at a speed between 18 and 20 km/h, and in the second reduction the train entered by 17 km/h. After entering the second reduction, the pressure in the train MAD dropped sharply to 0 bar at 00:49 a.m. The second-person locomotive driver of locomotive № 91530400605-8 and the locomotive driver of the pushing locomotive № 91520087020-1 inspected the train and found that there were derailed five tank cars, two of them lying down. After the received information, the locomotive driver first person in accordance with the rules of the SMS of BRC EAD duly notified the interested officials. The locomotive drivers



Fig. 1.2.

also submitted information to the national telephone number 112 about an accident with a train carrying liquid fuels (fig. 1.1, 1.2 and 1.3).

After receiving the notification, the train dispatcher closed the Vetovo-Senovo interstation for the movement of the trains and ordered the disconnection of the voltage in the catenary, which was disconnected by the energy dispatcher at 01:13 a.m.

At around 02:10 a.m., two specialized FSaCP vehicles arrived on the spot and undertook tamponing of the leaks and flooding the tanks with foam.

On 24.04.2021 diesel locomotive № 92520007106-4 was sent from Senovo station, which pulled the first four wagons together with locomotive № 91530400605-8, back to Senovo station at 05:53 a.m.

On 24.04.2021, locomotive № 810761 was sent from Vetovo station, which with three movements pulled the second non-derailed part of train № 90593 in Vetovo station.



Fig. 1.3.

As a result of the derailment of DFT № 90593, significant damages were caused to the railway infrastructure and on five tank cars.

In order to lift the derailed wagons and restore the capacity of the railway infrastructure, the Railway Infrastructure Manager has directed specialized recovery means to the spot of the accident.

After undertaking and carrying out restoration activities in the period 24.04 ÷ 01.05.2021 on clearing the derailed rolling stock and restoration of the railway infrastructure, in order to restore quickly the capacity of the railway infrastructure, the Railway Infrastructure Manager restored the movement of trains between Vetovo and Senovo stations with a speed of 25 km/h.

Given the major material damages to the railway infrastructure and the rolling stock, the Ruse District Prosecutor's Office has initiated pre-trial proceedings in order to establish the circumstances and causes that led to the accident and the guilty officials.

1.2. Location and time of the event occurrence.

The derailment of the wagons from DFT № 90593 occurred between the stations Vetovo and Senovo, as at 00:40 a.m. the sixth wagon derailed, and at 00:49 a.m. the other four wagons. At km 38⁺⁵⁰⁴ in the area of the first deceleration the right wheel of the first wheel-set of the first bogie of the sixth wagon № 33537851174-5 rose on the head of the right rail, moved on it for 14.34 meters, and derailed to the right, and the left wheel derailed in the track gauge at 1.30 meters before the right wheel at km 38^{+517,04} (Fig. 1.4).

Plan of the rail track: left curve with radius 482 m, superelevation 105 mm (fig. 1.5).

Rail track profile: uphill 2,3‰ (fig. 1.6).

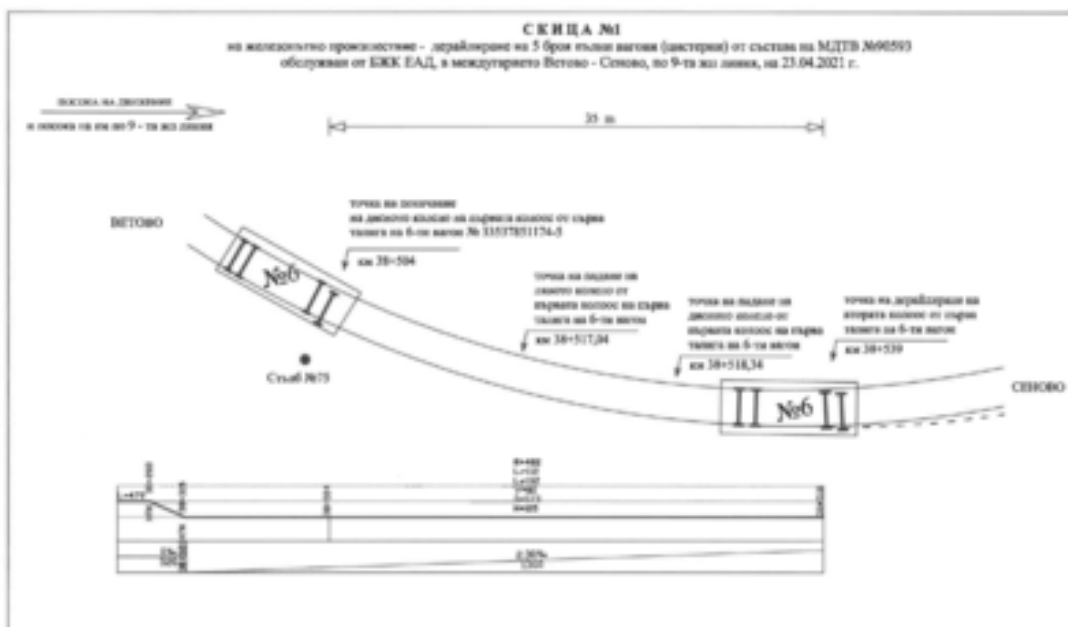


Fig. 1.4. Scheme № 1, start of derailment of sixth wagon № 31525400845-3 in Vetovo – Senovo on 23.04.2021

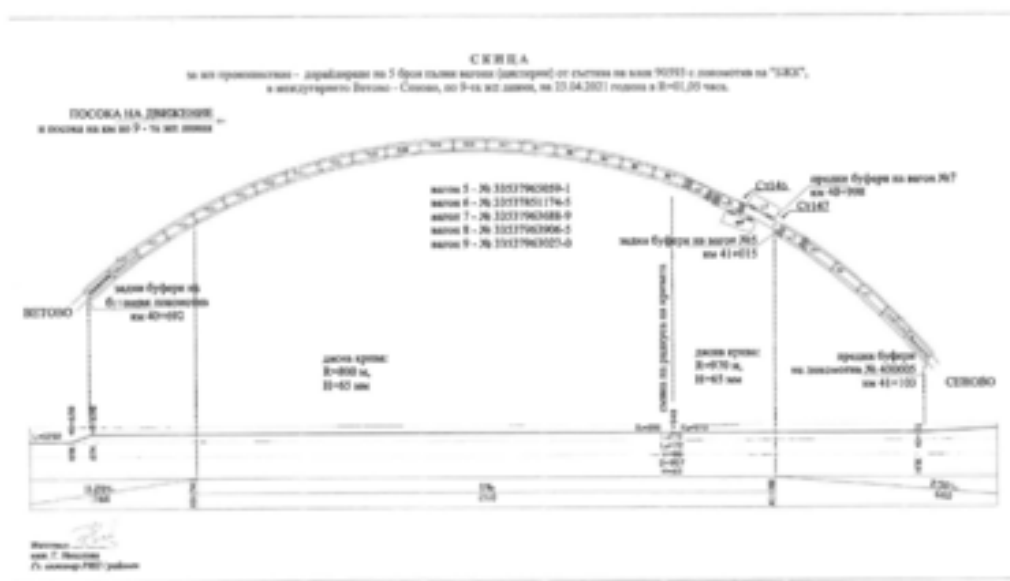


Fig. 1.5. Scheme – place of detection of DFT № 90593

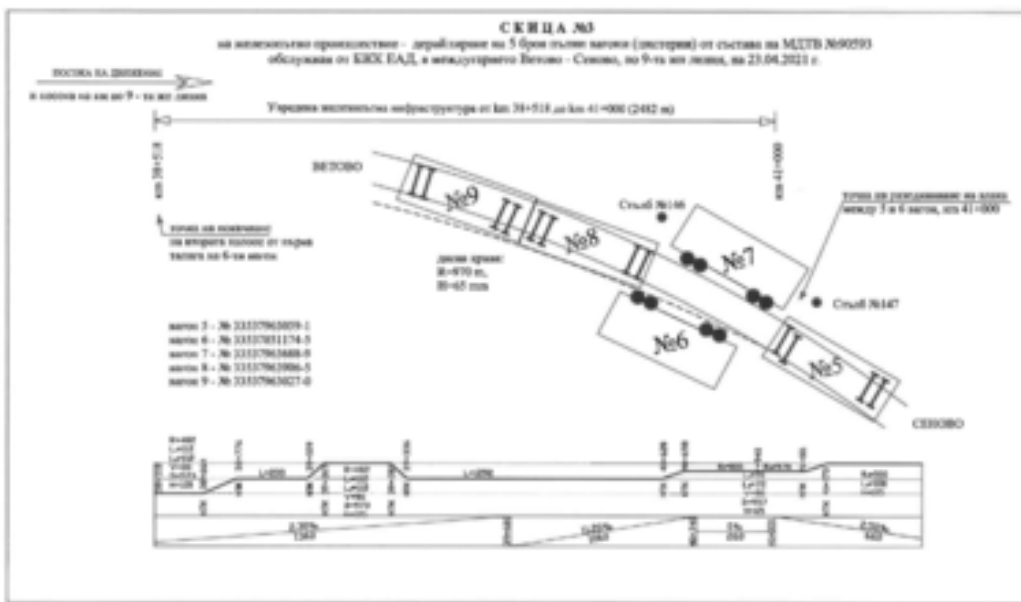


Fig. 1.6. Scheme № 3 – place of derailment of five wagons from the composition of DFT № 90593

1.3. Factors, defining the event.

A determining factor for the occurrence of the accident is non-compliance with the construction technology for repair of the rail track with mechanized replacement of reinforced concrete sleepers of the Railway Section Gorna Oryahovitsa - poor reinforcement of the rail track (with manual mechanized undercutting/tamping of the sleeper gird).

Contributing factor for the occurrence of the accident is the high freight voltage from the large number of freight trains that passed in the period from 17.04.2021 to 22.04.2021, combined with low movement speed of trains in the section with the given reductions up to 25 km/h.

1.4. Direct causes and consequences of the event.

The direct causes of the accident (derailment of the first and subsequently the second wheel-set of the first bogie of the 6th wagon) are unacceptably large superelevation in the left circular curve with a radius of 482 meters due to poor reinforcement of the rail track after the repair. The low speed of the passing freight trains caused an overload of the left inner rail thread, which contributed to the sharp increase of the cant in the curve to inadmissible values. The combination with the driving mode led to a decrease in the adhesion of the right wheel of the first wheel-set of the first bogie of the sixth wagon with the working surface of the right rail in the curve, which led to the wheel rising on the rail and derailing the first and then the second wheel-set.

1.5. Safety recommendation and addresses to which are directed.

The Investigation Commission proposes to the National Safety Authority RAEA safety recommendations relevant to SE NRIC.

Recommendation 1 proposes that SE NRIC and BRC EAD acquaint the interested staff with the content of this report.

Recommendation 2 proposes SE NRIC to comply with the requirements set out in Art. 89 of Ordinance № 59 on the activities related to the reconstruction of the railway infrastructure.

Recommendation 3 proposes that SE NRIC increases the control during and until the completion of the repairs of the railway infrastructure by assignment (with an external contractor) and in an economic way and the inspection “Transport safety” (including the regional inspections) to carry out inspections on the spot for observance of the norms for bringing the parameters of the rail track in compliance with the norms.

Recommendation 4 proposes SE NRIC to develop and approve uniform technologies for repair and maintenance of the rail track regarding the types of performed repair activities.

2. Investigation

2.1. Decision for starting the investigation.

The decision to initiate an investigation of the accident has been taken with respect to the seriousness and its impact on the safety. The investigation aims to prevent this type of accidents, which in similar circumstances could lead to significant consequences.

2.2. Motives for the decision to initiate the investigation.

The Decision to initiate the investigation is based on art. 20, paragraph 2, (a) of Directive (EU) 2016/798, art. 115к, paragraph 1, item 1 of RTA, art. 76, par. 1, item 1 of Ordinance No 59 dated 5.12.2006, and by Order of the NAMRATIB for assignment of Commission for investigation of the railway accident.

2.3. Scope and restrictions of the investigation.

The scope of the investigation examines and analyses the movement of DFT № 90593 and the technical condition of the RRS, the violations of regulations implemented by the entities (SE NRIC and BRC EAD) during the repair of the railway infrastructure.

Given the realized major damages, the investigation is focused on the circumstances that led to the causes for the accident - derailment of five tank cars full of fuel, from the composition of DFT № 90593 between the stations Vetovo - Senovo, which in other cases would be realized with huge damages, environmental pollution, etc.

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

The composition of the commission includes external independent experts - habilitated persons from the higher scientific circles and experts with free profession with qualification and professional orientation in fields of activity – railway infrastructure, and rail rolling stock.

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

During the investigation, the Commission defined the parameters of the investigation and coordinated its actions with the Task Force, which included representatives of the two entities. The Task Force has collected all books and specimens, as well as records from the recorders of locomotives № 91530400605-8 and № 91520087020-1. They were handed over to the Chair of the Investigation Commission within NAMRATIB. Interviews were conducted with the persons, directly involved in the accident. The entities were requested and provided information on the maintenance of the rail track between Vetovo and Senovo stations, as well as information on the repair, maintenance and persons responsible for the maintenance of the derailed wagons, and the technology for replacement of concrete sleepers. Interviews were conducted with the safety authorities of the two entities and with the management of the railway undertaking BRC EAD.

2.6. Degree of cooperation from the participating entities.

During the investigation, the railway undertaking BRC EAD and the persons from the railway undertaking involved in the accident fully cooperated with the Investigation Commission.

The Railway Infrastructure Manager did not cooperate with the Investigation Commission as it obstructed the measurement of the rail track in the derailment area. The Chair of the Investigation Commission within the NAMRATIB did not receive the opportunity for additional measurement of the rail track, which violated Art. 89, para. 2, item 1 of Ordinance № 59.

2.7. Methods and techniques of investigation and analysis.

After oral notification at 01:20 a.m., and a subsequent SMS notification at 01:33 a.m. by mobile phone on 23.04.2021 by representatives of the Railway Infrastructure Manager about the accident, the member of the Management Board of NAMRATIB with competence to investigate railway accidents analysed the information, notified the two entities (SE NRIC and BRC EAD) and departed for the place of the accident with an external expert.

The first meetings and talks were held on the spot with the representatives of the investigation bodies in the pre-trial proceedings of the Ruse District Prosecutor's Office (DP) in connection with the initiated procedural-investigative actions on their part, establishment of organization and subsequent actions in the conducted parallel independent investigation with the NAMRATIB.

At around 01:30 a.m., the authorities of the Ministry of Interior - Ruse arrived on the spot and cordoned off the area of the accident for access by external persons.

At 02:00 a.m. specialized vehicles of FSaCP - Ruse arrived on site and undertook tamponing of leaks of the lying 6th and 7th flowing tanks from the exhaust valves to the hatch of filling with gasoline and pouring foam constantly in order to minimize the risk of their ignition.

After the on-site inspections and analysis of the event, the member of the Management Board of NAMRATIB for investigation of railway accidents undertook investigation of the railway accident (in slightly different circumstances there would be severe consequences), for which the National Safety Authority was informed, and officials of the participating entities at the place of the accident (SE NRIC and BRC EAD) in accordance with Art. 71, para. 2 of Ordinance № 59.

In the presence of the member of the Management Board of NAMRATIB and the bodies of the pre-trial proceedings, the registration devices of the two locomotives № 91530400605-8 and № 91520087020-1 were unsealed. The recordings were downloaded from them to flash memory for decryption, analysis and expertise. The Investigation Commission carried out a preliminary review of the data downloaded from the registration devices of DFT № 90593 on 23.03.2021 from Ruse-marshalling yard to the stopping place of the first and last locomotive.

The warning devices in both locomotives were sealed with regular seals.

Interviews were conducted with the personnel involved in the accident on behalf of both entities (on-duty manager at Vetovo station, personnel from the railway section that repairs and maintains the rail track, and the locomotive crews of both locomotives, as well as other persons indirectly related to the accident).

The first inspections of the derailed five wagons of DFT № 90593 and the area of the rail track were performed, where the sixth wagon in a row derailed and the damaged section about 2500 m from the rail track in the interstation Vetovo - Senovo. The point of ascent of the wheel and the subsequent derailment of the sixth wagon from the train was established.

The railway undertaking BRC EAD and SE NRIC were allowed to tow the first four non-derailed wagons and the train locomotive № 91530400605-8 to Senovo station by locomotive №92520007106-4. After lifting the fifth derailed wagon on the rails, it was also towed by locomotive № 92520007106-4 to Senovo station. The derailed four tanks 6th, 7th, 8th, 9th remain in place, followed by the non-derailed nineteen wagons with locomotive № 91520087020-1.

On 24.04.2021, a comprehensive inspection of the damaged railway infrastructure and the derailed five wagons was performed again.

The bodies of the pre-trial proceedings with an external expert appointed by them and the Task Force performed measurements of the parameters of the rail track in the derailment zone of the first derailed wagon of train № 90593.

Representatives of the NAMRATIB were not invited to participate in the measurements.

With three consecutive exits of shunting locomotive № 92530810761-2 from Vetovo station the non-derailed 19 wagons and locomotive № 91520087020-1 were pulled from the interstation back to Vetovo station. In the interstation Vetovo - Senovo at km 41+000 were located the 4 derailed tanks, of which the 6th and 7th laying on both sides of the rail track. The bodies of FSaCP performed round-the-clock control and protection of the tanks during their transfer organized by BRC EAD in other empty tanks, delivered by locomotive № 92520007106-4 from Senovo station to the derailed tanks. The refuelling of the tanks continued until 28.04.2021.

On 25.04.2021, the Railway Infrastructure Manager established an organization and preparation for the restoration of about 2,500 m of damaged railway infrastructure. In parallel, the activities of transferring the derailed tanks to others continue.

On 13.05.2021 in the wagon construction factory "Traction" AD - Samuil the Task Force inspected the technical condition and measured the parameters of the running gear of the five derailed wagons №№ 33537965059-1, 33537851174-5, 33537963688-9, 33537963906-5, 33537963037-0 and drew up Statements of Findings for their technical condition. It carried out complete inspection of the technical condition of wagons №№ 33537963027-0 and 33537965059-1. The Task Force seized and handed over to the Chair of the Investigation Commission 2 polyamide inserts from the central bearings of the two bogies of wagon № 33537851174-5 for analysis. The Task Force inspected the tanks of wagons №№ 33537851174-5, 33537963688-9, 33537963906-5 at the base of LVZ - Ruse marshalling yard and inspection of the bogie from wagon № 33537963027-0 at the base of the railway undertaking "Express Service" EOOD.

The Chair of the Investigation Commission handed over the two polyamide inserts for preparation of an expert opinion on their condition at the Institute of Polymers at the Bulgarian Academy of Sciences.

At Prostorno and Vetovo stations, at the insistence of the Railway Infrastructure Manager, repeated measurements of the full tank wagons with mobile scales were performed.

On 18.05.2021, the Investigation Commission received the collected documentation, submitted by the appointed Task Force I-st category, in TOSAMD - Gorna Oryahovitsa regarding the registered railway accident - derailment of 5 full tank cars from the DFT № 90593 in the interstation Vetovo - Senovo on 23.04.2021.

2.8. Difficulties faced during the investigation.

During the investigation, the communication between the Investigation Commission and the representatives of the Railway Infrastructure Manager was not at the required level. The activities for the restoration of the railway infrastructure for the specific case started after a written permission from the investigation structures from the bodies of the pre-trial proceedings and the NAMRATIB. Proof of this statement are the following circumstances:

- The railway infrastructure manager did not comply with the requirements of Art. 89, para. 2, item 1 of Ordinance № 59 of 5.12.2006 for safety management in railway transport, in which is written the text: „item 1 where the investigation is carried out by the NAMRATIB, the head of the Task Force shall coordinate the recovery activities with the member of the NAMRATIB Management Board with competence for the investigation of railway accidents. "

- On 13.05.2021, Employees of the Railway Infrastructure Manager (not members of the Task Force) performed unregulated and uncoordinated with the Chair of the Investigation Commission within NAMRATIB, actions that are in violation of Art. 83, para. 4 of Ordinance № 59, in order to seize elements (parts) from the derailed sixth wagon № 33537851174-5 during its measurement for preparation of the Statement of findings for the technical condition of the wagon in the area of the railway undertaking "Traction" AD - Samuil.

2.9. Interaction with the judicial authorities.

In accordance with the Agreement on Cooperation between the Pre-trial Proceedings and the NAMRATIB, in force since 17.04.2018, after the completion of the inspections and interrogations of the staff by the pre-trial proceedings of Ruse, they gave a written permission to the Railway Infrastructure Manager in order to start rehabilitation activities on the railway infrastructure and the derailed RRS.

2.10. Other important information for the investigation context.

After pouring and emptying the last three derailed tanks, due to severe deformations on the body shell and their running gear and the inability to move on their own, the tanks without their running gear (bogies and wheel-sets) were loaded on cars and transported from the spot to a certain place with constant supervision.

3. Description of the event

3.1. Information on the event and the context.

3.1.1. Description of the event type.

- By telegram № 585/25.03.2021 of the Director General of SE NRIC it was allowed to the Railway Section Gorna Oryahovitsa to carry out "Repair of the rail track with mechanized change of sleepers in the interstation Vetovo - Senovo". The time schedules for the repairs were regulated in the following hours: 09: 45÷15: 50, 07: 10÷ 14:10 and 09:40 ÷ 15:50 hours.

- The management of the site and the investor control were carried out by order №V-A-4/01.03.2021 of the Director of Railway Section Gorna Oryahovitsa. The repair of the site was carried out according to the technology approved by the Director of the Railway Section Gorna Oryahovitsa.

- In accordance with the prepared construction technology for repair of the rail track with mechanized replacement of CRS sleepers from the Railway Section Gorna Oryahovitsa in the period 13.04. ÷ 14.04.2021 in the derailment zone of the train - km 38 + 100 ÷ 38 + 900 was performed another replacement of sleepers in the rail track. Until 08.04.2021, after the change of sleepers, a mechanized undercutting/tamping of the rail track with heavy-tamping machine (TPM) was carried out in order to bring the rail track within the norms. From 09.04.2021 the heavy-tamping machine was diverted from the site Vetovo - Senovo for work on the 4th main railway line until 16.04.2021. On 18.04.2021 the heavy-tamping machine from Gorna Oryahovitsa station departed for inspection of the brake system to Sofia station.

The image shows a printed document titled "Schedule of DFT № 90593". It contains several tables with columns for dates, times, and various technical specifications. Some parts of the document are highlighted in red ink.

№	Датум	Време	Содержание
1	13.04.2021	09:45 - 15:50	Механизация замены шпал
2	14.04.2021	07:10 - 14:10	Механизация замены шпал
3	15.04.2021	09:40 - 15:50	Механизация замены шпал

Fig. 3.1. Schedule of DFT № 90593

According to the telegram-permission of the Director General, the repair of the site for mechanized change of sleepers Vetovo - Senovo continues until 17.04.2021, and in that period after the change of sleepers, the rail track in order to be restored to normal was tamped by manual mechanization. After the completion of the repairs on 17.04.2021 until the occurrence of the accident on 23.04.2021, 128 trains weighing 95,250 tons passed along the interstation. The large number of passing passenger and freight trains with high weight has led to a sharp deterioration of the parameters of the rail track at a level that has contributed to the derailment of DFT № 90593.

At a request of the railway undertaking BRC EAD dated 21.04.2021 for transportation of liquid fuels in tank cars, SE NRIC prepared a schedule for the movement of DFT № 90593 on 22.04.2021 (Fig. 3.1) in the direction Ruse marshalling yard - Belozem (Fig. 3.2.).



Fig. 3.2. Map of the movement route of DFT № 90593

Фактно движение на влак 90593/ВРК/ на 22.04.2021г.

ВЛК 90593 ВРК 454 нр. 400 22.04

РУСЕ РАЗПРЕДЕЛ.	-	-	-	23:30	време
60 КИ ДУБАЛ III	4	-	-	23:34	време
ОБРАЗЦОВ ЧВАЗИК	21	23:55	11 00:06	+12секунти	
ИСТРЕКОС	13	-	-	119	+12секунти
73 ВЕТОВО	14	-	-	133	+14секунти
60 СЕНОВО	320	05:53	1		изтекло време част на влака от 4
вагона = номериран	40-0605+07-106				

Fig. 3.3. Actual movement of DFT № 90593

On 22.04.2021 at 23:30 p.m. DFT № 90593 departed from Ruse marshalling yard consisting of 28 wagons, of which 2 wagons guarded at the head and at the end of the train, 26 tank cars (full of gasoline), 437 meters, 1831 tons. An auxiliary locomotive was attached to the head of the train №92530600685-7, train locomotive № 91530400605-8 and auxiliary pushing locomotive №91520087020-1. The locomotives and the locomotive crews, servicing the train, were part of the BRC EAD railway undertaking.

DFT № 90593 was received at Obratzov Chiflik station at 23:55 p.m. on the second acceptance- departure track. After a stay of 11 minutes for uncoupling the auxiliary locomotive №92530600685-7, the train departed at 00:06 a.m. with train locomotive № 91530400605-8 and pushing auxiliary locomotive № 91520087020-1.

DFT № 90593 passed without stopping through Yastrebovo station at 00:19 a.m. and through Vetovo station at 00:33 a.m. to Senovo station (Fig. 3.2).

At around 01:05 a.m., the train dispatcher informed the traffic manager on-duty at Vetovo station that wagons of DFT № 90593 derailed at km 41 + 000 along Vetovo-Senovo interstation. The traffic manager on-duty at Vetovo station informed the interested services, and the officials for the railway accident.

After receiving the information, the train dispatcher ordered the energy dispatcher to turn off the voltage in the catenary and at 01:13 a.m. the voltage along Vetovo - Senovo interstation was turned off.

By order of the train dispatcher from 03:09 a.m. the interstation Vetovo - Senovo was closed for train traffic.

23.04.2021

Upon arrival at the site and inspections by the Task Force appointed by the Railway Infrastructure Manager and the other actors involved in the accident, the following was established:

Derailed wagon № 33537851174-5 - sixth in the train. The right wheel of the first wheel-set of the first bogie rose on the rail at km 38 + 504 and after about 14 meters the wheel derailed. After 35 meters, the second wheel-set of the first bogie of the sixth wagon derailed. For 2500 meters, the wagon was moving with the first bogie derailed in places tightly and on the side of the sleeper gird. At km 41 + 000, the train was split between wagon № 33537965059-1, fifth in the train and wagon № 33537851174-5, sixth in the train, where wagon № 33537965059-1, fifth in the train, derailed with the four wheel-sets and remained on the ballast prism, wagon № 33537851174-5, sixth in the train, derailed and laid to the right on the mileage of the rail track, dragging behind the seventh, eighth and ninth car. Wagon № 33537963688-9, seventh in the train, derailed and laid to the left of the rail track. Wagon № 33537963906-5, eighth in the train, derailed with the four axles and remained on the ballast prism. Wagon № 33537963027-0, ninth in the train, derailed with the first bogie, its buffers were mounted on the buffers of the eighth wagon, the first bogie remained in the air, and the second bogie remained on the rail track. No damage to the catenary was caused.

3.1.2. Description of the event location:

Date, punctual time and location of the event.

The derailment of DFT № 90593 occurred on 23.04.2021 at 00:40 a.m. while running at a speed of 19 km/h in the area of the first reduction between Vetovo and Senovo stations at km 38 + 504. The train was assigned to run in the direction of main railway lines №№ 9, 2, 3, 8 and deviation

from the main line № 26 with route Russe marshalling yard – Kaspichan – Shumen – Komunari – Karnobat – Zimnitsa – Stara Zagora – Belozem (fig. 3.4).



Fig. 3.4. Route of movement of DFT № 90593

- - Origin station of the train movement;
- - Main stations on the train alignment;
- - End destination station of the train movement;
- Place of accident;
- - Track that the train passed;
- - Track that the train did not succeed to pass.

3.1.2.1. Location of the occurred accident.

The railway accident occurred between the stations Vetovo - Senovo, the ascent of the right wheel of the wagon at the head of the rail was realized at km 38 + 504, left curve with radius $R = 482$ m, the rail track has a profile of 2.3 ‰ in the uphill. Vetovo - Senovo stations are located on the main railway line № 9. The railway line is conventional with speeds up to 100 km/h (Fig. 3.4).

DFT № 90593 run under schedule, shown on figures 3.1 and 3.2.

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

- In the dark part hours – 00:40 hours;
- Air temperature +6°C;
- Speed and wind direction 3,6 km/h, SSE;
- Weather – cloudy, with normal visibility of the signals;

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

- In the interstation Vetovo - Senovo in the derailment zone with tel. № 585/25.03.2021 of the Director General of SE NRIC it was allowed "Repair of the rail track with mechanized change of sleepers" in the period 02.04.÷17.04.2021 with regulated time of 09:40 ÷ 15:50 hours. Employer of the repair is the Railway Section Gorna Oryahovitsa and Contractor "Norval 19" EOOD, Varna, under Contract № 32106/01.03.2021.

- Two temporary speed reductions were implemented because of the repair technology
- km 37+800 ÷ 38+900 – 25 km/h with front 1100 meters;
- km 40+600 ÷ 41+650 – 25 km/h with front 1050 meters.

The indicated reductions were signalized as per Ordinance № 58.

Fatalities, injuries and material damages:

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

None.

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

None.

3.1.2.6. Passengers.

None.

3.1.2.7. External persons.

None.

3.1.2.8. Cargo, luggage or other property.

None.

3.1.2.9. Environment.

None.

3.1.2.10. Rolling stock.

- Damages caused to the running gear, frames and tanks of the derailed five tank cars №№ 33537965059-1, 33537851174-5, 33537963688-9, 33537963906-5, 33537963037-0.

- The railway undertaking BRC EAD presented a report for damages (loss) 3 wagons with №№ 33537851174-5, 33537963688-9, 33537963906-5 amounted to – 105 840,00 BGN.

- BRC EAD presented a Bill of quantity for damages caused to wagon № 33537965059-1 amounted to 922,25 BGN, and to wagon № 33537963027-0 amounted to 4 618,60 BGN.

3.1.2.11. Railway infrastructure.

- Amount for damaged rail track as a result of the derailment, with value 299 866,21 BGN along Vetovo-Senovo interstation;

- Total costs for damages: 411 247,06 BGN.

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

In the period 23.04 ÷ 01.05.2021, for the restoration of the railway infrastructure, the Railway Infrastructure Manager and the Railway undertakings have incurred additional costs for changing the train schedule.

- Deviated trains of the railway undertakings – 12 206,70 BGN;
- Cancelled trains of the railway undertakings – 35 629,73 BGN;
- Assigned trains of the railway undertakings – 13 571,41 BGN;
- Delayed trains of the railway undertakings – 4 948,40 BGN;
- Costs for restoration means – 3 458,16 BGN;

Total other costs: 69 814,64 BGN.

3.1.4. Identity of the participants and their functions.

3.1.4.1. Railway infrastructure:

- SE National railway infrastructure company has Safety Authorization No № BG 21/2018/0001 valid from 01.07.2018 until 30.06.2023.

SE NRIC personnel, involved in the accident:

- Traffic manager on duty in Vetovo station;
- Head of railway section – Razgrad;
- Technician manager HRM in railway section – Razgrad.

3.1.4.2. Railway undertaking:

- „Bulgarian Railway Company“ EAD possesses:
 - License for railway transport services performance;
 - Safety certificate Part A BG , valid until 30.12.2023;
 - Safety certificate Part B BG , valid until 30.12.2023;

BRC EAD personnel, involved in the accident:

- Locomotive driver, first person of locomotive № 91530400605-8;
- Locomotive driver, second person of locomotive № 91530400605-8;
- Locomotive driver, of locomotive № 91520087020-1;

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

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

Single main railway line № 9 in the interstation Vetovo - Senovo, left curve in the direction of train movement with radius $R = 482$ m and profile 2.3 ‰ in the uphill.

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

The Vetovo - Senovo interstation is equipped with a semi-automatic block system (SABS). Vetovo and Senovo stations are equipped with a Relay System for Key Dependence (RSKD).

3.1.5.3. Train protection systems.

There is no train protection system along Vetovo and Senovo interstation. Vetovo and Senovo stations are equipped with a train dispatcher radio connection (TDRC), with the help of which the locomotive driver makes a radio connection with a train dispatcher, with separate stations, with the trains in the respective section.

Locomotive № 91530400605-8 is equipped with an active type vigilance device and an electronic recorder type Program vizualizare inregistrari IVMS, Version 1.0.0.25132, SC Softronic Craiova.

Locomotive № 91520087020-1 is equipped with vigilance/warning device type electronic registering apparatus „Hasler“ TEL 1000.

3.1.6. Other information referring the event.

The train documents “Travel document”, “Certificate for brake mass” and “Nature sheet” (Fig. 3.5 - 3.11) correspond to the hours of the actual movement of IDFT № 90593 according to the data submitted by MRTO and the decipherment of the locomotives.

A coordinate plane with x and y axes ranging from -5 to 5. A dashed line passes through the points (-1.5, 0) and (0, 3). The region below this line is shaded in light blue, representing the solution set for the inequality $y < 2x + 3$.

Fig. 3.5. Travel document of locomotive № 91530400605-8, pg. 1

От Р. 19¹⁵ пох. бр. 102 до 3-го яруса от БП
и се открито изграба в Р. 19²⁰

Fig. 3.6. Travel document of locomotive № 91530400605-8, pg. 2

[illegible][illegible]

Fig. 3.9. Brake mass certificate of IDFT № 90593, front part

Fig. 3.10. Brake mass certificate of IDFT № 90593, back

Maryland State Highway 10									
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Fig. 3.11. Nature sheet of DFT № 90593

3.2. Factual description of the occurred.

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

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

DFT № 90593 passed through Vetovo station at 00:33 a.m. without stopping. The traffic manager on-duty ordered the route of the train without stopping and during the transit of the train from the platform he followed its passage through the station, without noticing any damage to the rolling stock. The train passed through Vetovo station at a speed of 57 km/h (Fig. 4.3). When the train entered the first reduction around 00:38 a.m., the train speed was 19 km/h. The train continued its movement and after 1700 meters entered in the second reduction at a speed of 17 km/h (Fig. 4.4, pos. 4). After 112 meters the train disconnected between the fifth and sixth wagon, the pressure in the main air duct from 5 bar began to drop sharply to 0 bar, the speed dropped sharply to 0 km/h, and the train stopped at the interstation Vetovo - Senovo at 00:49 a.m., km 41 + 403 (Fig. 4.4, items 5 and 6).

After the train stopping, the first-person locomotive driver of locomotive № 91530400605-8 ordered the second-person locomotive driver to inspect the train, the locomotive driver of locomotive № 91520087020-1 also left the end of the train, the two found that five tank cars of the train derailed, as the sixth and seventh wagons laid on the right and left of the rail track, respectively.

3.2.2.2. Rolling stock and technical facilities functioning.

Until the moment of the accident, the rolling stock, incl. both locomotives and 28 tank cars were technically sound and functioning normally.

The rail track along the interstation Vetovo - Senovo at the time of derailment was under repair and was not technically sound, as evidenced by the measurements of the parameters of the rail track at the time of derailment, reflected by the Task Force in the Statement of Findings dated 23.04.2021.

3.2.2.3. Operational system functioning.

The operational system is regular with proper functions.

3.2.3. Sequence of events from the beginning of the accident to the end of the rescue services actions:

At 00:40 a.m. derailed wagon № 33537851174-5 sixth and at 00:49 a.m. derailed four more tank cars, full № 33537965059-1 fifth, 33537963027-0 ninth, 33537963688-9 seventh, 33537963906-5, eighth from the composition of DFT № 90593 while running in the interstation Vetovo - Senovo at km 38⁺⁵⁰⁴;

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

After the arrival of the authorities of the Ministry of Interior and clarification of the situation, the area of the accident was cordoned off and no external persons were allowed except the rescue teams, the pre-trial authorities, the Investigation Commission of the NAMRATIB and the interested officials. Mass media access was limited

3.2.3.2. Actions of the emergency rescue services.

The actions of the emergency rescue services of the FSaCP were in round-the-clock work on securing the derailed full tanks from ignition and their transfer to other empty tanks from 24.04. to 30.04.2021.

3.2.3.3. Actions of the emergency rehabilitation services.

The train movement along Vetovo – Senovo interstation was interrupted within the period 23.04.-01.05.2021.

The following was performed in order the movement and capacity of the railway infrastructure to be recovered:

23.04.2021

At 03:29 a.m. recovery train departed from Ruse marshalling yard and arrived in Vetovo station at 04:05 a.m.

At 05:03 a.m. locomotive № 92520007106-4 was sent from Senovo station to km 41 + 100 to transport the first part of DFT № 90593, of locomotive 91530400605-8, 1 open wagon type E and 3 tank cars type Z back to the station Senovo at 05:53 a.m. Due to the lack of free tracks at Senovo station, at 05:56 a.m. the train was sent to Prostorno station.

After the rehabilitation works were authorized by the investigation bodies of the pre-trial proceedings at 18:50 p.m., the Railway Infrastructure Manager established an organization for the restoration of the railway infrastructure. These actions were also not coordinated with the member of the Management Board of NAMRATIB with competence for investigation of railway accidents.

With a specialized recovery device "Unimog", moved to kilometer 41+100, wagon №33537965059-1, fifth in the train, was lifted on the rail track at 20:30 p.m.

After retrieving the specialized vehicle "UNIMOG" from the rail track, locomotive №98520055264-6 left Senovo station, which was sent to transport the derailed fifth wagon at a speed of up to 5 km/h. The train was accepted back at Senovo station at 22:00 p.m., and departed at the same speed to Prostorno station.

Direct freight train № 40691 with 5 empty tanks and 2 security wagons in the direction Ruse marshalling yard - Gorna Oryahovitsa - Kaspichan - Senovo has been appointed for reloading the fuels from the four derailed tanks in other empty ones. From Ruse marshalling yard departed at 22:30 p.m., and arrived at Senovo station at 06:30 a.m. on 24.04.2021.

24.04.2021

At 08:45 a.m. locomotive № 810761 was sent from Vetovo station to kilometre 40 + 600 to transport locomotive № 91520087020-1, 1 open wagon type E and 1 tank car type Z from the DFT № 90593, the train was taken back at the station at 10:10 a.m.

At 10:25 a.m. locomotive № 810761 was sent again to kilometre 40 + 600 to transport 8 tank cars type Z from the train, it was transported back at Vetovo station at 11:45 a.m.

At 12:03 p.m. locomotive № 810761 was sent again to kilometre 40 + 600 to transport 9 type Z tank cars from the train, it was transported back at Vetovo station at 13:19 p.m.

At 13:51 p.m. specialized machine SM-053 departed from Vetovo station, exited the interstation up to kilometre 41 + 000 for lifting the catenary and returned in Vetovo station.

At 17:04 p.m. locomotive № 810761- departed from Vetovo station to the interstation up to kilometre 41 + 000 for transportation of wagon № 33537963027-0, ninth in the train, derailed with the first bogie and returned back to Vetovo station at 20:08 p.m.

At 18:23 p.m. locomotive № 92530600685-7, 1 open type E wagon and 2 type Z tank cars were sent from Senovo station to kilometre 41 + 100 for reloading the fuels from the derailed wagons.

25.04.2021

At 10:51 a.m. from Vetovo station TPM 2302, USP 303 and SM-053 run to kilometre 38+500 for work on the rail track and returned back at 13:05 p.m.

At 06:56 a.m. locomotive № 92530600685-7 was sent from Senovo station to kilometre 41+100 to collect 2 Z-type tank cars, reloaded and put back at Senovo station at 07:42 a.m.

At 08:01 a.m. from Senovo station to kilometre 41+100 specialized ADM machine was sent to dismantle the catenary and returned to Senovo station at 11:32 a.m.

At 11:47 a.m. ADM, locomotive № 92530600685-7, 1 tank car type Z and 1 open wagon type E were sent from Senovo station to kilometre 41+100, which were collected from the derailed wagons after the completion of the refuelling works back to Senovo station at 15:51 p.m.

Locomotives №№ 91520087020-1 and 91530400605-8 with 1 open wagon type E and 18 tank cars type Z of DFT № 90593 departed from Vetovo station at 20:53 p.m. and arrived at Ruse marshalling yard at 21:40 p.m.

A train with locomotive № 91530400605-8 and 21 platform wagons arrived at Vetovo station at 20:00 p.m. to renew the damaged railway infrastructure.

The repair works of the damaged railway infrastructure were performed by the railway company TCR EAD.

At 13:21 p.m. from Vetovo station departed a track laying machine in the interstation with 10 platform wagons for collecting old units with locomotive № 92520007367-2. The working train returned to Vetovo station at 18:40 p.m., left the track laying machine at the interstation. 400 meters of rail track from km 40 + 015 to km 39 + 615 were dismantled.

26.04.2021

At 08:47 a.m. TPM 2302 departed from Vetovo station in the interstation, tamped the rail track and returned at 10:41 a.m.

At 11:42 a.m. a working train with locomotive № 92520007367-2 and 9 platform wagons departed from Vetovo station along the interstation and returned back at 15:26 p.m. 400 meters of rail track from km 39 + 615 to km 39 + 215 were dismantled.

27.04.2021

At 08:56 a.m. insulated locomotive № 07367 departed from Vetovo station along the interstation and returned at 17:25 p.m. with 8 empty wagons.

At the end of the day in the interstation Vetovo - Senovo there were three derailed tank cars, a track laying machine and 12 platform wagons with new units for laying.

At Vetovo station on the first track was the derailed wagon № 33537963027-0, ninth in the train, which was empty, overloaded.

At Prostorno station on the first track was the derailed wagon № 33537965059-1, fifth in the train, empty, and overloaded.

A 400-meter new rail track was laid from km 39 + 215 to km 39 + 615.

28.04.2021

A 400-meter new rail track was laid from km 39 + 615 to km 40 + 015.

The catenary of the clearance gauge parameters from km 39 + 250 to km 40 + 000 was fixed.

The three derailed tank cars were lifted at 18:00 p.m., and at 19:00 p.m. the parts of their running gear were removed.

At 15:30 p.m. in Ruse marshalling yard on wagon scales by order of the Railway Infrastructure Manager was performed control measurement of 18 pcs. full tank cars type Z, part of the composition of DFT № 90593. After comparison with the values of the weights measured in Brazi Romania on 19.04.2021 with those measured in Ruse marshalling yard, Bulgaria on 28.04.2021 were found differences between the two measurements with values of ± 350 kg per wagon. During the control measurement it was established that the maximum permissible weight of the wagons and their base load were not exceeded.

29.04.2021

At 08:10 a.m. from Razgrad station working train № 90490 departed and arrived at Senovo station at 08:37a.m. At 09:00 a.m. from Senovo station in the intermediate station was sent DGKu 52-61 and returned at 09:36 a.m. At 09:45 a.m. working train № 90493 departed from Senovo station and arrived at Razgrad station at 10:16 a.m.

30.04.2021

A working train (hopper dispensers) with a locomotive № 55246 was sent from the Senovo station to the interstation to strengthen the renewed railway with ballast at 09:50, after unloading it returned at 10:55.

At 11:37 a.m. a working train (hopper dispensers) with locomotive № 98520055264-6 was sent from Senovo station to the interstation, after unloading it returned at 12:30 p.m.

At 14:10 p.m. in Karnobat station on a wagon scale of SE NRIC was carried out control measurement of 3 full tank cars type Z, part of the composition of DFT № 90593. The gross weights of the wagons coincide with those measured at Brazi station, Romania on 19.04.2021.

01.05.2021

At 09:04 a.m., a planning machine was sent from Vetovo station to the interstation and returned at 13:16 p.m.

At 09:07 a.m. TPM 08328 was sent from Senovo station to the interstation and returned at 16:14 p.m.

At 15:48 p.m. from Vetovo station in the interstation for regulation of the catenary was sent SM-053 and returned back at 17:08 p.m.

At 17:13 p.m. the power supply of the catenary in the interstation Vetovo - Senovo was restored.

At 17:25 p.m. the movement of all trains and vehicles in the interstation Vetovo - Senovo was restored with a reduction of the speed from km 37 + 800 to km 41 + 650 with a speed of 25 km/h.

4. Analysis of the event

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

4.1.2. Railway undertaking.

To clarify the causes of the accident it is necessary to make a comprehensive analysis of the technical condition of the wagons, their load and the movement of the train.

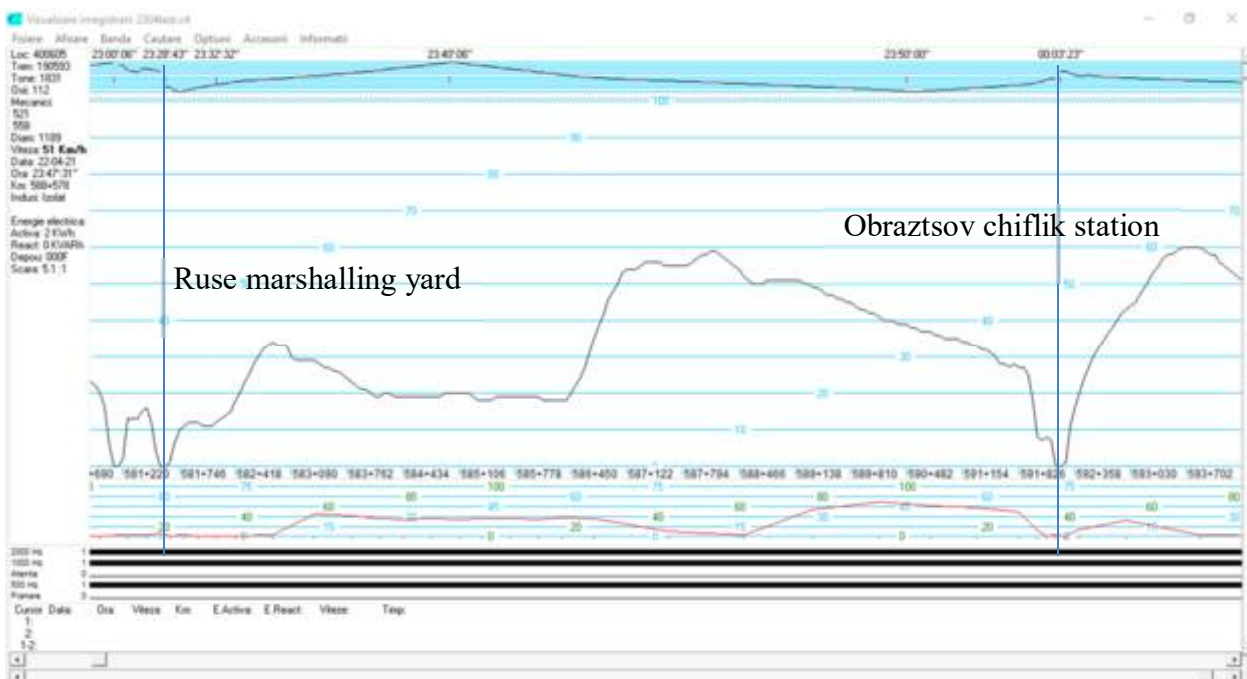


Fig. 4.1. Chart of the movement of train № 90593 from Ruse marshalling yard to Obratsov chiflik station

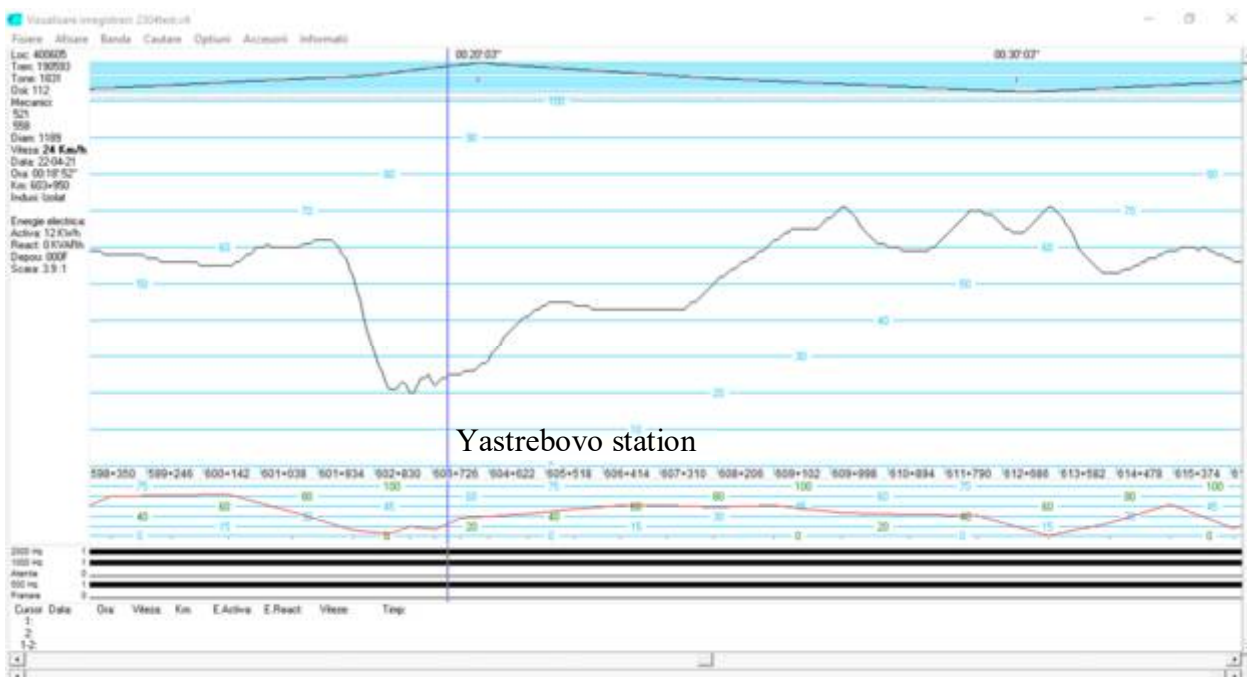


Fig. 4.2. Chart of the movement of train № 90593 while passing through Yastrebovo station

According to the data from the recording device of locomotive № 91530400605-8 of DFT №90593 departed from Ruse marshalling yard at 23:28:43 p.m. The readings of the locomotive odometer are 581,634. The train accelerated to 59 km/h between the stations and at 23:54:54 p.m. stopped at Obraztsov Chiflik station, which according to the locomotive odometer is at km 592,246. It stayed at the station for 8 minutes and 23 seconds and at 0:03:23 a.m. departed again (Fig. 4.1).

In the section from Obraztsov Chiflik station to the place of derailment the train moved without stopping, reaching a maximum speed of 71 km/h in the interstation Yastrebovo - Vetovo (Fig. 4.2 and Fig. 4.3).

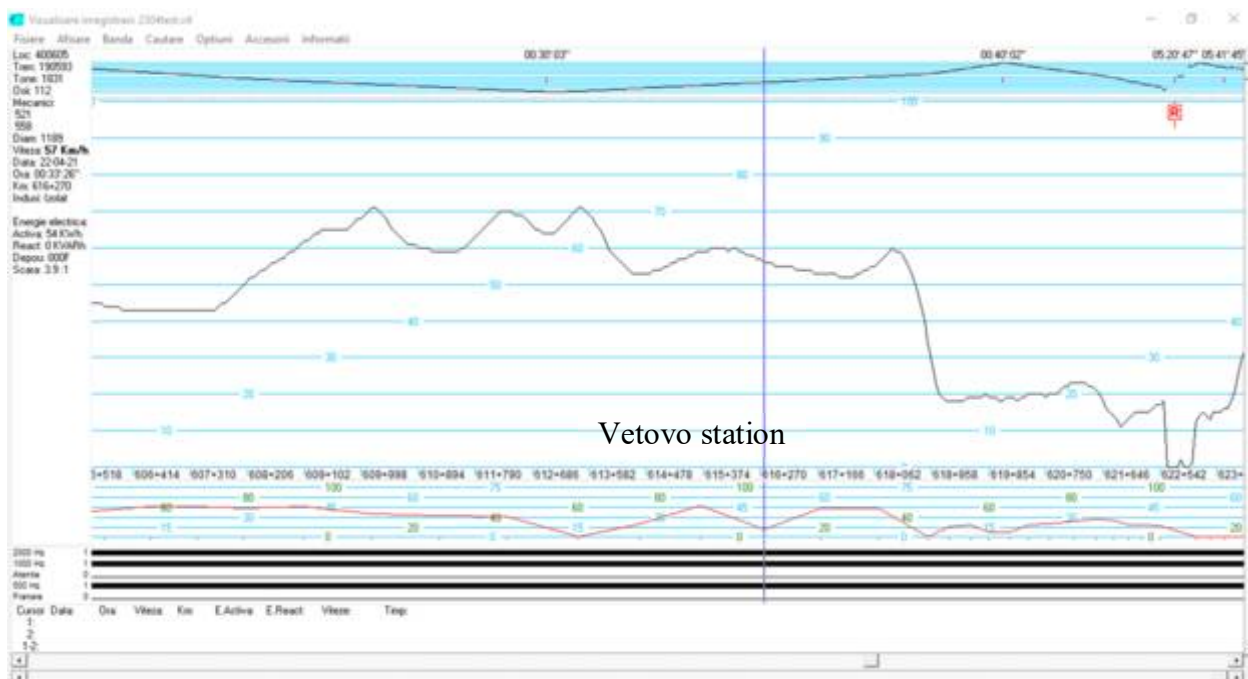


Fig. 4.3. Chart of the movement of DFT № 90593 while running through Vetovo station

The first reduction of the speed to 25 km/h in the interstation Vetovo - Senovo started at km 37⁺⁸⁰⁰, which corresponds to km 619,671 from the odometer of locomotive № 91530400605-8, and continued to km 38⁺⁹⁰⁰ with front of 1100 meters. The locomotive entered the first reduction of km 619,686 on the locomotive odometer at 0:38:47 a.m. with a speed of 19 km/h (Fig. 4.4, pos. 2), having previously reduced the speed below 25 km/h to km 619,014 on the locomotive odometer at 0:36:38 a.m., which corresponds to km 37⁺¹⁴³, i.e. 657 meters before the start of the reduction (Fig. 4.4, pos. 1). The train left the first reduction at km 620,750 at 0:42:08 a.m. at a speed of 19 km/h, which corresponds to km 38⁺⁹⁰⁰ from the railway line (Fig. 4.4, pos. 3). The speed in the front of the reduction varied between 18 and 20 km/h. After the first reduction of the locomotive, the speed remained below the limit of 25 km/h due to the fact that the wagons of the train were still in its front.

The second reduction started at km 40⁺⁶⁰⁰ and continued to km 41⁺⁶⁵⁰ with front of 1050 meters. The train entered it at km 622,486 on the locomotive odometer, which corresponds to km 40⁺⁶⁰⁰ of the railway line. The speed of train № 90593 when entering the second reduction was 17 km/h (Fig. 4.4, pos. 4). Shortly afterwards, the speed increased slightly to 18 km/h at km 622,598 at 0:48:36 a.m. (the device recorded a value of 0:49:36) (Fig. 4.4, pos. 5), after which it began to decrease sharply to the stopping moment at 0:48:54 a.m., at which the front buffers of the leading

locomotive № 91530400605-8 were located at km 622,626, corresponding to km 41⁺¹⁰³ of the railway line. Thus DFT № 90593 passed 3 612 meters with speed under 25 km/h (fig. 4.4, pos. 6).

The recording device of locomotive № 91530400605-8 did not register the pressure in the

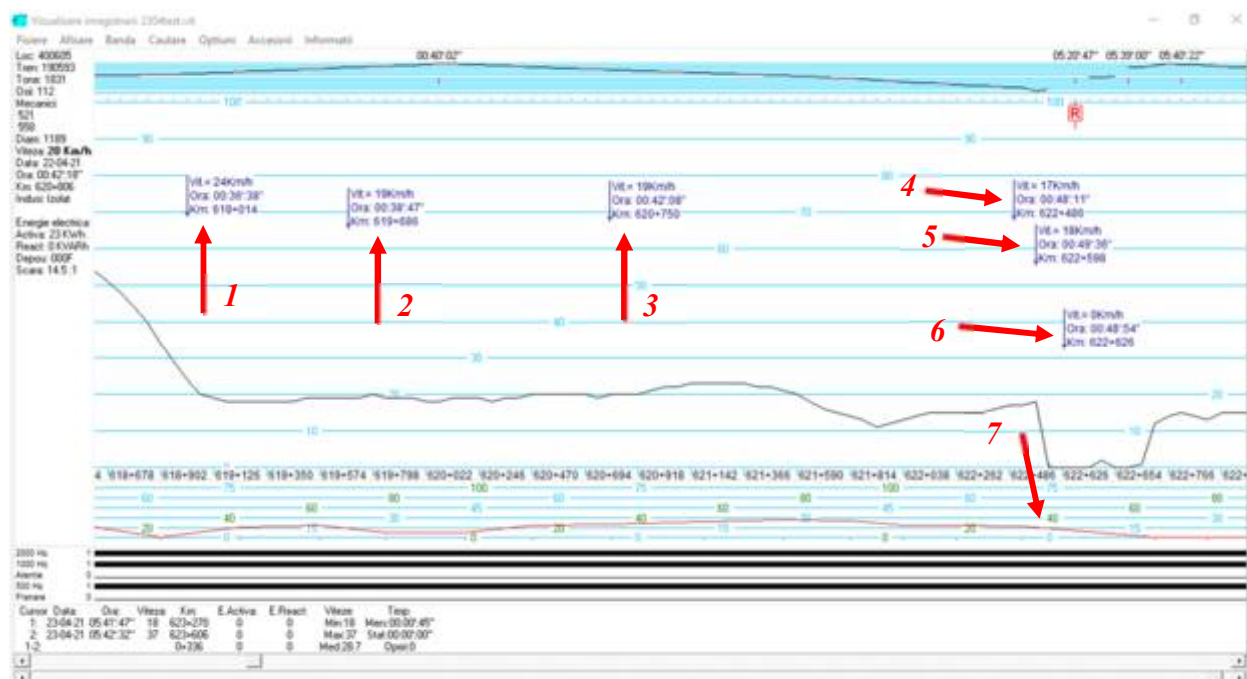


Fig. 4.4. Chart of movement of DFT № 90593 through the two fronts of reduction along Vetovo-Senovo interstation

main air duct, however it registered the level of the consumed traction energy, i.e. the loading of the traction engines. The chart shows that at the moment of reducing the speed (Fig. 4.4, pos. 6) the locomotive was in traction mode, which means that its braking system was not applied, therefore the retention of the automatic train brake occurred due to the bifurcation of the train and the pressure dropped in the main air duct (Fig. 4.4, pos. 7).

The sensor of the registration device of locomotive № 91530400605-8 is located on the fifth wheel-set, which is 4750 mm from the buffers of the second cabin. Since the locomotive was moving forward with the first cab, this means that the sensor was located 15.05 meters from the front buffers in the direction of travel. The first wagon (open, type E) is 14.29 meters long, and the other four tank cars are 12.51 meters long and three wagons 13.44 meters long, respectively, which makes the total length from the front buffers of the locomotive to the place of disconnection of the train 86.92 meters. After subtracting the length from the front buffers of the locomotive to the sensor, a total length of 71.87 meters is obtained, which shows that at the time of the train stop the disconnected wagons were located at km 41^{+031,51}.

The data from the recording device of locomotive № 91520087020-1, pushing auxiliary of DFT № 90593 were also analysed. The analysis was made from the moment of stopping, which on the locomotive odometer is at km 843,552. The total length of the wagons in the train is 437 meters. The sensor of the locomotive № 91520087020-1 is located on the third wheel-set, 12,265 m from the front buffers of the locomotive, which travelled with the first cabin forward. Thus, the distance between the sensors of the two locomotives is 454,015 meters. Since at the moment of stopping the front buffers of locomotive № 91530400605-8 were located at km 41⁺¹⁰³, the location of locomotive № 91520087020-1 should have corresponded to km 40⁺⁶⁴⁹ of the railway line, i.e. between the two reductions. In fact, due to the derailment of the wagons, due to the inertia of the movement, the non-

derailed wagons from the rear half of the train pushed the derailed ones and thus locomotive № 91520087020-1 was established at km 40⁺⁶⁹².

When analyzing the data from the registration device of locomotive № 91520087020-1 it makes an impression that the pressure in the main air duct was higher than the normal - 5.41 bar (Fig. 4.5, pos. 1). At the beginning of the recording, from which the movement of the locomotive is analyzed, the speed is 35 km/h (Fig. 4.5, pos. 2). That happened at km 839,885 on the locomotive's odometer at 00:36:34 a.m. on the locomotive clock. The speed gradually decreases and at km 840,055 at 00:36:56 a.m. the time is 19 km/h (Fig. 4.5, pos. 3). At this point, the master locomotive № 91530400605-8 entered the area of the first reduction. Locomotive № 91520087020-1 was located at km 37⁺³⁴⁵. The train moved at a speed between 17 and 23 km/h to km 843,533 on the locomotive odometer at 00:49:02 a.m. (Fig. 4.5, pos. 4). Then, at a speed of 19 km/h, the pressure in the main air duct began to decrease and for 18 meters from km 843,533 to km 843,552 in 14 seconds reached a value of 3.06 bar (Fig. 4.5, pos. 5), which corresponds to emergency stop with the automatic train brake and at 00:49:16 a.m. the speed reached 0 km/h, as locomotive № 91520087020-1 was established at km 843,552, which corresponded to km 40⁺⁶⁹² of the railway line (Fig. 4.5, pos. 6). The stopping time and the distance travelled corresponded to that recorded by the registration device of locomotive № 91530400605-8.

The Commission reviewed the Protocols of findings on the condition of the derailed wagons. It was established that the technical parameters of the wagons respect the requirements of Ordinance



Fig. 4.5. Chart of the movement of DFT № 90593 of the registering device of locomotive № 91520087020-1 latest data before the derailment

№ 58, as for wagon № 33537851174-5, sixth of the composition, the steepness of the flange of the right wheel of the first wheel-set of the first bogie, which was attacking during the derailment, was at the limit value ($qR = 6.5$ mm), as well as the left wheel of the second wheel-set of the first bogie (Fig. 4.6, items 1 and 2, Fig. 4.9, items 1 and 2). In the same way for wagon № 33537963027-0, ninth of the composition, the steepness of the flange of the left wheel of the first wheel-set and the left wheel of the second wheel-set of the first bogie was at the limit value ($qR = 6.5$ mm) (Fig. 4.11, pos. 1 and item 2, Fig. 4.12, item 1 and item 2).

ПРОТОКОЛ НА ТЕКУЩЕТО СЪСТОЯНИЕ НА ВАГОН

Днес 13.05.2018 г. 12¹⁵ часа _____ минути, комисия в състав:

1. Иван Державинскик длъжност РАК ОТДЕЛ, ВАСИЛ БИЧКОВ - ЕДР
(специалист вагони - представител на превозвача на ГДКПС)
2. Звезден Мичев длъжност РАК ОТДЕЛ БП - БИЧКОВ - ЕДР
(специалист локомотиви - представител на ползвателя на ТПС)
3. Веселин Голубев длъжност ЧАК НЕКАЧЕ - ИИПС ГОРНА ОРХОВИЦА
(специалист по железен път)
4. Емил Борисов длъжност НАС РЪК РЪС - ЧДБГД - ГОРНА ОРХОВИЦА
5. Константин Цонев длъжност РАК СЕКТОР, КИПЕК - ИИПС ГОРНА ОРХОВИЦА

(на четвърта и пета позиция участват представители на железопътната инфраструктура, специалисти по управление на движението, контактна мрежа и осигурителна техника, когато имат отношение към случая)

се събра в Тракийска АД САНЗНА на връзка със станало произшествие/инцидент
в близост до вагон от вагон 30533

(вид на произшествието/инцидента, място, дата, час)

и констатира следното състояние на вагон №
335378511745 РВ 13.05.2018 16/51M

(вид, номер и собственост на вагона, талига - вид, дата и място на последната ревизия (ремонт))

2^{та} ревизия - РВ 02.2018 № 345

1^{ва} ревизия - № 348 РВ 02.2018

3^{та} ревизия - № 346 РВ 02.2018

4^{та} ревизия - № 347 РВ 02.2018

ТАЛИГА 1 № 30 683

ТАЛИГА 2 № 36 683

[Signatures]

Fig. 4.6. Protocol of findings on the condition of wagon № 33537851174-5, sixth from the composition of the train, pg. 1

Stakeholders raised reasonable doubts as to the reliability of the measurements of the first wheel-set of the first bogie of wagon № 33537851174-5 with a Riftek / IDK device with a serial № 11213, certified until 10/2021, which is based on a calculation by the length of the chord in the rolling circle.

The Investigation Commission therefore ordered new precise measurements to be carried out in its presence. The measurements were performed in the factory of "Express Service" Ltd. - Ruse on a wheel axle lathe "HEGENSCHEIDT" (Fig. 4.7).



Fig. 4.7. Photo from the wheel-set measurement on the wheel-set lathe with the control board and the display with the results.

The obtained computer results are shown on fig. 4.8.

The results from the measurement show that all the parameters of the wheel-set are within the admissible thresholds.

HEGENSCHEIDT - MFD

EXPRESS SERVICE OOD 101945

Идентиф.

Дата на обработка: 29.09.2021 11:22:59

Ю опер. 0
 Причина за обр. 123
 Свст.КМ Р-1595A
 Вид обработка DIN5573-E1425-140-1360
 Профил 1
 Ю колоос 1
 Вид колоос 2
 Ю талига 1
 Ю МПС 00348
 Локока PUA-B, 118-A 0
 Вид МПС KOLOOS

Преда.изм.

Разстояние	1360.54	mm		
Зрелост?	1418.75	mm		
Разлика в диамет.	0.51	mm		
Диаметър	920.46	mm	Диско	919.95 mm
Акс. биемо	0.29	mm		0.28 mm
Рад. биемо	0.12	mm		0.06 mm
Вис. реб.	27.53	mm		26.75 mm
Дебелина реб.	29.47	mm		28.44 mm
Напр.	7.31	mm		6.85 mm

Зад.ст.

Вариант	1			
Диаметър	0.00	mm		
Дебелина реб.	0.00	mm	Диско	0.00 mm

Доп.изм.

Разстояние	0.00	mm		
РБСР	0.00	mm		
Разлика в диамет.	0.00	mm		
Диаметър	0.00	mm	Диско	0.00 mm
Акс. биемо	0.00	mm		0.00 mm
Рад. биемо	0.00	mm		0.00 mm
Вис. реб.	0.00	mm		0.00 mm
Дебелина реб.	0.00	mm		0.00 mm
Напр.	0.00	mm		0.00 mm

Извършена
 из-необходимост
 1. Монт. Табелата 1

Fig. 4.8. Protocol of findings from the measurement of wheel-set № 00348 of wagon № 33537851174-5 on a wheel-set lathe HEGENSCHEIDT

33537851174-5

1. Измерение расстояний между внутренними плоскостями на башмаках.

№	Объект на измерение			
	1,2	3,4	5,6	7,8
1	1361,5	1360,6	1359,8	1360
2	1361,8	1360,9	1359,9	1352,3
3	1361,6	1360,7	1360	1359,3

2. Диаметр на колесных и вращающихся.

Измерено	Объект на измерение							
	1	2	3	4	5	6	7	8
Измерено	313,2	311,2	313,4	313,5	313,1	313,9	313,7	313,0

3. Реборды.

	Объект на измерение							
	1	2	3	4	5	6	7	8
Дебелота	29	29	29	29,5	30	29,5	30	30
Высота	27	29,2	29	27	29	29	29	29
Вертикально подрезание	6,5	7,5	2,5	6,5	3	7,5	8	8

4. Расстояние между рельсами сбоку и рельсы на пути (таблицы).

Измерено	Объект на измерение							
	1	2	3	4	5	6	7	8
Измерено	ТАБЛИЦА Ч. КОЛЕСАТА СЯ ВЪЗМОЖНОСТИ							

5. Направление расстояния между буксовыми подшипниками и осевые колеса.

Измерено	Объект на измерение							
	1	2	3	4	5	6	7	8
Измерено	ТАБЛИЦА Ч. КОЛЕСАТА СЯ ВЪЗМОЖНОСТИ							

(Измерения се отчитат, гледано чело средно между буксами по оси на колесата)

6. Направление расстояния между буксовыми лъци и осевые колеса.

Измерено	Объект на измерение							
	1	2	3	4	5	6	7	8
Измерено	ТАБЛИЦА Ч. КОЛЕСАТА СЯ ВЪЗМОЖНОСТИ							

7. Пуфт между подшипниками на таблицах и вращающихся.

Измерено	Объект на измерение			
	1,3	2,4	5,7	6,8
Измерено	ТАБЛИЦА Ч. КОЛЕСАТА СЯ ВЪЗМОЖНОСТИ			

8. Высота на буферах.

Измерено	Объект на измерение			
	I	II	III	IV
Измерено	ТАБЛИЦА Ч. КОЛЕСАТА СЯ ВЪЗМОЖНОСТИ			

9. Измерение электрического сопротивления на колесных и на подшипниках.

№	Объект на измерение			
	1,2	3,4	5,6	7,8
1				
2	ИЛИ ОТНОШЕНИЕ			
3				

(Измерения се между подшипниками на таблицах на двете колесни и на таблицах на колесни 0,01 мм. Измерения се с максимално напрежение 1,8 до 2 V и ток от 4 до 5 A. Измерения се извършват от специален по осигуряваща техника, и измеренията на колесни - от специален.)

8

33537851174-5

Fig. 4.9. Protocol of findings on the condition of wagon № 33537851174-5, sixth from the composition of the train, pg. 2

33511745

10. Определяне посукуването на рамата и талигите

11. Определяне посукуването на колата на вагона

12. Други *Също изнесена вложка на централен лагер сачкован*
сектор от нив на първа таруга по посока на външен
изнесена вложка на централен лагер на втора таруга по посока на външен
 (състояние на букси, еднотинност на ресори и пружини, лагери, осни възли, теглични и
 отблъзнати съоръжения, възвози)
 и намере на мянества мултан и корезия, както и концентричен марб
 на чет от таруга Р25 на централния лагер на първа таруга по посока
 на външен

(функционален вентил – тип вкл./изкл., теглови регулатор – вкл./изкл., калотки –
 липсващи; сработени)
 намере на концентричен марб на чет от таруга Р25 и мянества
 нгнлност по посока на лагера

(състояние на колоосите – окопани, напластени, термооцветяване – цял и др.)

13. Състояние и вид на товара при необходимост

(натоварен в тара, от кого е приет, разположение на товара –
 равномерно/неравномерно, укрепване и др.)

14. Заключение за техническото състояние на вагона

ПОСОБА ЗА ИСПОЛНЯВАНЕ

(описват се резултатите от измерванията, които не отговарят на техническите норми, и
 се сравняват с тези от нормативните документи)

(вписва се и какво е отклонението от тях)

Комисия:

1. *Горан* 2. *Горан* 3. *Горан* 4. *Горан* 5. *Горан*

1. *Горан* 2. *Горан* 3. *Горан* 4. *Горан* 5. *Горан*

Настоящият протокол се изготви в *8.62* екземпляра, от които *1* екземпляр се
 предава на *СВ-ВН ЗА ДОНКМН* и *БНК ЕД*

Fig. 4.10. Protocol of findings on the condition of wagon № 33537851174-5, sixth from the composition of the train, pg. 3

КОНСТАТИВЕН ПРОТОКОЛ
за техническото състояние на вагон

Днес 13.05.2014 г. 14 часа 00 минути, композиция в състав:

- Иван Екимович длъжност РК. ОТЗД. ВИСИМ - БЖК ЕОД
(специалист вагони - представител на превозвача на ПЖПС)
- Златко Милев длъжност РК. ОТЗД. БП - БЖК ЕОД
(специалист локомотиви - представител на ползвателя на ТПС)
- Емил Бачев длъжност РК. РЖ. Русе - УРВ.О. Горна
Драговица
(специалист по железопът)
- Веселин Гавров длъжност ЧМ. МЕХАНИК ИАПТ-ЖК - Горна
Драговица
- Константин Царев длъжност РК. СЕКТОР "КНДСК" - ЖК - Горна
Драговица

(на четвърта и пета позиция участват представители на железопътната инфраструктура, специалисти по управление на движението, контактна мрежа и осигурителна техника, когато имат отношение към случая)

се събра в Тягово-ремонтна станция на връзка със станция промишленост/инфраструктура
Горна Драговица от БЖК 30553

(вид на производството/инцидента, място, дата, час)

и констатира следното състояние на вагон №
335379630270 КВ 13062014/16/514

(вид, номер и собственост на вагона, талон - вид, дата и място на последната ревизия (ремонт))

1^{ва} ревизия - № 536188 от 06.2013 г.
2^{ра} ревизия - № 71307880 от 06.2013 г.
3^{та} ревизия - № 773711 от 06.2013 г.
4^{та} ревизия - № 5329375 от 06.2013 г.

СМЕНИЛ РАМА НА ПЪРВА ТАЛОНА
СМЕНИЛ БУФЕРИ СТРАНА ПЪРВА ТАЛОНА

Fig. 4.11. Protocol of findings on the condition of wagon № 33537963027-0, ninth from the composition of the train, pg. 1

1. Измерения расстояний между вертикальными плоскостями на буксах.

№	Объект на измерение			
	1,2	3,4	5,6	7,8
1	1353,3	1361,3	1360,2	1352,2
2	1360,5	1361	1360,2	1359
3	1360,5	1360,2	1352,3	1359

2. Диаметр колесных вращающихся в колесе на тырельке.

	Объект на измерение							
	1	2	3	4	5	6	7	8
измерения	827,3	829	826,7	826,7	826,9	821,8	823,4	825,7

3. Реберца.

	Объект на измерение							
	1	2	3	4	5	6	7	8
Добелна	29,5	29,7	29,5	26,5	27	30	30	31
Височна	28	29	28,5	29	29	29	28,5	28,5
Вертикално отклонение	91	6,5	9	6,5	7	9	8	8,5

4. Расстояние между рельсами слева и справа от центра (таблица).

	Объект на измерение							
	1	2	3	4	5	6	7	8
измерения					12	11	10	10

5. Поперечное расстояние между буксовыми осями и осями вагона.

		Объект на измерение							
		1	2	3	4	5	6	7	8
измерения	лево					20	10	20	10
	право					18	10	20	10

(измерения се вземат, първоначално средно между буксите по оста на вагона)

6. Надлъжно расстояние между буксовыми осями и осями вагона.

	Объект на измерение							
	1	2	3	4	5	6	7	8
измерения								

7. Буф между вагонными на тягача и вагона на вагона.

	Объект на измерение		
	1,3	2,4	5,7
измерения			0
			25

8. Височина на буферите.

	Объект на измерение			
	I	II	III	IV
измерения			1035	1060

9. Измерения электрического сопротивления на колесных и на подшипниках.

№	Объект на измерение			
	1,2	3,4	5,6	7,8
1				
2	ИВНА ОТХОДИЛИ			
3				

(Измерения се вземат по показанията на таблометра на двете вагона и по таблица на показанията 0,01 ом. Измерения се с максимално напрежение 1,8 до 2 V и ток от 4 до 5 A. Измеренията се вземат от специална по осигуряваща техника, и показанията на табло - от таблометра.)

8

Fig. 4.12. Protocol of findings on the condition of wagon № 33537963027-0, ninth from the composition of the train, pg. 2

3353 79630270

10. Опреждане посукването на рамата и теглиците

11. Опреждане посукването на воша на вагона

12. Други технически дефекти

 (състояние на букси, еластичност на ресори и пружини, лагеря, осни вилки, теглични и отбивачни съоръжения, колооси)
№ 2 - КФ 02 19

 (функционален вентил - тип вкл./изкл., теглови регулатор - вкл./изкл., калитки - липсващи; сработени)

 (състояние на колоосите - овизани, наплатени, термичноцветвяване - цвят и др.)

13. Съставки и вид на товара при необходимост

 (натоварен и гара, от кого е приет, разположение на товара - равномерно/неравномерно, укрепване и др.)

14. Заключение за техническото състояние на вагона
вагона е пригоден

 (описват се резултатите от измерванията, които не отговарят на техническите норми, и се сравняват с тези от нормативните документи)

 (вписва се и какво е отклонението от тях)

Комисия:
 1. [Signature] 2. [Signature] 3. [Signature] 4. [Signature] 5. [Signature]
В. Въртев М. Милев В. Въртев М. Милев В. Въртев

Настоящият протокол се изготвя в 2 екземпляра, от които 2 екземпляра са
 предадени на МР 1244 вв. РОНКВ и ЕНК ВД

Fig. 4.13. Protocol of findings on the condition of wagon № 33537963027-0, ninth from the composition of the train, pg. 3

4.1.3. Railway infrastructure manager.

To clarify the causes for the accident, it is necessary to make a full analysis of the technical condition of the rail track in the derailment area. The movement of the train was in a left curve, in an uphill inclination 2,3 %.

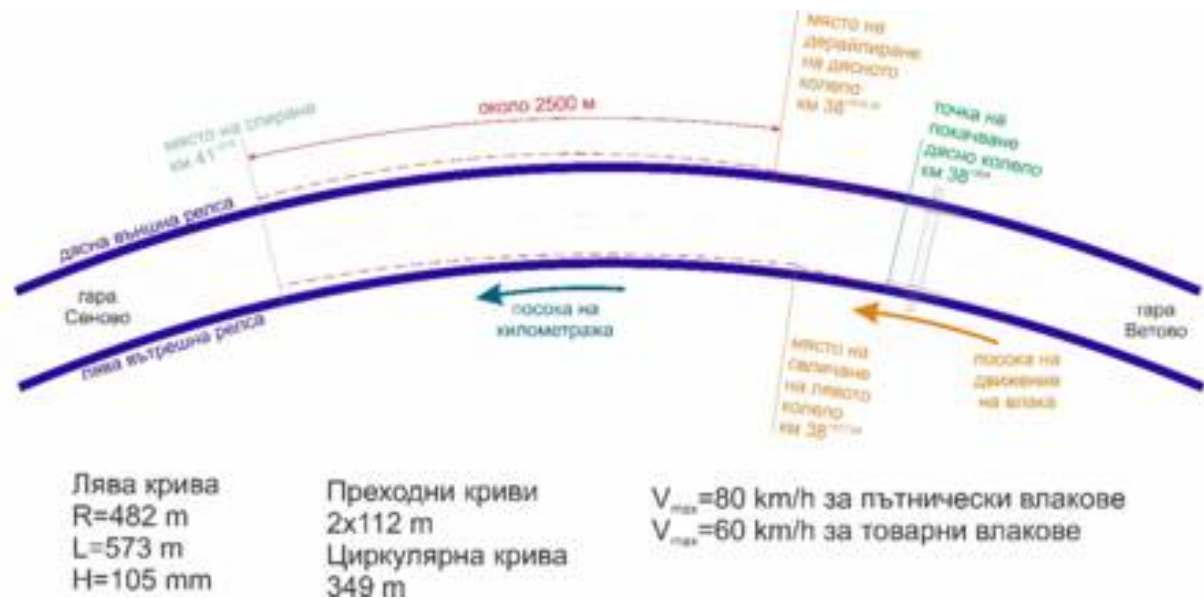


Fig. 4.14. Scheme of the derailment mechanism

4.1.3.1. Analysis on the rail track condition in and around the derailment area.

The accident occurred in a curve with radius of 482 meters. The rails are type 49 with a length of 25 meters, connected by steel connections on a pair of wooden sleepers in order to prevent vertical and horizontal divergence of the rails between them. In a unit with a length of 25 meters there are 40 concrete sleepers mixed type ST-6, ST-4T and ST-4 PAK68I and a double joint wooden sleeper, serving as a support in the joints. The fasteners are IC1 and elastic SKL-14.

While the train was moving in the Vetovo-Senovo interstation, the right wheel of the first wheel-set of wagon № 33537851174-5 - sixth in a row of the train, at km 38 + 504 rose on the head of the outer right rail, the flange was moving along the same for at 14.34 meters and slide on the outside of the right rail in the curve, which was left in the direction of train movement. At 13, 04 m from the zero point and 2.87 m from the approach in the track, the inner left wheel of the first wheel-set also collapsed. Subsequently, the second wheel-set from the first bogie derailed, leaving a clearly visible trace of about km 38 + 540. The next second bogie of the wagon, the following wagons and the pushing locomotive passed unimpeded through the place of derailment. The accident occurred in a left circular curve of the rail track in the direction of train movement. The normal cant height is $H = 105$ mm depending on the radius of the curve $R = 482$ m and speed for passenger trains $V = 80$ km/h for the interstation (Fig. 4.14).

The derailment was realized at km 38 + 504, which was in a zone with speed reduction, introduced from 15:00 on 8.04.2021 with $V = 25$ km/h from km 38 + 100 to km 38 + 900 with length 800 m after mechanized replacement of concrete sleepers. For the same reason, as of 15:40 on 15.04.2021, a second speed reduction of 25 km/h was introduced from km 37 + 800 to km 38 + 900 with a length of 1100 m. The reduction was signalled according to Article 390 of Ordinance № 58.

The latest measurement of the rail track was performed on 07.04.2021.

In order to clarify the circumstances and establish the causes that led to the accident, it is necessary to make a complete and in-depth analysis of the technical condition of the rail track.

In order to make a complete description of the rail track it is necessary to analyse all the parameters:

4.1.3.2. Analysis of the rail track under level

Transverse level of the rail track, measured 20 m before and after the point of ascent of the wheel (Fig. 4.15). The superelevation in the rail track curves depends on the radius of the same and the speed of the trains, and the higher (maximum) speed is taken for the movement. According to the Tables with technical parameters and norms, the maximum speed for the movement of passenger trains in the interstation Vetovo - Senovo is 80 km/h, for freight trains 60 km/h.

The superelevation specifically for the case is as follows:



Fig. 4.15. Condition of the rail track under level at the place of derailment, measured on the basis 10,70 m of the sixth wagon

$$H_{normal} = 8 \times \frac{v^2_{max}}{R} \text{ mm.}$$

$$H_H = 8 \times \frac{80^2}{482} = \frac{8 \times 6400}{482} = \frac{51\,200}{482} = 105 \text{ mm.}$$

Minimum acceptable superelevation:

Having superelevation of 105 mm (normal) the lateral acceleration is as follows:

$$p = \frac{v^2}{13R} - \frac{H}{153} = \frac{80^2}{13 \times 482} - \frac{105}{153} = \frac{6400}{6266} - \frac{105}{153} = 1,02 - 0,70 = 0,32 \text{ m/s}^2$$

Having implemented speed reduction $V=25$ km/h is obtained the following:

$$p = \frac{v^2}{13R} - \frac{105}{153} = \frac{25^2}{13 \times 482} - \frac{105}{153} = \frac{625}{6266} - \frac{105}{153} = 0,099 - 1,020 = -0,92 \frac{m}{s^2}$$

The ratio shows that there is a negative lateral acceleration at the introduced speed of 25 km/h, leading to overloading of the inner rail thread by the passing rolling stock. The Investigation Commission performed an analysis on the basis of the data from the Statement of Findings on the condition of the rail track, prepared by the Task Force on 23.04.2021 (Fig. 4. 16, a, b, c).

ФОРМ. 1.А.1.1.1.1
НА СЛУЖБЕНИМ ПОСРЕДСТВОМ РАБОТ

Датум: 23.04.2023 година и 17 часа и 50 минути, координате и угади:

1. мик. Греница Радикал Малинов - Радикалски район ГРКРС Рад при РП Седина Горна Одринска;

2. мик. Вод Малина Малина - Радикалски оград Белиштан на границата при „ГРК“ ЕАД;

3. мик. Дина Далина Корина - Белиштан Радикалски оград Рад при УДП Д Горна Одринска;

на сува, на м. 24-500 и междутарно Велко - Седина на 5-14 м. мик. при с. излизане на границата; Дароване на м. 36-5000 и междутарно Велко - Седина на м. 41-000 на 23.04.2023 година, в 17 часа и 50 минути

Известие оград и угади оград:

1. Известие оград на 20 м. при граница на границата

Таблица №1

Позиция на оград	Угади на оград	Дал. 1 (м.к.)	Дал. (м.к.)	Скрити променливи на Дина 1.8 м (м.к.)		Междутарно (м.к.) 1433 +	Фотос оград 200 (м.к.)	Известие на граница	
				Дал. р.	Дал. р.			вертикално	странично
1	2	1	4	2	2	7	8	0	18
Позиция на оград на граница	20		109			10	103	0	3
	10		111			12	100	0	8
	18		112			11	104	0	8
	17		112			14	103	0	4
	16		114			11	96	0	7
	17		118			11	95	0	5
	14	на оград	122			5	95	0	2
	13		127			4	88	0	0
	12		132			5	85	0	0
	11		134			5	80	0	0
	10		135			5	79	0	0
	9		132	10	0	5	79	0	0
	8		131			3	80	0	1
	7		130			3	83	0	0
	6		134			3	95	0	0
	5		135			5	100	0	0
	4		141			8	103	0	0
	3		140			5	104	0	0
2		147	18	12	5	108	0	0	
1		144			5	115	0	0	
Точка на оград	0		122	2	1	5	115	0	0

Fig. 4.16a. Protocol of Findings on the rail track condition,
pg. 1

2. Измерени параметри на 20 м. зона вколка на правоъгълността

Таблица №2

Посока на движението	Точки на измерване	Най. 1 (mm.)	Най. 2 (mm.)	Средна променливост на база (mm.)		Между-резили (mm) 1435+	Фини-корект 20m (mm)	Наклонове на релсите	
				Лева р.	Дясна р.			вертикални	скривни
1	2	3	4	5	6	7	8	9	10
Посока на движението на държавния жп	-1		125			5	112	0	0
	-2		126			5	114	0	0
	-3		124			3	114	0	0
	-4		122			4	118	0	0
	-5		118			3	113	0	0
	-6		112			5	110	0	0
	-7		108			6	109	0	0
	-8		105			3	113	0	0
	-9		102			5	117	0	0
	-10		97			5	117	0	0
	-11	настан	91			10	124	0	2
	-12	с тълб 75	95			10	123	0	2
	-13		100			12	120	0	5
	-14		103			12	116	0	7
	-15		108			12	119	0	4
	-16		109			8	115	0	4
	-17		111			10	115	0	4
	-18		112			13	115	0	4
	-19		114			11	110	0	4
	-20		115			13	107	0	5

Забелжка 1: В колона 3 на таблица № 2 се отразява изтоковното или съпадащото на началния настан, върха на знака, върха на сърието и крайния настан от най-близката точка до която се измерват или с която съвпадат.

3. При невъзможност да се определи точно място на точката на измерване се отразяват особеността на фиксирането (ограждането) и.

4. Констатиран други особености в зоната на непропорционалността.

4.1 Вид и състояние на пътя: **настанов, нострири**

4.1.1. Релси: ност **E 1 49**

4.1.2. Гриверси: **CT 6, CT 4T и CT 4 BAKGS II**

4.1.3. Средления: **K 1, SKL**

4.2. Геометрия на железния път: **Крива**

4.2.1. Прав участък

4.2.2. Крива с R = 482 (м), H = (105), (м)

4.2.3. Преходна крива: L_{ad} = 112 (м), 112 (м)

4.3. Профил на пътя: **сплесн (двиннени в посока)**

4.3.1. Наклонение: **-2,3 ‰**

Fig. 4.16b Protocol of Findings on the rail track condition, pg. 2

4.3.2. Надвишение -
4.3.3. Хоризонтал -
4.4. Ситуация на железния път:
4.4.1. Изход -
4.4.2. Насити -
4.4.3. Съсесен - Мост, надлез, водосток:
- $L_{10} = \dots\dots\dots$ (м);
- отстояние $L_{10} = \dots\dots\dots$ (м) от началото на моста (по посока на движението) до т. В.
- особености:
4.4.5. Тунел:
- $L_{10} = \dots\dots\dots$ (м);
- отстояние $L_{10} = \dots\dots\dots$ (м) от началото на тунела (по посока на движението) до т. В.
- особености:
4.4.6. Прелез, полевата пътека:
- състояние на прелезната част:
- широчина на жлеба мм, дълбочина на жлеба мм.
4.5. Загуба на устойчивост и изменение на геометричните параметри на железния път -
стандартно пропъждане, изгърбване и др.
4.5.1. Вид
4.5.2. Температура на релсите $t = \dots\dots\dots$ °C на местопроизшествието, измерена
в часа и минути на датата на произшествието;
4.5.3. Измерена температура на релсите $t = \dots\dots\dots$ °C, взета от най-близкото място на замерване
..... по часове;
4.5.4. Десетте температури на релсите за пет дни преди произшествието, взети от най-близкото
место, в което се прави такова замерване:
 $t_{1,10} = \dots\dots\dots$ °C; $t_{1,10} = \dots\dots\dots$ °C;
 $t_{2,10} = \dots\dots\dots$ °C; $t_{2,10} = \dots\dots\dots$ °C;
 $t_{3,10} = \dots\dots\dots$ °C; $t_{3,10} = \dots\dots\dots$ °C;
 $t_{4,10} = \dots\dots\dots$ °C; $t_{4,10} = \dots\dots\dots$ °C;
 $t_{5,10} = \dots\dots\dots$ °C; $t_{5,10} = \dots\dots\dots$ °C;
4.5.5. Неутрална температура на участък $t = \dots\dots\dots$ °C, в дата
4.5.6. Температура при която е извършен последен ремонт на БРП - $t = \dots\dots\dots$ °C и
дата
5. Стрелка:
5.1. Измерени параметри и състояние на стрелковите части по които се е движил возилото преди
и при дерайлирането:
5.2. Стрелковни траверси:
5.3. Стрелкови скрепления:
5.4. Начин на задвижване на езичите:
5.5. Описание, измерени параметри и състояние на заключването на езичите - липсващи елементи,
повреди, степен на износване, уплътняване:
тип
5.6. Параметри на железния път пред и след железопътната стрелка.
1. Наличие на прав елемент (колово) пред езиковата част на стрелката
2. Дължина на правия елемент $L = \dots\dots\dots$ (м);
Забелжка: При необходимост се измерват и други параметри на стрелките съгласно "Норми и
изисквания за железопътни стрелки тип 49 и по-големи" от 1981 г. и "Норми и изисквания за железопътни
760 мм. железопътни стрелки" от 1983 г. одобрени от Министъра на
транспорта:
II. Констатирани други особености на железния път и съоръженията:
Щети по железния път: на км. 38+518 (на 14-тия метър от точката на възкачане) съществени
стоманобетонни траверси от км. 38+518 до км. 41+000.

Fig. 4.16c. Protocol of Findings on the rail track condition, pg. 3

From the analysis of the transverse level at the point before the wheel rises, it is evident that there are large differences in values, reaching from 123 mm at the zero point to a value of 136 mm in item 9, including hidden dips. At a normal cant of 105 mm for speeds up to 60 km/h, the level in the circular curve may vary within ± 15 mm in a tolerance of 90 mm to 120 mm, provided that there

are no tolerances greater than those specified in Table 3.8. of the "Instruction for current maintenance of the rail track and railway switches". In this direction, there are no unacceptable inclinations of the wheelbase transitions in bogies and central bolts. There is a deviation and exceeding of ± 15 mm for the given cant of 105 mm in the curve for $V_{\max} = 60$ km/h. At the set speed (60 km/h) the maximum cant must be in the range of 90 to 120 mm, and the measured maximum cant is 136 mm, exceeding the values specified in Ordinance № 58. This is shown in Chart № 1 of figure 4.17, where there are increased values and compared to the average cant in 21 pcs. points before the rise point "0". For the deteriorated condition of the rail track in the area of the first reduction there is a signal from the locomotive crew of a passenger train № 90101 on 22.04.2021, an inspection and work was performed on the rail track, but not in the area of ascent and derailment of the wagon wheel, and about km 36 + 300, 35 + 800, 38 + 500, 38 + 800. On the same date, the traffic manager on-duty at Senovo station stopped a freight train № 90590 and handed over to the locomotive driver Order no II-A № 38 at 10:09 a.m. for passing with speed of 25 km/h, with higher attention and readiness to stop due to the rail track failures from km 38+400 to km 37+800 (fig. 4.17).

The engine driver of the train informed the train dispatcher that between the warning signal and the entrance signal at Vetovo station noticed broken joint connections, and 2-3 failed (dropped)

The document is a technical order (Заповедь) for railway maintenance. It contains the following details:

- Title:** ЗАПОВЕДЬ
- Order Number:** 38
- Train Number:** 90590
- Date:** 22.04.2021
- Time:** 10:09
- Location:** Vetovo station
- Table:** A table with 4 columns and 5 rows. The first column contains checkboxes. The second column contains handwritten numbers (1, 2, 3, 4, 5). The third column contains handwritten text (e.g., "не обнаружено", "не обнаружено"). The fourth column contains handwritten text (e.g., "не обнаружено", "не обнаружено").
- Signatures:** There are two signatures at the bottom of the document.
- Stamp:** A blue rectangular stamp with the text "ВЕРНО С ОРИГИНАЛОМ" (Correct with original).
- Seal:** A circular official seal of the railway authority.

Fig. 4.17

joints under level, which irregularities after the given signal were eliminated by hand tamping of the rail track.

According to the allegations of the transport safety auditor at RITS Gorna Oryahovitsa, responsible for the condition of the rail track, inspections were carried out from the cabin of a locomotive during the movement of a train. Specific inspections of the site during the repairs are not documented.

The transitions of superelevation based between the wheel-sets in the derailed bogie, and between the central bolts is as follows:

T. „0“ = 123 mm, corrected item 2 = 128 mm, corrected difference = 5 mm;

$$K = \frac{L}{H} = \frac{2000 \text{ mm}}{5 \text{ mm}} = 400; \text{ transition} = 1:400;$$

T. „0“ = 123 mm, corrected item 11 = 134 mm, Difference = 11 mm;

$$K = \frac{L}{H} = \frac{11 \text{ m}}{11 \text{ mm}} = \frac{11\,000 \text{ mm}}{11 \text{ mm}} = 1000; \text{ transition} = 1:1000;$$

From the calculations made for the inclination of the transitions, it can be concluded that they meet the regulatory requirements.

The data are registered in fig. 4.18, Chart № 1.

4.1.3.3. Analysis of the rail track under rail gauge.

Of the measured values of this parameter, registered in the statement of findings, the maximum is in points 17 and 18, respectively with track gauge 1449 (+14) and 1448 (+13 mm), which meets the regulatory requirements.

The data are registered in fig. 4.18, Chart № 2;

4.1.3.4. Analysis of the rail track in plan (under axis).

The position of the rail track in the plan is fixed with permanent benchmarks. In the absence of such, the position of the rail track in the plan is monitored and evaluated with alignment differences. For curves with $R > 300$ m, a chord = 20 m is used and measured ones every 10 m at the respective points. In this case, the measurement was performed every 1 m. The theoretical alignment is determined by the formula:

$$ft. = \frac{S^2}{8R} = \frac{20^2}{8 \times 482} = \frac{400 \times 1000}{3856} = \frac{400\,000 \text{ mm}}{3856} = 104 \text{ mm}.$$

The alignment difference at two adjacent points for the circular curve is determined by the formula:

$$\Delta f = |f_1 - f_2| - \text{in absolute value.}$$

In the diagram, the measured alignments in 1 m are equated in 10 m.

The largest alignment difference is 37 mm between point "0" and "10" with a limit of 48 mm for $V = 60$ km/h.

The measured values show that they meet the regulatory requirements.

The data are reflected in fig. 4.18, Chart № 3.

4.1.3.5. Analysis of the rail fatigue.

It is evident in the statement of findings that vertical operation of the rails is completely absent, while the maximum lateral in points 16 and 17 is respectively 5 and 4 mm with a permissible 13.5 mm according to the instructions.

The sleepers gird is made of mixed concrete sleepers ST-4; ST-6; ST-4T and mixed fastening IK1 and SKL = 14;

The rails are type 49 E1 with $L = 25$ m;

The data from the track measuring laboratory EM-120 are from 25.06.2020 and show that the rail track is within the norms.

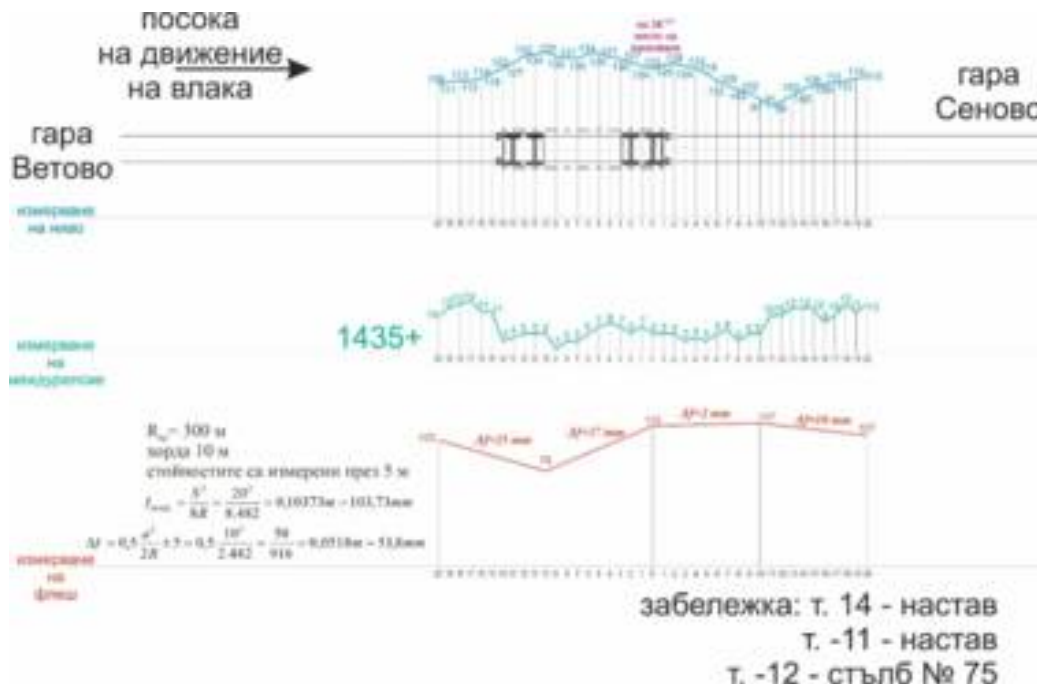


Fig. 4.18. Charts on the rail track condition in the accident area

4.1.4. Analysis of elements removed from the sixth wagon in "Traction" AD - Samuil

On 16.08.2021, the Chair of the Investigation Commission with the NAMRATIB provided 2 polyamide inserts removed from the central bearings of the derailed sixth wagon № 33537851174-5 of the Institute of Polymers at BAS and 1 new polyamide insert for a sample. The Institute prepared an expertise, including the chemical composition and strength characteristics of the inserts, which for this purpose prepared a Protocol of sample analysis.

Sample for analysis: Two polyamide inserts from central bearings of railway wagons

Sample type: New non used insert in white colour, and two strongly deformed, contaminated inserts in rusty-brown colour.



Fig. 4.19. Wag_new



Fig. 4.20. Wag_old (Center / melted)

Method of analysis: The analysis aims comparison of the content and the main physic-mechanical properties of new and old polyamide inserts removed from railway wagon.

From the tests were cut samples for subsequent analysis, as from the worn sample were removed samples of 2 areas, better kept (center of fig. 4.19. **Wag new**) and melted section (melted – on fig. 4.20 **Wag_old – Center / melted**), suffered evidently different loadings (marked in red).

Result from the analysis with infrared spectroscopy (fig. 4.21. a, b, c):

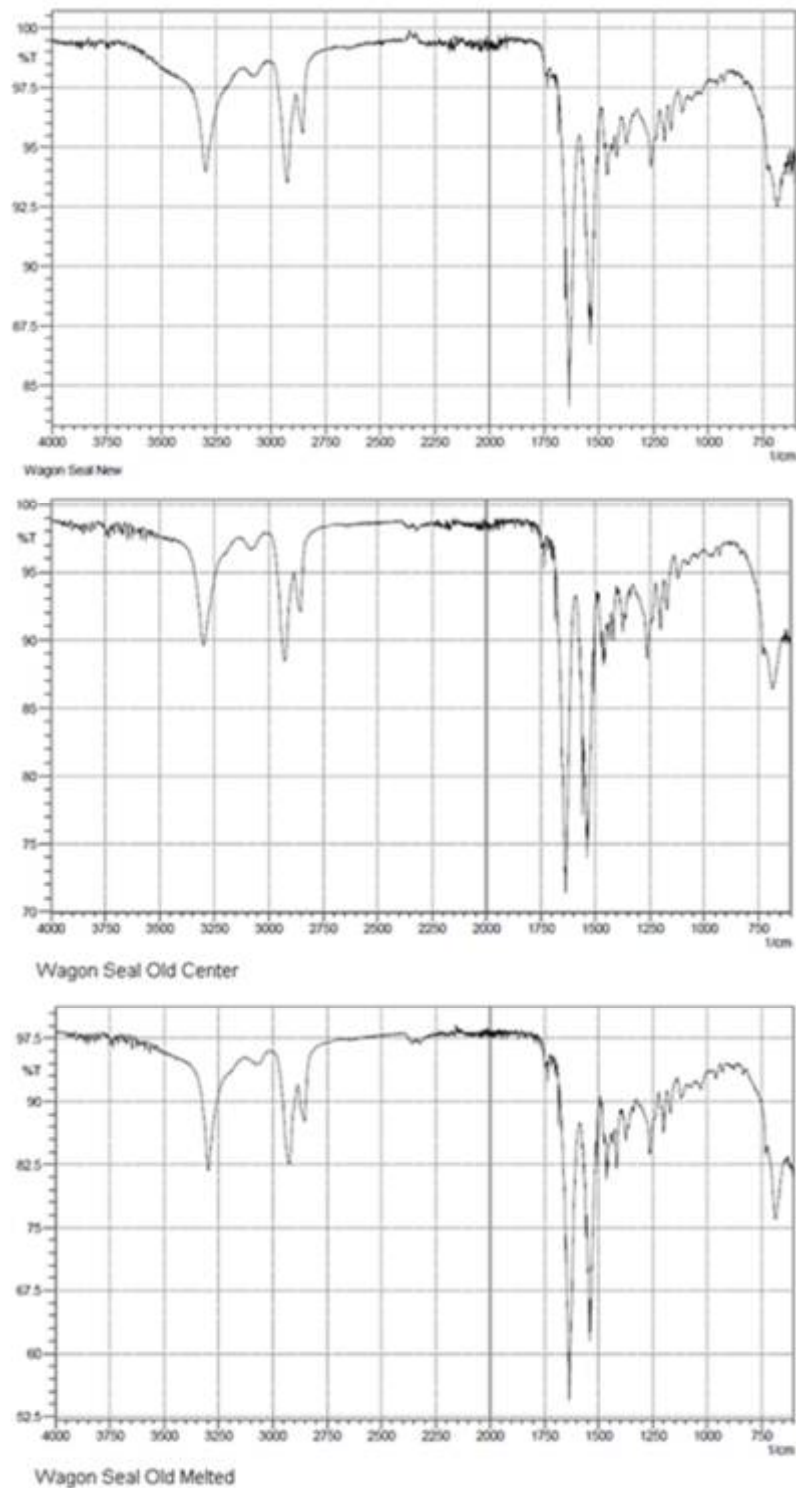


Fig. 4.21. a, b, c

In all three samples, the characteristic absorption polyamide-6 bands were observed at 1520, 1610, 2940 and 3300 cm^{-1} . No significant differences were observed in the spectra of the test samples.

Result of the analysis with thermo-gravimeter (Fig. 4.22. a, b, c):

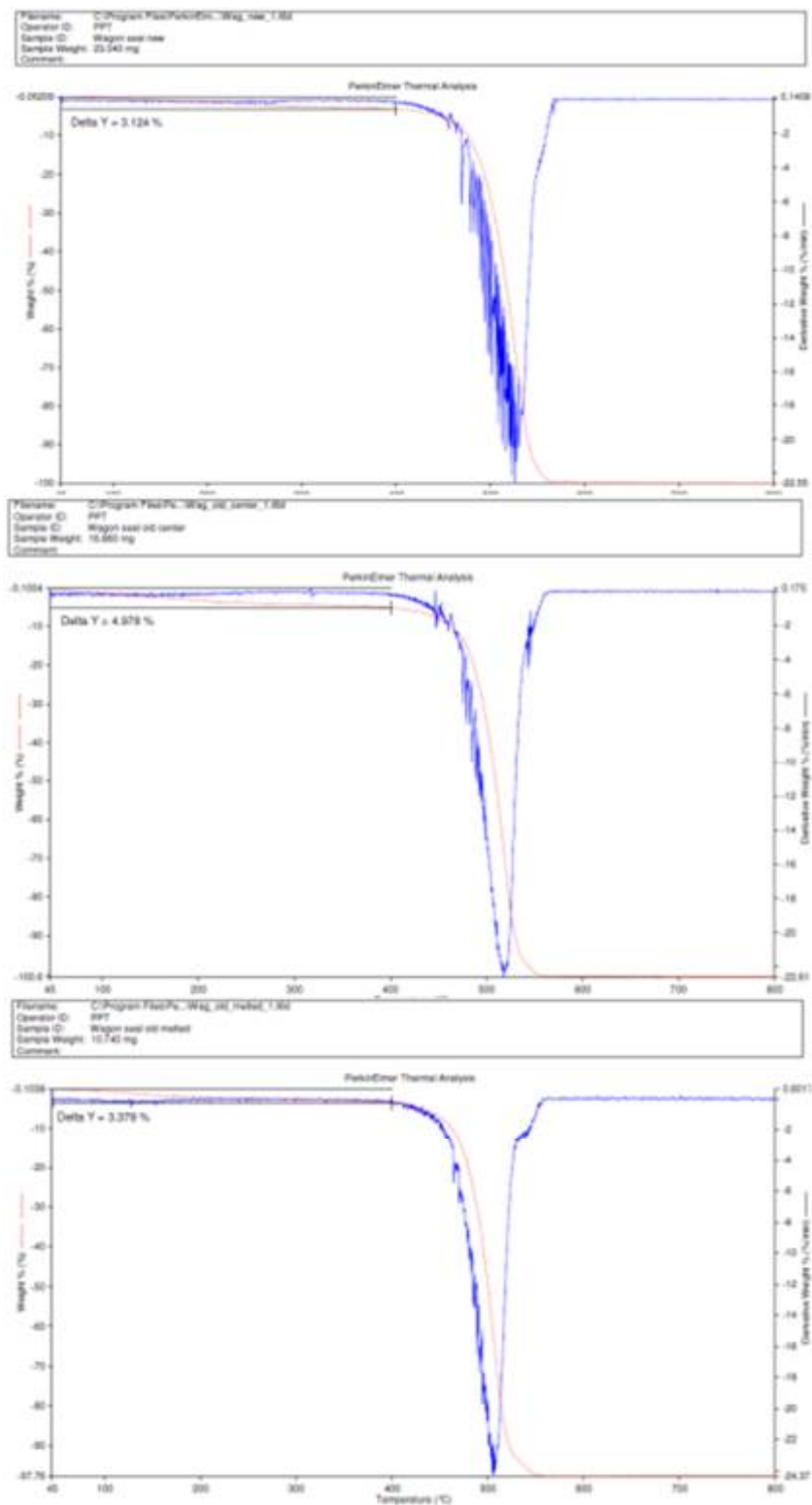


Fig. 4.22. a, b, c

In all three samples, a minimum mass loss of up to 400 °C was observed. The loss of about 3% in the range up to 200 °C in the **Wag_old samples** is due to the absorbed moisture. The polyamide decomposes in the range of 460 ÷ 580 oC, and the maximum rate of destruction is at 509 ÷ 529 oC. The lowest rate of destruction was observed in the submerged **Wag_old sample**. The presence of steel oxides (rust) in the same sample is probably the reason for the residual 2.34% of the mass of the sample.

Result of the analysis with differential scanning calorimeter (Fig. 4.23. a, b, c):

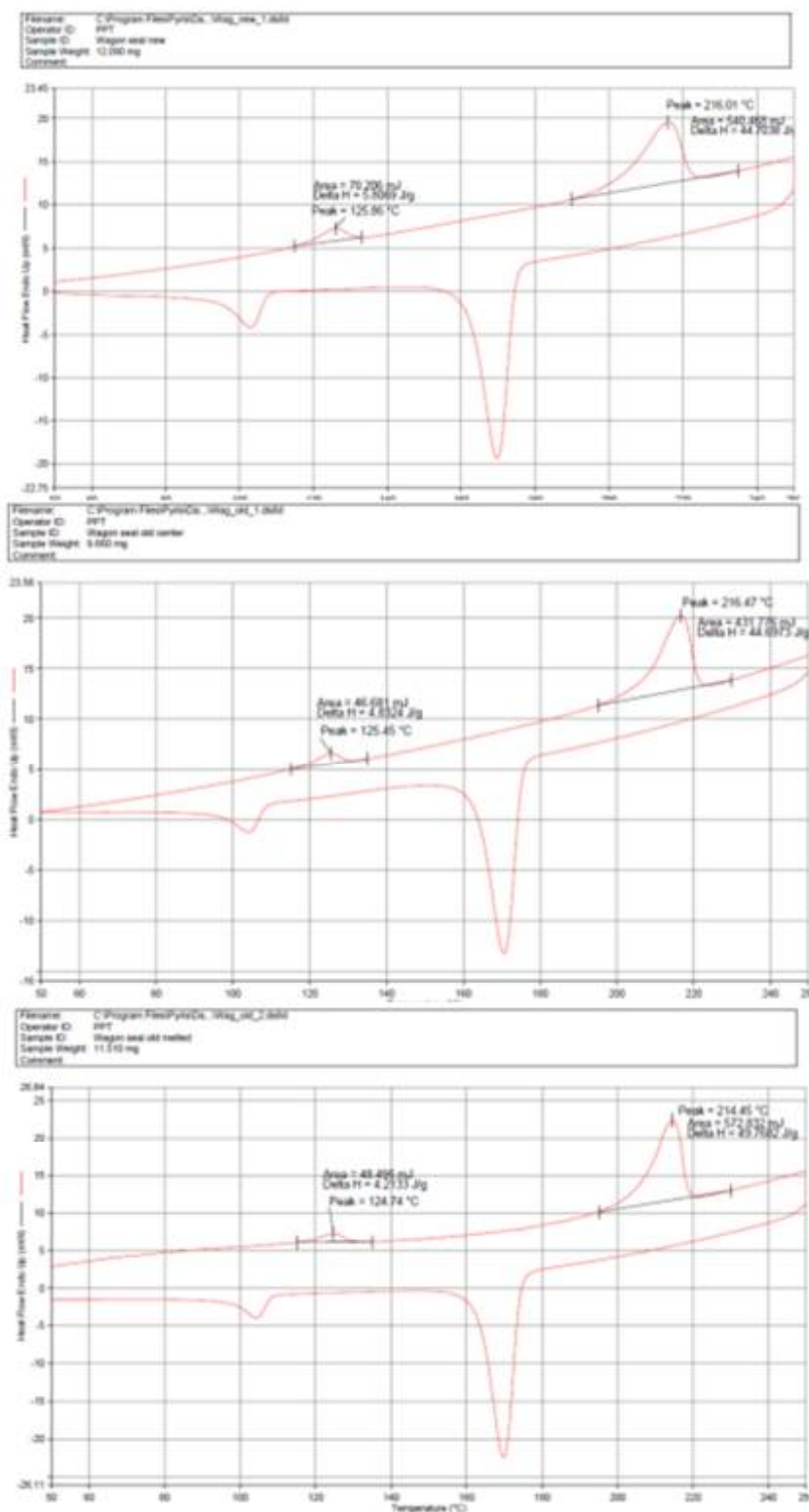


Fig. 4.23. a, b, c

All three samples are partially crystalline, with the crystalline phase melting in the range $192 \div 224$ ° C. The degree of crystallinity of Wag_new and Wag_old center is about 19.5%, and of the sample Wag_old melted is 21.7%. The difference is probably due to partial melting and subsequent recrystallization of the material. The melting peak at 125 ° C is not due to polyamide 6. It is possible to melt an added modifying agent (According to the TENMAT brochure, the product contains a friction-reducing modifying agent).

Result of Shore hardness analysis (T-1):

Table 1

SAMPLE	Hard 1	Hard 2	Hard 3	Hard 4	Hard aver
Wag_new	79	88	78	78	80.75
Wag_old center	69	71	69	71	70.00
Wag_old melted	58	56	55	61	57.50

4 measurements were performed on each sample and the average value was calculated. A decrease in the hardness of the material, which was subjected to mechanical overload for a short period, was found. The fusion sample has a significantly lower Shore hardness.

In conclusion, it can be said that both products are made of polyamide 6. The new and the old model, in its more preserved part, have identical physical and mechanical properties. A significant difference in properties is observed in the partially submerged area, showing that the insert has visibly undergone a large, asymmetric deformation, exceeding the conditions specified by the manufacturer in aggressive operation. In the process of operation with high loads and intensive friction for a short period (within minutes), a high temperature was reached at which the polyamide insert began to melt and deform.

In FIG. 4.24 and 4.25 show a certificate and a drawing of the central bolt insert of a wagon № 33537851174-5.



Фиг. 4.24. Сертификат на вложката.

Fig.4.24 Certificate of the insert

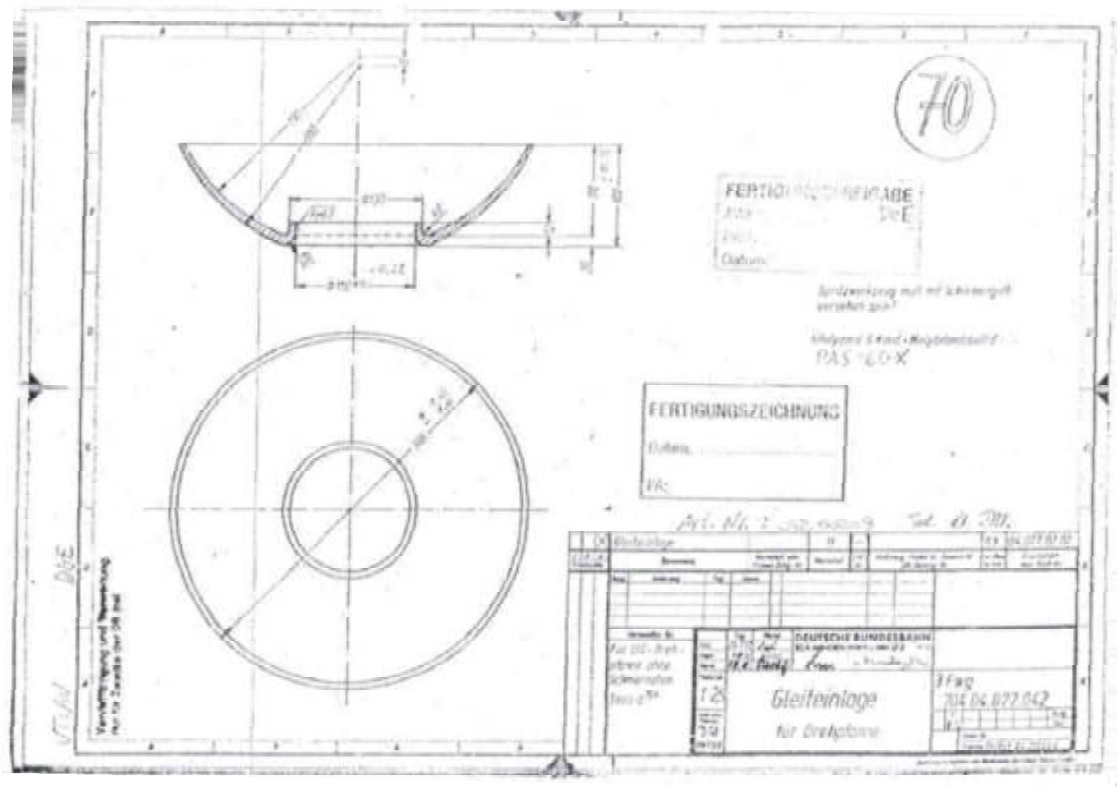


Fig. 4.25. Drawing of the insert.

4.1.5. Entities in charge of the technical maintenance.

Not applicable.

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

Not applicable.

4.1.7. National Safety Authority.

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

4.1.8. Notified bodies or Risk assessment bodies.

Not applicable.

4.1.9. 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.

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

Not applicable.

4.2. Rolling stock and technical facilities:

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

Not applicable.

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

Not applicable.

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

Not applicable.

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

Not applicable.

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

Not applicable.

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

4.2.7.1. Loading of the wagons.

After comparing the load of non-derailed tank cars in the composition of DFT № 90593 according to documents submitted by the sender FMV PETROM Bucharest - Petrobrazii from 19.04.2021 and after additional measurements of the weights of non-derailed tank cars at the request of the Railway Infrastructure Manager with a mobile scale of the company "Balance Systems" Ltd. on 29.04.2021 in Prostorno station and Vetovo station were found differences of 300 ÷ 600 kg, not exceeding the allowable axle loads of wagons for traffic on the national railway infrastructure. Therefore, the differences found by the Investigation Commission into the weights of some of the wagons are not a prerequisite/precaution for the train derailment.

4.3. Human factor:

4.3.2. Individual human characteristics:

4.3.2.1. Training and development, including skills and experience.

Railway undertaking:

- Locomotive driver first person of locomotive № 91530400605-8 – License № 1577 for obtaining professional qualification „Locomotive driver of electric locomotive series 42.000, 43.000, 44.000, 45.000 и 46.000“, training performed within the period 01.07.÷24.09.2004 issued by VTU „Todor Kableshev“;

License for locomotive driver №BG 71 2018 1665 issued by RA EA;

License № 558 for position „Locomotive driver“ at BRC EAD dated 08.11.2016.

Additional certificate issued on 13.03.2019 by BRC EAD, rolling stock, which is allowed the engine driver to drive – series 40.000 and 87.000 dated 13.03.2019 on the national railway infrastructure of the Republic of Bulgaria dated 13.03.2019.

- Locomotive driver second person of locomotive № 91530400605-8 – License № 1035 for obtaining professional qualification „Locomotive driver of electric locomotive series 46.000“,

training performed within the period 01.11.÷01.12.1999 issued by Professional Training Center (PTC) of Bulgarian State Railways (BDZ);

License for locomotive driver BG 71 2018 1741 issued by RA EA;

License № 521 for position „Locomotive driver“ at BRC EAD dated 03.09.2015.

Additional certificate issued on 14.03.2019 by BRC EAD, rolling stock, which is allowed the engine driver to drive – series 40.000, 87.000, 80/81.000 and 60.000 dated 14.03.2019 on the national railway infrastructure of the Republic of Bulgaria dated 14.03.2019.

- Locomotive driver of locomotive № 91520087020-1 - Diploma for semi-higher education № 23015 dated 20.08.1988 for educational qualification degree "Railway equipment - Electric locomotives" and professional qualification "Locomotive driver of electric locomotives", issued by VTU Todor Kableshkov;

License for locomotive driver BG 71 2018 1655 issued by RA EA;

License № 160 for position „Locomotive driver“ at BRC EAD dated 01.02.2008.

Additional certificate issued on 13.03.2019 by BRC EAD, rolling stock, which is allowed the engine driver to drive – series 40.000, 87.000, 80/81.000 and 60.000 dated 13.03.2019 on the national railway infrastructure of the Republic of Bulgaria dated 13.03.2019.

Railway infrastructure:

- Traffic manager in Vetovo station – Certificate of qualification № 15805 for „Traffic manager“, training performed within the period 13.05.÷07.10.2013 issued by the Professional Training Centre at NRIC;

Certificate № 3162 for position Traffic manager at TOSAD – Gorna Oryahovitsa dated 06.04.2016.

- Head of RTSM section Razgrad – Diploma of higher education № 046798, dated 30.06.2006 „Transport construction“, professional qualification „Civil Engineer“, issued by VTU „Todor Kableshkov“.

Certificate № 4211 for the position Head of section RTSM Railway section Gorna Oryahovitsa dated 16.08.2012.

- Technician head of group RLM Razgrad – Certificate of qualification № 16677 „Civil technician on maintenance and repair of railway lines and structures“, training performed within the period 24.03.÷17.07.2014 issued by the Professional Training Centre at NRIC;

Certificate № 418 for the position, „Technician head of group RLM“ in Gorna Oryahovitsa railway section dated 11.08.2021.

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

Railway undertaking:

- Locomotive driver first person of locomotive № 91530400605-8:

Single health information dossier № 1133 dated 14.12.2020, issued by the Transport Diagnostic and Consulting Center - Burgas.

Conclusion: suitable for locomotive driver.

Psychological examination № 1539/06.11.2017, issued by the Laboratory for Psychological Expertise at the National Multi-profile Transport Hospital Sofia for a locomotive driver - conclusion: allowed for a period of 5 years.

- Second-person locomotive driver of a locomotive № 91530400605-8:

Single Health Information Dossier № 109 of 02.02.2021, issued by the Transport Diagnostic and Consulting Center - Burgas.

Conclusion: suitable for locomotive driver.

Psychological examination № 923/23.07.2018, issued by the Laboratory for psychological expertise at the Multi-profile Transport Hospital Plovdiv for a locomotive driver - conclusion: allowed for a period of 3 years.

- Locomotive driver of a locomotive № 91520087020-1:

Card for preliminary medical examination issued on 26.10.2020 by the Transport Diagnostic and Consulting Center - Burgas.

Conclusion: suitable for locomotive driver.

Psychological examination № 817 / 14.09.2020, issued by the Laboratory for psychological expertise at the Multi-profile Transport Hospital Plovdiv for a locomotive driver - conclusion: allowed for a period of 3 years.

Railway infrastructure:

- Traffic manager at Vetovo station:

Card for mandatory periodic medical examination dated 20.10.2020, issued by the Department of Expert Advisory in Gorna Oryahovitsa, conclusion - valid.

Psychological examination № 401/14.04.2018, issued by psychological laboratory - railway transport Gorna Oryahovitsa for traffic manager.

Conclusion: allowed for a period of 5 years.

- Head of RTSM Razgrad section:

Card for periodic medical examination dated 29.06.2020, issued by the Department of Expert Consultative - Gorna Oryahovitsa, conclusion - valid.

- Technician head of RTSMR group:

Card for periodic medical examination from 21.06.2020, issued by the Department of Expert Consultative - Gorna Oryahovitsa, conclusion - valid.

4.3.2.3.Fatigue.

Railway undertaking:

- Locomotive driver first person of locomotive № 91530400605-8:

Rest/break: from 06:10 a.m. on 22.04.2021 to 14:00 p.m. on 22.04.2021 (7 hours and 50 minutes);

- Locomotive driver second person of locomotive № 91530400605-8:

Rest/break: from 06:10 a.m. on 22.04.2021 to 14:00 p.m. on 22.04.2021 (7 hours and 50 minutes);

- Locomotive driver of locomotive № 91520087020-1:

Rest/break: from 06:10 a.m. on 22.04.2021 to 14:00 p.m. on 22.04.2021. (7 hours and 50 minutes);

Railway infrastructure:

- Traffic manager Vetovo station:

Rest/break: from 19:00 p.m. on 21.04.2021 to 19:00 p.m. on 22.04.2021 (24 hours and 00 minutes);

- Head of RTSM Razgrad:

Full working time 40 hours a week.

- Technician head of group RLM:

Full working time 40 hours a week.

4.3.2.4.Motivation and attitudes.

Not applicable.

4.3.3. Work related factors:

4.3.3.1.Tasks planning.

BRC EAD performs rail freight transport under the Train Composition Plan, appointed in the Train Timetable and on additionally requested trains from the railway undertaking to the Railway Infrastructure Manager for development of schedules and their appointment for movement.

NRIC maintains, repairs and operates the railway infrastructure.

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

Not applicable.

4.3.3.3. Communication means.

Not applicable.

4.3.3.4. Practices and processes.

Not applicable.

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

Application of the national normative acts and internal standards.

4.3.3.6. Working time of the involved personnel.

Part of the staff involved in the accident of the two entities work in shifts, in which a summary calculation of working time in a 12-hour work shift and staff working a 40-hour working week are applied. The activity is performed in accordance with the requirements of the normative acts - Labour Code and Ordinance № 50 of 28.12.2001 for the working hours of the managerial and executive staff, engaged in providing the transportation of passengers and freights in the railway transport.

Risk treatment practices.

SE NRIC applies safety procedure SP 2.09 „Methods of evaluation, assessment and management of the risk „version 05 effective from 01.03.2019, which is part of the SMS.

BRC EAD applies the following procedures:

- SP 5.1.3 procedures for determining the level of risk;
- SP 5.2.3 procedure and method for determination level of risk in case of significant changes;
- SP 5.3.3 safety management procedure through a hazard register.

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

Not applicable.

4.3.4. Organizational factors and tasks:

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

In accordance with the requirements of the national normative acts, developed methodologies and good practices, the work and the workload of the personnel in operation are planned.

4.3.4.2. Communications, information and teamwork.

Not applicable.

4.3.4.3. Recruitment, staffing requirements, resources.

The staff in both entities are appointed with the relevant legal capacity, professional qualifications and skills of the respective positions.

4.3.4.4. Implementation management and supervision.

Not applicable.

4.3.4.5. Compensation (remuneration).

The staff involved in the accident by both entities have permanent employment contracts through which the remuneration for each position is determined.

4.3.4.6. Leadership, powers related issues.

Not applicable.

4.3.4.7. Organizational culture.

Not applicable.

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

The provisions of art. 89, para. 2, item 1 of Ordinance № 59 of 5.12.2006 on railway safety management are not met - The Task Force appointed by telegram № 1361/23.04.2021 of the Railway Infrastructure Manager has not coordinated the permit for restoration of the railway infrastructure before the Investigation Commission at the NAMRATIB has completed its work at the scene of the accident.

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.

4.3.5. Environmental factors:

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

Not applicable.

4.3.5.2. Meteorological and geographic conditions.

- In the dark part of the day – 00:40 a.m.;
- Air temperature +6°C;
- Speed and wind direction 3,6 km/h, SSE;
- Weather – cloudy, with normal visibility of the signals;

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

Not applicable.

4.3.6. Any other significant factor for the investigation objectives.

Not applicable.

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

4.4.2. 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;

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

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

4.4.3.1. Railway undertakings.

BRC EAD applies the following procedures:

- SP 5.1.3 procedures for determining the level of risk;
- SP 5.2.3 procedure and method for determination level of risk in case of significant changes;
- SP 5.3.3 safety management procedure through a hazard register.

4.4.3.2. Railway infrastructure.

SE NRIC applies safety procedure SP 2.09 „Methods of evaluation, assessment and management of the risk „version 05 effective from 01.03.2019, which is part of the SMS.

4.4.3.3. Entities in charge of the technical maintenance.

SE NRIC and BRC EAD are certified ECM.

SE NRIC applies safety procedure SP 2.09 „Methods of evaluation, assessment and management of the risk „version 05 effective from 01.03.2019, which is part of the SMS.

4.4.3.4. Manufacturers and all other participants.

Not applicable.

4.4.3.5. Reports on independent risk assessment.

There have not been performed an assessment by independent Assessment Body (AsBo) on changes/modifications performed in operational conditions and factors that refer to the occurred accident.

4.4.4. Safety Management System of the involved:

4.4.4.1. Railway Undertakings..

The latest annual planned supervision of the SMS of SE NRIC was performed in the period from 19.10.2020 to 30.10.2020.

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

Not applicable.

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

The results from the performed audits and inspections referring the functionality of the Safety Management System of SE NRIC and BRC EAD as per the requirements of Regulation (EU) 2018/761, Regulation (EU) No 1169/2010, Ordinance No 56 and Ordinance No 59 on respect of the specific requirements of the European legislation and national rules for design, maintenance and operation of the managed railway infrastructure demonstrate that the entities maintain SMS and are able to respect the requirements, envisaged in the respective normative documents.

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

4.4.7.1. Safety certificates of the involved railway infrastructure managers.

Safety Authorization No BG 21/2018/0001 valid from 01.07.2018 to 30.06.2023

4.4.7.2. Safety certificates of the involved railway undertakings.

BRC EAD

Safety Certificate part A BG 11 2018 0002, valid to 30.12.2023;

Safety Certificate part B BG 12 2018 0002, valid to 30.12.2023;

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

Not applicable.

4.4.7.4. Entities in charge of the technical maintenance.

BRC EAD has an ECM Certificate for railway vehicles BG/31/0020/0005 valid to 11.12.2025;

SE NRIC is in charge of the repair, maintenance and operation of the national railway infrastructure.

4.4.8. Other system factors.

Not applicable.

4.5. Previous similar cases.

A similar serious accident was investigated, subject to the Final Report of 29.09.2017 in a form appropriate to the type and severity of the accident, with relevant formulated safety recommendations - derailment of the fifth tank car, full, at the entrance in Hitrino station, around 05:37 a.m. on the turnout № 5 of the composition of DFT № 90570, moving in the direction Druzhba - Kaspichan - Ruse-north on 10.12.2016. The train was carrying dangerous goods in 23 tank cars filled with liquefied gas (propylene and propane-butane). The train was serviced by the railway undertaking Bulmarket Rail Cargo EOOD. As a result of the derailment of the 10th car, it broke through, the liquefied propylene gas leaked and a fire broke out, 7 people died, another 29 were seriously injured, all residents of the village of Hitrino, incl. and one shift employee at Hitrino station (switchman in post № 2), severe material damage was inflicted on the railway infrastructure, the rolling stock, the building stock near the railway infrastructure, as well as on the environment. The final report is available on the NAMRATIB website.

5. Conclusions

5.1. Summary of the analysis for the event causes.

The Investigation Commission visited the scene of the accident several times, got acquainted with the collected and provided documentation for the repair and maintenance of the rail track before the accident and with the construction technology and investor control for the repair of the rail track at the time of the accident.

The Investigation Commission also examined in detail the documentation provided on the technical condition of the five derailed tank cars №№ 33537965059-1, 33537851174-5, 33537963688-9, 33537963906-5, 33537963037-0 and in particular the sixth tank, the first derailed.

The Investigation Commission got acquainted with the situation on the spot, made several detailed and careful inspections of the rail track, the rolling stock, conducted an interview with the staff involved in the accident. It analysed in depth all the circumstances related to the derailment and made a summary of the accident.

The derailment occurred due to the deteriorated technical condition of the rail track, given the measured parameters after the accident. The poor strengthening of the rail track after the repair, combined with the high load voltage from the passing trains with low speed have caused unacceptable deviations in the level of the rail track above the maximum allowable values for a short period of time.

In the area of km 38 + 504 of derailment of the wagon were registered inadmissible deviations in the level of the rail track, which caused overloading of the inner left and unloading of the outer right wheel of the first wheel-set of the first bogie of the wagon, which led to its rise on the rail. The peripheral force caused the first wheel to move to the right and to derail. The left wheel slide off the left rail, and the right wheel after it slide off the right rail and the wheel-set started to move on the sleeper gird. After 35 meters, the second wheel-set of the first bogie derailed (evident from the traces left on the rail track). For about 2500 meters the wagon moved with a derailed first bogie. Due to the derailment of the sixth wagon, it laid to the right of the rail track and dragged the seventh, eighth and ninth behind, met the fifth car, as a result of which the main air duct disconnected and the train stopped.

5.2. Undertaken measures after the event occurrence.

The railway infrastructure manager undertook renewal of the damaged section of the rail track with a new one in the period 25.04. ÷ 01.05.2021. The renewal was carried out by the railway enterprise "Transport Construction and Rehabilitation" EAD.

The derailed wagons with № 33537965059-1 fifth and № 33537963027-0 ninth of the train were slightly damaged, removed in the wagon-building plant "Traction" AD - Samuil, and then sent to the owner in Romania. The remaining derailed wagons 6th, 7th and 8th had severe damage and deformation, for these reasons the tanks were loaded on cars and transported back, and their running gear (bogies and wheel-set of wagon) transported to Traction AD - Samuil.

5.3. Additional findings.

The Investigation Commission ordered, in its presence, new precise measurements of the first wheel-set of the first bogie of wagon № 33537851174-5. The measurements were performed in the factory "Express Service" Ltd. - Ruse on wheel-set lathe "HEGENSCHEIDT"

The obtained computer results from the printout of the lathe showed that all parameters of the wheel-set were within the permissible thresholds.

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 the following safety recommendations adapted to SE NRIC and BRC EAD.

- Recommendation 1 proposes that SE NRIC and BRC EAD acquaint the interested staff with the content of this report.
- Recommendation 2 proposes SE NRIC to comply with the requirements set out in Art. 89 of Ordinance № 59 on the activities related to the reconstruction of the railway infrastructure.
- Recommendation 3 proposes that SE NRIC increases the control during and until the completion of the repairs of the railway infrastructure by assignment (with an external contractor) and in an economic way and the inspection “Transport safety” (including the regional inspections) to carry out inspections on the spot for observance of the norms for bringing the parameters of the rail track in compliance with the norms.
- Recommendation 4 proposes SE NRIC to develop and approve uniform technologies for repair and maintenance of the rail track regarding the types of performed repair activities

With reference to the requirements of art. 91, paragraph 3 and art. 94 par. 1 and par. 4 of Ordinance No 59 dated 5.12.2006, the NAMRTAIB Investigation Commission provides a final report, which contains information from the conducted investigation with recommendations for improving the safety in railway transport

The NAMRTAIB Commission proposes a final report with safety recommendations dated 01.10.2021.

Chair:

Dr. Eng. Boycho Skrobanski

Deputy President of the NAMRTAIB AB

I, the undersigned Giulietta Marinova Marinova-Popova in my capacity of official translator, hereby certify that this is a true and complete translation from Bulgarian into English of the attached official document. The translation consists of 61 (sixty-one) pages.

Translator: Giulietta Marinova-Popova